U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-483/OLS-85-01

Docket No. 50-483 License No. NPF-30

Licensee: Union Electric Company

Facility Name: Callaway

Examination Administered At: Callaway

Examination Conducted: December 17, 18 and 19, 1985

Examiner: R. L. Higgins 1/3/86
Date

T. M. Burdick 1/3/86
Date

Approved By: D. I. McMillen, Chief 1/3/86
Operator Licensing Section Date

Examination Summary

Examination administered on December 17, 18 and 19, 1985
(Report No. 50-483/OLS-85-01)
Administered to six instant senior reactor operator candidates and one reactor operator candidate.
Results: The six senior reactor operator candidates passed and the reactor operator candidate failed.

8601090209 860103
PDR ADOCK 05000483
Q PDR

REPORT DETAILS

1. Examiners

*R. L. Higgins
T. M. Burdick

*Chief Examiner

2. Examination Review Meeting

An examination review meeting is no longer conducted. Specific facility comments concerning the Reactor Operator examination, followed by the NRC response, are included in the following paragraphs.

Question 2.08 Facility Comment:

The PDP has a variable capacity and at its minimum speed pumps 47 gpm. T61.06.11 S-11 CVCS Lesson Plan Page 13, Item 6.

NRC Response: Agree. The answer key was modified to award full credit for the response "PDP".

Question 2.11 Facility Comment:

The question is confusing because it implies a fault existed on the sequencer when no fault did exist. Condition only lasts 10 seconds.

NRC Response: Disagree. The scenario was based on an actual event. Sufficient information was given to determine the probable cause.

Question 3.07 Facility Comment:

At Callaway, the circ pump runback reduces unit load to 75%. OTN-DA-00001 Precaution and Limitation 2.4.

NRC Response: Agree. The answer key was changed.

Question 3.12.a Facility Comment:

In addition to the key's answer, we use the trip bypass switches for testability at Callaway. See ISF-SE-0JN31 and 32 and ISF-SE-00N34 and 35.

NRC Response: Agree. The answer key was modified to also grant full credit for the response "allow instrument testing."

Question 4.04.b Facility Comment:

In addition, the BOP RO also opens DC control power breaker to NB02 Bus. OTO-ZZ-00001 attachment 2, page 2 of 2, step 1.7.3.

NRC Response: Agree. The answer key was modified to also award full credit for the response "Opens DC control power breaker to Bus NB02."

Specific facility comments concerning the Senior Reactor Operator examination, followed by the NRC response, are included in the following paragraphs.

Question 5.13 Facility Comment:

The rods inserted in the core alter the flux profile causing more power to be produced near the edge of the core, thus increasing "Buckling." Large Pressurized Water Core Control Pages 3-23 and 3-24.

NRC Response: Agree. The answer key was modified to award full credit for the response "Increases Buckling."

Question 6.02. Facility Comment:

The purpose of the relationship between SR NIS and CCP suction valves is to protect against inadvertent dilution accidents while shutdown. Technical Specification 3/4 Page 3-2 and 3/4 Page 3-5.

NRC Response: Agree. The answer key was modified to also award full credit for the response "protect against inadvertent dilution accidents while shutdown."

Question 6.06 Facility Comment:

In addition to the key, "INPO Significant Operating Experience Report 82-3" should be added.

NRC Response: Since the examiner did not have a copy of "INPO Significant Operating Experience Report 82-3," additional facility explanation was needed. The additional explanation received was "overpressurization of AFW suction piping." The answer key was modified to also award full credit for the response "overpressurization of AFW suction piping."

Question 6.10 Facility Comment:

There is a fifth type of detector used at Callaway. T66.06.09F Fire Protection Lesson Plan, Pages 2, 3 and 4.

NRC Response: Required additional information, since the examiner did not have the reference. The additional information supplied by the facility was that the fifth type of detector was a Thermal type, which alarmed when a preset temperature was reached. The answer key was modified to accept this response as correct. The facility should update the lesson plan used for license operator training of fire detection instrumentation to reflect this additional type of detector.

Question 6.17. Facility Comment:

Reference detector numbers with noun names. T61.06.11 Process and Area Radiation Lesson Plan, page 7.

NRC Response: Agree. If the examinee referred to a radiation detector by its number, rather than its name, the examinee was awarded full credit. The answer key was modified accordingly.

Question 8.16 Facility Comment:

In addition to the key answer, ODP-ZZ-00002, Definition 2.2, offers additional information.

NRC Response: Agree. The answer key was modified to also award credit for the following responses:

1. Systems covered by the supplemental QA program for fire protection,
2. Systems covered by the supplemental QA program for seismic Class II/I,
3. Systems covered by the supplemental QA program, Group D augmented.

Question 8.17 Facility Comment:

In addition, the purpose of local control is to allow a person, other than the regular operator, to operate the equipment for testing, etc. APA-ZZ-00310 Steps 2.1.3 and 3.5.2.1.

NRC Response: Agree. The answer key was modified to also award full credit for the response "allow a person other that the regular operator to operate the equipment for testing or maintenance."

3. Exit Meeting

A formal exit meeting was not conducted due to inclement weather. The following information was conveyed by the NRC examiners to Callaway Training Department personnel during the course of the examinations.

a. Facility representatives were informed that three SROs and one RO definitely passed the oral/simulator portion of the licensing exam, and three SROs were considered marginal.

b. The examination room is not very conducive to exam administration. Wind noise was very distracting, rest rooms are located outside in a "port-a-potty," ventilation is very poor, there is no pencil sharpener, there is no phone in close proximity to the room, and the temperature of the room is very hard to control.

c. The lesson plans are not nearly detailed enough for exam preparation. Detailed system descriptions should be provided to the examiners prior to preparing future examinations.

d. Much information was not included in the original packages of reference material and had to be specifically requested, such as the index for the piping and instrument diagrams, and the external radiation exposure limits.

e. Not all topics in the KSA catalog, NUREG 1122, are addressed in Callaway reference material. Callaway is encouraged to generate a plant-specific KSA catalog and ensure all topics mentioned are addressed in reference material.

f. An additional sign for the simulator's side door is needed to preclude instrument technicians from inadvertently entering the simulator during NRC exams.

g. The simulator has a number of problems in properly simulating certain events. Specific instances were pointed out to the simulator operators during the course of the simulator examinations.

h. The computer programs used by the operators to calculate certain parameters, such as the ECP and heat balance, are not user friendly. Several examinees had difficulty using the computers, but were reluctant to calculate the values by hand.

i. Several examinees ignored off-normal or improper meter readings, assuming they were the "usual abnormal indications." This habit is potentially troublesome, since it leads to operators ignoring indications. Several operators operated for their whole scenario with the turbine-driven AFW pump controller in the improper position, a Tech Spec violation, yet they took no action.

j. During an inadvertent SI on one train, both diesels start, but the ESW pumps on the other SI train do not get a start signal. If an inadvertent SI occurred with no ESW pumps running, one of the diesel generators could be destroyed. The ESW pump start logic should be modified to prevent that problem.

k. No procedures are written to address problems in cold shutdown. Operators have to improvise with very little procedural guidance.

l. Several examinees had difficulty using the large book of steam and compressed water tables.

m. Personnel were observed in the plant without safety shoes, and in high noise areas without wearing sound attenuation devices.

n. Callaway Plant personnel were very cooperative and accommodating. Simulator operators John Dampf, Sam Henderson, and Paul Moody, were especially helpful.

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: CALLAWAY

REACTOR TYPE: PWR-WEC4

DATE ADMINISTERED: 85/12/17

EXAMINER: BURDICK, T

APPLICANT: _____

INSTRUCTIONS TO APPLICANT:

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

CATEGORY VALUE	% OF TOTAL	APPLICANT'S SCORE	% OF CATEGORY VALUE	CATEGORY
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	100.00			TOTALS

FINAL GRADE _____%

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

_____
APPLICANT'S SIGNATURE

QUESTION 1.01 (2.00)

a. For an operator taking data for a 1/M plot, how will the Shutdown margin (SDM) affect the time elapsed before a stable count rate can be obtained after withdrawing rods ? (0.5)

b. How will the initial count rate affect the count rate at criticality ? (0.5)

c. If the speed of the control rods were to somehow increase,what would be the effect be on:

1. Rod height at criticality ? (0.5)

2. Count rate at criticality ? (0.5)

QUESTION 1.02 (1.50)

During natural circulation cooldown, you notice pressurizer level suddenly increase after the initiation of pressurizer spray. Explain what is occurring. (1.5)

QUESTION 1.03 (2.00)

a. Since fuel temperature cannot be measured, what power distribution limit is observed at Callaway to prevent exceeding the fuel temperature limit ? (0.5)

b. If fuel temperature limit is 4700 deg's and cladding limit is 2200 deg's., what limit must be observed to prevent exceeding the clad limit when fuel temperature is above 2200 deg's ? (0.5)

c. Why will the fuel rod surface temperature peak towards the top of the core rather than the location of peak actual heat flux ? (1.0)

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

QUESTION 1.04 (2.00)

a. How do each of the following parameters change (increase, decrease or no change) if one main steam isolation valve closes with the plant at 50% load. Assume all controls are in automatic that no trip occurs.

1. Affected loop steam generator level (INITIAL change only)
2. Affected loop steam generator pressure
3. Affected loop cold leg temperature
4. Unaffected loop steam generator level (INITIAL change only)
5. Unaffected loop steam generator pressure
6. Unaffected loop cold leg temperature (1.5)

b. Which of the reactor protection system signals could be expected to cause a reactor trip ? (If more than one, list the one that would reach the trip point first.) (0.5)

QUESTION 1.05 (1.50)

A. Explain the effect on Shutdown Margin of a 25 ppm boron addition while operating at 50% power and all control systems in automatic. (.75)

B. List three (3) factors, other than RCS boron concentration, which effect Shutdown Margin (SDM) and are used in the SDM calculation. (.75)

QUESTION 1.06 (2.00)

Will the Departure from Nuclear Boiling Ratio (DNBR) increase, decrease or remain the same if the following plant parameters increase during power operation? Consider each parameter independently.

A. Reactor Coolant System (RCS) Pressure.
B. RCS Temperature.
C. RCS Flow.
D. Reactor Power. [0.5 ea.] (2.0)

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

QUESTION 1.07 (2.50)

a. Name the two methods of Xenon production and removal.

b. Name the method of Samarium production and removal.

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.

QUESTION 1.08 (2.00)

a. Why does Power Defect increase over core life when Doppler decreases?

b. Which reactivity affect is dominant in Power Defect at BOL and EOL?

QUESTION 1.09 (2.00)

Using Figure 1-1 produce a graph on answer paper representing the approximation of differential rod worth versus rod height. Be sure to label the axis and assign values to the scales.

QUESTION 1.10 (2.50)

Part of the reactor thermal safety limit is based upon not allowing saturation conditions at the core hot leg. State the reasoning behind this basis.

QUESTION 1.11 (2.00)

The refueling load pattern is intended to achieve low neutron leakage.

a. Why are used fuel assemblies placed on the periphery of the core?

b. What two advantages does lower neutron leakage offer?

QUESTION 1.12 (1.50)

There are several mechanisms by which fuel clad could potentially fail during operations. Name three

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

QUESTION 1.13 (1.50)

Assume the Callaway reactor operates for one full cycle at 100% and rods full out. No rod motion other than for exercising is performed and no trips occur. How will the axial flux distribution behave over core life? Include reasons for its behavior.

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

QUESTION 2.01 (1.50)

This past year an operator, alerted by an urgent failure alarm on the rod control system, tripped the reactor manually. Apparently the 480 VAC power supply to the MG sets had been lost.

a. How are the MG sets designed to compensate for a momentary power interruption?

b. What kind of urgent failure was caused by the power failure?

c. What would have happened if the RO did not trip the reactor manually?

QUESTION 2.02 (1.50)

Earlier this year the reactor operator on duty was alerted to a turbine trip caused by a HI-HI MSR level.

a. Where does the moisture separator drain tank normally drain to?

b. Where does it alternately drain to?

c. Why is there a turbine trip associated with a high MSR level?

QUESTION 2.03 (2.00)

Under certain conditions following a turbine trip the 13.8 KV buses will fast transfer to the startup transformer.

a. What are the three conditions?

b. What will happen if these conditions are not met?

QUESTION 2.04 (1.50)

An RO accidentally closed a MFW isolation valve resulting in a reactor trip.

a. How does valve closure stroke time differ from this event and a FWIS actuation.

b. What automatic signals will cause a FWIS?

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

QUESTION 2.05 (2.00)

During a startup in February the RO was feeding the SG's manually while monitoring feed flow on a recorder. Due to faulty indication the operator overfed the steam generators resulting in a HI-HI level. Part of the cause attributed to this event was the fact that the auxiliary boiler was out of service. Explain this reasoning.

QUESTION 2.06 (2.00)

Callaway was on RHR at 180 degrees and 360 psig with one RCP running. The operators were restoring train A RHR from a pump operability test. Upon opening crossover valve 8716B the operator noticed B RHR flow go to zero and turned the B RHR pump off. 15 seconds later he noticed zero pressure in the RCS and turned the RCP off. It was later determined that no RHR reliefs had lifted and no leaks had occured. The problem was attributed to a valving sequence error in the test recovery procedure.

a. Why did opening 8716 B cause a loss of RHR flow?

b. Why did the RCS depressurize immediatly afterward?

c. What affect did the event have on the RCP that was in operation at the time?

QUESTION 2.07 (2.50)

a. State the normal status/position during standby for RHR:
   1. suction
   2. heat exchanger flow control valves
   3. CCW flow
   4. train crosstie isolation
   5. cold leg return

b. Which valves must be manually opened when initiating recirculation flow for post accident core cooling?

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

QUESTION 2.08 (1.50)

An RCS leak is defined as being within the capacity of the CVCS system.

a. Which CVCS pump has the lowest flow capacity?

b. Which ECCS pump has the highest flow capacity?

c. Which ECCS pump has the highest head capacity?

QUESTION 2.09 (1.50)

a. What two conditions will cause automatic diversion of flow around the letdown demineralizers?

b. What condition requires manual diversion of flow around the letdown demineralizers? [excluding failure of any automatic functions]

QUESTION 2.10 (1.50)

The AFW system check valves at some nuclear plants have failed to seat properly allowing main feed water to back flow through the AFW pumps.

a. How does this compromise the ability of AFW to function?

b. What kind of LOCA condition requires the AFW for core cooling?

QUESTION 2.11 (3.00)

The Callaway plant was operating at full power when a faulted startup transformer resulted in a plant trip. During the subsequent transient steam dump failed to reseat and an SI was initiated. While performing the immediate actions for RT/TT and SI the RO noted that 1A RHR pump had not started and manually started it. If 1B RHR started explain why 1A had not.

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

QUESTION 2.12 (2.00)

a. If the RCS is designed for 2485 psig then why is there a requirement for an overpressure protection system when the plant is at low temperature and pressure?

b. The pressurizer safeties are designed for a specific transient. Describe it.

QUESTION 2.13 (2.50)

a. Describe two possible flowpaths from the boric acid storage tanks to the charging pumps.

b. The reactor makeup water isolation valve [V-178] to the blending tee has an orficed bypass line around it. What is the purpose of this line? When is it used? Why is it necessary?

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

QUESTION 3.01 (3.00)

An operator at Callaway was inattentive to his instrumentation and allowed a TS violation of the axial flux limits to exist for an extensive period of time.

a. What two specific symptoms were present which identified the deviation?

b. What two specific improvements have been made to help operators be more attentive to axial flux?

QUESTION 3.02 (2.00)

The plant is being cooled down using the atmospheric steam dumps. Steam pressure is 700 psig. You proceed to cool down further.

a. What control is adjusted to produce further cooldown?

b. What precaution must be observed while adjusting the control?

c. Why is this precaution necessary?

QUESTION 3.03 (2.00)

The instrument technicians were performing a test on a SG pressure channel when the associated steam generator level dropped to the LO-LO setpoint and tripped the reactor. Why did testing a pressure channel have such an affect on level?

QUESTION 3.04 (2.50)

As the last of the four power range NI channels was being adjusted the levels in all four SG's began decreasing. In the effort to restore level the plant experienced a Turbine Trip and FWIS but the reactor did not trip.

a. Why would adjusting of the last power range channel cause SG levels to decrease?

b. What caused the TT and FWIS?

c. Why didn't the reactor trip?

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

QUESTION 3.05 (1.00)

List the four automatic start signals for Component Cooling Water Pumps.

QUESTION 3.06 (1.50)

List ALL automatic start signals for the motor driven and turbine driven AFW pumps.

QUESTION 3.07 (1.50)

Name ALL plant conditions that will override the turbine controls to either reduce or stop turbine loading.

QUESTION 3.08 (1.50)

Name all the switches/controls/components that are manually operated incidental to realigning a control rod.

QUESTION 3.09 (2.00)

a. What are the input signals for the RVLIS?

b. What is the low point tap for RVLIS and how does this relate to the vessel elevation?

QUESTION 3.10 (2.00)

Name the four types of leak detection used to monitor for RCS leakage and which are required to be operable by TS.

QUESTION 3.11 (2.00)

a. At what pressure is SI blocked during a controlled plant cooldown?

b. How does the operator know the block permissive is activated?

c. How does the operator block SI?

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

QUESTION 3.12 (2.00)

The source and intermediate range nuclear instrumentation have both trip bypass and trip block features.

a. Why are the trip bypass controls needed?

b. When do trip block features reset automatically?

QUESTION 3.13 (2.00)

a. Name the six effluent flowpaths that are monitored by the RMS which provide automatic flow isolation features.

b. What is the reason for heat tracing sample lines on some radiation monitoring channels?

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

QUESTION 4.01 (1.50)

Your crew is preparing food in the control room pantry which is causing spurious alarms on the fire detectioin system. What administrative requirements are necessary to silence this nuisance alarm?

QUESTION 4.02 (3.00)

As the RO in the CR during refueling operations you are alerted to an increasing containment instrument sump level.

a. What CR instrumentation is used to determine level in the refueling pool?

b. What component would be the highest possible source of radiation if the refueling pool were draining?

c. What are eight the immediate operator actions for a decreasing RP level?

QUESTION 4.03 (1.50)

As the RO, you are alerted to a loss of CCW flow and a decreasing surge tank level.

a. How much time do you have to restore CCW before a reactor trip must be initiated?

b. Why must the reactor be tripped within this time frame?

QUESTION 4.04 (2.50)

When a fire results in CR evacuation:

a. Why is the BOP RO directed to the turbine building elevation 2033?

b. He is also directed to the DC switchgear rooms. Why?

c. The RO is directed to NB02. What for?

d. When starting pumps locally how do you verify the pump is running?

e. Why should train B equipment be used for plant shutdown?

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

QUESTION 4.05 (1.50)

You have indication that instrument air pressure is dropping and is at 100 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?

b. What actions are you required to perform if plant parameters begin to deviate from their normal operating band?

QUESTION 4.06 (1.50)

The plant undergoes a turbine trip from 100% power and the RO notes that an automatic trip did not occur nor does it trip manually.

a. What procedures are referred to in this situation?

b. What is the next alternative following the failure of a manual reactor trip initiation?

QUESTION 4.07 (2.00)

Name five of the seven symptoms of a misaligned control rod per the procedure, OTO-SF-00004.

QUESTION 4.08 (2.00)

Name four symptoms for a failed number one RCP seal.

QUESTION 4.09 (.25)

a. Who controls the use of orange Hold Off Tags and white Hold Off Tags?

b. Where are tags hung for manual and motor operated valves?

c. Who can release a tagout?

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

QUESTION 4.10 (1.50)

a. How often must a radiation worker review the requirements for entry into the RCA?

b. How does the radiation worker document that review?

c. How often is the radiation worker required to document the review?

QUESTION 4.11 (1.75)

When relieving the off-going RO:

a. How far back are you required to review the RO logs?

b. What six additional actions must be performed to satisfy the turnover checklist?

QUESTION 4.12 (1.00)

Name two exceptions to the requirement for independent verification on safety related systems.

QUESTION 4.13 (2.00)

Assume it is 0300 on 12/10/85 and the reactor is presently at 45% power. Considering the Delta-I penalty history listed below, when will you be allowed to increase power above 50%?

DATE	TIME OUT	TIME IN	POWER(%)
12/09/85	0300	0318	85
12/09/85	1557	1633	65
12/10/85	0138	0300	45

QUESTION 4.14 (1.00)

A precaution in the Power Operation Procedure, OTG-ZZ-00004, states that on rapid load decrease, the control rods should be promptly returned half way back to their original position. State why this is necessary.

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

(********** END OF EXAMINATION **********)

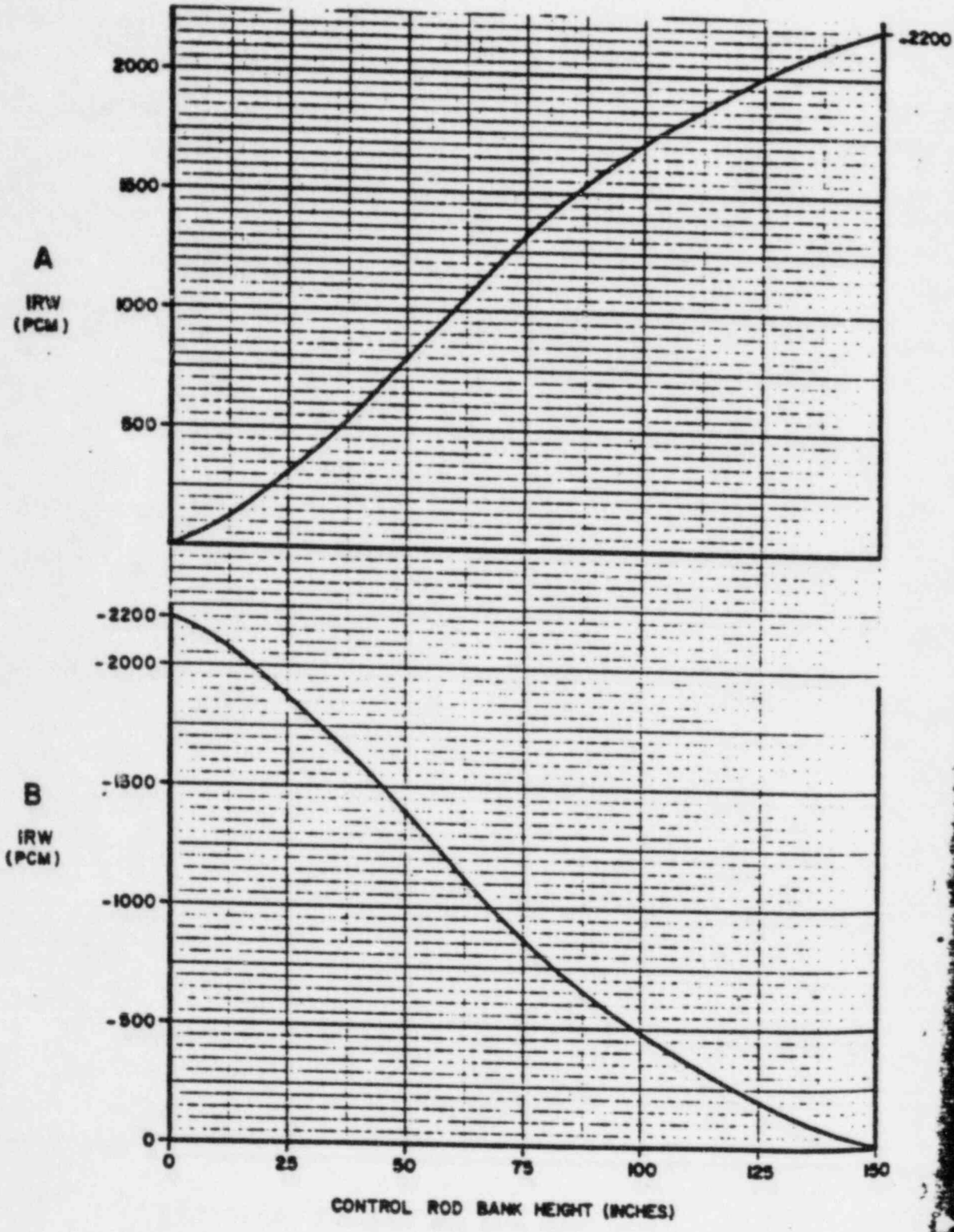


FIGURE 1-1 TYPICAL INTEGRAL ROD WORTH CURVES

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 1.01 (2.00)

a. The closer to criticality, (less SDM) the longer time required to reach a stable count rate. (0.5)

b. A higher initial count rate will result in a higher count rate at criticality. (0.5)

c. 1. Critical rod height is not affected. (0.5)

2. Critical count rate will be lower. (0.5)

REFERENCE
FUNDAMENTALS OF NUCLEAR REACTOR PHYSICS CHAPTER 8

ANSWER 1.02 (1.50)

a. Due to the decrease in pressurizer temperature/pressure [0.5] the system is voiding somewhere else [0.5] and forcing coolant into the pressurizer. [0.5] (1.5)

REFERENCE
THERMAL HYDRAULIC PRINCIPLES AND APPLICATION TO THE PWR II PAGE 14-11

ANSWER 1.03 (2.00)

a. Local power density-KW/FT. (0.5)

b. DNB or DNBR (accept either answer) OR "R" (0.5)

c. Fuel surface temperature is a function of heat flux and moderator temperature. [0.5] Moderature temperature is higher at the top of the core. [0.5] (1.0)

REFERENCE
THERMAL HYDRAULIC PRINCIPLES AND THE APPLICATION TO THE PWR II CHAPTER 13

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 1.04 (2.00)

a. 1. Decrease
2. Increase
3. Increase
4. Increase
5. Decrease
6. Decrease [0.25 each]

b. Lo-Lo S/G Level [.5]

REFERENCE
THERMAL HYDRAULIC PRINCIPLES AND APPLICATION TO THE PWR CHAPTER 12

ANSWER 1.05 (1.50)

A. SDM is increased [.25], with power remaining constant, rod position will be higher (and boron concentration will increase) [0.5]. (Since SDM is the instantaneous amount of reactivity by which the reactor is, or would be subcritical from its present condition.) (.75)

B. 1. Control rod position.
2. RCS average temperature.
3. Fuel burnup.
4. Xenon concentration. (Time since shutdown.)
5. Power level.
6. Samarium [3 @ .25 each]

REFERENCE
REACTOR CONTROL FOR LARGE PWR'S CHAPTER 7-13

ANSWER 1.06 (2.00)

A. Increase.
B. Decrease.
C. Increase.
D. Decrease. [0.5 ea.] (2.0)

REFERENCE
THERMAL HYDRAULIC PRINCIPLES AND APPLICATION TO THE PWR CHAPTER 13-41

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 1.07 (2.50)

a. Xenon is produced by fission [.25] and Iodine decay [.25]
Xenon is removed by neutron absorption [.25] and decay [.25]

b. Samarium is produced by Promethium decay [.25] and removed by neutron capture [.25]

c. Xenon will peak [.25] and then decrease to a new equilibrium below the initial value [.25]

Samarium will peak [.25] and then return to the initial value [.25]

REFERENCE
REACTOR CORE CONTROL FOR LARGE PWR'S CHAP 4, PAGE 3

ANSWER 1.08 (2.00)

a. As Doppler decreases the MTC is MORE NEGATIVE to a greater degree. [1.0]

b. Doppler dominates both at BOL and EOL. [1.0]

REFERENCE
REACTOR CORE CONTROL FOR LARGE PWR'S CHAPTER 3

ANSWER 1.09 (2.00)

See attached fig 1-1

REFERENCE
REACTOR CORE CONTROL FOR LARGE PWR'S PAGE 6-18

ANSWER 1.10 (2.50)

If saturation conditions were allowed to exist at the hot leg then further increases in core heat output would be undetected by the hot leg RTD and protection would be degraded.

REFERENCE
THERMAL HYDRAULIC PRINCIPLES AND APPLICATIONS TO THE PWR II, PAGE 13-53

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 1.11 (2.00)

a. Used fuel will produce a lower neutron flux at the core periphery.[1.0]

b. 1. increased net reactivity [longer cycle]
2. reduced neutron embrittlement of the vessel [.5 each]

REFERENCE
LARGE PWR CORE CONTROL 1-27 AND 28

ANSWER 1.12 (1.50)

a. burst or rupture due to internal forces

b. Zr-H2O reaction

c. errosion

d. corrosion [3 at .5 each]

e. melting

REFERENCE
LARGE PWR REACTOR CORE CONTROL, PAGES 1-22 THRU 25

ANSWER 1.13 (1.50)

Peaks below the centerline initially [.25] due to the MTC and lower core inlet temperature [.25]. Moves upward over core life [.25] due to lower core fuel depletion [.25] but tends to flatten out [.25] because MTC increases its affect [.25]

REFERENCE
LARGE PWR REACTOR CORE CONTROL 8-19 THRU 22

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 2.01 (1.50)

a. Flywheels are used for storing energy if power is lost momentarily.

b. Power cabinet urgent failure.

c. The reactor should trip. [.5 each]

REFERENCE
LER 483/85-11 AND LESSON PLAN PAGES 25-27

ANSWER 2.02 (1.50)

a. heater drain tank

b. condenser

c. prevent damage due to moisture carryover to LP turbines

REFERENCE
LP FW HTR EXT PAGE 12 AND LER 483/85-39

ANSWER 2.03 (2.00)

a. 1. CS in normal
   2. MG output breaker open
   3. synchro check relay satisfied [.5 each]

b. The buses will dead bus transfer to the statrup transformer a few seconds later. [.5]

SERVICE ELECTRICAL LESSON PLAN PAGES 2-7

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 2.04 (1.50)

a. 5 minutes [.25] vs. 5 seconds for FWIS [.25]

b. 1. SI
2. HI-HI SG LEVEL
3. LO-LO SG LEVEL
4. LOW TAVE [.25 each]

REFERENCE
MFW LESSON PLAN PAGES 25-27

ANSWER 2.05 (2.00)

The boiler preheats the feedwater during plant startup [1]. Without preheating feed water will undergo considerable expansion in the SG as it heats up resulting in level swell that is uncontrollable [1].

REFERENCE
LER/85-012

ANSWER 2.06 (2.00)

a. All flow was diverted through the opened valve to the RWST.[1.0]

b. The RCS depressurized to the RWST. [0.5]

c. The seal was damaged. [0.5]

REFERENCE
LER 483/84-16 AND RHR LESSON PLAN

ANSWER 2.07 (2.50)

a. 1. open to RWST
2. open for full flow
3. CCW isolated
4. crossties open
5. cold leg returns open [.3 each]

b. 1. CCW to HX's
2. RH to CCP's and SI pumps [.5 each]

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

REFERENCE
RHR LESSON PLAN PAGES 11-13; OTN-EJ-1; OP-M-JZ EJ 01

ANSWER 2.08 (1.50)

a. boric acid transfer pump

b. RHR pump

c. CCP [.5 each]

REFERENCE
LESSON PLANS FOR CVCS, RHR AND SI

ANSWER 2.09 (1.50)

a. 1. Hi temp from the LDHX [.5]
   2. Hi temp from BTRS RHHX [.5]

b. Hydrazine in the RCS [.5]

REFERENCE
CVCS LESSON PLAN PAGES 7-8, OTG-ZZ-1, 2.14

ANSWER 2.10 (1.50)

a. The hot MFW will prevent AFW operation due to cavitation or vapor binding of the pumps. [1.0]

b. Small break LOCA [.5]

REFERENCE
IE NOTICE 85-01, 84-06; INPO SER 5-84, SOER 84-3

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 2.11 (3.00)

The faulted startup transformer resulted in a loss of power to 1A RHR pump as well as the plant trip. [1.0]

Since the diesel takes ten seconds to ready for loading and the RHR pump sequences on ten seconds after the DG output breaker closes the 1A RHR pump start is delayed. [1.0]

1B RHR started immediately on SI actuation since it is powered from another source. [1.0]

REFERENCE
ESF POWER LESSON PLAN PAGES 3-1 THRU 17

ANSWER 2.12 (2.00)

a. Because the RCS is subject to failure at much lower pressures when the temperature is reduced. [1.0]

b. A TT [.25] without RT from 100% [.25] with no relief protection [.25] or SD actuation. [.25]

REFERENCE
RCS LESSON PLAN

ANSWER 2.13 (2.50)

a. 1. BAST to BATP then to blender then to inlet/outlet of VCT.
   2. BAST to BATP to charging pump suction via HN-8104.
   3. BAST to BATP to FCV 110A to manual valve V-177. [2 at .5 each]

b. The bypass allows reduced flow when the isolation is shut [.5]

   It is used in Mode 5. [.5]

   To restrict flow and prevent a dilution accident. [.5]

REFERENCE
CVCS LESSON PLAN AND NOTE 14 DWG 22BG05

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 3.01 (3.00)

a. 1. CRT display of cumulative violation time [.75]
   2. Alarm printer output [.75] also >1 NI channel indicator DI OOTB

b. 1. CRT display changes color [.75]
   2. Audible alarm window [.75]

REFERENCE
LER 483/85-037

ANSWER 3.02 (2.00)

a. pressure setpoint control [.5]

b. adjust very slowly [.5]

c. rapid pressure adjustment will cause safety injection [.5] due to rate sensitive sensors [.5]

REFERENCE
LER 483/85-009

ANSWER 3.03 (2.00)

The channel being tested was the controlling channel [.5]. Changing the channels output signal during the test affected the associated steam flow channel [.5]. A flow error was indicated by the level control system [.5]. The resultant adjustment to feed flow caused a low SG level [.5]

REFERENCE
LER 483/85-031

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 3.04 (2.50)

a. The SG levels were being controlled by the MFW bypasses in auto [.5]. These valves receive an input from the auctioneered high PRNI [.5]. As the last channel was adjusted down the valve control shut the valves [.5]

b. a high SG level [.5]

c. The reactor trip with a turbine trip does not occur at lower power.[.5]

REFERENCE
INCIDENT REPORT 84-814

ANSWER 3.05 (1.00)

a. low header pressure
b. with CCP start
c. LOCA sequencer
d. shutdown sequencer [.25 each]

REFERENCE
CCW LESSON PLAN PAGES 9-10

ANSWER 3.06 (1.50)

motor driven: a. LO-LO SG level on 1 SG
b. loss of both MFW pumps
c. LOCA sequencer
d. shutdown sequencer

turbine driven: a. LO-LO SG level on 2 SG's
b. undervoltage on NB01 or NB02 [.25 each]

REFERENCE
AFW LESSON PLAN PAGES 5-7

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 3.07 (1.50)

also: load limits

a. OPDT
b. OTDT
c. C-16 (low temp return to power)
d. loss of CW pump > ~~60%~~ 75% TB
e. high stator water temperature
f. low stator water pressure

~~6~~ 6 required for full credit

REFERENCE
RPS LESSON PLAN PAGES 9-10 AND EH LESSON PLAN PAGES 5-27

ANSWER 3.08 (1.50)

a. disconnect switches for affected bank
b. auto manual switch at P-A converter
c. Bank Selector Switch
d. In-Hold-Out switch
e. group step counters for affected bank
f. alarm reset for urgent failure [.25 each]

REFERENCE
CRD LESSON PLAN PAGE 25 AND OTO-SF-00004 PAGES 3-4

ANSWER 3.09 (2.00)

a. 1. wide range hot leg temperature [.5]
   2. reactor vessel differential pressure [.5]

b. seal table [.5] which is same elevation as vessel flange [.5]

REFERENCE
RCS INST LESSON PLAN PAGE 11 AND RV LESSON PLAN PAGE 22

ANSWER 3.10 (2.00)

a. particulate rad monitor
b. gaseous rad monitor
c. sump level
d. air cooler drain flow [.5 each]

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

REFERENCE
TS 3.4.6.1

ANSWER 3.11 (2.00)

a. 1970 psig [.5]

b. P-11 status light illuminates [.5]

c. Place BOTH A and B train switches for low pressurizer pressure SI to BLOCK [.5] and BOTH switches for low SG pressure SI to BLOCK [.5].

REFERENCE
RIS LESSOM PLAN PAGE 22; SI LESSON PLAN PAGE 7; OTG-ZZ-00006 PAGE 11

ANSWER 3.12 (2.00) [.5] Full credit for either AND FOR TESTING [.5]

a. To allow removal of a failed channel from service. [1.0]

b. IR block resets below P-10 at 10% [.5]
SR block resets below P-6 at 5x10E-11 [.5]

REFERENCE
NIS LESSON PLAN PAGE 29 AND OTG-ZZ-00005 PAGES 4 AND 8

ANSWER 3.13 (2.00)

a. 1. liquid radwaste discharge
2. SG blowdown
3. turbine building drains
4. secondary liquid waste
5. containment purge
6. radwaste building vent [.25 each]

b. To prevent condensation in the sample lines [.25] which would remove Tritium from the process sample flow stream. [.25]

REFERENCE
TS PAGES 3/4.3-63 TO 75 AND OTA-RL-RK061 WINDOW 61F (TCN 85-487)

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 4.01 (1.50)

a. TS review and SRO approval [.5]

b. Establishment of fire watches within one hour [.5]

c. Watch tours must be conducted at least hourly [.5]

REFERENCE
TS 3.3.3.7.b; ODP-ZZ-00001, 3.3.3 PAGE 2

ANSWER 4.02 (3.00)

a. pressurizer level [.5]

b. spent fuel in the RCC change fixture [.5]

c. 1. Evacuate unnecessary fuel handlers from containment.
2. Verify/increase air pressure in seal.
3. Transfer any fuel assembly in upender or transfer to SFP side.
4. Close transfer tube isolation valve.
5. Transfer any fuel in RP to the vessel.
6. Evacuate the remaining fuel handlers.
7. Notify the CR of refueling pool status.
8. Sound evacuation alarm. [8 at .25 each]

REFERENCE
OTO-KE-00001

ANSWER 4.03 (1.50)

a. 2 minutes [.5]

b. The RCP'S must be tripped if CCW is lost for 2 minutes or more and the reactor must be tripped first. [1.0]

REFERENCE
OTO-EG-00001

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 4.04 (2.50)

a. To trip RCP's

b. deenergize PORV's (.25) AND remove control power from NB02 (.25)

c. verify loss of offsite power and energize NB02 from DG

d. amp meters on breaker cubicles

e. it can be electrically isolated from the CR [.5 each]

REFERENCE
OTO-ZZ-00001 PAGES 1 AND 7; ATTACHMENTS 2, PAGE 1; 3, PAGE 1

ANSWER 4.05 (1.50)

a. blocked air dryers [.5]

b. Take appropriate action to restore parameters to NOB [.5] If they cannot be controlled or approach a trip setpoint then manually trip the reactor. [.5]

REFERENCE
OTO-KA-00001 PAGE 1-2

ANSWER 4.06 (1.50)

a. E-0, Reactor Trip or SI [.25] and FR-S.1, Response to Nuclear Power Generation [.25] A TWT

b. Deenergize the load centers PG19 [.5] and 20 [.5]

REFERENCE
E-0 AND FR-S.1

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 4.07 (2.00)

a. RPI rod deviation annunciator [80C]
b. RPI deviation or PR tilt [79C]
c. PR lower detector flux deviation [78C]
d. " upper " " " [78B]
e. One or more RPI not in agreement with other RPI's of the same group by plus or minus 12 steps.
f. One or more RPI not in agreement with associated group step counters demand height by plus or minus 12 steps.
g. Abnormal incore thermocouple or flux map readings. [5 at .4 each]

REFERENCE
OTO-SF-00004

ANSWER 4.08 (2.00)

a. #1 seal leakoff flow high
b. #1 seal leakoff temperature increasing
c. CCW thermal barrier discharge temperature increasing
d. #1 seal leakoff flow low
e. #1 seal DP low [4 at .5 each]

REFERENCE
OTO-BB-00002

ANSWER 4.09 (2.25)

a. Plant Operations controls orange tags [.25] and white are controlled by load dispatcher [.25] and power dispatcher [.25]

b. manual valve handwheel [.25]
motor valve handwheel [.25], supply breaker [.25] and control switch [.25]

c. The original holder [.25] or the Emergency Duty Officer [.25]

REFERENCE
APA-ZZ-00310 PAGES 2, 11, 18

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 4.10 (1.50)

a. prior to each entry [.5]

b. signs RWP sign in sheet [.5]

c. first entry each day [.5]

REFERENCE
APA-ZZ-00161 PAGE 6-7

ANSWER 4.11 (1.75)

a. Last three days or last watch whichever is shorter. [.25]

b. 1. Review Standing and Night Orders.
2. Test control room annunciators.
3. Review annunciator defeat log.
4. Discuss significant operations or maintenance in progress.
5. Perform control board walkdown.
6. Review incident reports. [.25 each]

REFERENCE
ODP-ZZ-00003 PAGES 3 AND 4 AND ATTACHMENT

ANSWER 4.12 (1.00)

a. Indirect indication depicting actual status [.5]

b. When the concept of ALARA would be violated [.5]

c. Post work functional test performed proves all equipment is correctly aligned. [.5]

d. Outage related work, system checklist completed prior to req'mt for operability. [.5]

REFERENCE
APA-ZZ-00310 PAGES 16-17

ANSWERS -- CALLAWAY -85/12/17-BURDICK, T

ANSWER 4.13 (2.00)

1614 ON 12/10/85

REFERENCE
TS 3/4.2.1

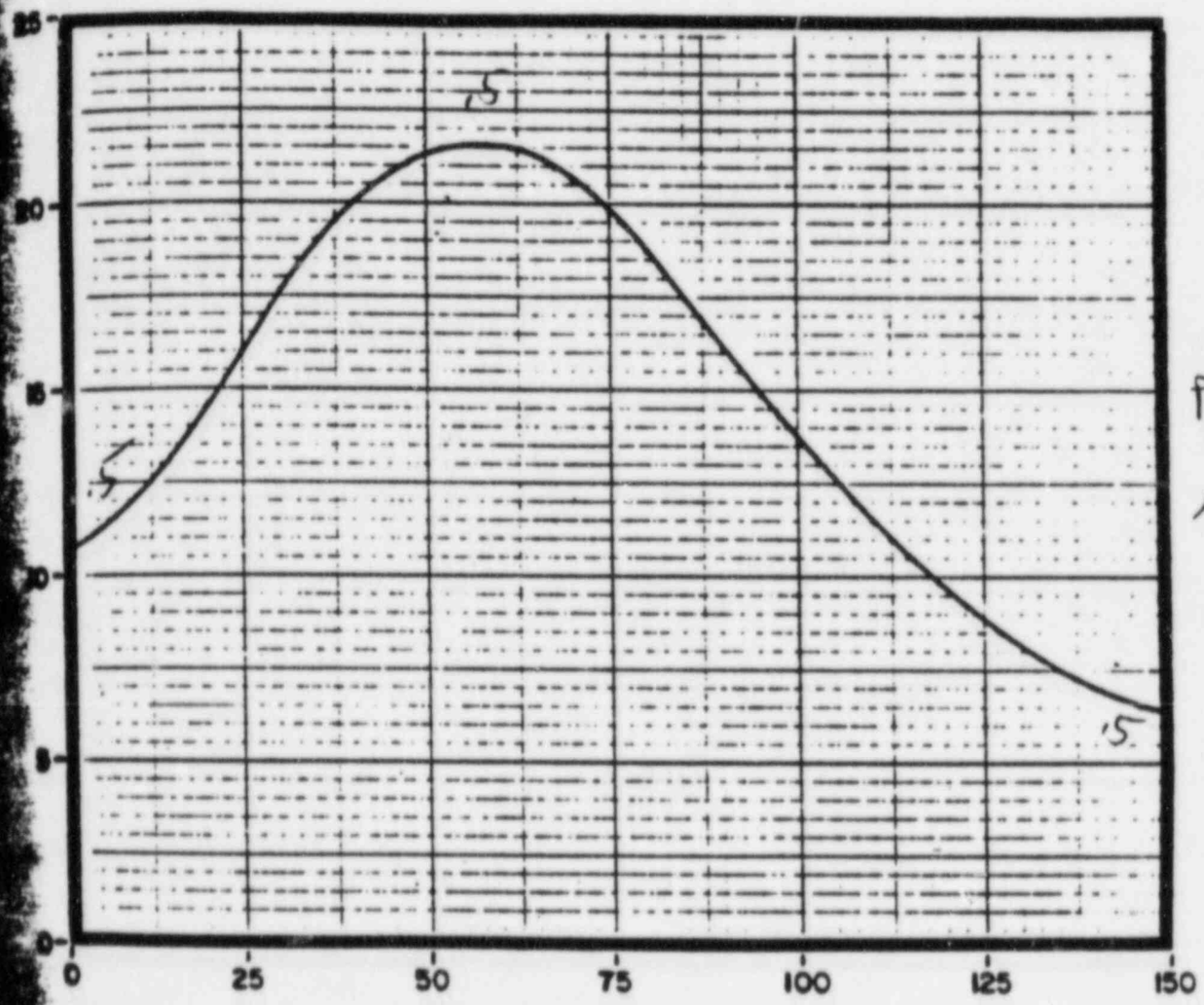
ANSWER 4.14 (1.00)

To dampen the resultant Xenon oscillation.

REFERENCE
OTG-ZZ-00004 PAGE 2

withdrawn position and becomes more negative as the rods are inserted. Figure FND-RF-47 shows graphs of integral rod worth corresponding to the differential rod worth curve in Figure FND-RF-46. Graph A has the reference at the bottom of the core and Graph B is drawn with the reference at the top of the core. In either case, the reactivity change resulting from any rod motion is:

$$\Delta\rho = IRW(final) - IRW(initial)$$



TYPICAL DIFFERENTIAL ROD WORTH CURVE

FIG. F-1

Master

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

FACILITY: CALLAWAY

REACTOR TYPE: PWR-WEC4

DATE ADMINISTERED: 85/12/17

EXAMINER: HIGGINS, R.

APPLICANT: _____

INSTRUCTIONS TO APPLICANT:

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

CATEGORY VALUE	% OF TOTAL	APPLICANT'S SCORE	% OF CATEGORY VALUE	CATEGORY
25.00	25.00			5. THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS
25.00	25.00			6. PLANT SYSTEMS DESIGN, CONTROL, AND INSTRUMENTATION
25.00	25.00			7. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL
25.00	25.00			8. ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS
100.00	100.00			TOTALS

FINAL GRADE _____%

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

_____
APPLICANT'S SIGNATURE

QUESTION 5.01 (1.50)

Assume that RCS temperature is 199 F at BOL, boron concentration is 1000 ppm, and shutdown margin is the minimum required by Technical Specifications under these conditions. What is the minimum number of gallons of 4% boric acid which must be added in order to raise RCS temperature above 200 F? Use Figures 5-1a and 5-1b. Show your work.

QUESTION 5.02 (1.00)

How is adequate shutdown margin verified during a reactor startup prior to criticality?

QUESTION 5.03 (1.00)

Why does the critical boron concentration decrease at a much more rapid rate at 9000 MWD/MTU than it does at 1000 MWD/MTU? Refer to Figure 5-3.

QUESTION 5.04 (2.00)

a. What are the three bases for establishing control rod INSERTION limits? (1.5)

b. What is the reason for establishing control rod WITHDRAWAL limits? (.5)

QUESTION 5.05 (1.00)

The reference text LARGE PWR CORE CONTROL states that a xenon instability (oscillation) is not a nuclear hazard. What problem does a xenon oscillation pose?

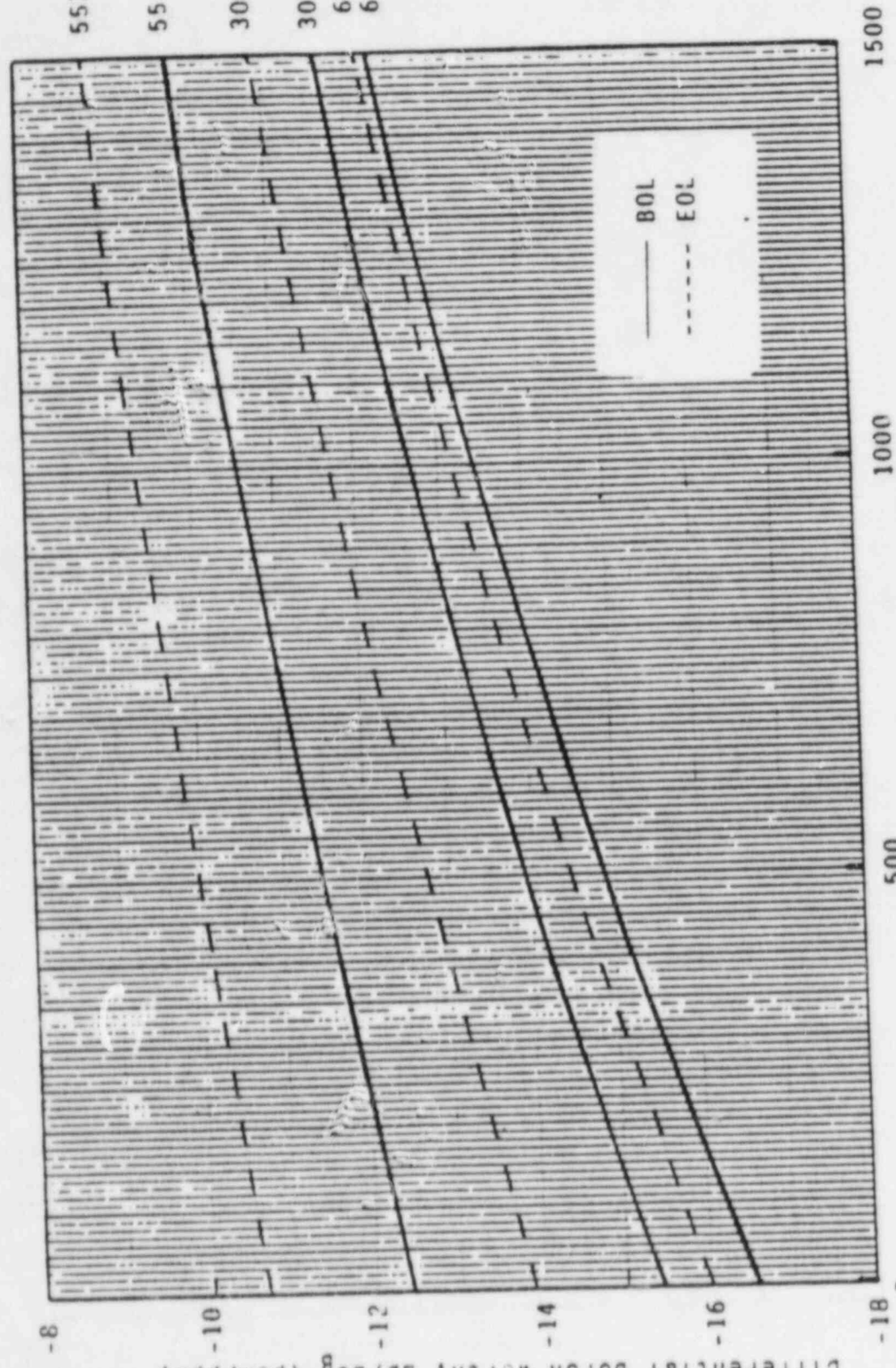
QUESTION 5.06 (1.00)

What is the basis for establishing limits on axial flux difference?

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

FIGURE 5-1a

William H. Stahl 7/26/83
Superintendent, Engineering Date



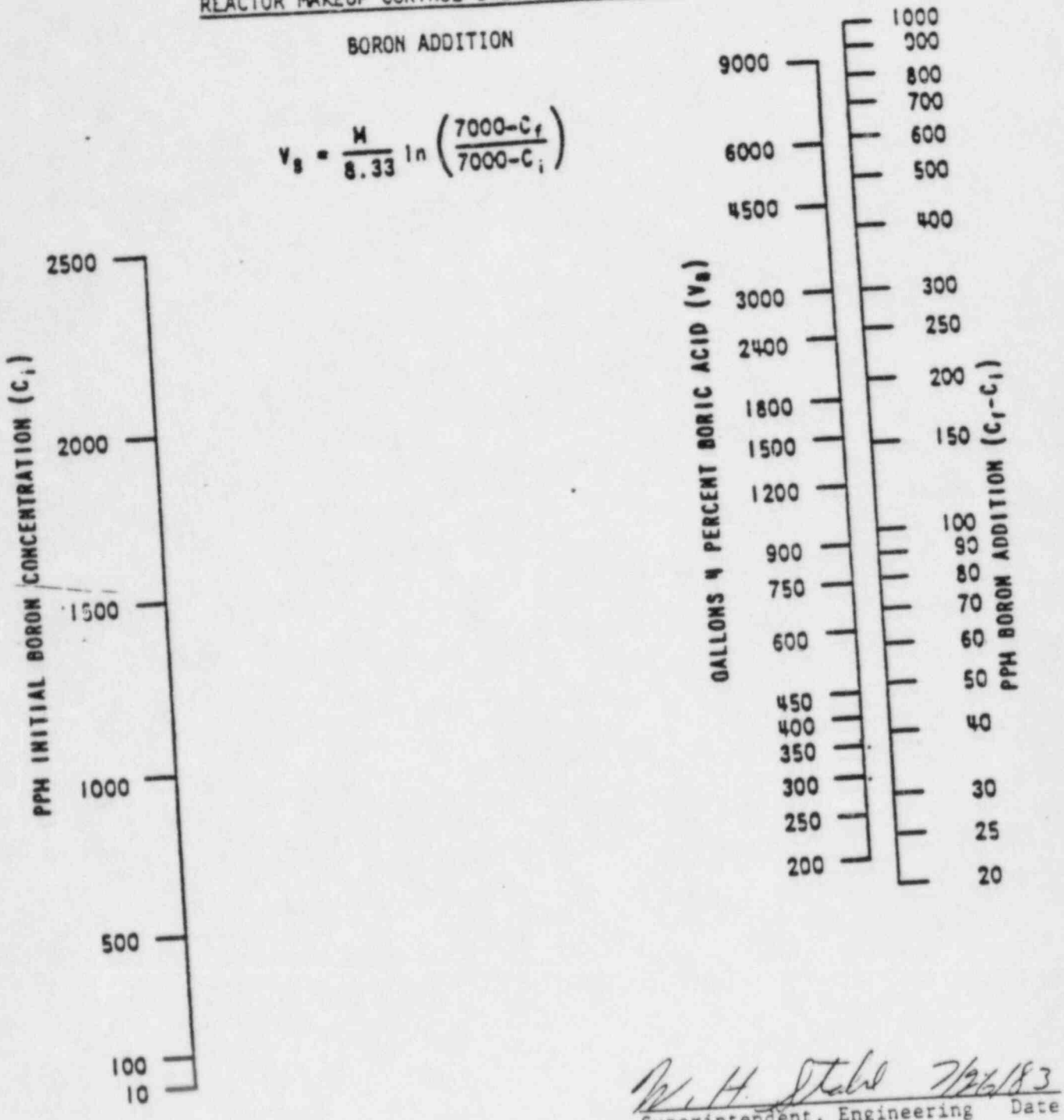
DIFFERENTIAL BORON WORTH VS. BORON CONCENTRATION AT BOL AND EOL
CYCLE 1

FIGURE 5-1b

REACTOR MAKEUP CONTROL SYSTEM NOMOGRAPHS

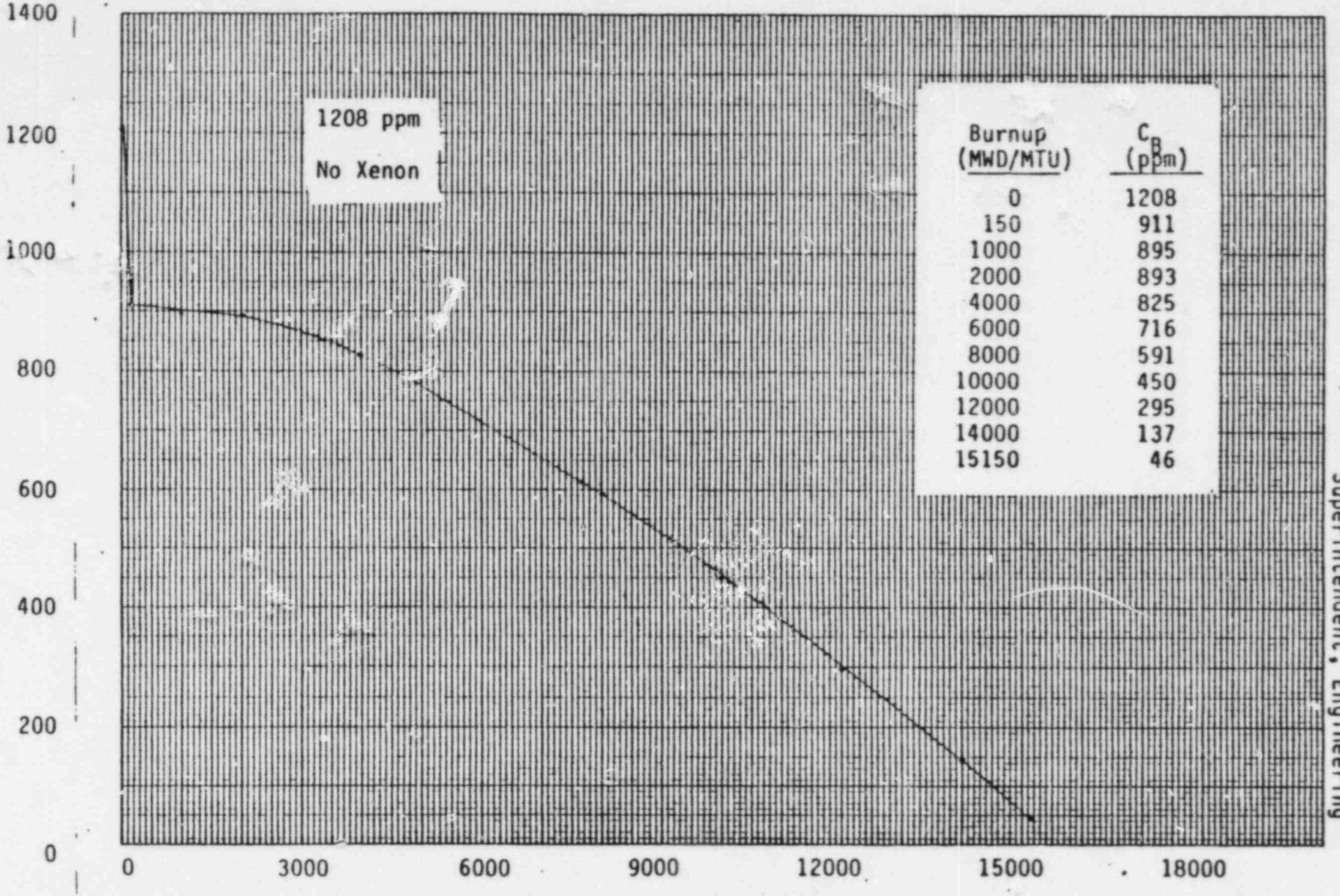
BORON ADDITION

$$V_B = \frac{M}{8.33} \ln\left(\frac{7000-C_f}{7000-C_i}\right)$$



W. H. Stubd 7/26/83
Superintendent, Engineering Date

NOTE: Refer to Table 7-1 for correction factors.



CRITICAL BORON CONCENTRATION VS. BURNUP
FOR HFP, ARO, EQUILIBRIUM XENON CONDITIONS
CYCLE 1

FIGURE 5-3

W. K. Campbell
Superintendent, Engineering

2/6/85
Date

QUESTION 5.07 (2.00)

Answer the following True/False questions:

a. The equilibrium xenon reactivity at 100% power is more than twice the equilibrium xenon reactivity at 50% power. (.5)

b. The peak xenon reactivity insertion (addition) following a trip from 100% equilibrium power is more than twice the peak xenon reactivity insertion (addition) following a trip from 50% equilibrium power. (.5)

c. The equilibrium samarium reactivity at 100% power is the same as the equilibrium samarium reactivity at 50% power. (.5)

d. The samarium reactivity added following a trip from 100% equilibrium power is the same as the samarium reactivity added following a trip from 50% equilibrium power. (.5)

QUESTION 5.08 (1.00)

Why is the delayed neutron importance function, $\overline{I}$, less than one?

QUESTION 5.09 (1.00)

Why does the effective delayed neutron fraction decrease from BOL to EOL?

QUESTION 5.10 (.50)

If the axial flux difference is out of the band to the left (too negative), should the operator borate or dilute? (Choose the correct response.)

QUESTION 5.11 (1.00)

Which two factors cause the target axial flux difference at EOL to differ from that at BOL?

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

QUESTION 5.12 (1.00)

Assuming all rods fully insert after a reactor trip from 100% power, approximately how long will it take for power to decrease to:

a. 5%? (.5)

b. the level at which the source range detectors will reengerize? (.5)

QUESTION 5.13 (1.00)

For a given boron concentration, why is MTC more negative with Banks C and D inserted in the core than with Bank D alone? Refer to Figure 5-13.

QUESTION 5.14 (.75)

What pressure, in psig, must be maintained in the steam generators in order to obtain a 100 F subcooling margin when RCS pressure is 1500 psig?

QUESTION 5.15 (.75)

What would be the tail pipe temperature downstream of an open pressurizer PORV if the pressurizer pressure is 2100 psig and the PRT pressure is 25 psig?

QUESTION 5.16 (1.00)

Name two mechanisms by which hydrogen can be introduced into the containment atmosphere following a LOCA.

QUESTION 5.17 (1.50)

a. What is the maximum hydrogen concentration at which the hydrogen recombiners may be placed into service? (.5)

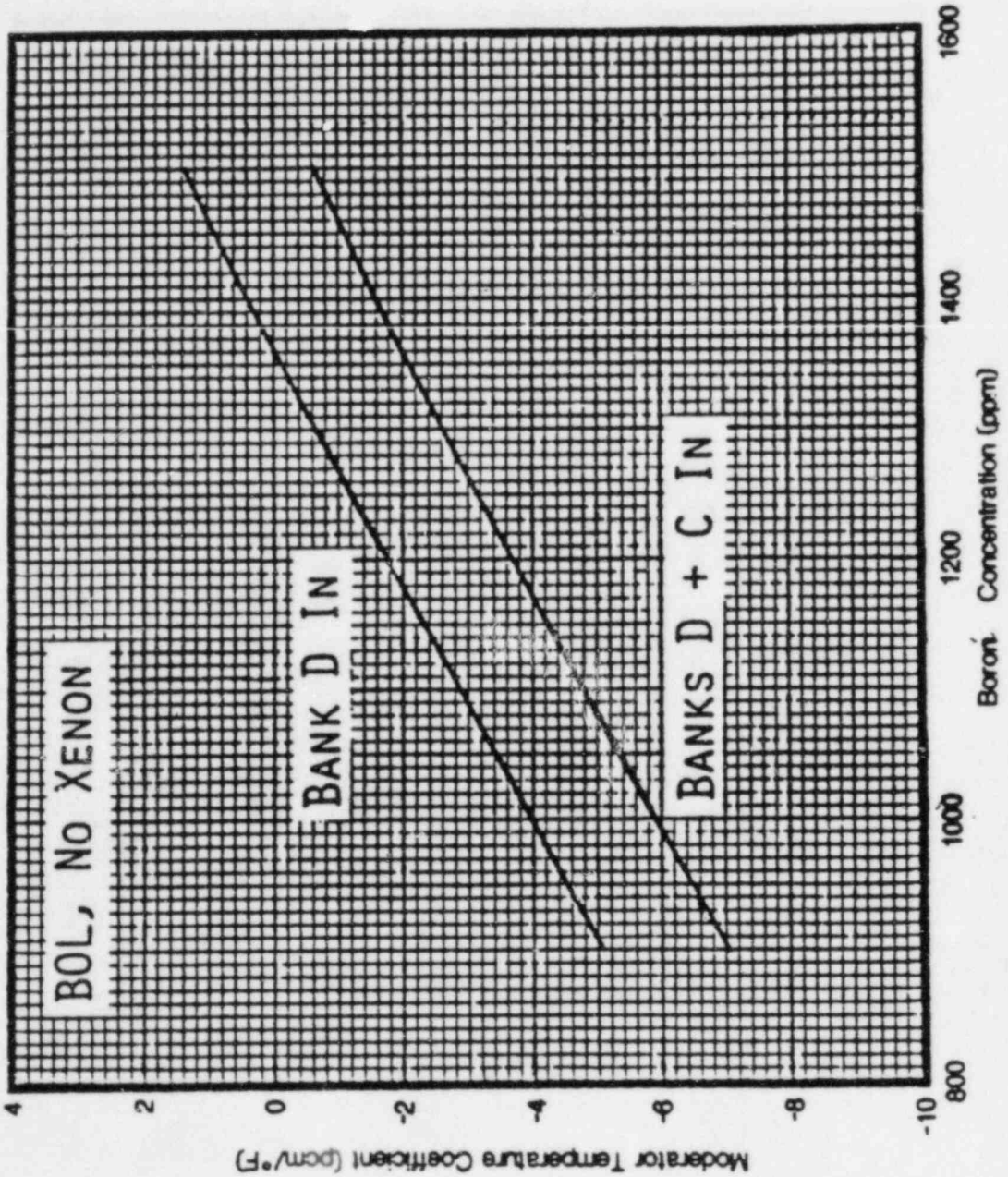
b. What is the basis for this precaution? (1.0)

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

FIGURE 5-13

RODDED MODERATOR TEMPERATURE COEFFICIENTS
AT HZP VERSUS BORON CONCENTRATION
BOL, NO XENON
CYCLE 1

W. H. Stahl 7/26/83
Superintendent, Engineering Date



QUESTION 5.18 (1.50)

With the plant at 100% power, how much higher above its nominal 100% power value must Tave be raised before the steam generator safety valve with the lowest setpoint opens? Nominal 100% power steam generator pressure is 1000 psig. Show your work.

QUESTION 5.19 (2.50)

For the following questions refer to Figure 5-19.

a. What is the basis for curve A? (.5)

b. Why does curve A have a negative slope (decrease with increasing power)? (.5)

c. On Figure 5-19, draw the curve representing the OTΔT setpoint, using the following equation: (1.0)
OTΔT setpoint = ΔT_o [1.10 - .0137/ F (T - T')]
ΔT_o = indicated ΔT at rated thermal power
T' = nominal Tave at rated thermal power

d. What design feature prevents Tave from exceeding the reactor core safety limit when reactor power is less than 30%? (.5)

QUESTION 5.20 (1.00)

Why is the initial reference transition nil ductility temperature less than the reference transition nil ductility temperature after 7 EFPY?

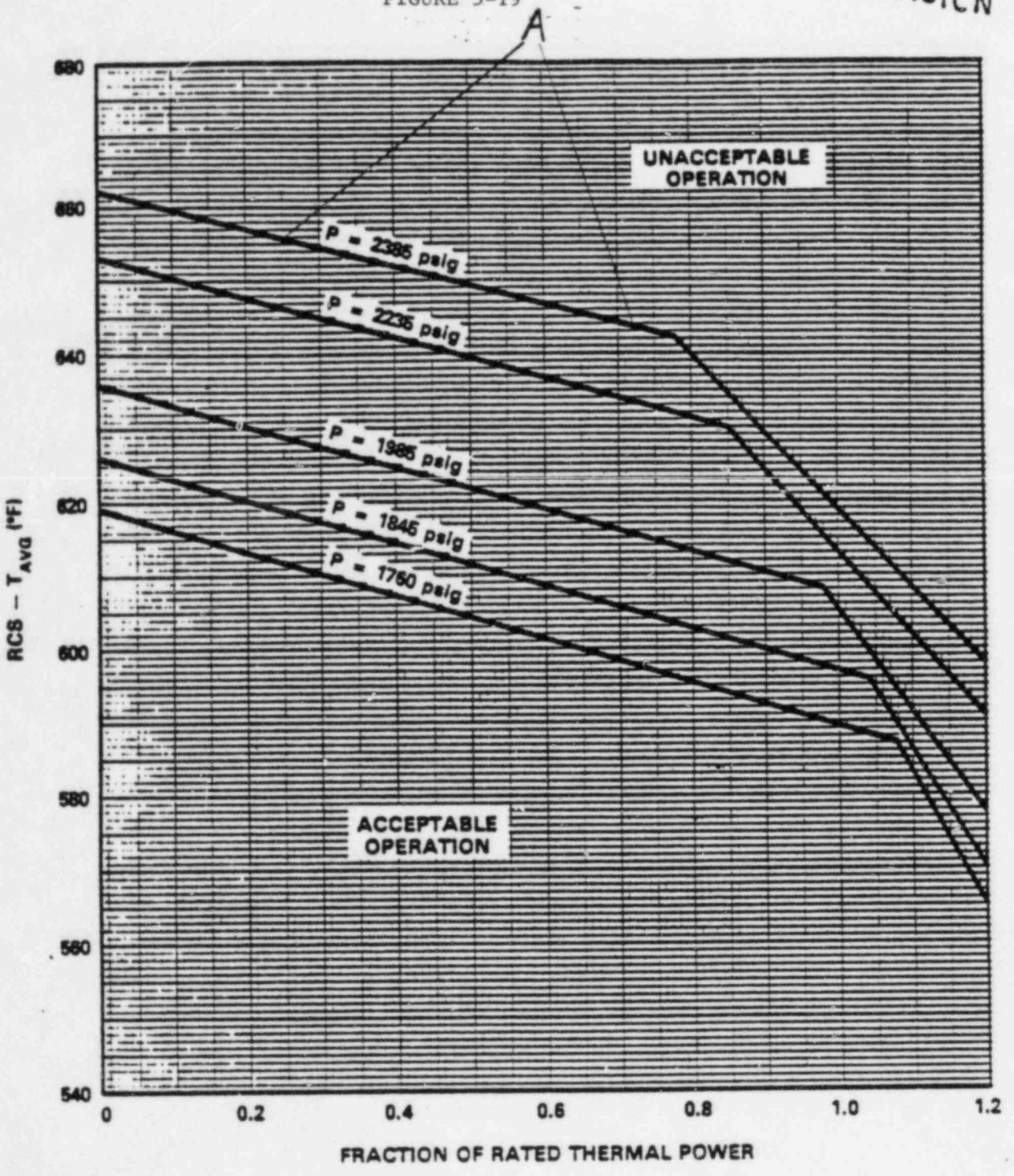
QUESTION 5.21 (1.00)

Why is a centrifugal pump normally started with its discharge valve shut?

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

FIGURE 5-19

REVISION 1



REACTOR CORE SAFETY LIMIT - FOUR LOOPS IN OPERATION

EQUATIONS

REACTOR THEORY

$$P = P_o e^{t/\tau} = P_o 10^{SUR \cdot t}$$

$$\tau = \frac{\bar{l}_e}{\rho} + \frac{\beta - \rho}{\lambda\rho} \quad \text{or} \quad \tau = \frac{\beta - \rho}{\lambda\rho}$$

$$\rho = \frac{k - 1}{k} \qquad \frac{k_2 - k_1}{k_2 k_1} = \Delta\rho$$

$$\frac{cps_2}{cps_1} = \frac{1 - k_1}{1 - k_2} \qquad k < 1$$

$$\frac{1}{M} = 1 - k$$

$$\frac{1}{M} = \frac{cps_o}{cps_n}$$

$$\rho_{net} = \Delta(\rho_{doppler} + \rho_{mod} + \rho_{void} + \rho_{Xe} + \rho_{Sm} + \rho_{Pu} + \rho_{Boron} + \rho_{rod} + \rho_{fuel} + \rho_{Poisons})$$

$$k_2 = k_1 + \delta k$$

$$\delta k = k - 1$$

$$SUR = \frac{26.06}{\tau}$$

$$P = \frac{\Sigma\phi V}{3.1 \times 10^{10}}$$

$$\Sigma = N\sigma$$

$$\phi = nv$$

Defect = Coeff x Δ Parameter

RADIATION

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

$$A = \lambda N$$

$$I = I_o e^{-\mu x} = I_o 10^{-x/TVT}$$

$$\lambda T_{\frac{1}{2}} = 0.693$$

$$R/hr \text{ @ } d \text{ feet} = \frac{6CE}{d^2}$$

$I_1 d_1^2 = I_2 d_2^2$ point source

$I_1 d_1 = I_2 d_2$ - line source

R/hr x time = R

Rad x QF = Rem

$$T_{\frac{1}{2}eff} = \frac{T_{\frac{1}{2}Bio} \times T_{\frac{1}{2}Rad}}{T_{\frac{1}{2}Bio} + T_{\frac{1}{2}Rad}}$$

MATH

$$y^a = b$$

$$\log_y b = a$$

$$\log_c x^c = c \log x$$

$$\log \frac{x}{y} = \log x - \log y$$

$$\log xy = \log x + \log y$$

FLUIDS/THERMO/HEAT TRANSFER

$$\dot{m} = A_1\rho_1 V_1 = A_2\rho_2 V_2$$

$$Q = A_1 V_1 = A_2 V_2$$

$$E_{in} = E_{out} + \Delta E_{stored}$$

$$E = KE + PE + U + pV + Q + W$$

$$PE = \frac{mg}{g_c} Z$$

$$KE = \tfrac{1}{2} m \frac{V^2}{g_c}$$

reduced for - turbine, SG pump, nozzle, orifice, condenser, pipe, Rx

flow α $\sqrt{dp}$

$$\text{head loss} = f\frac{L}{D}\frac{V^2}{2g_c} \quad \text{or head loss } \alpha\ V^2$$

head loss α Δp

$$p = h + p_{ambient} \qquad = k\frac{V^2}{2g_c}$$

$$F = pA$$

$$\Delta p_{2\,phase} = \Delta p_{1\,phase} \times K$$

k = f(quality & Pressure)

Pump laws speed α flow

(speed)^2 α pressure

(speed)^3 α power

$$Q = kA\Delta T = hA\Delta T = UA\Delta T$$

$$Q = mc_p\Delta T$$

$$Q = m\Delta h$$

$$Q = \varepsilon\sigma T$$

$$\Delta H = mc_p\Delta T$$

$$\Delta U = mc_v\Delta T$$

$$H = U + pV$$

$$\Delta S = \frac{\Delta Q}{T}$$

$$pV = nRT$$

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$$

$$C_1 V_1 + C_2 V_2 = C_3(V_1 + V_2)$$

Table 1. Saturated Steam: Temperature Table

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
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	0.12163	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	527.5	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
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	1.6834	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

*The states shown are metastable

Table 1. Saturated Steam: Temperature Table—*Continued*

Temp Fahr t	Abs Press Lb per Sq in p	Specific Volume Sat Liquid v_f	Evap v_{fg}	Sat Vapor v_g	Enthalpy Sat Liquid h_f	Evap h_{fg}	Sat Vapor h_g	Entropy Sat Liquid s_f	Evap s_{fg}	Sat Vapor s_g	Temp Fahr t
180.0	7.5110	0.016510	50.21	50.22	148.00	990.2	1138.2	0.2631	1.5480	1.8111	180.0
182.0	7.850	0.016522	48.172	48.189	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	24.876	24.894	184.20	967.8	1152.0	0.3181	1.4323	1.7505	216.0
220.0	17.186	0.016775	23.131	23.148	188.23	965.2	1153.4	0.3241	1.4201	1.7442	220.0
224.0	18.556	0.016805	21.529	21.545	192.27	962.6	1154.9	0.3300	1.4081	1.7380	224.0
228.0	20.015	0.016834	20.056	20.073	196.31	960.0	1156.3	0.3359	1.3961	1.7320	228.0
232.0	21.567	0.016864	18.701	18.718	200.35	957.4	1157.8	0.3417	1.3842	1.7260	232.0
236.0	23.216	0.016895	17.454	17.471	204.40	954.8	1159.2	0.3476	1.3725	1.7201	236.0
240.0	24.968	0.016926	16.304	16.321	208.45	952.1	1160.6	0.3533	1.3609	1.7142	240.0
244.0	26.826	0.016958	15.243	15.260	212.50	949.5	1162.0	0.3591	1.3494	1.7085	244.0
248.0	28.796	0.016990	14.264	14.281	216.56	946.8	1163.4	0.3649	1.3379	1.7028	248.0
252.0	30.883	0.017022	13.358	13.375	220.62	944.1	1164.7	0.3706	1.3266	1.6972	252.0
256.0	33.091	0.017055	12.520	12.538	224.69	941.4	1166.1	0.3763	1.3154	1.6917	256.0
260.0	35.427	0.017089	11.745	11.762	228.76	938.6	1167.4	0.3819	1.3043	1.6862	260.0
264.0	37.894	0.017123	11.025	11.042	232.83	935.9	1168.7	0.3876	1.2933	1.6808	264.0
268.0	40.500	0.017157	10.358	10.375	236.91	933.1	1170.0	0.3932	1.2823	1.6755	268.0
272.0	43.249	0.017193	9.738	9.755	240.99	930.3	1171.3	0.3987	1.2715	1.6702	272.0
276.0	46.147	0.017228	9.162	9.180	245.08	927.5	1172.5	0.4043	1.2607	1.6650	276.0
280.0	49.200	0.017264	8.627	8.644	249.17	924.6	1173.8	0.4098	1.2501	1.6599	280.0
284.0	52.414	0.01730	8.1280	8.1453	253.3	921.7	1175.0	0.4154	1.2395	1.6548	284.0
288.0	55.795	0.01734	7.6634	7.6807	257.4	918.8	1176.2	0.4208	1.2290	1.6498	288.0
292.0	59.350	0.01738	7.2301	7.2475	261.5	915.9	1177.4	0.4263	1.2186	1.6449	292.0
296.0	63.084	0.01741	6.8259	6.8433	265.6	913.0	1178.6	0.4317	1.2082	1.6400	296.0
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	1.5003	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
452.0	431.14	0.01947	1.05764	1.07711	432.5	772.3	1204.8	0.6308	0.8471	1.4778	452.0
456.0	448.73	0.01954	1.01518	1.03472	437.0	767.8	1204.8	0.6356	0.8385	1.4741	456.0

Table 1. Saturated Steam: Temperature Table—*Continued*

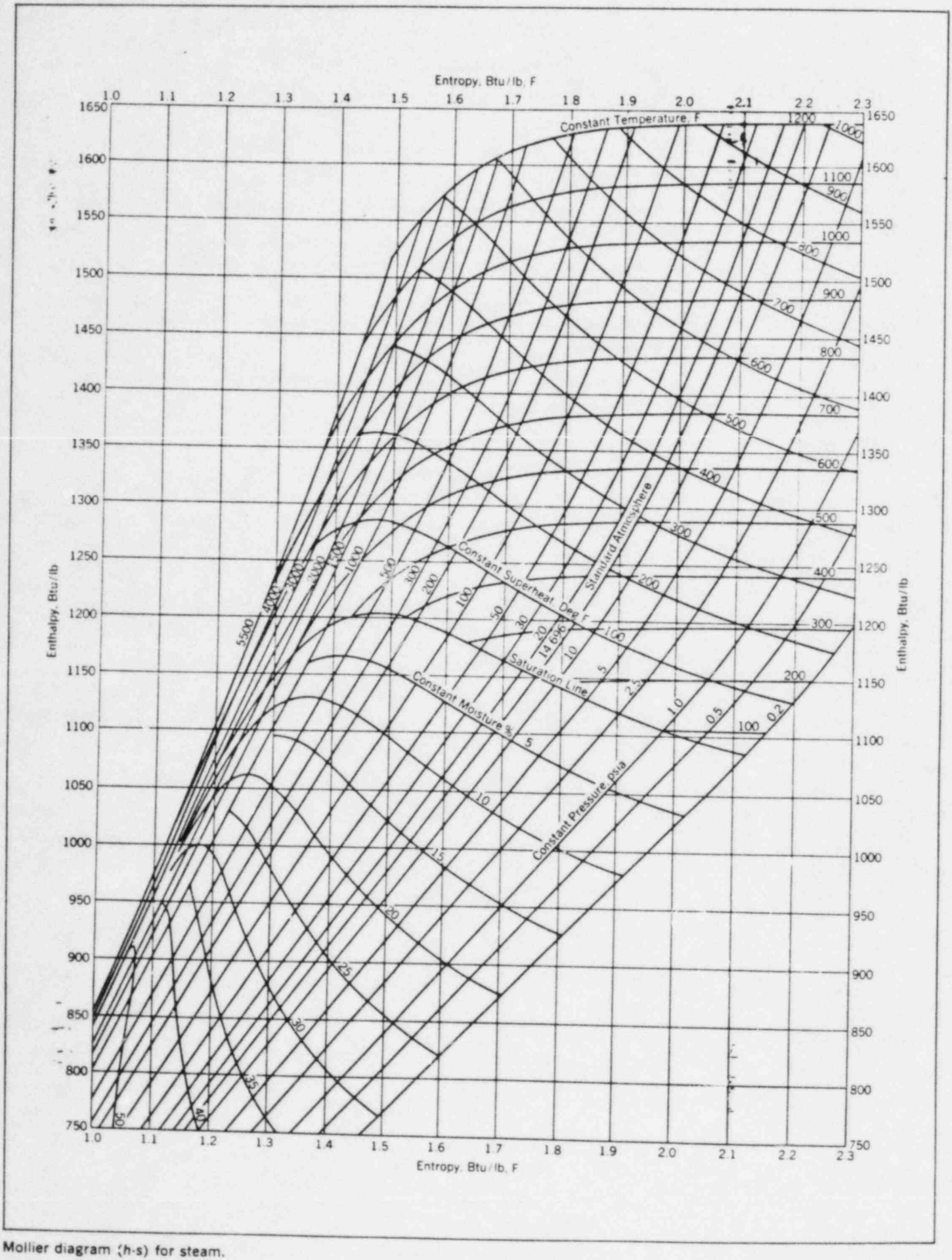
Temp Fahr t	Abs Press Lb per Sq In p	Specific Volume Sat Liquid v_f	Evap v_{fg}	Sat Vapor v_g	Enthalpy Sat Liquid h_f	Evap h_{fg}	Sat Vapor h_g	Entropy Sat Liquid s_f	Evap s_{fg}	Sat Vapor s_g	Temp Fahr t
460.0	466.87	0.01961	0.97463	0.99424	441.5	763.2	1204.8	0.6405	0.8299	1.4704	460.0
464.0	485.56	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
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	73.515	73.532	130.20	1000.9	1131.1	0.2349	1.6094	1.8443	5.0
10.0	193.21	0.016592	38.404	38.420	161.26	982.1	1143.3	0.2836	1.5043	1.7879	10.0
14.696	212.00	0.016719	26.782	26.799	180.17	970.3	1150.5	0.3121	1.4447	1.7568	14.696
15.0	213.03	0.016726	26.274	26.290	181.21	969.7	1150.9	0.3137	1.4415	1.7552	15.0
20.0	227.96	0.016834	20.070	20.087	196.27	960.1	1156.3	0.3358	1.3962	1.7320	20.0
30.0	250.34	0.017009	13.7266	13.7436	218.9	945.2	1164.1	0.3682	1.3313	1.6995	30.0
40.0	267.25	0.017151	10.4794	10.4965	236.1	933.6	1169.8	0.3921	1.2844	1.6765	40.0
50.0	281.02	0.017274	8.4967	8.5140	250.2	923.9	1174.1	0.4112	1.2474	1.6586	50.0
60.0	292.71	0.017383	7.1562	7.1736	262.2	915.4	1177.6	0.4273	1.2167	1.6440	60.0
70.0	302.93	0.017482	6.1875	6.2050	272.7	907.8	1180.6	0.4411	1.1905	1.6316	70.0
80.0	312.04	0.017573	5.4536	5.4711	282.1	900.9	1183.1	0.4534	1.1675	1.6208	80.0
90.0	320.28	0.017659	4.8779	4.8953	290.7	894.6	1185.3	0.4643	1.1470	1.6113	90.0
100.0	327.82	0.017740	4.4133	4.4310	298.5	888.6	1187.2	0.4743	1.1284	1.6027	100.0
110.0	334.79	0.01782	4.0306	4.0084	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	353.01	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	389.86	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
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	0.42274	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	0.16995	0.19540	666.3	475.8	1142.0	0.8574	0.4358	1.2931	1950.0
2000.0	635.80	0.02565	0.16266	0.18831	672.1	466.2	1138.3	0.8625	0.4256	1.2881	2000.0
2100.0	642.76	0.02615	0.14885	0.17501	683.8	446.7	1130.5	0.8727	0.4053	1.2780	2100.0
2200.0	649.45	0.02669	0.13603	0.16272	695.5	426.7	1122.2	0.8828	0.3848	1.2676	2200.0
2300.0	655.89	0.02727	0.12406	0.15133	707.2	406.0	1113.2	0.8929	0.3640	1.2569	2300.0
2400.0	662.11	0.02790	0.11287	0.14076	719.0	384.8	1103.7	0.9031	0.3430	1.2460	2400.0
2500.0	668.11	0.02859	0.10209	0.13068	731.7	361.6	1093.3	0.9139	0.3206	1.2345	2500.0
2600.0	673.91	0.02938	0.09172	0.12110	744.5	337.6	1082.0	0.9247	0.2977	1.2225	2600.0
2700.0	679.53	0.03029	0.08165	0.11194	757.3	312.3	1069.7	0.9356	0.2741	1.2097	2700.0
2800.0	684.96	0.03134	0.07171	0.10305	770.7	285.1	1055.8	0.9468	0.2491	1.1958	2800.0
2900.0	690.22	0.03262	0.06158	0.09420	785.1	254.7	1039.8	0.9588	0.2215	1.1803	2900.0
3000.0	695.33	0.03428	0.05073	0.08500	801.8	218.4	1020.3	0.9728	0.1891	1.1619	3000.0
3100.0	700.28	0.03681	0.03771	0.07452	824.0	169.3	993.3	0.9914	0.1460	1.1373	3100.0
3200.0	705.08	0.04472	0.01191	0.05663	875.5	56.1	931.6	1.0351	0.0482	1.0832	3200.0
3208.2*	705.47	0.05078	0.00000	0.05078	906.0	0.0	906.0	1.0612	0.0000	1.0612	3208.2*

*Critical pressure



Mollier diagram (*h*-*s*) for steam.

QUESTION 6.01 (1.00)

Why do the B and C SI accumulators have two vent valves?

QUESTION 6.02 (2.00)

a. Explain the relationship between the source range nuclear instruments and the CVCS. (1.0)

b. What is the basis for this relationship? (1.0)

QUESTION 6.03 (1.00)

Which power range reactor trip(s) can be blocked?

QUESTION 6.04 (2.00)

What are the two open interlocks provided for the RHR discharge valves to the charging and SI pumps, 8804 A and B, and what is the basis for each interlock?

QUESTION 6.05 (2.00)

a. What four signals will automatically start the motor driven AFW pumps? Include setpoints and coincidence. (1.0)

b. What signal(s) will cause the automatic switch of AFW pump suction from the CST to ESW? Include setpoints and coincidence. (1.0)

QUESTION 6.06 (1.00)

What AFW pump problem would be caused by back leakage of main feedwater into the AFW pump suction piping?

QUESTION 6.07 (1.00)

What air system design feature is installed to limit the rate of high pressure air loss during a major air line rupture?

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

QUESTION 6.08 (1.00)

a. How will the steam generator atmospheric relief valves fail (open, closed, as-is) if there is a complete loss of pneumatic pressure to the valve? (.5)

b. What design feature is employed to reduce the likelihood of a complete loss of pneumatic pressure to the steam generator atmospheric relief valves? (.5)

QUESTION 6.09 (1.00)

a. What signal(s) will cause the automatic closure of the CCW containment isolation valves? Include setpoints and coincidence. 0.5 (~~1.0~~)

b. Why are bypass valves installed around the CCW containment isolation valves? 0.5 (~~1.0~~)

QUESTION 6.10 (1.00)

Describe how two of the four types of fire detectors used at Callaway detect the presence of fires.

QUESTION 6.11 (1.00)

Name two of the three interlocks which must be satisfied in order to move the fuel handling system's transfer car.

QUESTION 6.12 (1.00)

What is the source of normal and emergency makeup to the spent fuel system?

QUESTION 6.13 (3.00)

a. Name four of the five control circuits which receive an auctioneered high Tave signal. (2.0)

b. Describe how the auctioneered low Tave signal is used. Include setpoints. (1.0)

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

QUESTION 6.14 (1.00)

Name two loads which are started by the LOCA sequencer which are not started by the LOP sequencer.

QUESTION 6.15 (1.00)

Why is it inadvisable to take more than one power range instrument at a time out of service during refueling?

QUESTION 6.16 (1.00)

Why are orifices installed in the reactor vessel head vent lines?

QUESTION 6.17 (1.00)

Name four conditions which will cause a Control Room Ventilation Isolation. Setpoints are not required.

QUESTION 6.18 (1.00)

A high radiation alarm is received on a particulate monitor. The filter push button is depressed, advancing the filter. Immediately after being returned to service the particulate monitor high radiation alarm actuates again. Is the alarm valid? Explain.

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

QUESTION 6.19 (1.00)

Why is the reactor makeup water valve V178 required to be closed when the reactor is in Mode 5? Refer to Figure 6-19.

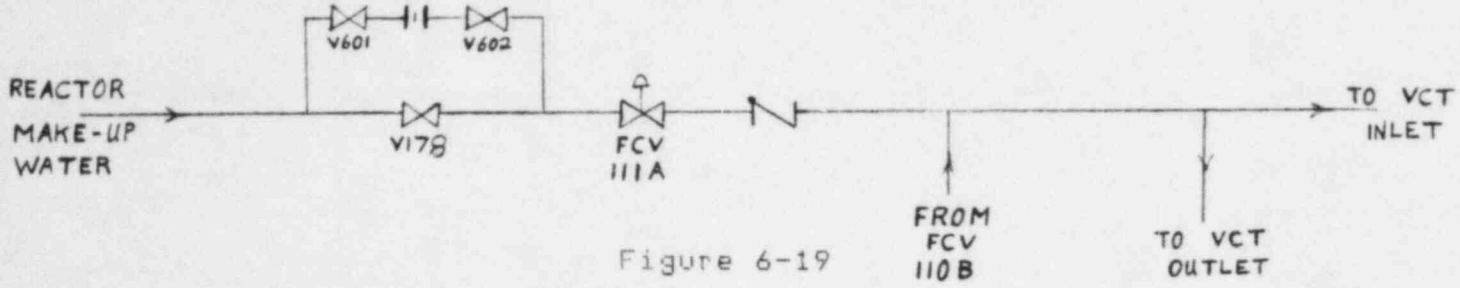


Figure 6-19

QUESTION 6.20 (1.00)

Why are anti-reverse rotation devices installed on the reactor coolant pumps to prevent their reverse rotation?

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

QUESTION 7.01 (1.00)

What four indications are used to verify a reactor trip per E-0?

QUESTION 7.02 (1.50)

a. What is ADVERSE CONTAINMENT? (.5)

b. Why are RCS wide range RTDs used instead of core exit TCs to determine RCS subcooling during ADVERSE CONTAINMENT? (1.0)

QUESTION 7.03 (1.00)

a. Main steam lines should be isolated following an SI if steam generator pressure drops below _____ psig. (.25)

b. If RCS pressure drops below _____ psig, the RHR pumps must be manually restarted. (.25)

c. Alternate water sources for the AFW pumps will be necessary if CST level decreases below _____. (.25)

d. Manually reinitiate SI if pressurezer level drops below _____ during ADVERSE CONTAINMENT. (.25)

QUESTION 7.04 (1.50)

What four conditions specified in E-0 require one or more RCPs to be tripped?

QUESTION 7.05 (1.00)

What action must be taken if two or more rods do not fully insert after a reactor trip?

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

QUESTION 7.06 (1.00)

If a pressurizer spray valve fails open and can not be closed, its associated RCP must be stopped. If pressurizer pressure continues to decrease, procedure ES-01 requires the D RCP to be stopped. Explain why.

QUESTION 7.07 (1.00)

When, following a failed RCP start attempt in which the RCP failed to achieve full speed, can a restart be attempted?

QUESTION 7.08 (1.50)

What five indications, per ES-0.4, are used to verify natural circulation?

QUESTION 7.09 (1.00)

Why are the seal injection throttle valves opened VERY SLOWLY when restoring seal injection flow to the RCPs?

QUESTION 7.10 (1.00)

Name the four ways specified in the steam generator tube rupture procedure to identify the ruptured steam generator.

QUESTION 7.11 (1.00)

In addition to dumping steam to the condenser or out the atmospheric relief valves, what two methods are available for post steam generator tube rupture cooldown?

QUESTION 7.12 (1.00)

What would be the indication of voiding in the RCS during depressurization?

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

QUESTION 7.13 (2.00)

a. When, after a LOCA, must ECCS be transferred from injection to cold leg recirculation? (.5)

b. When, after a LOCA, must ECS be transferred from cold leg to hot leg recirculation? (.5)

c. What are the two reasons for transferring to hot leg recirculation? (1.0)

QUESTION 7.14 (1.50)

a. What is the pressurizer auxiliary spray water differential temperature limit? (.5)

b. What action must be taken if this differential temperature limit is exceeded? (1.0)

QUESTION 7.15 (2.00)

All RCPs and RHR pumps may be shut off for a certain period of time during cold shutdown provided two precautions are observed.

a. How long is that period of time? (0.5)

b. What are those two precautions? (1.5)

QUESTION 7.16 (1.00)

Any plant changes which cause a sudden change in RCS temperature during an approach to criticality must be avoided. Name two plant changes which could affect RCS temperature.

QUESTION 7.17 (1.00)

What action must be taken if the reactor is not critical by the time the control rods reach the maximum allowable withdrawal limit?

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

QUESTION 7.18 (1.00)

What action must be taken following a thermal power change in excess of 15% of rated thermal power?

QUESTION 7.19 (1.00)

Why should the turbine not be operated at load with a back pressure in excess of 5 inches of mercury absolute?

QUESTION 7.20 (1.00)

When must the PORV Cold Overpressure Mitigation System be placed into service?

QUESTION 7.21 (1.00)

What are the immediate operator actions in case of a continuous rod withdrawal accident?

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

QUESTION 8.01 (.50)

True or False. The shift compliment may be one less than the minimum requirement for a maximum of two hours in order to accomodate on-coming shift members who arrive late.

QUESTION 8.02 (.50)

Who has the authority to clear the Control Room of nonessential personnel?

QUESTION 8.03 (1.00)

If an individual performing an activity can not follow the procedure as written, what must he do?

QUESTION 8.04 (.50)

True or False. If a temporary procedure change is being written, approved, and implemented in the field, its implementation is permitted prior to completion of the Nuclear Safety Evaluation Checklist.

QUESTION 8.05 (.50)

If a temporary change to a procedure is given to the SS/OS on a backshift, to whom does he send the original copy of this temporary change?

QUESTION 8.06 (.50)

Who can approve deviations from the overtime restrictions?

QUESTION 8.07 (.50)

True or False. Routine Reactor Building entries require completion of a Very High Radiation Area Access Request Form (CA 420) prior to the entry if the Reactor Building is designated a Very High Radiation Area.

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

QUESTION 8.08 (.50)

A maximum of _____ people are allowed inside containment at any one time while the reactor is in mode 1.

QUESTION 8.09 (1.00)

What action must be taken if the 2047 level Personnel Hatch becomes inoperable while personnel are inside containment when the reactor is in mode 1?

QUESTION 8.10 (.50)

Which individual has the authority to waive the pre-entry radiation survey requirement when conditions necessitate immediate access to the Reactor Building?

QUESTION 8.11 (.50)

True or False. The protective clothing requirements for an emergency Reactor Building entry are not applicable to fire brigade members who are dressed in bunker gear.

QUESTION 8.12 (.50)

True or False. Personnel entering a suspected atmosphere of unknown hazards in an emergency situation shall use an air purifying respirator (filter mask) until the atmosphere can be tested.

QUESTION 8.13 (.50)

True or False. Personnel who have accessed the RCA under a GRWP are not permitted to enter a room which has a SRWP in effect for any portion of that room.

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

QUESTION 8.14 (1.00)

a. Who has jurisdictional authority over the main generator disconnect switches? (.5)

b. Who has functional authority over the main generator disconnect switches? (.5)

QUESTION 8.15 (2.00)

Name two general situations in which tags placed on safety related systems do not require physical independent verification to be performed.

QUESTION 8.16 (1.00)

Name two of the three general categories of Safety Related systems.

QUESTION 8.17 (1.50)

a. What is the purpose of a Local Control Tag? (1.0)

b. How many Local Control Tags may be issued for a component at one time? (.5)

QUESTION 8.18 (.50)

If the individual holding the Workman's Protection can not be reached, who may assume responsibilty and authorize release?

QUESTION 8.19 (.50)

True or False. Priority E maintenance may start without an approved work request.

QUESTION 8.20 (.50)

True or False. Personnel Protection requirements are unnecessary and need not be assigned by the Safety Department prior to entry into a confined space if the atmosphere is classified as Class A.

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

QUESTION 8.26 (.50)

True or False. When one component addressed in a surveillance is in the Equipment Out-of-Service Log, the surveillance can not be signed as acceptable until the out-of-service component is returned to service and tested.

QUESTION 8.27 (.50)

True or False. Equipment Out-of-Service Log entries are required to be made for all Technical Specification equipment taken out of service, even if the reactor is in mode 4 and the equipment is only required to be operable when the reactor is in mode 1.

QUESTION 8.28 (.50)

Which of the following log books is NOT required to be reviewed by the on-coming shift supervisor PRIOR to watch relief?

a. Workman's Protection Assurance and Caution Tagging Log

b. U. R. O. Log

c. Temporary Modification Log

d. Equipment Out-of-Service Log

QUESTION 8.29 (1.50)

a. Which Technical Specification Safety Limit is applicable when the reactor is in mode 5? (.5)

b. What two actions must be taken within one hour if this Safety Limit is violated while the reactor is in mode 5? (1.0)

QUESTION 8.30 (1.00)

How many centrifugal charging pumps are required by Technical Specifications to be operable when the reactor is in mode:

a. 2?

b. 4?

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

QUESTION 8.31 (.50)

Whose permission is needed prior to changing the position of any locked component?

QUESTION 8.32 (1.00)

How is the position of a locked open valve verified if an installed locking device prevents handwheel movement?

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

Master

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 5.01 (1.50)

SDM in mode 5 is 1.0% Δk/k (.2)
SDM in mode 4 is 1.3% Δk/k (.2)
increase in SDM is .3% Δk/k, which equals 300 pcm (.3)
from Figure 5-1a, boron worth at 1000 pcm and 200 F is 13 pcm/ppm (.3)
change in boron concentration is 300/13 = 23 ppm (.2)
from Figure 5-1b, 220 gallons of boric acid must be added (.3)

REFERENCE
Tech Specs 3.1.1.1, 3.1.1.2, Table 1.2
KSA 3.1 001 010 K5.35; 3.6

ANSWER 5.02 (1.00)

Critical rod position is predicted to be greater than the zero power rod insertion limit (46 steps on bank C or 161 steps on bank B).

REFERENCE
Tech Specs 4.1.1.1.1
KSA 3.1 001 010 K5.35; 3.6

ANSWER 5.03 (1.00)

At 1000 MWD/MTU the poison rods are burning out, offsetting fuel depletion. At 9000 MWD/MTU almost all of the poison rods have burned out, requiring boron dilution to offset fuel depletion.

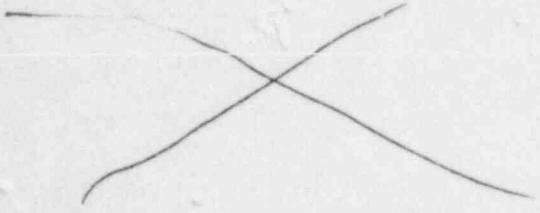
REFERENCE
Large PWR Core Control, p 2-12
KSA 3.1 001 010 K5.21; 3.9

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 5.04 (2.00)

a. Any three of the following (.5 each):
   1. Maintain acceptable power distribution limits.
   2. Maintain minimum shutdown margin.
   3. Limit potential effects of rod misalignment.
   4. Minimize effects of an ejected rod.

b. Maintain a negative MTC. modified



REFERENCE
a. Tech Spec Bases 3/4 1.3
   KSA 3.1-2 K5.04; 4.7

b. Curve Book Figure 2-13

ANSWER 5.05 (1.00)

Possibility of localized damage from some of the fuel elements becoming overheated. OR Exceeding power peaking factors.

REFERENCE
Large PWR Core Control, p 4-29
KSA 3.1-3 K5.38; 4.1

ANSWER 5.06 (1.00)

Ensure that the axial peaking factor for $F_Q(Z)$ is not exceeded during either normal operation or xenon redistribution.

REFERENCE
Tech Spec Bases 3/4 2.1
KSA 3.1-4 K5.52; 3.6

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 5.07 (2.00)

a. False (.5)

b. True (.5)

c. True (.5)

d. False (.5)

REFERENCE
Curve Book Figures 4-1, 4-2 and 4-3
Large PWR Control, p 4-31
KSA 3.1-2 K5.13; 4.0

ANSWER 5.08 (1.00)

Delayed neutrons are born at energies below the threshold energy for fast fission of uranium 238. ~~(which is more significant for a large, low-enriched core than is the reduced probability for delayed neutron leakage.)~~

REFERENCE
Fundamentals of Nuclear Reactor Physics, p 7-34
3.1 001 000 K5.47; 3.4

ANSWER 5.09 (1.00)

Production of plutonium isotopes.

REFERENCE
Fundamentals of Nuclear Reactor Physics, p 7-33
KSA 3.1-3 K5.47; 3.4

ANSWER 5.10 (.50)

Borate

REFERENCE
Large PWR Core Control, p 8-32
KSA 3.1-2 K5.06; 4.1

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 5.11 (1.00)

More negative MTC at EOL. (.5)
Greater fuel depletion at the bottom of the core at EOL. (.5)

REFERENCE
Large PWR Core Control, p 8-20
KSA 3.1-38 EK1.21; 3.2

ANSWER 5.12 (1.00)

a. ~~10~~ 9 to 15 seconds ~~immediately~~ (.5)

b. 12 to 16 minutes (.5)

REFERENCE
Fundamentals of Nuclear Reactor Physics, p 7-70
KSA 3.1-43 EK1.04; 3.9

ANSWER 5.13 (1.00)

Increasing moderator temperature increases the neutron migration length, increasing the probability of neutron leakage. With more rods inserted into the core, the significance of neutron leakage becomes greater for a given temperature. Increasing neutron leakage causes MTC to become more negative. or increases buckling.

REFERENCE
Large PWR Core Control, p 3-22
KSA 3.1-35 EK1.17; 3.7

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 5.14 (.75)

1500 psig = 1515 psia
1515 psia corresponds to a saturation temperature of 598 F
598 - 100 = 498 F
498 F corresponds to a saturation pressure of 675 psia
675 psia = 660 psig (.75)
(650 to 670 psig will be awarded full credit)

REFERENCE
Steam Tables
KSA 3.1-4 K5.56; 4.6

ANSWER 5.15 (.75)

2100 psig = 2115 psia
25 psig = 40 psia
Isenthalpic expansion of saturated steam from 2115 psia to 40 psia gives a saturated mixture of liquid and steam.
The saturation temperature at 40 psia is 267 F. (.75)
(260 F to 280 F will be awarded full credit.)

REFERENCE
Steam Tables
Mollier Diagram
KSA 3.3-2 A1.09; 3.7

ANSWER 5.16 (1.00)

Any two of the following:
1. Radiolytic decomposition of water (.5)
2. Zirconium-water reactions (.5)
3. Metal corrosion (.5)
4. Release of hydrogen dissolved in the RCS (.5)

REFERENCE
Containment Ventilation Lesson Plan, p 20
KSA 3.6-23 K5.03; 3.6

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 5.17 (1.50)

a. 6% (.5)

b. Prevent an explosion. (1.0)

REFERENCE
Containment Ventilation Lesson Plan, p 21
KSA 3.1-16 K5.02; 3.9

ANSWER 5.18 (1.50)

~~(Nominal 100% power Tave is 588.5 F.)~~ ~~(.2)~~

Lowest opening steam generator safety valve setpoint is 1185 psig. (.2)

1185 psig = 1200 psia (.2)

Saturation temperature corresponding to 1200 psia is 567 F. (.2)

Steam generator pressure at 100% power is 1000 psig.

1000 psig = 1015 psia (.2)

Saturation temperature corresponding to 1015 psia is 547 F. (.2)

567 F - 547 F = 20 F (.3)

REFERENCE
Tech Spec 3/4, p 7-3
Rod Control Lesson Plan, p 6
KSA 3.2-5 K5.08; 4.1

ANSWER 5.19 (2.50)

a. Prevent Thot from reaching saturation. (.5)

b. As power increases, ΔT increases, so Tave must decrease to keep Thot from reaching saturation. ~~Remains T~~ (.5)

c. See attached Figure 5-19. Tave increases from 0 to 100% power. (1.0)

d. Steam Generator Safety Valves (.5)

REFERENCE
Thermal Hydraulics, p 13-53
Tech Specs, p 2-1
System Generics 2-1, #5

FIGURE 5-19

REVISION 1

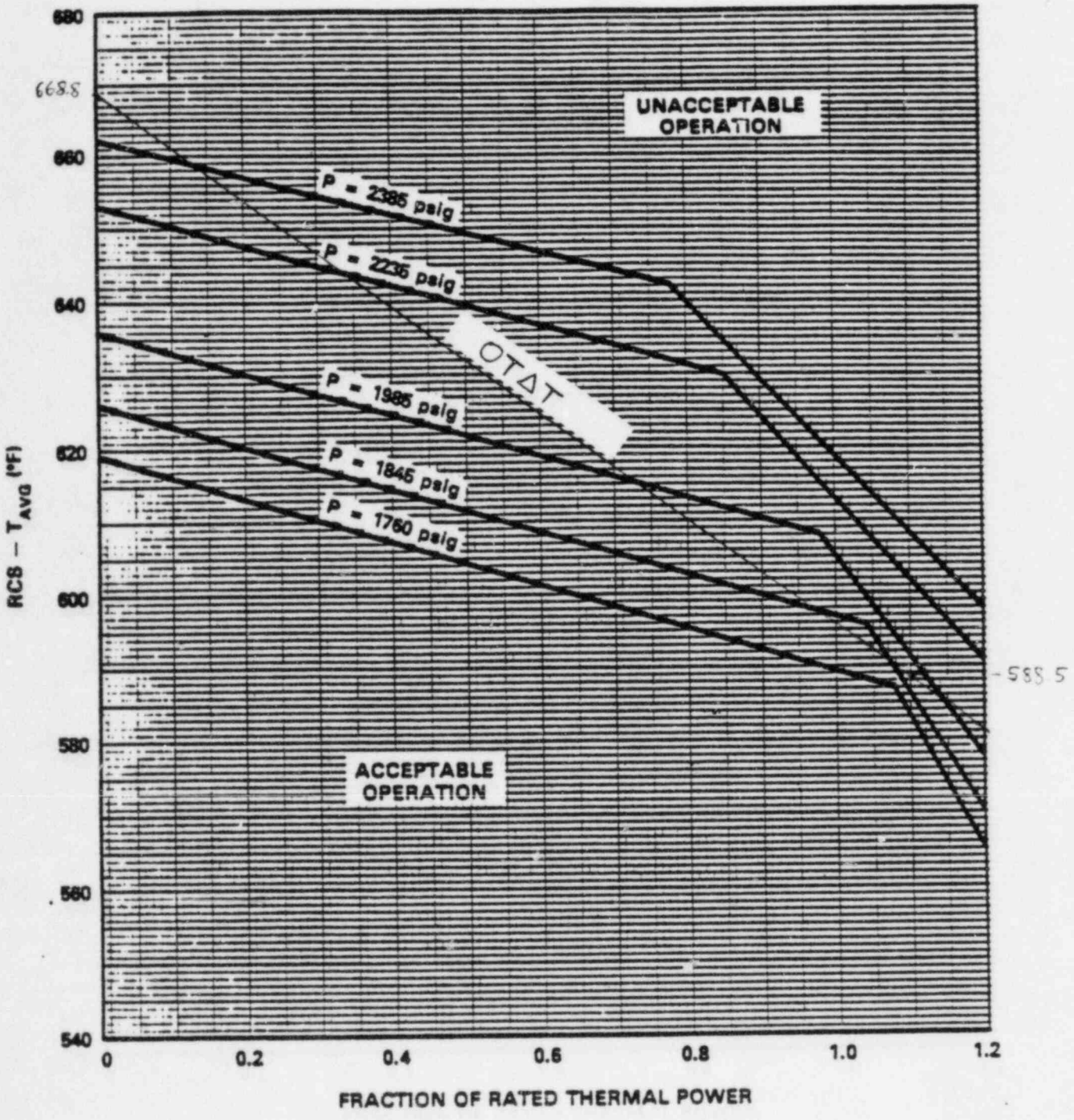


FIGURE 2.1-1

REACTOR CORE SAFETY LIMIT - FOUR LOOPS IN OPERATION

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

KSA 3.9-2 K5.01; 3.8

ANSWER 5.20 (1.00)

Neutron embrittlement

REFERENCE
Tech Specs Figure 3.4-3
Thermal Hydraulics, p 13-60
KSA 3.1-2 K5.15; 4.0

ANSWER 5.21 (1.00)

So the pump reaches rated speed faster, thus limiting the amount of time starting current is applied to the pump.

REFERENCE
Thermal Hydraulics, p 10-43
KSA p A-9, #12

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 6.01 (1.00)

The motor-operated gate valves for B and C accumulators may become inoperable after a LOCA because of their location. These accumulators have two vent valves to provide redundant means for venting nitrogen and preventing it from being introduced into the RCS.

REFERENCE
Accumulator Lesson Plan, p 4
KSA 3.2-13 K6.03; 3.2

ANSWER 6.02 (2.00)

a. Boron dilution protection system: if counts received by the source range instruments in one minute exceed twice the number of counts received in any one of the last ten minutes, charging pump suction shifts from the VCT to the RWST. (1.0)

b. Regain adequate shutdown margin. (1.0)

REFERENCE
NIS Lesson Plan, p 18

ANSWER 6.03 (1.00)

power range low power trip

REFERENCE
NIS Lesson Plan, p 27

ANSWER 6.04 (2.00)

1. RHR suction valves from the RCS (8701 A/B or 8702 A/B) must be closed. (.5)
   Overpressurization protection for the SI system. (.5)
2. Either both of the SI pump recirc valves (8814 A/B) or the common header isolation valve (8813) must be closed. (.5)
   Prevents pumping of radioactive fluid back to the RWST. (.5)

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

REFERENCE
RHR Lesson Plan, p 6

ANSWER 6.05 (2.00)

a. 1. 2/4 lo-lo steam generator levels (.05) of 23.5% (.1) on 1/4 steam generators (.1)
   2. loss of both MFW pumps (.25)
   3. LOCA sequencer (.25)
   4. LOP sequencer (.25)

b. 2/3 AFW suction pressure of 21.71 psia or less (.5) in conjunction with an AFW actuation signal (.5).

REFERENCE
AFW Lesson Plan, p 15

ANSWER 6.06 (1.00)

Possible pump failure due to steam binding. OR
Overpressurization of AFW pump suction piping.

REFERENCE
IE Bulletin No 85-01
KSA 3.5-43 A2.06; 3.0
Info significant operating experience report 82-3

ANSWER 6.07 (1.00)

Flow restricting orifices.

REFERENCE
Service and Instrument Air Lesson Plan, p 11

ANSWER 6.08 (1.00)

a. Closed (.5)

b. Nitrogen Accumulator (.5)

REFERENCE
Main Steam System P+ID, OP-M-02AB01(Q)
Service and Instrument Air Lesson Plan, p 10

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 6.09 (1.00)

a. CIS 'B': 2/4 containment pressure signals 27 psig or greater (0.5 ~~1.0~~)

b. Restore CCW flow to the RCPs during a CIS 'B' condition (0.5 ~~1.0~~)

REFERENCE
CCW Lesson Plan, p 19 and 22
Containment Spray Lesson Plan, p 11

ANSWER 6.10 (1.00)

Any two of the following (.5 each):
1. Ionization: detects ions produced during combustion.
2. Photo-electric: detects visible smoke particles.
3. Infrared: senses light produced by open flames.
4. Thermal: senses rate of temperature rise. or when preset temperature is reached

REFERENCE
Pyrotronics Lesson Plan, p 7

ANSWER 6.11 (1.00)

Two of the following:
1. Permissive switch on the containment control console is in the permissive position. (.5)
2. Both upender lifting arms are in the down position. (.5)
3. The fuel transfer tube gate valve is fully open. (.5)

REFERENCE
Fuel Handling System Lesson Plan, p 9

ANSWER 6.12 (1.00)

Normal - CVCS (.5)
Emergency - ESW (.5)

REFERENCE
Fuel Pool Cooling Lesson Plan, p 10

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 6.13 (3.00)

a. Four of the following (.5 each):
   1. Rod Control System
   2. Steam Dump Control System
   3. Pressurizer Level Control System
   4. Reactivity Computer for MTC
   5. Rod Insertion Limit

b. C-16, the automatic turbine loading stop signal (.25) which inhibits turbine loading if Tave is less than 553 F (.25) or 20 F below Tref (.25), whichever is lower (.25).

REFERENCE
RCS Instrumentation Lesson Plan, p 18

ANSWER 6.14 (1.00)

Any two of the following (.5 each):
1. SI pumps
2. RHR pumps
3. Containment Spray Pumps

REFERENCE
Safeguards Power Lesson Plan, p 3-15, 16

ANSWER 6.15 (1.00)

If two or more power range instruments exceed P-10, both source range detectors would be disabled.

REFERENCE
NI Lesson Plan, p 23

ANSWER 6.16 (1.00)

Limit flow to the capacity of one centrifugal charging pump in the event of a vent line rupture.

REFERENCE
Reactor Vessel and Core Construction Lesson Plan, p 21

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 6.17 (1.00)

Any four of the following:

1. Containment High Radiation RE 31+32 (.25)
2. Control Room Air Supply High Radiation RE 04+05 (.25)
3. Containment Purge Exhaust High Radiation RE 22+33 (.25)
4. Containment Isolation Phase A (.25)
5. Safety Injection (.25)
6. Fuel Building High Radiation (FBIS) (.25)

REFERENCE
Ventilation System Lesson Plan, p 11

ANSWER 6.18 (1.00)

The alarm is not valid. (.5) It takes several minutes for particulates to collect on the filter paper and be transported to the detector. (.5)

REFERENCE
Process Radiation and Area Radiation Monitoring System Lesson Plan, p 9 and 18

ANSWER 6.19 (1.00)

Minimize the severity of a dilution accident.

REFERENCE
CVCS P+ID, OP-22BG05(Q), Note 14

ANSWER 6.20 (1.00)

Reverse rotation during pump starts causes excessive starting currents.

REFERENCE
Reactor Coolant Lesson Plan, p 10

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 7.01 (1.00)

1. All rod bottom lights illuminated (.25)
2. Reactor trip and bypass breakers open (.25)
3. NR-45 recorder - decreasing flux (.25)
4. NIS indicators - decreasing flux (.25)

REFERENCE
E-0, p 2

ANSWER 7.02 (1.50)

a. 160 F (.5)

b. Core exit TCs are not reliable in the post-LOCA containment environment. (1.0)

REFERENCE
E-0, p 2 and 13

ANSWER 7.03 (1.00)

a. 615 (.25)

b. 320 (.25)

c. 15% (.25)

d. 28% (.25)

REFERENCE
E-0, p 6, 8 and 14, and the foldout

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 7.04 (1.50)

1. At least one charging pump or SI pump running and RCS pressure less than 1400 psig. (.6) (.3)
2. CCW flow to the RCP motor is lost for more than two minutes. (.3)
3. Upper bearing temperature reaches 195 F. (.15)
4. Lower bearing temperature reaches 195 F. (.15)

REFERENCE
E-0 foldout

ANSWER 7.05 (1.00)

Emergency borate 100 ppm for each control rod not fully inserted.

REFERENCE
ES-0.1, p 3

ANSWER 7.06 (1.00)

The spray driving head is the differential pressure between the surge line and spray line. With D RCP running, the static pressure at the surge line will be less than the static pressure in the loop with the idle RCP, thereby generating spray flow.

REFERENCE
Reactor Coolant Lesson Plan, p 22

ANSWER 7.07 (1.00)

After the motor has been allowed to cool by standing idle for at least 30 minutes.

REFERENCE
ES-0.1, attachment 4, p 1

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 7.08 (1.50)

1. RCS subcooling - more than instrument error OR per ~~curve~~ graph) (.3)
2. Steam pressure - stable (.3)
3. RCS hot leg temperature - stable or slowly decreasing (.3)
4. RCS cold leg temperature - near saturation temperature for steam pressure (.3)
5. Core exit TCs - stable or slowly decreasing (.3)

REFERENCE
ES-0.4, attachment 2

ANSWER 7.09 (1.00)

Avoid thermally shocking the RCP bearings and seals.

REFERENCE
ES-1.1, attachment 4, p 2

ANSWER 7.10 (1.00)
any 3 or 4 of the following (1.25 each):
1. Unexpected increase in the steam generator narrow range level ~~(.25)~~
2. High activity in the steam generator sample ~~(.25)~~
3. High radiation in the steam generator steam line ~~(.25)~~
4. High radiation in the steam generator blowdown line (.25)
5. Reduced feed flow to the affected steam generator ~~(.25)~~

REFERENCE
E-3, p 4

ANSWER 7.11 (1.00)

1. Backfill (.5)
2. Blowdown (.5)

REFERENCE
ES-3.1, 3.2, 3.3

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 7.12 (1.00)

Rapidly increasing/fluctuating pressurizer level.

REFERENCE
ES-1.2, p 17

ANSWER 7.13 (2.00)

a. When RWST level drops to 36% (.5)

b. 24 hours after initiation of the LOCA (.5)

c. 1. Flush boron from the upper regions of the core (.5)
2. Quench any steam bubble in the top of the head (.5)

REFERENCE
SI Lesson Plan, p 8
E-1, p 12 and 13

ANSWER 7.14 (1.50)

a. 320 F (.5)

b. Initiate an incident report for accountability (1.0)

REFERENCE
OTG-ZZ-00001, step 2.6.1.1

ANSWER 7.15 (2.00)

a. One hour (.5)

b. 1. No operations which could cause RCS dilution are permitted. (.75)
2. Core outlet temperature is maintained at least 10 F below saturation. (.75)

REFERENCE
OTG-ZZ-00001, step 2.9.1

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 7.16 (1.00)

1. Feeding the steam generators (.5)
2. Withdrawing steam from the steam generators (.5)

REFERENCE
OTG-ZZ-00002, step 2.8

ANSWER 7.17 (1.00)

Fully insert Control Bank D

REFERENCE
OTG-ZZ-00002, step 4.2.11

ANSWER 7.18 (1.00)

Sample the unit vent and containment purge for principle gamma emitters.
OR RCS Dose Equivalent iodine and gross activity is completed.
REFERENCE OR Notify Chemistry to sample the RCS
OTG-ZZ-00003, step 2.6
00004, 2.9 and 2.10

ANSWER 7.19 (1.00)

A generator or electrical trip could overspeed the turbine.

REFERENCE
OTG-ZZ-00003, step 2.7

ANSWER 7.20 (1.00)

Prior to any RCS cold leg temperature reaching 368 F ~~(.5)~~
~~(and with pressurizer pressure 700 psig)~~ ~~.5)~~

REFERENCE
OTG-ZZ-00006, step 4.1.23

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 7.21 (1.00)

1. Place the rod bank selector switch in manual and attempt to insert the control rods. (.5)
2. If the rods continue withdrawing, trip the reactor. (.5)

REFERENCE
OTO-SF-00002, p 2

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 8.01 (.50)

False

REFERENCE
APA-ZZ-00010 step 6.6

ANSWER 8.02 (.50)

SS/OS

REFERENCE
APA-ZZ-00010 step 6.8.3

ANSWER 8.03 (1.00)

Place the system/component in a stable and safe condition (.5) and notify the responsible supervisor. (.5)

REFERENCE
APA-ZZ-00100 step 2.2.4.1.1

ANSWER 8.04 (.50)

True

REFERENCE
APA-ZZ-00101 step 5.1.5.1

ANSWER 8.05 (.50)

RMS Supervisor (Document Control)

REFERENCE
APA-ZZ-00101 step 5.1.11

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 8.06 (.50)

Plant Manager or EDO.

REFERENCE
APA-ZZ-00130 step 2.2

ANSWER 8.07 (.50)

False

REFERENCE
APA-ZZ-00160 step 4.4.4.1.3

ANSWER 8.08 (.50)

20

REFERENCE
APA-ZZ-00160 step 4.4.4.3.4

ANSWER 8.09 (1.00)

Reactor Building access should be discontinued and all personnel should exit the Reactor Building.

REFERENCE
APA-ZZ-00160 step 4.4.4.3.5

ANSWER 8.10 (.50)

Shift Supervisor

REFERENCE
APA-ZZ-00160 step 4.4.5.1

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 8.11 (.50)

True

REFERENCE
APA-ZZ-00160 step 4.4.5.1.4

ANSWER 8.12 (.50)

False

REFERENCE
APA-ZZ-00160 steps 4.13.6.4 and 4.13.7

ANSWER 8.13 (.50)

False

REFERENCE
APA-ZZ-00161 step 3.5

ANSWER 8.14 (1.00)

a. Power Dispatcher

b. SS/OS

REFERENCE
APA-ZZ-00310 step 3.4.2

ANSWER 8.15 (2.00)

1. When independent indication unequivocally depicts the status of the component.
2. When the concept of ALARA would be violated.

REFERENCE
APA-ZZ-00310 step 4.2.2.1

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 8.16 (1.00)

Two of the following:
1. systems which assure the integrity of the RCS boundary.
2. systems which assure the capability to shutdown the reactor and maintain it safely shutdown.
3. systems which mitigate off-site exposures.

also systems covered by supplemental QA programs for fire protection, seismic class II/I or Group D augmented.

REFERENCE
APA-ZZ-00101 step 2.8
ODP-ZZ-00002 step 2.2

ANSWER 8.17 (1.50)

a. Protection of the individual who must operate a component during the course of maintentance or testing. (1.0)

b. One or allow person ~~to read~~ other than regular operator to operate equipment (.5)

REFERENCE
APA-ZZ-00310 steps 3.5.2.1 and 3.5.2.5

ANSWER 8.18 (.50)

EDO

REFERENCE
APA-ZZ-00310 step 4.3.2

ANSWER 8.19 (.50)

True

REFERENCE
APA-ZZ-00320 step 2.9.1

ANSWER 8.20 (.50)

False

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

REFERENCE
APA-ZZ-00372 step 4.4.1.6

ANSWER 8.21 (1.00)

a. Plant Manager or EDO

b. SS

REFERENCE
APA-ZZ-00380 steps 5.1.5.1.1 and 5.1.5.2

ANSWER 8.22 (.50)

False

REFERENCE
APA-ZZ-00742 step 5.2.2

ANSWER 8.23 (.50)

OS

REFERENCE
APA-ZZ-00743 step 2.2

ANSWER 8.24 (2.00)

a. Site Emergencies

b. Alert

c. Public Relations

d. Recovery Manager

REFERENCE
EIP-ZZ-00102 steps 4.3, 4.11.1, 4.10.4 and 4.12

QUESTION 8.21 (1.00)

Who is the approval authority for installing jumpers on:

a. Safety Related equipment? (.5)

b. non-Safety Related equipment? (.5)

QUESTION 8.22 (.50)

True or False. When several hot work jobs are to be performed in a plant area where hot work permits are required, only one hot work permit needs to be issued.

QUESTION 8.23 (.50)

Who is the Fire Brigade Leader?

QUESTION 8.24 (2.00)

Complete the following statements.

a. Evacuation is mandatory for emergencies classified as _____ or higher. (.5)

b. The OSC shall be activated for emergencies classified as _____ or higher. (.5)

c. The emergency coordinator or EDO shall contact _____ to give approved information for release to the news media. (.5)

d. At Site or General Emergency classification levels, the _____ is notified and asked to activate the Corporate Emergency Organization. (.5)

QUESTION 8.25 (1.00)

Under what circumstances is it permissible to use recycled (tritiated) water to provide makeup to the RMWST?

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

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 8.25 (1.00)

To avoid load reduction when normal makeup water is not available from the DWST or RMWST.

REFERENCE
Standing Order 85-025

ANSWER 8.26 (.50)

False

REFERENCE
Standing Order 84-24

ANSWER 8.27 (.50)

True

REFERENCE
ODP-ZZ-00002 step 4.1.2

ANSWER 8.28 (.50)

b.

REFERENCE
ODP-ZZ-00003 steps 4.2.4 and 4.2.7.2

ANSWER 8.29 (1.50)

a. RCS pressure shall not exceed 2735 psig. (.5)

b. 1. Reduce RCS pressure to within its limit within 5 minutes. (.5)
2. Notify the NRC Operations Center by telephone as soon as possible. (.5)

REFERENCE
Tech Spec 2.1.2 and 6.7.1.a

ANSWERS -- CALLAWAY -85/12/17-HIGGINS, R.

ANSWER 8.30 (1.00)

a. 2

b. 1

REFERENCE
Tech Spec 3.5.2 and 3.5.3

ANSWER 8.31 (.50)

SS/OS

REFERENCE
ODP-ZZ-00004 step 5.4.2

ANSWER 8.32 (1.00)

Remove the locking device and attempt to move the handwheel in the closed direction only enough to verify valve movement.

REFERENCE
ODP-ZZ-00004 step 6.1.2