U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-255/OLS-86-01

Docket No. 50-255 License No. DPR-20

Licensee: Consumers Power Company
212 West Michigan Avenue
Jackson, MI 49201

Facility Name: Palisades Nuclear Plant

Examination Administered At: Palisades Nuclear Plant, Covert, MI
and Midland Training Center, Midland, MI

Examination Conducted: June 24, July 22, 23 and 24, and August 27, 1986

Examiner(s): R L Higgins
R. L. Higgins — 9/30/86 Date

R L Higgins for
R. G. Clark — 9/30/86 Date

R L Higgins for
J. D. Smith — 9/30/86 Date

R L Higgins for
J. W. Upton — 9/30/86 Date

Approved By: Thomas M Burdick
Thomas M. Burdick, Chief
Operating Licensing Section — 9/30/86 Date

Examination Summary

Examination administered on June 24, July 22, 23 and 24, and August 27, 1986 (Report No. 50-255/OLS-86-01)
Examinations were administered to two reactor operator candidates and eight senior reactor operator candidates.
Results: Both reactor operator candidates and seven senior reactor operator candidates passed.

REPORT DETAILS

1. Examiners

R. L. Higgins, RIII
R. G. Clark, PNL
J. D. Smith, PNL
J. W. Upton, PNL

2. Examination Review Meeting

An examination review meeting is no longer conducted. A copy of the examinations and answer keys are left with the facility after the last candidate completes his exam. The facility has five working days in which to make comments to the NRC concerning the examinations and answer keys. The following paragraphs contain the facility comments concerning the reactor operator examination followed by the NRC response.

Question 1.11

Facility Comment: The examination answer key indicates a value of lambda equal to .08. Our student handout assumes a value of .1 for lambda, which would change the answer to the question of rod height equal to 92 inches (+ or - 2 inches).

Recommendation: An alternate answer for rod height should be acceptable based on the value of lambda assumed.

Reference: Palisades student handout SH-PQDO Reactor Startup, Objective No. 4.24 (PQDOOK5.20).

NRC Response: Agree. The answer key was expanded to also award full credit if the candidate used a value of lambda equal to .1.

Question 2.01

Facility Comment: The examination answer key indicates a minimum of two gross radioactivity monitors for a liquid batch release. The reference cited on the key indicates only one monitor is required, which agrees with Palisades Technical Specifications.

Recommendation: Change the answer key to reflect "B. One" as the correct answer for the minimum number of gross radioactivity monitors for a liquid batch release.

Reference: Palisades Technical Specification Table No. 3.24-1, Student handout SH-PNPD Radwaste, Objective No. 4.7 (PNPDOG5.03).

NRC Response: Agree. The answer key was change to "B."

Question 2.02a

Facility Comment: The examination answer key indicates that the diesel generator K-6A jacket water cooler is supplied by critical header A. The reference cited indicates critical header B is the cooling water supply for K-6A.

Recommendation: Change the examination answer key to critical header B.

References: Palisades P&ID M-208 SH.1A, Student handout SH-PNAA Service Water System, Objective No. 4.4 (PNAAOK1.01).

NRC Response: Agree. The answer key was changed to "critical header B."

Question 2.04c

Facility Comment: The examination answer key indicates the motive force for filling a SIT is a HPSI pump. Depending upon the mode of operation assumed in answering the question, the containment spray pumps may also be used.

Recommendation: Accept containment spray pumps as an alternate answer.

Reference: SOP 4 Containment Spray and Iodine Removal System Procedure Section 7.1.1.

NRC Response: Agree. The answer key was expanded to also grant full credit for the response "containment spray pumps."

Question 2.07

Facility Comment: The examination answer key describes two flow paths by which decay heat is removed from the core to the "ultimate heat sink" immediately following a post LOCA Recirculation Actuation Signal. The answer key is not in accordance with the reference cited.

Recommendation: Revise answer key to reflect the reference cited.

Reference: Student Handouts: SH-PNMB Containment Spray System, Objective No. 4.14 (PNMBOG4.05), and SH-PNMC Containment Air Cooling System, Objective No. 4.4 (PNMCOK1.01).

NRC Response: Agree. The following changes to the answer key were made: (1) Accepted "LPSI pumps" as a correct alternative to "minirecirc pumps"; (2) Replaced "cooling towers" with "lake"; (3) Accepted "CCW" as a correct alternative to "CNTM air coolers."

Question 2.10c

Facility Comment: The examination answer key only lists one source of water to routinely fill the spent fuel pool. PMW or UW may also be used to fill the spent fuel pool on a routine bases.

Recommendation: Accept PMW via P-90 or UW via P-91 as alternate answers.

Reference: SFPO-1 Addition of Water to the Spent Fuel Pool.

NRC Response: Agree. The answer key was modified to also grant full credit for any of the following responses: "utility water"; "primary makeup water"; or "gravity feed from the SIRWT."

Question 2.11b

Facility Comment: The examination answer key lists "none" as the effect of a turbine trip signal on the feedwater regulating valves. This answer is based on the reference cited (PNGAOK3.01), which is a learning objective looking at a very specific interrelationships between systems that had been previously presented. There is an additional reference that was not cited that describes the interrelationship between a turbine trip and the feedwater regulating valves. As described in that reference the valves "remain in their as is position."

Recommendation: Change the examination answer key from "None" to "as is."

Reference: Student handouts: SH-PNGA HP and LP Turbines, Objective No. 4.15 (PNGAOK3.01), SH-PNFB Steam Generator Water Level Control, Objective No. 4.5 (PNFBOK5.03).

NRC Response: Agree. The answer was changed to "as is."

Question 2.12b,c,d,e,i

Facility Comment: The answers listed on the examination answer key are based on the reference cited (EOP-1, Attachment 3, Revision 16) which provides Reset SIS repositioning criteria; however, the question deals with SIS Actuation response.

Recommendation: Change the examination answer key to:

b. trip
c. all 3 start with standby power available
d. closed
e. closed
i. no effect

References: Palisades Logic Diagram Engineered Safeguards E-17 SH.3; EOP-1, Attachment 3, Revision 16; XE-17 SH.11.

NRC Response: Agree. The answer key was changed to b. "trip"; c. "all 3 start with standby power available"; d. "closed"; e. "closed"; and i. "no effect."

Question 3.01a

Facility Comment: The examination answer key states "Both valves shut" which is not correct, only the main feedwater regulating valve on the affected steam generator will shut.

Recommendation: Change the examination answer key to "the affected steam generator feedwater regulating valve would shut."

Reference: Palisades P&ID M-207 SH. 1, Palisades System Information Manual Chapter 6b, Page 26, Section c.2.

NRC Response: Agree. The answer key was changed to "the feedwater regulating valve for the affected steam generator would shut."

Question 3.02

Facility Comment: The examination answer key lists the synchro-transmitters as providing the input signal to the nixie tubes; actually, the synchro-transmitters provide the input signal to the Position Indication Primary (PIP) which provides the input signal to the nixie tubes. The key lists the CRDM limit switches as the input devices to the matrix board display; however, the Secondary Position Indication (SPI) provides input to the matrix board display as well.

Recommendation: Change the answer key to accept, for full credit, either the synchro-transmitters provide the input signal or the Position Indication Primary (PIP) provides the input signal to the nixie tubes. Change the answer key to also accept SPI as an input to the matrix board display.

Reference: Palisades System Information Manual Chapter 10b, Pages 10 and 11.

NRC Response: Agree. The following changes were made to the answer key: (1) Accept either "PIP" or "synchro-transmitters" as providing the input signal to the nixie tubes; (2) Accept either "SPI" or "limit switches" as providing the input signal to the matrix board display.

Question 3.03

Facility Comment: The examination answer key is not all inclusive of the automatic actions associated with loss of the instrument AC bus.

Recommendation: Change the examination answer key to also accept the items listed in the references attached.

References: ONP-24.5 Loss of Instrument AC Bus YO1, Revision 11; ARP-24, Revision 36, annunciator number 30; and P&ID M-653 SH.3.

NRC Response: Expanded the answer key to also grant credit for the following responses:

(1) SPI is lost;
(2) PIP is lost;
(3) Rod matrix display is lost;
(4) Startup, intermediate and power range recorders are lost;
(5) Cooling tower pumps trip;
(6) Pressurizer PORV temperature indication is lost;
(7) All pressurizer temperature indications are lost;
(8) Containment temperature and humidity indications are lost;
(9) Letdown and charging temperature and flow indications are lost;
(10) Boric acid storage tank levels are lost;
(11) AFW discharge pressure indication is lost; and
(12) CCW surge tank level indication is lost.

Question 3.05d

Facility Comment: The examination answer key lists the suction damper (PO-8001) closing as a result of an automatic action from the fuel handling building radiation monitor (RE-5712). The damper only closes automatically on the fan motor being de-energized.

Recommendation: Change the examination answer key to eliminate the closing of the damper for full credit as an automatic action of the associated radiation monitor.

Reference: Palisades P&ID M-658, Revision 12.

NRC Response: Agree. The answer key was modified to no longer require "closes suction damper (PO-8001)" for full credit.

Question 3.07

Facility Comment: The examination answer key does not include all of the Engineering Safety Features that could possibly be actuated on a feedline rupture inside the containment at 95% of full power.

Recommendation: Add to the examination answer key as alternate answers to the following:

Main feedwater regulating and bypass valves closing on the affected steam generator low pressure of 500 psi.

Auxiliary feedwater initiation on two out of four low level in either steam generator of 28.7%.

Control Room ventilation actuation on Containment High Pressure (CHP).

Reactor trip on CHP or Low S/G Pressure.

Reference: Palisades ARP-21 Annunciators: Page 4, Number 8, Page 5, Number 2., Page 9, Number 8.; Student Handout SH-PNPC Control Room Ventilation System, Objective No. 4.32 (PNPCG12.04).

NRC Response: Agree. The answer key was expanded to also grant credit for the following: (1) "main feedwater regulating and bypass valves closing on the affected steam generator if pressure drops below 500 psi;" (2) "auxiliary feedwater initiation due to a level indication of 28.7% or less on two out of four steam generator level indicators;" (3) "control room ventilation actuation on containment high pressure;" and (4) "reactor trip on containment high pressure or low steam generator pressure."

Question 3.08a

Facility Comment: The examination answer key does not reflect the same answer as cited in the reference.

Recommendation: Include in the examination answer key an alternate answer that reflects the cited reference.

References: Student Handout SH-PNEB Auxiliary Feedwater System, Objective No. 4.10 (PNEBG12.02).

NRC Response: Modified the answer key to also accept "Feed Only Good Generator (FOGG) is unreliable."

Question 3.09a

Facility Comment: The reference cited in the examination answer key had nothing to do with the question that was asked. In order to answer the question, formulas and values for the constants and conversion factors that the I&C Department is given and uses while calibrating the instruments should have been provided to the operators during the test. Furthermore, our calculations do not support a calculated trip set point of 230^{0} psia which would result in a reactor trip per the answer key for Channel A. We assumed a normal Th reading of 585 degrees F for non affected channels, a Th reading of 600 degrees F for the affected channel, Tc readings 535.5 degrees F and a PCS pressure of 2010 psia. Using the attached I&C Department Monthly Technical Specification Test (MI-2A), we calculated the less than full power value (PY 1)

at 2.46 volts and the greater than full power value (PY 2) at 3.012 volts. Using the standard I&C volt to psia conversion formula {[(volt-1)/4]*1000}+1500 we obtained a value of 1865 psia for a calculated trip set point for the less than full power condition and a value of 2003 psia calculated trip set point for the greater than full power condition. These calculated trip set points result in a trip free condition on Channel A with a PSC pressure of 2010 psia.

Recommendations: Because the examinees were unable to calculate the absolute value for the set point, the examination answer key should be changed to give full credit to answers that state the assumption of a Channel A TM/LP trip or trip free condition and then demonstrate the ability to determine if a reactor trip occurred in accordance with the reference cited.

Reference: Student Handout SH-PNNB Reactor Protective System, Objective No. 4.41 (PNNBG27.01); Palisades Technical Specification Test Reactor Protective Trip Units Procedure No. MI-2A, Revision 2.

NRC Response: Agree. Since the exact trip setpoint for the TMLP trip can not be calculated with the information available in the facility literature, it is uncertain whether a trip would occur. The answer key was modified to award full credit if mention was made that the TMLP setpoint was raised.

Question 3.09c

Facility Comment: Based on the interpretation of the question "PCS flow indication to" the examinee could assume failure of the same signal that provides input to the flow indication as to the trip devices.

Recommendation: Include in examination answer key an alternate answer that allows for an assumption of a trip condition on Channel C and therefore concludes with a reactor trip.

References: Palisades P&ID M-204 SH. 1, Revision 33.

NRC Response: Agree. If the candidate mentions that the flow indication to Channel C is a differential pressure signal, the candidate will be awarded full credit for stating that the reactor would trip.

Question 3.10

Facility Comment: The reference cited states, "using all available indications."

Recommendation: Accept alternate listings of "all available indications," especially with respect to Parts "c" and "d."

Reference: Palisades EOP-1, Attachment 3, Revision 16, Page 1.

NRC Response: Partially agree. The answer key will be modified as follows: (1) the response "core exit thermocouples" will also be accepted as a correct response for Part "a;" (2) the statement "on two channels" will not be required in part "d" for the "steam flow" response.

Question 4.04

Facility Comment: The objectives in our licensed operator training program do not require trainees to memorize General Operating Procedures. However, we do include objectives similar to the following: Given a simulator scenario with only one start up detector available, using GOP-3, perform an approach to criticality.

NRC Response: The candidates were not required to memorize the procedure, but they should be familiar enough with the procedure to know the major steps.

Question 4.09a

Facility Comment: The examination answer key indicates that the basis for establishing and maintaining PCS temperature at 525 degrees F to 530 degrees F is to maintain subcooling margin before initiating cooldown, which is not reflected in the reference cited.

Recommendation: Revise the examination answer key to indicate that the basis for establishing and maintaining PCS temperature at 525 degrees F. to 530 degrees F. is to maintain shutdown margin before initiating cooldown.

Reference: Palisades EOP8.2, Revision 15, Pages 1-7.

NRC Response: Agree. The answer key was changed to "Maintain shutdown margin. . ."

Question 4.10

Facility Comment: 4.10a. Based on the guidance given in our ONP-3 Loss of Feedwater, the value for either tripping the plant or reducing power is given as an approximation due to the necessary averaging of eight channels of indicators disagreeing within their expected allowed tolerances.

4.10c. and g. Neither of these states a specific value for the amount of PCS leakage, which would allow assumptions to be made by the examinees.

4.10f. The examination answer key does not reflect the reference cited.

Recommendation: 4.10a. Revise examination answer key to include as an alternate answer "Trip."

4.10c. and g. Revise examination answer key to include reasonable assumptions that could be made about the amount of PCS leakage, such as, "continue operations" due to PCS leakage within Technical Specification Limits.

4.10f. Change the examination answer key to include as an alternate answer "reduce power" based on guidance given in the reference cited.

Reference: 4.10a. ONP-3 LOSS OF FEEDWATER, Revision 11.

4.10c. and g. Palisades Technical Specifications, Section 3.1.5.

4.10f. EOP-5 LOSS OF INSTRUMENT AIR, Revision 13.

NRC Response: Partially agree. The following modifications were made to the answer key: (1) for part "a," the NRC disagrees with the facility, so the required answer remains "reduce power;" (2) for parts "c" and "g," the answer "continue operations if leakage is within Technical Specification Limits" will also be awarded full credit; and (3) for part "f," the answer "reduce power if the leak rate is small enough to allow time for component isolation and additional supply from the Feedwater Purity Building" will be awarded full credit.

The following paragraphs contain the facility comments concerning the senior reactor operator examination followed by the NRC Responses.

Question 5.02

Facility Comment: If the candidate uses only the Mollier diagram provided and follows constant enthalpy from interpolated points for 1715 psia/715 psia to 35 psia, he has to again interpolate between hundred degree lines which are one-half inch apart. Therefore, the allowable temperature band for an acceptable answer should be expanded.

Recommendation: The acceptance band should be expanded to +/- 15 degrees F. instead of +/- 5 degrees F. The concept of isenthalpic expansion is what is important, not the exact final temperature.

Reference: Mollier diagram from test, Attachment 5.02.

NRC Response: Disagree. The answer key was not changed.

Question 5.08

Facility Comment: The question infers exclusion of DNB as a possible answer.

Recommendation: Specific reference to DNB should not be a criterion to award full credit.

NRC Response: Disagree. The answer key was not changed.

Question 5.13

Facility Comment: There are several factors which change over core life to influence flux which thereby changes control rod worth. The answer key concentrates on only one of those factors. Additional acceptable factors are suggested.

Recommendation: Allow the following as an additional acceptable answer: "Neutron flux increases over the life of the core due to several factors (reduction in boron concentration, depletion of burnable poisons, fuel depletion necessitating an increase in flux to maintain a constant fission rate, etc.). This increase in flux results in a larger control rod worth since rod worth is proportional to neutron flux (thermal and epithermal)."

Reference: Palisades student handout SH-PQBO, Attachment 5.13.

NRC Response: Agree. The answer key was modified to also grant credit for the following responses: (1) "increase thermal neutron flux at EOL;" and (2) "depletion of burnable poisons and the reduction in boron reduces the competition for neutrons, causing the rods to be exposed to a greater neutron flux."

Question 6.01.b

Facility Comment: The question does not require a listing of the components supplied by CCW in containment.

Recommendation: Allow the following as an additional acceptable answer: "Prevent a loss of instrument air from causing a loss of CCW to the components in containment (cooled by CCW)."

NRC Response: Disagree. The candidate must state the specific CCW components in containment to receive full credit.

Question 6.04

Facility Comment: The description of the trip devices listed as answers 2 and 3 on the answer key may be described differently by the applicants. The following descriptions are provided to the examiner for clarification.

Recommendation: Allow the following descriptions of the main feed pump trip devices as additional acceptable answers:

1. The manual trip button (electrical) at the main feed water pump (answer 2) is actually located on the local control console.

2. The manual trip lever (mechanical) at the main feed water pump (answer 3) is actually a button or plunger type trip device.

Reference: Control Oil System Drawing for Utility Boiler Feed Pump Drive, Attachment 6.04.

NRC Response: Agree. The answer key was modified as follows: (1) for answer 2, both phrases "at the main feedwater pump" and "on the local control console" were awarded full credit; and (2) for answer 3, full credit will be given for "button or plunger type trip device" as well as "manual trip lever."

The original answers were taken verbatim from facility literature. The facility is admonished to revise its literature to reflect actual plant conditions.

Question 6.06

Facility Comment: The backup sources of seal oil vary depending upon the operating mode of the main turbine (operating or on the turning gear). Therefore, additional acceptable sources are recommended.

Recommendation: If normal seal oil pressure is decreasing, the seal oil pressure regulator automatically opens to supply backup oil from a variety of sources. These sources are:

*Air Side High Pressure Seal Oil Backup Pump

*Turning Gear Oil Pump

*Emergency Bearing Oil Pump

*Shaft Driven Main Lube Oil Pump

Emergency Air Side Seal Oil Backup Pump

*These pumps will supply seal oil via the seal oil pressure regulator. The operating condition of each of these pumps is dependent upon bearing oil pressure and turbine conditions which will determine if each pump is available, not seal oil pressure. Therefore, the order of these four (4) pumps is irrelevant when considering decreasing seal oil pressure. It is recommended that the acceptable answers be evaluated accordingly.

Reference: Seal Oil Diagram, Attachment 6.08.

NRC Response: Agree. The candidates will be awarded full credit regardless of the order in which their answers appear.

Question 6.07

Facility Comment: One of the automatic trips of the diesel generator output breaker is the diesel engine trip. Therefore, any condition which causes an automatic trip of the diesel engine (thereby causing the breaker to trip) should be an additional acceptable answer.

Recommendation: Allow the following additional acceptable answers:

-Low lube oil pressure

-Overcrank

-Overspeed

Reference: Palisades Student Handout SH-PNHB, Attachment 6.07.

NRC Response: Agree. The answer key was modified to accept "Low lube oil pressure," "overcrank," and "overspeed" as acceptable responses in lieu of the response "engine trip."

Question 6.10.c

Facility Comment: The allowable band for the approximate value of Primary Coolant Pump vapor seal pressure is too restrictive based upon operational experience. The PCP vapor seal pressure is manually controlled by throttling a manual valve (MV-2194) which controls PCP seal bleed off flow to the Volume Control Tank. Therefore, if VCT pressure is altered the vapor seal pressures will be effected also. The maximum allowable VCT pressure is 50 psig (High pressure alarm). At 50 psig in the VCT the vapor seal pressure of the PCPs will be approximately 100 psia (See control room traces from SH-PNJD, Objective No. 4.25 supporting information).

Recommendation: Revise the allowable band for approximate values of PCP vapor seal pressure to 20 to 100 psi.

Reference: Attachment 6.10.c, excerpts from SH-PHJD and ARP 4. Palisades P&ID M202, Sheet 1, Revision 32.

NRC Response: Partially agree. The answer key was modified to accept answers between 20 and 50 psia. The facility is admonished to revise its literature to correctly reflect actual plant conditions.

Question 6.10.d

Facility Comment: The allowable band for the approximate value of primary coolant pump amperage is too restrictive based upon plant experience.

Recommendation: Revise the allowable band for approximate values of Primary Coolant Pump amperage to 600 to 650 amps.

Reference: Control Room Log Sheet No. 1, May 10, 1986, Attachment 6.10.d.

NRC Response: Partially agree. The answer key was expanded to "600-630 amps." The facility is admonished to revise its literature to reflect actual plant conditions.

Question 6.11

Facility Comment: The noun name of the valve downstream of the blender (CV-2155) is commonly described as the "blender outlet valve" vs. the "boric acid makeup valve."

Recommendation: Allow an additional acceptable answer of "blender outlet valve" as a description of CV-2155.

Reference: Attachment 6.11, Palisades P&ID M-202, Sheet 1A, Revision 3.

NRC Response: Agree. The answer key was modified to also grant credit for the response "blender outlet valve" in lieu of "boric acid makeup stop valve."

Question 6.12.a

Facility Comment: An alternate acceptable answer is to describe only the configuration of the pressurizer pressure "controller" (due to the wording of the question). ("60 to 70 psi lower than the normal pressure setpoint of 2010 psia") is too restrictive based upon operational experience. Ideally, the pressure controller should be set 75 psi lower than the desired PZR pressure. This setpoint will allow the PZR spray valves to start to open thereby maintaining the desired setpoint (2010 psia); however, this is an ideal setpoint which assumes the calibration of the pressure controller and spray valves are exact. In reality, the operators adjust the setpoint of the controller to whatever pressure is necessary to maintain the desired pressure. Therefore, the acceptable band for the controller pressure should be expanded to "approximately 50 to 75 psi lower than the normal pressure setpoint of 2010 psia."

Recommendations:

1. Allow an alternate acceptable answer to be restricted only to the configuration of the pressurizer pressure "controller."

2. Expand the allowable range of the pressurizer pressure controller setpoint to "approximately 50 to 75 psi lower than the normal pressure setpoint of 2010 psia."

References: Attachment 6.12.a, excerpts from: Palisades Student Handout SH-PNKD (Objectives No. 4.14 and 4.13), Palisades SOP 1, Revision 16.

NRC Response: Disagree. The answer key was not changed.

Question 6.12.b

Facility Comment: Due to the configuration of the pressurizer pressure control system, the spray valves will be partially open when pressure is being maintained at the desired pressure (as described in the comment to part "a" of the question).

Upon an increasing pressure transient the spray valves will continue to open thereby limiting a pressure increase. According to the original design of the pressure control system these valves would not open until 2085 psia. Therefore, in accordance with our present configuration, during a transient which results in increasing pressure, the spray valves would respond more quickly than if the control system was configured according to design.

During normal operation the pressurizer pressure will fluctuate if operated according to design. The controllers for the proportional heaters will not provide the fine control necessary to maintain the desired pressure. The result is a "saw toothed" trace on the pressure recorder. With our present configuration of the control system the spray valves provide a more smooth pressure control during normal operation.

Recommendation: Allow an additional acceptable answer of "provides for smoother pressure control."

Reference: Attachment 6.12.b, excerpts from Palisades Student Handout Sh-PNKD.

NRC Response: Agree. The answer key was expanded to also grant credit for the response "smoother pressure control."

Question 6.14

Facility Comment: The answer to this question (and the plant training material) is incomplete. While it is true that the water is less dense during the recirculation phase this does not fully explain why the flowrate through the containment spray pumps increase post-RIAS.

Prior to RIAS the suction pressure of the spray pumps is determined by the level, pressure and temperature of the water in the SIRW Tank. Post-RIAS the suction pressure of the pumps is determined by the level, pressure and temperature of the water in the containment sump. The net effect of the change in these parameters is to cause the head of the containment spray pumps to decrease upon shifting of the suction to the containment sump, primarily because the suction pressure has increased dramatically. The net effect is an increase in total spray flow.

Recommendation: Allow "because the suction pressure increases post-RIAS" as an acceptable answer.

Reference: Attachment 6.14, FSAR, Table 6-7.

NRC Response: Agree. The answer key was modified to also grant full credit for the following response: "The pump must add greater head during the injection phase than during the recirculation phase. During the injection phase the pump's suction is from the SIRWT and it is pumping against high containment pressure. During the recirculation phase the pump's suction is from the containment sump, so the high containment pressure adds to the pump's suction pressure."

Question 6.18

Facility Comment: The answer key only lists valve numbers as acceptable answers. The noun names of these valves are provided for clarification.

Recommendation: Allow the following valve names in addition to valve numbers:

CV-0738, S/G Surface Blowdown Valve
CV-0739, S/G Surface Blowdown Valve
CV-0770, S/G Bottom Blowdown Valve
CV-0771, S/G Bottom Blowdown Valve
CV-0704, Blowdown Tank to Mixing Basin Valve

Reference: Attachment 6.19, SOP-7, Revision 9.

NRC Response: Full credit was awarded if the candidate used the correct valve name instead of the valve number.

Question 7.03.b

Facility Comment: The answer to this question is in EOP 1, Step No. 4.10, which is a subsequent action. Our objectives in the lesson plan for EOP 1 state that students must be able to state symptoms, automatic actions, and immediate actions from memory, without the aid of references. In accordance with NUREG 1021, ES-402, students were given the clear expectation

that they did not have to memorize specific information in subsequent actions unless there was a specific objective over a particular section of the subsequent actions, but only had to "describe generally the objectives and methods." We reviewed each of the subsequent actions of each EOP and ONP and identified several such objectives, but did not determine that memorizing the steps in Section 4.10 of EOP 1 was necessary for successful task performance, since the operator would be required to use the procedure in executing the task.

Recommendation: Allow the following as an acceptable answer:

"Isolate the steam generators and emergency borate."

NRC Response: Disagree. Operators must know what to do during circumstances which require prompt action, whether that prompt action is called "immediate action" or not. The candidate must state how to isolate the steam generator and how much to emergency borate in order to get full credit.

Question 7.04

Facility Comment: In accordance with ES-402 the candidate is expected to "describe generally the objectives and methods" of subsequent actions. Therefore, exact setpoints and details should not be required for full credit.

Recommendation: Accept the following answer as the minimum information required for full credit:

1. Unable to maintain adequate PCS subcooling.
2. Unable to maintain adequate PZR level.
3. No steam generators are available for removing heat.

NRC Response: Disagree. Operators must know what to do during circumstances which required prompt operator action, whether that action is called an "immediate action" or not. The answer key was not changed.

Question 7.05

Facility Comment: In accordance with ES-402 the candidate is expected to "describe generally the objectives and methods" of subsequent actions. The basis for this question is Step No. 4.9 of EOP 2.1, therefore, exact setpoints and details should not be required for full credit.

Recommendation: Accept the following answer as the minimum information required for full credit:

> "The two conditions are: battery discharge amps must be minimized quickly and maintained at the reduced discharge rate."

NRC Response: Partially agree. The answer key was modified to grant full credit for the response "battery current is reduced to less than 150 amps within 30 minutes of the onset of the loss of AC Power."

Question 7.06

Facility Comment: We do not have an objective addressing memorizing Section 4.1 of EOP-4, but have decided to add an objective requiring students to know these general conditions from memory. Since the basis for the question is a subsequent action (allowing time for reference to procedures) the following answer is suggested.

Recommendation: Accept the following answer as the minimum information required for full credit:

1. Primary Coolant Pump seal bleed off temperature is alarming (setpoint of alarm is 180°F.).

2. Primary Coolant Pump bearing temperature is alarming (setpoint of alarm is 175°F.).

3. All or most CRDM seal Bleed-off temperatures are alarming (setpoint of alarm is 200°F.).

4. CCW flow is interrupted and cannot be restored (greater than 10 minutes).

NRC Response: Disagree. The operator must know the conditions and actions to take when a prompt operator action is required, whether or not that action is called "immediate action." The answer key was not changed.

Question 7.07

Facility Comment: The wording of this question does not exclude the candidate from providing conditions listed in the immediate actions (see Step No. 3.4) which necessitate tripping the Reactor. The following answer is therefore suggested.

Recommendation: Allow the following as the minimum required information for awarding full credit:

"Any two (2) of the following three (3):

-air pressure less than 50 psig
-instrument air pressure dropping rapidly
-indication of erratic equipment behavior"

NRC Response: Disagree. The operator must know the conditions and actions to take when prompt operator action is required, whether or not that action is called "immediate action." The answer key was not changed.

Question 7.10

Facility Comment: In accordance with ES-402 the candidate is expected to "describe generally the objectives and methods" of subsequent actions. The basis for this question is subsequent action Step No. 4.24.3.b of EOP 8.1, therefore, details should not be required for full credit. Our analysis indicated that students do not need to state this information from memory. On-the-job performance would be done with the use of the procedure as an aid.

Recommendation: Allow the following as the minimum information required for full credit:

"Establish HPSI flow to the PCS, through the PORV's (feed and Bleed)"

Reference: Attachment 7.10, EOP 8.1, Revision 18

NRC Response: Disagree. The operator must know the conditions and actions to take when prompt operator action is required, whether or not that action is called "immediate action." The answer key was not changed.

Question 7.11

Facility Comment: The answer key omitted one of the four immediate actions of EOP 9 (Activate Site Emergency Plan) for the "fuel handling accident on the reactor refueling side" event.

Recommendation: Allow any three (3) of the following four (4) actions for full credit:

1. Dispatch personnel immediately to secure the equipment access door and the personnel air lock doors.

2. Notify the Control Room and Evacuate Containment.

3. Evaluate status of containment penetrations and initiate actions necessary to prevent air leakage from containment.

4. Activate the Site Emergency Plan.

Reference: Attachment 7.11, EOP-9, Revision 12.

NRC Response: Agree. The answer key was expanded to also grant credit for the response "activate the Site Emergency Plan."

Question 8.03

Facility Comment: This question does not match the condition statement in our objective which reads: "Given the Plant Administrative Procedures and an employee's work history for the last 168 hours, determine if the employee would exceed restrictions if assigned overtime." Our objective does not require the student to state this information from memory.

Recommendation: For comment only. No recommended action for the purposes of this examination.

NRC Response: Disagree. A senior reactor operator must know how much time operators are allowed by administrative procedure to work during a week.

Question 8.05

Facility Comment: The answer key does not state that the Shift Engineer must activate the Site Emergency Implementing Procedure during an accident.

Recommendation: Allow the following as an additional acceptable answer in lieu of "Function as site emergency director until relieved." "Implement the Site Emergency Implementing Procedures" (thereby establishing the Shift Engineer as the SED)

Reference: Attachment 8.05, EI-1. Revision 11

NRC Response: Agree. The answer key was expanded to also grant full credit for the response "implement the site emergency implementing procedures."

Question 8.06

Facility Comment: This question does not match the condition statement in our objective. We do require students to know from memory that a refamiliarization requirement exists, but we do not require memorization of the details of that section of the procedures. We expect the supervisor to look up the procedure when making the determination that a refamiliarization shift is required for somebody.

Recommendation: For comment only. No recommended action for the purposes of this examination.

NRC Response: Disagree. A senior reactor operator must know whether or not the operators under his supervision require refamiliarization training in order to satisfy the currency requirements of the plant administrative procedures.

Question 8.16.a

Facility Comment: Plant Administrative Procedure 4.02 allows a valve/breaker found out of position to be repositioned with the authorization of the Shift Supervisor. In such a situation, it would be unnecessary for the person performing the system checklist to note the condition on the "Record of Exceptions" sheet.

Recommendation: Allow the following additional answer for part "a" of the question:

> "Notify the Shift Supervisor and reposition the valve/breaker as authorized."

Reference: Attachment 8.16.a, Administration Procedure No. 4.02

NRC Response: Agree. The answer key was expanded to also grant full credit for the response "Notify the shift supervisor and reposition the valve/breaker as directed."

Question 8.19.b

Facility Comment: The plant terminology used for part "b" of the answer may not be familiar to the examiner, therefore, clarification is provided. The floor plugs are identified by the room under the floor plug (i.e., the West Safeguards room floor plug is actually located in the CCW room floor and the Safeguards room ceiling).

NRC Response: Noted.

Question 8.28.a

Facility Comment: The question does not sufficiently limit the scope of possible correct answers. For example, one possible correct answer could be "1250 mrem" in accordance with 10 CFR 20 criteria.

Recommendation: Evaluate the candidates answers in accordance with the assumptions stated.

NRC Response: Disagree. The question refers directly to a specific limitation stated in the facility's administrative procedure. The answer key was not changed.

3. Exit Meeting

On July 24, 1986, the PNL examiners met with representatives of the plant staff to discuss the results of the simulator and oral examinations. The following personnel attended the Exit Meeting:

PNL: R. G. Clark
J. D. Smith
J. W. Upton

Palisades: W. G. Merwin
R. B. Heimsath
S. Ghidotti
R. J. Frigo

NRC Senior Resident Inspector: E. R. Swanson

The examiners made the following observations concerning the training program:

a. The candidates had been well trained in the knowledge and use of plant P&IDs. They indicated competency in the use of electrical drawings as well as piping diagrams.

b. The candidates were responsive to the questions of the examiners and demonstrated their intent to convince the examiners that they could operate the power plant in a safe manner.

c. The overall rating of the simulator teams of candidates for communication would be barely satisfactory. Numerous examples were provided in the meeting.

d. The candidates did not appear to be well trained in the implementation of the Emergency Plan. This deficiency was noted in both the simulator portion of the examination and in the operating portion. In the simulator examinations the candidates (as the Shift Supervisor) were reluctant to make a classification because that would be the Shift Engineer's responsibility. Upon followup at the plant, the candidates seemed to have difficulty in classifying an event in which the severity of the conditions would determine the classification.

Proctor

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: PALISADES

REACTOR TYPE: PWR-CE

DATE ADMINISTERED: 86/08/12

EXAMINER: DUDLEY, N.

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:

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

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

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

_____
Candidate's Signature

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

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

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

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

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

6. Use only the paper provided for answers.

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

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

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

10. Skip at least three lines between each answer.

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

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

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

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

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

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

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

18. When you complete your examination, you shall:

a. Assemble your examination as follows:

(1) Exam questions on top.

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

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

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

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

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

QUESTION 1.01 (.50)

Which one of the following descriptions best supports the reason why Xenon reactivity increases sharply after a trip from 1000 hours at 100% power?

A. Xenon decays less rapidly due to a reduction in the neutron flux.
B. Iodine half-life is ~~much~~ shorter than Xenon half-life.
C. Iodine production is greatly reduced and Xenon production is greatly increased due to the reduction in neutron flux.
D. Due to reduced neutron absorption, Iodine concentration increases, and Xenon decays directly from Iodine, thus Xenon increases.

QUESTION 1.02 (.60)

Select the most correct statement from the following.

A. If two centrifical pumps are in parallel then the combined pump head will be approximately the sum of the individual pump heads.

B. If two centrifical pumps are in series then the combined power requirements will be approximately equal to the cube of the individual pump power.

C. If two centrifical pumps are in parallel then the combined flow will be approximately equal to the sum of the individual pump flows.

D. If two centrifical pumps are in series the flow of each pump will be approximately equal to the square of the individual pump speed.

QUESTION 1.03 (2.50)

A nearly instantaneous load reduction from 100% power to 50% power is made. The plant is now at a steady state power level of 50% with Tave at its proper value and no rod motion. How much makeup water must be added during the next six hours to maintain Tave at its proper value with no rod motion? Assume the initial PCS boron concentration at 50% power is 500 ppm and the plant burnup is 2.6 GWD/MTU. Portions of the Technical Data Book have been provided. Show all calculations, reference any figures used, and state all assumptions.

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

QUESTION 1.04 (1.50)

a. For an operator taking data for a 1/M plot, how will the value of Keff affect the time elapsed before a stable count rate can be obtained after withdrawing rods ?

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

QUESTION 1.05 (1.00)

With all systems in manual and no operator action, what effect (increase, decrease, or no change) will decreasing the circulation water temperature have on the following?

a. Condenser vacuum
b. Condensate Pump NPSH

QUESTION 1.06 (2.00)

a. List two plant evolutions which could result in a waterhammer. (0.8)

b. Give two examples of how waterhammer can be minimized. (1.2)

QUESTION 1.07 (1.50)

Indicate whether each of the following will INCREASE, DECREASE, or REMAIN UNCHANGED as the discharge valve of a running, motor operated, centrifugal pump is throttled (valve moved in the shut direction):

a. Pump motor amps

b. Pump discharge flow

c. Pump discharge pressure

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

QUESTION 1.08 (2.40)

a. Why does nucleate boiling heat transfer remove more heat than non-boiling heat transfer?

b. Why does film boiling heat transfer remove less heat than non-boiling heat transfer?

QUESTION 1.09 (2.50)

a. In Figure 5.2 in the Technical Data Book, explain why rod worth at 80 inches increases over core life. (1.0)

b. Explain qualitatively what effect a dropped rod would have on reactor power and Tave if the plant was initially at 100% power with all rods withdrawn. Assume all systems in manual and no reactor trip occurs. (1.5)

QUESTION 1.10 (2.50)

a. The overall power coefficient is a combination of three coefficients. List those coefficients in order from the largest to the smallest contributor to the overall power coefficient. (1.5)

b. What are two reasons for the Total Power Defect increasing with power? (1.0)

QUESTION 1.11 (2.00)

If the reactor is critical at 10 E -4 % power and rod group 4 is at 80 inches at EOC, how far should group 4 be withdrawn to establish a 0.3 DPM startup rate? Show all calculations, reference any figures, and state any assumptions.

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

QUESTION 1.12 (3.00)

What effect, if any, will each of the following plant upsets have on subcooling margin? Assume all systems are in manual. Justify your answers and consider each upset separately.

a. A pressurizer PORV begins leaking while at 80% power.
b. One PCP is secured for physics testing while operating at 10% power.
c. Steam Generator level is being controlled 4% above setpoint while at 30% power.

QUESTION 1.13 (3.00)

Determine and explain what effect, if any, each of the following changes in plant parameters will have on shutdown margin. Consider each parameter separately.

a. During a reactor startup the levels in both steam generators are rapidly increased 5% .

b. After raising power from 50% to 100% conditions are stabilized and no further operator actions are taken for six hours.

c. Rods are borated to all out position from some intermediate position.

QUESTION 2.01 (.60)

What is the minimum number of gross radioactivity monitors required for a liquid batch release through a three inch discharge line? Choose the most correct answer.

A. None
B. One
C. Two
D. Three

QUESTION 2.02 (2.00)

Indicate whether the following service water loads are supplied by the non-critical header, critical header A, critical header B, or critical header A and B.

a. Diesel generator K-6A jacket water cooler
b. Component cooling water heat exchanger E-54B
c. Engineered safeguards pumps seal cooling
d. Auxiliary building air conditioning condensers
e. Containment air coolers

QUESTION 2.03 (1.50)

a. What design feature of the reactor vessel prevents complete draining of the vessel?

b. What is the design purpose of having the reactor vessel supported by steel pads resting on sliding plates?

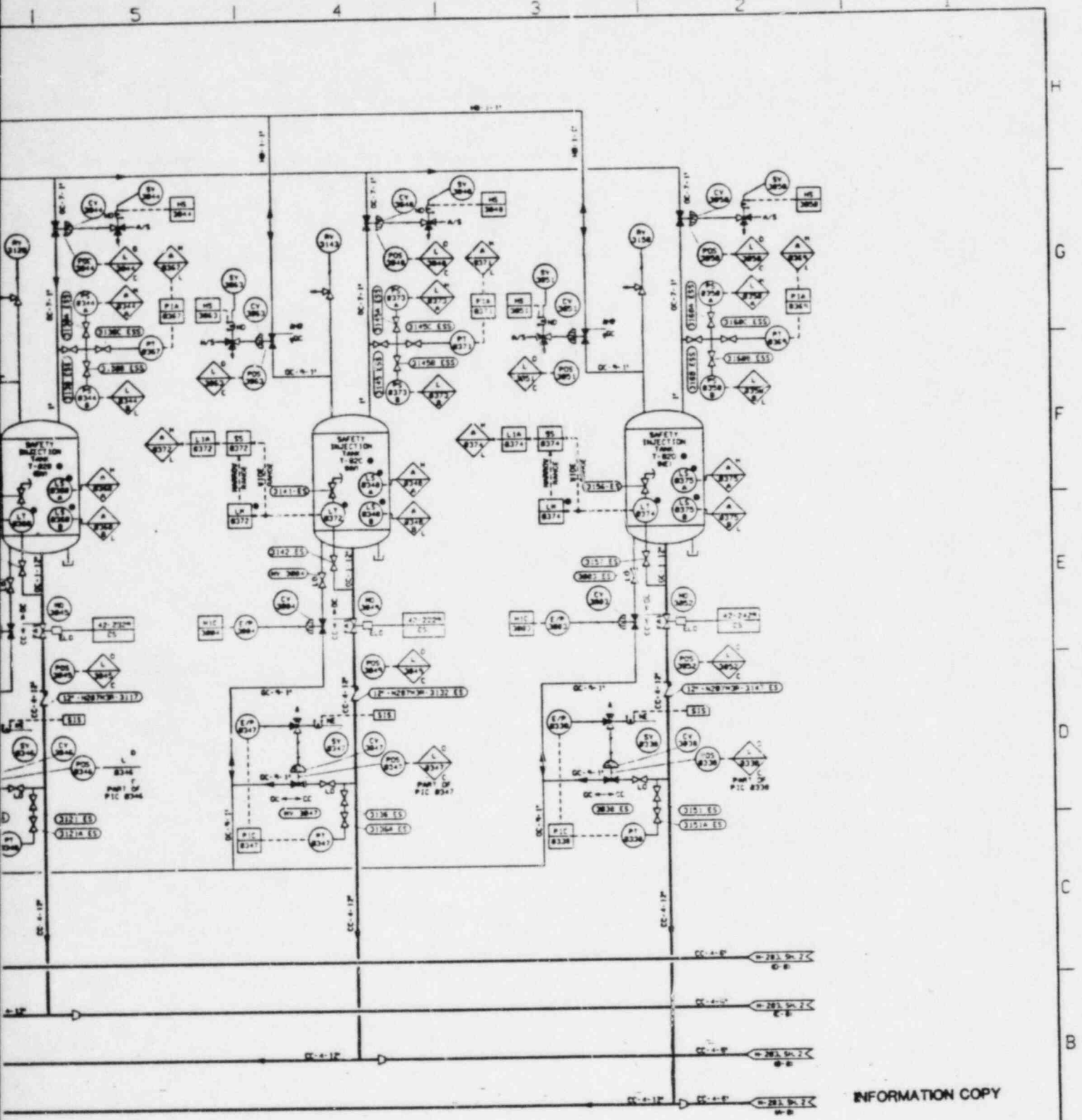
QUESTION 2.04 (2.10)

a. What would be the probable cause of the pressure instrument (PT 0338) downstream of the 12 inch check valve to the Safety Injection Tank (SIT) reading 2000 psig? See attached figure.

b. How would the pressure be reduced?

c. What is the source and motive force used to fill an SIT?

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



INFORMATION COPY

PALISADES PLANT
CONSUMERS POWER COMPANY

PIPING & INSTRUMENT DIAGRAM
SAFETY INJECTION, CONTAINMENT SPRAY
& SHUTDOWN COOLING SYSTEM

8950 | M-203 SH. 1 | 27

QUESTION 2.05 (2.50)

For each of the following valves indicate whether the valve will fail open, fail shut, fail as is, or will not be affected by a loss of instrument air.

a. Pressurizer spray valve
b. Condensate sump recirculation valve (CV-0730A)
c. Main feedwater bypass valve (CV-0734)
d. Main steam isolation valve
e. Atmospheric steam dump

QUESTION 2.06 (2.00)

A double ended load center is a 480 volt bus which can be supplied by two different power sources.

a. How is paralleling of double ended load centers prevented? (0.8)

b. What are three reasons for not paralleling double ended load centers? (1.2)

QUESTION 2.07 (2.00)

Describe the two paths by which decay heat would be removed immediately following a post LOCA Recirculation Actuation Signal. Start at the fuel cladding and continue to the ultimate heat sink. Include major components or systems.

QUESTION 2.08 (2.50)

a. What two design features would prevent control rod damage during a rod drop? (1.2)

b. Would any control rods drop if power was lost to MCC1? Assume the selector switch in the spreading room was selected to MCC1. Justify your answer. (1.3)

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

QUESTION 2.09 (2.40)

What is the reason for the limitation allowing operation with one Primary Coolant Pump (PCP) seal failed but requiring immediate shutdown if more than one PCP seal fails? See item (i) on the precautions and limitations provided.

QUESTION 2.10 (2.40)

State the components which are routinely used to:

a. Maintain the clarity and chemistry of the spent fuel pool.

b. Reduce the temperature of the spent fuel pool.

c. Raise level in the spent fuel pool.

QUESTION 2.11 (2.00)

What effect, if any, does a turbine trip signal (45 psig auto oil pressure) have on:

a. Reactor Protection System
b. Feedwater regulating valves
c. Cooling tower fans
d. Emergency diesel generator

QUESTION 2.12 (3.00)

What response, if any, should be observed for each of the following components after a Safety Injection Actuation Signal?

a. Service water outlet valve (VHX-4)
b. Containment air coolers (V-1B,2B,3B, and 4B)
c. Component Cooling Water (CCW) pumps (P-52A, B, and C)
d. CCW to spent fuel pool and evaporators (CV-0944A)
e. VCT outlet valve (MO-2087)
f. Gravity feed valves (MO-2169 and 2170)
g. CCW to containment (CV-0910)
h. 1E bus feeder breaker (152-303)
i. Emergency diesel generators
j. Instrument air compressors

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

g. During heat-up or cooldown of the primary coolant system, at least one primary coolant pump must be operation if shutdown cooling is not operating.

h. Primary coolant pumps shall not be started if rolling in the reverse direction.

i. Failure of more than one of the three main pressure seals on a Primary Coolant Pump requires immediate shutdown and cooldown in accordance with GOP 8 and GOP 9. Operation with one main seal and low-pressure seal failed is possible if additional leakage is within limitation of the radwaste system. Maximum expected leakage with all main seals failed should not exceed approximately 30 GPM. (See ARP 5, "Primary Coolant Pump Seal Pressure Off Normal," for failed seal criteria.)

j. Primary coolant pump seals shall be vented prior to starting of the pump following any operation which could introduce air into the system including "Steam Generator Air Sweeps."

k. Primary coolant pump seals shall be provided with a source of cool, clean, borated water (flush flow) during any filling of the primary coolant system from a level below the upper seal or after reactor head replacement, during venting of the seals, during primary coolant pump run for "Steam Generator Air Sweeps" and during seal run-in operation of the primary coolant pump(s).

l. Primary coolant pump seals shall be run in for a period of two hours subsequent to any repair or replacement of the seals, or if the primary coolant level has been below the elevation of the upper seal for a week or more.

m. If pressurizer sprays are operated when differential temperature between spray water and pressurizer water is greater than 200°F, log time, differential temperature and pressurizer pressure in Reactor Logbook. A cumulative total of spray cycles with greater than 200°F differential temperature will be kept inside the cover of each Reactor Logbook. The abnormal operating limit is 350°F, but can be exceeded in an emergency situation.

n. A reactor coolant pump shall not be started with one or more of the PCS cold leg temperatures less than or equal to 250°F unless; 1) the pressurizer water volume is less than 700 cubic feet; or 2) the secondary water temperature of each steam generator is less than 70°F above each of the PCS cold leg temperatures. (Reference c)

o. No more than two (2) primary coolant pumps shall be operated when the primary coolant temperature is less than 250°F.

p. No more than three (3) primary coolant pumps shall be operated when primary coolant temperature is less than 400°F.

QUESTION 3.01 (2.40)

What effect, if any, would a failure high of steam generator level instrument, LIA-0702A, have on: (Figure PNFB-6 is provided)

a. Main feedwater regulating valves to steam generators E-50A and B.

b. Bypass valves to steam generators E-50A and B.

c. Main feedwater pumps to steam generators E-50A and B.

d. Overall plant operations if no operator action is taken.

QUESTION 3.02 (2.40)

List four control room indications, not including alarms, which provide control rod position indication, and explain HOW the indication signals are produced.

QUESTION 3.03 (2.50)

What five automatic actions would occur if the instrument AC bus was deenergized during power operations?

QUESTION 3.04 (1.40)

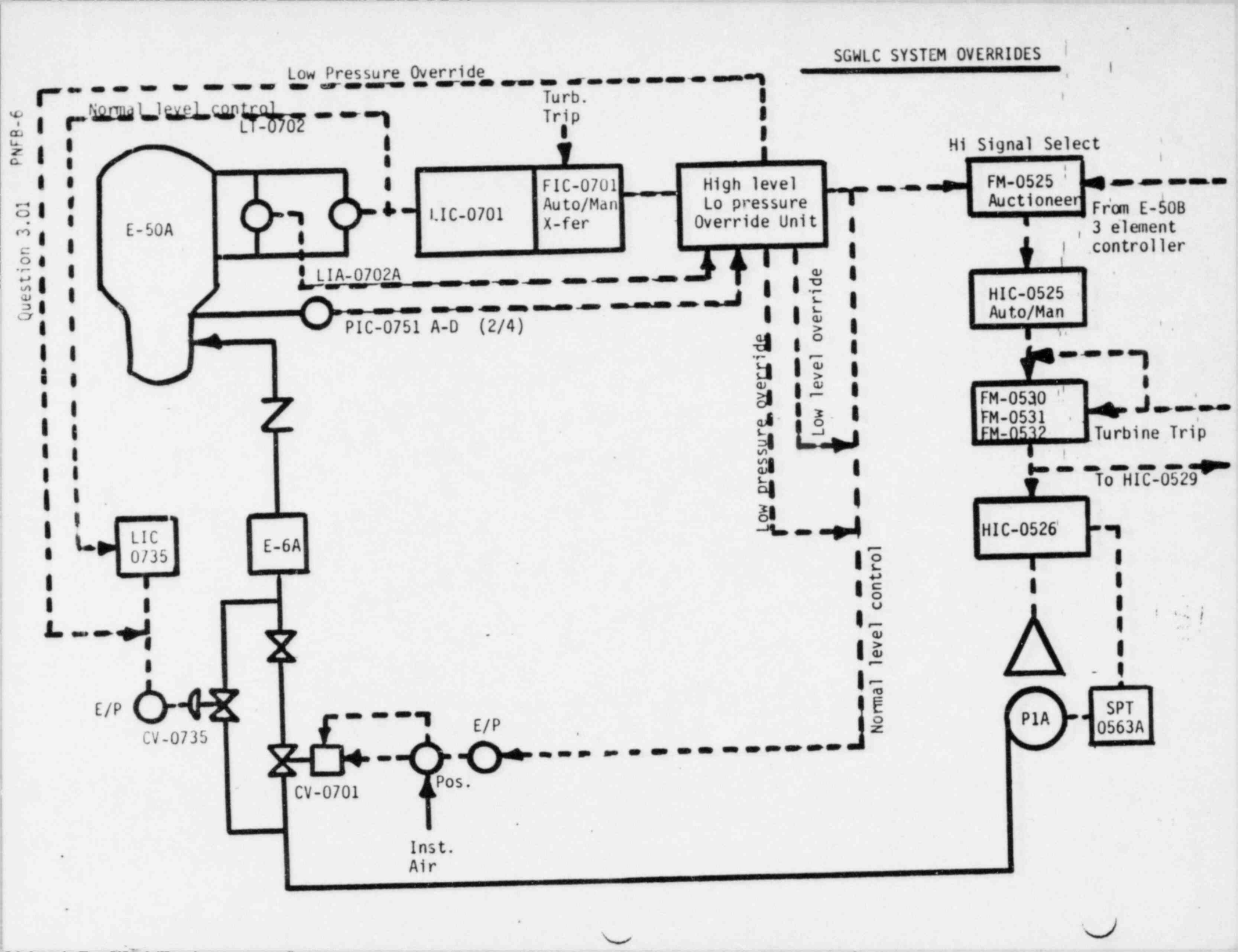
List FOUR automatic diesel generator trips and indicate whether each trip is overridden by a Safety Injection Actuation Signal.

QUESTION 3.05 (2.40)

Explain what automatic actuations, if any, are associated with each of the following radiation monitors. Do not include alarm indications.

a. Steam generator blowdown monitor (RE-0707)
b. Stack monitors (RIA-2318)
c. Engineered safeguards room west (RE-1811)
d. Fuel handling building (RE-5712)

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


SGWLC SYSTEM OVERRIDES
Question 3.01 PNFB-6
Low Pressure Override
Normal level control
LT-0702
Turb. Trip
Hi Signal Select
E-50A
LIC-0701
FIC-0701 Auto/Man X-fer
High level Lo pressure Override Unit
FM-0525 Auctioneer
From E-50B 3 element controller
LIA-0702A
PIC-0751 A-D (2/4)
HIC-0525 Auto/Man
Low pressure override
Low level override
FM-0530 FM-0531 FM-0532
Turbine Trip
To HIC-0529
LIC 0735
E-6A
HIC-0526
E/P
CV-0735
E/P
Normal level control
P1A
SPT 0563A
CV-0701
Pos.
Inst. Air

QUESTION 3.06 (2.40)

What signals, including power levels, type of channels, and number of channels, produce each of the following?

a. Bypass of the reactor trip on "High Startup Rate" (1.2)
b. Removal of voltage from the startup channels (0.6)
c. Bypass of the reactor trip on "Loss of Load" (0.6)

QUESTION 3.07 (2.00)

If during reactor plant operations at 95% power a feedline rupture were to occur inside the containment, what are the FIVE Engineering Safety Features (ESFs) that could possibly be actuated and what signals will cause these actuations? Include setpoints and logic.

QUESTION 3.08 (3.00)

a. Why are the eight motor operated valves associated with the auxiliary feedwater system normally positioned to the open position rather than the auto position?

b. What actions, if any, should an operator take if one minute after the receipt of an Auxiliary Feedwater Actuation Signal the auxiliary feedwater pumps P-8A and P-8B have not started and P-8C is running? Feed flow to SG E-50A is 100 gpm and to SG E-50B is 50 gpm. Pressure in SG E-50A is 930 psia and in SG E-50B is 900 psia. Justify your answer and assume all switches are in automatic.

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

QUESTION 3.09 (3.00)

For each of the following pairs of simultaneous instrumentation failures indicate whether the reactor should or should not have tripped. JUSTIFY your answer and consider each pair of failures separately. Figure PNNB-7 is supplied.

a. Th indication to channel A fails to 600 F and RCS pressure indication to channel B fails to 1700 psia.

b. SG A level indication to channel A fails to 20% and SG B level indication to channel A fails to 20%.

c. PCS flow indication to channel C fails to 0% and loop 2A differential pressure indication to channel D fails low.

d. Power supply to channel A drawer fails and the upper detector on nuclear instrument power range safety channel B fails high.

QUESTION 3.10 (3.50)

What indications must be checked to verify compliance with each of the following Safety Injection Actuation Signal reset criteria. Include the number of channels that must be checked.

a. PCS is greater or equal to 25 F subcooled with Primary Coolant Pumps (PCP) running. (0.9)

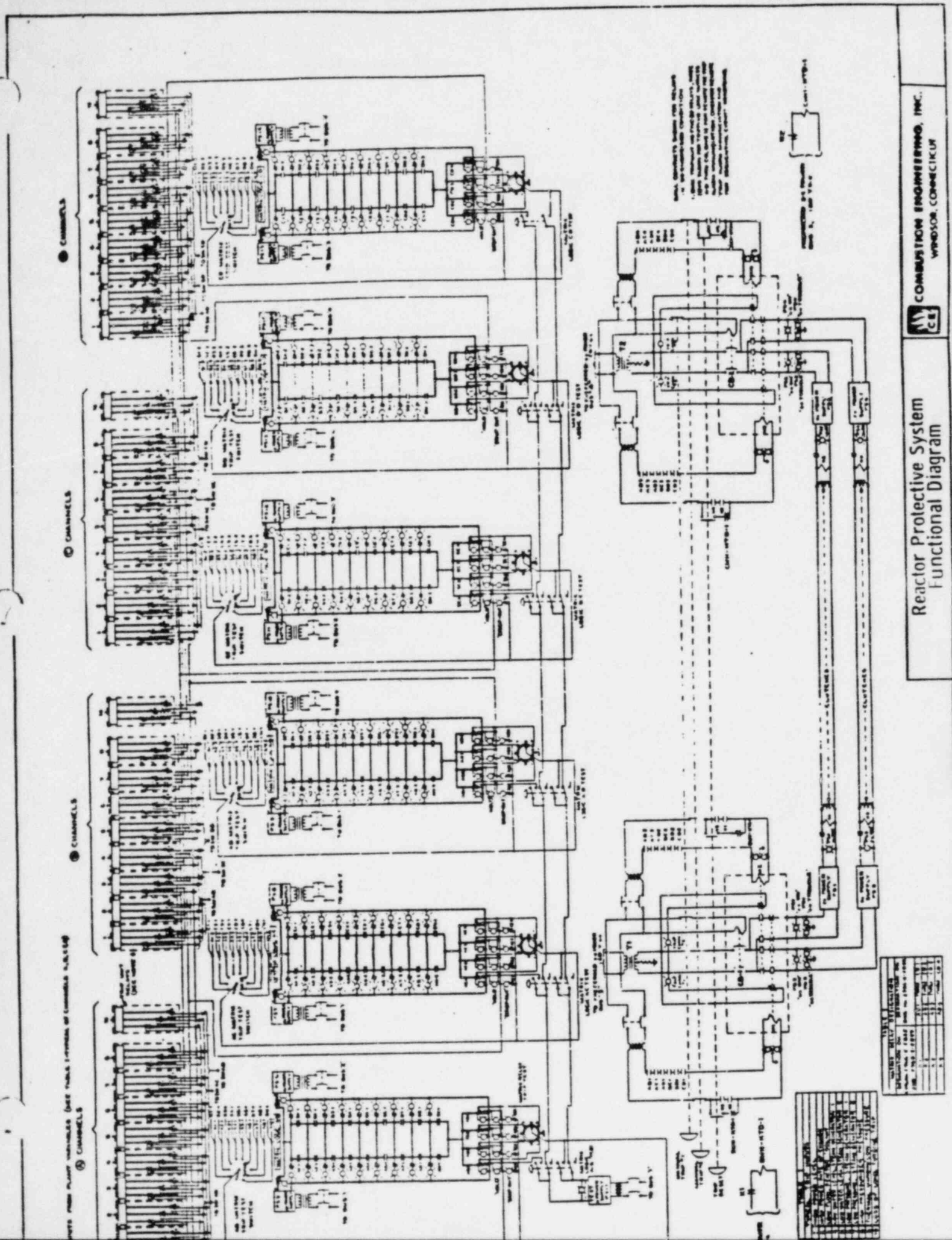
b. PCS is greater than or equal to 25 F subcooled with PCP's not running. (0.8)

c. Pressurizer level is greater than 20% and constant or increasing. (0.6)

d. At least one steam generator is available for removing heat. (1.2)

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

FIGURE PNNB-7



QUESTION 4.01 (2.00)

a. What is a licensed operator's responsiblility concerning the RPS and RPCIC panels when there is fuel in the reactor?

b. Under what circumstances, if any, can an operator depart from an operating procedure?

c. What actions should an operator take if, while performing a checklist, he finds a valve in the Safety Injection System shut which should be open?

d. Who is responsible for maintaining the fuel status board?

QUESTION 4.02 (1.50)

Answer the following questions concerning normal reactor startups.

a. What is the MINIMUM temperature for criticality?

b. What is the MAXIMUM startup rate permitted under normal conditions?

c. What is the MINIMUM number of PCPs required to be running prior to startup utilizing control rods?

QUESTION 4.03 (1.00)

From the Emergency Operating Procedure (EOP) Index provided, list the EOP which should be used to:

a. Determine power supplies and room locations for motor operated valves.

b. Determine the reset criteria for SIAS and SIS equipment.

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

QUESTION 4.04 (2.50)

Explain how an approach to criticality should be conducted with only one operable startup detector. Limit your explaination to the order and levels of positive reactivity additions made by dilution or rod withdrawal. State your initial assumptions concerning boron concentration and rod position. Actual values are not required.

QUESTION 4.05 (2.50)

a. What actions, if any, are required if there is indication that FOUR full length control rods have not inserted following a reactor trip? (1.0)

b. Why are two Primary Coolant Pumps (PCP) tripped when PCS pressure drops below 1300 psia and all PCP's are tripped at a lower PCS pressure following initiation of Safety Injection after a reactor trip? (1.5)

QUESTION 4.06 (3.00)

a. Explain why each of the following procedural steps is an indication of natural circulation.

   1. Delta T is less than 50 F
   2. SG level > -84% wide range
   3. Loop Tc constant or decreasing (1.5)

b. During depressurization while on Natural Circulation PCS pressure is 650 psia, core exit thermo-couples are at 500 F, Th is 500 F and Tc is 480 F. Has a void formed in the PCS? A page of ONP-21 is provided. (0.5)

c. What are the maximum and minimum PCS pressures allowed in the PCS if PCS temperature is 290 F and forced circulation has just been reestablished by starting a PCP? SOP 1 figure 1-2a is provided. (1.0)

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

Question 4.05

PALISADES NUCLEAR PLANT

EMERGENCY OPERATING PROCEDURES INDEX

PROCEDURE NUMBER	PROCEDURE TITLE	REVISION NUMBER	BIENNIAL REVIEW PERFORMED	DOCUMENT SPONSOR
EOP 1	REACTOR TRIP	16	86/03/17	RJFrigo
EOP 2	LOSS OF AC POWER	14	84/08/23	RJFrigo
EOP 3	LOSS OF SERVICE WATER	1	86/01/24	RJFrigo
EOP 4	LOSS OF COMPONENT COOLING	2	83/12/05	RJFrigo
EOP 5	LOSS OF INSTRUMENT AIR	13	83/12/05	RJFrigo
EOP 6	MAIN STEAM LINE BREAK/MAIN FEEDWATER LINE BREAK INSIDE CONTAINMENT	16	86/03/17	RJFrigo
EOP 7	MAIN STEAM LINE BREAK/MAIN FEEDWATER LINE BREAK OUTSIDE CONTAINMENT	14	86/03/17	RJFrigo
EOP 8.1	LOSS OF COOLANT ACCIDENT	18	86/03/17	RJFrigo
EOP 8.2	STEAM GENERATOR TUBE RUPTURE	15	86/03/17	RJFrigo
EOP 9	FUEL HANDLING ACCIDENT	12	86/01/24	RJFrigo
EOP 10	CONTROL ROOM EVACUATION	Canceled		
EOP 10.1	FIRE WHICH THREATENS SAFETY RELATED EQUIPMENT	1	85/04/25	RJFrigo
EOP 10.2	ALTERNATE SAFE SHUTDOWN PROCEDURE	15	85/05/28	RJFrigo
EOP 11	LOSS OF CONTAINMENT INTEGRITY	13	83/12/05	RJFrigo
EOP 12	ABNORMAL RELEASE OF RADIOACTIVITY	12	86/01/24	RJFrigo

QUESTION 4.07 (2.50)

During a serious emergency, operators may be called upon to assist in search and rescue or recovery operations in the plant.

a. In such cases, what dose could an operator receive:

1) To bring an injured worker to safety? (0.5)
2) To eliminate the further escape of radioactive effluents ? (0.5)

b. What are the possible effects of receiving radiation exposures of the levels of 50 rem ? Include short and long term effects. (1.0)

c. Who must authorize this voluntary radiation exposure up to the emergency limits ? (0.5)

QUESTION 4.08 (3.00)

What immediate actions should be taken if the Shift Supervisor determines that the plant cannot be maintained in hot standby due to a fire in the cable spreading room?

QUESTION 4.09 (3.00)

Explain the basis or reasons for the following subsequent actions in the Steam Generator Tube Rupture procedure, EOP-8.2.

a. Establish and maintain PCS temperature at 525 F to 530 F (Listed in order of preferrence).

b. Reduce and maintain PCS pressure as low as possible in the operating region.

c. Maintain PCS pressure approximately 0 - 100 psi higher than the isolated Steam Generator.

d. If affected Steam Generator level approaches full scale, drain to the Miscellaneous Waste System.

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

TITLE: NATURAL CIRCULATION

Question 4.06

4.8.9 During PCS depressuration, monitor for void formation. If substantial void formations are indicated by one or more of the following, go to Section 4.9 and 4.10.

a. During steady state conditions, charging a known volume of water/boric acid into the PCS does not result in a corresponding increase in pressurizer level.

b. Pressurizer level increases significantly greater than expected while operating auxiliary spray.

c. If pressurizer level control system is in automatic, an unanticipated letdown flow greater than charging flow.

NOTE: During periods of abnormal pressurizer level behavior, charging and letdown controls should be placed in manual since automatic actions may be opposite to those which should be taken.

d. Qualified core exit thermocouples read higher than saturation conditions or are erratic.

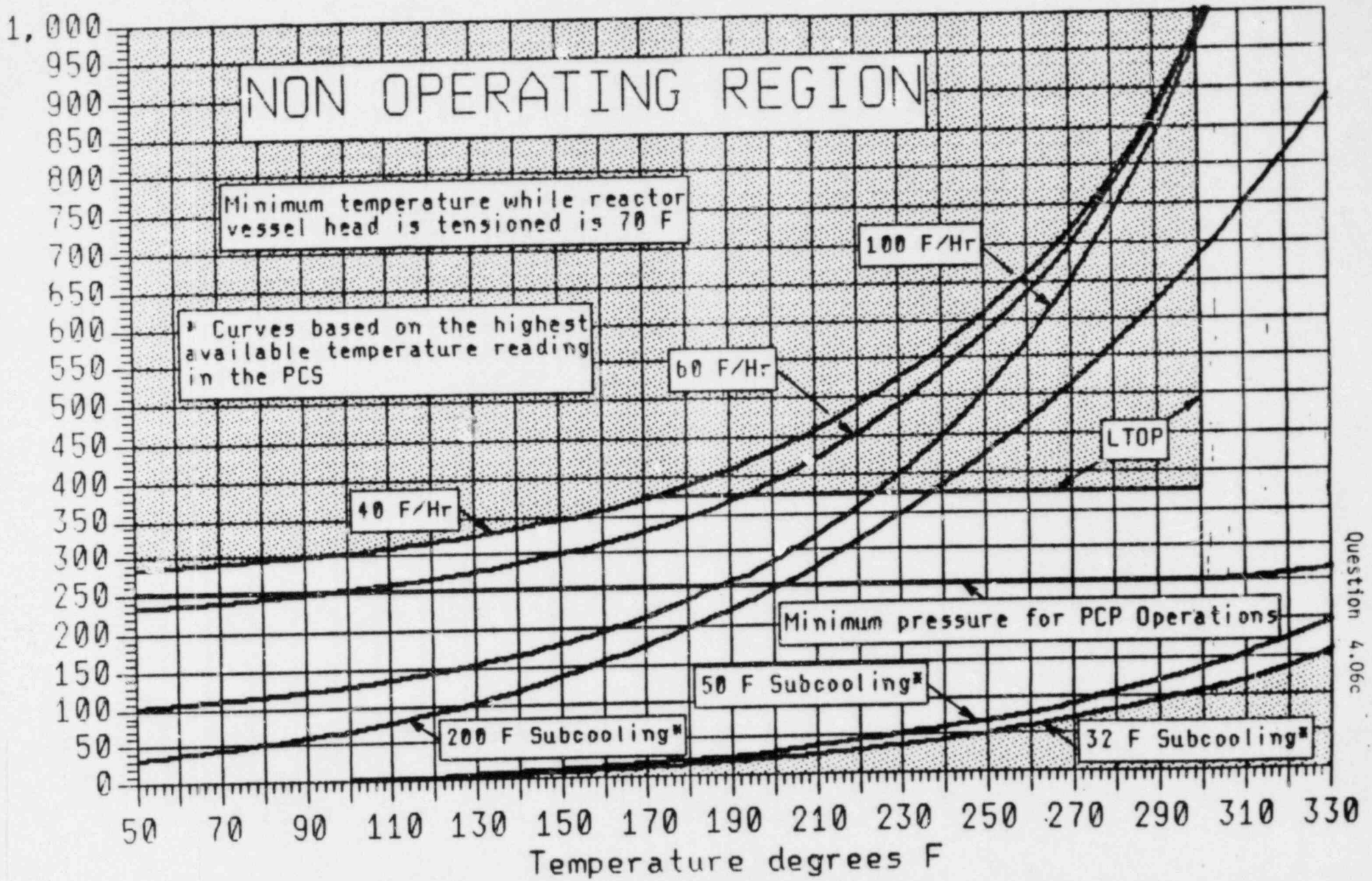
e. Increased core ΔT above full power (50°F).

f. Startup neutron detectors showing erratic indication.

g. Loop T_hs increasing or erratic.

h. Loop T_cs erratic.

PALISADES PLANT PRESSURE - TEMPERATURE LIMITS
FOR COOLDOWN TO 1.3 X 10^{19} nvt
SOP 1 Figure 1-2a



Question 4.06c

QUESTION 4.10 (4.00)

For each of the following situations indicate whether the operator should continue operations, reduce power, shutdown the reactor, or trip the reactor. Consider each situation seperately.

a. Reactor power is 70% and one of the two condensate pumps trip.
b. Reactor power is 20% and condenser vacuum has dropped to 17" of Hg.
c. Reactor power is 50% and a steam generator tube leak is identified.
d. Reactor power is 80% and component cooling water has been lost for two minutes. There are no temperature alarms.
e. Reactor power is 80% and non-critical service water has been lost for two minutes. There are no temperature alarms.
f. Reactor power is 100% and instrument air header pressure has decreased from 90 to 80 psig over the last 10 minutes and is continuing to decrease.
g. Reactor power is 75%, total leakage is 3 gpm and a CRDM seal has been confirmed to be leaking.
h. Reactor power is 100% and a fuel element failure has been identified by coolant activity as being above Technical Specification limits.
i. Reactor power is 90% and a single rod drops into the core.
j. Reactor power is 100% and a major fire is reported in the HPSI pump room.

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

EQUATIONS

REACTOR THEORY

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

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

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

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

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

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

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

$$k_2 = k_1 + \delta k$$

$$\delta k = k - 1$$

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

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

$$\Sigma = N\sigma$$

$$\phi = nv$$

Defect = Coeff x Δ Parameter

RADIATION

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

$$A = \lambda N$$

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

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

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

$$I_1 d_1^2 = I_2 d_2^2 \qquad \text{point source}$$

$$I_1 d_1 = I_2 d_2 \quad \text{- line source}$$

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

$$y^a = b$$

$$\log_y b = a$$

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

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

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

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 $\sqrt{dp}$

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

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

$$F = pA$$

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

k = f(quality & Pressure)

Pump laws speed α flow

(speed)^2 α pressure

(speed)^3 α power

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

$$Q = mc_p\Delta T$$

$$Q = m\Delta h$$

$$Q = \varepsilon\sigma T$$

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

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

$$H = U + pV$$

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

$$pV = nRT$$

$$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$$

$$C_1V_1 + C_2V_2 = C_3(V_1 + V_2)$$

Table 1. Saturated Steam: Temperature Table

Temp Fahr t	Abs Press Lb per Sq in p	Specific Volume Sat Liquid v_f	Specific Volume Evap v_{fg}	Specific Volume Sat Vapor v_g	Enthalpy Sat Liquid h_f	Enthalpy Evap h_{fg}	Enthalpy Sat Vapor h_g	Entropy Sat Liquid s_f	Entropy Evap s_{fg}	Entropy Sat Vapor s_g	Temp Fahr t
32.0*	0.08859	0.016072	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	2.0085	90.0
92.0	0.74313	0.016105	441.3	441.3	60.014	1041.6	1101.6	0.1151	1.8881	2.0032	92.0
94.0	0.79062	0.016111	416.2	416.3	62.010	1040.5	1102.5	0.1188	1.8792	1.9980	94.0
96.0	0.84071	0.016117	392.8	392.9	64.006	1039.3	1103.3	0.1224	1.8704	1.9928	96.0
98.0	0.89352	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	1.00786	0.016137	331.1	331.1	69.995	1035.9	1105.9	0.1331	1.8444	1.9775	102.0
104.0	1.06958	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	1.3507	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	238.22	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	4.3066	0.016374	84.56	84.57	123.95	1004.6	1128.6	0.2248	1.6318	1.8566	156.0
158.0	4.5191	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 values shown are those under

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

Temp Fahr t	Abs Press Lb per Sq In p	Specific Volume: Sat Liquid v_f	Specific Volume: Evap v_{fg}	Specific Volume: Sat Vapor v_g	Enthalpy: Sat Liquid h_f	Enthalpy: Evap h_{fg}	Enthalpy: Sat Vapor h_g	Entropy: Sat Liquid s_f	Entropy: Evap s_{fg}	Entropy: Sat Vapor s_g	Temp Fahr t
180.0	7.5110	0.016510	50.21	50.22	148.00	990.2	1138.2	0.2631	1.5480	1.8111	180.0
182.0	7.850	0.016522	48.172	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	166.05	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
202.0	12.012	0.016650	32.350	32.367	170.11	976.6	1146.8	0.2971	1.4760	1.7731	202.0
204.0	12.514	0.016664	31.135	31.151	172.11	975.4	1147.5	0.3001	1.4697	1.7698	204.0
206.0	13.034	0.016677	29.974	29.991	174.12	974.1	1148.3	0.3031	1.4634	1.7665	206.0
208.0	13.569	0.016691	28.862	28.878	176.14	972.8	1149.0	0.3061	1.4571	1.7632	208.0
210.0	14.121	0.016704	27.797	27.814	178.15	971.6	1149.8	0.3091	1.4509	1.7599	210.0
212.0	14.691	0.016718	26.780	26.799	180.17	970.3	1150.5	0.3121	1.4447	1.7569	212.0
214.0	15.278	0.016731	25.807	25.824	182.18	969.0	1151.2	0.3151	1.4385	1.7536	214.0
216.0	15.901	0.016747	24.878	24.894	184.20	967.8	1152.0	0.3181	1.4323	1.7505	216.0
218.0	16.524	0.016761	23.990	24.006	186.22	966.5	1152.7	0.3211	1.4262	1.7473	218.0
220.0	17.186	0.016775	23.131	23.148	188.23	965.2	1153.4	0.3241	1.4201	1.7442	220.0
222.0	17.866	0.016805	21.529	21.545	192.27	962.6	1154.9	0.3300	1.4081	1.7380	222.0
224.0	18.556	0.016805	21.529	21.545	192.27	962.6	1154.9	0.3300	1.4081	1.7380	224.0
226.0	19.265	0.016818	20.056	20.073	194.31	960.0	1156.3	0.3359	1.3961	1.7320	226.0
228.0	20.015	0.016834	20.056	20.073	196.31	960.0	1156.3	0.3359	1.3961	1.7320	228.0
230.0	20.787	0.016848	18.701	18.718	198.33	958.7	1157.0	0.3389	1.3901	1.7290	230.0
232.0	21.567	0.016864	18.701	18.718	200.35	957.4	1157.8	0.3417	1.3842	1.7260	232.0
234.0	22.368	0.016878	17.454	17.471	202.36	956.1	1158.5	0.3447	1.3783	1.7230	234.0
236.0	23.216	0.016895	17.454	17.471	204.40	954.8	1159.2	0.3476	1.3725	1.7201	236.0
238.0	24.068	0.016911	16.287	16.304	206.43	953.5	1159.9	0.3506	1.3666	1.7172	238.0
240.0	24.968	0.016926	16.304	16.321	208.45	952.1	1160.6	0.3533	1.3609	1.7142	240.0
242.0	25.826	0.016958	15.243	15.260	212.50	949.5	1162.0	0.3591	1.3494	1.7085	242.0
244.0	26.796	0.016990	14.264	14.281	216.56	946.8	1163.4	0.3645	1.3379	1.7028	244.0
246.0	27.766	0.017022	13.358	13.375	220.67	944.1	1164.7	0.3706	1.3266	1.6972	246.0
248.0	28.766	0.017055	12.520	12.538	224.69	941.4	1166.1	0.3763	1.3154	1.6917	248.0
250.0	29.796	0.017089	11.745	11.762	228.76	938.6	1167.4	0.3819	1.3043	1.6862	250.0
252.0	30.856	0.017123	11.025	11.042	232.83	935.9	1168.7	0.3876	1.2933	1.6808	252.0
254.0	31.946	0.017157	10.358	10.375	236.91	933.1	1170.0	0.3932	1.2823	1.6755	254.0
256.0	33.066	0.017193	9.738	9.755	240.96	930.3	1171.3	0.3987	1.2715	1.6702	256.0
258.0	34.216	0.017228	9.162	9.180	245.08	927.5	1172.5	0.4043	1.2607	1.6650	258.0
260.0	35.427	0.017264	8.627	8.644	249.17	924.6	1173.8	0.4098	1.2501	1.6599	260.0
262.0	36.637	0.017300	8.1280	8.1453	253.3	921.7	1175.0	0.4154	1.2395	1.6548	262.0
264.0	37.894	0.017336	7.6634	7.6817	257.4	918.8	1176.2	0.4208	1.2292	1.6499	264.0
266.0	39.179	0.017373	7.2301	7.2475	261.5	915.9	1177.4	0.4263	1.2189	1.6449	266.0
268.0	40.494	0.017411	6.8259	6.8433	265.6	913.0	1178.6	0.4317	1.2087	1.6400	268.0
270.0	41.839	0.017449	6.4483	6.4658	269.7	910.0	1179.7	0.4372	1.1979	1.6351	270.0
272.0	43.214	0.017486	6.0955	6.1130	273.8	907.0	1180.9	0.4426	1.1877	1.6303	272.0
274.0	44.619	0.017524	5.7656	5.7830	278.0	904.0	1182.0	0.4479	1.1776	1.6255	274.0
276.0	46.054	0.017562	5.4566	5.4742	282.1	901.0	1183.1	0.4533	1.1676	1.6209	276.0
278.0	47.519	0.017601	5.1673	5.1849	286.3	897.9	1184.1	0.4586	1.1576	1.6162	278.0
280.0	49.014	0.017639	4.8961	4.9138	290.4	894.8	1185.2	0.4640	1.1477	1.6116	280.0
282.0	50.539	0.017678	4.6418	4.6595	294.6	891.6	1186.2	0.4693	1.1378	1.6071	282.0
284.0	52.095	0.017718	4.4030	4.4208	298.7	888.5	1187.2	0.4745	1.1280	1.6025	284.0
286.0	53.681	0.017758	4.1788	4.1966	302.9	885.3	1188.2	0.4798	1.1183	1.5981	286.0
288.0	55.298	0.017798	3.9681	3.9859	307.1	882.1	1189.1	0.4850	1.1088	1.5938	288.0
290.0	56.946	0.017838	3.7699	3.7878	311.3	878.8	1190.1	0.4902	1.0990	1.5892	290.0
292.0	58.625	0.017879	3.5834	3.6013	315.5	875.5	1191.0	0.4954	1.0894	1.5849	292.0
294.0	60.335	0.017920	3.4078	3.4258	319.7	872.2	1191.1	0.5006	1.0799	1.5806	294.0
296.0	62.077	0.017961	3.2423	3.2603	323.9	868.9	1192.7	0.5058	1.0705	1.5763	296.0
298.0	63.850	0.018002	3.0863	3.1044	328.1	865.5	1193.6	0.5110	1.0611	1.5721	298.0
300.0	65.655	0.018043	2.9392	2.9573	332.3	862.1	1194.4	0.5161	1.0517	1.5678	300.0
302.0	67.493	0.018085	2.8007	2.8184	336.5	858.6	1195.2	0.5212	1.0424	1.5637	302.0
304.0	69.363	0.018127	2.6693	2.6873	340.8	855.1	1195.9	0.5263	1.0332	1.5595	304.0
306.0	71.265	0.018169	2.5451	2.5633	345.0	851.6	1196.7	0.5314	1.0240	1.5554	306.0
308.0	73.201	0.018211	2.4279	2.4462	349.3	848.1	1197.4	0.5365	1.0148	1.5513	308.0
310.0	75.170	0.018254	2.3170	2.3353	353.6	844.5	1198.0	0.5416	1.0057	1.5473	310.0
312.0	77.172	0.018297	2.2120	2.2304	357.9	840.8	1198.7	0.5466	0.9966	1.5432	312.0
314.0	79.208	0.018340	2.1126	2.1311	362.2	837.2	1199.3	0.5516	0.9876	1.5392	314.0
316.0	81.279	0.018383	2.0184	2.0369	366.5	833.4	1199.9	0.5567	0.9786	1.5352	316.0
318.0	83.384	0.018427	1.9291	1.9477	370.8	829.7	1200.4	0.5617	0.9696	1.5313	318.0
320.0	85.524	0.018470	1.8444	1.8630	375.1	825.9	1201.0	0.5667	0.9607	1.5274	320.0
322.0	87.699	0.018514	1.7640	1.7827	379.4	822.0	1201.5	0.5717	0.9518	1.5234	322.0
324.0	89.910	0.018558	1.6877	1.7064	383.8	818.2	1201.9	0.5766	0.9429	1.5195	324.0
326.0	92.156	0.018603	1.6152	1.6340	388.1	814.2	1202.4	0.5816	0.9341	1.5157	326.0
328.0	94.438	0.018647	1.5463	1.5651	392.5	810.2	1202.8	0.5866	0.9253	1.5118	328.0
330.0	96.756	0.018692	1.4808	1.4997	396.9	806.2	1203.1	0.5915	0.9165	1.5080	330.0
332.0	99.110	0.018737	1.4184	1.4374	401.3	802.2	1203.5	0.5964	0.9077	1.5042	332.0
334.0	101.50	0.018783	1.3591	1.3782	405.7	798.0	1203.7	0.6014	0.8990	1.5004	334.0
336.0	103.93	0.018828	1.3026	1.3219	410.1	793.9	1204.0	0.6063	0.8903	1.4966	336.0
338.0	106.40	0.018874	1.2488	1.2680	414.6	789.7	1204.2	0.6112	0.8816	1.4928	338.0
340.0	108.91	0.018920	1.1976	1.2168	419.0	785.4	1204.4	0.6161	0.8729	1.4890	340.0
342.0	111.46	0.018966	1.1487	1.1686	423.5	781.1	1204.6	0.6210	0.8643	1.4853	342.0
344.0	114.06	0.019013	1.1021	1.1215	428.0	776.7	1204.7	0.6259	0.8557	1.4815	344.0
346.0	116.70	0.019060	1.0576	1.0767	432.5	772.3	1204.8	0.6308	0.8471	1.4778	346.0
348.0	119.39	0.019107	1.0152	1.0343	437.0	767.8	1204.8	0.6356	0.8385	1.4741	348.0

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

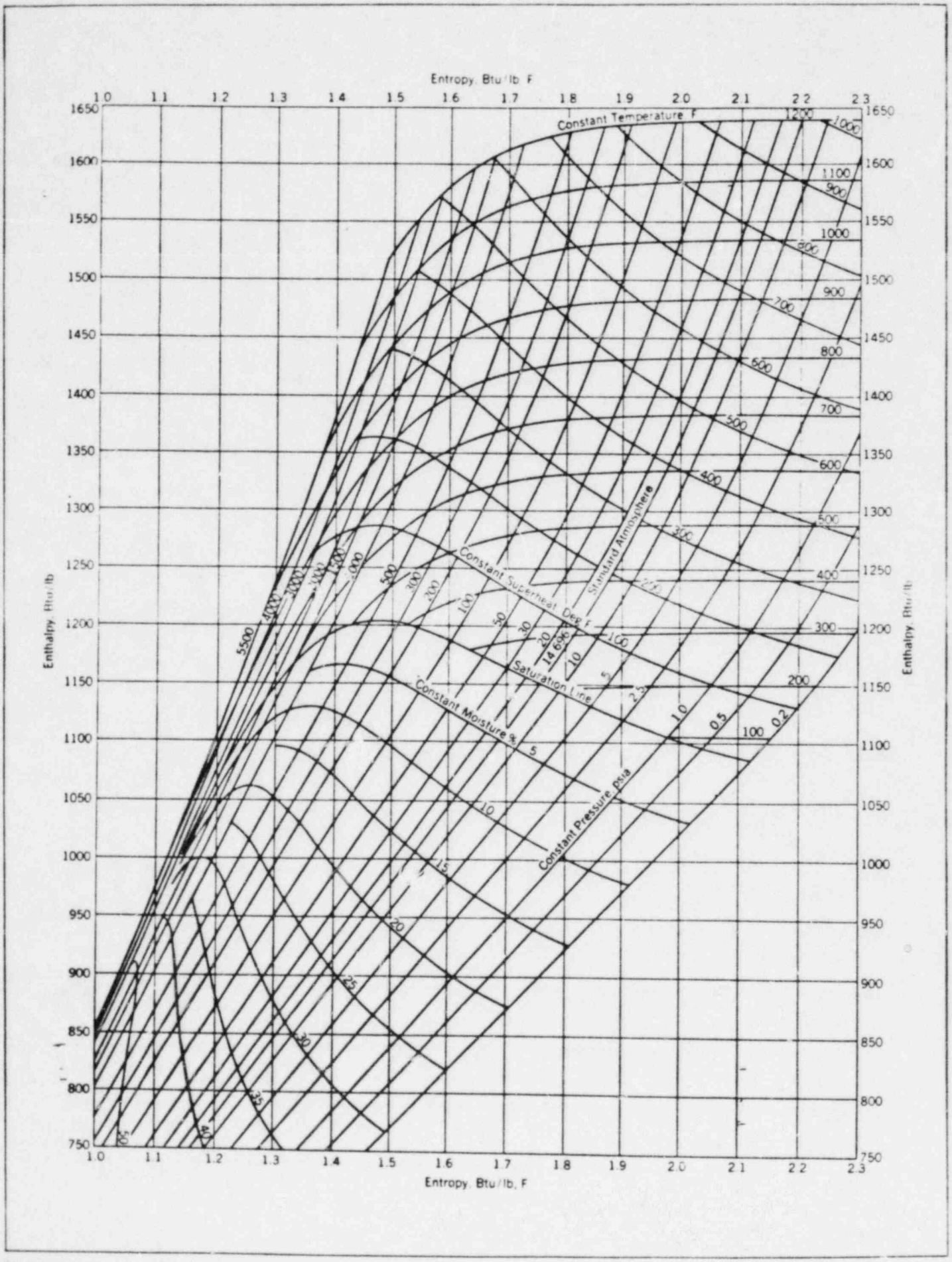
Temp Fahr t	Abs Press Lb per Sq In p	Specific Volume Sat Liquid v_f	Specific Volume Evap v_{fg}	Specific Volume Sat Vapor v_g	Enthalpy Sat Liquid h_f	Enthalpy Evap h_{fg}	Enthalpy Sat Vapor h_g	Entropy Sat Liquid s_f	Entropy Evap s_{fg}	Entropy Sat Vapor s_g	Temp Fahr t
468.0	466.87	0.01981	0.97463	0.99424	441.5	763.2	1204.8	0.6406	0.8299	1.4704	468.0
464.0	485.56	0.01969	0.93588	0.95557	446.1	758.6	1204.7	0.6454	0.8213	1.4667	464.0
460.0	504.83	0.01976	0.89885	0.91862	450.7	754.0	1204.6	0.6502	0.8127	1.4629	460.0
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
488.0	566.15	0.02000	0.79716	0.81717	464.5	739.6	1204.1	0.6648	0.7871	1.4518	488.0
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	1028.45	0.02169	0.41048	0.43217	546.9	645.0	1191.9	0.7476	0.6400	1.3876	548.0
552.0	1062.50	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	0.35096	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	0.5768	1.3593	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	1497.6	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
616.0	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	0.8808	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	0.08795	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	1.0008	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	1.2187	1.6440	60.0
70.0	302.93	0.017482	6.1875	6.2050	272.7	907.8	1180.6	0.4411	1.1905	1.6316	70.0
80.0	312.04	0.017573	5.4536	5.4711	282.1	900.9	1183.1	0.4534	1.1675	1.6208	80.0
90.0	320.28	0.017659	4.8779	4.8953	290.7	894.6	1185.3	0.4643	1.1470	1.6113	90.0
100.0	327.82	0.017740	4.4133	4.4310	298.5	888.6	1187.2	0.4743	1.1284	1.6027	100.0
110.0	334.79	0.01782	4.0306	4.0484	305.8	883.1	1188.9	0.4834	1.1115	1.5950	110.0
120.0	341.27	0.01789	3.7097	3.7275	312.6	877.8	1190.4	0.4919	1.0960	1.5879	120.0
130.0	347.33	0.01796	3.4364	3.4544	319.0	872.8	1191.7	0.4998	1.0815	1.5813	130.0
140.0	353.04	0.01803	3.2010	3.2190	325.0	868.0	1193.0	0.5071	1.0681	1.5752	140.0
150.0	358.43	0.01809	2.9958	3.0139	330.6	863.4	1194.1	0.5141	1.0554	1.5695	150.0
160.0	363.55	0.01815	2.8155	2.8336	336.1	859.0	1195.1	0.5206	1.0435	1.5641	160.0
170.0	368.42	0.01821	2.6556	2.6738	341.2	854.8	1196.0	0.5269	1.0322	1.5591	170.0
180.0	373.08	0.01827	2.5129	2.5312	346.2	850.7	1196.9	0.5328	1.0215	1.5543	180.0
190.0	377.53	0.01833	2.3847	2.4030	350.9	846.7	1197.6	0.5384	1.0113	1.5498	190.0
200.0	381.87	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	2.18017	359.9	839.1	1199.0	0.5490	0.9923	1.5413	210.0
220.0	389.88	0.01850	2.06775	2.08625	364.2	835.4	1199.6	0.5540	0.9834	1.5374	220.0
230.0	393.70	0.01855	1.97993	1.99848	368.3	831.8	1200.1	0.5588	0.9748	1.5336	230.0
240.0	397.39	0.01860	1.89906	1.91765	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	1201.4	0.5722	0.9507	1.5229	260.0
270.0	407.81	0.01875	1.69137	1.71013	383.6	818.3	1201.9	0.5764	0.9433	1.5196	270.0
280.0	411.09	0.01880	1.63169	1.65049	387.1	815.1	1202.3	0.5805	0.9361	1.5166	280.0
290.0	414.28	0.01885	1.57597	1.59482	390.6	812.0	1202.6	0.5844	0.9291	1.5136	290.0
300.0	417.35	0.01885	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	409.6	794.2	1204.0	0.6059	0.8899	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	0.44595	542.6	650.4	1192.9	0.7434	0.6476	1.3910	1000.0
1050.0	550.53	0.02177	0.40047	0.42224	550.1	640.9	1191.0	0.7507	0.6344	1.3851	1050.0
1100.0	556.28	0.02195	0.37863	0.40058	557.5	631.5	1189.1	0.7578	0.6216	1.3794	1100.0
1150.0	561.82	0.02214	0.35859	0.38073	564.8	622.2	1187.0	0.7647	0.6091	1.3738	1150.0
1200.0	567.19	0.02232	0.34013	0.36245	571.9	613.0	1184.8	0.7714	0.5969	1.3683	1200.0
1250.0	572.38	0.02250	0.32306	0.34556	578.8	603.8	1182.6	0.7780	0.5850	1.3630	1250.0
1300.0	577.42	0.02269	0.30722	0.32991	585.6	594.6	1180.2	0.7843	0.5733	1.3577	1300.0
1350.0	582.32	0.02288	0.29250	0.31537	592.3	585.4	1177.8	0.7906	0.5620	1.3525	1350.0
1400.0	587.07	0.02307	0.27871	0.30178	598.8	576.5	1175.3	0.7966	0.5507	1.3474	1400.0
1450.0	591.70	0.02327	0.26584	0.28911	605.3	567.4	1172.8	0.8026	0.5397	1.3423	1450.0
1500.0	596.20	0.02346	0.25372	0.27719	611.7	558.4	1170.1	0.8085	0.5288	1.3373	1500.0
1550.0	600.59	0.02366	0.24235	0.26601	618.0	549.4	1167.4	0.8142	0.5182	1.3324	1550.0
1600.0	604.87	0.02387	0.23159	0.25545	624.2	540.3	1164.5	0.8199	0.5076	1.3274	1600.0
1650.0	609.05	0.02407	0.22143	0.24551	630.4	531.3	1161.6	0.8254	0.4971	1.3225	1650.0
1700.0	613.13	0.02428	0.21178	0.23607	636.5	522.2	1158.6	0.8309	0.4867	1.3176	1700.0
1750.0	617.12	0.02450	0.20263	0.22713	642.5	513.1	1155.6	0.8363	0.4765	1.3128	1750.0
1800.0	621.02	0.02472	0.19390	0.21861	648.5	503.8	1152.3	0.8417	0.4662	1.3079	1800.0
1850.0	624.83	0.02495	0.18558	0.21052	654.5	494.6	1149.0	0.8470	0.4561	1.3030	1850.0
1900.0	628.56	0.02517	0.17761	0.20278	660.4	485.2	1145.6	0.8522	0.4459	1.2981	1900.0
1950.0	632.22	0.02541	0.16999	0.19540	666.3	475.8	1142.0	0.8574	0.4358	1.2931	1950.0
2000.0	635.80	0.02565	0.16266	0.18831	672.1	466.2	1138.3	0.8625	0.4256	1.2881	2000.0
2100.0	642.76	0.02615	0.14885	0.17501	683.8	446.7	1130.5	0.8727	0.4053	1.2780	2100.0
2200.0	649.45	0.02669	0.13603	0.16272	695.5	426.7	1122.2	0.8828	0.3848	1.2676	2200.0
2300.0	655.85	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	0.11267	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	0.0488	1.0839	3200.0
3204.2*	705.47	0.05078	0.00000	0.05078	906.0	0.0	906.0	1.0612	0.0000	1.0612	3204.2*

*Critical pressure



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

LIST OF EFFECTIVE PAGES

LIST OF EFFECTIVE PAGES

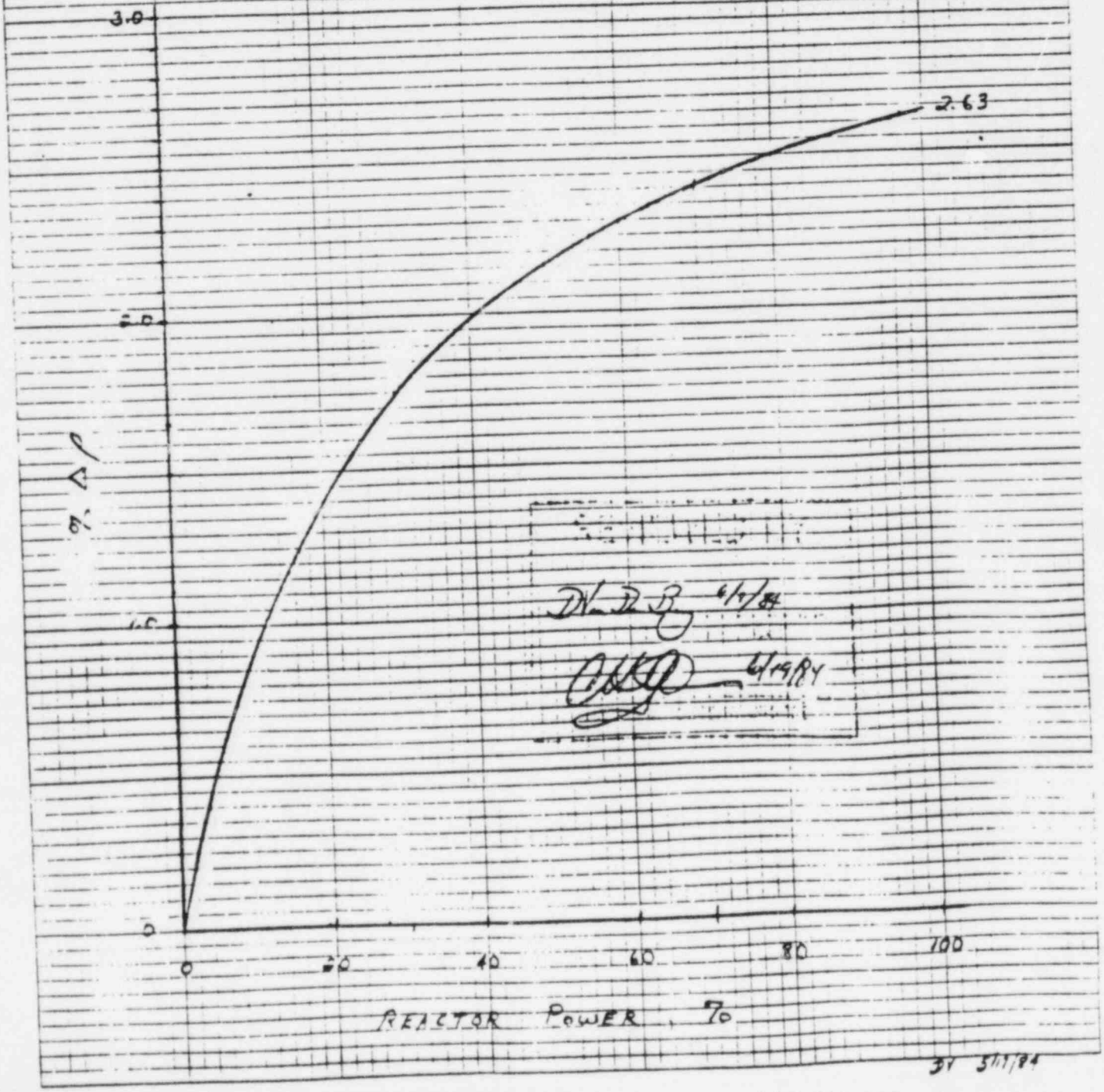
Figure	Title	Rev
4.0,	Reciprocal Boron Worth	
4.1	HZP Reciprocal Boron Worth vs. Burnup	1
5.0,	Control Rod Worth	
5.1	Integral Rod Worth	1
5.2	Group 4 Worth at 80 Inches vs. Burnup	1
6.0,	Boron Rundown	
6.1	Predicted Boron Concentration vs. Burnup	1
7.0,	Boration	
7.1	Boric Acid Batching Graph	0
7.2	Boration Rate Addition	0
7.3	Boration Volume Addition	0
8.0,	Dilution	
8.1	Gallons PMW per ppm Boron	0
8.2	Formula Sheet (Pages 1 & 2)	0
8.3	Boron Dilution Rate (120°F)	0
8.4	Boron Dilution Rate (532°F)	0
8.5	Dilution Make-up Volume (120°F)	0
8.6	Dilution Make-up Volume (532°F)	0

FIGURE 4.1 Rev 1

EQUALIBRIUM XENON

vs.

REACTOR POWER



DWB 4/7/84

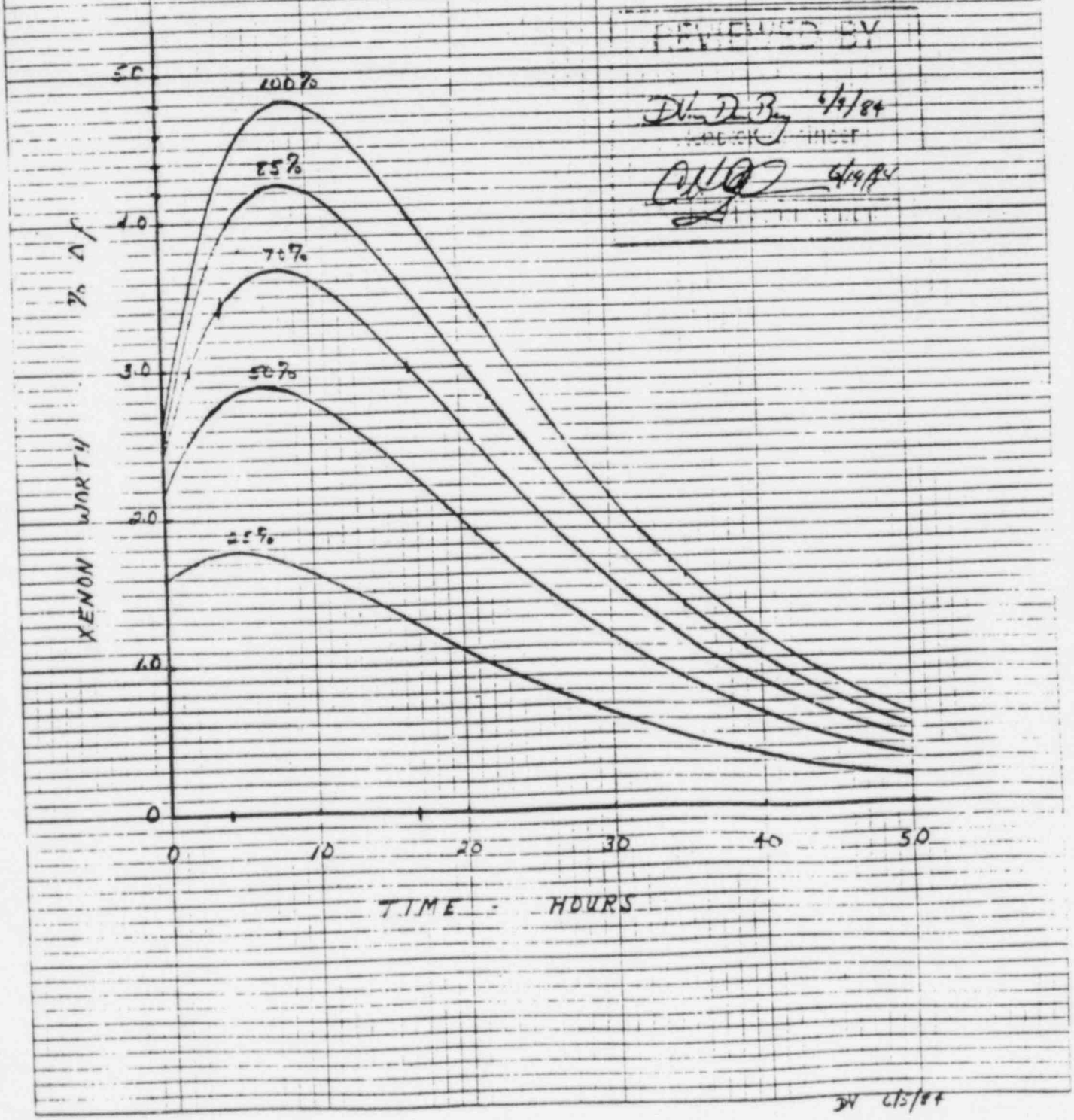
4/19/84

3Y 5/1/84

FIGURE 3.2 , REV 1

XENON WORTH VS. TIME

TRIPS FROM VARIOUS POWERS



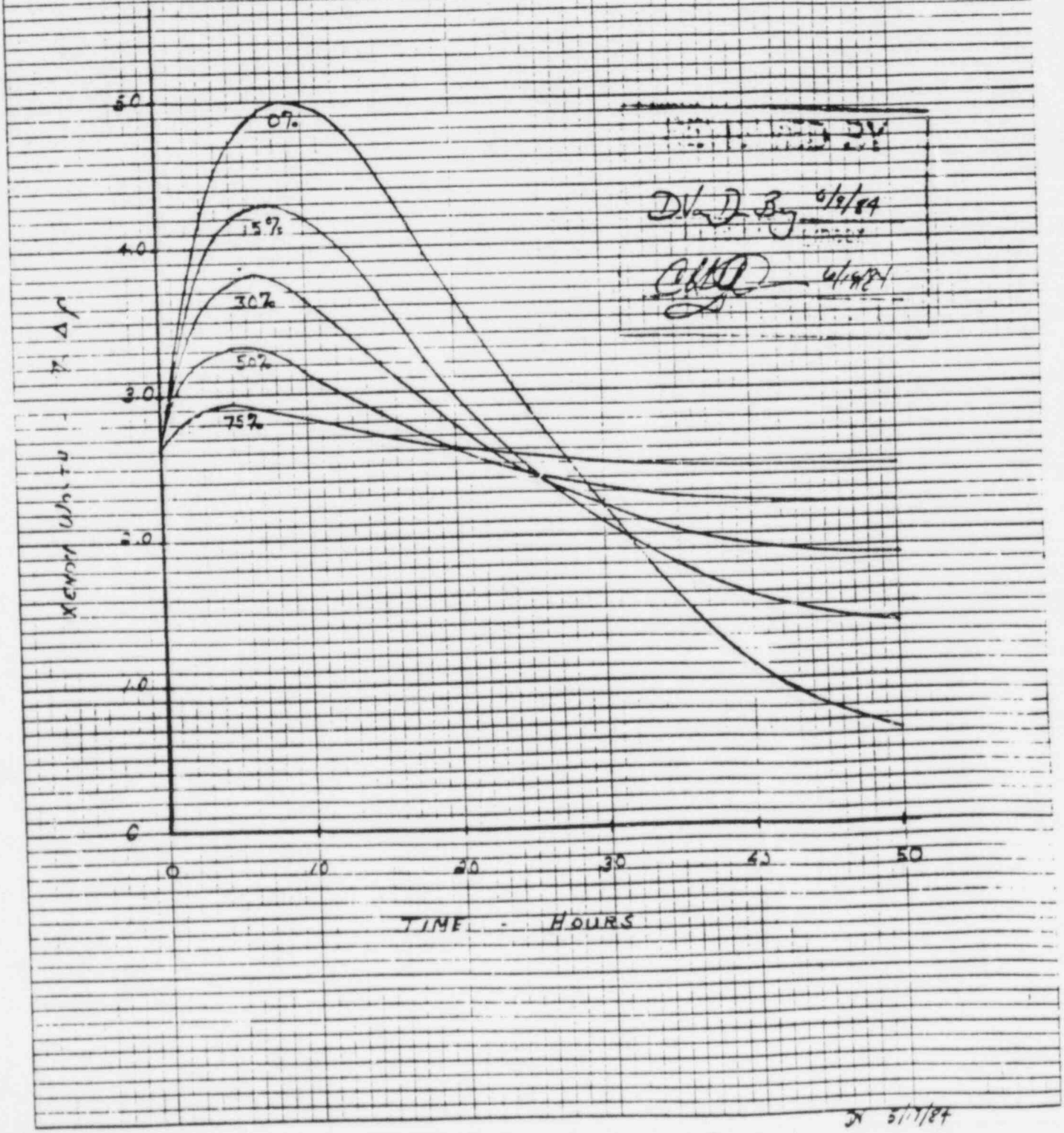
46 0702

10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

FIGURE 2.3, Rev 1

XENON WORTH VS. TIME

STEP DECREASES FROM 100% POWER



DV

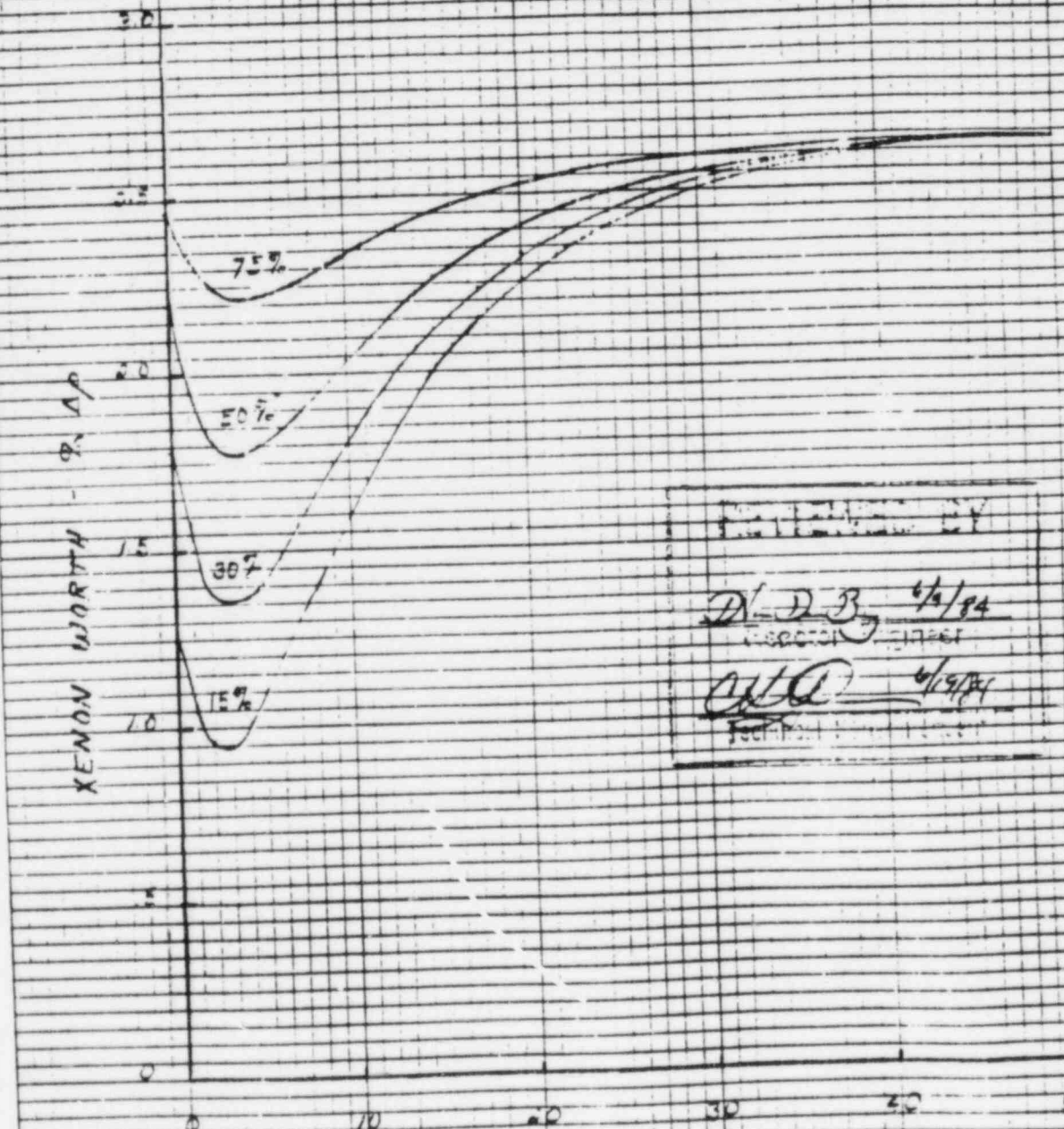
DV 6/9/84

6/4/84

5/7/84

FIGURE 2.4, REV 1

XENON WORTH VS. TIME
STEP INCREASES TO 100% FROM VARIOUS POWER LEVELS



DRAWN BY
D. D. B. 6/9/84
CHECKED
6/9/84

D 5/25/84

Section 3

46 0702

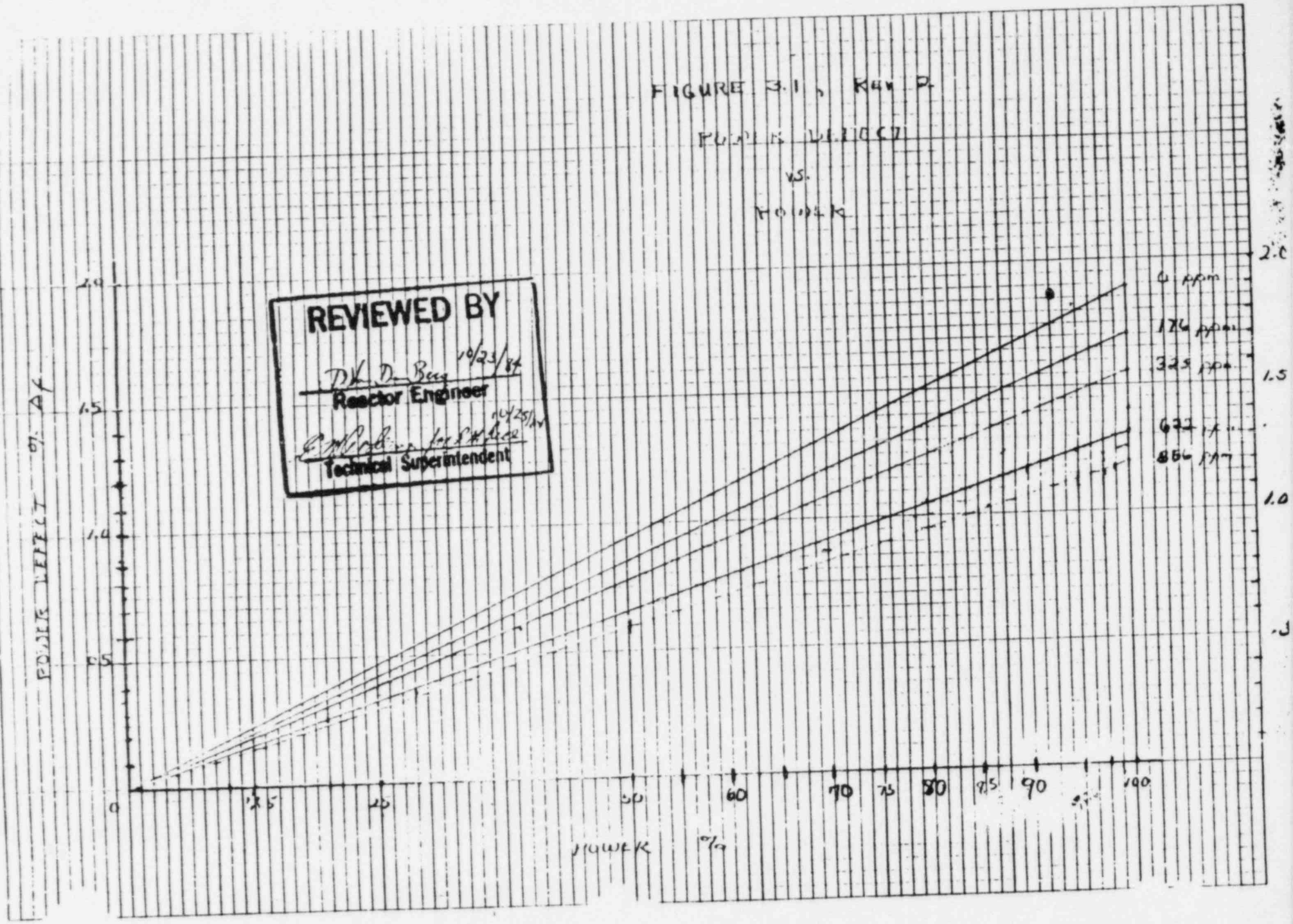
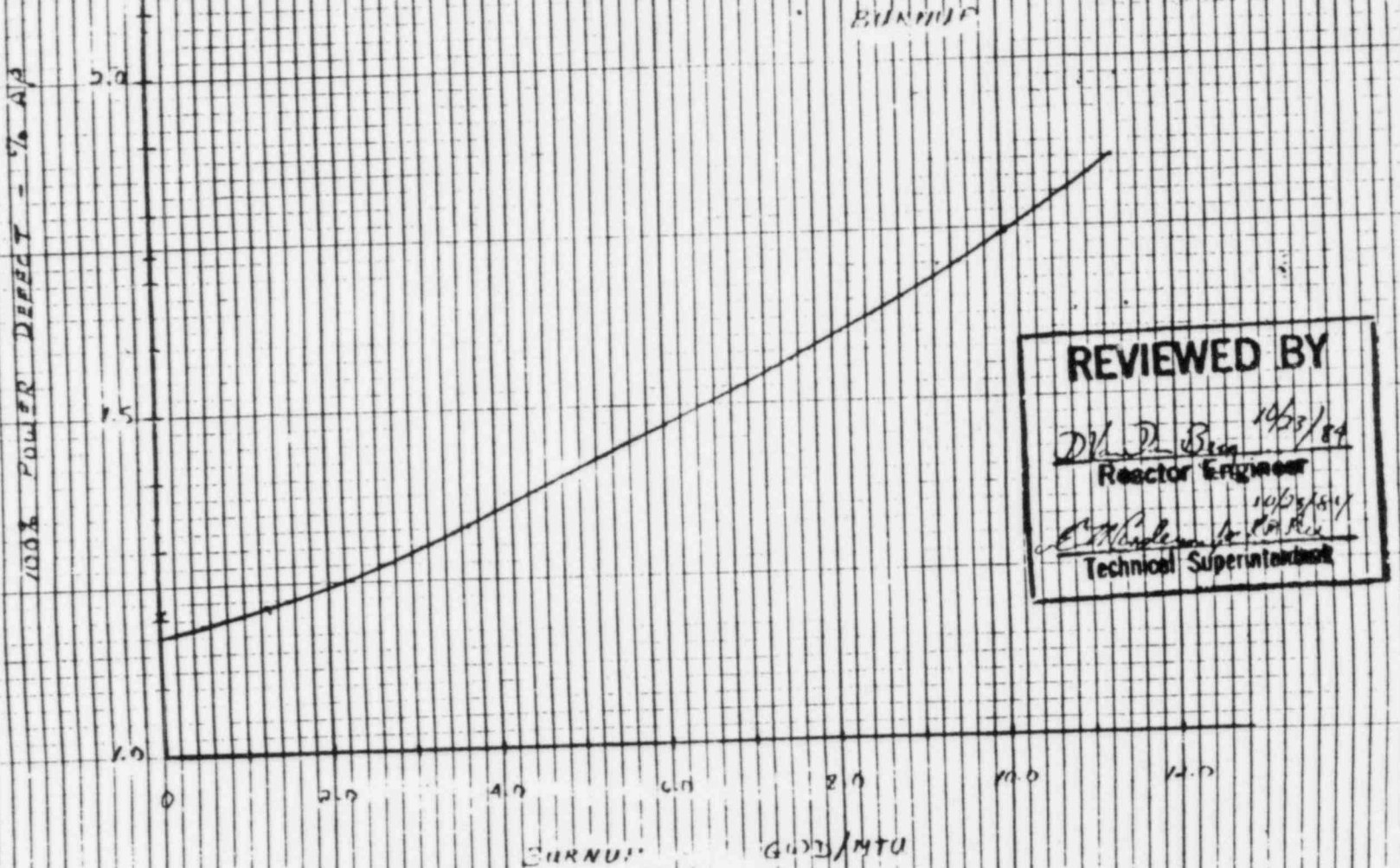


FIGURE 3.2. REV 0

100% POWER DEFECT

VS.

BURNUP



REVIEWED BY

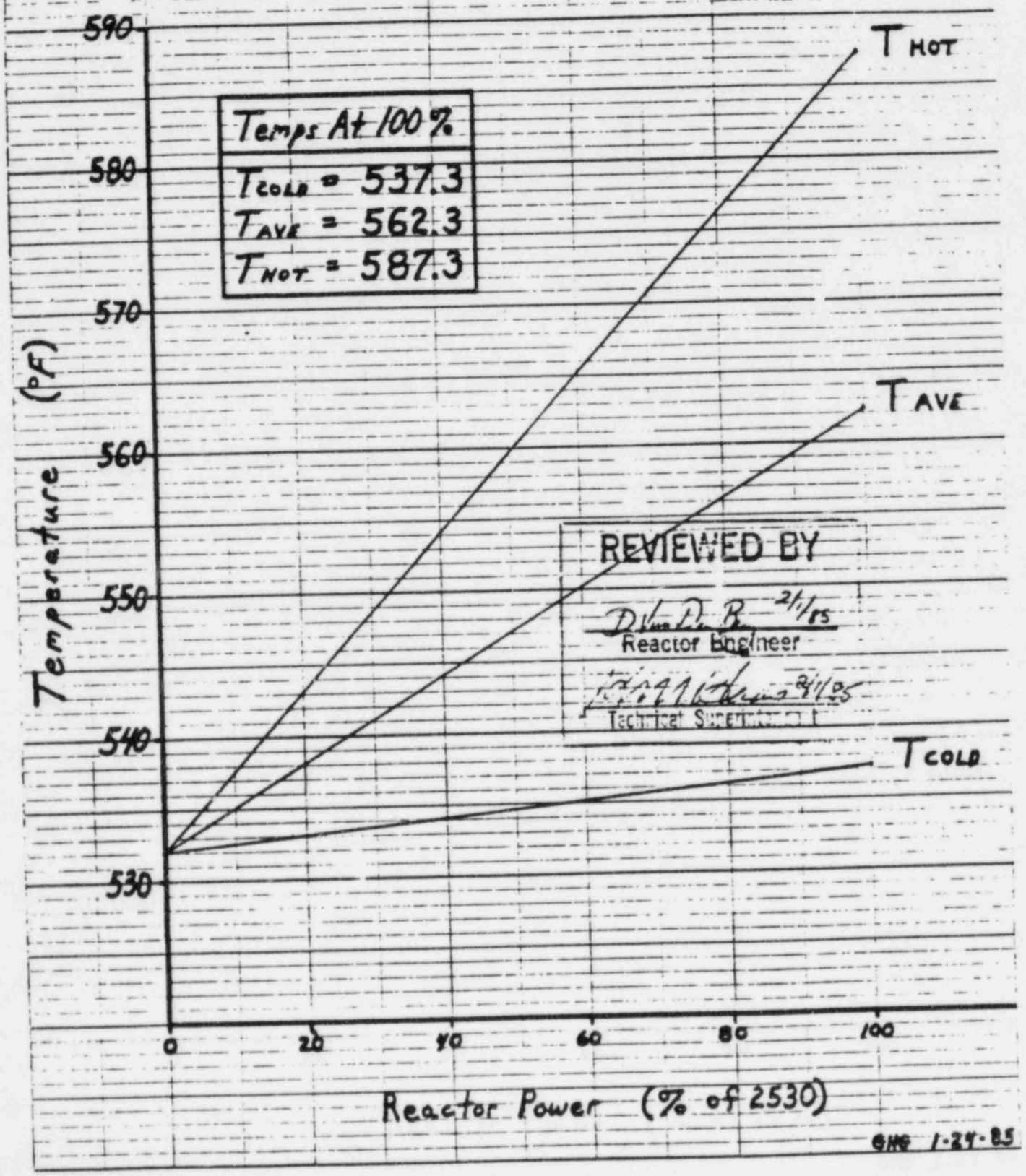
D. P. Bley 10/23/84
Reactor Engineer

10/23/84
Technical Superintendent

Figure 3.3, Revision 1

Programmed PCS Temperature vs Reactor Power

(100% = 2530 MWt
PCS Pressure = 2010 psia)



46 0780

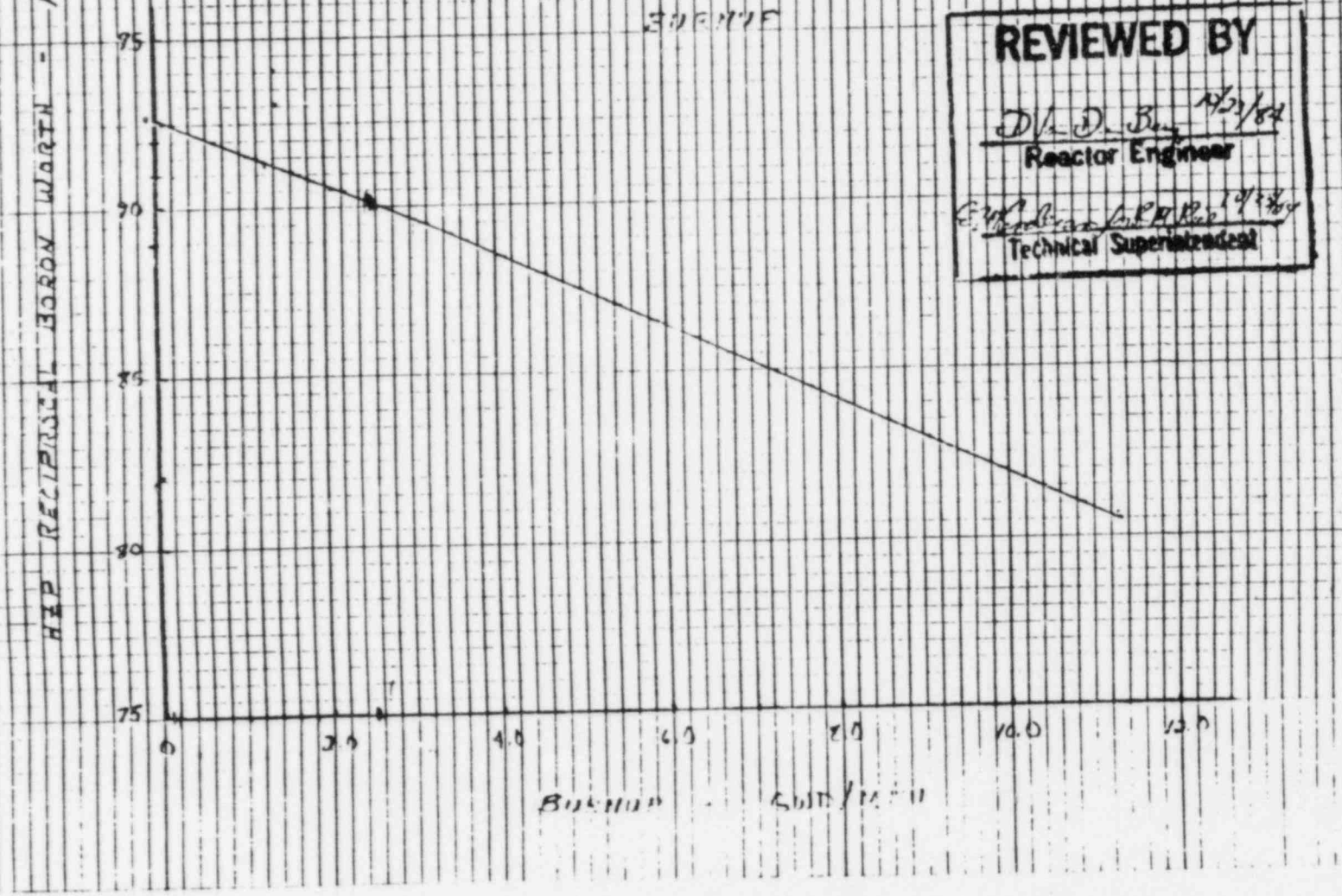
K&E 10 X 10 TO THE INCH • 5 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

FIGURE 4.1, REV 1

HFP RECIPROCAL BORON WORTH

VS.

BORON



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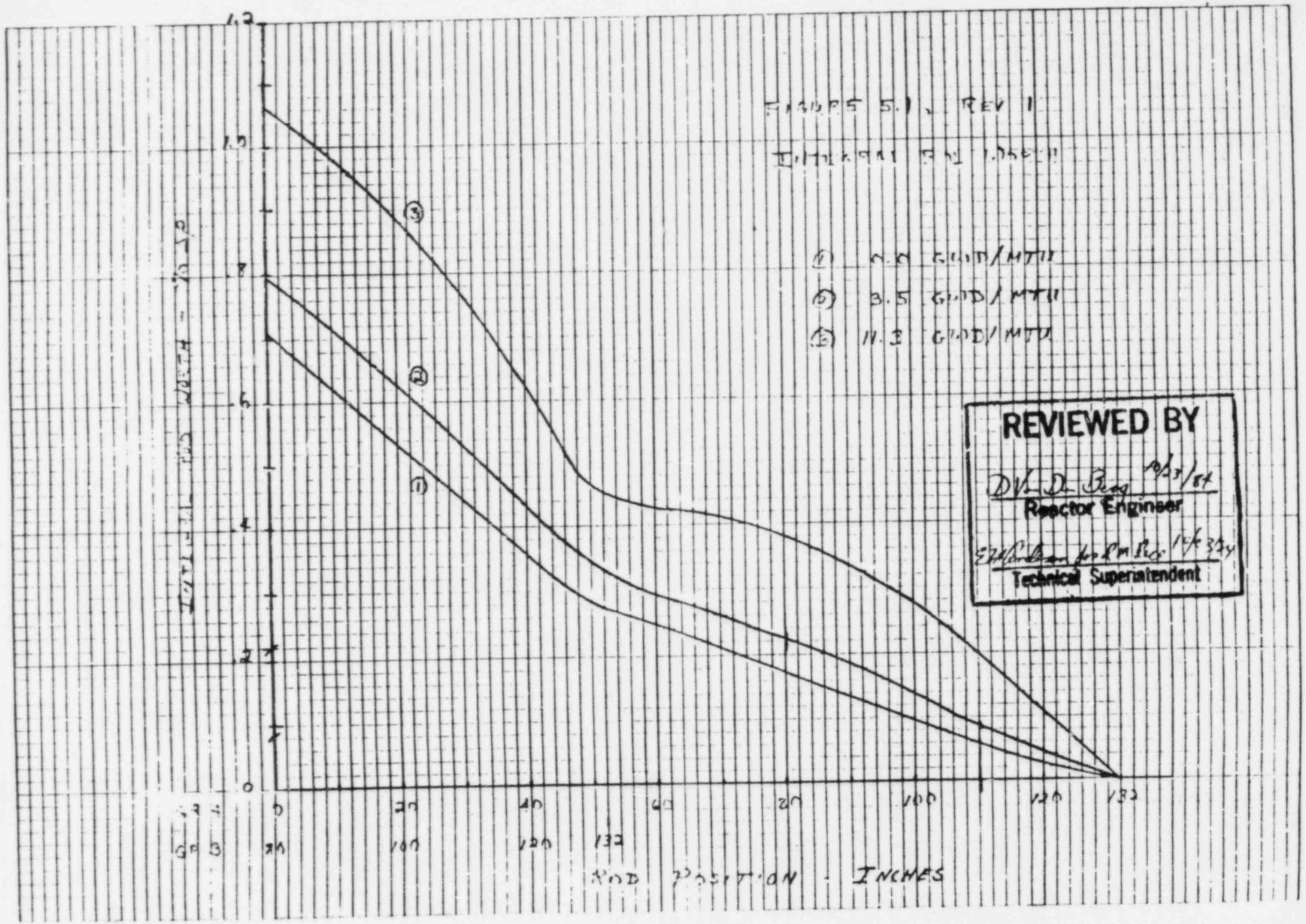
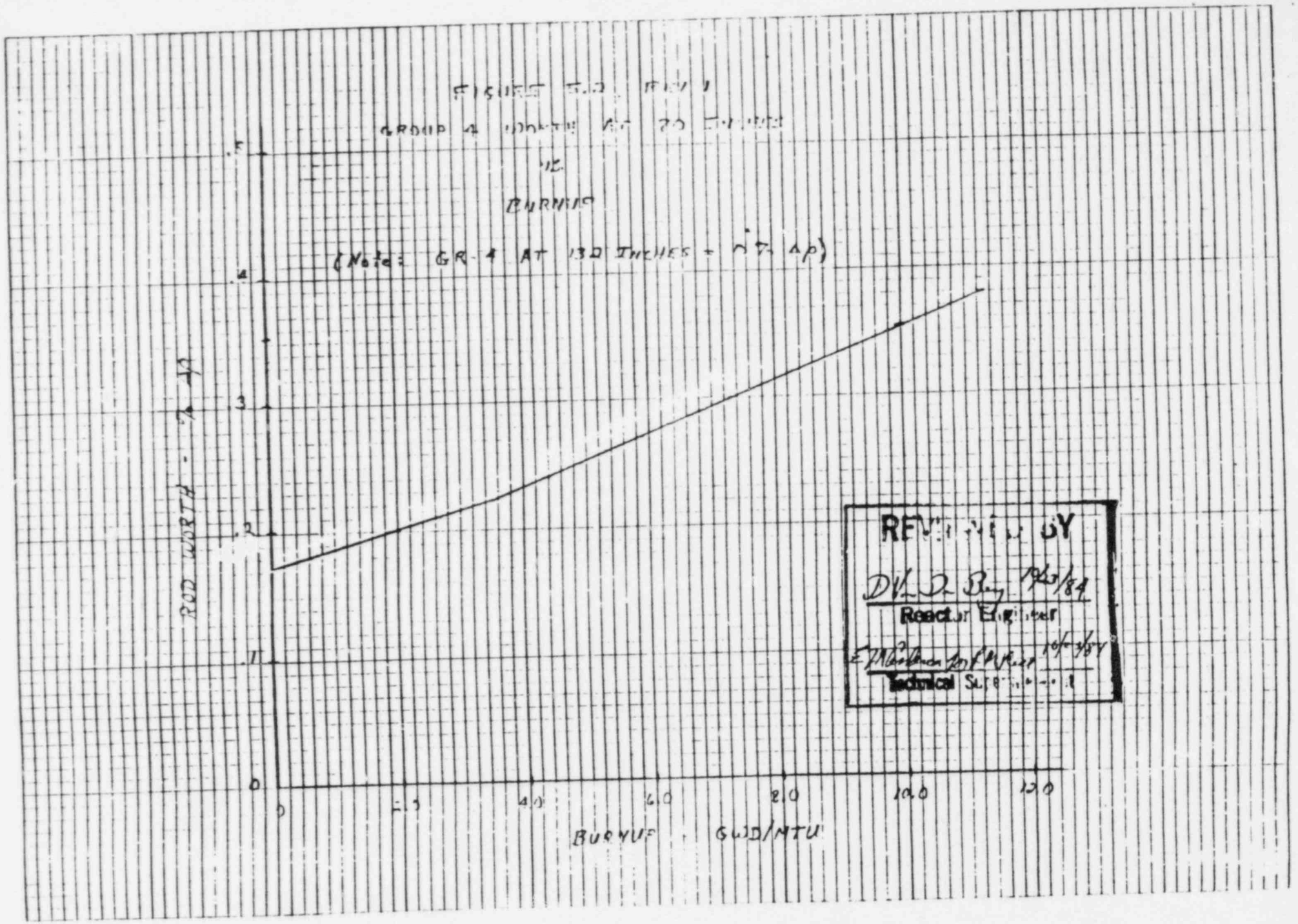
D. D. B. 11/23/84
Reactor Engineer

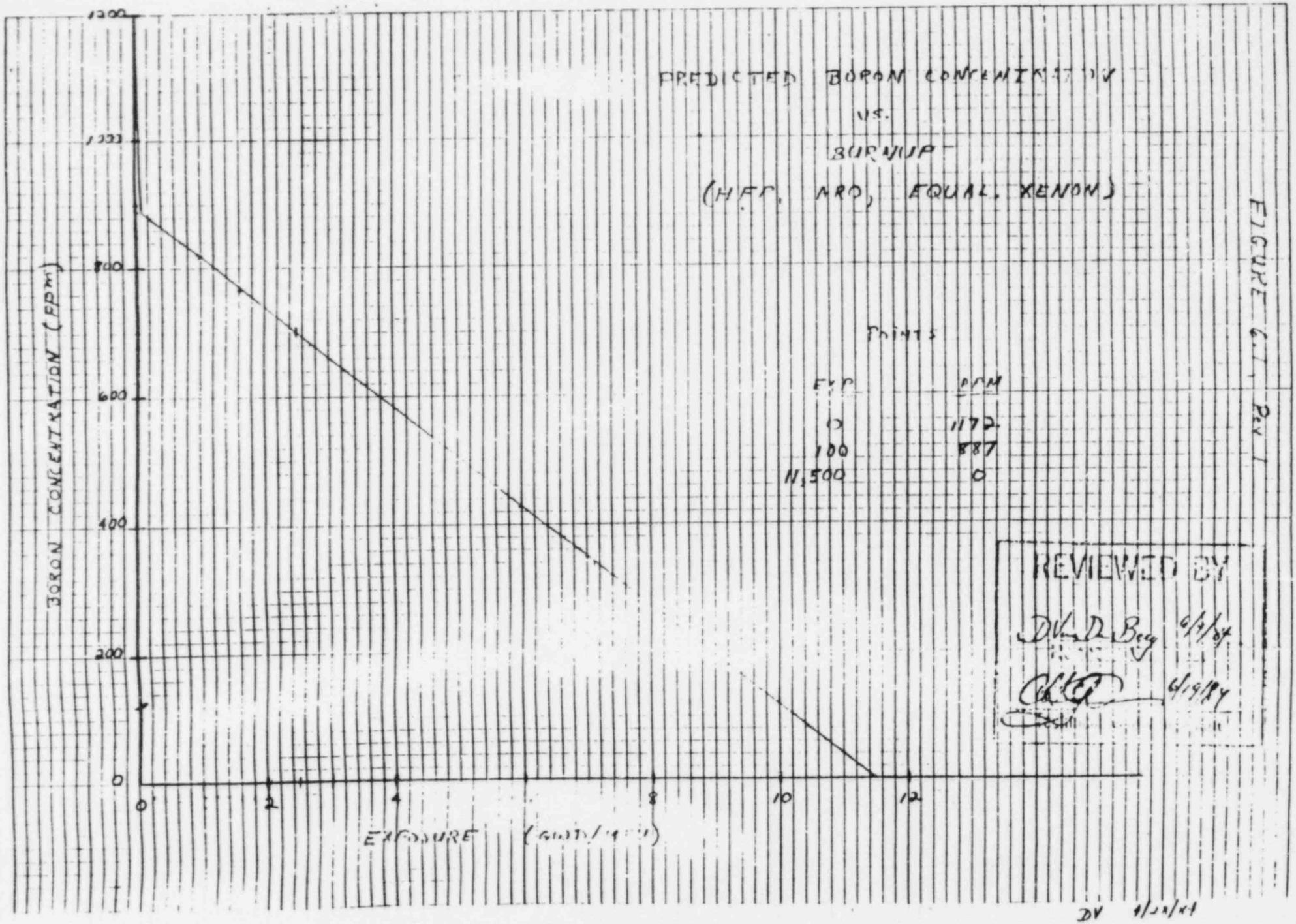
[signature] 11/23/84
Technical Superintendent

Section 4


1.2
1.0
.8
.6
.4
.2
0
0
20
40
60
80
100
120
132
INCHES
③
②
①
REVIEWED BY
Reactor Engineer
Technical Superintendent

Section 5





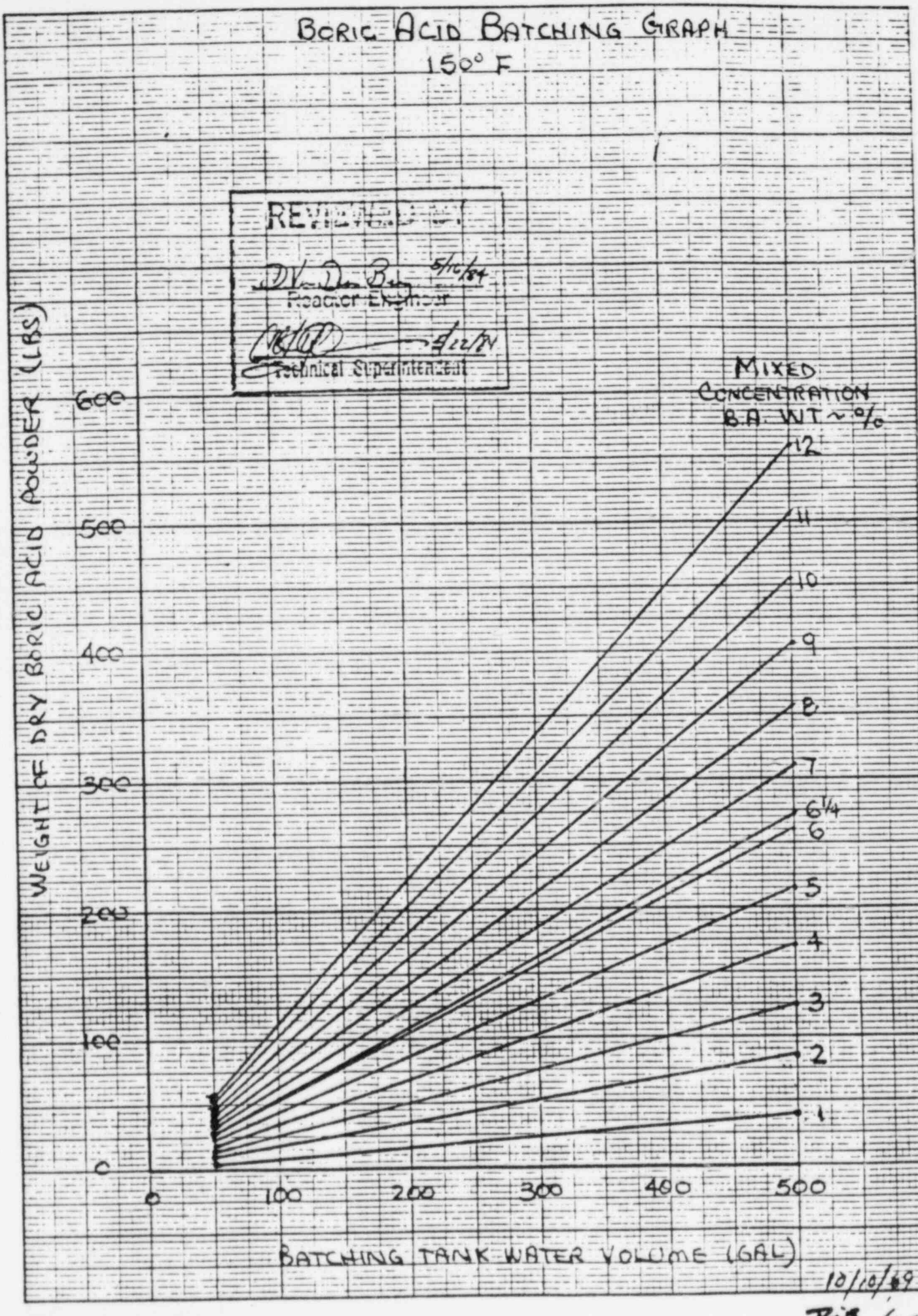
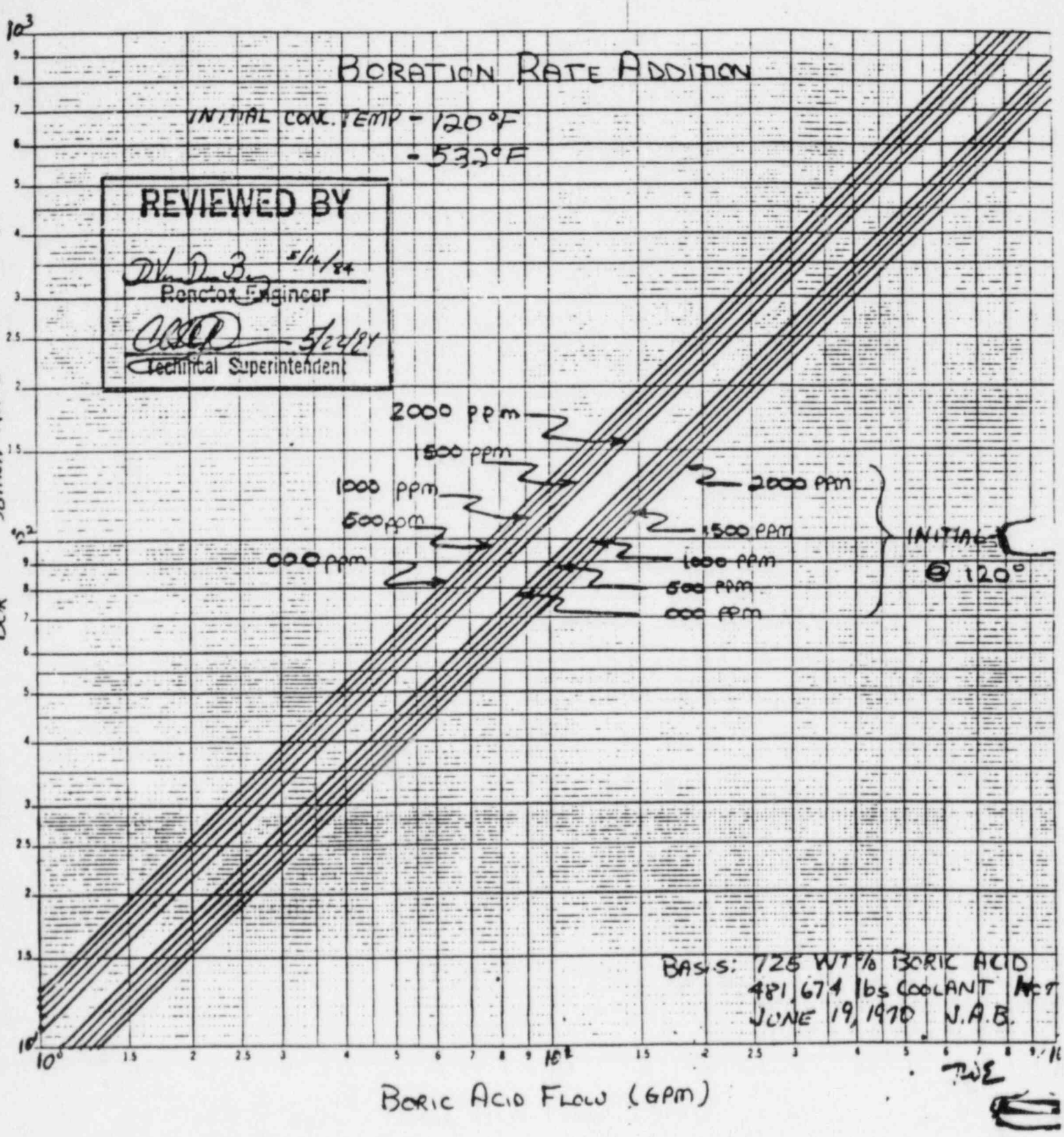

BORIC ACID BATCHING GRAPH
150° F
REVIEWED:
Reactor Engineer
5/10/84
Technical Superintendent
MIXED CONCENTRATION B.A. WT ~ %
12
11
10
9
8
7
6¼
6
5
4
3
2
1
WEIGHT OF DRY BORIC ACID POWDER (LBS)
600
500
400
300
200
100
0
0
100
200
300
400
500
BATCHING TANK WATER VOLUME (GAL)
10/10/89

Figure 7.2, Rev 0



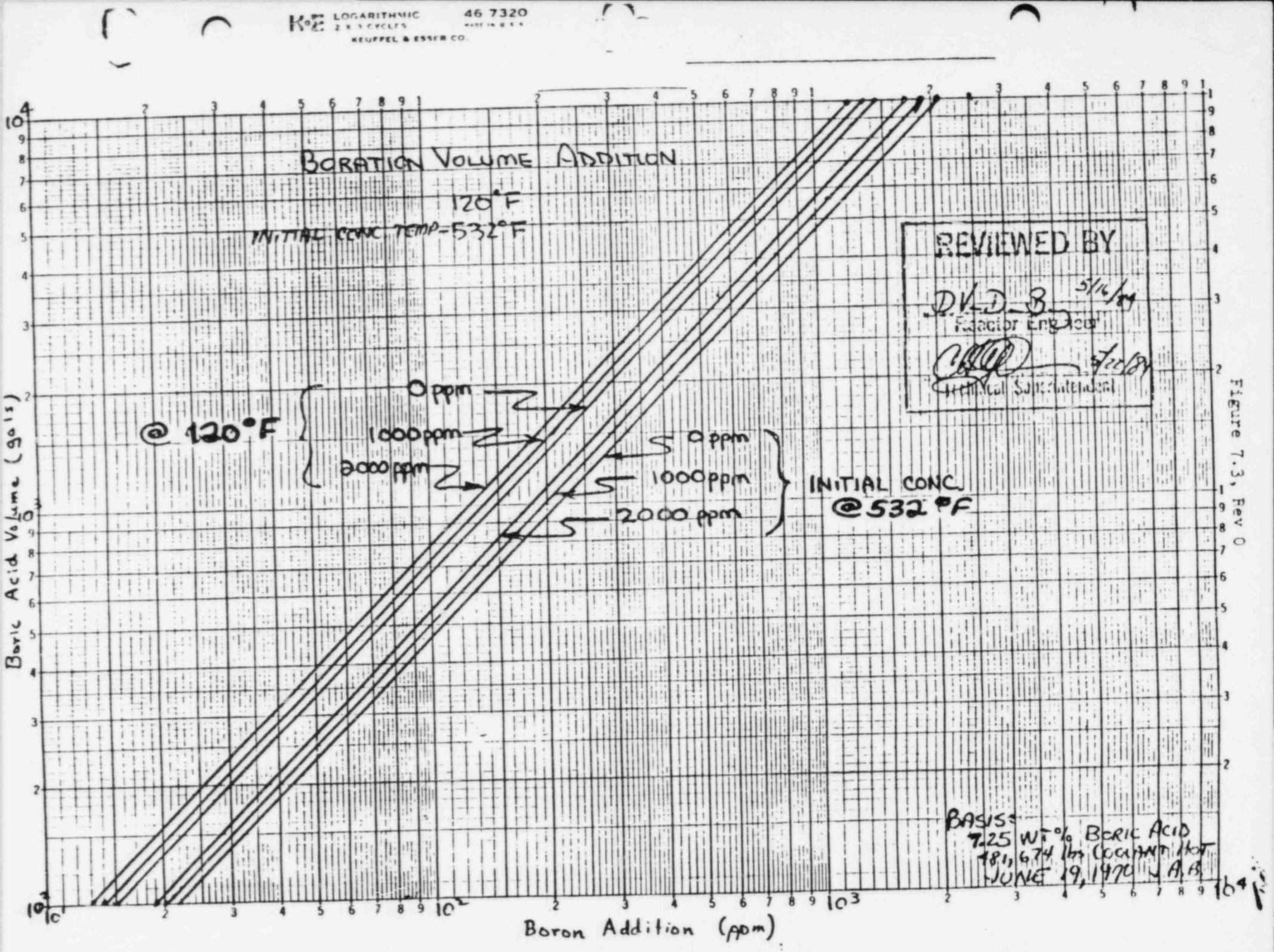
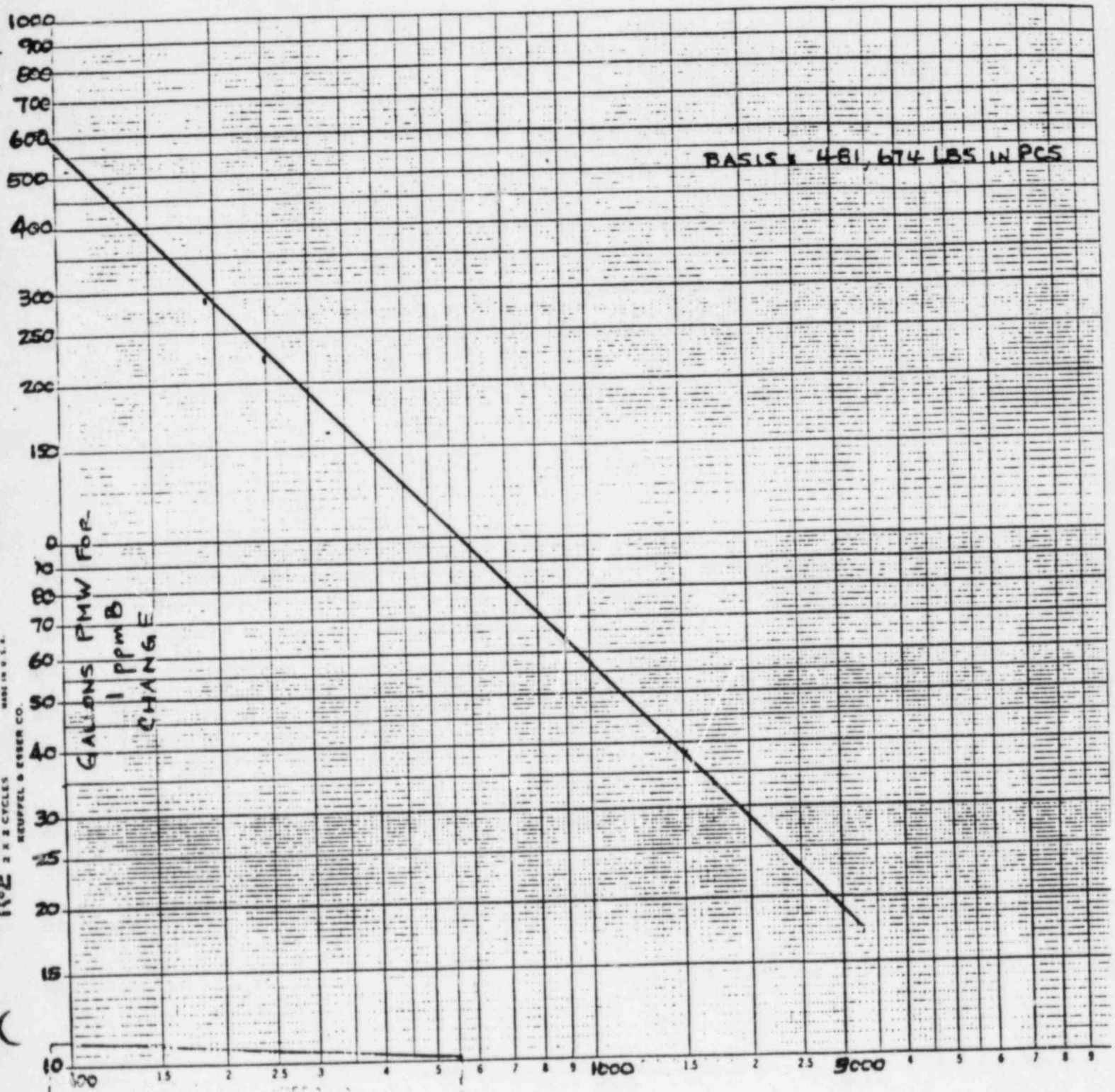


Figure 7.3, Rev 0

Figure 8.1, Rev 0

HOT 532°F

GALLONS PMW PER ppm BORON



Reviewed By: T.W. Edwards

Date 10/2/75

V.I.R. ... 10-13-75

FORMULA SHEET

I. Boron Addition

A. HOT_V Gal. B.A. $= 5.77 \times 10^4 \ln \frac{(B.A.T.k.\ PPM\text{-}PC(Initial)}{(B.A.T.k.\ PPM\text{-}PC(Final)}$

B. $COLD_V$ Gal. B.A. $= 8.48 \times 10^4 \ln \frac{(B.A.T.k.\ PPM\text{-}PC(Initial)}{(B.A.T.k.\ PPM\text{-}PC(Final)}$

C. V Gal. B.A. for desired PPM increase $=$ $\frac{\text{Gal. of Water to Borate} \times \text{Desired PPM increase}}{\text{B.A.T.k. PPM}}$

II. Dilution

A. HOT_V Gal. PMW $= 5.77 \times 10^4 \ln \frac{(PC\ Initial)}{(PC\ Final)}$

B. $COLD_V$ Gal. PMW $= 8.48 \times 10^4 \ln \frac{(PC\ Initial)}{(PC\ Final)}$

III. Blend Ratio

$\frac{B.A.T.k.\ PPM}{PC\ PPM} - 1 = \frac{\#of\ Gal.\ PMW}{1\ Gal.\ B.A.}$

REVIEWED BY

DMKennedy 4-5-83
Reactor Engineer

4/7/83
Technical Superintendent

IV. Mixing Water and Concentrated B.A.

A. $$\text{Final Concentration} = \frac{(\text{Initial Gal. X Initial Conc.})}{(\text{Initial Gal. + Gal. } H_2O \text{ Added})}$$

B. $$\text{Gal. of } H_2O \text{ Needed For Desired Conc.} = \frac{(\text{Initial Gal X Initial Conc.})}{\text{Final Conc.}} - \text{Initial Gal.}$$

V. Mixing 2 Tanks of Different Concentrations.

A. $$\text{Final Conc.} = \frac{(\text{Conc. Of Tank "A" X Gal. Tk. "A"}) + (\text{Conc. Of Tk. "B" X Gal. Tk. "B}}{(\text{Gal. Tk. "A" + Gal. Tk. "B"})}$$

B. $$\text{Gal. Conc. B.A. for Desired PPM Increase} = \frac{\text{Gal. Of Water to Borate X Desired PPM Increase}}{\text{PPM Of Conc. B.A. - PPM Final}}$$

VI. To Predict Or Determine Evap. Bottoms Concentration

$$\text{Gal. Of Feed To Evap.} = \frac{\text{Increase in Bottom Conc.}}{\text{Conc. Of Feed To Evap.}} \times \text{Evap. Concentrate Volume}$$

VII. Pressure, Temperature Volume, Of A Gas

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

P = Absolute pressure

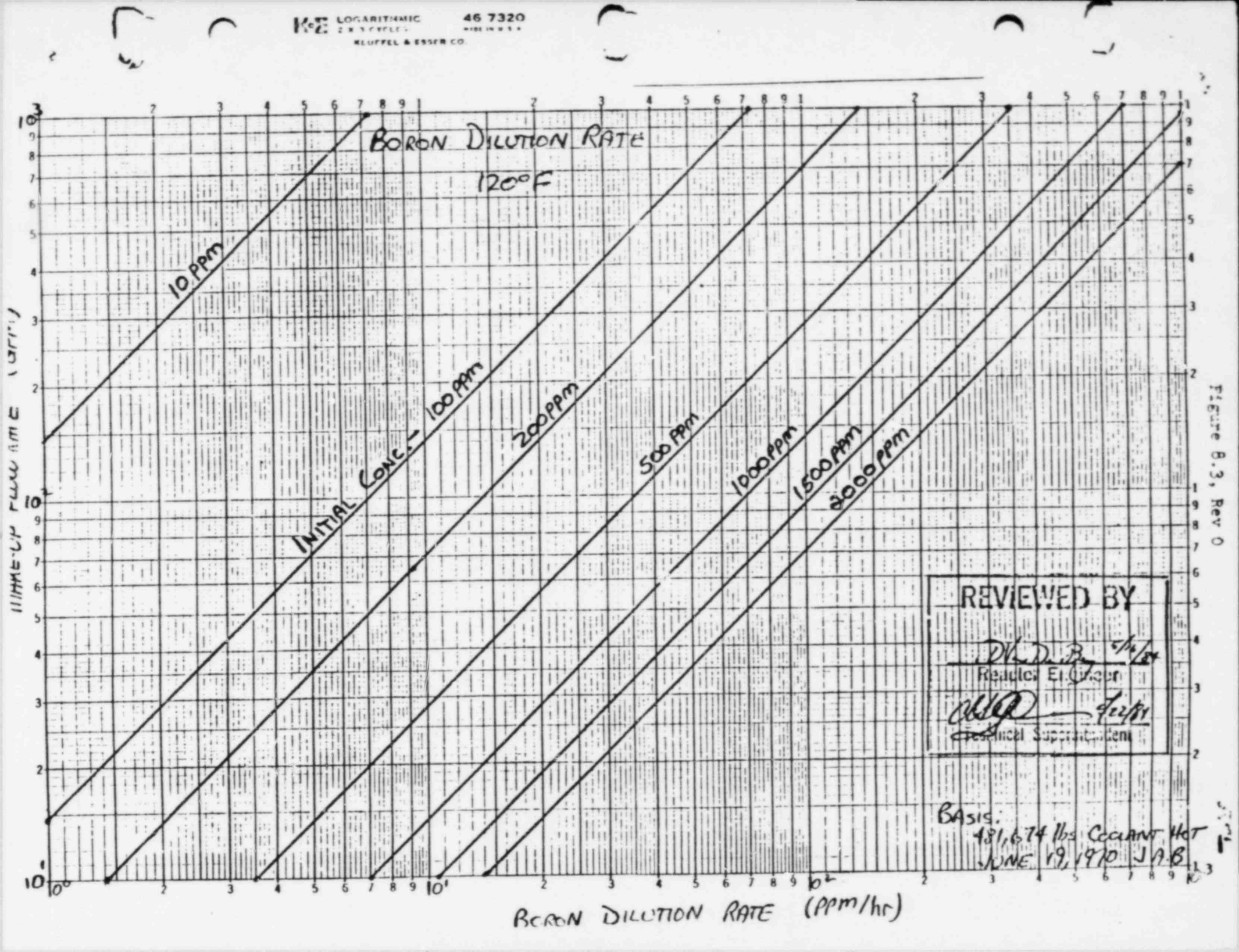
V = Volume

T = Temp. $^{\circ}$Rankine ($^{\circ}$F + 460)

REVIEWED BY

Reactor Engineer 7-11-83

Technical Superintendent 4/14/83


K&E LOGARITHMIC 2 X 3 CYCLES 46 7320 MADE IN U.S.A.
KEUFFEL & ESSER CO.
BORON DILUTION RATE
120°F
10 PPM
INITIAL CONC = 100 PPM
200 PPM
500 PPM
1000 PPM
1500 PPM
2000 PPM
REVIEWED BY
Reactor Engineer
Technical Superintendent
BASIS:
181,674 lbs COOLANT HOT
JUNE 19, 1970 JAB
BORON DILUTION RATE (PPM/HR)
Figure 8.3, Rev 0

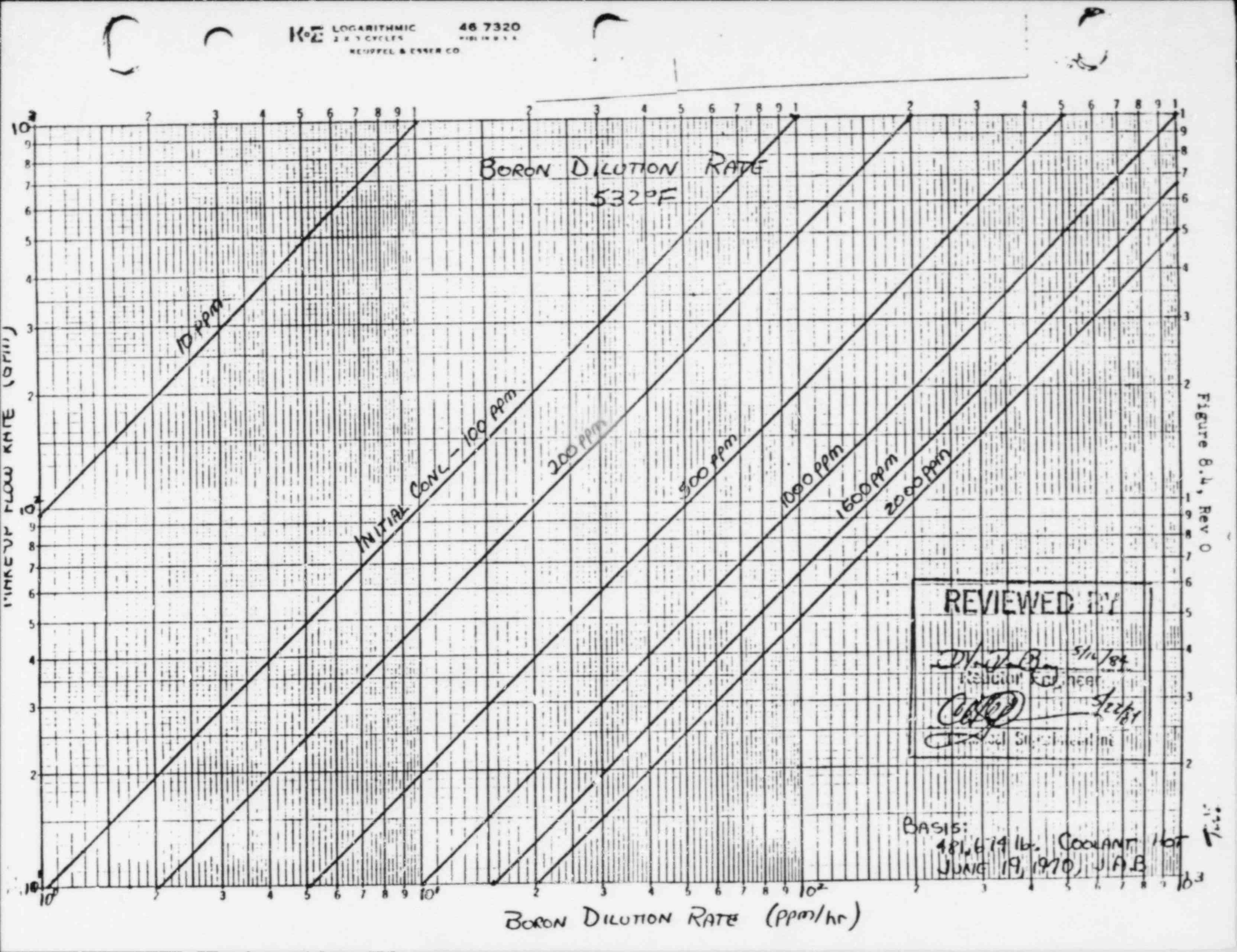


Figure 8.4, Rev 0

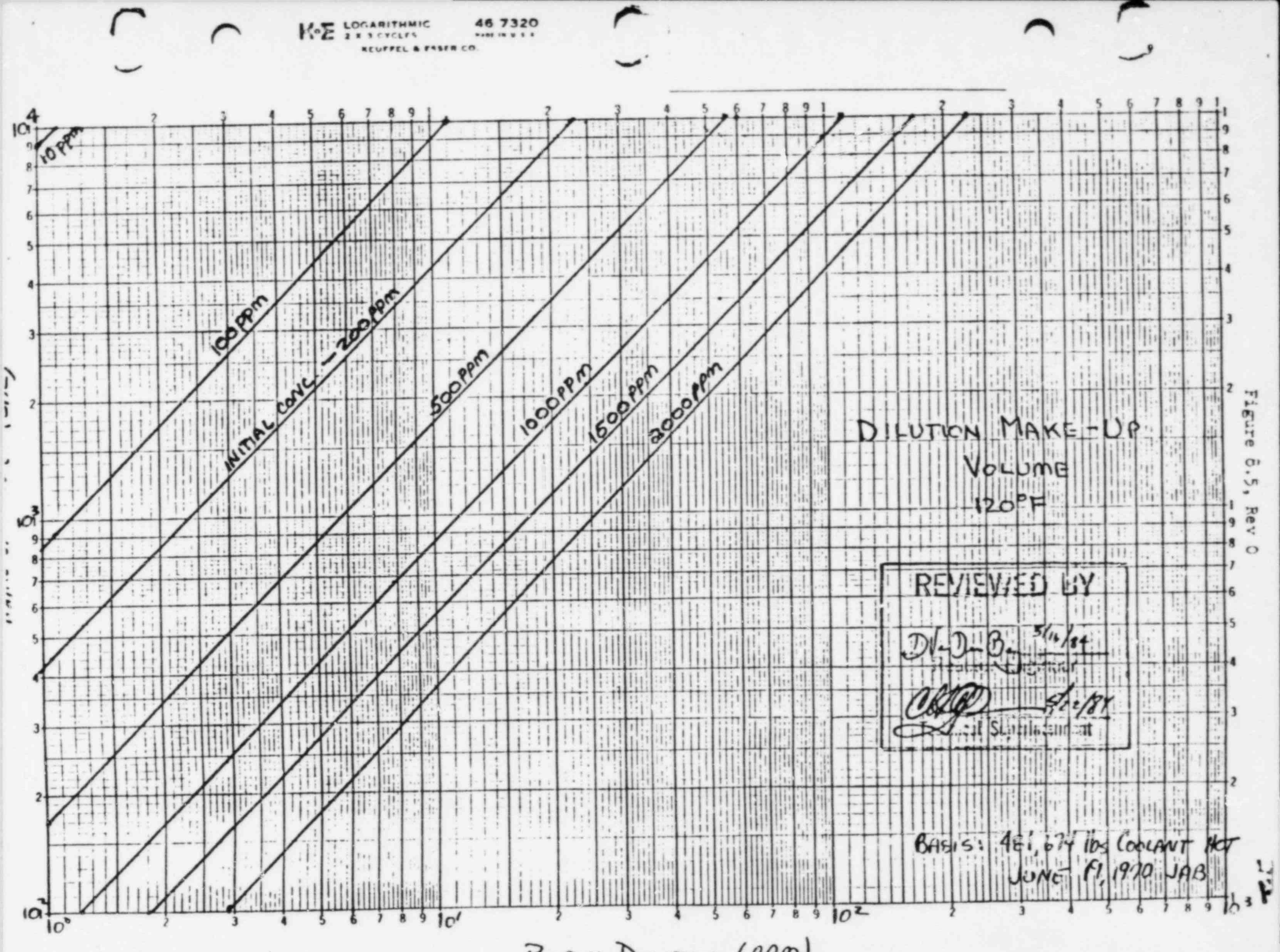


Figure 6.5, Rev 0

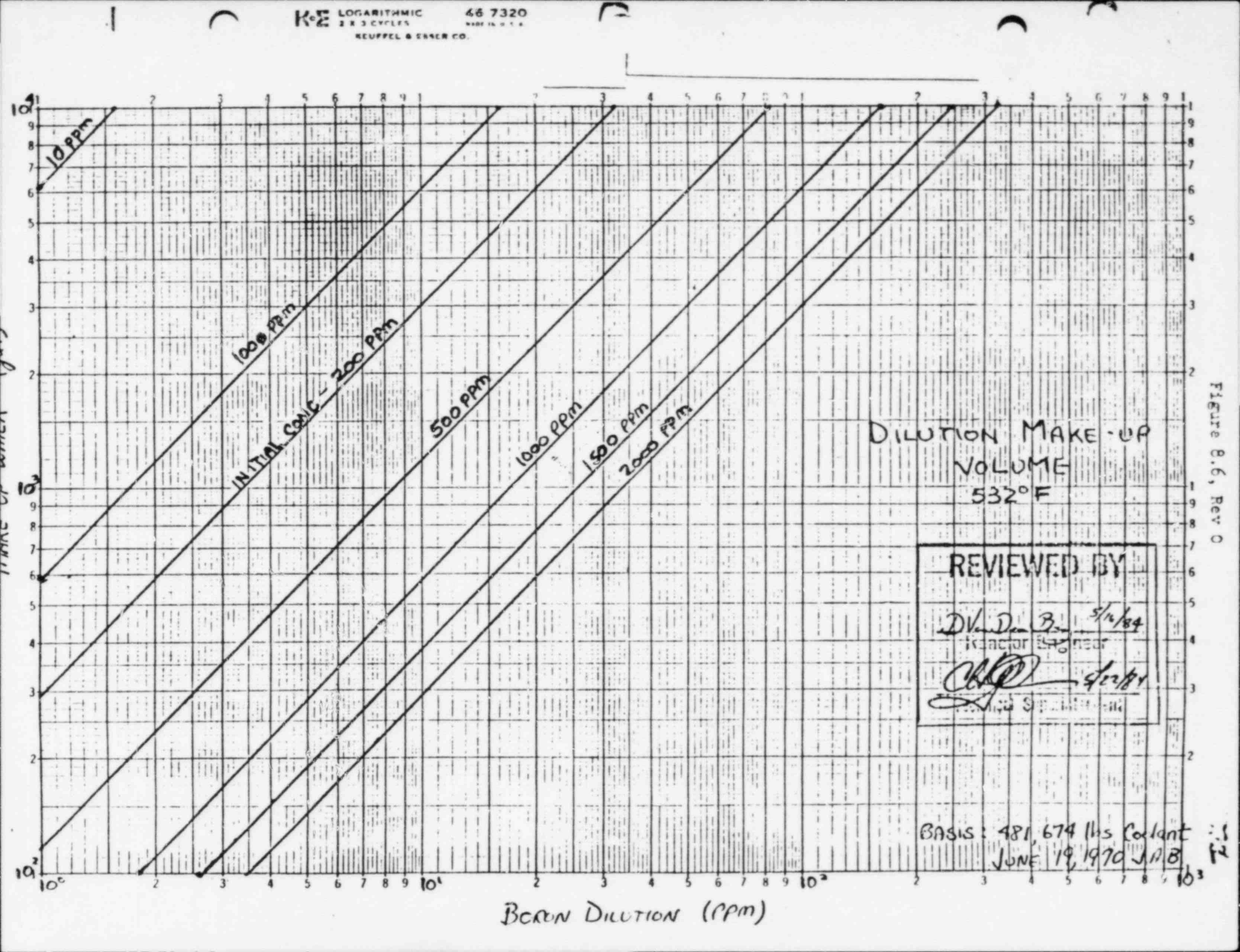


Figure 8.6, Rev 0

1. PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 1.01 (.50)

B [0.5]

REFERENCE
PQBOOK5.28

KA: p. 3.1-17 K5.20 3.6

ANSWER 1.02 (.60)

C. [0.6]

REFERENCE
PRAOOK6.09

Appendix pg A-9 2.9

ANSWER 1.03 (2.50)

3.33 - 2.65 = 0.68 % p Figure 2.3 [0.8]
90 ppm / %p X 0.68 %p = 61.2 ppm Figure 4.1 rev 1 [1.0]
7,600 gal (+/- 300 gal) Figure 8.6 rev 0 [0.7]

REFERENCE
PQBOG28.02
OG35.01
OK05.29

KA: p 3.1-45 EK1.02 3.6

ANSWER 1.04 (1.50)

a. The closer to criticality, (large Keff) the longer time required to reach a stable count rate. [0.75]

b. A higher initial count rate will result in a higher count rate at criticality. [0.75]

REFERENCE

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1. PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

KA: p 3.1-7 K5.08 2.9

ANSWER 1.05 (1.00)

a. Increase
b. Increase [0.5 each]

REFERENCE
PRA04.50

KA: p 3.5-3 A1.05 3.2
p 3.2-2 K5.11 4.0

ANSWER 1.06 (2.00)

a. Valve operation, opening or closing
Pump starting or stopping
Oscillation of auto control valves [any 2 @ 0.4 each]
Reasonable answers will be accepted.

b. Insure adequate pressure control during valve operations
Use thermal insulation and steam drains to prevent formation of condensate
Slowly opening of valves between voided and full systems
Proper venting of components
Adequate level on tanks in systems where the tanks provide supply or surge function
Proper use of steam traps and vents
Proper sequencing of valves in pressurized systems (Two required) (1.2)
Reasonable answers will be accepted.

REFERENCE
PRA04.101
PRA04.102

ANSWER 1.07 (1.50)

a. decrease
b. decrease
c. increase [0.5 each]

REFERENCE
PRA04.91

1. PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 1.08 (2.40)

a. Nucleate boiling creates turbulent flow which promotes more mixing(1.2).
OR The coolant picks up latent heat of vaporization and carries it to cooler parts of the channel (1.2).

b. In film boiling, a film of steam coats the clad surface and forms an insulating layer (1.2).

REFERENCE
PRADOK5.11

KA: p 3,4-23 EK1.03 4.5

ANSWER 1.09 (2.50)

a. The fission product inventory increases at EOL. [0.3]
Fission products are good thermal neutron absorbers, so the neutron energy spectrum will shift towards the epithermal region. [0.4]
Rods are good absorbers of epithermal neutrons. [0.3] OR
Thermal neutron flux increases at EOL due to fuel burnup and boron removal. [0.5]
Rod worth is directly proportional to thermal neutron flux. [0.5]

b. Reactor power will decrease and return to equilibrium power. [0.5]
Tave will decrease. [0.5]
The negative reactivity inserted by the dropped rod would be countered by positive reactivity inserted by MTC. (0.5)

REFERENCE
PQOBOOK5.06

KA: p 3.1-2 K 5.05 3.5
K 5.10 3.9

1. PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 1.10 (2.50)

a. FTC [0.4]
MTC [0.4]
Void defect [0.4]
[0.3] for proper order

b. Program Tave increases as power increases which adds negative reactivity through MTC [0.5]
Fuel temperature increases as power increases which adds negative reactivity through FTC [0.5]

REFERENCE
PQCOG37.14

KA: p 3.1-3 K 5.49 3.4

ANSWER 1.11 (2.00)

SUR = 26 (lambda) (p) / (B - p) [0.4]
0.3 = 26 (~~0.08~~) (p) / (0.0053 - p) [0.7]
(26 X 0.08 + 0.3) p = 0.3 X 0.0053 [0.2]
p = 0.00067 or 6.7 E -4 [0.1]

From figure 5.1 rev 1 curve 3; rod height = 94 in (+/- 2 in) [0.6]

REFERENCE
PQDOG35.1

KA: p 3.1-3 K5.47 2.9

1. PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 1.12 (3.00)

a. Subcooling margin would decrease [0.5]
due to decreased PCS pressure. [0.5]

b. Subcooling margin would not change [0.5]
since Tave would remain the same. [0.5]
(Delta T across the SG would increase.)

c. Subcooling margin would not change [0.5]
since heat transfer would not be affected. [0.5]

REFERENCE
PRADOK6.01

KA: p 3.4-24 EA2.01 4.6

ANSWER 1.13 (3.00)

a. Shutdown margin decreases. [0.5]
PCS temperature decreases adding positive reactivity to the core. [0.5]

b. Shutdown margin remains the same. [0.5]
Reactivity effects of xenon and temperature will compensate for each other. [0.5]

c. Shutdown margin increases. [0.5]
More rod worth will be available for insertion on a trip. [0.5]

REFERENCE
PQFOOA1.03

KA: p 3.1-17 K5.19 3.5

2. PLANT DESIGN INCLUDING SAFETY AND EMERGENCY SYSTEMS

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 2.01 (.60)

C. Two [0.6] B. One

REFERENCE
PNPDOG5.03

KA: p 3.11-14 K6.10 2.5

ANSWER 2.02 (2.00)

a. ~~B~~ B
b. A
c. A and B
d. non-critical
e. B

[0.4 each]

REFERENCE
PNAADK1.01

KA: p3.5-45 K1.05 3.8
K1.01 3.4
K1.16 3.6

ANSWER 2.03 (1.50)

a. Elevation of the lowest penetration (hot leg) is (6 ft) above the top of the fuel assemblies. [0.75]

b. Allows for thermal expansion of the reactor vessel. [0.75]

REFERENCE
PNJBOK4.03 Q1
K4.02 Q1

KA: P 3.2-1 K4.01 2.7

ANSWER 2.04 (2.10)

a. Leak by of the primary check valve. [0.7]
b. Bleed pressure through CV-3038 to radioactive waste treatment system. [0.7]

c. SIRWT [0.4] by using HPSI pump [0.3]
or CS pump [0.3]

REFERENCE
PNMA0K1.02

KA: p 3.2-9 K1.06 2.2
3.2-12 K2.03 3.3

ANSWER 2.05 (2.50)

a. closed
b. closed
c. open
d. as is
e. closed
[0.5 each]

REFERENCE

EOP-5 Rev 13, p 2, 3

KA: p 3.8-10 EA2.08 2.9

ANSWER 2.06 (2.00)

a. Prevented by mechanical interlocks. [0.8]

b. Cross connect a safeguard bus with a non-safeguards bus
Elimination of safeguard bus redundancy
Cross connecting out of phase
Exceeding bus ratings [any 3 @ 0.4 each]
Loss of both buses due to a fault;
Exceeding bkr ratings;

REFERENCE
PNIBG37.01

KA: p 3.7-3 A2.06 3.4
A2.15 2.8

K4.05 2.7

ANSWER 2.07 (2.00)

Out the break to the sump [0.1]
LPSI ~~Through~~ Minrecir pumps [0.1]
SDC HX [0.3]
CCW [0.2]
SW [0.2]
~~Cooling towers~~ [0.1]
Lake

Out break to the sump [0.1]
Through CS system [0.2]
CCW or CNTM Air Coolers [0.4]
SW [0.2]
~~Cooling towers~~ [0.1]
Lake

REFERENCE
PNMBOG4.05
PNMCOK1.01

KA: p 3.2-15 K4.03 3.4

ANSWER 2.08 (2.50)

a. Damping of buffer postion on a wet scram [0.6]
Energy absorber prevents damage on a dry scram [0.6]

b. No rod drop. [0.3]
MCC1 provides power to rod drive motor and brake which is engaged when deenergized. [0.6]
The clutch which provides union is not effected by loss of MCC1. [0.4]

REFERENCE
PNLAOK4.01
K2.01
G4.03

KA: p 3.1-2 K4.07 3.7
3.1-1 K2.03 2.7

ANSWER 2.09 (2.40)

Pumps can be operated with one failed seal because the other seals will prevent gross leakage. [1.2]
If more than one seal has failed, ~~debris may be introduced into the bleed off flow, possibly causing~~ additional rapid seal failure resulting in a LOCA. [1.2]
there is an increased possibility of

REFERENCE
PNJDOG7.01

KA: p 3.4-2 K6.02 2.7
K4.07 3.2

ANSWER 2.10 (2.40)

a. Spent fuel pool filter [0.2]
Spent fuel pool demineralizer [0.3]
Skimmer [0.3]

b. Spent fuel pool heat exchanger [0.4]
P-51 A or B [0.4]

c. SIRWT [0.4]
P-51B [0.4]
utility water, PMW, gravity from SIRWT

REFERENCE
PNOAOG4.02
G9.01
SOP-27, p 3

KA: p 3.11-5 K4.02 2.5
K3.03 3.0
K4.01 2.9

ANSWER 2.11 (2.00)

a. Loss of load signal if greater than 15% power
b. ~~None~~ fail as is
c. Trips cooling tower fans
d. Start signal for diesel generator

[0.5 each]

REFERENCE
PNGA0K3.01

KA: 3.5-11 A3.04 3.4

ANSWER 2.12 (3.00)

a. open
b. ~~4 start in slow speed~~ all trip (only single speed fans)
c. ~~2 of 3 start~~ all 3 start
d. ~~open~~ shut
e. ~~open~~ shut
f. open
g. open
h. open
i. ~~Start but do not load on bus~~ no effect
j. Not effected

[0.3 each]

REFERENCE

EOP-1, Att. 3, rev. 16; p 3, 4

KA: p 3.2-27 A3.02 4.1

3. INSTRUMENTS AND CONTROLS

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 3.01 (2.40)

a. ~~Both~~ the affected S/G valves shuts [0.6]
b. No effect [0.6]
c. No effect [0.6]
d. Rx trips on low steam generator water level [0.6]

REFERENCE

PNFBOK6.02

KA: p 3.5-36 K4.05 2.5
p 3.5-56 EA2.05 3.5

ANSWER 3.02 (2.40)

Position Indication Primary [0.3] synchro-transmitters [0.3]
Secondary Position Indication [0.3] reed switches [0.3]
Nixie tubes [0.3] synchro-transmitters [0.3] on PIP [0.3]
Matrix board display [0.3] limit switches [0.3] on SPI

REFERENCE
PNLA0A4.04
A4.03
A4.02
A4.01

KA: 3.1-31 K4.03 3.2
K4.06 3.4
K1.02 3.2

SPI is lost
rod matrix display is lost
SU, int + PR recorders lost
PIP lost
cooling tower pump stop
pzr PORV temp ind
all pzr temp ind.
cont temp + humidity
letdown + charging temps flows
BAST storage tank levels
AFW discharge
CCW surge tank level

ANSWER 3.03 (2.50)

All charging pumps start
Charging pump suction shifts from VCT to SIRWT
Intermediate and letdown bypass valves close
Feedpumps go to minimum speed
Backup pressurizer heaters energize
[0.5 each]

isolate letdown

REFERENCE
PNIC0A2.01

KA: p 3.9-1 K1.01 3.4

ANSWER 3.04 (1.40)

Low lube oil pressure (40 psig)
Overcrank (35 sec jacket water pressure < 10 psig, speed < 120 rpm)
Overspeed (990 - 1035 rpm)
Generator differential relay [0.3 each]

Not overridden by SIAS signal [0.2]

REFERENCE
PNHBOK4.04

KA: p 3.7-11 K4.04 3.9

ANSWER 3.05 (2.40)

a. Isolates blowdown tank (5 valves) [0.6]
b. None [0.6]
c. Shuts ventilation dampers [0.6]
d. Trips fuel area supply fan (V-69) [0.3]
~~Closes suction damper (HD-5001)~~ ~~[0.2]~~
Stops exhaust fan non-selected for standby (V-70A or B) [0.3]

REFERENCE
PNPA0K1.01

KA: p 3.9-23 K4.01 4.0

ANSWER 3.06 (2.40)

a. Below 10E -4% power [0.3] on 1 of 2 wide range channels [0.3]
Above 15% power [0.3] on 2 of 4 power range safety channels [0.3]

b. Above 10E-5% power [0.3] on 1 of 2 wide range channels [0.3]

c. Below 15% power [0.3] on 2 of 4 power range safety channels [0.3]

REFERENCE
PNNA0G9.01
K1.06
K4.03

KA: p 3.9-5 K4.01 3.1
K4.06 3.9

3. INSTRUMENTS AND CONTROLS

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 3.07 (2.00)

SIAS [0.3]
CIS [0.3]
CSAS [0.3]
(CNTM Air Cooler DNBR mode) all on HI Containment press. [0.2]
of 3.7 - 4.4 psig [0.1]
on 2/4 logic [0.1]

Steam Line Isolation [0.3] on Low SG press. [0.2]
510 of ~~500~~ psia [0.1]
on 2/4 logic [0.1]

REFERENCE
PNMA4.19
PNMB4.09
PNMFA2.01
TS Table 3.16.1

AFAS
CPHVAC
FRVs
Rxtrip

ANSWER 3.08 (3.00)

FOGG is unreadable - possibly with respect to ruptured S/G

a. On a massive SG tube failure the combination of ramping turbine load and filling the SG could result in isolation of the incorrect SG. [1.5]

b. Take no action. OR Attempt to start P-8A. [0.5]
The steam-driven AFW pump, P-8B, will not automatically start until 80 seconds after the AFAS. [1.0]

REFERENCE
PNEBG12.02
PNEBOK4.05

KA: p 3.5-42 K4.02 4.5
K5.01 3.6

3. INSTRUMENTS AND CONTROLS

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 3.09 (3.00)

a. Trip [0.25] TM/LP set point raises to ~~2300 psia~~ an unknown value on channel A
Pressure is below TM/LP floor on channel B. [0.5]

b. No trip [0.25] Both trips on same channel. [0.5]

c. No trip [0.25] Flow indication does no provide trip signal. [0.5]

d. Trip [0.25] Trip signal produced when trip drawer is deenergized.
Second trip from high power. [0.5]

→ question interpretation, ΔP provides signal for flow; (wording of question is incorrect ΔP provides the trip signal, flow is not. should have been "Channel C flow indication fails to 0"

REFERENCE

PNNBG27.01

KA: p 3.9-1 K4.02 3.9

ANSWER 3.10 (3.50)

a. Hot leg temperature on 4 channels [0.3] core exit thermocouples
Cold leg temperature on 4 channels [0.3]
PCS pressure on 4 channels [0.3]

b. Qualified core exit thermocouples, 4 required [0.4]
PCS pressure on 4 channels [0.4]

c. PZR level [0.6]

d. Steam flow (on two channels) [0.4]
Main feed or Aux. feed flow on two channels [0.4]
Steam dump or bypass position on two channels [0.4]

REFERENCE

EOP 1, ATT. 3, rev. 16, p 1

KA: p 3.4-24 EA2.01 4.6
EA2.05 3.4
EA2.08 3.8

4. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 4.01 (2.00)

a. Maintain panels in view at all time. [0.5]

b. In an emergency situation needed to protect the public health and safety. [0.3] when authorized by an SRO [0.2]

c. Notify SRO and request permission to open valve. [0.5]

d. Control operator [0.5]

REFERENCE
PS00G23.03
G23.06
G13.06
G26.05

KA: System Wide Generics 23 2.8
22 4.3
13 3.7

ANSWER 4.02 (1.50)

a. 525 F
b. 1 DPM
c. 4 PCP
[0.50 each]

REFERENCE
GOP-3, Att 1, rev 5, p 1, 4

KA: p 2-1 Plant Wide Generics 12c 3.5

4. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 4.03 (1.00)

a. EOP-10.1
b. EOP-1
[0.5 each]

REFERENCE
EOP-10.1, Att 1, rev 2
EOP-1, Att 3, rev 16

KA: Plant Wide Generics 28 2.9

ANSWER 4.04 (2.50)

Establish shutdown boron or critical boron concentration (plus 50) whichever is greater. [0.6]
Pull rods until Group 4 is at 130 inches. [0.6]
Determine critical boron from 1/M plot (critical approach sheet) [0.7]
Dilute to criticality (stop 2 minutes prior to 1/M plot prediction) [0.6]

REFERENCE
GOP-3, Att 1, rev 5; p 5, 6

KA: p 3.1-7 K5.06 3.3
K5.13 3.1
K5.16 2.9

4; PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 4.05 (2.50)

a. Depress backup manual trip button (RPS panel C06) [0.5]
Emergency borate 225 per rod (900 ppm) or cold shutdown [0.5]

b. With LOCA in hot leg PCP's would cause deeper core uncovery [0.5]
Better heat removal under forced circulation. [0.5]
Protect pumps from damage. [0.5]

REFERENCE
PTBHOK6.02
EOP-1, rev 16, p 1
ONP-7, rev 10, p 1

KA: p 3.1-50 Generic 11 4.5
p 3.3-8 EK3.23 4.2

ANSWER 4.06 (3.00)

a. 1. Indicates flow has not stagnated. [0.5]
2. Indicates SG is available for heat removal. [0.5]
3. Indicates flow has not stagnated. [0.5]
or S/G is receiving heat

b. YES [0.5]

c. 250 to 375 psia [1.0]

REFERENCE
PTBNOA2.02
A2.07
G28.02

KA: p 3.7-21 EK1.01 3.7
EK1.04 3.1

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 4.07 (2.50)

a. 1) 75 REM
2) 25 REM [0.5 each]

b. Increased likelihood of cancer, particularly leukemia. Short term somatic effects include blood changes. [1.0]

c. SED [0.5]

REFERENCE
Proc. No EI-2.1 p 2, 3

KA: 3.11-27 EK1.01 3.5
3.11-29 EK1.02 2.6

ANSWER 4.08 (3.00)

Trip the reactor
Verify turbine trip
Trip main feedpump
Trip all but one PCP in each loop
Activate Site Emergency plan
[0.6 each]

REFERENCE
PTBEG11.08

KA: p 3.8-13 System Generic 11 4.5

4. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL

ANSWERS -- PALISADES -86/08/12-DUDLEY, N.

ANSWER 4.09 (3.00)

a. Maintain ~~subcooling~~ shutdown margin before initiating cooldown. [0.75] OR
Prevent lifting secondary safety valve. [0.75]

b. Prevent lifting secondary safety valve. [0.75] OR
Reduce flow out tube leak. [0.75]

c. Prevent PCS dilution. [0.75]

d. Prevent release of contaimination to the environment. [0.75] OR
Prevent overstressing Main Steam piping. [0.75]

REFERENCE

EOP-8.2, rev 15, p 4

KA: p 3.3-17 EK3.05 3.7

ANSWER 4.10 (4.00)

a. Reduce power (below 60%)
b. Trip
c. Shutdown or continue ops if leak is less than Tech Spec limit (~.1 gpm)
d. Remain at power
e. Trip
f. Shutdown or continue ops and try and reseat the air leak
g. Shutdown or continue ops if leakage is w/i Tech Specs
h. Shutdown
i. Reduce power
j. Trip

[0.4 each]

REFERENCE

EOP-3, rev 1, p 1
EOP-4, rev 2, p 1
EOP-5, rev 13, p 1
EOP-10.1, rev 2, p 1
ONP- 5, rev 12, p 1
ONP-11, rev 10, p 1
ONP-23.1, rev 12, p 2
ONP-23.2, rev 0, p 1

KA: Plant Wide Generic 10 4.1

Master

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

FACILITY: PALISADES

REACTOR TYPE: PWR-CE

DATE ADMINISTERED: 86/06/24

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

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

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

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

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

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

6. Use only the paper provided for answers.

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

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

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

10. Skip at least three lines between each answer.

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

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

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

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

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

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

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

18. When you complete your examination, you shall:

    a. Assemble your examination as follows:

        (1) Examination questions on top.

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

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

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

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

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

QUESTION 5.01 (1.50)

a. TRUE or FALSE. Excessive motor amperage is one indication that a centrifugal pump is at shutoff head. (.5)

b. What are the amperage limitations for the motor-driven AFW pumps? (1.0)

QUESTION 5.02 (1.00)

What will be the temperature of the PORV discharge line if a PORV opens when there is a steam bubble in the pressurizer, quench tank pressure is 20 psig, and pressurizer pressure is:

a. 1700 psig? (.5)

b. 700 psig? (.5)

QUESTION 5.03 (1.50)

State six indications of void formation.

QUESTION 5.04 (1.00)

Why does the reference transition nil ductility temperature of the reactor vessel increase with reactor operation?

QUESTION 5.05 (1.00)

a. TRUE or FALSE. Assuming all other conditions are identical, the flow obtainable through two 2 inch diameter pipes will be greater than the flow obtainable through one 3 inch diameter pipe. (.5)

b. TRUE or FALSE. Assuming all other conditions are identical, the flow through a hole with a differential pressure of 200 psi will be more than twice the flow through the same hole if the differential pressure is only 100 psi. (.5)

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

QUESTION 5.06 (1.00)

What is meant by the term "minimum required NPSH"?

QUESTION 5.07 (1.00)

If a step change increase in turbine load occurs, what is the initial response of:

a. steam generator level? (.5)

b. pressurizer level? (.5)

QUESTION 5.08 (1.00)

For 3-pump operation the limiting condition is void fraction rather than DNBR. Why is excessive void fraction a threat to fuel cladding integrity?

QUESTION 5.09 (1.00)

The speed of a positive displacement pump must be increased in order to increase the flow rate. Why is a higher pump head developed at the increased flow rate, even though the pump head at each point along the pump characteristic curve remains the same as pump speed is increased? Refer to Figure FND-FF-44.

QUESTION 5.10 (2.00)

a. What type of startup requires that the shift supervisor use an inverse multiplication plot? (.5)

b. Assume that the initial equilibrium count rate during a startup is 8 counts per second. A certain amount of reactivity is then added, raising the equilibrium count rate to 14 counts per second. If this same amount of reactivity is added again, what will be the new equilibrium count rate? Show your work! (1.5)

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

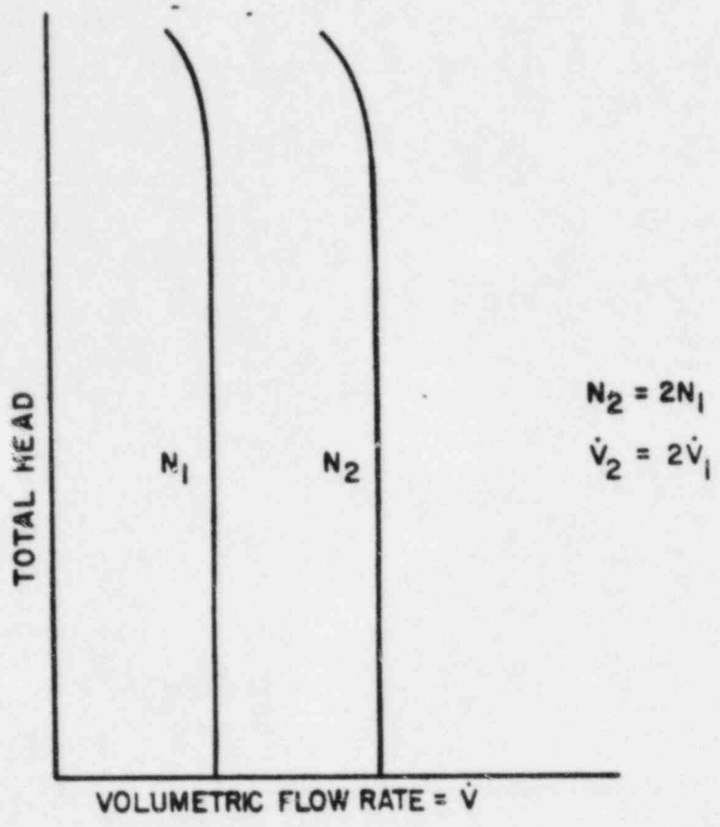


FIGURE FMD-FF-44: TYPICAL CHARACTERISTIC CURVES FOR POSITIVE DISPLACEMENT PUMP AT VARIOUS SPEEDS (REV. 4)

QUESTION 5.11 (2.00)

a. The reactor shall not be made critical, even during low power physics tests, if primary coolant temperature is less than _____. (.5)

b. What is the basis for the minimum temperature for criticality of 525 F in all instances except low power physics tests? (1.5)

QUESTION 5.12 (3.00)

Calculate how long it will take to raise power at the maximum permissible startup rate from the power level at which the reactor is considered critical for the purposes of administrative control to the highest permitted power level in the hot standby condition. Show your work!

QUESTION 5.13 (1.50)

Explain why control rod worth increases from BOL to EOL. Refer to Figure 5.1.

QUESTION 5.14 (2.00)

Explain why the maximum xenon concentration after a trip varies almost linearly with the power level just prior to the trip. Refer to Figure 2.2.

QUESTION 5.15 (1.00)

Explain why the 100% power defect increases with fuel burnup. Refer to Figure 3.2.

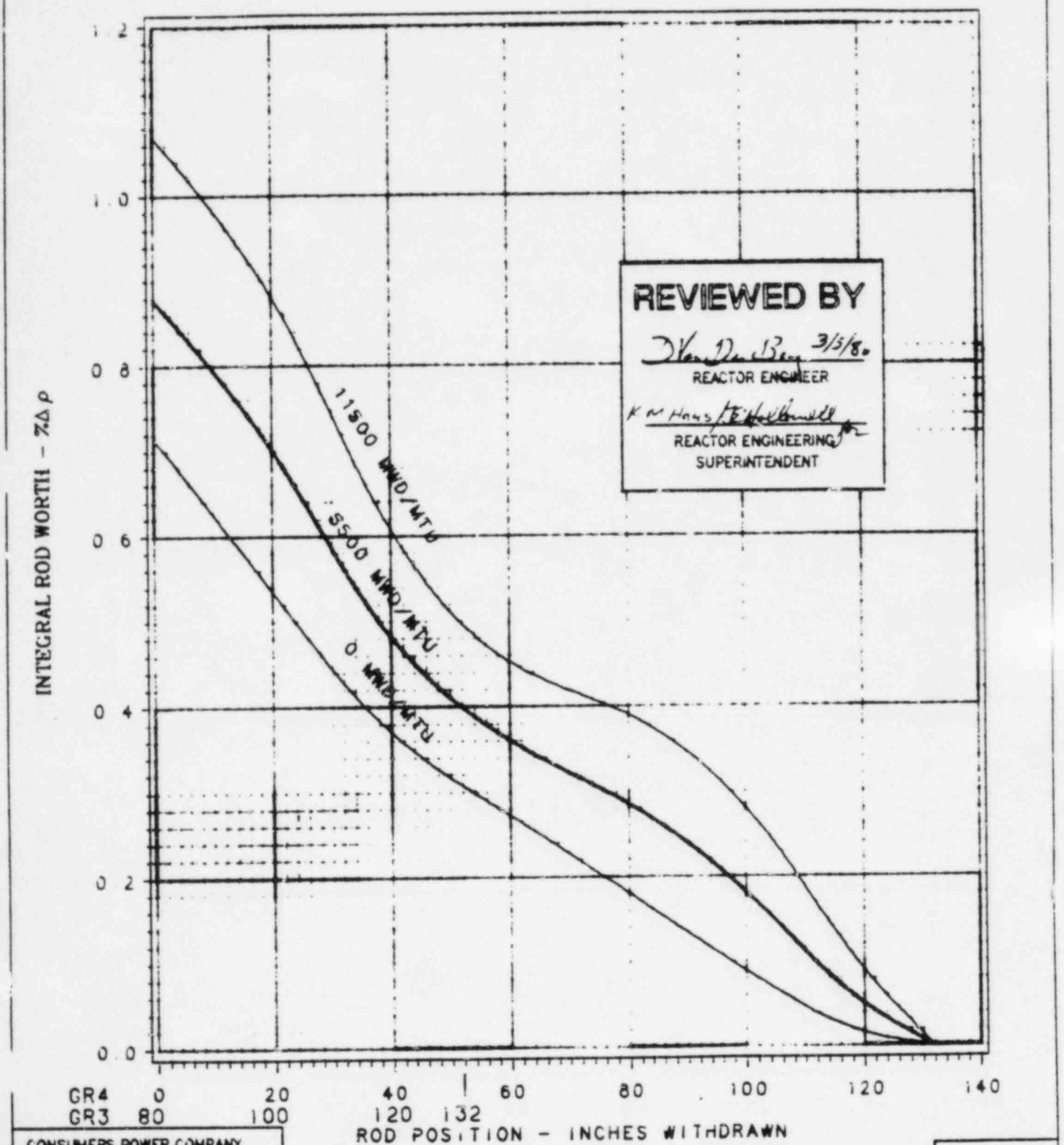
QUESTION 5.16 (1.50)

State the three purposes of the power dependent insertion limits.

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

PALISADES TECHNICAL DATA BOOK FIGURE 5.1, REV 2

CYCLE7
INTEGRAL ROD WORTH



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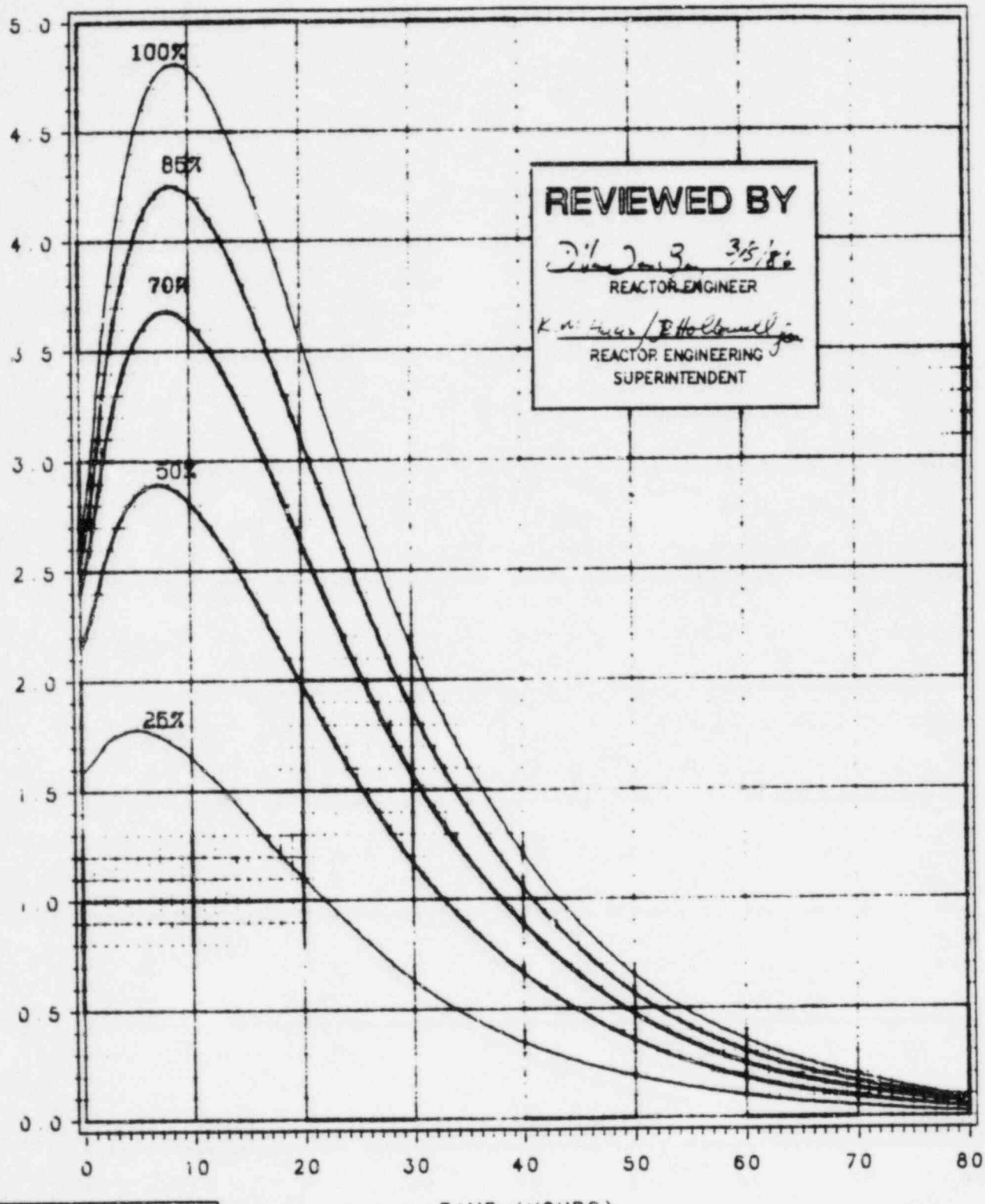
PALISADES TECHNICAL DATA BOOK FIGURE 2.2, REV 2

CYCLE 7

XENON WORTH VS TIME
TRIPS FROM VARIOUS POWERS



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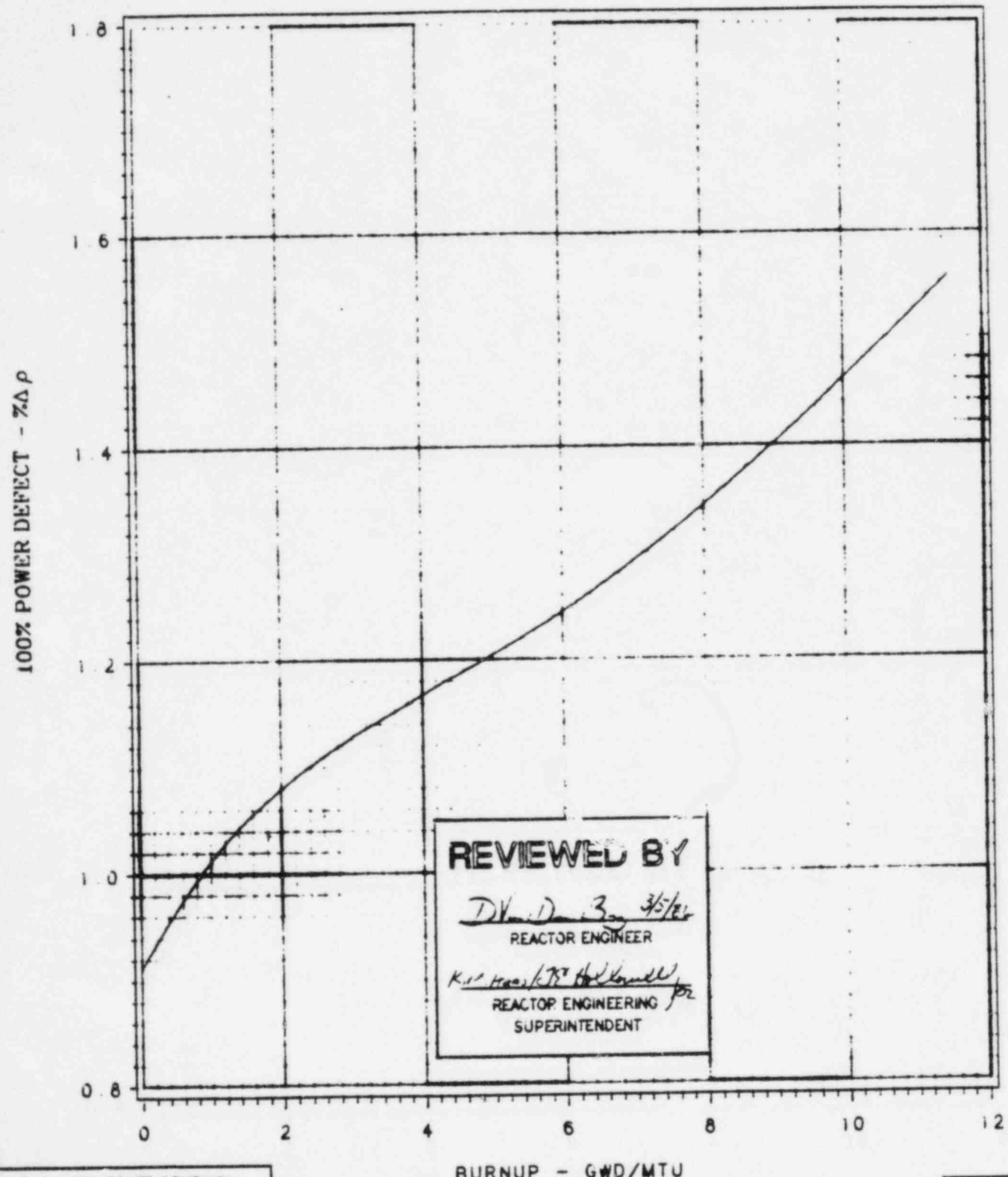
PALISADES TECHNICAL DATA BOOK FIGURE 3 2, REV 3

CYCLE 7

100% POWER DEFECT VS BURNUP



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QUESTION 5.17 (1.00)

RIA 2326 is the normal range noble gas activity monitor. What is a "noble gas"?

QUESTION 5.18 (1.00)

The nitrogen-16 equilibrium radioactivity value in the primary coolant is 121 μc/ml. Explain how nitrogen-16 is formed. Equations may be used, but are not required.

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

QUESTION 6.01 (1.50)

a. What is the failed position of the CCW containment isolation valves (CV-0910, 0911 and 0940) if instrument air is lost? (.5)

b. What is the basis for having the CCW containment isolation valves fail to this position upon loss of instrument air? (1.0)

QUESTION 6.02 (2.00)

State all the interrelationships between the fire protection system and the following systems:

a. service water system.

b. spent fuel pool system.

QUESTION 6.03 (1.00)

What are the four automatic trips for the motor driven AFW pumps?

QUESTION 6.04 (1.50)

What are the three manual methods of tripping a main feedwater pump?

QUESTION 6.05 (1.00)

Explain how the following signals will affect the main feed water regulating valve and the main feed water regulating bypass valve. Consider each case separately.

a. Steam generator level of 90%.

b. Steam generator pressure of 460 psig.

QUESTION 6.06 (1.00)

State the four backup supply sources for the main generator seal oil in order of decreasing pressure.

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

QUESTION 6.07 (2.00)

What are the five automatic trips for the diesel generator output breaker?

QUESTION 6.08 (1.00)

State all the signals which will initiate the DBA sequencers.

QUESTION 6.09 (1.00)

State the two interlocks, including setpoints, which prevent starting a PCP.

QUESTION 6.10 (1.00)

State the approximate values for the following PCP parameters during plant operation at power:

a. Lower seal temperature.

b. Middle seal pressure.

c. Vapor seal pressure.

d. Motor amperes.

QUESTION 6.11 (2.00)

State all seven automatic responses which occur in the CVCS system when an SIS is generated with standby power available.

QUESTION 6.12 (2.00)

a. How is the pressurizer pressure controller normally configured for power operation?

b. Give two reasons for using this configuration for pressurizer pressure control.

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

QUESTION 6.13 (2.00)

a. What interlock is associated with the hot leg safety injection valves?

b. What is the basis for this interlock?

QUESTION 6.14 (1.00)

Why does the containment spray pump have a higher capacity during the recirculation phase than it does during the injection phase?

QUESTION 6.15 (1.00)

Explain how the containment hydrogen sample isolation valves can be reopened when a CHP signal is still present.

QUESTION 6.16 (1.00)

What will initiate a "dropped rod" alarm on a power range safety channel?

QUESTION 6.17 (1.00)

What is the function of the suppression coil network systems which are incorporated in the four "M" relay control power circuits?

QUESTION 6.18 (1.00)

What automatic actions, if any, are associated with the steam generator blowdown radiation montitor?

QUESTION 6.19 (1.00)

What two methods are used for bridge and trolley indexing?

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

QUESTION 7.01 (1.00)

What two indications are used to verify a reactor trip?

QUESTION 7.02 (2.00)

EOP 1 requires additional immediate action(s) to be taken if a safety injection occurs in conjunction with a reactor trip. What are these additional immediate action(s), and what indication(s) are used to determine whether these additional immediate actions must be performed? (Include setpoints as applicable).

QUESTION 7.03 (2.50)

If, following a safety injection, the pressure in either steam generator falls below a certain value and continues to drop, four actions must be taken.

a. What is this steam generator pressure?

b. What are these four actions?

QUESTION 7.04 (1.50)

What three conditions require the reinitiation of HPSI after SIAS has been reset?

QUESTION 7.05 (1.00)

During a loss of all immediately available AC power, battery capacity will not be exceeded during the expected four to six hour discharge period provided two conditions are met. What are these two conditions?

QUESTION 7.06 (2.00)

A manual trip of the reactor and turbine generator is required if any of four conditions occur during a loss of component cooling. What are these four conditions?

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

QUESTION 7.07 (1.00)

What two conditions associated with a loss of instrument air require a reactor trip?

QUESTION 7.08 (1.00)

How is containment isolation manually initiated?

QUESTION 7.09 (1.00)

What is the reason for the precaution against simultaneously starting two or more RCPs?

QUESTION 7.10 (2.00)

What five actions must be taken to facilitate RCS heat removal if shutdown cooling cannot be established and heat removal by steam generators can no longer be maintained?

QUESTION 7.11 (1.50)

What three immediate actions must be taken if a fuel handling accident occurs on the reactor refueling side?

QUESTION 7.12 (1.00)

What four types of items should the operators take with them when evacuating the control room?

QUESTION 7.13 (1.00)

How can the reactor be tripped if it can not be automatically or manually tripped from the control room?

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

QUESTION 7.14 (1.00)

What action must be taken if lake water rises above the 590 foot level and enters the main plant building?

QUESTION 7.15 (1.00)

What is basis for the requirement that PORV breakers 52-196 and 224 normally be open?

QUESTION 7.16 (1.00)

What action must be taken if fuel pool or reactor cavity water level begins to decrease rapidly during irradiated fuel movement?

QUESTION 7.17 (1.00)

a. What is the maximum permissible containment building air temperature?

b. What action must be taken if this temperature is exceeded?

QUESTION 7.18 (1.00)

What is the basis for the precaution against changing diesel generator voltage control from automatic to manual while the diesel is loaded onto an engineered bus?

QUESTION 7.19 (1.50)

If one of the two startup range channels fails during a startup, is it permissible to continue with the startup? Explain.

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

QUESTION 8.01 (.50)

PORV breakers 52-196 and 52-224 shall normally be open when PCS temperature is above 325 F. Which individual on shift, if any, can direct that the breaker be closed?

QUESTION 8.02 (.50)

TRUE or FALSE. The tagging procedures specified in section 8 of the SOPs are mandatory and must be followed whenever work is to be performed on the respective component.

QUESTION 8.03 (1.00)

a. What is the maximum amount of time which an auxiliary operator is allowed to work during any 168 hour period? (.5)

b. Who can authorize deviations from the working hour restrictions? (.5)

QUESTION 8.04 (1.00)

When, if ever, is it permissible to take actions which intentionally depart from Technical Specifications?

QUESTION 8.05 (1.00)

What are the two priorities of the shift ~~supervisor~~ engineer, in order of importance, during an accident?

QUESTION 8.06 (.50)

A refamiliarization shift is required of any licensed RO who has not performed as a licensed RO within the past _____.

QUESTION 8.07 (.50)

Which individual is normally responsible for maintaining the control room logbook?

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

QUESTION 8.08 (.50)

TRUE or FALSE. The radwaste logbook is to be treated as a legal document subject to being entered in a court record.

QUESTION 8.09 (1.00)

a. At least _____ auxiliary operators shall be on shift at all times. (.5)

b. How many licensed personnel (specify RO and SO) must be in the control room at all times when the plant is in a mode other than cold or refueling shutdown? (.5)

QUESTION 8.10 (1.00)

What action must be done to perform an evolution for which no procedure exists?

QUESTION 8.11 (.50)

Permanent plaques listing operational information may be affixed to control panels provided the _____ concurs.

QUESTION 8.12 (1.00)

What two conditions must be satisfied prior to removing one diesel generator from service when the plant is less than 325 F?

QUESTION 8.13 (1.00)

How is the repositioning of locked breaker documented if the locked breaker is repositioned without using a checklist, Technical Specification surveillance or a switching and tagging order?

QUESTION 8.14 (.50)

TRUE or FALSE. Switch positions designated by switching and tagging orders supersede system checklists.

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

QUESTION 8.15 (.50)

During startup evolutions, portions of a system's checklist may be waived by the _____.

QUESTION 8.16 (1.50)

a. What action should an operator take if, while performing a checklist, a valve which is required to be open by the "Place in Position" column is found to be closed? (.5)

b. Which individual can authorize opening a normally-open valve which is found to be closed? (.5)

c. Which individual can authorize a "locked open" valve to be "locked closed"? (.5)

QUESTION 8.17 (.50)

TRUE or FALSE. All caution tags issued, including those controlled within a Technical Specification surveillance procedure or switching and tagging order, shall be entered in and controlled by the caution tag log.

QUESTION 8.18 (1.00)

a. Under what circumstance can the requirement for quarterly verification of workmen's protective tags be waived for specific tags? (.5)

b. Who has the authority to grant this waiver? (.5)

QUESTION 8.19 (2.00)

The removal or opening of three floor plugs/hatches require additional control beyond simple Shift Supervisor approval whenever PCS temperature exceeds 325 F.

a. What additional control is required? (.5)

b. Name these three floor plugs/hatches. (1.5)

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

QUESTION 8.20 (1.00)

How is a control valve tagged to maintain it in the shut position if the valve fails to the open position upon loss of air?

QUESTION 8.21 (.50)

TRUE or FALSE. The responsibility for making the decision to startup the reactor after a reactor trip is vested in the Operations Superintendent.

QUESTION 8.22 (1.00)

Maintenance immediately necessitated by four situations is defined as emergency maintenance. What are these four situations?

QUESTION 8.23 (.50)

What priority is assigned to urgent maintenance?

QUESTION 8.24 (.50)

TRUE or FALSE. Access into high radiation areas under general RWPs is allowed with radiation safety technician coverage and without dedicated coverage by qualified operations personnel.

QUESTION 8.25 (.50)

Which individual, if any, may extend a standard RWP past its expiration date?

QUESTION 8.26 (.50)

What additional requirement is imposed upon personnel who enter a radiologically controlled area under a general RWP when work is being performed in the area under a standard RWP?

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

QUESTION 8.27 (1.00)

How must the primary dosimetry device be worn to insure proper monitoring of:

a. beta dose? (.5)

b. neutron dose? (.5)

QUESTION 8.28 (2.00)

a. What is the whole body dose limit for newly employed females with unknown prior exposure histories? (.5)

b. Which three individuals must approve non-emergency whole body exposures in excess of 5 rems per year? (1.5)

QUESTION 8.29 (1.50)

Which three decisions may not be delegated by the SED during an emergency?

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

EQUATIONS

REACTOR THEORY

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

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

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

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

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

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

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

$$k_2 = k_1 + \delta k$$

$$\delta k = k - 1$$

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

$$P = \frac{I\phi V}{3.1 \times 10^{16}}$$

$$I = N\sigma$$

$$\phi = nv$$

Defect = Coeff x Δ Parameter

RADIATION

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

$$A = \lambda N$$

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

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

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

$$I_1 d_1^2 = I_2 d_2^2 \qquad \text{point source}$$

$$I_1 d_1 = I_2 d_2 \quad \text{- line source}$$

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

$$y^a = b$$

$$\log_{y_c} b = a$$

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

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

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

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

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

$$F = pA$$

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

k = f(quality & Pressure)

Pump laws speed α flow

(speed)^2 α pressure

(speed)^3 α power

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

$$Q = mc_p\Delta T$$

$$Q = m\Delta h$$

$$Q = \varepsilon\sigma T$$

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

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

$$H = U + pV$$

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

$$pV = nRT$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$C_1V_1 + C_2V_2 = C_3(V_1 + V_2)$$

Table 1. Saturated Steam: Temperature Table

Temp Fahr t	Abs Press Lb per Sq In. p	Specific Volume: Sat. Liquid v_f	Specific Volume: Evap v_{fg}	Specific Volume: Sat. Vapor v_g	Enthalpy: Sat. Liquid h_f	Enthalpy: Evap h_{fg}	Enthalpy: Sat. Vapor h_g	Entropy: Sat. Liquid s_f	Entropy: Evap s_{fg}	Entropy: Sat. Vapor s_g	Temp Fahr t
32.0*	0.08859	0.016022	3304.7	3304.7	-0.0179	1075.5	1075.5	0.0000	2.1873	2.1873	32.0*
34.0	0.09600	0.016021	3061.9	3061.9	1.996	1074.4	1076.4	0.0041	2.1762	2.1802	34.0
36.0	0.10395	0.016020	2839.0	2839.0	4.008	1073.2	1077.2	0.0081	2.1651	2.1732	36.0
38.0	0.11249	0.016019	2634.1	2634.2	6.018	1072.1	1078.1	0.0122	2.1541	2.1663	38.0
40.0	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	1.6534	1.8852	142.0
144.0	3.1997	0.016312	111.74	111.76	111.95	1011.7	1123.6	0.2051	1.6759	1.8810	144.0
146.0	3.3653	0.016322	106.58	106.59	113.95	1010.5	1124.5	0.2084	1.6684	1.8769	146.0
148.0	3.5381	0.016332	101.68	101.70	115.95	1009.3	1125.3	0.2117	1.6610	1.8727	148.0
150.0	3.7184	0.016343	97.05	97.07	117.95	1008.2	1126.1	0.2150	1.6536	1.8686	150.0
152.0	3.9065	0.016353	92.66	92.68	119.95	1007.0	1126.9	0.2183	1.6463	1.8646	152.0
154.0	4.1025	0.016363	88.50	88.52	121.95	1005.8	1127.7	0.2216	1.6390	1.8606	154.0
156.0	4.3068	0.016374	84.56	84.57	123.95	1004.6	1128.6	0.2248	1.6318	1.8566	156.0
158.0	4.5197	0.016384	80.82	80.83	125.96	1003.4	1129.4	0.2281	1.6245	1.8526	158.0
160.0	4.7414	0.016395	77.27	77.29	127.96	1002.2	1130.2	0.2313	1.6174	1.8487	160.0
162.0	4.9722	0.016406	73.90	73.92	129.96	1001.0	1131.0	0.2345	1.6103	1.8448	162.0
164.0	5.2124	0.016417	70.70	70.72	131.96	999.8	1131.8	0.2377	1.6032	1.8409	164.0
166.0	5.4623	0.016428	67.67	67.68	133.97	998.6	1132.6	0.2409	1.5961	1.8371	166.0
168.0	5.7223	0.016440	64.78	64.80	135.97	997.4	1133.4	0.2441	1.5892	1.8333	168.0
170.0	5.9926	0.016451	62.04	62.06	137.97	996.2	1134.2	0.2473	1.5822	1.8295	170.0
172.0	6.2736	0.016463	59.43	59.45	139.98	995.0	1135.0	0.2505	1.5753	1.8258	172.0
174.0	6.5656	0.016474	56.95	56.97	141.98	993.8	1135.8	0.2537	1.5684	1.8221	174.0
176.0	6.8690	0.016486	54.59	54.61	143.99	992.6	1136.6	0.2568	1.5616	1.8184	176.0
178.0	7.1840	0.016498	52.35	52.36	145.99	991.4	1137.4	0.2600	1.5548	1.8147	178.0

*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	Specific Volume Evap v_{fg}	Specific Volume Sat Vapor v_g	Enthalpy Sat Liquid h_f	Enthalpy Evap h_{fg}	Enthalpy Sat Vapor h_g	Entropy Sat Liquid s_f	Entropy Evap s_{fg}	Entropy Sat Vapor s_g	Temp Fahr t
188.0	7.5110	0.016510	50.21	50.22	148.00	980.2	1138.2	0.2531	1.5480	1.8111	188.0
192.0	7.850	0.016522	48.172	48.189	150.01	979.0	1139.0	0.2662	1.5413	1.8075	192.0
194.0	8.703	0.016534	46.232	46.249	152.01	977.8	1139.8	0.2694	1.5346	1.8040	194.0
196.0	8.568	0.016547	44.383	44.400	154.02	976.5	1140.5	0.2725	1.5279	1.8004	196.0
198.0	8.947	0.016559	42.621	42.638	156.03	975.3	1141.3	0.2756	1.5213	1.7969	198.0
200.0	9.340	0.016572	40.941	40.957	158.04	974.1	1142.1	0.2787	1.5149	1.7934	200.0
202.0	9.747	0.016585	39.337	39.354	160.05	972.8	1142.9	0.2818	1.5082	1.7900	202.0
204.0	10.168	0.016598	37.808	37.824	162.05	971.6	1143.7	0.2848	1.5017	1.7865	204.0
206.0	10.605	0.016611	36.348	36.364	164.06	970.4	1144.4	0.2879	1.4952	1.7831	206.0
208.0	11.058	0.016624	34.954	34.970	166.08	979.1	1145.2	0.2910	1.4888	1.7798	208.0
210.0	11.526	0.016637	33.622	33.639	168.09	977.9	1146.0	0.2940	1.4824	1.7764	210.0
212.0	12.012	0.016664	31.135	31.151	172.11	975.4	1147.5	0.3001	1.4697	1.7698	212.0
214.0	13.568	0.016691	28.862	28.878	176.14	972.8	1149.0	0.3061	1.4571	1.7632	214.0
216.0	14.695	0.016719	26.782	26.799	180.17	970.3	1150.5	0.3121	1.4447	1.7568	216.0
218.0	15.901	0.016747	24.878	24.894	184.20	967.8	1152.0	0.3181	1.4323	1.7505	218.0
220.0	17.186	0.016775	23.131	23.148	188.23	965.2	1153.4	0.3241	1.4201	1.7442	220.0
222.0	18.556	0.016805	21.529	21.545	192.27	962.6	1154.9	0.3300	1.4081	1.7380	222.0
224.0	20.015	0.016834	20.056	20.073	196.31	960.0	1156.3	0.3359	1.3961	1.7320	224.0
226.0	21.567	0.016864	18.701	18.718	200.35	957.4	1157.8	0.3417	1.3842	1.7260	226.0
228.0	23.216	0.016895	17.454	17.471	204.40	954.8	1159.2	0.3476	1.3725	1.7201	228.0
230.0	24.968	0.016926	16.304	16.321	208.45	952.1	1160.6	0.3533	1.3609	1.7142	230.0
232.0	26.826	0.016958	15.243	15.260	212.50	949.5	1162.0	0.3591	1.3494	1.7085	232.0
234.0	28.796	0.016990	14.264	14.281	216.56	946.8	1163.4	0.3649	1.3379	1.7028	234.0
236.0	30.883	0.017022	13.358	13.375	220.62	944.1	1164.7	0.3706	1.3266	1.6972	236.0
238.0	33.091	0.017055	12.520	12.538	224.69	941.4	1166.1	0.3763	1.3154	1.6917	238.0
240.0	35.427	0.017089	11.745	11.762	228.76	938.6	1167.4	0.3819	1.3043	1.6862	240.0
242.0	37.894	0.017123	11.025	11.042	232.83	935.9	1168.7	0.3876	1.2933	1.6808	242.0
244.0	40.500	0.017157	10.358	10.375	236.91	933.1	1170.0	0.3932	1.2823	1.6755	244.0
246.0	43.249	0.017193	9.738	9.755	240.99	930.3	1171.3	0.3987	1.2715	1.6702	246.0
248.0	46.147	0.017228	9.162	9.180	245.08	927.5	1172.5	0.4043	1.2607	1.6650	248.0
250.0	49.200	0.017264	8.627	8.644	249.17	924.6	1173.8	0.4098	1.2501	1.6599	250.0
252.0	52.414	0.01730	8.1280	8.1453	253.3	921.7	1175.0	0.4154	1.2395	1.6548	252.0
254.0	55.795	0.01734	7.6634	7.6807	257.4	918.8	1176.2	0.4208	1.2290	1.6498	254.0
256.0	59.350	0.01738	7.2301	7.2475	261.5	915.9	1177.4	0.4263	1.2186	1.6449	256.0
258.0	63.084	0.01741	6.8259	6.8433	265.6	913.0	1178.6	0.4317	1.2082	1.6400	258.0
260.0	67.005	0.01745	6.4483	6.4658	269.7	910.0	1179.7	0.4372	1.1979	1.6351	260.0
262.0	71.119	0.01749	6.0955	6.1130	273.8	907.0	1180.9	0.4426	1.1877	1.6303	262.0
264.0	75.433	0.01753	5.7655	5.7830	278.0	904.0	1182.0	0.4479	1.1776	1.6256	264.0
266.0	79.953	0.01757	5.4566	5.4742	282.1	901.0	1183.1	0.4533	1.1676	1.6209	266.0
268.0	84.688	0.01761	5.1673	5.1849	286.3	897.9	1184.1	0.4586	1.1576	1.6162	268.0
270.0	89.643	0.01766	4.8961	4.9138	290.4	894.8	1185.2	0.4640	1.1477	1.6116	270.0
272.0	94.826	0.01770	4.6418	4.6595	294.6	891.6	1186.2	0.4692	1.1378	1.6071	272.0
274.0	100.245	0.01774	4.4030	4.4208	298.7	888.5	1187.2	0.4745	1.1280	1.6025	274.0
276.0	105.907	0.01779	4.1788	4.1966	302.9	885.3	1188.2	0.4798	1.1183	1.5981	276.0
278.0	111.820	0.01783	3.9681	3.9859	307.1	882.1	1189.1	0.4850	1.1086	1.5936	278.0
280.0	117.992	0.01787	3.7699	3.7878	311.3	878.8	1190.1	0.4902	1.0990	1.5892	280.0
282.0	124.430	0.01792	3.5834	3.6013	315.5	875.5	1191.0	0.4954	1.0894	1.5849	282.0
284.0	131.142	0.01797	3.4078	3.4258	319.7	872.2	1191.1	0.5006	1.0799	1.5806	284.0
286.0	138.138	0.01801	3.2423	3.2603	323.9	868.9	1192.7	0.5058	1.0705	1.5763	286.0
288.0	145.424	0.01806	3.0863	3.1044	328.1	865.5	1193.6	0.5110	1.0611	1.5721	288.0
290.0	153.010	0.01811	2.9392	2.9573	332.3	862.1	1194.4	0.5161	1.0517	1.5678	290.0
292.0	160.903	0.01816	2.8002	2.8184	336.5	858.6	1195.2	0.5212	1.0424	1.5637	292.0
294.0	169.113	0.01821	2.6691	2.6873	340.8	855.1	1195.9	0.5263	1.0332	1.5595	294.0
296.0	177.648	0.01826	2.5451	2.5633	345.0	851.6	1196.7	0.5314	1.0240	1.5554	296.0
298.0	186.517	0.01831	2.4279	2.4462	349.3	848.1	1197.4	0.5365	1.0148	1.5513	298.0
300.0	195.729	0.01836	2.3170	2.3353	353.6	844.5	1198.0	0.5416	1.0057	1.5473	300.0
302.0	205.294	0.01842	2.2120	2.2304	357.9	840.8	1198.7	0.5466	0.9966	1.5432	302.0
304.0	215.220	0.01847	2.1126	2.1311	362.2	837.2	1199.3	0.5516	0.9876	1.5392	304.0
306.0	225.516	0.01853	2.0184	2.0369	366.5	833.4	1199.9	0.5567	0.9786	1.5352	306.0
308.0	236.193	0.01858	1.9291	1.9477	370.8	829.7	1200.4	0.5617	0.9696	1.5313	308.0
310.0	247.259	0.01864	1.8444	1.8630	375.1	825.9	1201.0	0.5667	0.9607	1.5274	310.0
312.0	258.725	0.01870	1.7640	1.7827	379.4	822.0	1201.5	0.5717	0.9518	1.5234	312.0
314.0	270.600	0.01875	1.6877	1.7064	383.8	818.2	1201.9	0.5766	0.9429	1.5195	314.0
316.0	282.894	0.01881	1.6152	1.6340	388.1	814.2	1202.4	0.5816	0.9341	1.5157	316.0
318.0	295.617	0.01887	1.5463	1.5651	392.5	810.2	1202.8	0.5866	0.9253	1.5118	318.0
320.0	308.780	0.01894	1.4808	1.4997	396.9	806.2	1203.1	0.5915	0.9165	1.5080	320.0
322.0	322.391	0.01900	1.4184	1.4374	401.3	802.2	1203.5	0.5964	0.9077	1.5042	322.0
324.0	336.463	0.01906	1.3591	1.3782	405.7	798.0	1203.7	0.6014	0.8990	1.5004	324.0
326.0	351.00	0.01913	1.30266	1.32179	410.1	793.9	1204.0	0.6063	0.8903	1.4966	326.0
328.0	366.03	0.01919	1.24887	1.26806	414.6	789.7	1204.2	0.6112	0.8816	1.4928	328.0
330.0	381.54	0.01926	1.19761	1.21687	419.0	785.4	1204.4	0.6161	0.8729	1.4890	330.0
332.0	397.56	0.01933	1.14874	1.16806	423.5	781.1	1204.6	0.6210	0.8643	1.4853	332.0
334.0	414.09	0.01940	1.10212	1.12152	428.0	776.7	1204.7	0.6259	0.8557	1.4815	334.0
336.0	431.14	0.01947	1.05764	1.07711	432.5	772.3	1204.8	0.6308	0.8471	1.4778	336.0
338.0	448.73	0.01954	1.01518	1.03472	437.0	767.8	1204.8	0.6356	0.8385	1.4741	338.0

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

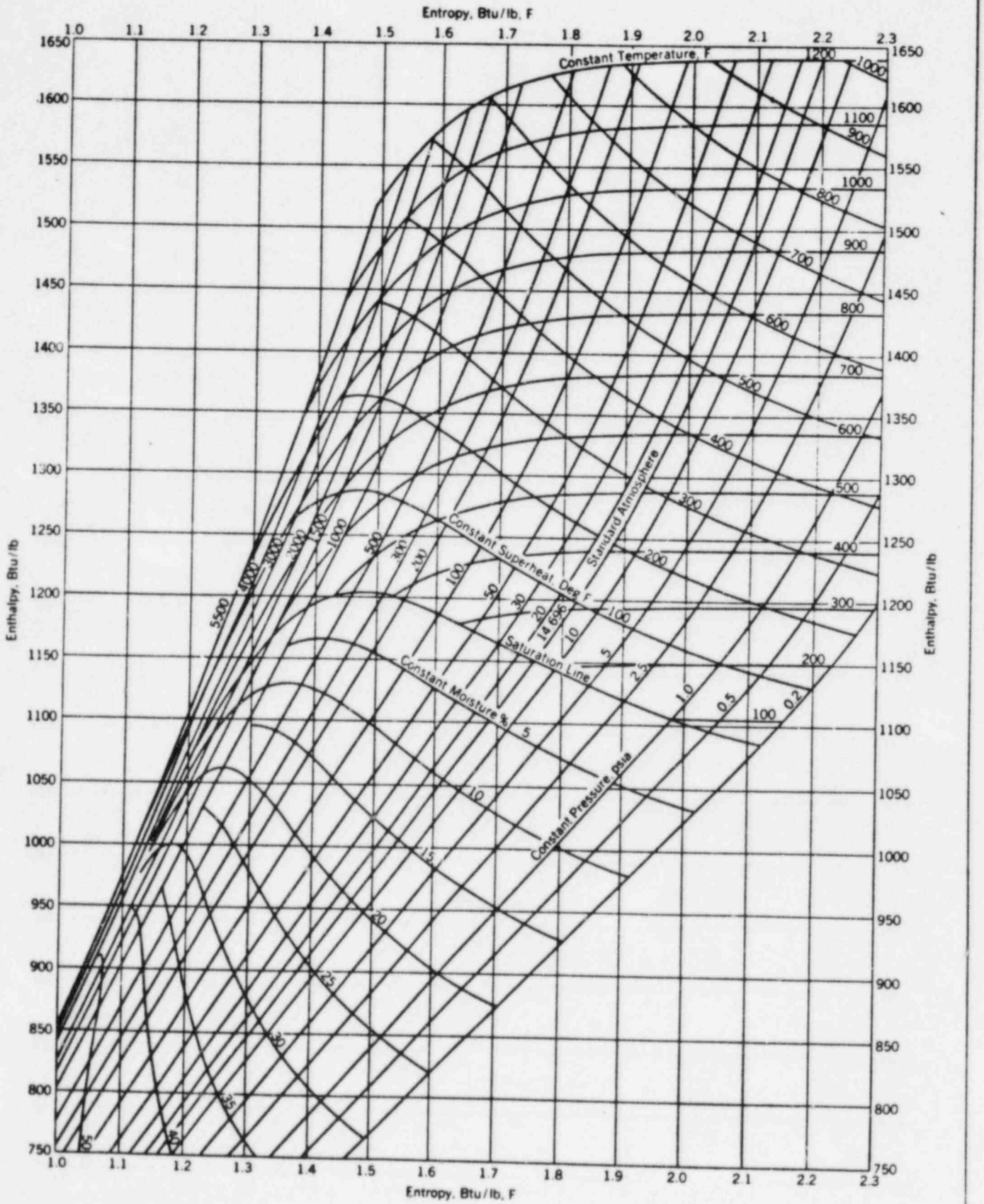
Temp Fahr t	Abs Press Lb per Sq In p	Specific Volume Sat Liquid v_f	Specific Volume Evap v_{fg}	Specific Volume Sat Vapor v_g	Enthalpy Sat Liquid h_f	Enthalpy Evap h_{fg}	Enthalpy Sat Vapor h_g	Entropy Sat Liquid s_f	Entropy Evap s_{fg}	Entropy Sat Vapor s_g	Temp Fahr t
460.0	466.87	0.01961	0.97463	0.99424	441.5	763.2	1204.8	0.8405	0.8299	1.4704	460.0
464.0	485.56	0.01969	0.93588	0.95557	446.1	758.6	1204.7	0.8454	0.8213	1.4667	464.0
468.0	504.83	0.01976	0.89885	0.91862	450.7	754.0	1204.6	0.8502	0.8127	1.4629	468.0
472.0	524.67	0.01984	0.86345	0.88329	455.2	749.3	1204.5	0.8551	0.8042	1.4592	472.0
476.0	545.11	0.01992	0.82958	0.84950	459.9	744.5	1204.3	0.8599	0.7956	1.4555	476.0
480.0	566.15	0.02000	0.79716	0.81717	464.5	739.6	1204.1	0.8648	0.7871	1.4518	480.0
484.0	587.81	0.02009	0.76613	0.78622	469.1	734.7	1203.8	0.8696	0.7785	1.4481	484.0
488.0	610.10	0.02017	0.73641	0.75658	473.8	729.7	1203.5	0.8745	0.7700	1.4444	488.0
492.0	633.03	0.02026	0.70794	0.72820	478.5	724.6	1203.1	0.8793	0.7614	1.4407	492.0
496.0	656.61	0.02034	0.68065	0.70100	483.2	719.5	1202.7	0.8842	0.7528	1.4370	496.0
500.0	680.86	0.02043	0.65448	0.67492	487.9	714.3	1202.2	0.8890	0.7443	1.4333	500.0
504.0	705.78	0.02053	0.62938	0.64991	492.7	709.0	1201.7	0.8939	0.7357	1.4296	504.0
508.0	731.40	0.02062	0.60530	0.62592	497.5	703.7	1201.1	0.8987	0.7271	1.4258	508.0
512.0	757.72	0.02072	0.58218	0.60289	502.3	698.2	1200.5	0.9036	0.7185	1.4221	512.0
516.0	784.76	0.02081	0.55997	0.58079	507.1	692.7	1199.8	0.9085	0.7099	1.4183	516.0
520.0	812.53	0.02091	0.53864	0.55956	512.0	687.0	1199.0	0.9133	0.7013	1.4146	520.0
524.0	841.04	0.02102	0.51814	0.53916	516.9	681.3	1198.2	0.9182	0.6926	1.4108	524.0
528.0	870.31	0.02112	0.49843	0.51955	521.8	675.5	1197.3	0.9231	0.6839	1.4070	528.0
532.0	900.34	0.02123	0.47947	0.50070	526.8	669.6	1196.4	0.9280	0.6752	1.4032	532.0
536.0	931.17	0.02134	0.46123	0.48257	531.7	663.6	1195.4	0.9329	0.6665	1.3993	536.0
540.0	962.79	0.02146	0.44367	0.46513	536.8	657.5	1194.3	0.9378	0.6577	1.3954	540.0
544.0	995.22	0.02157	0.42677	0.44834	541.8	651.3	1193.1	0.9427	0.6489	1.3915	544.0
548.0	1028.49	0.02169	0.41048	0.43217	546.9	645.0	1191.9	0.9476	0.6400	1.3876	548.0
552.0	1062.59	0.02182	0.39479	0.41660	552.0	638.5	1190.6	0.9525	0.6311	1.3837	552.0
556.0	1097.55	0.02194	0.37966	0.40160	557.2	632.0	1189.2	0.9575	0.6222	1.3797	556.0
560.0	1133.38	0.02207	0.36507	0.38714	562.4	625.3	1187.7	0.9625	0.6132	1.3757	560.0
564.0	1170.10	0.02221	0.35099	0.37320	567.6	618.5	1186.1	0.9674	0.6041	1.3716	564.0
568.0	1207.72	0.02235	0.33741	0.35975	572.9	611.5	1184.5	0.9725	0.5950	1.3675	568.0
572.0	1246.26	0.02249	0.32429	0.34678	578.3	604.5	1182.7	0.9775	0.5859	1.3634	572.0
576.0	1285.74	0.02264	0.31162	0.33426	583.7	597.2	1180.9	0.9825	0.5766	1.3592	576.0
580.0	1326.17	0.02279	0.29937	0.32216	589.1	589.9	1179.0	0.9876	0.5673	1.3550	580.0
584.0	1367.7	0.02295	0.28753	0.31048	594.6	582.4	1176.9	0.9927	0.5580	1.3507	584.0
588.0	1410.0	0.02311	0.27608	0.29919	600.1	574.7	1174.8	0.9978	0.5485	1.3464	588.0
592.0	1453.3	0.02328	0.26499	0.28827	605.7	566.8	1172.6	1.0030	0.5390	1.3420	592.0
596.0	1497.8	0.02345	0.25425	0.27770	611.4	558.8	1170.2	1.0082	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
616.0	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	0.13878	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	0.016037	1235.5	1235.5	27.382	1060.1	1087.4	0.0547	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	1.2187	1.6440	60.0
70.0	302.93	0.017482	6.1875	6.2050	272.7	907.8	1180.6	0.4411	1.1905	1.6316	70.0
80.0	312.04	0.017573	5.4536	5.4711	282.1	900.9	1183.1	0.4534	1.1675	1.6208	80.0
90.0	320.28	0.017659	4.8779	4.8953	290.7	894.6	1185.3	0.4643	1.1470	1.6113	90.0
100.0	327.82	0.017740	4.4133	4.4310	298.5	888.6	1187.2	0.4743	1.1284	1.6027	100.0
110.0	334.79	0.01782	4.0306	4.0484	305.8	883.1	1188.9	0.4834	1.1115	1.5950	110.0
120.0	341.27	0.01789	3.7097	3.7275	312.6	877.8	1190.4	0.4919	1.0960	1.5879	120.0
130.0	347.33	0.01796	3.4364	3.4544	319.0	872.8	1191.7	0.4998	1.0815	1.5813	130.0
140.0	353.04	0.01803	3.2010	3.2190	325.0	868.0	1193.0	0.5071	1.0681	1.5752	140.0
150.0	358.43	0.01809	2.9958	3.0139	330.6	863.4	1194.1	0.5141	1.0554	1.5695	150.0
160.0	363.55	0.01815	2.8155	2.8336	336.1	859.0	1195.1	0.5206	1.0435	1.5641	160.0
170.0	368.42	0.01821	2.6556	2.6738	341.2	854.8	1196.0	0.5269	1.0322	1.5591	170.0
180.0	373.08	0.01827	2.5129	2.5312	346.2	850.7	1196.9	0.5328	1.0215	1.5543	180.0
190.0	377.53	0.01833	2.3847	2.4030	350.9	846.7	1197.6	0.5384	1.0113	1.5498	190.0
200.0	381.80	0.01839	2.2689	2.2873	355.5	842.8	1198.3	0.5438	1.0016	1.5454	200.0
210.0	385.91	0.01844	2.16373	2.18217	359.9	839.1	1199.0	0.5490	0.9923	1.5413	210.0
220.0	389.88	0.01850	2.06779	2.08629	364.2	835.4	1199.6	0.5540	0.9834	1.5374	220.0
230.0	393.70	0.01855	1.97991	1.99846	368.3	831.8	1200.1	0.5588	0.9748	1.5336	230.0
240.0	397.39	0.01860	1.89909	1.91765	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	538.35	0.02141	0.45064	0.47205	534.7	660.0	1194.7	0.7358	0.6612	1.3970	950.0
1000.0	544.58	0.02159	0.42436	0.44596	542.6	650.4	1192.9	0.7434	0.6476	1.3910	1000.0
1050.0	550.53	0.02177	0.40047	0.42224	550.1	640.9	1191.0	0.7507	0.6344	1.3851	1050.0
1100.0	556.28	0.02195	0.37863	0.40058	557.5	631.5	1189.1	0.7578	0.6215	1.3794	1100.0
1150.0	561.82	0.02214	0.35859	0.38073	564.8	622.2	1187.0	0.7647	0.6091	1.3738	1150.0
1200.0	567.19	0.02232	0.34013	0.36245	571.9	613.0	1184.8	0.7714	0.5969	1.3683	1200.0
1250.0	572.38	0.02250	0.32306	0.34556	578.8	603.8	1182.6	0.7780	0.5850	1.3630	1250.0
1300.0	577.42	0.02269	0.30722	0.32991	585.6	594.6	1180.2	0.7843	0.5733	1.3577	1300.0
1350.0	582.32	0.02288	0.29250	0.31537	592.3	585.4	1177.8	0.7906	0.5620	1.3525	1350.0
1400.0	587.07	0.02307	0.27871	0.30178	598.8	576.5	1175.3	0.7966	0.5507	1.3474	1400.0
1450.0	591.70	0.02327	0.26584	0.28911	605.3	567.4	1172.8	0.8026	0.5397	1.3423	1450.0
1500.0	596.20	0.02346	0.25372	0.27719	611.7	558.4	1170.1	0.8085	0.5288	1.3373	1500.0
1550.0	600.59	0.02366	0.24235	0.26601	618.0	549.4	1167.4	0.8142	0.5182	1.3324	1550.0
1600.0	604.87	0.02387	0.23159	0.25545	624.2	540.3	1164.5	0.8199	0.5076	1.3274	1600.0
1650.0	609.05	0.02407	0.22143	0.24551	630.4	531.3	1161.6	0.8254	0.4971	1.3225	1650.0
1700.0	613.13	0.02428	0.21178	0.23607	636.5	522.2	1158.6	0.8309	0.4867	1.3176	1700.0
1750.0	617.12	0.02450	0.20263	0.22713	642.5	513.1	1155.6	0.8363	0.4765	1.3128	1750.0
1800.0	621.02	0.02472	0.19390	0.21861	648.5	503.8	1152.3	0.8417	0.4662	1.3079	1800.0
1850.0	624.83	0.02495	0.18558	0.21052	654.5	494.6	1149.0	0.8470	0.4561	1.3030	1850.0
1900.0	628.56	0.02517	0.17761	0.20278	660.4	485.2	1145.6	0.8522	0.4459	1.2981	1900.0
1950.0	632.22	0.02541	0.16999	0.19540	666.3	475.8	1142.0	0.8574	0.4358	1.2931	1950.0
2000.0	635.80	0.02565	0.16266	0.18831	672.1	466.2	1138.3	0.8625	0.4256	1.2881	2000.0
2100.0	642.76	0.02615	0.14885	0.17501	683.8	446.7	1130.5	0.8727	0.4053	1.2780	2100.0
2200.0	649.45	0.02669	0.13603	0.16272	695.5	426.7	1122.2	0.8828	0.3848	1.2676	2200.0
2300.0	655.89	0.02727	0.12406	0.15133	707.2	406.0	1113.2	0.8929	0.3640	1.2569	2300.0
2400.0	662.11	0.02790	0.11287	0.14076	719.0	384.8	1103.7	0.9031	0.3430	1.2460	2400.0
2500.0	668.11	0.02859	0.10209	0.13068	731.7	361.6	1093.3	0.9139	0.3206	1.2345	2500.0
2600.0	673.91	0.02938	0.09172	0.12110	744.5	337.6	1082.0	0.9247	0.2977	1.2225	2600.0
2700.0	679.53	0.03029	0.08165	0.11194	757.3	312.3	1069.7	0.9356	0.2741	1.2097	2700.0
2800.0	684.96	0.03134	0.07171	0.10305	770.7	285.1	1055.8	0.9468	0.2491	1.1958	2800.0
2900.0	690.22	0.03262	0.06158	0.09420	785.1	254.7	1039.8	0.9588	0.2215	1.1803	2900.0
3000.0	695.33	0.03428	0.05073	0.08500	801.8	218.4	1020.3	0.9728	0.1891	1.1619	3000.0
3100.0	700.28	0.03681	0.03771	0.07452	824.0	169.3	993.3	0.9914	0.1460	1.1373	3100.0
3200.0	705.08	0.04472	0.01191	0.05663	875.5	56.1	931.6	1.0351	0.0482	1.0832	3200.0
3206.2*	705.47	0.05078	0.00000	0.05078	906.0	0.0	906.0	1.0612	0.0000	1.0612	3206.2*

*Critical pressure



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

Master

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 5.01 (1.50)

a. FALSE. (.5)
b. P-8A 101 amps (.5)
P-8C 93 amps (.5)

REFERENCE
EOP-1, step 3.6

ANSWER 5.02 (1.00)

a. 258 F (250 - 260) (.5)
b. 325 F (320 - 330) (.5)

REFERENCE
Steam Tables

ANSWER 5.03 (1.50)

Any six of the following (.25 each):
1. Core outlet temperature reading above saturation.
2. Core differential temperature above full power (50 F).
3. Erratic indication on the startup neutron detectors.
4. Erratic indication on qualified core exit thermocouples.
5. Hot leg temperature increasing or erratic.
6. Cold leg temperature erratic.
7. Pressurizer level increases significantly greater than expected when operating auxiliary spray.
8. Unanticipated letdown flow greater than charging flow when pressurizer level control is in automatic.
9. During steady state conditions, charging a known volume of water or boric acid into the PCS does not result in a corresponding increase in pressurizer level.

REFERENCE
EOP 8.1, step 4.8.a
ONP 21, step 4.8.9

ANSWER 5.04 (1.00)

Fast neutron irradiation of the reactor vessel.

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

REFERENCE
Tech Spec 3-6

ANSWER 5.05 (1.00)

a. FALSE (.5)
b. FALSE (.5)

REFERENCE
Thermal-Hydraulic Principles and Applications to the PWR, 8-20 and 10-5

ANSWER 5.06 (1.00)

Smallest amount of net positive suction head a pump must have to prevent cavitation.

REFERENCE
Thermal-Hydraulic Principles and Applications to the PWR, 10-56

ANSWER 5.07 (1.00)

a. increase (.5)
b. decrease (.5)

REFERENCE
Thermal-Hydraulic Principles and Applications to the PWR, 12-52 and 55

ANSWER 5.08 (1.00)

Excessive void fraction causes flow instability (.5) which could cause the premature onset of DNB (.5).

REFERENCE
Tech Spec 2-2 and 2-7

ANSWER 5.09 (1.00)

Greater system resistance to flow at the increased fluid velocity.

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

REFERENCE
Thermal-Hydraulic Principles and Applications to the PWR, 10-52

ANSWER 5.10 (2.00)

a. Whenever only one source range instrument is operable. (.5)
b. $(CR1)/(CR2) = (1 - Keff2)/(1 - Keff1)$ (.1)
$Keff2 = Keff1 + \Delta K$ (.1)
$(CR1)/(CR2) = (1 - Keff1 - \Delta K)/(1 - Keff1)$ (.1)
$(CR1)/(CR2) = 1 - [(\Delta K)/(1 - Keff1)]$ (.1)
$(\Delta K)/(1 - Keff1) = 1 - [(CR1)/(CR2)]$ (.1)
$(\Delta K)/(1 - Keff1) = 1 - (8/14) = 6/14 = 3/7$ (.1)
$\Delta K = 3(1 - Keff1)/7$ (.1)
$(1 - Keff1) = (7/3)(\Delta K)$ (.1)
$(CR2)/(CR3) = (1 - Keff3)/(1 - Keff2)$ (.1)
$Keff3 = Keff2 + \Delta K = Keff1 + 2\Delta K$ (.1)
$(CR2)/(CR3) = (1 - Keff1 - 2\Delta K)/(1 - Keff1 - \Delta K)$ (.1)
$(CR2)/(CR3) = [((7/3)(\Delta K)) - (2\Delta K)]/[((7/3)(\Delta K)) - (\Delta K)]$ (.1)
$(CR2)/(CR3) = [(7/3) - 2]/[(7/3) - 1] = (1/3)/(4/3) = 1/4$ (.1)
$CR2 = (1/4)(CR3)$ (.1)
$CR3 = (4)(CR2) = (4)(14) = 56$ (.1)

REFERENCE
NUS Reactor Operation 12.4-2
GOP 3, step 5.0

ANSWER 5.11 (2.00)

a. 352 F (.5)
b. Restrict the amount of positive reactivity which could result from PCS depressurization (1.0), since MTC will be more positive at lower temperatures (.5).

REFERENCE
Tech Spec 3-13

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 5.12 (3.00)

Maximum permissible startup rate is 1.0 DPM. (.5)
Power level at which the reactor is considered critical for the purposes of administrative control is 10**(-4)%. (.5)
Highest permitted power level in hot standby is 2%. (.5)
$P = (P_c)\ 10^{**}[(SUR)(time)]$ (.5)
$10^{**}[(SUR)(time)] = P/P_c$
$(SUR)(time) = \log(P/P_c)$
$time = [1/(SUR)]\log(P/P_c)$ (.5)
$time = (1/1)\log[2/10^{**}(-4)] = \log(2*10^{**}4) = 4.3$ minutes (.5)

REFERENCE
GLC 3, step 2.3.2
Tech Spec 1-1

ANSWER 5.13 (1.50)

Fission product inventory increases with fuel burnup (.5). Fission products are strong thermal neutron absorbers, so as fission product inventory increases the neutron flux spectrum shifts to the epithermal range (.5). Control rods are strong epithermal neutron absorbers, so the relative strength of the control rods will increase as fission product inventory increases (.5).
also depletion of burnable poisons and reduction of boric acid reduces competition for neutrons causes resistance to flux increase & thermal neutron flux at EOL.

REFERENCE
SH PNJB, p 12
Reactor Core Control, 6-25
SH PQBO, p12

ANSWER 5.14 (2.00)

Most of the xenon after a trip is due to iodine decay, rather than to the xenon which was present at the time of the trip and has not yet decayed (1.0). Since iodine concentration is linear with reactor power, the maximum xenon concentration after a trip will be linear with reactor power since the only removal mechanism for xenon after a trip is xenon decay (1.0).

REFERENCE
PWR Core Physics B-4, p 23-25

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 5.15 (1.00)

Because MTC, which is part of the power defect, becomes much more negative with fuel burnup (.5) due to boron removal by dilution (.5).

REFERENCE
PWR Core Physics B-3, p 63

ANSWER 5.16 (1.50)

1. Limit the worth of the control rods. (.5)
2. Ensure adequate shutdown margin. (.5)
3. Maintain hot channel factors within limits of transient analysis. (.5)

REFERENCE
SH PNLB 4.19

ANSWER 5.17 (1.00)

A gas which is chemically inert. (Does not react chemically.)
(A gas such as helium, argon, krypton, xenon or radon.)

REFERENCE
Webster's New Collegiate Dictionary
SH PNPA 4.10

ANSWER 5.18 (1.00)

Reaction of oxygen-16 with a high energy neutron.

REFERENCE
Nuclear Engineering Handbook, p 7-20
SH PNPA 4.10

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 6.01 (1.50)

a. Open. (.5)
b. Prevent a loss of instrument air from causing a loss of CCW to the PCPs (.25), CRDMs (.25), letdown heat exchanger (.25) or shield cooling coils (.25).

REFERENCE
SH PNAB 4.11

ANSWER 6.02 (2.00)

a. 1. The fire protection system can provide partial backup supply to both critical service water headers. (.5)
   2. The fire protection system can provide cooling water to the service/instrument air compressors. (.5)
   3. The service water booster pumps can be aligned via temporary connections as a backup for the fire system jockey pump. (.5)
b. Fire water can be supplied as emergency makeup to the spent fuel pool via a swing-elbow connection. (.5)

REFERENCE
SH PNAD 4.9

ANSWER 6.03 (1.00)

Each of the following is worth .25.
1. Bus undervoltage.
2. Low pump suction pressure.
3. Overcurrent.
4. Load shed.

REFERENCE
SH PNEP 4.16

ANSWER 6.04 (1.50)

1. Manual trip button in the main control room. (.5)
2. Manual trip button at the main feed water pump. (.5)
3. Manual trip lever at the main feed water pump. (.5)

shut MSIVs

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

REFERENCE
SH PNFA 4.8

ANSWER 6.05 (1.00)

a. Feed water regulating valve will shut. (.25)
   Feed water regulating bypass will be unaffected. (.25)
b. Feed water regulating valve will shut. (.25)
   Feed water regulating bypass valve will shut. (.25)

REFERENCE
SH PNFB 6.6

ANSWER 6.06 (1.00)

(.25 each)
1. Main oil pump if the turbine is rotating faster than 2/3 speed.
2. Air side HP seal oil backup pump.
3. Emergency air side seal oil backup pump.
4. Turning gear oil pump.

REFERENCE
SH PNGD 4.9

ANSWER 6.07 (2.00)

(.4 each)
1. Engine trip.
2. Loss of excitation.
3. Overcurrent.
4. Differential relay.
5. Bus transfer.

REFERENCE
SH PNHB 4.17

ANSWER 6.08 (1.00)

1. Bus 1C or 1D undervoltage and SIS (.5) OR
2. Reactor trip or turbine trip and undervoltage on the startup transformer and SIS (.5).

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

REFERENCE
SH PNHD 4.4

ANSWER 6.09 (1.00)

(.5 each)
1. Lift oil pressure below 2000 psig.
2. CCW flow less than 80 gpm.

REFERENCE
SH PNJC 4.9

ANSWER 6.10 (1.00)

(.25 each) 150
a. 100 - ~~140~~ F
b. 1200 - 1400 psia
c. 20 - ~~50~~ 55 psia
d. 600 - ~~620~~ 630 psia

REFERENCE
SH PNJD 4.15

ANSWER 6.11 (2.00)

(.3 each except where noted)
1. Boric acid pumps start (P 56 A and B).
2. Coolant charging pumps start (P 55 A, B and C).
3. Boric acid gravity feed valves open (MOV-2169 and 2170).
4. Boric acid pumped feed stop valve (MOV-2140) opens.
5. VCT outlet valve (MOV-2087) closes.
6. Concentrated boric acid tanks recirc valves (CV-2130 and 2136) close.
7. Boric acid makeup stop valve (CV-2155) closes. (.2)

REFERENCE
SH PNKA 4.24

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 6.12 (2.00)

a. Backup heaters are all in the "ON" position (.5) with the pressure controller auto setpoint set for 60 to 70 psi lower than the normal pressure setpoint of 2010 psia (.5).
b. (Any two of the following at .5 each)
   1. Quicker spray response.
   2. Better boron mixing between the PCS and PZR.
   3. Less thermal shock on the spray nozzles.

REFERENCE
SH PNKD 4.14

ANSWER 6.13 (2.00)

a. A hot leg safety injection valve can not be opened until the cold leg safety injection valve in its train is shut. (1.0)
b. Insure HPSI pumps do not experience pump run out. (1.0)

REFERENCE
SH PNMA 4.23 and 4.24

ANSWER 6.14 (1.00)

The water during the recirculation phase is less dense.

pump must add greater head during injection phase than during recirc phase, ~~because~~ During injection its suction pressure is from the SIRT and it is pumping against very high pressure containment. During recirc phase the suction is from the containment sump so the high containment pressure adds to the suction pressure

REFERENCE
SH PNMB 4.11
FSAR 6.2
Tab B 6-7
Grafix M-6 and M7

ANSWER 6.15 (1.00)

Turn key switches HS-2418 and 2419 to the "Accident" position (.5), then turn hand switches HS-2416 and 2417 to the "close" and then to the "open" position (.5).

Hydrogen isolation valves bypass switches

Hydrogen isolation valves control switches

REFERENCE
SH PNMD 4.10
Grafix M 224 sheet 2

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 6.16 (1.00)

Any one of the four power range safety channels detecting a drop in power (.4) of more than 8% (.3) in less than 8 seconds (.3).

REFERENCE
SH PNNA 4.46

ANSWER 6.17 (1.00)

Prevent arcing across the matrix relay contacts when a reactor trip signal deenergizes a matrix relay, causing its associated matrix contact to open.

REFERENCE
SH PNNB 4.39

ANSWER 6.18 (1.00)

(Either of the following for full credit)
1. Isolates the steam generator blowdown tank.
2. Shuts CV-0704, 0738, 0739, 0770 and 0771.

REFERENCE
SH PNPA 4.10

ANSWER 6.19 (1.00)

(.5 each)
1. Digital readout on the console.
2. Mechanical pointer system along the trolley rail and the bridge.

REFERENCE
SH PNOC 4.15

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 7.01 (1.00)

(.5 each)
1. All the full length control rods indicate fully inserted.
2. Reactor power is decreasing (negative startup rate).

REFERENCE
EOP 1, step 3.1

ANSWER 7.02 (2.00)

If pressurizer pressure is less than 1300 psia, trip two PCPs (one in each loop, preferably P-50A and 50D). (1.0)
If pressurizer pressure drops below the minimum pressure for PCP operation, then trip the remaining two PCPs. (1.0)

REFERENCE
EOP 1, step 3.6

ANSWER 7.03 (2.50)

a. 800 psia. (.5)
b. (.5 each)
   1. Close both MSIVs (CV-0510 and 0501).
   2. Close both feedwater regulating valves (CV-0701 and 0703).
   3. Close both feedwater regulating bypass valves (CV-0734 and 0735).
   4. Emergency borate to establish 3.75% shutdown margin or cold shutdown boron concentration, whichever is greater.

REFERENCE
EOP 1, step 4.10

ANSWER 7.04 (1.50)

(.5 each)
1. PCS subcooling is less than 25 F.
2. Pressurizer level is below 20% or decreasing.
3. No steam generators are available for removing heat.

REFERENCE
EOP 1, step 4.15

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 7.05 (1.00)

Battery current is reduced to less than 150 amps within 30 minutes of the onset of the loss of AC power (1.0) (and maintained below 150 amps until AC power is restored to the battery chargers (0.5)).

REFERENCE
EOP 2.1, step 4.9

ANSWER 7.06 (2.00)

(.5 each)
1. PCP seal bleed off temperature exceeds 185 F.
2. PCP bearing temperature exceeds 175 F.
3. All (or most) control rod drive seal leak off temperatures exceed 200 F.
4. CCW flow to the PCPs is interrupted for more than ten minutes.

REFERENCE
EOP 4, step 4.1

ANSWER 7.07 (1.00)

(.5 each)
1. Instrument air pressure drops below 50 psig.
2. First indication of erratic equipment behavior.

REFERENCE
EOP 5, step 4.1

ANSWER 7.08 (1.00)

Pushing left and right HIGH RADIATION INITIATE pushbuttons.

REFERENCE
EOP 6

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 7.09 (1.00)

Prevent causing excessive starting currents on Bus 1A or 1B.

REFERENCE
EOP 8.1, step 4.19

ANSWER 7.10 (2.00)

(.4 each)
1. Maximize HPSI cold leg injection flow.
2. Close PORV breakers.
3. Open PORV isolation valves.
4. Check PORV handswitches in auto.
5. Pull out any two pressurizer high pressure bistable trip modules on the RPS to open the PORVs.

REFERENCE
EOP 8.1, step 4.2.4.3.b

ANSWER 7.11 (1.50)

(.5 each)
1. Dispatch personnel to secure the equipment access door and the personnel air lock doors if they are open.
2. Notify the control room and evacuate containment.
3. Evaluate the status of containment penetrations and initiate any actions necessary to prevent air leakage from containment.

REFERENCE
EOP 9, step 3.1

ANSWER 7.12 (1.00)

(.25 each)
1. Radios.
2. Vital area door keys.
3. Locked valve keys.
4. Emergency flashlights.

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

REFERENCE
EOP 10.2, step 4.1

ANSWER 7.13 (1.00)

Open breakers RPS 42-1 and 42-2 at the CRDM clutch power supply transformers in the cable spreading area.

REFERENCE
ONP 7, step 4.1

ANSWER 7.14 (1.00)

Trip the reactor and follow up with EOP 1.

REFERENCE
ONP 12, Seich, step 4.2

ANSWER 7.15 (1.00)

The basis is a fire in the cable spreading room or control room could cause "hot shorts" simultaneously in the control circuits for a PORV and its block valve (.5), resulting in the equivalent of a LOCA during a fire (.5).

REFERENCE
SOP 1, step 4.0.u

ANSWER 7.16 (1.00)

Immediately place the bundle back in the core, tilt machine or spent fuel rack, whichever is most convenient.

REFERENCE
SOP 28, step 5.26

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 7.17 (1.00)

a. 150 F. (.5)
b. Shutdown the plant in accordance with Tech Spec 3.0.3. (.5)
hot stby in 6 hrs, hot S/D in next 6 hrs, cold S/D in following 6 hrs.

REFERENCE
SOP 24, step 4.0.1

ANSWER 7.18 (1.00)

There will be a voltage perturbation because auto and manual output voltage will not be the same unless they are adjusted prior to loading.

REFERENCE
SOP 22, step 7.5.3.e

ANSWER 7.19 (1.50)

It is permissible to continue the startup (.5) if both WRL channels and the other startup range channel remain operable (.5), and a 1/M plot is maintained until criticality is achieved (.5).

REFERENCE
SOP 35, step 4.0.b

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 8.01 (.50)

Shift Supervisor.

REFERENCE
SOP 1, step 4.0.u

ANSWER 8.02 (.50)

False.

REFERENCE
Any SOP, section 8

ANSWER 8.03 (1.00)

a. 72 hours. (.5)
b. Plant General Manager. (.5)

REFERENCE
Admin Proc 1.00, steps 26.1 and 26.3

ANSWER 8.04 (1.00)

In an emergency (.5) when abiding by Technical Specifications would not provide adequate or equivalent protection to the public (.5).

REFERENCE
10CFR50.54(X)

ANSWER 8.05 (1.00)

1. Function as site emergency director until relieved. (.5)
2. Perform the accident assessment function. (.5)

REFERENCE
Admin Proc 4.00, step 4.10.1.1

ANSWER 8.06 (.50)

35 days.

REFERENCE
Admin Proc 4.01, step 5.1

ANSWER 8.07 (.50)

Control operator 1.

REFERENCE
Admin Proc 4.01, step 5.7.2.b.2

ANSWER 8.08 (.50)

True

REFERENCE
Admin Proc 4.01, step 5.7.2

ANSWER 8.09 (1.00)

a. 4. (.5)
b. Two licensed individuals (.25), at least one of whom holds an SO license (.25).

REFERENCE
Admin Proc 4.01, step 5.1.1

ANSWER 8.10 (1.00)

A procedure shall be developed and approved prior to commencing the evolution.

REFERENCE
Admin Proc 4.01, step 5.3.9

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 8.11 (.50)

Shift Supervisor.

REFERENCE
Admin Proc 4.01, step 5.8

ANSWER 8.12 (1.00)

One service water pump (.4) and one component cooling water pump (.4) are operable on the operable diesel generator (.2).

REFERENCE
Admin Proc 4.01, step 5.11.a

ANSWER 8.13 (1.00)

By logging it in the control room logbook (.5), along with the names of the repositioner and verifier (.5).

REFERENCE
Admin Proc 4.02, step 5.3.4

ANSWER 8.14 (.50)

True.

REFERENCE
Admin Proc 4.02, step 7.2

ANSWER 8.15 (.50)

Operations Superintendent.

REFERENCE
Admin Proc 4.02, step 7.2.1

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

ANSWER 8.16 (1.50)

a. Note the condition on the "Record of Exceptions" sheet. (.5)
b. Shift Supervisor. (.5)
c. Operations Superintendent. (.5)

REFERENCE
Admin Proc 4.02, step 7.2.2 and 7.2.3

ANSWER 8.17 (.50)

False

REFERENCE
Admin Proc 4.03, step 14.1

ANSWER 8.18 (1.00)

a. If the verification would result in significant radiation exposure. (.5)
b. Operations Superintendent. (.5)

REFERENCE
Admin Proc 4.03, step 10.2

ANSWER 8.19 (2.00)

a. A jumper link and bypass must by used. (.5)
b. 1. Engineering safeguards room floor plugs. (.5)
   2. West engineering safeguards room hatch. (.5)
   3. AFW room floor plug. (.5)

REFERENCE
Admin Proc 4.03, step 19.0

ANSWER 8.20 (1.00)

A mechanical block is installed on the valve to keep it shut (.5), then a tag is placed on the mechanical block (.5).

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

REFERENCE
Admin Proc 4.03, attachment 1, step 2.7.b

ANSWER 8.21 (.50)

False

REFERENCE
Admin Proc 4.08, step 4.1

ANSWER 8.22 (1.00)

(.25 each)
1. Allow safe shutdown of the plant.
2. Reduce imminent possibility of personnel injury.
3. Reduce imminent possibility of damage to major equipment.
4. Reduce imminent possibility of hazard to public safety.

REFERENCE
Admin Proc 5.01, step 5.12

ANSWER 8.23 (.50)

Priority 8.

REFERENCE
Admin Proc 5.01, attachment 1, block 19

ANSWER 8.24 (.50)

True

REFERENCE
Admin Proc 7.03, step 5.1.c

ANSWER 8.25 (.50)

Radiation Saftety Supervisor

ANSWERS -- PALISADES -86/06/24-HIGGINS, R.

REFERENCE
Admin Proc 7.03, step 5.2.a

ANSWER 8.26 (.50)

Read, sign and comply with the standard RWP.

REFERENCE
Admin Proc 7.03, step 7.2.c

ANSWER 8.27 (1.00)

a. With the window on the front of the badge facing away from the body. (.5)
b. Close to the body. (.5)

REFERENCE
Admin Proc 7.04, steps 5.3.1.c and 5.4.d

ANSWER 8.28 (2.00)

a. 300 mrem. (.5)
b. 1. Radiological Services Manager (.5)
2. Plant General Manager (.5)
3. Vice President of Nuclear Operations (.5)

REFERENCE
Admin Proc 7.04, step 5.2.b; table 1

ANSWER 8.29 (1.50)

1. Recommend protective actions to off-site organizations (.5)
2. Evacuate the site. (.5)
3. Authorize exposures in excess of 10CFR20 limits. (.5)

REFERENCE
Site Emergency Plan 5.4.1