U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-237/OL-85-02

Docket Nos. 50-237; 50-249 Licenses No. DPR-19; DPR-25

Licensee: Commonwealth Edison Company
Post Office Box 767
Chicago, IL 60690

Facility Name: Dresden Nuclear Power Station 2 and 3

Examination Administered At: Morris, IL

Examination Conducted: June 10-14, 1985

Examiners: E. Plettner
E Plettner 8/23/85
Date

J. D. McMillen
J. Lang for 8/23/85
Date

Approved By: J. D. McMillen 8/23/85
Date

Examination Summary

Examination administered on June 10-14, 1985 (Report No. 50-237/OL-85-02)
Results: Eleven candidates took the examination and seven passed.

REPORT DETAILS

1. Examiners

   E. Plettner, Region III, Chief Examiner
   T. Lang, Region III
   J. McMillen, Region III

2. Examination Review Meeting

   After completion of the written examination an exam review was conducted with Mr. S. Mattson, Mr. S. Stiles and Mr. B. Zank. Facility comments were for the most part editorial and have been incorporated in the master examination and answer key for both RO and SRO exams.

3. Exit Meeting

   At the conclusion of the examinations, an exit meeting was held with the plant staff. They were informed of all candidates who clearly passed the oral and simulator exams.

MASTER COPY

U.S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY	Dresden 2/3
REACTOR TYPE:	BWR GE 3
DATE ADMINISTERED:	June 10, 1985
EXAMINER:	F. Plettner
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%.

Category Value	% of Total	Applicant's Score	% of Category Value	
25	25	___	___	1. Principles of Nuclear Power Plant Operations, Thermodynamics, Heat Transfer and Fluid Flow
25	25	___	___	2. Plant Design Including Safety and Emergency Systems
25	25	___	___	3. Instruments and Controls
25	25	___	___	4. Procedures - Normal, Abnormal, Emergency and Radiological Control
100	100	___	___	TOTALS

Final Grade ____ %

All work done on this exam is my own, I have neither given or received aid.

____
Applicant's Signature

Section 1 - Questions - Principles of Nuclear Power Plant Operations, Thermodynamics, Heat Transfer and Fluid Flow.

1.01 a. Excess reactivity is initially loaded into the reactor to compensate for Keff decreasing from BOL to EOL. Give two (2) reasons why Keff will decrease at various times from BOL to EOL. (1.0)

b. For a period of time during core life, Keff will actually increase (become more reactive). Give two (2) reasons for the core becoming more reactive. (1.0)

1.02 EXPLAIN or DEFINE the following terms:

a. Prompt Critical (0.5)
b. Reactor Period (0.5)
c. Subcritical Multiplication (0.5)

1.03 Which of the following radioactive isotopes found in the reactor coolant would NOT indicate a leak through the fuel cladding? (1.0)

a. I-131
b. Xe 133
c. Co-60
d. Kr-85

1.04 Prior to startup (all rods in) the SRM countrate is 20CPS and K effective in 0.96. If the control rods are pulled to give a delta K of +0.035, what count rate on the SRMs could be expected when the period becomes infinite? (1.0)

a. 40
b. 160
c. 80
d. 120

1.05 Referring to the attached curve (Fig. 1), which of the following regions on the curve is associated with the heat transfer mechanism known as "transition boiling"? (1.0)

a. A + B
b. D
c. E
d. C + D
e. B + C

1.06 A moderator is necessary to slow neutrons down to thermal energies. Which of the following is the best reason for operating with thermal instead of fast neutrons. (1.0)

a. Increased neutron efficiency since thermal neutrons are less likely to leak out of the core than fast neutrons.

b. Reactors operating primarily on fast neutrons are inherently unstable and have a higher risk of going prompt critical.

c. The fission cross section of the fuel is much higher for thermal neutrons than for fast neutrons.

d. Doppler and moderator temperature coefficients become positive as neutron energy increases.

1.07 Which of the following statements best describes the condition known as "condensate depression"? (1.0)

a. Can lead to condensate pump cavitation if condensate depression is too great.

b. Decreases as hotwell level rises.

c. Reduces Rankine cycle efficiency.

d. Increases as condensate temperature increases.

1.08 Which of the following statements correctly completes the following sentence? Departure from nucleate boiling is the point where: (1.0)

a. Void fraction equals one.

b. The heat transfer mechanism changes from nucleate boiling to single phase convection.

c. Radiative heat transfer becomes insignificant.

d. The heat transfer rate increases substantially when nucleate boiling reaches its maximum.

1.09 Which of the following is <u>NOT</u> correct concerning decay heat? (1.0)

a. Is the heat produced by the energy released from the radioactive decay of fission products.

b. Can be determined by the reading on the SRMs when reactor is shutdown.

c. Is approximately 6% of the total energy released from fission.

d. Is still a significant contributor to the energy in the reactor core for approximately two hours after the reactor has been shutdown.

1.10 Figure 1.21 is a representation of how the resonance peaks of U-238 "flatten out" or Doppler broaden as fuel temperature increases. Which of the following are the correct labels for the X and Y axes? (1.0)

a. X is neutron flux; Y is interaction rate

b. X is interaction rate; Y is neutron density

c. X is atom density of U-238; Y is neutron flux

d. X is neutron energy; Y is microscopic capture cross section

1.11 The ratio of Pu-239 and Pu-240 atoms to U-235 atoms changes over core life. Which of the pairs of parameters listed below are most affected by this change? (1.0)

a. Doppler coefficient and beta

b. Moderator temperature coefficient and doppler coefficient

c. Beta and moderator coefficient

d. Moderator temperature coefficient and neutron generation time

1.12 What is "pump runout" and why is it an undesirable condition? (1.0)

1.13 Give three parameters which effect the NPSH of a recirculation pump. (1.5)

1.14 A reactor is exactly critical. Control rods are then withdrawn to insert .0005 Delta-k/k (assume Beta 0.007, Lambda=.1/sec) Show all work.

a. What is the resulting stable period? (0.5)

b. How long will it take for power to increase by a factor of 10? (0.5)

c. What would the period be for a further addition of .0005 Delta-k/k? (0.5)

1.15 a. Where do delayed neutrons come from? (0.5)

b. What fraction of the thermal neutrons are delayed at BOC? EOC? (0.5)

c. Why does this fraction in part (b) change from BOC to EOC? (1.0)

1.16 The reactor is started up after a refueling outage. Rods are pulled to the 100% line and power is then increased to 100% with recirculation flow. After approximately 20 hours, reactor power has decreased to about 98% with no operator action.

a. What is the primary cause for this reduction in power. (0.5)

b. Briefly explain why control rod withdrawals are not recommended at a high power levels. (1.0)

1.17 Concerning the core thermal limits:

a. For each condition (1-4) given below, INDICATE whether it will cause an INCREASE, a DECREASE, or have NO EFFECT on CRITICAL POWER Ratio.

1. Local peaking factor (LPF) INCREASES (0.5)

2. DECREASE in inlet subcooling (0.5)

3. INCREASE in reactor pressure (0.5)

4. Axial power peak shifts from BOTTOM to TOP of channel (0.5)

b. With regard to MAPRAT:

1. WHAT is the relationship between MAPRAT and MAPLHGR? (0.5)

2. IS a MAPRAT of 1.05 acceptable? (.25)

3. WHAT physical consequence could occur if the MAPRAT limit is exceeded? (.75)

1.18 What are three (3) sources of neutrons <u>other than</u> installed sources when the reactor is shutdown? (1.5)

END OF SECTION 1

Section 2 - Questions - Plant Design Including Safety and Emergency Systems

2.01 If a complete loss of Instrument Air were to occur with the plant operating at full power and with no operator action, what would be the effect on the following components: (NOTE: Limit your answer to effects caused in relation to instrument air only).

a. CRD Hydraulic flow control valve (0.5)

b. CRD Hydraulic scram valves (0.5)

c. CRD Hydraulic instrument volume (0.5)

d. Main Feed pump minimum flow valve (0.5)

e. Main Feed regulating valves (0.5)

2.02 What four (4) conditions must be met for the standby Reactor Feed Pump to auto start? (Include setpoints where applicable) (3.0)

2.03 For each of the HPCI (High Pressure Coolant Injection) System component failures listed below, STATE WHETHER OR NOT HPCI WILL AUTO INJECT into the reactor vessel, IF IT WILL NOT INJECT WHY, AND IF IT WILL INJECT, provide ONE POTENTIAL ADVERSE EFFECT OR CONSEQUENCE of system operation with the failed component. Assume NO OPERATION ACTION, and the component is in the failed condition at the time HPCI received the auto initiating signal.

a. The GLAND SEAL EXHAUSTER VACUUM PUMP fails to operate. (1.0)

b. The turbine AUXILIARY LUBE OIL PUMP fails to operate. (1.0)

c. The MINIMUM FLOW VALVE fails to auto open (stays shut) when system conditions require it to be open. (1.0)

d. The HPCI pump DISCHARGE FLOW ELEMENT output signal to the HPCI flow controller is failed at its maximum output. (1.0)

2.04 State what problem would be associated with each of the following conditions:

a. Scram outlet valve fails to open on a scram. (1.0)

b. Failure of both CRD Hydraulic pumps (two problems required other than part c below). (2.0)

c. Isolating CRD Hydraulic water to the recirculation pumps. (1.0)

2.05 What are the four chain of events postulated to occur in a control rod drop accident? (2.0)

2.06 There are five (5) conditions which will automatically trip the Reactor Building Ventilation supply and exhaust fans. WHAT are four (4) of these conditions? (2.0)

2.07 Indicate if the following statements regarding the Fire Protection System are TRUE or FALSE.

a. The ten wall-mounted hose-reel CARDOX assemblies located throughout the plant each have a separate CO2 storage tank. (0.5)

b. Although the Service Water Tie Line Valve (MO2-3906) is locked in the closed position, pressure in the Fire Protection Water System is normally maintained by the Service Water System. (0.5)

c. In the automatic mode of operation of the Halon Suppression System, an activation signal turns on the evacuation lights, sounds a siren and immediately commences a 3 minute injection of Halon. (0.5)

d. Once the Halon system begins to inject in the Aux. Electric Room, it is possible to secure the injection with an abort switch located adjacent to the door to the Aux. Electric Room. (0.5)

2.08 a. List all the sources in order of preference, of makeup water to the shell side of the isolation condenser. (1.5)

b. List three (3) of the four (4) conditions which will cause valves (1301-17, -20) to auto close. (1.5)

2.09 State whether the following conditions would (increase, decrease, not change) the indicated level of the Yarway Instrument. (0.5 points for each answer.) (2.5)

a. Equalizing valve leaks

b. Subcooling in variable leg

c. Steam carry under

d. Rapid decrease in reactor vessel pressure

e. Flashing of condensate pot

END OF SECTION 2

Section 3 - Questions - Instruments And Control

3.01 Answer the following questions in regard to LPCI loop select logic:

a. How does the logic determine how many recirc pumps are running? (Include Set Point) (1.5)

b. How does the logic determine which is the undamaged recirc loop? (1.5)

c. If the logic determines that neither loop is damaged, which loop will select for LPCI injection? (0.5)

3.02 Where does the signal orginate and under what (logic) conditions will the OFF-GAS system isolate. (2.0)

3.03 Describe how the EHC Pressure Control and Logic System would respond if while operating at 100% power, the maximum combined flow fails to zero. Take your discussion to a final steady state condition. (i.e., Reactor scram or maximum combined flow at zero and state the final plant steady state condition. Assume no other operator action and all systems are in normal full power lineups.) (4.0)

3.04 What happens when an "Edge Rod Selected" signal is generated in the Rod Block Monitor System? (0.5)

3.05 LPRM output signals are sent to various systems. List four (4) of the five (5) systems. (2.0)

3.06 What are two reasons for the mechanical interlocks associated with the reserve power supply to the RPS bus? (1.0)

3.07 For each of the following, state whether a ROD BLOCK, HALF SCRAM, FULL SCRAM, or NO REACTOR PROTECTION System ACTION is generated for that condition. NOTE: IF two or more actions are generated, i.e. rod block and half-scram, state the most severe, i.e. half-scram.

a. APRM B Downscale, Mode Switch in RUN (0.5)

b. 12 LPRM inputs to APRM C, Mode Switch in STARTUP (0.5)

c. Flow ~~Units~~ converter A and B Upscale (>108% flow), Mode Switch in RUN (0.5)

d. Reactor water level 55", Reactor power 18%, Mode Switch in RUN (0.5)

3.08 How is reduced sensitivity accomplished in the IRM when compared to the SRM? (3 Required for full credit) (1.5)

3.09 What are the automatic modes of operation for the safety/relief valves? Target Rock (1.5)

3.10 Answer the following questions in regards Nuclear Boiler Instrumentation.

a. What system uses the narrow ranges GE/MAC instrument input? (0.5)

b. What four (4) out of five (5) systems use rea:tor pressure input? (2.0)

c. How does jet pump flow affect the wide range Yarway instruments reading actual verses indicated? (0.5)

3.11 What occurs when the "Emergency In" position is used in the Reactor Manual Control System? (1.5)

3.12 Match the recirculation flow control alarm with its setpoint. (2.5)

a.	Speed Signal Failure	1.	Below 4 psid, 28 sec. after start
b.	Incomplete Sequence Trip	2.	Feedwater flow below 20%
c.	Recirc Pump Low Differential Pr sure	3.	Less than 1.0 ma output from function generator
d.	Recirc Pump Locked Rotor Trip	4.	Below 4 psid
e.	Recirc Loop Flow Limit	5.	Below 4 psid, 30 sec. after start

END OF SECTION 3

Section 4 - Questions - Procedures - Normal, Abnormal, Emergency and Radiological Control

4.01 What five (5) actions shall the on-coming NSO perform during the shift turnover? (2.5)

4.02 What are an operators actions on the loss of cooling by RBCCW? (2.0)

4.03 When paralleling electrical sources the synchroscope should be rotating ___A___ in the ___B___ direction and ___C___ voltage should be slightly ___D___ than the ___E___ voltage. (Fill in the blanks). (2.5)

4.04 Define or explain the following:

a. High radiation area (1.0)

b. Effective half-life (1.0)

c. Curie (1.0)

d. REM (1.0)

4.05 What is the whole body dose limit in an emergency condition that:

a. Involves protecting equipment (0.5)

b. Involves life saving action (0.5)

4.06 What are your actions upon orders from the Shift Supervisor to Evacuate the Control Room? (Assume 100% power normal operation) (2.5)

4.07 Assume an ATWS event has occurred:

a. What are the required immediate operator actions? (Identify the differences between Units 2 and 3 actions) (2.0)

b. Under what conditions can the NSO inject SBLC without authorization from a supervisor? (1.0)

c. After the Standby Liquid Control System is initiated, WHAT are the five (5) indications that the system is operating? (2.0)

4.08 What are an operators action upon receiving a Reactor High Pressure? (2.5)

4.09 List the following items in the order of occurrence during a normal unit shutdown (per procedure DGP 2-1) and match the approximate conditions (i.e. power, press, or temp) at which each is performed. (3.0)

a.	Verify Rod Worth Minimizer Low Power Setpoint (LPSP) window is lit.	1.	40% power
b.	Verify Rod Worth Minimizer Transition window is lit.	2.	feed flow 20%
c.	Transfer level control to the Low Flow Control Valve.	3.	200 MWE
d.	Remove the second feed pump from service.	4.	power between 5% and 10%
e.	Transfer the Reactor Mode Switch to startup.	5.	35% power
f.	Remove feedwater heaters from service.	6.	feed flow less than or equal 10%

END OF SECTION 4

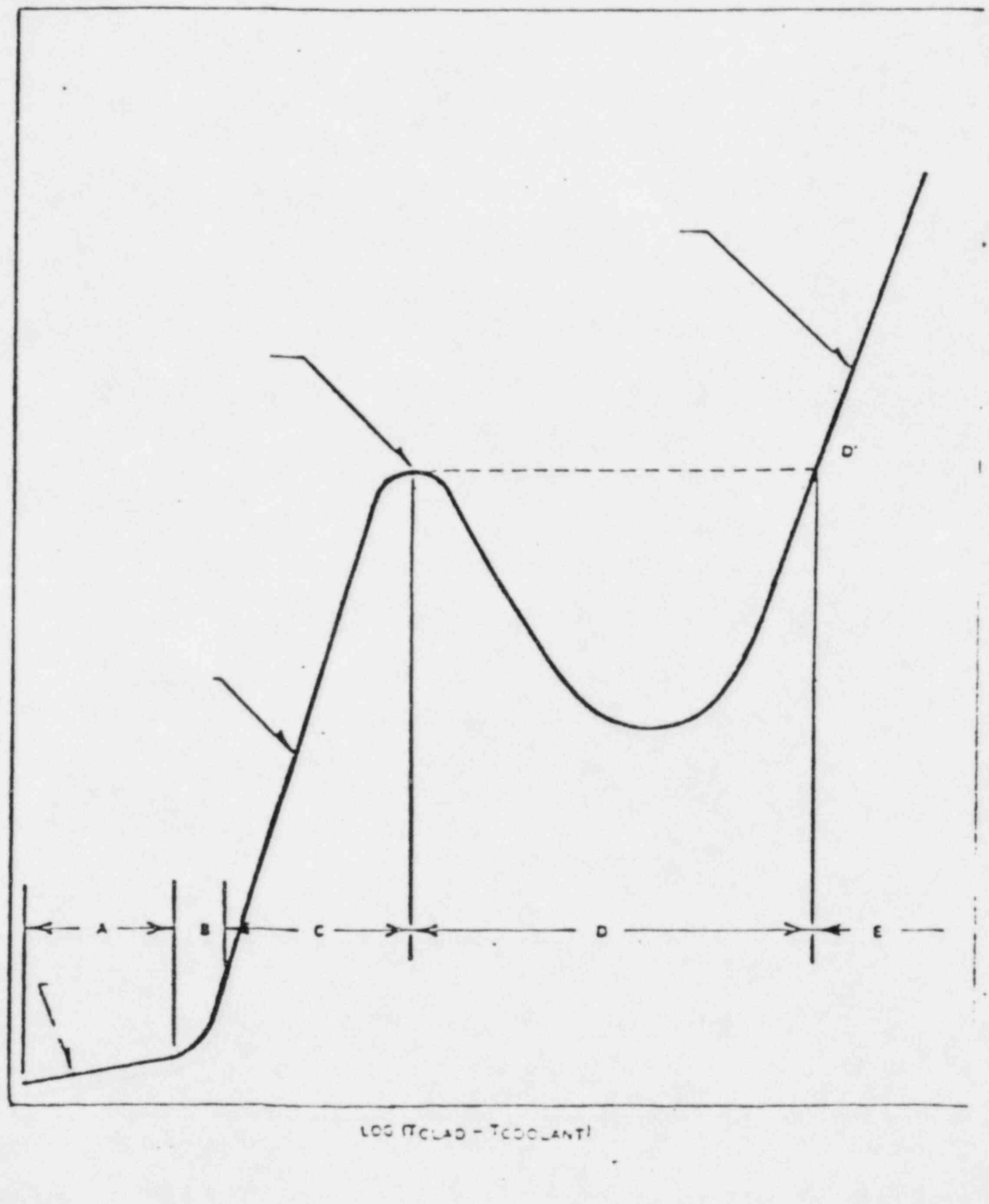

Figure 1. Heat Flux Versus Temperature Difference Between Cladding and Coolant

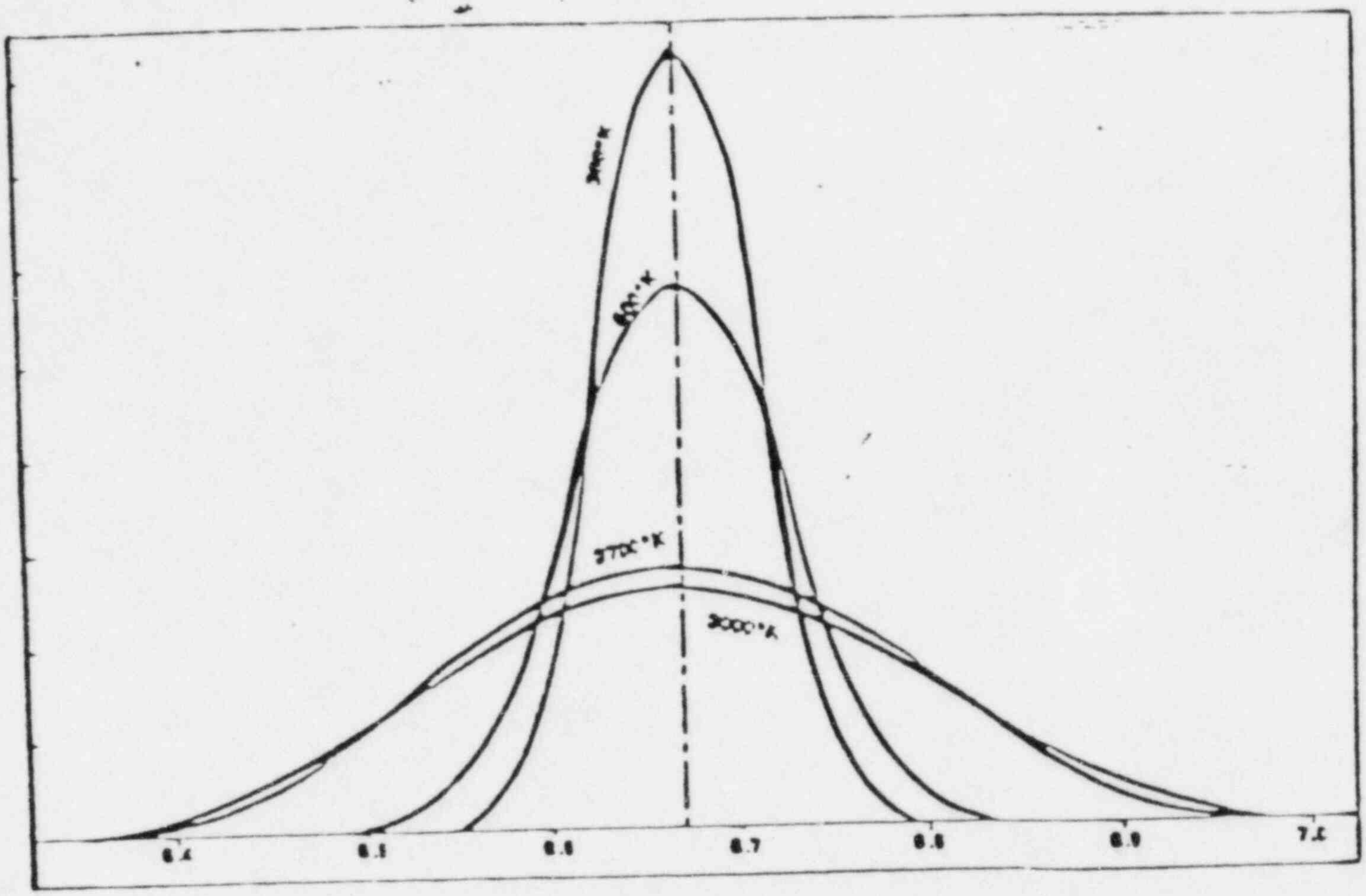

Figure 1.21

$f = ma$

$v = s/t$

Cycle efficiency = (Network out)/(Energy in)

$w = mg$

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

$A = N\sigma\phi(1-e^{-\lambda t})$

$E = mc^2$

$KE = 1/2\ mv^2$

$a = (V_f - V_o)/t$

$A = \lambda N$

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

$PE = mgh$

$V_f = V_o + at$

$w = e/t$

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

$\frac{P}{\rho(g)} + \frac{V^2}{2g} + y = K$

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

$\Delta E = 931\ \Delta m$

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

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

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

$Pwr = W_f \Delta h$

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

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

$TVL = 1.3/\mu$

$HVL = -0.693/\mu$

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

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

$SUR = 26.06/T$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$I_1 d_1 = I_2 d_2$

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

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

$\Sigma = \sigma N$

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

Water Parameters

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

Miscellaneous Conversions

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

Table 2. Properties of Saturated Steam and Saturated Water (Pressure)

Press. psia	Temp. F	Volume, ft³/lbm Water v_f	Evap. v_{fg}	Steam v_g	Enthalpy, Btu/lbm Water h_f	Evap. h_{fg}	Steam h_g	Entropy, Btu/lbm × R Water s_f	Evap. s_{fg}	Steam s_g	Energy, Btu/lbm Water u_f	Steam u_g
1800.0	621.02	0.02472	0.19390	0.21861	648.5	503.8	1152.3	0.8417	0.4662	1.3079	640.3	1079.5
1780.0	619.47	0.02463	0.19734	0.22197	646.1	507.5	1153.6	0.8395	0.4703	1.3098	638.0	1080.5
1760.0	617.90	0.02454	0.20084	0.22538	643.7	511.2	1154.9	0.8374	0.4744	1.3118	635.7	1081.5
1740.0	616.33	0.02445	0.20442	0.22887	641.3	514.9	1156.2	0.8352	0.4785	1.3137	633.4	1082.5
1720.0	614.73	0.02437	0.20806	0.23243	638.9	518.5	1157.4	0.8331	0.4826	1.3157	631.1	1083.4
1700.0	613.13	0.02428	0.21178	0.23607	636.5	522.2	1158.6	0.8309	0.4867	1.3176	628.8	1084.4
1680.0	611.51	0.02420	0.21558	0.23978	634.0	525.8	1159.8	0.8287	0.4909	1.3196	626.5	1085.3
1660.0	609.87	0.02411	0.21945	0.24357	631.6	529.5	1161.0	0.8265	0.4950	1.3215	624.2	1086.2
1640.0	608.22	0.02403	0.22341	0.24744	629.1	533.1	1162.2	0.8243	0.4992	1.3235	621.8	1087.1
1620.0	606.55	0.02395	0.22745	0.25140	626.7	536.7	1163.4	0.8221	0.5034	1.3255	619.5	1088.0
1600.0	604.87	0.02387	0.23159	0.25545	624.2	540.3	1164.5	0.8199	0.5076	1.3274	617.1	1088.9
1580.0	603.17	0.02378	0.23581	0.25960	621.7	543.9	1165.7	0.8176	0.5118	1.3294	614.8	1089.8
1560.0	601.45	0.02370	0.24014	0.26384	619.2	547.6	1166.8	0.8153	0.5160	1.3314	612.4	1090.6
1540.0	599.72	0.02362	0.24456	0.26818	616.7	551.2	1167.9	0.8131	0.5203	1.3333	610.0	1091.5
1520.0	597.97	0.02354	0.24909	0.27263	614.2	554.8	1169.0	0.8108	0.5245	1.3353	607.6	1092.3
1500.0	596.20	0.02346	0.25372	0.27719	611.7	558.4	1170.1	0.8085	0.5288	1.3373	605.2	1093.1
1480.0	594.41	0.02338	0.25847	0.28186	609.1	562.0	1171.2	0.8061	0.5332	1.3393	602.7	1094.0
1460.0	592.61	0.02331	0.26334	0.28665	606.6	565.6	1172.2	0.8038	0.5375	1.3413	600.3	1094.8
1440.0	590.78	0.02323	0.26833	0.29156	604.0	569.2	1173.3	0.8014	0.5419	1.3433	597.8	1095.6
1420.0	588.93	0.02315	0.27345	0.29660	601.4	572.9	1174.3	0.7990	0.5463	1.3453	595.3	1096.3
1400.0	587.07	0.02307	0.27871	0.30178	598.8	576.5	1175.3	0.7966	0.5507	1.3474	592.9	1097.1
1380.0	585.18	0.02300	0.28410	0.30710	596.2	580.1	1176.3	0.7942	0.5552	1.3494	590.3	1097.9
1360.0	583.28	0.02292	0.28965	0.31256	593.6	583.7	1177.3	0.7918	0.5597	1.3515	587.8	1098.6
1340.0	581.35	0.02284	0.29534	0.31818	590.9	587.4	1178.3	0.7893	0.5642	1.3535	585.3	1099.4
1320.0	579.40	0.02277	0.30119	0.32396	588.3	591.0	1179.3	0.7868	0.5688	1.3556	582.7	1100.1
1300.0	577.42	0.02269	0.30722	0.32991	585.6	594.6	1180.2	0.7843	0.5733	1.3577	580.1	1100.9
1290.0	576.43	0.02265	0.31029	0.33295	584.2	596.5	1180.7	0.7831	0.5757	1.3587	578.8	1101.2
1280.0	575.42	0.02262	0.31341	0.33603	582.9	598.3	1181.2	0.7818	0.5780	1.3598	577.5	1101.6
1270.0	574.42	0.02258	0.31658	0.33916	581.5	600.1	1181.6	0.7805	0.5803	1.3608	576.2	1101.9
1260.0	573.40	0.02254	0.31980	0.34234	580.2	601.9	1182.1	0.7793	0.5826	1.3619	574.9	1102.3
1250.0	572.38	0.02250	0.32306	0.34556	578.8	603.8	1182.6	0.7780	0.5850	1.3630	573.6	1102.6
1240.0	571.36	0.02247	0.32637	0.34884	577.4	605.6	1183.0	0.7767	0.5874	1.3640	572.3	1103.0
1230.0	570.32	0.02243	0.32973	0.35216	576.0	607.4	1183.5	0.7754	0.5897	1.3651	570.9	1103.3
1220.0	569.28	0.02239	0.33314	0.35554	574.6	609.3	1183.9	0.7741	0.5921	1.3662	569.6	1103.7
1210.0	568.24	0.02236	0.33661	0.35897	573.2	611.1	1184.4	0.7728	0.5945	1.3673	568.2	1104.0
1200.0	567.19	0.02232	0.34013	0.36245	571.9	613.0	1184.8	0.7714	0.5969	1.3683	566.9	1104.3
1190.0	566.13	0.02228	0.34371	0.36599	570.5	614.8	1185.3	0.7701	0.5993	1.3694	565.5	1104.7
1180.0	565.06	0.02225	0.34734	0.36958	569.0	616.6	1185.7	0.7688	0.6017	1.3705	564.2	1105.0
1170.0	563.99	0.02221	0.35103	0.37324	567.6	618.5	1186.1	0.7674	0.6042	1.3716	562.8	1105.3
1160.0	562.91	0.02217	0.35478	0.37695	566.2	620.3	1186.6	0.7661	0.6066	1.3727	561.4	1105.6
1150.0	561.82	0.02214	0.35859	0.38073	564.8	622.2	1187.0	0.7647	0.6091	1.3738	560.1	1106.0
1140.0	560.73	0.02210	0.36247	0.38457	563.3	624.1	1187.4	0.7634	0.6115	1.3749	558.7	1106.3
1130.0	559.63	0.02206	0.36641	0.38847	561.9	625.9	1187.8	0.7620	0.6140	1.3760	557.3	1106.6
1120.0	558.52	0.02203	0.37041	0.39244	560.5	627.8	1188.2	0.7606	0.6165	1.3771	555.9	1106.9
1110.0	557.40	0.02199	0.37449	0.39648	559.0	629.6	1188.7	0.7592	0.6190	1.3783	554.5	1107.2
1100.0	556.28	0.02195	0.37863	0.40058	557.5	631.5	1189.1	0.7578	0.6216	1.3794	553.1	1107.5
1090.0	555.14	0.02192	0.38285	0.40476	556.1	633.4	1189.5	0.7564	0.6241	1.3805	551.7	1107.8
1080.0	554.00	0.02188	0.38714	0.40902	554.6	635.3	1189.9	0.7550	0.6266	1.3817	550.2	1108.1
1070.0	552.86	0.02184	0.39150	0.41335	553.1	637.1	1190.3	0.7536	0.6292	1.3828	548.8	1108.4
1060.0	551.70	0.02181	0.39594	0.41775	551.6	639.0	1190.7	0.7522	0.6318	1.3840	547.4	1108.7
1050.0	550.53	0.02177	0.40047	0.42224	550.1	640.9	1191.0	0.7507	0.6344	1.3851	545.9	1109.0
1040.0	549.36	0.02174	0.40507	0.42681	548.6	642.8	1191.4	0.7493	0.6370	1.3863	544.5	1109.3
1030.0	548.18	0.02170	0.40976	0.43146	547.1	644.7	1191.8	0.7478	0.6396	1.3874	543.0	1109.6
1020.0	546.99	0.02166	0.41454	0.43620	545.6	646.6	1192.2	0.7463	0.6423	1.3886	541.5	1109.9
1010.0	545.79	0.02163	0.41941	0.44103	544.1	648.5	1192.6	0.7449	0.6449	1.3898	540.0	1110.1
1000.0	544.58	0.02159	0.42436	0.44595	542.6	650.4	1192.9	0.7434	0.6476	1.3910	538.6	1110.4
990.0	543.36	0.02155	0.42942	0.45097	541.0	652.3	1193.3	0.7419	0.6503	1.3922	537.1	1110.7
980.0	542.14	0.02152	0.43457	0.45609	539.5	654.2	1193.7	0.7404	0.6530	1.3934	535.6	1111.0
970.0	540.90	0.02148	0.43982	0.46130	537.9	656.1	1194.0	0.7389	0.6557	1.3946	534.0	1111.2
960.0	539.65	0.02145	0.44518	0.46662	536.3	658.0	1194.4	0.7373	0.6584	1.3958	532.5	1111.5
950.0	538.39	0.02141	0.45064	0.47205	534.7	660.0	1194.7	0.7358	0.6612	1.3970	531.0	1111.7
940.0	537.13	0.02137	0.45621	0.47759	533.2	661.9	1195.1	0.7342	0.6640	1.3982	529.4	1112.0
930.0	535.85	0.02134	0.46190	0.48324	531.6	663.8	1195.4	0.7327	0.6668	1.3995	527.9	1112.2
920.0	534.56	0.02130	0.46770	0.48901	530.0	665.8	1195.7	0.7311	0.6696	1.4007	526.3	1112.5
910.0	533.26	0.02127	0.47363	0.49490	528.3	667.7	1196.1	0.7295	0.6724	1.4019	524.8	1112.7
900.0	531.95	0.02123	0.47968	0.50091	526.7	669.7	1196.4	0.7279	0.6753	1.4032	523.2	1113.0
890.0	530.63	0.02119	0.48586	0.50706	525.1	671.6	1196.7	0.7263	0.6782	1.4045	521.6	1113.2
880.0	529.30	0.02116	0.49218	0.51333	523.4	673.6	1197.0	0.7247	0.6811	1.4057	520.0	1113.4
870.0	527.96	0.02112	0.49863	0.51975	521.8	675.6	1197.3	0.7230	0.6840	1.4070	518.4	1113.7
860.0	526.60	0.02109	0.50522	0.52631	520.1	677.6	1197.7	0.7214	0.6869	1.4083	516.7	1113.9
850.0	525.24	0.02105	0.51197	0.53302	518.4	679.5	1198.0	0.7197	0.6899	1.4096	515.1	1114.1
840.0	523.86	0.02101	0.51886	0.53988	516.7	681.5	1198.2	0.7180	0.6929	1.4109	513.4	1114.3
830.0	522.46	0.02098	0.52592	0.54689	515.0	683.5	1198.5	0.7163	0.6959	1.4122	511.8	1114.5
820.0	521.06	0.02094	0.53314	0.55408	513.3	685.5	1198.8	0.7146	0.6990	1.4136	510.1	1114.8
810.0	519.64	0.02091	0.54052	0.56143	511.6	687.6	1199.1	0.7129	0.7020	1.4149	508.4	1115.0
800.0	518.21	0.02087	0.54809	0.56896	509.8	689.6	1199.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 2. Properties of Saturated Steam and Saturated Water (Pressure)

Press. psia	Temp. F	Volume, ft³/lbm Water v_f	Evap. v_{fg}	Steam v_g	Enthalpy, Btu/lbm Water h_f	Evap. h_{fg}	Steam h_g	Entropy, Btu/lbm × R Water s_f	Evap. s_{fg}	Steam s_g	Energy, Btu/lbm Water u_f	Steam u_g
200.0	381.80	0.01839	2.2689	2.2873	355.5	842.8	1198.3	0.5438	1.0016	1.5454	354.8	1113.7
198.0	380.96	0.01838	2.2912	2.3095	354.6	843.6	1198.2	0.5428	1.0035	1.5463	353.9	1113.6
196.0	380.12	0.01836	2.3139	2.3322	353.7	844.4	1198.1	0.5417	1.0054	1.5471	353.0	1113.5
194.0	379.26	0.01835	2.3370	2.3554	352.8	845.1	1197.9	0.5406	1.0074	1.5480	352.1	1113.4
192.0	378.40	0.01834	2.3606	2.3790	351.9	845.9	1197.8	0.5395	1.0094	1.5489	351.2	1113.2
190.0	377.53	0.01833	2.3847	2.4030	350.9	846.7	1197.6	0.5384	1.0113	1.5498	350.3	1113.1
188.0	376.65	0.01832	2.4093	2.4276	350.0	847.5	1197.5	0.5373	1.0133	1.5507	349.4	1113.0
186.0	375.77	0.01831	2.4344	2.4527	349.1	848.3	1197.3	0.5362	1.0153	1.5516	348.4	1112.9
184.0	374.88	0.01830	2.4600	2.4783	348.1	849.1	1197.2	0.5351	1.0174	1.5525	347.5	1112.8
182.0	373.98	0.01828	2.4862	2.5045	347.2	849.9	1197.0	0.5339	1.0194	1.5534	346.5	1112.7
180.0	373.08	0.01827	2.5129	2.5312	346.2	850.7	1196.9	0.5328	1.0215	1.5543	345.6	1112.5
178.0	372.16	0.01826	2.5402	2.5585	345.2	851.5	1196.7	0.5316	1.0236	1.5552	344.6	1112.4
176.0	371.24	0.01825	2.5681	2.5864	344.2	852.3	1196.5	0.5305	1.0257	1.5562	343.6	1112.3
174.0	370.31	0.01824	2.5966	2.6149	343.2	853.1	1196.4	0.5293	1.0279	1.5571	342.7	1112.2
172.0	369.37	0.01823	2.6258	2.6440	342.2	853.9	1196.2	0.5281	1.0300	1.5581	341.7	1112.0
170.0	368.42	0.01821	2.6556	2.6738	341.2	854.8	1196.0	0.5269	1.0322	1.5591	340.7	1111.9
168.0	367.47	0.01820	2.6861	2.7043	340.2	855.6	1195.8	0.5256	1.0344	1.5601	339.7	1111.8
166.0	366.50	0.01819	2.7173	2.7355	339.2	856.5	1195.7	0.5244	1.0367	1.5611	338.6	1111.6
164.0	365.53	0.01818	2.7493	2.7674	338.2	857.3	1195.5	0.5232	1.0389	1.5621	337.6	1111.5
162.0	364.54	0.01817	2.7820	2.8001	337.1	858.2	1195.3	0.5219	1.0412	1.5631	336.6	1111.3
160.0	363.55	0.01815	2.8155	2.8336	336.1	859.0	1195.1	0.5206	1.0435	1.5641	335.5	1111.2
158.0	362.55	0.01814	2.8498	2.8679	335.0	859.9	1194.9	0.5194	1.0458	1.5652	334.5	1111.0
156.0	361.53	0.01813	2.8849	2.9031	333.9	860.8	1194.7	0.5181	1.0482	1.5662	333.4	1110.9
154.0	360.51	0.01812	2.9210	2.9391	332.8	861.6	1194.5	0.5168	1.0506	1.5673	332.3	1110.7
152.0	359.48	0.01810	2.9579	2.9760	331.8	862.5	1194.3	0.5154	1.0530	1.5684	331.2	1110.6
150.0	358.43	0.01809	2.9958	3.0139	330.6	863.4	1194.1	0.5141	1.0554	1.5695	330.1	1110.4
149.0	357.91	0.01808	3.0151	3.0332	330.1	863.9	1194.0	0.5134	1.0566	1.5700	329.6	1110.3
148.0	357.38	0.01808	3.0347	3.0528	329.5	864.3	1193.9	0.5127	1.0579	1.5706	329.0	1110.3
147.0	356.84	0.01807	3.0545	3.0726	329.0	864.8	1193.8	0.5120	1.0591	1.5712	328.5	1110.2
146.0	356.31	0.01806	3.0746	3.0927	328.4	865.2	1193.6	0.5114	1.0604	1.5717	327.9	1110.1
145.0	355.77	0.01806	3.0950	3.1130	327.8	865.7	1193.5	0.5107	1.0616	1.5723	327.4	1110.0
144.0	355.23	0.01805	3.1156	3.1337	327.3	866.2	1193.4	0.5100	1.0629	1.5729	326.8	1109.9
143.0	354.69	0.01805	3.1365	3.1546	326.7	866.6	1193.3	0.5093	1.0642	1.5734	326.2	1109.8
142.0	354.14	0.01804	3.1577	3.1757	326.1	867.1	1193.2	0.5086	1.0655	1.5740	325.6	1109.7
141.0	353.59	0.01803	3.1792	3.1972	325.5	867.5	1193.1	0.5079	1.0668	1.5746	325.1	1109.7
140.0	353.04	0.01803	3.2010	3.2190	325.0	868.0	1193.0	0.5071	1.0681	1.5752	324.5	1109.6
139.0	352.48	0.01802	3.2230	3.2411	324.4	868.5	1192.8	0.5064	1.0694	1.5758	323.9	1109.5
138.0	351.92	0.01801	3.2454	3.2634	323.8	868.9	1192.7	0.5057	1.0707	1.5764	323.3	1109.4
137.0	351.36	0.01801	3.2681	3.2861	323.2	869.4	1192.6	0.5050	1.0720	1.5770	322.7	1109.3
136.0	350.79	0.01800	3.2912	3.3091	322.6	869.9	1192.5	0.5043	1.0733	1.5776	322.1	1109.2
135.0	350.23	0.01799	3.3145	3.3325	322.0	870.4	1192.4	0.5035	1.0747	1.5782	321.5	1109.1
134.0	349.65	0.01799	3.3382	3.3562	321.4	870.8	1192.2	0.5028	1.0760	1.5788	320.9	1109.0
133.0	349.08	0.01798	3.3622	3.3802	320.8	871.3	1192.1	0.5020	1.0774	1.5794	320.3	1108.9
132.0	348.50	0.01797	3.3866	3.4046	320.2	871.8	1192.0	0.5013	1.0788	1.5800	319.7	1108.8
131.0	347.92	0.01797	3.4113	3.4293	319.6	872.3	1191.9	0.5005	1.0801	1.5807	319.1	1108.7
130.0	347.33	0.01796	3.4364	3.4544	319.0	872.8	1191.7	0.4998	1.0815	1.5813	318.5	1108.6
129.0	346.74	0.01795	3.4619	3.4799	318.3	873.3	1191.6	0.4990	1.0829	1.5819	317.9	1108.5
128.0	346.15	0.01794	3.4878	3.5057	317.7	873.8	1191.5	0.4982	1.0843	1.5826	317.3	1108.4
127.0	345.55	0.01794	3.5141	3.5320	317.1	874.3	1191.3	0.4975	1.0858	1.5832	316.7	1108.3
126.0	344.95	0.01793	3.5407	3.5586	316.4	874.8	1191.2	0.4967	1.0872	1.5839	316.0	1108.2
125.0	344.35	0.01792	3.5678	3.5857	315.8	875.3	1191.1	0.4959	1.0886	1.5845	315.4	1108.1
124.0	343.74	0.01792	3.5953	3.6132	315.2	875.8	1190.9	0.4951	1.0901	1.5852	314.8	1108.0
123.0	343.13	0.01791	3.6232	3.6411	314.5	876.3	1190.8	0.4943	1.0915	1.5858	314.1	1107.9
122.0	342.51	0.01790	3.6516	3.6695	313.9	876.8	1190.7	0.4935	1.0930	1.5865	313.5	1107.8
121.0	341.89	0.01790	3.6804	3.6983	313.2	877.3	1190.5	0.4927	1.0945	1.5872	312.8	1107.7
120.0	341.27	0.01789	3.7097	3.7275	312.6	877.8	1190.4	0.4919	1.0960	1.5879	312.2	1107.6
119.0	340.64	0.01788	3.7394	3.7573	311.9	878.3	1190.2	0.4911	1.0975	1.5885	311.5	1107.5
118.0	340.01	0.01787	3.7697	3.7875	311.3	878.8	1190.1	0.4903	1.0990	1.5892	310.9	1107.4
117.0	339.37	0.01787	3.8004	3.8183	310.6	879.3	1189.9	0.4894	1.1005	1.5899	310.2	1107.3
116.0	338.73	0.01786	3.8316	3.8495	309.9	879.9	1189.8	0.4886	1.1021	1.5906	309.5	1107.2
115.0	338.09	0.01785	3.8634	3.8813	309.3	880.4	1189.6	0.4877	1.1036	1.5913	308.9	1107.0
114.0	337.43	0.01785	3.8957	3.9136	308.6	880.9	1189.5	0.4869	1.1052	1.5921	308.2	1106.9
113.0	336.78	0.01784	3.9286	3.9464	307.9	881.4	1189.3	0.4860	1.1067	1.5928	307.5	1106.8
112.0	336.12	0.01783	3.9620	3.9799	307.2	882.0	1189.2	0.4852	1.1083	1.5935	306.8	1106.7
111.0	335.46	0.01782	3.9960	4.0138	306.5	882.5	1189.0	0.4843	1.1099	1.5942	306.1	1106.6
110.0	334.79	0.01782	4.0306	4.0484	305.8	883.1	1188.9	0.4834	1.1115	1.5950	305.4	1106.5
109.0	334.11	0.01781	4.0658	4.0837	305.1	883.6	1188.7	0.4826	1.1132	1.5957	304.7	1106.3
108.0	333.44	0.01780	4.1017	4.1195	304.4	884.1	1188.5	0.4817	1.1148	1.5965	304.0	1106.2
107.0	332.75	0.01779	4.1382	4.1560	303.7	884.7	1188.4	0.4808	1.1165	1.5972	303.3	1106.1
106.0	332.06	0.01779	4.1753	4.1931	303.0	885.2	1188.2	0.4799	1.1181	1.5980	302.6	1106.0
105.0	331.37	0.01778	4.2132	4.2309	302.2	885.8	1188.0	0.4790	1.1198	1.5988	301.9	1105.8
104.0	330.67	0.01777	4.2517	4.2695	301.5	886.4	1187.9	0.4780	1.1215	1.5995	301.2	1105.7
103.0	329.97	0.01776	4.2910	4.3087	300.8	886.9	1187.7	0.4771	1.1232	1.6003	300.4	1105.6
102.0	329.26	0.01776	4.3310	4.3487	300.0	887.5	1187.5	0.4762	1.1249	1.6011	299.7	1105.4
101.0	328.54	0.01775	4.3717	4.3895	299.3	888.1	1187.3	0.4752	1.1267	1.6019	299.0	1105.3
100.0	327.82	0.01774	4.4133	4.4310	298.5	888.6	1187.2	0.4743	1.1284	1.6027	298.2	1105.2

MASTER COPY

Section 1 Answers - Principles of Nuclear Power Plant Operations, Thermodynamics, Heat Transfer and Fluid Flow.

1.01 a. Keff decreases due to fission product buildup (0.5) and fuel burnup (0.5).

b. Burnable poison is burning out (0.5) and Pu-239 is building in (0.5).

Reference: Standard Nuclear Principles

1.02 (a) Reactor critical on prompt neutrons alone. (0.5)

(b) Time in seconds required for power to change by factor of 'e'. (0.5)

(c) The multiplication of neutrons by the fuel in a subcritical reactor. [illegible] (0.5)

Reference: Standard Nuclear Principles

1.03 (c) (1.0)

Reference: Standard Nuclear Principles

1.04 (b) (1.0)

Reference: Standard Nuclear Principles

1.05 (b) (1.0)

Reference: Standard Thermo-Hydraulic Principles

1.06 (c) (1.0)

Reference: Standard Nuclear Principles

1.07 (c) (1.0)

Reference: Standard Thermodynamic and Fluid Flow Principles

1.08 (d) (1.0)

Reference: Standard Thermal Hydraulic Principles and Applications

1.09 (b) (1.0)

Reference: Standard Nuclear Principles

1.10 (d) (1.0)

Reference: Standard Doppler Coefficient Principles

1.11 (a) (1.0)

Reference: Standard Nuclear Principles

1.12 Increase in pump flow due to loss of backpressure. (0.5)
The increased flow causes the motor to draw more current and possibly damage the motor winding. (0.5)

Reference: Dresden Heat Transfer and Fluid Flow

1.13 a. Pressure due to water column (0.5)

b. Pressure as measured in the steam dome (0.5)

c. Pressure loss due to irreversible flow losses (friction) (0.5)

d. Temperature will also be accepted.

Reference: GE Manual, Section 7, pages 94-96

1.14 a. tau === 130 sec. Lambda-eff Delta-k/k .1(.0005) (0.5)

b. P = P o e t /tau implies 10 = e t/130 implies in 10 = t/130 implies t = 130 in 10 = 299 sec. (0.5)

c. tau === 60 sec. .1(.0001) .0001 (0.5)

Reference: GE Reactor Theory, page 11 and 12

1.15 a. Neutrons produced indirectly from the fission process. They are born from the decay of the fission programs or delayed neutron precursors. (0.5)

b. BOC .0072 (.010) EOC .0056 (.010) (0.5)

c. The . Pu-239 has a Beta of .0002 and Pu-239 accounts for 30% of all fissions at the EOC. The EOC value is a weighted average of P239 and U235 fractions and 1 smaller than BOC because Beta Pu-239 is smaller than Beta U238. (1.0)

Reference: Q&A Bank Reactor Theory Section

1.16 a. As the reactor operates at power, Xenon builds into equilibrium, adding negative reactivity, causing power to decrease. (0.5)

b. A rod withdrawal from a high power region will cause a power increase in the adjacent fuel rods because of being closer to thermal limit and therefore cause damage. (1.0)

Reference: Dresden General Physics BWR RX Theory

1.17 a. a Decreases (0.5)
b Decreases (0.5)
c Decreases (0.5)
d Decreases (0.5)

b. 1. MAPRAT is the ratio of APLGHR TO Limit APLHGR OR the ratio of APLHGR (act) to MAPLHGR (LCO) (0.5)

2. NO (.25)

3. The clad temperature can exceed 2200 degrees F. during a DBA LOCA (.75)

Reference: HT&FF, page 16 & 17, GE Thermodynamics, HT&FF, pages 9-85, to 9-89

1.18 Photo-neutron source (Naturally occuring deuterium and fission or decay gammas react to form hydrogen and a neutron). (0.5)

Spontaneous fission (Uranium, plutonium and curium undergo spontaneous fission. Curium is the most significant producer of neutrons). (0.5)

Alpha-neutron reactions (Oxygen-18 is uranium oxide fuel reacts with an alpha particle to produce a neutron). (0.5)

Reference: Theory Review, page 28 & 30

END OF SECTION 1

Section 2 Answers

2.01 a. Flow control valve would close (0.5)

b. Scram valves would open under spring pressure and control rods would be inserted. (0.5)

c. Instrument volume vent and drain valves would close. (0.5)

d. Main feed pump minimum flow valve would open. (0.5)

e. Both the main feed regulation valves would fail as is. (0.5)

Reference: Instrument Air LP, Rev. 3, page 14.15

2.02 a. Standby FRP must be selected

b. Suction press must be greater than 120 (+/-2) psig

c. Vent fan must be on

d. Oil press must be greater than 20 (+/-2) psig

(4 @ 0.5 ea + 2 s.p. @ 0.5 ea)

Reference: Dresden Cond & Feed Lesson Plan Table 2

2.03 a. Will inject (0.25). Turbine seal leakage resulting in potential airborne activity in the HPCI room (0.75). (1.0)

b. Will not inject (0.25). Turbine stop and control valves will not open (0.75). (1.0)

c. Will inject (0.25). Pump overheating and seal damage may result during low or no flow conditions (0.75). (1.0)

d. Will not inject (0.25). Maximum signal from the flow element will cause the controller to keep turbine speed at minimum (0.75). (1.0)

Reference: Dresden HPCI Lesson Plan

2.04 a. Either: Internal damage to mechanism or rod will scram slowly on seal leakage. (1.0)

b. High temperatures in the CRD; inability to move the rod; discharge of scram accumulators (2 required). (2.0)

c. Either crud buildup in the recirc. pump seals or reduced seal lifetime. (1.0)

Reference: CRD Hydraulic Lesson Plan

2.05 a. The CRDM separates from the control rod blade. (0.5)

b. The drive mechanism is withdrawn. (0.5)

c. The blade sticks in the core and does not follow the drive mechanism. (0.5)

d. The blade then breaks free and drops to the position of the drive mechanism, thus rapidly inserting reactivity and generating heat in the fuel. (0.5)

Reference: Dresden RWMS Lesson Plan, page 2

2.06 a. Low flow through an operating fan (will accept) any one butterfly damper is closed.

b. A group II isolation.

c. R.B. exhaust or refueling floor high radiation.

d. Low voltage on a bus.

e. Abnormal reactor building air pressure.

f. R. B. exhaust high radiation.

(Any 4 @ 0.5 ea)

Reference: Dresden RB Vent Sys Lesson Plan, page 7

2.07 a. False (0.5)
b. True (0.5)
c. False (0.5)
d. True (0.5)

Reference: Fire Protection L.P., Rev. 7, pages 3, 7, 12, 16, 17

2.08 a. Clean, demineralized water system (0.5)
Condensate transfer system (0.5)
Fire protection/service water system (0.5)

b. Valve (1301-3) is open.

Reactor pressure is 10% psig after 15 second time delay:

A group I isolation signal is present.

A group V isolation signal is present .

(Any 3 @ 0.5 ea)

Reference: Isolation Condenser L.P., page 3 & 4

2.09 a. Increase (0.5)
b. Increase (0.5)
c. Decrease (0.5)
d. Increase (0.5)
e. Increase (0.5)

Reference: BWR Training Center, Morris Book 1, Lesson Plan #4, pages 6-13

END OF SECTION 2

Section 3 Answers

3.01 a. By monitoring the differential pressure (0.5) across each recirc pump (0.5) for a 2 psig or greater dp, indicating the pump is running (0.5).

b. By comparing the pressure in the riser pipes on one recirc loop with the pressure in the riser pipes of the other loop. The undamaged loop will have a higher pressure than the damaged loop. (1.5)

c. Loop B (0.5)

Reference: LPCI LP, Rev. 5, page 15

3.02 . An off-gas high-high radiation in the 15 minute holdup volume.* (0.5) Both detectors > high-high (0.5) or one > high-high and the other downscale (0.5) starts a 15 minute time delay (0.5).

Reference: Dresden Off-Gas Sys Lesson Plan, page 13-14

3.03 As the maximum combined flow decreases below 100%, the control valves will start to close and the bypass valves will remain closed (1.0). As the control valves continue to close, reactor pressure increases (0.5). The reactor will scram on high flux - high pressure (0.5). Reactor pressure will continue to increase until the safety/relief valves lift and then reseat (0.5). The isolation condenser will initiate (0.5). The final steady state conditions will be the reactor shutdown and pressure maintained with the isolation condenser (1.0).

Reference: Dresden EHC Lesson Plan.

3.04 Automatically bypasses both the RBM channels. (0.5)

Reference: Dresden RBM Lesson Plan, page 6

3.05 a. RBMs
b. APRMs (if assigned to APRM)
c. The process computer
d. Full core display
e. 902-37 back panel meters.

(Any 4 @ .05 ea)

Reference: Dresden Lesson Flan LPRM, page 18

3.06 a. Prevents the MG set and the reserve power source from simultaneously supplying a RPS bus. (0.5)

b. Prevents selecting the reserve power supply to more than one RPS bus. (0.5)

Reference: Dresden Lesson Plan RPS

3.07 a. rod block (0.5)

b. ~~half-scram~~ no reactor protection action (0.5)

c. rod block (0.5)

d. no reactor protection system action (0.5)

Reference: Dresden Lesson Plan RPS, APRM Systems

3.08 a. A lower argon pressure (0.5)

b. Less total U^{235} in the U_3O_6 coating (0.5)

c. Reduced detector operating voltage (0.5)

Reference: Dresden Lesson Plan IRM

3.09 a. Self-actuation on high pressure (0.5)

b. Pilot actuation on ADS signal (0.5)

c. Pressure relief function (0.5)

Reference: Dresden Lesson Plan ADS

3.10 a. Feedwater level control system (0.5)

b. ECCS control circuitry
Reactor Protection System
Isolation condenser control circuit
Safety/relief and electromatic relief valve controls
(Any 4 @ 0.5 ea)

c. Jet pump flow will cause level to indicate higher than actual (0.5)

Reference: Dresden Nuclear Boiler Instrumentation Lesson Plan, page 12 & 23

3.11 a. Bypasses all interlocks to insert the rod except the rod worth minimizer insert block and any select block. (0.5)

b. Bypassing the timer. (0.5)

c. No settle function. (0.5)

Reference: Dresden RMCS Lesson Plan, page 7

3.12 a.	Speed Signal Failure	3.	Less than 1.0 ma output from function generator	(0.5)
b.	Incomplete Sequence Trip	1.	Below 4 psid, 28 sec. after start	(0.5)
c.	Recirc Pump Low Differential Pressure	4.	Below 4 psid	(0.5)
d.	Recirc Pump Locked Rotor Trip	5.	Below 4 psid, 30 sec. after start	(0.5)
e.	Recirc Loop Flow Limit	2.	Feedwater Flow below 20% or discharge valve not full open	(0.5)

Reference: Dresden Ricirc flow control lesson plan - page 15

END OF SECTION 3

Section 4 Answers

4.01 a. Complete Emergency Systems checklist (Appendix A) (0.5)

b. Review the previous shifts Daily Surveillance sheets. Verify results as logged are within Technical Specification limits. (0.5)

c. Review the NSO's log from the last date on shift or for the preceding four (4) days whichever is less. (0.5)

d. Review Night Orders and Degraded Equipment Log. (0.5)

e. Compete the NSO's turnover checklist for the on-coming NSO (Appendix A) (0.5)

Reference: Dresden Operating Orders DAP 7-2, pages 2 & 3

4.02 a. Attempt to restore RBCCW flow. (0.5)

b. If RBCCW flow is lost and cannot be restored within one minute, TRIP Recirculation Pumps A and B. (0.5)

c. Verify that a reactor scram occurs when drywell pressure reaches +2 psig (0.5) or MANUALLY SCRAM the reactor if equipment damage appears imminent (0.5). ~~(0.5)~~

Reference: Dresden DOA 3700-1, Page 1, RBCCW

4.03 a. Slow

b. Fast (clockwise)

c. Incoming

d. Higher

e. Running

(5 @ 0.5 ea)

Reference: Dresden DGP 1-1, page 19 of 26 steps 5.1 and 5.m

4.04 a. An area where you could receive > 100 mrem in one hour (1.0)

b. A weighted half-life of a radioactive material which takes into account the decay characteristic (physical half-life) of the material and retention of the material within the body (biological half-life). (1.0)

c. 3.7 x 10 to the 10 power disintegrations/sec. (1.0)

d. Measure of dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of 1 roengten of x-rays. (1.0)

Reference: 10 CFR 20

4.05 a. 25 rems (0.5)

b. 75 rems (0.5)

Reference: Dresden Radiation Protection Standards, page 26

4.06 a. Manually scram the reactor (0.5)

b. Verify all rods in (0.5)

c. Leave the Mode Switch in Run (0.5)

d. Trip the Control Rod Drive pump (0.5)

e. Trip the turbine (0.5)

Reference: Dresden EPIP 200-20, page 1

4.07 a. 1. Scram the reactor manually by depressing both manual trip buttons.

2. Trip both A and B Reactor Recirculation MG Sets.

3. Place the Mode Switch to Shutdown.

4. Monitor nuclear instrumentation for decreasing neutron flux and local areas of high reactivity.

5. Trip hydrogen addition (Unit 2 only)

(5 @ 0.40 ea)

b. If either two (2) or more adjacent rods are not inserted past the 06 position OR thirty (30) or more rods are not inserted past the 06 position AND if reactor water level cannot be maintained OR suppression pool water temperature cannot be maintained below 110°F. (1.0)

c. 1. Amber pilot of Squib firing continuity circuit not lit

2. Flow Indication Pilot Light lit

3. Water clean-up system isolation

4. Decreasing level of Standby Liquid Storage Tank

5. Standby Liquid Squib Valve Circuit Fail Annunciator Light lit

6. Pump discharge pressure increases

(5 @ 0.40 ea)

Reference: Dresden DGA 18, page 7, DOP 1100-2, page 1 of 3 and 3 of 3
SBLC Lesson Plan, page 14

4.08. a. Verify that the Main Steam Bypass Valves are controlling reactor pressure. MONITOR reactor pressure by multiple indications. (0.5)

b. VERIFY that the Reactor SCRAMS when reactor pressure reaches 1060 psig. Follow the Unit 2/3 Reactor Scram procedure, DGP 2-3. (0.5)

c. VERIFY that Relief Valves OPEN when relief valve setpoints are reached. (0.5)

d. VERIFY isolation condenser initiation if reactor pressure remains greater than 1070 psig for longer than 15 seconds. (0.5)

e. VERIFY that A and B Recirculation M.G. Set Field Breakers TRIP if reactor pressure reaches 1240 psig. (0.5)

Reference: Dresden DGA-6, page 1 & 2, Reactor High Pressure

4.09 d. 40% power (0.5)

b. 35% power (0.5)

f. Convenient time below 200 MWE (0.5)

a. 2 x 10 E+6 lbm/hr feed flow or 20% (0.5)

c. Feedwater total flow is less than or equal to 10% of rated (0.5)

e. Reactor power is between 5% and 10% (0.5)
(Items f and a may be reversed)

Reference: Dresden DGP 2-1 page 4 of 13 thru 10 of 13

END OF SECTION 4

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

Examiner's Copy

FACILITY: Dresden 2-3

REACTOR TYPE: BWR-3

DATE ADMINISTERED: June 10, 1985

EXAMINER: McMillen/Lang

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%.

Category Value	% Of Total	Applicant's Score	% Of Category Value	Category
24	24.1	____	____	5. Theory of Nuclear Power Plant Operation, Fluids, and Thermodynamics
25	25.3	____	____	6. Plant Systems Design, Control, and Instrumentation
25	25.3	____	____	7. Procedures - Normal, Abnormal, Emergency, and Radiological Control
25	25.3	____	____	8. Administrative Procedures, Conditions, and Limitations
100	100	____	____	TOTALS

Final Grade ________%

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

____

Applicant's Signature

5. Theory of Nuclear Power Plant Operations, Fluids and Thermodynamics

5.1 The change in reactivity associated with a change in Keff from 0.920 to 1.004 is approximately: (1.0)

a. 0.091
b. 0.084
c. 0.087
d. 0.080

5.2 Which of the following is NOT a characteristic of subcritical multiplication. (1.0)

a. For equal reactivity additions, it takes longer for the equilibrium subcritical multiplication level to be reached as Keff approaches unity.

b. If the reactor is shutdown long enough, the source range instruments will lose their ability to determine the subcritical multiplication level even though the core may still be at the middle of life.

c. If 2 notches of rod withdrawal increases the subcritical multiplication level by 10 cps, then 4 notches or rod withdrawal will increase the subcritical multiplication level by approximately 20 cps.

d. Doubling the indicated count rate by reactivity additions will reduce the margin to critical by approximately one half.

5.3. Which reactivity coefficient is the most dominant when pulling rods in startup and 150°F. (1.0)

a. Pressure coefficient
b. Moderator coefficient
c. Doppler coefficient
d. Void coefficient

5.4 The highest internal stresses placed on a pressurized system boundary such as reactor vessel is: (1.0)

a. on the thickest components during a heatup
b. on the thinnest components during a heatup
c. on the thinnest components during a cooldown
d. ~~on the thinnest components during a cooldown~~ thickest

5.5 The need to change the RTNDT of the reactor vessel over the life of the plant is the result of: (1.0)

a. thermal cycles (heatup and cooldown transients)
b. pressure cycles (changes in pressure)
c. gamma radiation
d. neutron radiation

5.6 During a design basis accident of a loss of coolant, the thermal limit that protects the fuel is (1.0)

a. LHGR
b. APLGHR HG
c. MAFLHGOR
d. MCPR

5.7 The quality of steam to the turbine refers to: (1.0)

a. the ratio of the vapor mass to the sum of the liquid and vapor masses.

b. the ratio of the liquid mass to the sum of the liquid and vapor masses.

c. the ratio of the liquid mass to the vapor mass.

d. the ratio of the vapor mass to the liquid mass.

5.8 Which of the following statements describes the effect the magnitude of the initial level of source range counts would have on critical rod position and the power level (count rate) at criticality: (1.0)

a. The critical rod position would not be affected by the source range count rate and the power level (count rate) when criticality is reached would be higher.

b. The critical rod position would be lower since the source range count rate is higher and the power level (count rate) when criticality is reached would be higher.

c. The critical rod position would be lower since the source range count rate is higher and the power level (count rate) when criticality is reached would be lower.

d. The critical rod position would not be affected by the source range count rate and the power level (count rate) when criticality is reached would be lower.

5.9 Which of the following statements describes the reason for the change in critical power as the reactor pressure increases from 800 to 1100 psi. (1.0)

a. a decrease in local quality occurs which causes the margin between actual and critical qualities to increase and thus power increases.

b. Steam bubbles increase in quantity and collect more readily at the heat transfer surface, thus making the transition between nucleate and film boiling easier.

c. Local quality decreases along the boiling length and thus a greater critical power is necessary to drive quality up to the critical limit.

d. Boiling length decreases so the voids are formed lower in the core and thus the critical quality is greater lower in the core and transition boilings occurs at a point below the midpoint of the core.

5.10 EXPLAIN or DEFINE the following terms:

a. Prompt Critical (0.5)
b. Reactor Period (0.5)
c. Subcritical Multiplication (0.5)

5.11 (Assume 100% power) Then reactor power is reduced by driving rods. The recirculation pump speed remains constant. Core flow changes because of the actions taken. Choose the proper reason for the core flow change. (1.0)

a. Flow will decrease because of an increase in two phase flow conditions.

b. Flow will increase due to the increased natural circulation

c. Flow will increase because of a reduction in two phase flow conditions.

d. Flow will increase because of an increase in two-phase flow conditions.

5.12 The MAPLHGR curve increases early core life and as exposure increases the limit begins to increase at a decreasing rate and then decreases. Choose the condition that is NOT responsible for this: (1.0)

a. Burnable poison depletion
b. Fission gas build-up
c. Local peaking factors
d. Reduced heat transfer rate

5.13 Which of the following statements is correct concerning control rod worth? (1.0)

a. It is proportional to reactor power

b. It is lower in regions of higher relative neutron flux

c. It is proportional to rod speed

d. It is higher in regions of higher relative neutron flux

5.14 Regarding MCPR (Minimum Critical Power Ratio):

a. What PHENOMENON could exist if a fuel bundle were operated at a MCPR LESS THAN ONE and WHAT would very likely be the CONSEQUENCE of the phenomenon? (1.0)

b. WHY must the Technical Specification MCPR limit include a 'K' factor when core flow is LESS THAN RATED? (1.0)

c. HOW is the margin to MCPR changed (INCREASES, DECREASES, or REMAINS CONSTANT) when inlet sub-cooling decreases? (0.5)

5.15 Which of the following radioactive isotopic found in the reactor coolant would not indicate a leak through the fuel cladding? (1.0)

a. I-131
b. Xe 133
c. Co-60
d. Kr-85

5.16 A moderator is necessary to slow neutrons down to thermal energies. Which of the following is the most correct reason for operating with thermal instead of fast neutrons. (1.0)

a. Increased neutron efficiency since thermal neutrons are less likely to leak out of the core than fast neutrons.

b. Reactors operating primarily on fast neutrons are inherently unstable and have a higher risk of going prompt critical.

c. The fission cross section of the fuel is much higher for thermal neutrons than for fast neutrons.

d. Doppler and moderator temperature coefficients become positive as neutron energy increases.

5.17 Which of the following statements best describes the condition known as "condensate depression?" (1.0)

a. Can lead to condensate pump cavitation of condensate depression is too great.

b. Decreases as hotwell level rises.

c. Reduces Rankins cycle efficiency.

d. Increases as condensate temperature increases.

5.18 Which of the following statements most correctly completes the following sentence? Departure from nucleate boiling is the point where: (1.0)

a. Void fraction equals one

b. The heat transfer mechanism changes from nucleate boiling to single phase convection.

c. Radiative heat transfer becomes insignificant.

d. The heat transfer rate sustainable with nucleate boiling reaches its maximum.

5.19 Which of the following is <u>NOT</u> correct concerning decay heat? (1.0)

a. Is the heat produced by the energy released from the radioactive decay of fission products.

b. Can be determined by the reading on the SRM's when the reactor is shutdown.

c. Is approximately 6% of the total energy released from fission.

d. Is still a significant contributor to the energy in the reactor core for approximately two hours after the reactor has been shutdown.

5.20 Figure 1.21 is a representation of how the resonance peaks of U-238 "flatten out" or Doppler broaden as fuel temperature increases. Which of the following are the correct labels for the X and Y axes? (1.0)

a. X is neutron flux; X is interaction rate

b. X is neutron energy; Y is microscopic capture cross section

c. X is atom density of U-238; Y is neutron flux

d. X is interaction rate; Y is neutron density.

5.21 The ratio of Pu-239 and Pu-240 atoms to U-235 atoms changes over core life. Which of the pairs of parameters listed below are most affected by this change? (1.0)

a. Moderator temperature coefficient and Doppler coefficient

b. Doppler coefficient and beta

c. Beta and moderator coefficient

d. Moderator temperature coefficient and neutron generation time.

5.22 Prior to startup (all rods in) the SRM countrate is 20CPS and K effective in 0.96. If the control rods are pulled to give a delta K of ±0.035, what count rate on the SRM's could be expected when the period becomes infinite? (1.0)

a. 40
b. 160
c. 80
d. 120

5.24 Referring to the attached curve (Fig. 1), which of the following regions on the curve is associated with the heat transfer mechanism known as "transition boiling?"

END OF CATEGORY 5

6. Plant Systems Design, Control and Instrumentation

6.1 a. An operator is driving in a control rod. Explain WHY during motion of the drive mechanism there is no cooling water reaching the drive mechanism. (1.5)

b. Indicate whether the following statements are TRUE or FALSE.

Reword for next exam.

1. There are two pairs of Alternate Rod Insertion (ARI) Valves located on the Scram dump valve air supply and upstream of the backup scram valves. (0.75)

2. Depressing both of the pushbuttons on one side of the rod select matrix will energize either the "A" group or the "B" group ARI valves. (0.75)

6.2 With regard to the ADS system:

a. What is the initiation logic? (setpoints required) (1.0)

b. What is the source of power to the relief valve solenoids? (0.5)

c. Why can't the ADS valves operate at less than 150 psig? (0.5)

6.3 For each of the HPCI system component failures listed below, STATE WHETHER OR NOT HPCI WILL AUTO INJECT into the reactor vessel; IF IT WILL NOT INJECT, WHY, and, IF IT WILL INJECT, provide ONE POTENTIAL ADVERSE EFFECT OR CONSEQUENCE of system operation with the failed component. Assume NO OPERATOR ACTION and the component is in the failed condition at the time HPCI receives the auto initiating signal.

a. The Gland Seal Exhauster Vacuum Pump fails to operate (1.0)

b. The Turbine Auxiliary Lube Oil Pump fails to operate (1.0)

c. The Minimum Flow Valve fails to auto open (stays shut) when systems conditions require it to be open. (1.0)

d. The HPCI pump Discharge Flow Element output signal to the HPCI flow controller is failed at its maximum output. (1.0)

6.4. Answer the following questions regarding the LPCI loop select logic.

a. How does the logic determine how many recirculation pumps are running? (Include setpoints where applicable). (1.5)

b. How does the logic determine which recirculation loop is UNDAMAGED? (1.5)

c. If the logic determines that neither loop is damaged, which loop will it select for LPCI injection? (0.5)

6.5 Describe the control action of the recirculation flow control system, if both recirculation pumps were operating at 50% when an operator closes the discharge valve on the "B" recirculation pump. (Assume the discharge bypass valve is open). (2.5)

6.6 a. What are three sources of makeup water to the shell side of the Isolation Condenser? (1.5)

b. What is the relationalship of the Isolation Condenser to the 480VAC Bus 28 and 29? (0.5)

c. How long can the isolation condenser operate without shellside makeup if the minimum level requirement was met? (0.5)

6.7 If a complete loss of instrument air where to occur with the plant operating at full power and no operator action, what would be the affect on the following components (Limit your answers to affects caused in relation to instrument air only).

a. CRD Hydraulic flow control valve (0.5)
b. CRD Hydraulic scram valves (0.5)
c. CRD Hydraulic instrument volume (0.5)
d. Main Feed pump minimum flow valve (0.5)
e. Main Feed Regulating valve (0.5)

6.8 State whether each of the following statements about the AC electrical distribution system are True or False.

a. The Unit 2 auxiliary transformer (TR-21) will lockout following a main generator trip. (0.5)

b. During normal operation with the main generator synchronized to the grid, Buses (22 and 24) are normally powered from reserve auxiliary transformer TR-22. (0.5)

c. There is no automatic transfer feature on RPS A. (0.5)

d. Reactor Feed Pump 2A is powered by the 4.16 KV Bus 21. (0.5)

6.9 The electrical portion of the Feedwater Level Control System is a GE/MAC. Discuss how the vessel level instrument implements the logic of a GE/MAC controller by answering the following questions:

a. A full range deflection of the vessel level input signal produces an output from 10-50 ma. Why is a 10 ma output maintained? (0.5)

b. What is the range of vessel level input that the 10-50 ma output represents? (0.5)

c. If a 3 inch change in vessel level input causes a 2 ma change in the controller output, what is the output signal in millamps with an input signal at the normal reactor vessel water level. (Show any calculations you may use). (1.0)

6.10 The Standby Liquid Control System has a minimum and maximum injection time designed into it. What is the bases for these times? (1.0)

END OF CATEGORY 6

7. Procedures-Normal, Abnormal, Emergency, and Radiological Control

7.1 State whether each of the following statements concerning 10 CFR 20 is TRUE or FALSE.

a. Exposure of the whole body of any individual to 5 rems or more of radiation requires immediate notification to the Director of the appropriate NRC Office. (0.5)

b. The maximum permissible level of radiation in an unrestricted area is two millirems per hour. (0.5)

c. 0.1 rad due to neutrons is equivalent to one rem. (0.5)

d. A high radiation area is any accessible area where a major portion of the body could receive a dose in excess of 100 mrems in five consecutive days. (0.5)

7.2 List the following items in order that they would occur during a normal cold plant startup, (in accordance with DGP 1-1 and give the approximate (±10 psi) reactor pressure at which each is done. (3.5)

a. Line up HPCI for auto initiation
b. Place first feed pump in service
c. Place steam seals in service
d. Start steam jet air ejectors
e. Shift to RWCU recirculation pump
f. Fully withdraw the SRM's

7.3 DOA 300-5 Inoperable or Failed Control Rod Drive States: "If reactor power is less than or equal to 20% and a control rod is determined to be uncoupled, fully insert the rod to position 00."

Give three indications of an uncoupled or stuck control rod. (1.5)

7.4 The Unit 2 is operating at 85% power and the Main Generator field breakers trip open which results in a turbine trip and a reactor scram. What are the required immediate action steps. Be specific, an action step may have more than one action item and if so it will have more value. (4.0)

7.5 What are two (2) general instructions concerning rod movements to minimize the risk of inadvertent short periods? (2.0)

7.6 Assume an ATWS event has occurred:

a. Under what conditions can the NSO inject SBLC without authorization from a supervisor.? (1.0)

b. What is the difference between the immediate actions required for Unit 1 compared to Unit 2. (0.5)

c. After the SBLC system has been initialed, give four indications that show the system is operating. (1.0)

7.7 State the reasons for each of the following precautions from DOP 202-1, Recirculation Startup:

a. After a pump trip, shut the pump discharge valve and pump discharge bypass valve. (1.0)

b. After approximately five minutes, the discharge valve and discharge bypass valve should be opened. Misleading? (1.0)

c. Establish flow from the seal purge system to recirculation pump seals only after the pump discharge and suction valves are verified open. (1.0)

7.8 How will the following parameters vary as a result of a failed jet pump. (i.e., increase, decrease, remain constant; vary more or less than normal readings)?

a. Core thermal power (0.5)
b. Recirculation pump flow for a given speed (0.5)
c. Individual jet pump flow indication (0.5)
d. Electrical output (0.5)
e. Core Flow (0.5)

7.9 In accordance with the refueling procedure DFP-800-1, how many SRM's are required and where are they to be located during fuel movement? (1.5)

7.10 A. Before leaving the control room during a control room evacuation, what four actions are to be taken by the NSO? (2.0)

B. Where will the shift foreman establish his control center? (0.5)

END CATEGORY 7

8. Administrative Procedures, Conditions, and Limitations

8.1 The technical specifications for Dresden contain two leak rate limits. List these two limits and state the basis for each. (2.0)

8.2 What is the function of the low pressure closure of the MSIV's while in RUN and WHY is there a reactor scram interlocked with this closure? (3.0)

8.3 According to 10 CFR 50, the one hour reporting requirement for each of the following conditions is applicable. (True or False).

a. The plant is in a condition not covered by operating and emergency procedures. (0.5)

b. The loss of the off-site notification system. (0.5)

c. A valid automatic initiation of the Reactor Protection System. (0.5)

d. A shutdown was commenced because the plant was in violation of the Technical Specifications. (0.5)

8.4 List four conditions that require the post-accident lineup of the high radiation sampling system and use of the post-accident sampling procedure. (4.0)

8.5 A. What is a Limiting Control Rod Pattern? (1.0)

B. If a Limiting Control Rod Pattern exists and a RBM Channel becomes inoperable, what action must be taken? (1.0)

8.6 According to the "Out-of-Service and Personnel Protection" procedure DAP 3-5, the request for equipment outage, there are cases which require additional approvals besides the Shift Supervisor. List two of these cases and who must approve. (Titles only needed) (2.0)

8.7 There are several provisions that must be met in order to operate with one recirculation loop out of service. What are four of these provisions? Set points not required. (4.0)

8.8 What are the personnel requirements for the fire brigade? (2.0)

8.9 List four of the immediate operative actions for DGA-16 Coolant High Activity Fuel Element Failure. (4.0)

END CATEGORY 8

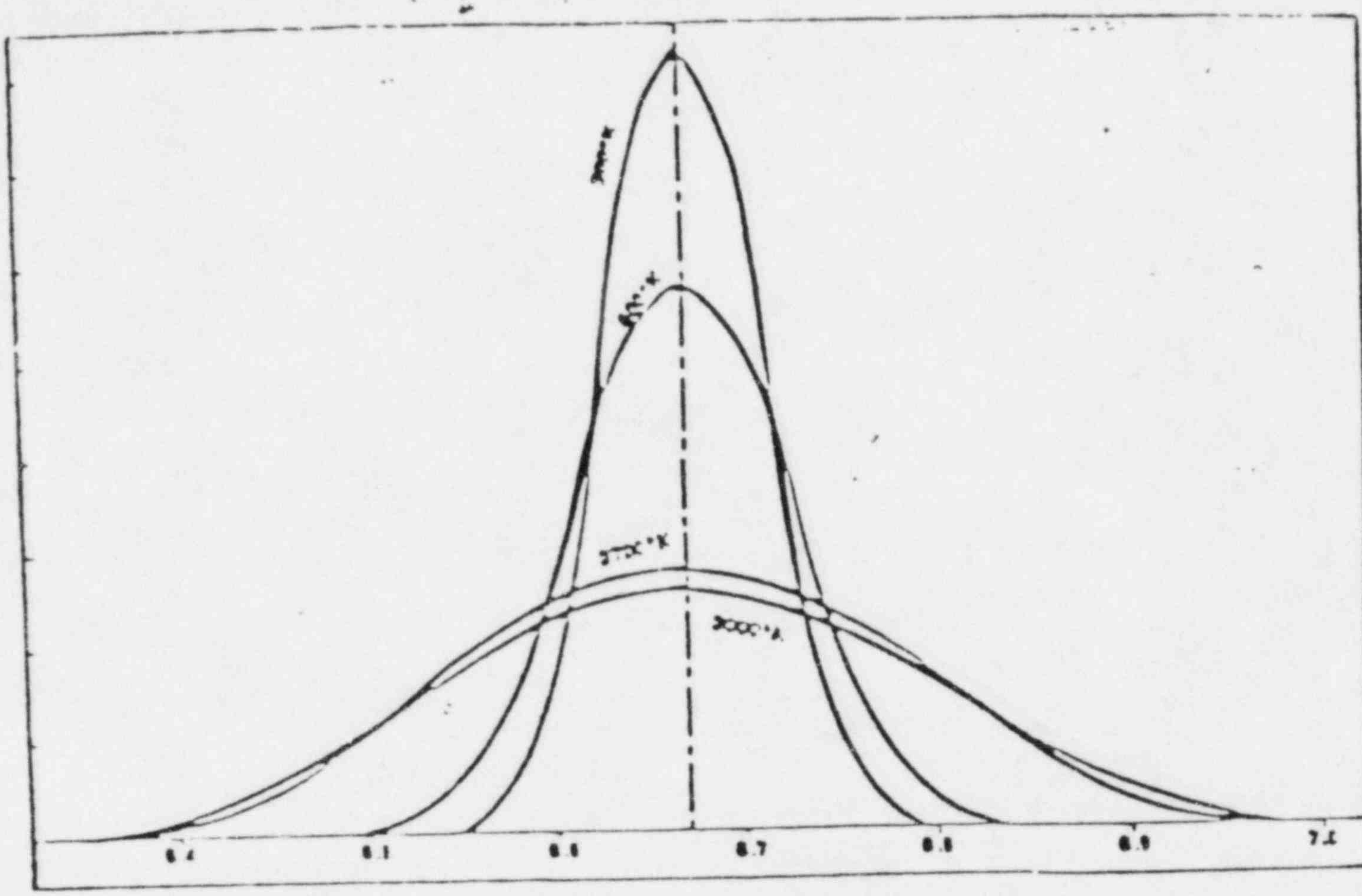

Figure 1.21

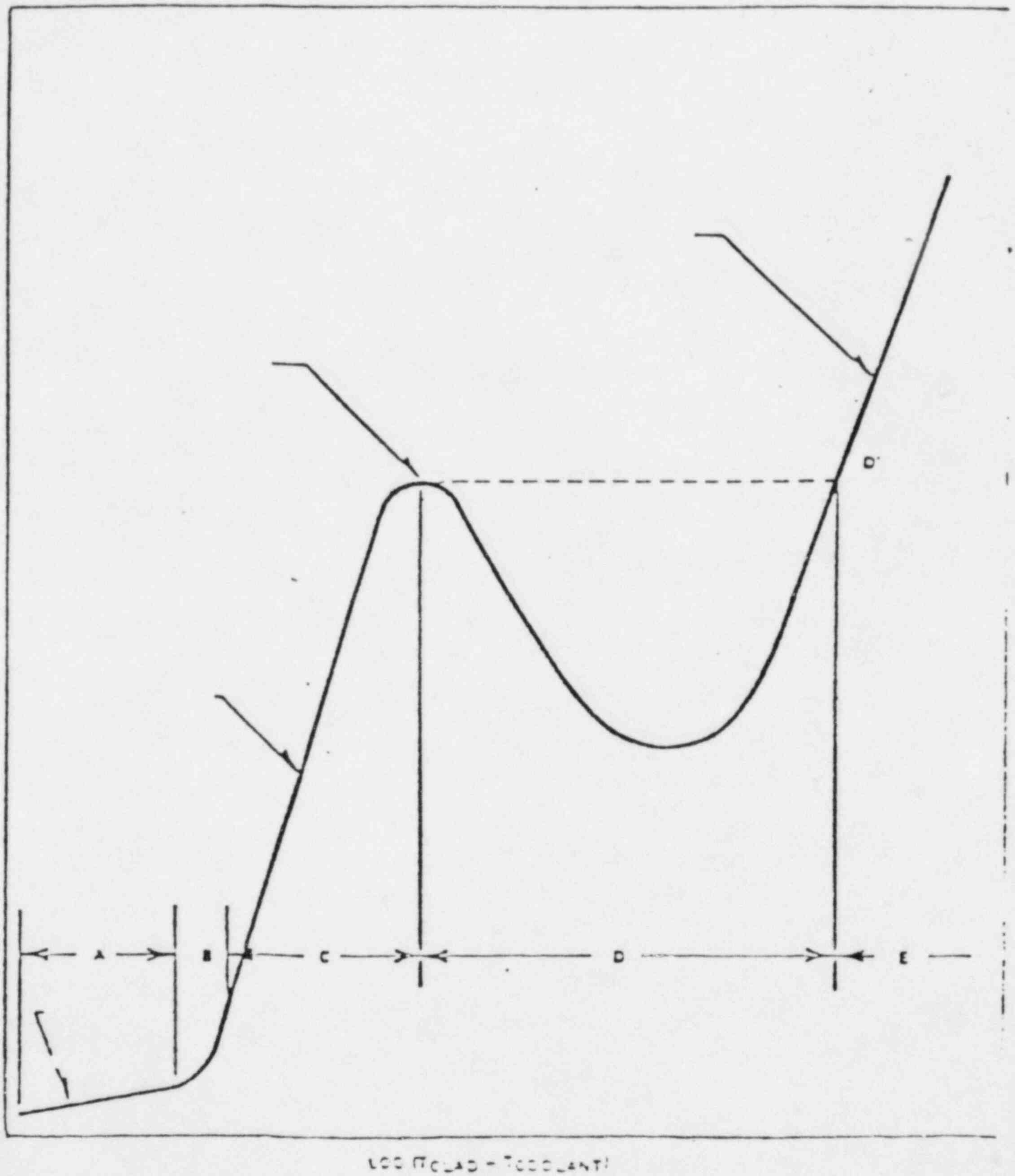

Figure 1. Heat Flux Versus Temperature Difference Between Cladding and Coolant

EQUATION SHEET

$f = ma$

$v = s/t$

Cycle efficiency = (Network out)/(Energy in)

$w = mg$

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

$E = mc^2$

$KE = 1/2\ mv^2$

$a = (V_f - V_o)/t$

$A = \lambda N$

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

$PE = mgh$

$V_f = V_o + at$

$w = \theta/t$

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

$NPSH = P_{in} - P_{sat}$

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

$\dot{m} \alpha \rho AV$

$\Delta E = 931\ \Delta m$

$I = I_o e^{-Ex}$

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

$Q = UA\Delta h$

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

$Pwr = W_f \Delta h$

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

$TVL = 1.3/\mu$

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

$HVL = -0.693/\mu$

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

$SUR = 26.06/T$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$I_1 d_1 = I_2 d_2$

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

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

$\Sigma = \sigma N$

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

NPSH = Static head - h_L - P_{sat}

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

Water Parameters

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

Miscellaneous Conversions

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

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	1.6834	1.8852	142.0
144.0	3.1997	0.016312	111.74	111.76	111.95	1011.7	1123.6	0.2051	1.6759	1.8810	144.0
146.0	3.3653	0.016322	106.58	106.59	113.95	1010.5	1124.5	0.2084	1.6684	1.8769	146.0
148.0	3.5381	0.016332	101.68	101.70	115.95	1009.3	1125.3	0.2117	1.6610	1.8727	148.0
150.0	3.7184	0.016343	97.05	97.07	117.95	1008.2	1126.1	0.2150	1.6536	1.8686	150.0
152.0	3.9065	0.016353	92.66	92.68	119.95	1007.0	1126.9	0.2183	1.6463	1.8646	152.0
154.0	4.1025	0.016363	88.50	88.52	121.95	1005.8	1127.7	0.2216	1.6390	1.8606	154.0
156.0	4.3068	0.016374	84.56	84.57	123.95	1004.6	1128.6	0.2248	1.6318	1.8566	156.0
158.0	4.5197	0.016384	80.82	80.83	125.96	1003.4	1129.4	0.2281	1.6245	1.8526	158.0
160.0	4.7414	0.016395	77.27	77.29	127.96	1002.2	1130.2	0.2313	1.6174	1.8487	160.0
162.0	4.9722	0.016406	73.90	73.92	129.96	1001.0	1131.0	0.2345	1.6103	1.8448	162.0
164.0	5.2124	0.016417	70.70	70.72	131.96	999.8	1131.8	0.2377	1.6032	1.8409	164.0
166.0	5.4623	0.016428	67.67	67.68	133.97	998.6	1132.6	0.2409	1.5961	1.8371	166.0
168.0	5.7223	0.016440	64.78	64.80	135.97	997.4	1133.4	0.2441	1.5892	1.8333	168.0
170.0	5.9926	0.016451	62.04	62.06	137.97	996.2	1134.2	0.2473	1.5822	1.8295	170.0
172.0	6.2736	0.016463	59.43	59.45	139.98	995.0	1135.0	0.2505	1.5753	1.8258	172.0
174.0	6.5656	0.016474	56.95	56.97	141.98	993.8	1135.8	0.2537	1.5684	1.8221	174.0
176.0	6.8690	0.016486	54.59	54.61	143.99	992.6	1136.6	0.2568	1.5616	1.8184	176.0
178.0	7.1840	0.016498	52.35	52.36	145.99	991.4	1137.4	0.2600	1.5548	1.8147	178.0

*The states shown are metastable

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

Temp Fahr t	Abs Press Lb per Sq In p	Specific Volume Sat Liquid v_f	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	166.08	979.1	1145.2	0.2910	1.4888	1.7798	198.0
200.0	11.526	0.016637	33.622	33.639	168.09	977.9	1146.0	0.2940	1.4824	1.7764	200.0
204.0	12.512	0.016664	31.135	31.151	172.11	975.4	1147.5	0.3001	1.4697	1.7698	204.0
208.0	13.568	0.016691	28.862	28.878	176.14	972.8	1149.0	0.3061	1.4571	1.7632	208.0
212.0	14.696	0.016719	26.782	26.799	180.17	970.3	1150.5	0.3121	1.4447	1.7568	212.0
216.0	15.901	0.016747	24.876	24.894	184.20	967.8	1152.0	0.3181	1.4323	1.7505	216.0
220.0	17.186	0.016775	23.131	23.148	188.23	965.2	1153.4	0.3241	1.4201	1.7442	220.0
224.0	18.556	0.016805	21.529	21.545	192.27	962.6	1154.9	0.3300	1.4081	1.7380	224.0
228.0	20.015	0.016834	20.056	20.073	196.31	960.0	1156.3	0.3359	1.3961	1.7320	228.0
232.0	21.567	0.016864	18.701	18.718	200.35	957.4	1157.8	0.3417	1.3842	1.7260	232.0
236.0	23.216	0.016895	17.454	17.471	204.40	954.8	1159.2	0.3476	1.3725	1.7201	236.0
240.0	24.968	0.016926	16.304	16.321	208.45	952.1	1160.6	0.3533	1.3609	1.7142	240.0
244.0	26.826	0.016958	15.243	15.260	212.50	949.5	1162.0	0.3591	1.3494	1.7085	244.0
248.0	28.796	0.016990	14.264	14.281	216.56	946.8	1163.4	0.3649	1.3379	1.7028	248.0
252.0	30.883	0.017022	13.358	13.375	220.62	944.1	1164.7	0.3706	1.3266	1.6972	252.0
256.0	33.091	0.017055	12.520	12.538	224.69	941.4	1166.1	0.3763	1.3154	1.6917	256.0
260.0	35.427	0.017089	11.745	11.762	228.76	938.6	1167.4	0.3819	1.3043	1.6862	260.0
264.0	37.894	0.017123	11.025	11.042	232.83	935.9	1168.7	0.3876	1.2933	1.6808	264.0
268.0	40.500	0.017157	10.358	10.375	236.91	933.1	1170.0	0.3932	1.2823	1.6755	268.0
272.0	43.249	0.017193	9.738	9.755	240.99	930.3	1171.3	0.3987	1.2715	1.6702	272.0
276.0	46.147	0.017228	9.162	9.180	245.08	927.5	1172.5	0.4043	1.2607	1.6650	276.0
280.0	49.200	0.017264	8.627	8.644	249.17	924.6	1173.8	0.4098	1.2501	1.6599	280.0
284.0	52.414	0.01730	8.1280	8.1453	253.3	921.7	1175.0	0.4154	1.2395	1.6548	284.0
288.0	55.795	0.01734	7.6634	7.6807	257.4	918.8	1176.2	0.4208	1.2290	1.6498	288.0
292.0	59.350	0.01738	7.2301	7.2475	261.5	915.9	1177.4	0.4263	1.2186	1.6449	292.0
296.0	63.084	0.01743	6.8259	6.8433	265.6	913.0	1178.6	0.4317	1.2082	1.6400	296.0
300.0	67.005	0.01745	6.4483	6.4658	269.7	910.0	1179.7	0.4372	1.1979	1.6351	300.0
304.0	71.119	0.01749	6.0955	6.1130	273.8	907.0	1180.9	0.4426	1.1877	1.6303	304.0
308.0	75.433	0.01753	5.7655	5.7830	278.0	904.0	1182.0	0.4479	1.1776	1.6256	308.0
312.0	79.953	0.01757	5.4566	5.4742	282.1	901.0	1183.1	0.4533	1.1676	1.6209	312.0
316.0	84.688	0.01761	5.1673	5.1849	286.3	897.9	1184.1	0.4586	1.1576	1.6162	316.0
320.0	89.643	0.01766	4.8961	4.9138	290.4	894.8	1185.2	0.4640	1.1477	1.6116	320.0
324.0	94.826	0.01770	4.6418	4.6595	294.6	891.6	1186.2	0.4692	1.1378	1.6071	324.0
328.0	100.245	0.01774	4.4030	4.4208	298.7	888.5	1187.2	0.4745	1.1280	1.6025	328.0
332.0	105.907	0.01779	4.1788	4.1966	302.9	885.3	1188.2	0.4798	1.1183	1.5981	332.0
336.0	111.820	0.01783	3.9681	3.9859	307.1	882.1	1189.1	0.4850	1.1086	1.5936	336.0
340.0	117.992	0.01787	3.7699	3.7878	311.3	878.8	1190.1	0.4902	1.0990	1.5892	340.0
344.0	124.430	0.01792	3.5834	3.6013	315.5	875.5	1191.0	0.4954	1.0894	1.5849	344.0
348.0	131.142	0.01797	3.4078	3.4258	319.7	872.2	1191.9	0.5006	1.0799	1.5806	348.0
352.0	138.138	0.01801	3.2423	3.2603	323.9	868.9	1192.7	0.5058	1.0705	1.5763	352.0
356.0	145.424	0.01806	3.0863	3.1044	328.1	865.5	1193.6	0.5110	1.0611	1.5721	356.0
360.0	153.010	0.01811	2.9392	2.9573	332.3	862.1	1194.4	0.5161	1.0517	1.5678	360.0
364.0	160.903	0.01816	2.8002	2.8184	336.5	858.6	1195.2	0.5212	1.0424	1.5637	364.0
368.0	169.113	0.01821	2.6691	2.6873	340.8	855.1	1195.9	0.5263	1.0332	1.5595	368.0
372.0	177.648	0.01826	2.5451	2.5633	345.0	851.6	1196.7	0.5314	1.0240	1.5554	372.0
376.0	186.517	0.01831	2.4279	2.4462	349.3	848.1	1197.4	0.5365	1.0148	1.5513	376.0
380.0	195.729	0.01836	2.3170	2.3353	353.6	844.5	1198.0	0.5416	1.0057	1.5473	380.0
384.0	205.294	0.01842	2.2120	2.2304	357.9	840.8	1198.7	0.5466	0.9966	1.5432	384.0
388.0	215.220	0.01847	2.1126	2.1311	362.2	837.2	1199.3	0.5516	0.9876	1.5392	388.0
392.0	225.516	0.01853	2.0184	2.0369	366.5	833.4	1199.9	0.5567	0.9786	1.5352	392.0
396.0	236.193	0.01858	1.9291	1.9477	370.8	829.7	1200.4	0.5617	0.9696	1.5313	396.0
400.0	247.259	0.01864	1.8444	1.8630	375.1	825.9	1201.0	0.5667	0.9607	1.5274	400.0
404.0	258.725	0.01870	1.7640	1.7827	379.4	822.0	1201.5	0.5717	0.9518	1.5234	404.0
408.0	270.600	0.01875	1.6877	1.7064	383.8	818.2	1201.9	0.5766	0.9429	1.5195	408.0
412.0	282.894	0.01881	1.6152	1.6340	388.1	814.2	1202.4	0.5816	0.9341	1.5157	412.0
416.0	295.617	0.01887	1.5463	1.5651	392.5	810.2	1202.8	0.5866	0.9253	1.5118	416.0
420.0	308.780	0.01894	1.4808	1.4997	396.9	806.2	1203.1	0.5915	0.9165	1.5080	420.0
424.0	322.391	0.01900	1.4184	1.4374	401.3	802.2	1203.5	0.5964	0.9077	1.5042	424.0
428.0	336.463	0.01906	1.3591	1.3782	405.7	798.0	1203.7	0.6014	0.8990	1.5004	428.0
432.0	351.00	0.01913	1.30266	1.32179	410.1	793.9	1204.0	0.6063	0.8903	1.4966	432.0
436.0	366.03	0.01919	1.24887	1.26806	414.6	789.7	1204.2	0.6112	0.8816	1.4928	436.0
440.0	381.54	0.01926	1.19761	1.21687	419.0	785.4	1204.4	0.6161	0.8729	1.4890	440.0
444.0	397.56	0.01933	1.14874	1.16806	423.5	781.1	1204.6	0.6210	0.8643	1.4853	444.0
448.0	414.09	0.01940	1.10212	1.12152	428.0	776.7	1204.7	0.6259	0.8557	1.4815	448.0
452.0	431.14	0.01947	1.05764	1.07711	432.5	772.3	1204.8	0.6308	0.8471	1.4778	452.0
456.0	448.73	0.01954	1.01518	1.03472	437.0	767.8	1204.8	0.6356	0.8385	1.4741	456.0

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

Temp Fahr t	Abs Press Lb per Sq In p	Specific Volume Sat Liquid v_f	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	0.6405	0.8299	1.4704	460.0
464.0	485.56	0.01969	0.93588	0.95557	446.1	758.6	1204.7	0.6454	0.8213	1.4667	464.0
468.0	504.83	0.01976	0.89885	0.91862	450.7	754.0	1204.6	0.6502	0.8127	1.4629	468.0
472.0	524.67	0.01984	0.86345	0.88329	455.2	749.3	1204.5	0.6551	0.8042	1.4592	472.0
476.0	545.11	0.01992	0.82958	0.84950	459.9	744.5	1204.3	0.6599	0.7956	1.4555	476.0
480.0	566.15	0.02000	0.79716	0.81717	464.5	739.6	1204.1	0.6648	0.7871	1.4518	480.0
484.0	587.81	0.02009	0.76613	0.78622	469.1	734.7	1203.8	0.6696	0.7785	1.4481	484.0
488.0	610.10	0.02017	0.73641	0.75658	473.8	729.7	1203.5	0.6745	0.7700	1.4444	488.0
492.0	633.03	0.02026	0.70794	0.72820	478.5	724.6	1203.1	0.6793	0.7614	1.4407	492.0
496.0	656.61	0.02034	0.68065	0.70100	483.2	719.5	1202.7	0.6842	0.7528	1.4370	496.0
500.0	680.86	0.02043	0.65448	0.67492	487.9	714.3	1202.2	0.6890	0.7443	1.4333	500.0
504.0	705.78	0.02053	0.62938	0.64991	492.7	709.0	1201.7	0.6939	0.7357	1.4296	504.0
508.0	731.40	0.02062	0.60530	0.62592	497.5	703.7	1201.1	0.6987	0.7271	1.4258	508.0
512.0	757.72	0.02072	0.58218	0.60289	502.3	698.2	1200.5	0.7036	0.7185	1.4221	512.0
516.0	784.76	0.02081	0.55997	0.58079	507.1	692.7	1199.8	0.7085	0.7099	1.4183	516.0
520.0	812.53	0.02091	0.53864	0.55956	512.0	687.0	1199.0	0.7133	0.7013	1.4146	520.0
524.0	841.04	0.02102	0.51814	0.53916	516.9	681.3	1198.2	0.7182	0.6926	1.4108	524.0
528.0	870.31	0.02112	0.49843	0.51955	521.8	675.5	1197.3	0.7231	0.6839	1.4070	528.0
532.0	900.34	0.02123	0.47947	0.50070	526.8	669.6	1196.4	0.7280	0.6752	1.4032	532.0
536.0	931.17	0.02134	0.46123	0.48257	531.7	663.6	1195.4	0.7329	0.6665	1.3993	536.0
540.0	962.79	0.02146	0.44367	0.46513	536.8	657.5	1194.3	0.7378	0.6577	1.3954	540.0
544.0	995.22	0.02157	0.42677	0.44834	541.8	651.3	1193.1	0.7427	0.6488	1.3915	544.0
548.0	1028.49	0.02169	0.41048	0.43217	546.9	645.0	1191.9	0.7476	0.6400	1.3876	548.0
552.0	1062.59	0.02182	0.39479	0.41660	552.0	638.5	1190.6	0.7525	0.6311	1.3837	552.0
556.0	1097.55	0.02194	0.37966	0.40160	557.2	632.0	1189.2	0.7575	0.6222	1.3797	556.0
560.0	1133.38	0.02207	0.36507	0.38714	562.4	625.3	1187.7	0.7625	0.6132	1.3757	560.0
564.0	1170.10	0.02221	0.35099	0.37320	567.6	618.5	1186.1	0.7674	0.6041	1.3716	564.0
568.0	1207.72	0.02235	0.33741	0.35975	572.9	611.5	1184.5	0.7725	0.5950	1.3675	568.0
572.0	1246.26	0.02249	0.32429	0.34678	578.3	604.5	1182.7	0.7775	0.5859	1.3634	572.0
576.0	1285.74	0.02264	0.31162	0.33426	583.7	597.2	1180.9	0.7825	0.5766	1.3592	576.0
580.0	1326.17	0.02279	0.29937	0.32216	589.1	589.9	1179.0	0.7876	0.5673	1.3550	580.0
584.0	1367.7	0.02295	0.28753	0.31048	594.6	582.4	1176.9	0.7927	0.5580	1.3507	584.0
588.0	1410.0	0.02311	0.27608	0.29919	600.1	574.7	1174.8	0.7978	0.5485	1.3464	588.0
592.0	1453.3	0.02328	0.26499	0.28827	605.7	566.8	1172.6	0.8030	0.5390	1.3420	592.0
596.0	1497.8	0.02345	0.25425	0.27770	611.4	558.8	1170.2	0.8082	0.5293	1.3375	596.0
600.0	1543.2	0.02364	0.24384	0.26747	617.1	550.6	1167.7	0.8134	0.5196	1.3330	600.0
604.0	1589.7	0.02382	0.23374	0.25757	622.9	542.2	1165.1	0.8187	0.5097	1.3284	604.0
608.0	1637.3	0.02402	0.22394	0.24796	628.8	533.6	1162.4	0.8240	0.4997	1.3238	608.0
612.0	1686.1	0.02422	0.21442	0.23865	634.8	524.7	1159.5	0.8294	0.4896	1.3190	612.0
616.0	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	0.8806	0.3893	1.2699	648.0
652.0	2239.2	0.02691	0.13124	0.15816	700.0	418.7	1118.7	0.8868	0.3767	1.2634	652.0
656.0	2301.7	0.02728	0.12387	0.15115	707.4	405.7	1113.1	0.8931	0.3637	1.2567	656.0
660.0	2365.7	0.02768	0.11663	0.14431	714.9	392.1	1107.0	0.8995	0.3502	1.2498	660.0
664.0	2431.1	0.02811	0.10947	0.13757	722.9	377.7	1100.6	0.9064	0.3361	1.2425	664.0
668.0	2498.1	0.02858	0.10229	0.13087	731.5	362.1	1093.5	0.9137	0.3210	1.2347	668.0
672.0	2566.6	0.02911	0.09514	0.12424	740.2	345.7	1085.9	0.9212	0.3054	1.2266	672.0
676.0	2636.8	0.02970	0.08799	0.11769	749.2	328.5	1077.6	0.9287	0.2892	1.2179	676.0
680.0	2708.6	0.03037	0.08080	0.11117	758.5	310.1	1068.5	0.9365	0.2720	1.2086	680.0
684.0	2782.1	0.03114	0.07349	0.10463	768.2	290.2	1058.4	0.9447	0.2537	1.1984	684.0
688.0	2857.4	0.03204	0.06595	0.09799	778.8	268.2	1047.0	0.9535	0.2337	1.1872	688.0
692.0	2934.5	0.03313	0.05797	0.09110	790.5	243.1	1033.6	0.9634	0.2110	1.1744	692.0
696.0	3013.4	0.03455	0.04916	0.08371	804.4	212.8	1017.2	0.9749	0.1841	1.1591	696.0
700.0	3094.3	0.03662	0.03857	0.07519	822.4	172.7	995.2	0.9901	0.1490	1.1390	700.0
702.0	3135.5	0.03824	0.03173	0.06997	835.0	144.7	979.7	1.0006	0.1246	1.1252	702.0
704.0	3177.2	0.04108	0.02192	0.06300	854.2	102.0	956.2	1.0169	0.0876	1.1046	704.0
705.0	3198.3	0.04427	0.01304	0.05730	873.0	61.4	934.4	1.0329	0.0527	1.0856	705.0
705.47*	3208.2	0.05078	0.00000	0.05078	906.0	0.0	906.0	1.0612	0.0000	1.0612	705.47*

*Critical temperature

Table 2: Saturated Steam: Pressure Table

Abs Press Lb/Sq In p	Temp Fahr t	Specific Volume: Sat Liquid v_f	Specific Volume: Evap v_{fg}	Specific Volume: Sat Vapor v_g	Enthalpy: Sat Liquid h_f	Enthalpy: Evap h_{fg}	Enthalpy: Sat Vapor h_g	Entropy: Sat Liquid s_f	Entropy: Evap s_{fg}	Entropy: Sat Vapor s_g	Abs Press Lb/Sq In p
0.08865	32.018	0.016022	3302.4	3302.4	0.0003	1075.5	1075.5	0.0000	2.1872	2.1872	0.08865
0.25	59.323	0.016032	1235.5	1235.5	27.382	1060.1	1087.4	0.0542	2.0425	2.0967	0.25
0.50	79.586	0.016071	641.5	641.5	47.623	1048.6	1096.3	0.0925	1.9446	2.0370	0.50
1.0	101.74	0.016136	333.59	333.60	69.73	1036.1	1105.8	0.1326	1.8455	1.9781	1.0
5.0	162.24	0.016407	73.515	73.532	130.20	1000.9	1131.1	0.2349	1.6094	1.8443	5.0
10.0	193.21	0.016592	38.404	38.420	161.26	982.1	1143.3	0.2836	1.5043	1.7879	10.0
14.696	212.00	0.016719	26.782	26.799	180.17	970.3	1150.5	0.3121	1.4447	1.7568	14.696
15.0	213.03	0.016726	26.274	26.290	181.21	969.7	1150.9	0.3137	1.4415	1.7552	15.0
20.0	227.96	0.016834	20.070	20.087	196.27	960.1	1156.3	0.3358	1.3962	1.7320	20.0
30.0	250.34	0.017009	13.7266	13.7436	218.9	945.2	1164.1	0.3682	1.3313	1.6995	30.0
40.0	267.25	0.017151	10.4794	10.4965	236.1	933.6	1169.8	0.3921	1.2844	1.6765	40.0
50.0	281.02	0.017274	8.4967	8.5140	250.2	923.9	1174.1	0.4112	1.2474	1.6586	50.0
60.0	292.71	0.017383	7.1562	7.1736	262.2	915.4	1177.6	0.4273	1.2167	1.6440	60.0
70.0	302.93	0.017482	6.1875	6.2050	272.7	907.8	1180.6	0.4411	1.1905	1.6316	70.0
80.0	312.04	0.017573	5.4536	5.4711	282.1	900.9	1183.1	0.4534	1.1675	1.6208	80.0
90.0	320.28	0.017659	4.8779	4.8953	290.7	894.6	1185.3	0.4643	1.1470	1.6113	90.0
100.0	327.82	0.017740	4.4133	4.4310	298.5	888.6	1187.2	0.4743	1.1284	1.6027	100.0
110.0	334.79	0.01782	4.0306	4.0484	305.8	883.1	1188.9	0.4834	1.1115	1.5950	110.0
120.0	341.27	0.01789	3.7097	3.7275	312.6	877.8	1190.4	0.4919	1.0960	1.5879	120.0
130.0	347.33	0.01796	3.4364	3.4544	319.0	872.8	1191.7	0.4998	1.0815	1.5813	130.0
140.0	353.04	0.01803	3.2010	3.2190	325.0	868.0	1193.0	0.5071	1.0681	1.5752	140.0
150.0	358.43	0.01809	2.9958	3.0139	330.6	863.4	1194.1	0.5141	1.0554	1.5695	150.0
160.0	363.55	0.01815	2.8155	2.8336	336.1	859.0	1195.1	0.5206	1.0435	1.5641	160.0
170.0	368.42	0.01821	2.6556	2.6738	341.2	854.8	1196.0	0.5269	1.0322	1.5591	170.0
180.0	373.08	0.01827	2.5129	2.5312	346.2	850.7	1196.9	0.5328	1.0215	1.5543	180.0
190.0	377.53	0.01833	2.3847	2.4030	350.9	846.7	1197.6	0.5384	1.0113	1.5498	190.0
200.0	381.80	0.01839	2.2689	2.2873	355.5	842.8	1198.3	0.5438	1.0016	1.5454	200.0
210.0	385.91	0.01844	2.16373	2.18217	359.9	839.1	1199.0	0.5490	0.9923	1.5413	210.0
220.0	389.88	0.01850	2.06779	2.08629	364.2	835.4	1199.6	0.5540	0.9834	1.5374	220.0
230.0	393.70	0.01855	1.97991	1.99846	368.3	831.8	1200.1	0.5588	0.9748	1.5336	230.0
240.0	397.39	0.01860	1.89909	1.91769	372.3	828.4	1200.6	0.5634	0.9665	1.5299	240.0
250.0	400.97	0.01865	1.82452	1.84317	376.1	825.0	1201.1	0.5679	0.9585	1.5264	250.0
260.0	404.44	0.01870	1.75548	1.77418	379.9	821.6	1201.5	0.5722	0.9508	1.5230	260.0
270.0	407.80	0.01875	1.69137	1.71013	383.6	818.3	1201.9	0.5764	0.9433	1.5197	270.0
280.0	411.07	0.01880	1.63169	1.65049	387.1	815.1	1202.3	0.5805	0.9361	1.5166	280.0
290.0	414.25	0.01885	1.57597	1.59482	390.6	812.0	1202.6	0.5844	0.9291	1.5135	290.0
300.0	417.35	0.01889	1.52384	1.54274	394.0	808.9	1202.9	0.5882	0.9223	1.5105	300.0
350.0	431.73	0.01912	1.30642	1.32554	409.8	794.2	1204.0	0.6059	0.8909	1.4968	350.0
400.0	444.60	0.01934	1.14162	1.16095	424.2	780.4	1204.6	0.6217	0.8630	1.4847	400.0
450.0	456.28	0.01954	1.01224	1.03179	437.3	767.5	1204.8	0.6360	0.8378	1.4738	450.0
500.0	467.01	0.01975	0.90787	0.92762	449.5	755.1	1204.7	0.6490	0.8148	1.4639	500.0
550.0	476.94	0.01994	0.82183	0.84177	460.9	743.3	1204.3	0.6611	0.7936	1.4547	550.0
600.0	486.20	0.02013	0.74962	0.76975	471.7	732.0	1203.7	0.6723	0.7738	1.4461	600.0
650.0	494.89	0.02032	0.68811	0.70843	481.9	720.9	1202.8	0.6828	0.7552	1.4381	650.0
700.0	503.08	0.02050	0.63505	0.65556	491.6	710.2	1201.8	0.6928	0.7377	1.4304	700.0
750.0	510.84	0.02069	0.58880	0.60949	500.9	699.8	1200.7	0.7022	0.7210	1.4232	750.0
800.0	518.21	0.02087	0.54809	0.56896	509.8	689.6	1199.4	0.7111	0.7051	1.4163	800.0
850.0	525.24	0.02105	0.51197	0.53302	518.4	679.5	1198.0	0.7197	0.6899	1.4096	850.0
900.0	531.95	0.02123	0.47968	0.50091	526.7	669.7	1196.4	0.7279	0.6753	1.4032	900.0
950.0	538.39	0.02141	0.45064	0.47205	534.7	660.0	1194.7	0.7358	0.6612	1.3970	950.0
1000.0	544.58	0.02159	0.42436	0.44596	542.6	650.4	1192.9	0.7434	0.6476	1.3910	1000.0
1050.0	550.53	0.02177	0.40047	0.42224	550.1	640.9	1191.0	0.7507	0.6344	1.3851	1050.0
1100.0	556.28	0.02195	0.37863	0.40058	557.5	631.5	1189.1	0.7578	0.6216	1.3794	1100.0
1150.0	561.82	0.02214	0.35859	0.38073	564.8	622.2	1187.0	0.7647	0.6091	1.3738	1150.0
1200.0	567.19	0.02232	0.34013	0.36245	571.9	613.0	1184.8	0.7714	0.5969	1.3683	1200.0
1250.0	572.38	0.02250	0.32306	0.34556	578.8	603.8	1182.6	0.7780	0.5850	1.3630	1250.0
1300.0	577.42	0.02269	0.30722	0.32991	585.6	594.6	1180.2	0.7843	0.5733	1.3577	1300.0
1350.0	582.32	0.02288	0.29250	0.31537	592.3	585.4	1177.8	0.7906	0.5620	1.3525	1350.0
1400.0	587.07	0.02307	0.27871	0.30178	598.8	576.5	1175.3	0.7966	0.5507	1.3474	1400.0
1450.0	591.70	0.02327	0.26584	0.28911	605.3	567.4	1172.8	0.8026	0.5397	1.3423	1450.0
1500.0	596.20	0.02346	0.25372	0.27719	611.7	558.4	1170.1	0.8085	0.5288	1.3373	1500.0
1550.0	600.59	0.02366	0.24235	0.26601	618.0	549.4	1167.4	0.8142	0.5182	1.3324	1550.0
1600.0	604.87	0.02387	0.23159	0.25545	624.2	540.3	1164.5	0.8199	0.5076	1.3274	1600.0
1650.0	609.05	0.02407	0.22143	0.24551	630.4	531.3	1161.6	0.8254	0.4971	1.3225	1650.0
1700.0	613.13	0.02428	0.21178	0.23607	636.5	522.2	1158.6	0.8309	0.4867	1.3176	1700.0
1750.0	617.12	0.02450	0.20263	0.22713	642.5	513.1	1155.6	0.8363	0.4765	1.3128	1750.0
1800.0	621.02	0.02472	0.19390	0.21861	648.5	503.8	1152.3	0.8417	0.4662	1.3079	1800.0
1850.0	624.83	0.02495	0.18558	0.21052	654.5	494.6	1149.0	0.8470	0.4561	1.3030	1850.0
1900.0	628.56	0.02517	0.17761	0.20278	660.4	485.2	1145.6	0.8522	0.4459	1.2981	1900.0
1950.0	632.22	0.02541	0.16999	0.19540	666.3	475.8	1142.0	0.8574	0.4358	1.2931	1950.0
2000.0	635.80	0.02565	0.16266	0.18831	672.1	466.2	1138.3	0.8625	0.4256	1.2881	2000.0
2100.0	642.76	0.02615	0.14885	0.17501	683.8	446.7	1130.5	0.8727	0.4053	1.2780	2100.0
2200.0	649.45	0.02669	0.13603	0.16272	695.5	426.7	1122.2	0.8828	0.3848	1.2676	2200.0
2300.0	655.89	0.02727	0.12406	0.15133	707.2	406.0	1113.2	0.8929	0.3640	1.2569	2300.0
2400.0	662.11	0.02790	0.11287	0.14076	719.0	384.8	1103.7	0.9031	0.3430	1.2460	2400.0
2500.0	668.11	0.02859	0.10209	0.13068	731.7	361.6	1093.3	0.9139	0.3206	1.2345	2500.0
2600.0	673.91	0.02938	0.09172	0.12110	744.5	337.6	1082.0	0.9247	0.2977	1.2225	2600.0
2700.0	679.53	0.03029	0.08165	0.11194	757.3	312.3	1069.7	0.9356	0.2741	1.2097	2700.0
2800.0	684.96	0.03134	0.07171	0.10305	770.7	285.1	1055.8	0.9468	0.2491	1.1958	2800.0
2900.0	690.22	0.03262	0.06158	0.09420	785.1	254.7	1039.8	0.9588	0.2215	1.1803	2900.0
3000.0	695.33	0.03428	0.05073	0.08500	801.8	218.4	1020.3	0.9728	0.1891	1.1619	3000.0
3100.0	700.28	0.03681	0.03771	0.07452	824.0	169.3	993.3	0.9914	0.1460	1.1373	3100.0
3200.0	705.08	0.04472	0.01191	0.05663	875.5	56.1	931.6	1.0351	0.0482	1.0832	3200.0
3208.2*	705.47	0.05078	0.00000	0.05078	906.0	0.0	906.0	1.0612	0.0000	1.0612	3208.2*

*Critical pressure

CATEGORY 5 ANSWERS

5.1 (a)
General Nuclear Principles

5.2 (c)
General Nuclear Principles

5.3 (b)
General Nuclear Principles

5.4 (d) C
General Thermodynamics and Stress Analysis

5.5 (d)
General Nuclear Principles

5.6 (c)
General Nuclear Principles

5.7 (a)
General Thermal Principles

5.8 (a)
General Nuclear Principles

5.9 (b)
General Nuclear Principles

5.10 (a) Reactor critical on prompt neutrons alone. (0.5)

(b) Time in seconds required for power to change by a factor of 'e'. (0.5)

(c) The multiplication of neutrons by the fuel in a subcritical reactor. (0.5)

Standard Nuclear Principles

5.11 (c)
Standard Nuclear Principles

5.12 (a)
Standard Nuclear Principles

5.13 (d)
Standard Nuclear Principles

5.14 (a) Transition Boiling may occur which could result in clad failure. (1.0)

(b) To make the MCPR limit more conservative to account for the possibility of a sudden flow increase and a corresponding power increase. (1.0)

(c) Decreases. (.5)
Standard Thermo-Hydraulic Principles

5.15 (c)
Standard Nuclear Principles

5.16 (c)
Standard Nuclear Principles

5.~~18~~ 17 (c)
Standard Thermodynamic and Fluid Flow Principles

5.~~19~~ 15 (d)
Standard Thermal Hydraulic Principles and Applications

5.20 17 (b)
Standard Nuclear Principles

5.21 20 (b)
Standard Doppler coefficient principles

5.22 21 (b)
Standard Nuclear Principles

X 5.~~23~~ 22 (b)
Standard Nuclear Principles

5.24 23 ~~(b)~~ D
Standard Thermo-Hydraulic Principles

~~5.24 — D~~

CATEGORY 6 ANSWERS

6.1 (a) Cooling water normally follows from the cooling water header through a check valve to the drive insert line at about 20 psi above reactor pressure. (0.5)

When a drive is in motion the pressure in the insert line is at 280 psi greater than reactor pressure. (0.5)

The dp between drive water and cooling water will keep cooling water check valve closed and prevent cooling water flow. (0.5)

(b) (1) False

(b) (2) True

Ref: CRD Hydraulics LP pg.6, 7, 27.

6.2 (a) (1) Hi drywell greater than 2 psig
(2) Low level less than 59 in.
(3) 120 Sec timer expired
(4) Low pressure. ECCS pump running
} 1.0

(b) 125 VDC 0.5

(c) Rx pressure inadequate to overcome spring forces. 0.5
Ref: MTC book 3, ADS LP.

6.3 (a) Will inject (0.25)
Turbine seal leakage resulting in potential airborne activity in the HPCI room. (0.75)

(b) Will not inject (0.25)
Turbine stop and control valves will not open (0.75)

(c) Will inject (0.25)
Pump overheating and seal damage may result during low or no flow conditions (0.75)

(d) Will not inject (0.25)
Maximum signal from the flow element will cause the controller to keep turbine speed at minimum (0.75)

Ref: HPCI Lesson Plan.

6.4 (a) By monitoring the DP (0.5)
Across each recirculation pump (0.5)
For a 2 psid or greater dp, indicating the pump is running (0.5)

(b) By comparing the pressure in the riser pipes on one recirculation loop with the pressure in the riser pipes of the other loop. The undamaged loop will have a higher pressure than the damaged loop. 1.5

(c) Loop B.

Ref: LPCI Lesson Plan. Rev. 5, pg. 15.

6.5 (1) The limiter would try to reduce pump "B" speed to 28%.
(2) The mismatched circuit would stop the scoop tube insertion at 40% (10% mismatch).
(3) The "B" pump would be running at 40% with the discharge valve shut (pump damage could result).
(4) The mismatch circuity trips the low speed pump when the discharge valve goes shut.

2.5

Ref: Dresden Recirculation Flow Control, Lesson Plan, pg. 13.

6.6 (a) Clean demineralized H^2O system, Condensate Transfer system, service water/fire protection. 1.5
(b) Powers motor operated inboard isolation valves. 0.5
(c) ~~Five minutes~~. 20 min. per Iso Cond lesson plan pg. 4. (0.5)

6.7 (a) Valve would close
(b) Scram valves would open
(c) Instrument volume vent and drain valves would close
(d) Minimum flow valve would open
(e) Regulating valves would stay as is

2.5

Ref: Instrument air, Lesson Plan pg. 14-15

6.8 (a) False
(b) True
(c) True
(d) True

Ref: Lesson Plan, Bk 2, April 13, pages 7-10

6.9 (a) Maintaining a minimum output allows the detection of an electrical fault in the device.
(b) 0-60 inch vessel level
(c) Normal level 30 inches midway between 0-60 inches, therefore this would be half the difference in the range of the output or 20 ma (0.33)
10 ma + 20 ma = 30 ma (0.33)

Ref: Feedwater Control, Rev. 8, Page 6-7

6.10 The minimum time minimizes imperfect mixing and reactivity digging (0.5)
The maximum time is fast enough to overcome any positive reactivity effects due to cooldown and xenon decay from peak. (0.5)

CATEGORY 7 ANSWERS

7.1 (a) False
(b) True
(c) True
(d) False
Ref: 10 CFR 20

7.2 C, F, A, D, B, E
25, 50, 90, 200, 300, 920

E - should be 50#
F should be 0#
F, C, E, A, D, B
0 (25) 50# 90# 200# 300#

Acceptable answer for C is also, when sufficient steam available

Ref: DGP-1-1 pg 5-12

7.3 (1) No nuclear instrumentation response during rod withdrawal
(2) Rod overtravel alarm
(3) No position indication past position 48 on a withdrawal signal after drive flow decreases to stall flow.
(4) No position indication response to control rod movement

1.5

Ref: DGP 300-5, pg. 3-4

7.4 (1)	Place mode switch in shutdown (or refuel)	(0.4)
(2)	Check all rods fully inserted	(0.4)
(3)	Verify APRM's decreasing or downscale	(0.4)
(4)	Maintain feed water in auto unless controller failure occurs. Control level ±20 and ±40 inches by observing more than one available indication	(0.8)
(5)	Verify turbine and generator have tripped and speed is decreasing and OCB;s are open	(0.8)
(6)	Verify bypass valves are controlling Reactor Pressure	(0.4)
(7)	Start Emergency bearing oil pump	(0.4)
(8)	Verify auxiliary power transfers to transformer 22	(0.4)

7.5 (1)	All rods in BPWS groups 3 and 4 must be notch withdrawn between positions 04 and 12	(1.0)
(2)	Notch override shall not be used after a black and white pattern is reached until at least one Bypass valve is partially open or unit is on the line	(1.0)

Ref: DGP-3-4, Rev. 5, pgs. 2-6

7.6 (a) If either two or more adjacent rods are not inserted past 06 or 30 or more rods are not inserted past 06 and if reactor water level cannot be maintained or suppression pool water temperature cannot be maintained below 110°F.

(1.0)

(b) Unit 2 must trip Hydrogen addition (.5)

(c) (1) Continuity circuit pilot light not lit
(2) Flow pilot light lit
(3) Clean-up system isolated
(4) Pump discharge pressure increasing
(5) Decreasing level in SBLC tank

} 1.0

Ref: DGA 18, p.7; DOP 1100-2, pgs. 1-3.

7.7 (a) Prevent reverse rotation of the pump
(b) Maintain temperature in idle loop
(c) Prevent overpressurization of the recirculation loop

Ref: DOP 202-1, pg. 2-3; DOP 202-4 pg. 2

7.8 (a) Decrease
(b) Increase
(c) Vary less
(d) Decrease
(e) Increase

Ref: Dresden DOA 201-1, symptoms pg. 1

7.9 2 SRM's one in quadrant where fuel or rods are being moved and one in adjacent quadrant.

Tech Spec. 3.10

7.10 (a) Manually scram reactor, leave mode switch in run, trip CRD pumps, trip turbine
(b) RB second floor.

CATEGORY 8 ANSWERS

8.1 (a) 5 gpm unidentified
(b) 25 gpm total
(a) crack propagation
(b) sump pump capacity

Ref: T.S. 3/4.6

8.2 (a) The low pressure closure protects against a rapid cool down due to a failure of a pressure regulator (1.5)
(b) The scram is in anticipation of the pressure and flux transient which would occur following the MSIV closure (1.5)

8.3 (a) True
(b) True
(c) False
(d) True

Ref: 10 CFR 50.72

8.4 (1) Group 1 isolation on 3x normal MSL Rad level
(2) Group II isolation on Drywell High Rod level
(3) Reactor water level decreased below or is below the TAF as a result of an operational transient or accident condition.
(4) Reactor water level cannot be determined or was indeterminate at some time during an event.
(5) Failure of the RPS to initiate or complete a scram once a scram signal has been initiated or once a LSSS has been exceeded.
(6) Other conditions as deemed appropriate by the Rad/Chem Director or Station Director.

Ref: EPIP 300-Ti

8.5 (a) A pattern which results in the core being on a thermal hydraulic limit (operating on a limiting value for APLHGR, LHGR or MCPR).
(b) Place inoperable RBM channel in tripped condition within one hour.

Ref: DOA 700-3; T.S. 3.2.C

8.6 (1) Outage of ECCS and primary components. Ops Eng.
(2) Outage of buses, transformer, DG's and bus til breakers (Until support Ops Eng.)
(3) Reliability related Equipment (Ops Eng)
(4) Outages of Fire Protection systems or equipment (Station Fire Marshal)

Ref: Dresden DAP 3-5, pg. 1-2

8.7. (1) Steady state thermal limit less than 50%
(2) MPCR limit increased by 0.03
(3) MPCR LCO is increased by 0.03
(4) MAPLHGR limit is reduced to 70% of current value
(5) APRM Scram and Rod Block setpoints and RBM setpoints reduced by 3.5%.
(6) Suction valve in idle loop closed
(7) APRM flux noise is less than 5% peak to peak over a half hour average
(8) Core plate delta p noise is less than 1psi peak to peak

Ref: T. S. Amend. 75, pg. 6

8.8. (a) At least five persons that do not include shift crew necessary for safe shutdown of plant and any personnel required for essential functions during the fire emergency.

8.9 (1) Stop any power changes in progress
(2) Compare readings. Main Stream Line radiation versus off gas, and flux tilt monitors and recorders.
(3) If main steam or off-gas bi rad alarms annunciate, adjust power down to keep activity below trip set point. (Reduce recirculation flow and/or insert rods)
(4) If off-gas Hi-Hi rad monitor annunciates, rapidly reduce power below the monitors trip point and reset off-gas monitor.
(5) If main steal line Hi-Hi rad alarms annunciate follow scram procedure and verify the automatic actions procedures.

(Note 4: Reset the monitors as soon as activity is below the set points. Off gas line will isolate if monitors are not reset within 15 minutes.