U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket Nos. 50-373; 50-374 Licenses No. NPF-11, NPF-18

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

Facility Name: LaSalle County Nuclear Station

Examination Administered At: LaSalle County Nuclear Station

Examination Conducted: April 16-18, 1984

Examiners: L. Dimmock — 5/22/84
L. Dimmock (Chief Examiner) Date

T. Lang — 5/22/84
T. Lang Date

G. Sly — 5/22/84
G. Sly Date

Approved By: J. I. McMillen, Chief — 5/22/84
J. I. McMillen, Chief Date
Operator Licensing Section

Examination Summary

Examination administered on April 16-18, 1984.
Written and oral examinations were administered to two SRO and three RO candidates. Written re-examinations were administered to two RO candidates.
Results: Two RO candidates and two SRO candidates successfully passed the required examinations and will be issued licenses.

DETAILS

1. Examiners

*L. Dimmock, NRC
G. Sly, PNL
T. Lang, NRC

*Chief Examiner

2. Examination Review Meeting

The exam review was conducted by the Chief Examiner and facility representatives as follows:

RO	SRO
L. Melanger	R. Crawford
S. Harmon	T. Shaffer
C. Kelly	S. Harmon

The written comments obtained form the facility for the RO exam contained one comment on a question. This stated that for question 1.3 "OTB should be used instead of DNB." As the examination was all ready completed, nothing could be done regarding this comment.

All other comments were either clarification or amplification of answers. As a result of the comments the following changes were made to the examination:

Question

1.2.b Due to the possibility that this question could be interpreted such that either true or false could be the correct response, this question was deleted.

2.2.a. Value of question was changed form 1.5 points to 1 point due to one portion of the answer key being in error due to an error in the reference material.

All other written comments for the RO exam affected only the answer key. All those that were found to be justified are included in the answer key.

The written comments obtained from the facility for the SRO exam affected only the answer key. All those that were found to be justified are included in the answer key.

3. Exit Meeting

At the conclusion of the site visit the examiners met with representatives of the plant staff to discuss the initial results of the oral examinations. Those individuals who clearly passed the oral examinations were identified in this meeting.

MASTER

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

Facility: LaSalle

Reactor Type: BWR

Date Administered: April 16, 1984

Examiner: G. A. Sly

Candidate: _____

INSTRUCTIONS TO CANDIDATE:

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

Category Value	% of Total	Candidate's Score	% of Cat. Value	Category
25	25			5. Theory of Nuclear Power Plant Operation, Fluids and Thermodynamics
25	25			6. Plant System Design, Control and Instrumentation
25	25			7. Procedures - Normal, Abnormal, Emergency, and Radiological Control
25	25			8. Administrative Procedures, Conditions, and Limitations
100				TOTALS

Final Grade _____ %

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

_____
Candidate's Signature

5.0 THEORY OF NUCLEAR POWER PLANT OPERATIONS, FLUIDS AND THERMODYNAMICS (25.0)

5.1 a. Assume the reactor is in the process of being shutdown; at time T = 0, the reactor pressure is 940 psig. At time T = 30 min, the reactor pressure is 560 psig. Has the cooldown rate been exceeded? Show how you arrived at your answer. (1.5)

b. Assuming the same conditions as in part "a" above, how much energy (per pound mass) has been removed from the reactor fluid? (Show work.) (1.25)

ANSWER

5.1 a. 940 psig = 955 psia T_{sat} = 539°F
560 psig = 575 psia T_{sat} 481.5°F
ΔT = 539 - 481.5°F = 57.5°F 105°F/hr
Cooldown = 100°F/hr
So cooldown has been exceeded, if continued for another 30 minutes

b. $Q = mc_p\Delta T$
$Q/m = c_p \Delta T = 1 \left(\frac{BTU}{lbm-°F}\right) * 57.5°F = 57.5 \frac{BTU}{lbm}$

Ref. LaSalle 25 LPSDC Pg. 6.

$Q = m \Delta h = (536.8 - 466.4 \frac{BTU}{lbm}) = 69.1 \frac{BTU}{lbm}$

5.2 The following questions are concerned with pumps:

a. A positive NPSH indicates that bubbles can't form at the pump suction. (True or False) (0.5)

b. The velocity of a fluid is greater on the discharge side of a pump than on the suction side because of the energy added to the fluid by the pump. (True or False) (0.5)

c. Fluid friction cause an increase in temperature of fluid flowing in a pipe and thus the enthalpy of the fluid increases as it flows through a pipe. (True or False.) Briefly explain why the above is true or false. (1.5)

ANSWER

5.2 a. True

b. False

c. False (.5) Enthalpy = U + Pv. Although the internal energy U is increased due to a rise in temperature the drop in Pv causes the enthalpy to remain unchanged.

Ref. 75 LPSDL pg. 32 and 34.

5.3 Your latest computer printout of MFLPD, MAPRAT, PKF shows the following values for Regions 1 to 3.

Region	1	2	3
MFLPD	0.95	1.0	1.05
MAPRAT	0.92	1.08	1.00
PKF	0.5	1.0	2.0

a. Are any of the values beyond their safety limits? If so which ones and what should the values be? (1.0)

b. Why are each of the above limits imposed? (What do they protect against?) (2.25)

ANSWER

5.3 a. MFLPD Region 3 <1.00 (0.5)
MAPRAT Region 2 <1.00 (0.5)

b. MFLPD - Maintains <1% cladding strain, fuel failure.

MAPRAT - Maintains <2200°F following LOCA, decay heat removal.

PKF - Radial peaking factor @ MFLCPR no direct protection, but a major factor in MCPR, LHGR, MAPLHGR.

Ref. LPRT 75 pg. 39, 41.

5.4 The following concerns the Critical Power Ratio (CPR).

a. Define CPR (1.0)

b. Maintaining high values of CPR (greater than 1.06) guarantees that no Boiling Transition will occur within the core (True or False). (0.5)

ANSWER

5.4 a. CPR is the ratio of the bundle power which would produce equilibrium quality equal to but not exceeding, the correlation value X_c, to the bundle power at the reactor condition of interest.

b. False

Ref. 74LPSOL pg. 19

a. $CPR = \frac{\text{Bundle power to produce onset of transition boiling}}{\text{actual bundle power.}}$

5.5 a. In the nuclear fission process, which is larger the Kinetic energy of fission fragments or the Kinetic energy of fission neutrons. (0.5)

b. Which of the above produces the most heat to generate reactor power? (0.5)

ANSWER

5.5 a. Kinetic energy of fission fragments.

b. Kinetic energy of fission fragments.

Ref. 1LPRT Figure 6

5.6 Does a power change from 40% power to 30% power take longer, shorter, or the same, as a power change from 40% to 50% power? (Assume constant rod speed.) Explain your answer. (1.0)

ANSWER

5.6 Longer, because the power down transient is limited by the decay of the long-lived delayed neutron precursors where the power up tansient is dependent only on prompt neutrons and short-lived delay neutron precursors.

5.7 a. List the three principal Reactivity Coefficients that affect LaSalle's nuclear reactor operations and their approximate value at BOL. (Do not use Power Coefficient) (1.5)

b. Which coefficient is the most significant (influential) to under the following conditions. first coefficient to turn power in the following conditions:

1. during rod drop accident
2. pulling rods at 1% power
3. MSIV closure. (1.5)

ANSWER

5.7 a. (~~0.5~~ 0.25 for each response; ~~0.5~~ 0.25 for each value)

Moderator coefficient = -1×10^{-4} $\Delta K/K$ / 1°F moderator
Doppler coefficient = -1×10^{-5} $\Delta K/K$ / 1°F fuel
Void coefficient = -1×10^{-3} $\Delta K/K$ / 1% void increased

b. 1. Doppler coefficient
2. Moderator coefficient
3. Void coefficient or Doppler due to proctors comment above.

Ref: 1LPRT 41, 46, 47

5.8 The LaSalle Reactor is taken to criticality from a cold condition and then placed on a 80 second positive period.

a. From control room nuclear instrumentation how can the operator tell when the heating range has been reached? (Rod position and recirc. are held constant). (1.0)

b. In which of the following intervals was the heating range entered? Explain the reason for your answer. (Show all work) (1.5)

Interval 1 - reactor power increased by a factor of 6 in 143.3 seconds

Interval 2 - reactor power increased by a factor of 5 in 128.8 seconds

Interval 3 - reactor power increased by a factor of 3 in 99.0 seconds.

(Note: the intervals may not be in sequence)

ANSWER

5.8 a. Operator can notice that period has become longer.

b. Interval 3 (0.5) the period has lengthened from 80 seconds. The other intervals have 80 second periods (1.0).

Ref. General control room indications.

5.9 Do the following situations cause an increase, decrease or have no affect on control rod worth: (2.0)

a. An increase in void fraction
b. An increase in fuel temperature
c. An increase in control rod density
d. An increase in moderator temperature

ANSWER

5.9 a. decrease (0.5)
b. decrease (0.5)
c. decrease (0.5)
d. increase (0.5)

Ref. 1 LPRT pg. 43, 44

5.10 a. What are the approximate values of the delayed fraction of neutrons, effective beta, at beginning and end of core life? (0.5)

b. Why does this change occur? (0.5)

c. What is the effect (if any) on reactor operation? Explain. (0.5)

ANSWER

5.10 a. 0.72% @ BOL 0.56% @ EOL

b. Buildup of Pu_{239} with core age.

c. Shorter period, core more responsive to same reactivity insertion later in core life.

Ref. 1 LPRT pg. 28

5.11 a. There are (7) seven sources, each producing 500 n/gen., installed in a empty reactor vessel. An assembly having a Keff = 0.75 is then loaded into the vessel. What is the maximum equilbrium neutron level achievable? (1.0)

b. Is K_{eff} dependent or independent of initial source range counts? Briefly explain your answer. (1.0)

ANSWER

5.11 a. N = S[1/(1 -Keff)] = 3500 (1/0.25) = 14,000 neuts/gen.

b. Independent (0.25) initial count rate doesn't affect the amount of reactivity required to go critical (CRP). The higher the count rate, the higher the count rate when criticality is reached (0.75). K_{eff} is independent of neutron level.

Ref. 1 LPRT pg. 25, 20, 17.

5.12 Describe the reason behind the shape of the Kexcess verses Exposure Curve. Include in your answer major deviation(s) in the curve and reason(s) for deviation(s). (Drawing of a figure may be helpful). (2.0)

ANSWER

5.12 1. Decreases due to Xe and Sm buildup.

2. Increases due to poison (Gd) burnup and Pu_{239} buildup (not to initial value)

3. Decreases to EOL due to fuel depletion.

Ref. 1LPRT pg. 57, figure 54

6.0 PLANT SYSTEMS DESIGN, CONTROL, AND INSTRUMENTATION

6.1 List four (4) independent sources of power to the 141Y (142Y) essential buses. (2.0)

ANSWER

6.1 (Any of four (4), 0.5 each.)

1. #1 offsite: Ring bus through SAT.
2. #2 offsite: Opposite ring bus through Unit 2 SAT & Unit ties.
3. #1 onsite: UAT & bus 141x(142x) ties.
4. #2 onsite: Diesel generators.
5. #1 offsite: Back feed through UAT with generator links removed.

Ref. LaSalle T.M. Chapter 42 pg 16 & 17.

6.2 a. What is the starting sequence for the LPCI pumps following an automatic initiation if:

1. normal auxiliary power exists (0.5)

2. normal auxiliary power doesn't exist. (0.5)

b. Upon automatic initiation of LPCI, does the water flow through the "A" and "B" RHR heat exchangers? Explain your answer. (1.0)

ANSWER

6.2 a. 1. All loops start instantly

2. "C" loop starts instantly, "A" and "B" loops delayed 5 seconds.

b. No (0.25) The heat exchanger bypass valves are interlocked open for 10 minutes; to ensure the maximum amount of water flow is available for injection (0.75). ? (Some water (though reduced amount) will flow through Hx's if Hx inlet and outlet valves are open while Hx bypass valve is open)

Facility comment

Ref. LLSD Chapter 39 pg. 20.

6.3 Describe the action of the following valves upon initiation of a scram, stating whether solenoid valve(s) energize or deenergize, air operated valves are pressurized or vented. Also, give a brief description of the function performed (e.g., lines vented).

a. Scram discharge volume vent/drain valves (0.75)

b. Scram pilot valves. (0.75)

c. Scram inlet and outlet valves. (0.75)

d. Back-up scram valves. (0.75)

ANSWER

6.3 a. Vented, all valves shut.

b. De-energize, bleed air from the associated scram valves.

c. Vented, open under piston area of CRD/vent over piston area of CRD.

d. Energize, bleed air from scram valves.

Ref. LaSalle Training Manual Chapter 20, pg. 11-15.
(0.25 for actuation type/0.5 for function.)

6.4 a. Since a low flow signal of less than 60 gpm will open the RCIC minimum flow valve, why doesn't the CST drain through this valve to the Suppression Pool when the RCIC system is not in service? (0.5)

b. How does the control logic of the RCIC turbine governor control system affect RCIC turbine speed during an emergency actuation? (Take discussion from system initiation to rated turbine speed). (1.0)

c. On the RCIC turbine exhaust line there are two pressure sensors. One upstream and one downstream of the exhaust line drain pot. What is the function of each sensor and where can the signals be monitored? (2.0)

ANSWER

6.4 a. You also need the discharge pressure to be greater than 125 psig.

b. By taking the minimum of the rated signal (600 gpm) and the ramp generator (0-600 gpm) over a 12 second period.

c. Upstream--is control room and local indication only ~~(1.5)~~ downstream--actuates at 25 psig to cause a trip of the RCIC turbine and initiate a C.R. alarm.

Ref. LaSalle T.M. Chapter 41, pg. 13, 20, 19.

6.5 While performing a diesel surveillance of D/G (0) with Unit 1, a high drywell signal occurs on Unit 2.

a. Does the D/G (0) auto transfer to the Unit 2 bus? Explain your response. (1.5)

b. If the D/G (0) also receives a high water temperature trip, what happens to D/G (0) operations? (1.0)

ANSWER

6.5 a. No, (0.5) the DG output breaker won't auto transfer because both bus breakers (1413 and 2413) are not both open. (1.0)

b. The D/G (0) will trip because it is still controlled by Unit 1. An 86 lockout relay stops the diesel and locks out the start signal. C.A.F.

Ref. LLSD Chapter 47, Figure 11, pg. 19, 21, and 22.

on either Unit

b. D/G(0) will not trip. LOCA signal disables High Cooling water temp. trip 86 device.

a. Also accept for reason DG breaker won't auto transfer because there is no undervoltage initiation on U-2 241Y.

6.6 a. If the reactor is operating at 75% power with the unit generator synched to the grid, and an operator depresses the "All Valves Closed" pushbutton on the S/U rate section of the EHC control panel, what will happen to the plant? Explain. (1.0)

b. Three runbacks are provided in the Load Control unit of the EHC system. What will initiate each runback and to what level will it runback load? (1.5)

ANSWER

6.6 a. Nothing will happen (0.5). Once a main generator output breaker is closed, 1800 rpm is locked in and cannot be deselected unless the turbine trips or the generator output breakers are both opened. (0.5) (1.0)

b. Load rejection--Will runback to zero. (0.5)

Synch Speed--Runback to near zero (2%). (0.5)

Loss of Stator Cooling--Runback to 25% (0.5)

Ref. LLSD Chapter 26, pg. 37, 12.

b. "Power Load Unbalance" para a. "Load Limiter"

6.7 a. What are the requirements regarding LPRM inputs to an APRM to be able to consider an APRM operable? (1.0)

b. If the requirements of part "a" were not met, would you be required to manually trip the circuitry? Explain your answer. (1.5)

ANSWER

6.7 a. To consider an APRM operable, there must be at least two LPRM's per level in addition to a total of one-half the LPRM inputs.

b. Yes, (0.5) If the total number of inputs falls below one-half the LPRMs, an APRM inop signal would automatically be generated by the count circuitry. But, if the requirement of at least two LPRM inputs per level is not met the circuitry will not automatically generate an inop trip--this must be operator initiated.

Ref. LLSD Chapter 14, pg. 10 and T.S. 3/4 3-5
T.S. Table 3.3.1-1.

a. Change to "At least 2 LPRM's/level and at least 14 LPRM inputs".

6.8 For the following valves, state to which isolation group they belong:

1. RWCU return from vessel (F004) (0.25)
2. RBCCW return from vessel (WR180, WR179). (0.25)
3. Steam inlet to RCIC turbine (E51-F008). (0.25)
4. MSIV inboard and outboard. (0.25)
5. Recirculation sample valves. (0.25)
6. RHR shutdown cooling supply (E12-F008). (0.25)

ANSWER

6.8
1. Group 5, pg. 18
2. Group 2, pg. 16
3. Group 8, pg. 21
4. Group 1, pg. 14
5. Group 3, pg. 16
6. Group 6, pg. 19.

Ref. LLSD Chapter 49.

6.9 a. The recirculation flow control valve position is limited during startup until two interlocks are met.

1. What is the limited valve position? (0.5)

2. What are the two interlocks which must be met to exceed the valve position in part "1"? (1.0)

b. What are the two conditions that will automatically switch the flux estimate from the filtered APRM signal to the raw APRM signal? (1.0)

ANSWER

6.9 a. 1. 10% position.

2. less than 2 RFP and greater than low level alarm point (31.5").

b. 1. If the actual APRM signal reaches 110%.

2. If a 5% difference exists between estimated and actual flux.

Ref. LLSD Chapter 6, pg. 19.

(Because startup may occur before recirc pump startup or reactor startup)

a.1. accept "Full open" on part 1

with

a.2. cavitation interlock "10.1° ΔT and < 30% feedwater flow."

6.10 With regard to the Feedwater Control System, what three (3) conditions must be verified by the operator before you could transfer from the motor speed changer to the electric automatic positioner? What is the reason for each condition. (1.5)

ANSWER

6.10 1. EAP control switch in auto (EAP @ HSS), bumpless transfer.

2. Solenoid SV-7 de-energized, EAP pilot valve operational.

3. MSC controlling, turbine speed, procedure not necessary.

Ref. LLSD Chapter 29, pg. 10, 8, 10.
0.5 for condition, 0.25 for reason)

See facility comments:

also any 3 manual conditions listed in LOI-FW-04 in facility comments package.

6.11 Answer whether the following concerning the Reactor Water Level Control System (RWLCS) are True or False:

a. The three (3) element control system can simultaneously control all three (3) feed pumps automatically. (0.5)

b. The "C" narrow range level channel is for indication only and does not input into the vessel level signal. (0.5)

c. Following a reactor scram from normal 100% power operation, the FWLCS auto transfers from three element to single element control of the motor driven feed pump. (0.5)

ANSWER

6.11 a. False (2) pg. 4

b. True pg. 12

c. True pg. 49, 50.

Ref. LLSD Chapter 31.

7.0 PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL

7.1 State which LGA (000-01 to 000-05) would have an entry condition of the following: (An answer may be used for more than one condition.)

a. RPV water level less than 12.5" (0.5)

b. Suppression pool temperature equal to 105°F. (0.5)

c. Reactor Scram (0.5)

d. Drywell pressure greater than 1.69 psig. (0.5)

ANSWER

7.1 a. Level Control (LGA-01)

b. Containment Control (LGA-03)

c. Level Control (LGA-01)

d. Level Control (LGA-01); Containment Control (LGA-03)

Ref. LaSalle LGA 01 to 05

c. also accept "Rx scram does not necessarily cause entry into an LGA".

7.2 a. As part of LOA-GA-01 (Loss of Hydrogen Coolers) immediate operator actions if you lose a section of a duplex Hydrogen Cooler you should reduce generator load to what value? (0.5)

b. In the subsequent actions of the same procedure, it states that the cold gas temperature should remain within a given range of operational values. What are the high and low operational limits andd what are the reasons for therm? (1.5)

ANSWER:

7.2 a. 80% generator load.

b. 33°C, (0.25) prevents condensation in generator casing.
46°C, (0.25) provides adequate cooling @ rated condtions.

Ref. LOA-GA-01 and LLSD Chapter 45 pg. 13

7.3 Reactor power operation with one recirculation pump is permitted provided that (5) five conditions are met. List four (4) of the five (5) conditions. (3.0)

ANSWER

7.3 a. The steady state thermal power doesn't exceed 50% of rated.

b. The Minimum Critical Power Ratio (MCPR) Safety Limit (T.S. 2.1.2) and Operating Limit (T.S. 3.2.3) are increase by 0.01.

c. The MAPLHGR limits are reduced by a factor of 0.85.

d. The APRM flow-biased scram and rod block setpoints and the RBM setpoints are reduced by 5.3%.

e. The APRM flux noise is not greater than 5% peak-to-peak and core plate d/p noise is not greater than 1 psi peak-to-peak (T.S. 3/4.4.1.1).

Ref. LaSalle LGP-1-2 pg. 6.

7.4 According to LGA-02 (RPV Pressure Reduction - ADS Failure) the operator is to rapidly reduce RPV pressure using systems that will minimize radioactive release. Arrange the following systems in increasing radioactive release order. (1.5)

a. Main steam line drains

b. Turbine driven feed pumps

c. Main turbine bypass valves

d. RCIC

e. RHR steam condensing mode

f. RWCU coolant rejection

ANSWER

from facility comments.

7.4 a. 4 — 1 - d
b. 2 — 2 - e
c. 1 — 3 - f
d. 3 — 4 - b
e. 5 — 5 - c
f. 6 — 6 - a

Ref. LaSalle LGA-C2 pg. 2.

7.5 According to the precautions in LGP-1-2 (Unit Startup to Hot Standby), additional caution should be used when pulling control rods in the region of criticality to avoid short periods. How would the following reactor conditions or characteristics influence the point of criticality? (3.0)

1. Xenon Concentration
2. Control Rod Position
3. Order of Withdrawal
4. Core Exposure.

ANSWER

7.5 1. Xenon Concentration - Xenon tends to suppress the flux in previously high powered regions of the core (generally bottom and center). Rod worth is, therefore, diminished in high Xenon concentration regions and enhanced in other regions.

2. Control Rod Position - The zero power worth of a control rod depends on its axial position greater rod worth in central region of pull.

3. Order of Withdrawal - If the rods of an array are defined such that sufficient radial separation is maintained, the flux will be losely coupled and the rods may be withdrawn in sequential order with decreasing rod worths (i.e. the first rod of a group is generally worth more than successive rods in that group).

4. Core Exposure - After an initial decrease due to Samarium build in core reactivity will increase. This will result in a trend toward earlier criticalities during the first point of the fuel cycle.

Ref. La Salle LGP-1-2 pg. 4, 5

7.6 What tests or verifications are necessry to demonstrate that each SRM channel is operable prior to and during core alterations? (2.25)

ANSWER

Demonstrate each SRM channel to be operable by:

a. Performing a channel check, channel function test

b. Verifying that the SRM count rate is at least 3.0 cps

c. Verifying that a detector of an operable SRM channel is located in the core quadrant where core alterations are being performed and one operable SRM channel is located in an adjacent quadrant and that the detectors are fully inserted.

Ref.LFP-100-1 PG. 2,3

b. > 0.7 spec 3.0 cps if sig./noise ratio is less than 2:1.

7.7 The Reactor Operator reports that he has high area radiation in the off gas area and that the off gas system pressure experienced an abnormally high pressure spike followed by a pressure reduction.

a. What would you conclude has happened? (0.5)

b. What would be (3) three immediate action that you would perform according to the procedure in part "b"? (1.5)

ANSWER

7.7 a. LOA-OG-02 (Off Gas Hydrogen Explosion)

b. IMMEDIATE ACTIONS

(any 3, at 0.5 each)

1. PERFORM an immediate load reduction in accordance with LOA-OG-01, Load Reduction for Off Gas Emergency.

2. WARN all personnel to stay clear of Off Gas areas.

3. NOTIFY the Shift Supervisor and the Load Dispatcher of the load reduction.

4. CHECK that the Adsorber Bed High Temperature alarm remains CLEAR.

5. CHECK all Off Gas Area Radiation Monitors for increased radiation levels.

7.8 According to LOA-NB-09 (Transient with Failure to Scram), what conditions would necessitate the actuation of the Standby Liquid Control System? (2.0)

ANSWER

7.8 If (5) five or more adjacent rods are not inserted to at least notch position 06 or thirty (30) or more rods are not inserted to at least notch position 06 (1.0) and Reactor Vessel water level cannot be maintained above + 12.5" or Suppression Pool Temperature reaches 110°F. (1.0)

Ref. LaSalle LOA-NB-09, pg. 3

7.9 While on his rounds an Auxiliary Operator notices leakage of a black substance from the SAT 142 Transformer. The decision is made to take it out of service (OOS) for maintenance. The plant is at 100% normal power operation.

a. What buses should be transferred to UAT 142 before taking SAT 141 OOS. (1.5)

b. What Tech. Spec. concerns would you have with SAT 142 Out of Service. (Consider only the first (8) eight hours following SAT 142 OOS) (1.0)

ANSWER

7.9 a. 1. 152
2. 141-Y
3. 142-Y

b. Must demonstrate operability of
1. remaining A.C. sources within one hour.
2. test diesels one at a time within 4 hours. → N.A. > 1hr.

Ref. LaSalle LOA-AP-01, T.Spec 3/4.8, pg 3/4 8-1

& also accept 142X

7.10 a. What are the indications of a stuck rod? (1.0)

b. When attempting to move the stuck rod the Reactor Operator observes the control rod drive flow to fluctuate abnormally. What (2) two conditions could cause this fluctuation? (1.5)

ANSWER

7.10 a. 1. Rod Position Indication does not change

2. Nuclear Instrumentation does not respond.

b. 1. Air in insert and/or withdraw lines

2. bad drive seals (other reasonable answers acceptable).

Ref. LaSalle LOA-RD-01, pg. 1, 2

7.11 According to LOA-NB-02 (Stuck Open Safety Relief Valve), what are the (3) three operational limits which would require you to scram the reactor? (2.25)

ANSWER

7.11 1. Valve open after (4) four attempts to close it or

2. The pool temperature monitoring system indicates 110°F or

3. (2) two minutes have elapsed since valve opened.

Ref. LaSalle LOA-NB-02

8.0 ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS

8.1 For each of the following conditions, state the reason (bases), per Tech. Specs., each system is considered inoperable (i.e., why it cannot perform its intended function).

a. A drywell suppression chamber vacuum breaker cannot be completely shut and has no position indication. (0.75)

b. The chloride concentration has been reported to be greater than 0.3 ppm for 100 hrs. (0.75)

c. While performing a scram discharge volume vent and drain valve test, it is reported that the drain valve won't cycle closed. (0.75)

d. The Auxiliary Operator reports that the Standby Liquid Control tank temperature is 58°F. (0.75)

ANSWER

a. Excessive drywell to pressure suppression chamber leak rate and bypass of the suppression pool on a LOCA, pg. B 3/4 6-4.

b. Prevent stress corrosion of stainless steel (not fuel). Pg. B 3/4 4-2.

c. Scram discharge volume is unable to isolate the reactor from the environment. Pg. B 3/4 1-2.

d. Tank temperature too low; potential for boron to precipitate out. Pg. B 3/4 1.5.

Ref. LaSalle T/S.

8.2 Technical Specifications (6.1.c), designates the total minimum shift compliment with both Unit 1 and Unit 2 in Condition 1? List by their title the number of individuals required, license held, and unit assigned. (3.0)

ANSWER

Answer	License	Assigned
1 SE	SRO: both units	both units
1 SF	SRO: both units	both units
3 RO	RO:1 both units 1 each unique unit	1 each unit; 1 both units
3 AO	No license	1 each unit; 1 both units
1 SCRE/STA	SRO	both units

0.2 points for each correct response.

Ref. Unit 2 T/S 6.1.c Fig. 6.1-3 pg. 6-13

8.3 a. State the (2) two Technical Specification Thermal Power Safety Limits. (2.0)

b. Why is there a need for two (2) limits? (0.5)

ANSWER

a. 1. Low Pressure, Low Flow:
Thermal power shall not exceed 25% of rated thermal power with the reactor vessel steam dome pressure less than 785 psig or core flow less than 10% rated flow.

2. High Pressure, High Flow:
The Minimum Critical Power Ratio (MCPR) shall not be less than 1.06 with the reactor steam dome greater than 785 psig and core flow greater than 10% of rated flow.

b. The two limits are needed to cover all ranges of reactor operation.

Ref. T/S 2.1 and B.2-1, B-2-3

8.4 a. The plant is in the process of starting up (Condition 2) with all systems and components normal except that the "A" IRM has previously failed high and was subsequently bypassed. The "C" IRM now loses power and is declared inoperative. May the plant continue in this Condition for an extended period of time without being in violation of Tech. Specs? Also give the appropriate action statement. (1.5)

b. Could you place the mode switch in run (Condition 1) to bypass the action statement in part "A". Explain your answer. (1.5)

ANSWER

a. Yes, (0.5) place the RPS A channel in the tripped position within one hour. (1.0)

b. ~~No, (0.5) entry into an operational condition, or other specified condition, shall not be made unless the conditions for the LCO are met. (1.0)~~ N.A.

Ref. T/S 3/4.3 pg. 3/4 3-1, 3-2 / pg. 3/4 0-1

b. Yes (0.5) Specification 3.0.4 doesn't apply, (1.0) according to T/S 3/4.3 pg. 3/4 3-1.

8.5 What must be done in the event of a safety limit being exceeded? (1.5)

ANSWER

The reactor shall be shutdown immediately and reactor operation shall not be resumed until authorized by the NRC. The condition of shutdown shall be promptly reported to the Division Vice President, Nuclear Station or his designated alternate.

Ref. LaSalle Tech. Specs. Section 6.4 pg 6-19

8.6 Concerning Procedure LGP-3-2 (Reactor Scram), fill in the blank with an appropriate word or phrase:

a. Place the mode switch to shutdown prior to the reactor pressure decreasing to _____ psig. (0.5)

b. If it becomes necessary to raise reactor water level, do so _____ to minimize _____. (1.0)

c. Limit cooldown rate to less than or equal to _____ °F/hr. (0.5)

d. Under emergency conditions, when Control Rod Drive Pumps are being used as a source of makeup to the reactor vessel, _____ the scram. (0.5)

ANSWER

a. ~~845~~ 854 psig
b. slowly, thermal shock
c. 100
d. DO NOT reset.

Ref. LGP-3-2, pg. 2

8.7 In regard to implementation of a Temporary System Change on a Backshift or Weekend:

a. What are the administrative approvals/authorizations required before a Temporary System Change may be implemented? (1.0)

b. Where will the original copy of the Temporary System Change be filed? (0.5)

ANSWER

a. 1. Safety evaluation - reviewed by 2 SRO.

2. Authorized by S.E.

b. The original goes to the onsite review committee while a copy of the original is filed in the S.E. office. Upon completion of the onsite review, the copy in the S.E. office is replaced with the original.

Ref. LAP-240-6 pg. 3, 4

8.8 In the event of an accident situation, what are the initial responsibilities of the:

a. Shift Engineer (1.0)

b. SCRE. (1.0)

c. Cognizant Shift Foreman. (1.0)

ANSWER

a. During an accident the Shift Engineer shall within 10 minutes establish himself in the Control Room and shall remain as the command authority in the Control Room until the transient has stabilized or until properly relieved.

b. The Shift Control Room Engineer will act as an advisor to the Shift Engineer during an accident condition.

c. During an accident the cognizant Shift Foreman shall within 10 minutes report to the Control Room. He will be available to perform any function as directed by the Shift Engineer including direct supervision of the Control Room and plant operations.

Ref. LaSalle LAP-200-5, pg. 1

8.9 State whether the following examples would constitute the filing of a radiation occurrence report. Answer yes or no and give a brief explanation for your response.

a. At a frisking station it is found that the Unit 1 A.O. has received 0.5 mR above background clothing contamination. (0.75)

b. Radiation Protection monitors a one-hour dose rate of 100 millirem at the edge of a Radiation Area. (0.75)

c. While performing maintenance on the RFP one worker of three drops his self reading dosimeter. (0.75)

d. A 30 year old worker with a cumulative dose of 50 rem receives 2 rem in one quarter with administrative approval. (0.75)

ANSWER

a. No, the limit is 1 mR.

b. Yes, the room is miss-posted because anywhere inside should exceed 100 millirems measured at the edge.

c. No, still has adequate dosimetry. (second dosimeter)

d. No, as long as admin. approved he could receive up to 3 rem. 5(n-18) = 60 rem maximum.

Ref. LRP 1000-1 pg. 25, 24, 25, 24-25

8.10 State whether each of the following statements are True or False:

a. During shutdown margin tests, with the head removed, all personnel are prohibited entry to the refueling floor. (0.5)

b. Core alterations shall be observed and directly supervised by either a licensed Senior Reactor Operator or SRO limited to Fuel Handling from the refueling deck. (0.5)

c. During core alterations, two (2) SRMs shall be operable, one in the core quadrant where the fuel is being moved and one in an adjacent quadrant or one in each of the adjacent quadrants of where fuelis being moved. (0.5)

d. A fuel array of four (4) bundles outside of normal fuel storage areas or properly designed fuel shipping container is prohibited. (0.5)

ANSWER

a. True LAP 100-6 pg. 3

b. True Tech Spec. Section 6 pg. 6-1

c. False LFP-100-1 pg. 2

d. True LFP-100-1 pg. 6

EQUATION SHEET

Where $\dot{m}_1 = \dot{m}_2$

$(\text{density})_1(\text{velocity})_1(\text{area})_1 = (\text{density})_2(\text{velocity})_2(\text{area})_2$

$KE = \frac{mv^2}{2}$ $\quad PE = mgh$ $\quad PE_1+KE_1+P_1V_1 = PE_2+KE_2+P_2V_2$ where V = specific volume, P = Pressure

$Q = \dot{m}c_p(T_{out}-T_{in})$ $\quad Q = UA\,(T_{ave}-T_{stm})$ $\quad Q = \dot{m}(h_1-h_2)$

$P = P_0 10^{sur(t)}$ $\quad P = P_0 e^{t/T}$ $\quad SUR = \frac{26.06}{T}$ $\quad N = S\left[\frac{1}{1-K_{eff}}\right]$

delta $K = (K_{eff}-1)/K_{eff}$ $\quad CR_1(1-K_{eff1}) = CR_2(1-K_{eff2})$

$M = \frac{(1-K_{eff1})}{(1-K_{eff2})}$ $\quad SDM = \frac{(1-K_{eff}) \times 100\%}{K_{eff}}$

decay constant $= \frac{\ln(2)}{t_{1/2}} = \frac{0.693}{t_{1/2}}$ $\quad A = A_0 e^{-(\text{decay constant})x(t)}$

Water Parameters

1 gallon = 8.345 lbs
1 gallon = 3.78 liters

$1\ ft^3 = 7.48$ gallons

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 psia = 29.9 in Hg

Miscellaneous Conversions

1 Curie = 3.7×10^{10} dps
1 kg = 2.21 lbs

1 hp = 2.54×10^3 Btu/hr

1 Mw = 3.41×10^6 Btu/hr

1 inch = 2.54 centimeters
Degrees F = (1.8) x (Degrees C) + 32
1 Btu = 778 ft-lbf
g = 32.174 $ft\text{-}lbm/lbf\text{-}sec^2$

Table 1. Saturated Steam: Temperature Table

Temp Fahr t	Abs Press. Lb per Sq In. p	Specific Volume: Sat. Liquid v_f	Evap v_{fg}	Sat. Vapor v_g	Enthalpy: Sat. Liquid h_f	Evap h_{fg}	Sat. Vapor h_g	Entropy: Sat. Liquid s_f	Evap s_{fg}	Sat. Vapor s_g	Temp Fahr t
32.0*	0.08859	0.016022	3304.7	3304.7	−0.0179	1075.5	1075.5	0.0000	2.1873	2.1873	32.0*
34.0	0.09600	0.016021	3061.9	3061.9	1.995	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	79.93	1030.2	1110.2	0.1507	1.8021	1.9528	112.0
114.0	1.4299	0.016180	238.21	238.22	81.97	1029.1	1111.0	0.1542	1.7938	1.9480	114.0
116.0	1.5133	0.016188	225.84	225.85	83.97	1027.9	1111.9	0.1577	1.7856	1.9433	116.0
118.0	1.6009	0.016196	214.20	214.21	85.97	1026.8	1112.7	0.1611	1.7774	1.9386	118.0
120.0	1.6927	0.016204	203.25	203.26	87.97	1025.6	1113.6	0.1646	1.7693	1.9339	120.0
122.0	1.7891	0.016213	192.94	192.95	89.96	1024.5	1114.4	0.1680	1.7613	1.9293	122.0
124.0	1.8901	0.016221	183.23	183.24	91.96	1023.3	1115.3	0.1715	1.7533	1.9247	124.0
126.0	1.9959	0.016229	174.08	174.09	93.96	1022.2	1116.1	0.1749	1.7453	1.9202	126.0
128.0	2.1068	0.016238	165.45	165.47	95.96	1021.0	1117.0	0.1783	1.7374	1.9157	128.0
130.0	2.2230	0.016247	157.32	157.33	97.96	1019.8	1117.8	0.1817	1.7295	1.9112	130.0
132.0	2.3445	0.016256	149.64	149.66	99.95	1018.7	1118.6	0.1851	1.7217	1.9068	132.0
134.0	2.4717	0.016265	142.40	142.41	101.95	1017.5	1119.5	0.1884	1.7140	1.9024	134.0
136.0	2.6047	0.016274	135.55	135.57	103.95	1016.4	1120.3	0.1918	1.7063	1.8980	136.0
138.0	2.7438	0.016284	129.09	129.11	105.95	1015.2	1121.1	0.1951	1.6986	1.8937	138.0
140.0	2.8892	0.016293	122.98	123.00	107.95	1014.0	1122.0	0.1985	1.6910	1.8895	140.0
142.0	3.0411	0.016303	117.21	117.22	109.95	1012.9	1122.8	0.2018	1.6534	1.8852	142.0
144.0	3.1997	0.016312	111.74	111.76	111.95	1011.7	1123.6	0.2051	1.6759	1.8810	144.0
146.0	3.3653	0.016322	106.58	106.59	113.95	1010.5	1124.5	0.2084	1.6683	1.8769	146.0
148.0	3.5381	0.016332	101.68	101.70	115.95	1009.3	1125.3	0.2117	1.6610	1.8727	148.0
150.0	3.7184	0.016343	97.05	97.07	117.95	1008.2	1126.1	0.2150	1.6536	1.8686	150.0
152.0	3.9065	0.016353	92.66	92.68	119.95	1007.0	1126.9	0.2183	1.6463	1.8646	152.0
154.0	4.1025	0.016363	88.50	88.52	121.95	1005.8	1127.7	0.2216	1.6390	1.8606	154.0
156.0	4.3068	0.016374	84.56	84.57	123.95	1004.6	1128.6	0.2248	1.6318	1.8566	156.0
158.0	4.5197	0.016384	80.82	80.83	125.96	1003.4	1129.4	0.2281	1.6245	1.8526	158.0
160.0	4.7414	0.016395	77.27	77.29	127.96	1002.2	1130.2	0.2313	1.6174	1.8487	160.0
162.0	4.9722	0.016406	73.90	73.92	129.96	1001.0	1131.0	0.2345	1.6103	1.8448	162.0
164.0	5.2124	0.016417	70.70	70.72	131.96	999.8	1131.8	0.2377	1.6032	1.8409	164.0
166.0	5.4623	0.016428	67.67	67.68	133.97	998.6	1132.6	0.2409	1.5961	1.8371	166.0
168.0	5.7223	0.016440	64.78	64.80	135.97	997.4	1133.4	0.2441	1.5892	1.8333	168.0
170.0	5.9926	0.016451	62.04	62.06	137.97	996.2	1134.2	0.2473	1.5822	1.8295	170.0
172.0	6.2736	0.016463	59.43	59.45	139.98	995.0	1135.0	0.2505	1.5753	1.8258	172.0
174.0	6.5656	0.016474	56.95	56.97	141.98	993.8	1135.8	0.2537	1.5684	1.8221	174.0
176.0	6.8690	0.016486	54.59	54.61	143.99	992.6	1136.6	0.2568	1.5616	1.8184	176.0
178.0	7.1840	0.016498	52.35	52.36	145.99	991.4	1137.4	0.2600	1.5548	1.8147	178.0

*The states shown are metastable

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

Temp Fahr t	Abs Press Lb per Sq In. p	Specific Volume Sat. Liquid v_f	Evap v_{fg}	Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Evap h_{fg}	Sat. Vapor h_g	Entropy Sat. Liquid s_f	Evap s_{fg}	Sat. Vapor s_g	Temp Fahr t
180.0	7.5110	0.016510	50.21	50.22	148.00	990.2	1138.2	0.2631	1.5480	1.8111	180.0
182.0	7.850	0.016522	48.172	48.189	150.01	989.0	1139.0	0.2662	1.5413	1.8075	182.0
184.0	8.203	0.016534	46.232	46.249	152.01	987.8	1139.8	0.2694	1.5346	1.8040	184.0
186.0	8.568	0.016547	44.383	44.400	154.02	986.5	1140.5	0.2725	1.5279	1.8004	186.0
188.0	8.947	0.016559	42.621	42.638	156.03	985.3	1141.3	0.2756	1.5213	1.7969	188.0
190.0	9.340	0.016572	40.941	40.957	158.04	984.1	1142.1	0.2787	1.5148	1.7934	190.0
192.0	9.747	0.016585	39.337	39.354	160.05	982.8	1142.9	0.2818	1.5082	1.7900	192.0
194.0	10.168	0.016598	37.808	37.824	162.05	981.6	1143.7	0.2848	1.5017	1.7865	194.0
196.0	10.605	0.016611	36.348	36.364	164.06	980.4	1144.4	0.2879	1.4952	1.7831	196.0
198.0	11.058	0.016624	34.954	34.970	166.08	979.1	1145.2	0.2910	1.4888	1.7798	198.0
200.0	11.526	0.016637	33.622	33.639	168.09	977.9	1146.0	0.2940	1.4824	1.7764	200.0
202.0	12.512	0.016664	31.135	31.151	172.11	975.4	1147.5	0.3001	1.4697	1.7698	202.0
208.0	13.568	0.016691	28.862	28.878	176.14	972.8	1149.0	0.3061	1.4571	1.7632	208.0
212.0	14.696	0.016719	26.782	26.799	180.17	970.3	1150.5	0.3121	1.4447	1.7568	212.0
216.0	15.901	0.016747	24.878	24.894	184.20	967.8	1152.0	0.3181	1.4323	1.7505	216.0
220.0	17.185	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	1156.2	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	1.7259	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	1.6809	264.0
268.0	40.500	0.017157	10.358	10.375	236.91	933.1	1170.0	0.3932	1.2823	1.6755	268.0
272.0	43.249	0.017193	9.738	9.755	240.99	930.3	1171.3	0.3987	1.2715	1.6702	272.0
276.0	46.147	0.017228	9.162	9.180	245.08	927.5	1172.5	0.4043	1.2607	1.6650	276.0
280.0	49.200	0.017264	8.627	8.644	249.17	924.6	1173.8	0.4098	1.2501	1.6599	280.0
284.0	52.414	0.01730	8.1280	8.1453	253.3	921.7	1175.0	0.4154	1.2395	1.6548	284.0
288.0	55.795	0.01734	7.6634	7.6807	257.4	918.8	1176.2	0.4208	1.2290	1.6498	288.0
292.0	59.350	0.01738	7.2301	7.2475	261.5	915.9	1177.4	0.4263	1.2186	1.6449	292.0
296.0	63.084	0.01741	6.8259	6.8433	265.6	913.0	1178.6	0.4317	1.2082	1.6400	296.0
300.0	67.005	0.01745	6.4483	6.4658	269.7	910.0	1179.7	0.4372	1.1979	1.6351	300.0
304.0	71.119	0.01749	6.0955	6.1130	273.8	907.0	1180.9	0.4426	1.1877	1.6303	304.0
308.0	75.433	0.01753	5.7655	5.7830	278.0	904.0	1182.0	0.4479	1.1776	1.6256	308.0
312.0	79.953	0.01757	5.4566	5.4742	282.1	901.0	1183.1	0.4533	1.1676	1.6209	312.0
316.0	84.688	0.01761	5.1673	5.1849	286.3	897.9	1184.1	0.4586	1.1576	1.6162	316.0
320.0	89.643	0.01766	4.8961	4.9138	290.4	894.8	1185.2	0.4640	1.1477	1.6116	320.0
324.0	94.826	0.01770	4.6418	4.6595	294.6	891.6	1186.2	0.4692	1.1378	1.6071	324.0
328.0	100.245	0.01774	4.4030	4.4208	298.7	888.5	1187.2	0.4745	1.1280	1.6025	328.0
332.0	105.907	0.01779	4.1788	4.1966	302.9	885.3	1188.2	0.4798	1.1183	1.5981	332.0
336.0	111.820	0.01783	3.9681	3.9859	307.1	882.1	1189.1	0.4850	1.1086	1.5936	336.0
340.0	117.992	0.01787	3.7699	3.7878	311.3	878.8	1190.1	0.4902	1.0990	1.5892	340.0
344.0	124.430	0.01792	3.5834	3.6013	315.5	875.5	1191.0	0.4954	1.0893	1.5847	344.0
348.0	131.142	0.01797	3.4078	3.4258	319.7	872.2	1191.1	0.5006	1.0799	1.5806	348.0
352.0	138.138	0.01801	3.2423	3.2603	323.9	868.9	1192.7	0.5058	1.0705	1.5763	352.0
356.0	145.424	0.01805	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	1.5235	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	0.5865	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	1.30256	1.32179	410.1	793.9	1204.0	0.6063	0.8903	1.4966	432.0
436.0	366.03	0.01919	1.24387	1.25806	414.6	789.7	1204.2	0.6112	0.8816	1.4928	436.0
440.0	381.54	0.01926	1.19761	1.21637	419.0	785.4	1204.4	0.6161	0.8729	1.4890	440.0
444.0	397.56	0.01933	1.14874	1.16806	423.5	781.1	1204.6	0.6210	0.8643	1.4853	444.0
448.0	414.09	0.01940	1.10212	1.12152	428.0	776.7	1204.7	0.6259	0.8557	1.4815	448.0
452.0	431.14	0.01947	1.05764	1.07711	432.5	772.3	1204.8	0.6308	0.8471	1.4778	452.0
456.0	448.73	0.01954	1.01518	1.03472	437.0	767.8	1204.8	0.6356	0.8385	1.4741	456.0

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

Temp Fahr t	Abs Press. Lb per Sq In. p	Specific Volume Sat. Liquid v_f	Evap v_{fg}	Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Evap h_{fg}	Sat. Vapor h_g	Entropy Sat. Liquid s_f	Evap s_{fg}	Sat. Vapor s_g	Temp Fahr t
460.0	466.87	0.01961	0.97463	0.99424	441.5	763.2	1204.8	0.6405	0.8299	1.4704	460.0
464.0	485.56	0.01959	0.93588	0.95557	446.1	758.6	1204.7	0.6454	0.8213	1.4667	464.0
468.0	504.83	0.01976	0.89895	0.91862	450.7	754.0	1204.6	0.6502	0.8127	1.4629	468.0
472.0	524.67	0.01984	0.86345	0.88329	455.2	749.3	1204.5	0.6551	0.8042	1.4592	472.0
476.0	545.11	0.01992	0.82958	0.84950	459.9	744.5	1204.3	0.6599	0.7956	1.4555	476.0
480.0	566.15	0.02000	0.79716	0.81717	464.5	739.6	1204.1	0.6648	0.7871	1.4518	480.0
484.0	587.81	0.02009	0.76613	0.78622	469.1	734.7	1203.8	0.6696	0.7785	1.4481	484.0
488.0	610.10	0.02017	0.73641	0.75658	473.8	729.7	1203.5	0.6745	0.7700	1.4444	488.0
492.0	633.03	0.02026	0.70794	0.72820	478.5	724.6	1203.1	0.6793	0.7614	1.4407	492.0
496.0	656.61	0.02034	0.68065	0.70100	483.2	719.5	1202.7	0.6842	0.7528	1.4370	496.0
500.0	680.86	0.02043	0.65448	0.67492	487.9	714.3	1202.2	0.6890	0.7443	1.4333	500.0
504.0	705.78	0.02053	0.62938	0.64991	492.7	709.0	1201.7	0.6939	0.7357	1.4296	504.0
508.0	731.40	0.02062	0.60530	0.62592	497.5	703.7	1201.1	0.6987	0.7271	1.4258	508.0
512.0	757.72	0.02072	0.58218	0.60289	502.3	698.2	1200.5	0.7036	0.7185	1.4221	512.0
516.0	784.76	0.02081	0.55997	0.58079	507.1	692.7	1199.8	0.7085	0.7099	1.4183	516.0
520.0	812.53	0.02091	0.53864	0.55956	512.0	687.0	1199.0	0.7133	0.7013	1.4146	520.0
524.0	841.04	0.02102	0.51814	0.53916	516.9	681.3	1198.2	0.7182	0.6926	1.4108	524.0
528.0	870.31	0.02112	0.49843	0.51955	521.8	675.5	1197.3	0.7231	0.6839	1.4070	528.0
532.0	900.34	0.02123	0.47947	0.50070	526.8	669.6	1196.4	0.7280	0.6752	1.4032	532.0
536.0	931.17	0.02134	0.46123	0.48257	531.7	663.6	1195.4	0.7329	0.6665	1.3993	536.0
540.0	962.79	0.02146	0.44367	0.46513	536.8	657.5	1194.3	0.7378	0.6577	1.3954	540.0
544.0	995.22	0.02157	0.42677	0.44834	541.8	651.3	1193.1	0.7427	0.6489	1.3915	544.0
548.0	1028.49	0.02169	0.41048	0.43217	546.9	645.0	1191.9	0.7476	0.6400	1.3876	548.0
552.0	1062.59	0.02182	0.39479	0.41660	552.0	638.5	1190.6	0.7525	0.6311	1.3837	552.0
556.0	1097.55	0.02194	0.37966	0.40160	557.2	632.0	1189.2	0.7575	0.6222	1.3797	556.0
560.0	1133.38	0.02207	0.36507	0.38714	562.4	625.3	1187.7	0.7625	0.6132	1.3757	560.0
564.0	1170.10	0.02221	0.35099	0.37320	567.6	618.5	1186.1	0.7674	0.6041	1.3716	564.0
568.0	1207.72	0.02235	0.33741	0.35975	572.9	611.5	1184.5	0.7725	0.5950	1.3675	568.0
572.0	1246.26	0.02249	0.32429	0.34678	578.3	604.5	1182.7	0.7775	0.5859	1.3634	572.0
576.0	1285.74	0.02264	0.31162	0.33426	583.7	597.2	1180.9	0.7825	0.5766	1.3592	576.0
580.0	1326.17	0.02279	0.29937	0.32216	589.1	589.9	1179.0	0.7876	0.5673	1.3550	580.0
584.0	1367.7	0.02295	0.28753	0.31048	594.6	582.4	1176.9	0.7927	0.5580	1.3507	584.0
588.0	1410.0	0.02311	0.27608	0.29919	600.1	574.7	1174.8	0.7978	0.5485	1.3464	588.0
592.0	1453.3	0.02328	0.26499	0.28827	605.7	566.8	1172.6	0.8030	0.5390	1.3420	592.0
596.0	1497.8	0.02345	0.25425	0.27770	611.4	558.8	1170.2	0.8082	0.5293	1.3375	596.0
600.0	1543.2	0.02364	0.24384	0.26747	617.1	550.6	1167.7	0.8134	0.5196	1.3330	600.0
604.0	1589.7	0.02382	0.23374	0.25757	622.9	542.2	1165.1	0.8187	0.5097	1.3284	604.0
608.0	1637.3	0.02402	0.22394	0.24796	628.8	533.6	1162.4	0.8240	0.4997	1.3238	608.0
612.0	1686.1	0.02422	0.21442	0.23865	634.8	524.7	1159.5	0.8294	0.4896	1.3190	612.0
616.0	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	0.09793	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
0.01355	32.018	0.016022	3302.4	3302.4	0.0003	1075.5	1075.5	0.0000	2.1872	2.1872	0.01355
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	227.95	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	7.1552	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	0.01795	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	2.2683	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	2.05779	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	1.89309	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	1.52354	1.54274	394.0	808.9	1202.9	0.5882	0.9223	1.5105	300.0
350.0	431.73	0.01912	1.30942	1.32854	409.8	794.2	1204.0	0.6059	0.8909	1.4968	350.0
400.0	444.60	0.01934	1.14162	1.16025	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	0.7554	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	0.58830	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	0.45054	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	0.32305	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	0.8159	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	0.12405	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	0.9133	0.3206	1.2315	2500.0
2600.0	673.91	0.02933	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	684.95	0.03134	0.07171	0.10305	770.7	285.1	1055.8	0.9469	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

MASTER

U.S. NUCLEAR REGULATORY COMMISSION

REGION III

FACILITY: LaSalle
REACTOR TYPE: BWR
DATE ALMINISTERED: April 16, 1984
EXAMINER: L. Dimmock
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	
25.0	25.0	____	____	1. Principles of Nuclear Power Plant Operations, Thermodynamics, Heat Transfer and Fluid Flow
25.0	25.0	____	____	2. Plant Design Including Safety and Emergency Systems
25.0	~~24.8~~ 25.0	____	____	3. Instruments and Controls
25.0	~~24.8~~ 25.0	____	____	4. Procedures - Normal, Abnormal, Emergency and Radiological Control
100.0	____	____	____	TOTALS

Final Grade _____%

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

_____
Applicant's Signature

1. PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW (25.5)

1.1 The following MULTIPLE CHOICE questions concern SUBCRITICAL MULTIPLICATION. SELECT the ONE CORRECT ANSWER in parts (a) and (b) below.

a. SUBCRITICAL COUNT RATE is: (0.5)

(1) Inversely proportional to S (source strength) and proportional to k-eff,

(2) Proportional to S and k-eff,

(3) Inversely proportional to S and k-eff,

(4) Proportional to S and inversely proportional to k-eff.

b. A LARGER multiplication factor, K, results in: (0.5)

(1) A smaller neutron population when critical is reached,

(2) A longer time to reach the steady state value of subcritical neutron population,

(3) More control rod withdrawal to reach critical,

(4) A shorter time to reach the steady state value of subcritical neutron population.

1.2 a. Define Critical Power Ratio. (1.0)

b. ~~True/False. A CPR of 1.0 for a fuel bundle means that transition boiling is occuring somewhere along that bundle length. (0.5)~~ DELETED

1.3 Match the FAILURE MECHANISM from column "1" and the LIMITING CONDITIONS from column "2" with associated POWER DISTRIBUTION LIMITS (a-c) below. (3.0)

a. Linear Heat Generation Rate (LHGR)

b. Average Planer Linear Heat Generation Rate (APLHGR)

c. Minimum Critical Power Ratio (MCPR)

"1" FAILURE MECHANISM	"2" LIMITING CONDITIONS
1. Fuel Clad Cracking Due to Lack of Cooling Caused by DNB.	1. Limit Clad Temp to 2200°F.

2. Fuel Clad Cracking Due to High Stress from Pellet Expansion.	2. Prevent Transient Boiling.
3. Gross Clad Failure Due to Decay Heat and Stored Heat Following a LOCA.	3. 1% Plastic Strain.

1.4 a. What is "pump runout" and why is it an undesirable condition? (1.5)

b. What are two reasons a centrifugal pump should be started with the discharge piping filled and the discharge valve shut. (1.0)

1.5 During a reactor startup the time for the neutron flux indication on the IRM's to go from 20 to 40 on range 2 is found to be 1 minute. What reactor period would this be? (1.0)

1.6 For the following transients, indicate which coefficient of reactivity; alpha T, alpha D, or alpha V tends to change reactor power FIRST and in what DIRECTION.

a. Fast closure of one MSIV. (0.5)

b. Isolation of a feedwater heater string. (0.5)

c. A control rod drop. (0.5)

1.7 Explain WHY reactor POWER DECREASES WHEN recirculation FLOW IS DECREASED when at power. Ensure your discussion continues to a STABLE CONDITION after the flow change. (2.5)

1.8 Assume your reactor has been operating at rated power for one month and then scrams.

a. What reactor period would you expect to see after the initial prompt drop in reactor power? (0.5)

b. Explain your answer for part a. (1.0)

1.9 Give three (3) reasons why samarium is not considered a problem during reactor operations. (2.25)

1.10 a. What are four (4) of the design or operational factors that insure adequate Net Positive Suction Head (NPSH) for the recirculation pumps? (2.0)

b. Explain what NPSH is. (1.0)

1.11 How do the following coefficients change from BOL to EOL (i.e., more negative, less negative, remains the same)? Briefly explain why.

a. alpha T (1.25)

b. alpha D (1.25)

c. alpha V (1.25)

1.12 List four reasons why your reactor has excess reactivity. (2.0)

2. PLANT DESIGN INCLUDING SAFETY AND EMERGENCY SYSTEMS (25.5)

2.1 The Reactor Water Cleanup (RWCU) Discharge Flow Control valve, (F033) will automatically close on either of two blowdown line pressure signals. For each of the two closure signals below (Parts a. and b.):

(1) Where is the pressure sensed in the blowdown line (UPSTREAM or DOWNSTREAM of the blowdown FCV)?

(2) Why is the FCV auto closed if that condition exists?

a. 5 psig decreasing pressure. (1.5)

b. 140 psig increasing pressure. (1.5)

2.2 For the following groups of RHR valves, what are the interlocks associated with these valves? Include when these interlocks are active and also any conditions necessary to automatically bypass the interlocks.

a. Suppression Pool Cooling (F011A/B) and Suppression Pool Spray Valves (F027A/B). (1.5) (1.5)

b. Drywell Spray Valves (F016A/B and F017A/B). (1.5)

c. LPCI Injection Valves (F042A/B/C). (1.5)

2.3 Concerning the relief valve low-low set function:

a. What is the purpose? (0.5)

b. What actuates the LLS? (1.0)

c. How does the LLS perform its purpose? (1.0)

d. Does the LLS actuate on manual operation of the relief valves, automatic operation of the relief valves, or on either one? (0.5)

2.4 During normal operation, your equipment attendant calls you with a problem. In his rounds he has noticed that the CRD charging header pressure indicator is showning about 1550#, but all the accumulator gauges are reading from 1100# to 1150#. Is there a problem? Explain. (1.5)

2.5 a. What are the (3) three automatic start signals for the emergency D/G's? (1.5)

b. Can any of the D/G's be paralleled locally? (If so, which one(s)?) (0.5)

c. What start signals will start the D/G when the maintenance control switch is in Maintenance position? (0.5)

2.6 The MSIV's will go closed on any of seven (7) different signals. Name 6 of them and include setpoints if applicable. (3.0)

2.7 Assume HPCS system has just auto isolated due to high vessel level.

a. What level caused the isolation? (0.5)

b. What valve goes closed on an isolation? (0.5)

c. How can the valve be re-opened? (1.0)

d. What action will automatically start to close the HPCS suction valve from the CST? (1.0)

2.8 The purpose of primary and secondary containment is to provide a leakage barrier to prevent any significant fission product release caused by any DBA. What are five (5) other barriers to release? (2.5)

2.9 Your recirc. system has numerous interlocks (trips) or alarms that must be reset using switches on H13-P602. Name 5 of these trips or alarms. Do not include the alarms cleared by the common annunicator clear button. (2.5)

3. INSTRUMENTS AND CONTROLS (25.0)

3.1 During normal operation of the CRD system the FCV will position itself to keep the flow at the controller setpoint. Explain what happens to the flow indication and the FCV position following a reactor scram. Explain any differences from normal operation. (3.0)

3.2 If reactor building temperature were to see a significant increase in temperature (~ 60°F increase from 70° to 130°) would you expect all the level instruments to show the same direction of change and the same amount of change? Explain briefly. (1.5)

3.3 The SBLC injection sparger is a multiple purpose line. One purpose is for poison injection. What are 5 other uses of this line? (2.5)

3.4 Regarding recirculation flow.

a. What 3 conditions will automatically cause both Loop Flow Controllers for the recirculation system to transfer from automatic to manual (Self Triggering transfer to manual)? (1.5)

b. What is the reason that a flux estimator signal is used instead of the actual APRM signal for the flux controller? (0.5)

c. What two (2) conditions will automatically initiate a switch over from flux estimator to actual APRM signal? (Include setpoints if applicable.) (2.0)

3.5 a. What two (2) conditions of the stator cooling system will cause a turbine runback? (1.0)

b. When will these cause a turbine trip? (1.0)

3.6 Regarding the remote shutdown system panel:

a. What is the purpose of the Remote Shutdown Transfer Switches? (0.5)

b. What is the purpose of having control of "A" recirc pump suction valve (B33-F023A) on this panel? (1.0)

c. What are three (3) primary containment instrumentation indications shown on the panel? (1.0)

3.7 Assume an LPRM spikes enough to give you an "LPRM High" alarm, but returns to normal fast enough so that you don't see which one it was on the full core display. Other than the computer, is there any way to determine which LPRM spiked? (1.0)

3.8 While withdrawing control rods during startup, what two (2) methods are used to verify control rod coupling? (1.0)

3.9 The flow show on the total core flow recorder is determined by summing the flow through each jet pump. Is this flow indication accurate during single loop operation? Explain why or why not. (1.5)

3.10 Indicate at what level (either by number or inches) the following will occur:

a. Initiate RCIC

b. Hi level alarm

c. Trip recirc pump off

d. Close HPCS injection valve

e. Reactor scram

f. 2/3 core height

g. Recirc runback permissive

h. Start div. 3 D/G

i. Start div. 1 D/G (3.0)

3.11 Under what three conditions will the Rod Worth Minimizer apply an Insert Block? (3.0)

4. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL (25.0)

4.1 While performing a unit startup, what 5 things must be verified or performed just prior to placing the mode switch in RUN? (2.5)

4.2 What method is used to maintain the vessel water level between 32-38 inches throughout the heatup phase of a startup? Explain why this is necessary. (1.5)

4.3 When reactor power is greater than or equal to 25% of rated thermal power and when reactor power has been increased by more than 15% of rated thermal power and steady-state operating conditions have been re-established, what 4 items must be verified to be within Tech Spec limits? (2.0)

4.4 According to your REACTOR SCRAM procedure, LGP-3-2:

a. What two methods are to be used to verify that all rods are fully inserted? (1.0)

b. What is the reason for placing the Mode Switch to Shutdown immediately following the scram? (1.0)

4.5 Under emergency conditions when Control Rod Drive Pumps are a major source of makeup water to the vessel, the scram should/ should not be reset as soon as possible? Pick the correct answer and explain why. (1.5)

4.6 Reactor Power operation with one Recirculation Pump is permitted, provided 6 conditions exist. List four of these six conditions. (4.0)

4.7 Per the startup to hot standby procedure, LGP-1-2, what four (4) methods may be used for pressure control once pressure has been reached? (2.0)

4.8 List four (4) of the six (6) systems that are considered to be alternate injection systems per your LGA's. (2.0)

4.9 For a normal unit shutdown, there are two (2) temperature limits in regard to cooldown. What are these limits? (2.0)

4.10 On a loss of feedwater heaters while at full power, what actions must you take in regard to reactor power? (3.5)

4.11 In the case of a stuck open relief valve you are required to scram the reactor if one (1) of three (3) conditions exist. What are these (3) conditions? (2.0)

$f = ma$

$w = mg$

$E = mc^2$

$KE = 1/2\ mv^2$

$PE = mgh$

$V_f = V_o + at$

$v = s/t$

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

$a = (V_f - V_o)/t$

$w = \theta/t$

$\dot{m} = \rho AV$

$\Delta E = 931\ \Delta m$

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

$Q = UA\Delta h$

$Pwr = W_f \Delta h$

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

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

$SUR = 26.06/T$

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

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

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

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

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

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

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

$I = \sigma N$

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

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

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

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

$I = I_o e^{-Ex}$

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

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

$TVL = 1.3/\mu$

$HVL = -0.693/\mu$

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

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

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

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

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

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

$I_1 d_1 = I_2 d_2$

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

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

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

Water Parameters

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

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)

MASTER

ANSWERS

1.1 a. 2

b. 2

Ref: Standard Nuclear Theory

1.2 a. Critical Power Ratio is the ratio of the bundle power which would produce equalibrium quality equal to, but not exceeding, the correlation value (X_c), [i.e., bundle power which would produce transition boiling] to the bundle power at the reactor condition of interest.

b. ~~False~~ DELETED QUESTION

Ref: 74 LPSDL

1.3

PWR DIST LIMITS	FAILURE MECH	LIMITING COND
a. LHGR	2	3
b. APLHGR	3	1
c. MCPR	1	2

Ref: 74 LPSDL

1.4 a. 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 [1.0]. (1.5)

ABOVE DESIGN — NOT NECESSARILY FOR CURRENT

b. Water hammer [0.5] and excessive starting current [0.5]. (1.0)

Ref: Standard Fluid Flow.

1.5 $P = P_o e^{T/}$ $T = 1$ min. $\frac{P}{P_o} = 2$

$\frac{P}{P_o} = e^{T/2}$

$2 = e^{1/}$ $\ln 2 = \frac{1}{}$ $= \frac{1}{\ln 2} = \frac{1}{.693} = 1.443$ min.

1.6 a. Alpha V increases power (.5 each)

b. Alpha T increases power

c. Alpha D decreases power

Ref: G.E. BWR Transient Analysis

1.7 Decreasing recirc flow results in voids being swept out of the core at a slower rate [0.5], resulting in increased core void concentration [0.5] and decreased neutron moderation [0.5]. When recirc flow stops decreasing, power stops decreasing due the negative reactivity insertion (above) being balanced by a positive reactivity insertion [0.5] from decreased void generation at the new lower power level [0.5].

Ref: Std Nuclear Theory

1.8 a. -80 sec. (0.5)

b. After the initial prompt drop, power cannot decrease faster than the longest lived delayed neutron appears. (1.0)

Ref: Std Nuclear Theory

1.9 1. Relatively low cross-section for absorbtion. (.75 each)

2. Low fission yield.

3. Long half-life.

Ref: Standard Nuclear Theory

1.10 a. 1. They are located as far below the normal water line as possible to provide the greatest static head. (4 at 0.5 each)

2. With feed flow less than 30% they are tripped to slow speed.

3. At high power operation adequate NPSH is obtained from feedwater subcooling.

4. Low reactor Vessel water level trip, (12.5" or -50") cavitation interlock.

5. Suction valve closed trip, cavitation interlock.

6. If ΔT steam line - pump suction < 10.1°F trip to slow speed.

7. Cannot transfer to fast speed unless F.W. flow > 30% and FCV is in minimum position.

b. NPSH is the required press and temp conditions at the suction of a pump that will not result in cavitation.

Ref: Recirc. System Lesson Plan.

1.11 a. alpha T becomes less negative. (~~.25~~ .50)

Two factors contribute towards less negative.
f becomes less (fuel burn up). (.75)
B^2 becomes less (rods pulled out).

EITHER - Adjust for CREDIT

b. Alpha D becomes more negative [~~.25~~ .50]. This is due to the buildup of Pu-240 which is a significant resonant absorber. (.75)

c. Alpha V becomes less negative [~~.25~~ .50]. Same reasons as for alpha T. EITHER ANSWER FOR CREDIT. (.75)

Ref: Reactor Physics Review

1.12 Fuel burnup, fission product poison (includes xenon or samarium), temperature coefficient, void coefficient.

Ref: Std Nuclear Theory

ANSWERS

2.1 a. Upstream [0.5] (1) prevents condenser vacuum from draining c/u system or (2) Siphoning the reactor vessel to the main condenser or LRW. OR LINE BREAK (1 pt for either)

b. Downstream [0.5]. Protects low pressure piping to radwaste or the main condenser from overpressure. (1.0)

Ref: C.U. Lesson Plan.

2.2 a. The suppression pool cooling and spray valves close on LPCI initiation [0.5] and then cannot be opened unless F042 (LPCI injection) is fully closed [0.5]. In addition, ~~to keep suppression pool spray valve open high D.W. pressure must be present. (1.69 psig) [0.5]~~ DELETE .5 PTS

b. These valves can normally only be opened one [0.5] at a time but both can be opened if LPCI has initiated, Hi D.W. pressure exists and F042 is closed (LPCI injection) [1.0].

c. The LPCI injection valves open automatically upon the following conditions:
/ < 500 # RX PRESS

1. ~~DP across the injection valve decreases to ≤ 700 psid. (0.5)~~ ANY 3 @ .5 ea

2. Initiation signals are present: 1.69# in the drywell and -129" Reactor Vessel Level (Level 1). ~~(0.5)~~

3. No undervoltage on bus feeding pump. ~~(0.5)~~
4 < 500 # DOWNSTREAM OF INJECTION VALVE

Ref: RHR Lesson Plan

2.3 a. To minimize containment fatigue from duty cycles. OR TO REDUCE RELIEF VLV CYCLING

b. LLS logic is armed whenever any two or more of the safety/ relief valves are signaled to open.

c. By changing the opening and reclosing pressures that the valves associated with the LLS operate at.

d. This will function if valves are opened manually or automatically.

Ref: Main Stream Lesson Plan

2.4 There is no problem. These are ~ normal pressure. (0.5)

The piston bottoms out when water pressure reaches the pressure shown on the gauges. Any higher pressure will not show up on the gauge which is on the gas side. The water side will actually be at the charging water pressure. (1.0)

Ref: CRD

2.5 a. Hi drywell pressure (0.5)
low reactor water level (0.5)
loss of bus voltage (0.5)

b. Only the HPCS diesel can be paralleled locally.

c. None.

Ref: D/G Lesson Plan

2.6 Low Rx water level (-50") (level 2). (Any 6 0.5 each)
Main Steamline hi radiation (3x Normal) or Inop.
Low turbine inlet pressure 854 psig in run.
Main Steamline high steam flow 134%.
High Steam Tunnel temperature 140°F or loss of detector control power.
High Steam Tunnel Ventilation ΔT 24°F or loss of detector control power.
Low Condenser Vacuum 7" hg.
Manual pushbutton (A or C) and (B or D) depressed.

Ref: Main Steam L.P.

2.7 a. (+ 55.5") level 8

b. HPCS injection valve (F 004)

c. When the Rx hi level trip clears and the reset is pressed EITHER or the Rx high level trip clears and the low level (-50") is received.

d. The suction valve from the suppression pool being not fully closed. SUPP POOL HI LVL OR LOW CST TANK LVL

Ref: HPCS L.P.

2.8 fuel matrix (ceramic UO_2) (Any 5 at 0.5 each)
fuel clad
water coolant
Rx vessel + coolant pressure boundary
controlled ventilation
liquid radwaste system

Ref: Containment L.P.

2.9 Steam line pump A(B) suction low DT. (Any 5 at 0.5 each)
F.W. pump A(B) trip interlock.
Vessel low level interlock.
F.W. A(B) low flo interlock.
Flow A(B) control valve inhibit.
Pump vibration alarm.
Estimator Failure/Maintenance Alarms (Timers).

Ref: Recirc L.P.

ANSWERS

3.1 Following a reactor scram the charging water flow will increase to all the drives to recharge them [0.5]. Flow indication will increase [0.5] and a signal will go to the FCV to close it [0.5]. The FCV will not completely close but will close off most flow through it [0.5]. Because charging water taps off between the flow element and the FCV, flow indication will remain high even with the FCV almost closed [1.0].

Ref: CRD L.P.

3.2 No. [0.5] The direction and amount of change is dependent upon which leg (the reference or variable leg) has the longest imposed run in the reactor building. Some indicated levels would increase and some would decrease and the amount would vary. (1.0)

3.3 Core DP measurement
HPCS line break detection
Jet pump DP tap
RWCU bottom head drain flow tap
CRD drive water DP tap
CRD cooling water DP tap

(Any 5 at 0.5 each)

Ref: SBLC L.P.

3.4 a. Flux controller output abnormal. (HIGH OR LOW)
High drywell pressure.
Recirc. pump high to low transfer. (ANY CAUSES - RPT, HPCS, RCIC, etc.)

b. The APRM signal is too noisy (constantly oscillating, not smooth).

c. When APRM signal reaches 110%. If a 5% difference exists between estimated flux and actual flux.

Ref: Core Flow Control L.P.

3.5 a. Loss of stator cooling as sensed by low inlet pressure or high outlet temperature.

b. If stator current does not drop to 23% of rated current or less within 35 minutes. OR < 7% IN 2 MIN.

Ref: Gen Aux Sys L.P.

3.6 a. Transfers control of required systems from the control room to the remote shutdown control panel.

b. Allows for closing of the A recirc. loop suction valve when in shutdown cooling. This will prevent cycling of the RHR flow through the recirc. loop only.

c. S.P. temp, S. P. level, D. W. press., or D.W. temp. Any 3.

Ref: Remote S/D L.P.

3.7 Yes, the LPRM Hi light on the back panel is a seal-in and this would indicate which LPRM spiked.

3.8 While pulling rod observe any nuclear instrumentation response. When at position 48, attempt to withdraw rod past position 48. } Any Two

OBSERVE CHANGE IN STEAM FLOW.

Ref: LGP 1-1

3.9 Yes, the flow indication is accurate during one loop operation [0.5]. The loop flow signals must pass through forward/reverse flow logic which will subtract the idle loop flow from the active loop flow [1.0].

3.10 a. -50" (2) (1/3 each)

b. 40.5" (7)

c. -50" (2)

d. 55.5" (8)

e. 12.5" (3)

f. -211" (0) OR -161" LGA'S USE TAF, NOT 2/3 CORE HEIGHT

g. 31.5" (4)

h. -50" (2)

i. -129" (1)

3.11 An Insert Block is applied:

1. On the receipt of the third insert error.

2. When a withdraw error is received, a withdraw block is applied, and a rod other than the error rod is selected.

3. During down power manuevering, a withdraw error is found to exist, or the operating sequence is not yet latched when power drops below the LPSP for at least 5 sec.

4. < 20% POWER (LPSP)

5. RWM NOT BYPASSED

ANSWERS

4.1 1. All APRM's that are not bypassed are indicating between 5% and 12%. (0.5)

2. Verify no APRM DOWNSCALE lights are illuminated unless they are bypassed. (0.5)

3. Verify that the Main Condenser backpressure is less than 7 inches Hg. (0.5)

4. Verify that the Div I/Div II LOW VACUUM alarm is cleared. (0.5)

5. Plan one IRM/APRM recorder on each RPS channel to APRM. (0.5)
SEE ATTACHED PAGE

Ref: LGP 1-1

4.2 Reject water as necessary through the RWCU system. (0.5)
Thermal expansion of the water from heatup as well as CRD input. (1.0)
ALSO THROTTLE THE FW 003 FRV INLET STOP

Ref: LGP 1-1

4.3 APLHGR (0.5)
APRM rod block and scram setpoint adjustment (0.5)
MCPR (0.5)
LHGR (0.5)

Ref: LGP 1-1

4.4 a. Rod Sequence Control Matrix (0.5)
Computer program OD-7. (0.5)

b. To prevent an isolation when reactor pressure decreases to 854 psig. (1.0)

Ref: LGP 3-2

4.5 Should not. You want to maintain flow into the vessel through the scram valves.

Ref: LGP 3-2

4.6 Any four. (1.0 each)

a. The steady state thermal power doesn't exceed 50% of rated.

b. RR Pump drive flow in the active loop does not exceed 30375 GPM (75%).

c. The Minimum Critical Power Ratio (MCPR) Safety Limit (T.S. 2.1.2) and Operating Limit (T.S. 3.2.3) are increased by 0.01.

d. The MAPLHGR limits are reduced by a factor of 0.85.

QUESTION 4.1

ALSO EXCEPT

6. VERIFY NO LEAKS
7. VERIFY > 854 ㎩ (alarms clear)
8. TURBINE OIL SURVEILLANCE
9. STOP EHC PRESSURE SET @ 930 PSIG
10. MSIV LOW VACUUM B/P TO NORMAL
11. KEEP RX POWER < 12%
12. BYPASS VALVES OPEN
13. FEEDWATER REG VALVE OPEN

e. The APRM flow-biased scram and rod block setpoints and the RBM setpoints are reduced by 5.3%.

f. The APRM flux noise is not greater than 5% peak-to-peak and core plate d/p noise is not greater than 1 psi peak-to-peak (T.S. 3/4.4.1.1).

Ref: LGP 1-1

4.7 1. Control rods (0.5 each)

2. RCIC - but do not inject

3. Steam condensing mode of RHR

4. Relief valves may be manually operated

Ref: LGP 1-2

4.8 Any four. (0.5 each)

1. Fuel pool emergency make up to reactor

2. Reactor fill from SBLC

3. ECCS water leg pumps

4. Cycled condensate makeup to the reactor

5. Suppression pool makeup to the reactor

6. Diesel fire pump makeup to the reactor

Ref: LGA-04

4.9 1. Do not exceed 100°/hr cooldown rate.

2. Do not cooldown below 90°F with head bolts tensioned.

Ref: LGP 2-1

4.10 1. Insert CRAM arrays per the CRSP to clear APRM Hi's. (.75)

2. Reduce total core flow ~ 5 x 10^6 lb/hr for every 10°F that the temperature drops. (.75)

3. If the feedwater temperature drops more than 150°F, manually scram the reactor. (.75)

4. Reduce power if necessary to maintain vessel level above 31.5". (0.5)

5. Manually scram the reactor if a high level in any heater is apparent and neither its Extraction Steam non return nor its Extraction Steam inlet valve can be closed. (.75)

Ref: LOA-FW-01

4.11 1. If valve remains open after a maximum of (4) attempts to close it or (3 at 2/3 each)

2. The pool temperature monitoring system indicates ~~100~~ 110° F or

3. Two minutes have elapsed since the valve opened.

Ref: LOA-NB-02