U. S. NUCLEAR REGULATORY COMMISSION REGION I
OPERATOR LICENSING EXAMINATION REPORT

EXAMINATION REPORT NO. 84-40

FACILITY DOCKET NO. 50-352

FACILITY LICENSE NO. CPPR-106

LICENSEE: Philadelphia Electric Company
2301 Market Street
Philadelphia, Pennsylvania 19101

FACILITY: Limerick Generating Station

DATES: August 14 - 15, 1984

CHIEF EXAMINER: [signature] 10/25/84
John Berry, Reactor Engineer (Examiner) Date

APPROVED BY: [signature] 10/25/84
Chief, Project Section 1D Date

SUMMARY: This examination report contains the results of the Operator Licensing examinations administered at the Limerick Generating Station on August 14 and 15, 1984. Written examinations were administered to 12 candidates, and Oral/Simulator examinations were administered to 5 candidates. 2 Reactor Operator candidates failed the written examination, all other candidates passed all portions of the examinations. No significant strengths or weaknesses were noted from the examinations.

REPORT DETAILS

TYPE OF EXAMS: Initial X Replacement ____ Requalification ____

EXAM RESULTS:

	RO Pass/Fail	SRO Pass/Fail	Inst. Cert Pass/Fail	Fuel Handler Pass/Fail
Written Exam	4/2	6/0	/	/
Oral Exam	2/0	1/0	/	/
Simulator Exam	3/0	1/0	1/0	/
Overall	5/2	6/0	1/0	/

1. CHIEF EXAMINER AT SITE: John Berry, USNRC

2. OTHER EXAMINERS: David Lange, USNRC

   Brian Hajek, USNRC Consultant

3. PERSONS EXAMINED

RO	SRO	INSTRUCTOR CERTIFICATION
K. Berry	W. Barnshaw	J. Goodbred
R. Forst	T. Crosier	
N. Kinyon-Samec	A. Romano	
R. Landis	W. Russel	
D. Robertshaw	G. Shiendelman	
T. Tragemann	W. Truax	
M. Westermann		

1. Summary of generic strengths or deficiencies noted on oral exams:

   No prominent strengths or deficiencies were noted on the oral exams.

2. Summary of generic strengths or deficiencies noted from grading of written exams:

   No generic weaknesses were noted on the written exams. As a group, the SRO candidates did extremely well in sections seven (7) and eight (8) of the written exam.

3. Comments on availability and candidate familiarization with plant reference material:

   All candidates were adequately familiar with the plant reference material.

4. Comments on availability and candidate familiarization with plant design, procedure, T. S. changes and LERs:

   Most areas of the plant were easily accessible. The candidates' familiarization with plant design was sufficient.

5. Comments on interface effectiveness with plant training staff and plant operations staff during exam period.

   The plant training staff and the operations staff were both cooperative and helpful during the exam period.

6. Improvements noted in training programs as a result of prior operator licensing examinations/suggestions, etc:

   No suggestions concerning improvements in training programs were made by the examiners.

7. Personnel Present at Exit Meeting:

NRC Personnel

John Berry, BWR Chief Examiner, USNRC, Region I
David Lange, BWR Examiner, USNRC, Region I
Brian Hajek, USNRC Consultant
David Lipinski, USNRC Resident Inspector, Millstone Units 1 and 2
Lynn Banavitch, BWR Examiner Trainee, USNRC, Region I

Facility Personnel

Richard Andrews	Fred Grames
Edward Brohl	Richard Helt
R. W. Bulmer	Graham Leitch
John Doering	Michael Martin
Ed Firth	Joseph Murray

8. Summary of NRC Comments made at exit interview:

The examiners stated that all of the candidates who were administered the oral and/or simulator examinations would be recommended as clear passes.

The examiners noted that the candidates' performance during the simulator examinations was generally very good, although the examiners noted a generic weakness among the candidates in communications.

It was suggested that a second intercom phone be installed in the simulator to allow examiners to listen to the candidates' instructions and responses.

The examiners felt that some of the licensee employees were overly sensitive during the exam reviews. They also suggested that more operations staff personnel attend the exam reviews.

The next reexamination date was tentatively scheduled for November 19-20, 1984.

It was noted by the examiners that the LGS Security personnel followed inconsistent procedures. For example, one group of examiners was allowed access to the Diesel Generator Rooms without displaying any identification other than an NRC hard hat. Another group had excessive difficulty in getting into the Control Room.

The examiners requested that the LGS Training staff provide the ON/OT Bases and Annunciator cards for future exam preparation.

The examiners expressed their appreciation to the training staff members for their cooperation during the examination period.

9. Summary of facility comments and commitments made at exit interview:

The training staff felt the examinations were fair and asked that the results be determined as soon as possible.

The licensee agreed that another intercom phone should be installed in the simulator.

10. Resolutions of the Philadelphia Electric Comments on the LGS Reactor Operator Examination administered August 14, 1984.

Question No.	Resolution
1.03a	Accepted at review.
1.04	Accepted at review.
1.06.a.2	The answer key already stated any other examples.
1.09	This answer was already in the key. This was pointed out during the exam review.
2.05.b	The two parts of the suggested answer are related and must be considered as such. Thus only one answer is still required.
2.07.b	Acknowledged in review and graded accordingly.
3.02.c	This was accounted for during the exam.
4.01.a	This comment was not implemented. Four out of five of the candidates had the correct interpretation.
4.02.b	Operator action was not requested.

4.07.a. It is clearly stated that OT-112 is being considered.

4.09.c. Comment accepted.

All comments made on the SRO Examination during the exam review were accepted and incorporated during grading.

Attachment:

Written Examination(s) and Answer Key(s) (SRO/RO)

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

Facility: LIMERICK 1

Reactor Type: BWR

Date Administered: 84/08/14

Examiner: BERRY, J.A.

APPLICANT: MASTER COPY

INSTRUCTIONS TO APPLICANT:

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

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

FINAL GRADE _______________%

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

____
APPLICANT'S SIGNATURE

QUESTION 5.01 (1.00)

Consider a real plant system (NON-IDEAL) with two pumps in parallel, one of which is running. The second pump is started. System flow will be: (Choose the correct answer.) EXPLAIN YOUR CHOICE. (1.0)

a. double the original flow
b. less than double the original flow
c. greater than double the original flow
d. the same; only the discharge head changes

QUESTION 5.02 (3.00)

Fo each of the following events, or changes in plant status, state whether the change will bring the system CLOSER TO, FARTHER FROM, or HAVE NO EFFECT ON the point at which the Reactor Recirculation Pumps will cavitate. GIVE A BRIEF EXPLAINATION FOR EACH.

a. Increase in reactor water level (1.0)
b. Loss of a feedwater heater (1.0)
c. Increase in Recirculation Pump speed (1.0)

QUESTION 5.03 (3.00)

When the reactor is at full power and a feedwater controller malfunction results in a loss of feedwater flow, a reactor scram will occur (due to low reactor water level) within a short period of time. During the time period JUST PRIOR TO THE SCRAM, is reactor power expected to INCREASE, DECREASE or REMAIN CONSTANT? Give TWO REASONS for your answer. (3.0)

QUESTION 5.04 (3.00)

A Boiling Water Reactor operates with three seperate THERMAL LIMITS. List each of the three limits AND EXPLAIN the SPECIFIC heat transfer related problem that the limit protects against. (3.0)

QUESTION 5.05 (2.00)

Since a Control Rod can absorb only those neutrons which thermalize within one thermal diffusion length of the rod, variations in the thermal diffusion length will directly affect ROD WORTH. WHAT is the single most important factor affecting a change in THERMAL DIFFUSION LENGTH, and thus affecting ROD WORTH and HOW does it affect it ? (2.0)

QUESTION 5.06 (2.00)

a. What are two causes of WATER HAMMER ? (1.0)

b. What are two things that could be done to prevent water hammer events from occuring ? (1.0)

QUESTION 5.07 (2.50)

Using the attached Power to Flow Operating Map, answer the following:

a. Explain the transition point that Region 1 represents, and why steady state operation cannot exist in this region. (1.0)

b. What operating zone does Region 2 represent ? (0.5)

c. What damage could be expected if operating in Region 3, and how is this precluded and prevented ? (1.0)

QUESTION 5.08 (3.00)

For the following events, state the 1. INITIAL POWER RESPONSE (Increase, Decrease) and, 2. WHICH REACTIVITY COEFFICIENT IS RESPONSIBLE, AND WHY, FOR THAT INITIAL RESPONSE.

a. Single MSIV Closure at 85% Power. (1.0)

b. Isolation of Extraction Steam to High Pressure Feedwater Heaters at 100% power. (1.0)

c. Control Rod drop at 1% power from full in to full out. (1.0)

QUESTION 5.09 (3.00)

The End of Cycle Recirculation pump trip (EOC-RPT) system is an essential safety supplement to the Reactor Protection System.

a. What are the two most limiting events this system is designed for ?(1.5)

b. Based on these events, what actual physical phenomenon is involved and how does tripping of the recirculation pumps aid in controlling this phenomenon.? (1.5)

QUESTION 5.10 (2.50)

With the reactor operating at 100% steady state conditions, there is an inadvertant trip of one recirculation pump. What will be the INITIAL response of INDICATED REACTOR VESSEL LEVEL to this event and WHAT IS THE REASON for that response ? (2.5)

QUESTION 6.01 (3.00)

a. If the reactor is at operating pressure, and all of the HCU's are depressurized, will the control rods be able to be inserted on a valid scram signal? Why or why not? (1.5)

b. During operation at rated conditions it is discovered that the scram discharge volume high water level bypass switch has been in the bypass position since startup. Could this have prevented a valid high instrument volume scram from occuring ? Explain. (1.5)

QUESTION 6.02 (3.00)

For each of the IRM (Intermediate Range Monitoring) range changes below, provide the following:
- The indicated level on the NEW RANGE
- Any automatic actions initiated as a result of the indicated level on the NEW RANGE. (3.0)

a. Switching from range 4, reading 25, up to range 6.
b. Switching from range 6, reading 39, down to range 5.

QUESTION 6.03 (3.00)

Consider the Feedwater and Level Control System (FWLCS) and assume operation at 100% power in three element control. Explain what will happen if one of the steam flow inputs is lost. Include in your discussion why the various error signals are developed and the subsequent results. (Specific milliamp or millivolt values are not required.) Also indicate final results for reactor power, steam flow (actual and indicated), feed flow, and vessel level (in reference to level setpoint). (3.0)

QUESTION 6.04 (3.50)

Consider the EHC (Electro-Hydraulic Control) System: (An EHC logic diagram is attached.)

a. The 'A' pressure regulator output FAILS HIGH TO 40 PSI, during operation at 100% reactor power. (No operator action)
   1. Will the 'B' regulator take control? (Yes or No) (0.75)
   2. What will happen to reactor power immediately following the failure? (Increase or decrease) (0.75)
   3. WHY will reactor power respond as indicated in part '2'? (0.75)
   4. Will the reactor scram ? Why or Why not? (0.75)

b. What will occur if the 'All Valves Closed' button is pushed at 100% reactor power? Explain. (0.5)

QUESTION 6.05 (3.00)

The reactor is operating at 100% power when a small area break occurs. HPCI is out of service, RCIC fails to start automatically and cannot be started manually. All signals are present and valid for auto blowdown system actuation except the timer has NOT timed out.

a. The operator attempts to reset a VALID high drywell pressure signal. Will the auto blowdown timer reset ? Explain (1.0)

b. RCIC is now started and water level is raised to above the low-low setpoint. What effect does this have on auto blowdown initiation if the timer HAS NOT timed out? If the timer HAS timed out? Briefly explain BOTH. (1.0)

c. If the 125 VDC Electrical Distribution System is lost will auto blowdown occur ? EXPLAIN (1.0)

QUESTION 6.06 (3.00)

Following an auto initiation of RCIC at a reactor pressure of 800 PSIG, reactor pressure decreases to 400 PSIG. HOW ARE THE FOLLOWING PARAMETERS AFFECTED (INCREASES, DECREASES, REMAINS CONSTANT) by the change in reactor pressure? BRIEFLY EXPLAIN YOUR CHOICE.
(ASSUME the RCIC System is operating as designed.)

a. RCIC flow to the reactor. (1.0)

b. RCIC pump discharge head (assume NPSH remains constant). (1.0)

c. RCIC turbine RPM. (1.0)

QUESTION 6.07 (3.00)

The plant is operating at 100% power. APRM channels A and C have failed high. Instrument technicians are investigating while you research Technical Specifications. A plant auxiliary operator wants to shift .PS B power supply to its alternate power supply for training. Would you let him? Explain why or why not. Direct your answer toward system response instead of administrative requirements. (3.0)

QUESTION 6.08 (1.00)

If the 'A' Emergency Service Water Pump control is transferred to the Remote Shutdown Panel ______ (Choose the correct answer below to complete the sentence) (1.0)

a. the controls for the 'A' ESW Pump and valves, which are normally supplied by Division I power, will now receive power from Div. III
b. control of the pump from the control room is bypassed, and it can be operated only frum the Remote Shutdown Panel.
c. opeartion and control of the pump from the control room is still possible should a LOCA signal be received.
d. and a LOCA signal is received, the pump will trip and will require manual operator action for re-starting.

QUESTION 6.09 (2.50)

Will the loss of the 125VDC Electrical System affect the operability of the Diesel Generators ? Explain. (2.5)
(NOTE: Do not consider Tech Spec operability, but rather whether the DGs will operate as designed.)

QUESTION 7.01 (3.50)

In regard to T-101, 'RPV Control, RC/Q, RC/L and RC/P':

a. What are the four (4) entry conditions of the procedure. (2.0)
b. Step RC/P-5 of T-101 directs you to determine '...is any SRV open or cycling?' What are three indications you would use to determine if an SRV was open or cycling. (1.5)

QUESTION 7.02 (2.25)

In regard to GP-5, 'Power Operations':
When increasing power with flow, the procedure directs you to moniter the core after every power increase by using a Process Computer Request. For each of the following parameters from the P-1 printout, explain what IT ACTUALLY MEANS.

1. CMFLPD less than or equal to 1.0 (0.75)
2. CMFLCP less than or equal to 1.0 (0.75)
3. CWT less than or equal to 100 MLB/HR (0.75)

QUESTION 7.03 (1.75)

In regard to Surveillance Test Procedures in general:

a. What is the SIGNIFICANCE of procedural steps that are marked with an asterisk (*)? (1.0)
b. What ACTION is required if an asterisked item CANNOT be successfully completed? (0.75)

QUESTION 7.04 (3.00)

'A plant shutdown or scram SHALL be initiated by any Senior Licensed Operator or Licensed Operator when.....'. LIST THE THREE GENERAL CONDITIONS that are given in LGS Admin. Procedure A-7, 'Shift Operations'. (3.00)

QUESTION 7.05 (2.50)

a. In accordance with the Limerick Generating Station Emergency Plan Implementation Procedures, what are the EMERGENCY EXPOSURE GUIDELINES for the following situations:(WHOLE BODY ONLY)
   1. Life Saving and Reduction of Injury (0.5)
   2. Operation of Equipment to Mitigate an Emergency (0.5)
   3. Protection of Health and Safety of the Public (0.5)
   4. Other Emergency Activities (0.5)
   5. Reentry/Recovery Activities (0.5)

QUESTION 7.06 (3.00)

Concerning the General Fire Fighting Pr.cedure, SE-8:

a. If additional fire-fighting equipment and personnel are needed to control a fire on-site, WHO should be notified ? (1.0)
b. Upon arrival of the assistance requested in part 'a', WHO is responsible for control and direction of fire-fighting activities ?(1.0)
c. What are two locations, on-site at Limerick, where you could go to obtain portable fire-fighting equipment, and what would be available at these locations ? (BE SPECIFIC !) (1.0)

QUESTION 7.07 (3.00)

Concerning Administrative Procedure A-3 (Procedures for Temporary Changes to Approved Procedures);

a. What are three (3) actions that the PROPOSER of the temporary change shall be responsible for ? (1.0)
b. WHO can approve temporary procedure changes on a back-shift, and HOW is this accomplished ? (1.0)
c. Can approval be made via telephone ? Explain. (0.5)
d. Under what condition(s) may unnecessary portions of procedures be deleted WITHOUT a temporary change being generated ? (0.5)

QUESTION 7.08 (3.00)

Concerning Procedure SE-1, " PLANT SHUTDOWN FROM OUTSIDE THE CONTROL ROOM ":

a. What are the immediate operator actions if the main control room becomes uninhabitable ?(3 required) (1.5)

b. For EACH of the following systems or components, LIST THREE automatic actions, interlocks, or trips which are defeated upon transfer of all Remote Transfer switches to the Emergency Position ?

1. RCIC (0.75)

2. RHRSW (0.75)

QUESTION 7.09 (3.00)

Limerick Off-Normal Procedure ON-100 lists symptoms of a failed Jet Pump. For each of the indications listed below, state what would be the change in the parameter that would be indicative of a FAILED JET PUMP. (i.e. Increase/Decrease/No Change)

a. Reactor Power. (0.75)

b. Indicated Core Flow. (0.75)

c. Drive flow in the defective jet pump loop. (0.75)

d. Delta Pressure on the jet pump sharing a riser with the failed jet pump. (0.75)

QUESTION 8.01 (3.00)

* NOTE: USE THE ATTACHED SECTIONS OF THE TECHNICAL SPECIFICATIONS TO *
* ANSWER THE FOLLOWING QUESTION. FULLY REFERENCE ALL SECTIONS YOU USE *

Mid-way through the 4PM to midnight shift, you are informed that while troubleshooting an EHC problem the Instrument Technicians discovered that the Bypass Valve Control Unit on the EHC System is INOP, and the demand signal for the Bypass Valves is locked-in at ZERO demand. They estimate that it will take until tommorrow to repair the circuitry. The plant is presently operating at 80% power with direction from the Station Superintendent to increase power to 100% at 20MW thermal/hour. In accordance with the Technical Specifications, what action(s) are you required to take ? (3.0)

QUESTION 8.02 (3.00)

In accordance with the Technical Specificati ns, the reactor was scrammed due to Suppression Chamber water temperature being greater than 110 degrees F. The reactor is now in HOT SHUTDOWN, Suppression Pool Cooling is ON, and Suppression Chamber water temperature is 98 degrees F. CAN YOU STARTUP THE REACTOR AND ENTER OPERATIONAL CONDITION 2. EXPLAIN YOUR ANSWER FULLY. (3.0)

QUESTION 8.03 (3.00)

In accordance with the Limerick Generating Station Technical Specifications, define the following terms:

a. Operable (1.0)
b. Shutdown Margin (1.0)
c. Limiting Control Rod Pattern (1.0)

QUESTION 8.04 (2.50)

Section 3.4 of Technical Specifications provides guidance for Limiting Conditions for Operation concerning inoperable control rods. One specific action statement says 'With more than eight (8) control rods inoperable be in at least hot shutdown within 12 hours'. If an adaquate shutdown margin can still be maintained, what is the bases for this action statement ? (2.5)

QUESTION 8.05 (2.50)

Section 6.2.2,Administrative Controls,of Technical Specifications outlines the minimum shift crew composition for the conduct of plant operations.

a. Draw a block diagram of the minimum operations shift crew composition showing reporting relationships and thoes individuals requiring NRC licenses. (2.0)

b. What position is not required with the plant in the shutdown or refuel mode? (0.5)

QUESTION 8.06 (2.00)

The Limerick Safety Limits are listed below. Pick the ones that are not correct as written and state what must be changed to make it correct. (NOTE: There MAY be more than one error in a Safety Limit)

a. Thermal power shall not exceed 30% of Rated Thermal power with turbine first stage pressure less than 785 psig, or core flow less than 10% of rated flow. (0.5)

b. The minimum critcal power ratio (MCPR) shall be less than 1.06 with the reactor vessel steam dome pressure greater than 785 psig and core flow greater than 20 % of rated flow. (0.5)

c. The reactor coolant system pressure as measured in the reactor vessel steam dome shall not exceed 1375 psig. (0.5)

d. The reactor vessel water level shall be maintained seventeen (17) inches above the top of the active fuel at all times (0.5)

QUESTION 8.07 (3.00)

* NOTE: USE THE ATTACHED SECTIONS OF THE TECHNICAL SPECIFICATIONS *
* TO ANSWER THIS QUESTION. FULLY REFERENCE ALL SECTIONS YOU USE *

During the 4 PM to Midnight shift, with the reactor at 100% power, you notice that the 'B' Recirculation Pump speed is approx. 7% faster than the 'A' pump. In attempting to match the two speeds, you receive a scoop tube lock-out on the 'B' Motor Generator set. An attempt to reset the lock-out fails, and the pump speeds are now 8% apart.
WHAT INITIAL ACTIONS MUST YOU TAKE, AND WHAT MUST BE DONE IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS IF THIS PROBLEM CONTINUES ? (3.0)

QUESTION 8.08 (3.00)

* NOTE: USE THE ATTACHED SECTIONS OF THE TECHNICAL SPECIFICATIONS TO *
* ANSWER THE FOLLOWING QUESTION. FULLY REFERENCE ALL SECTIONS YOU USE *

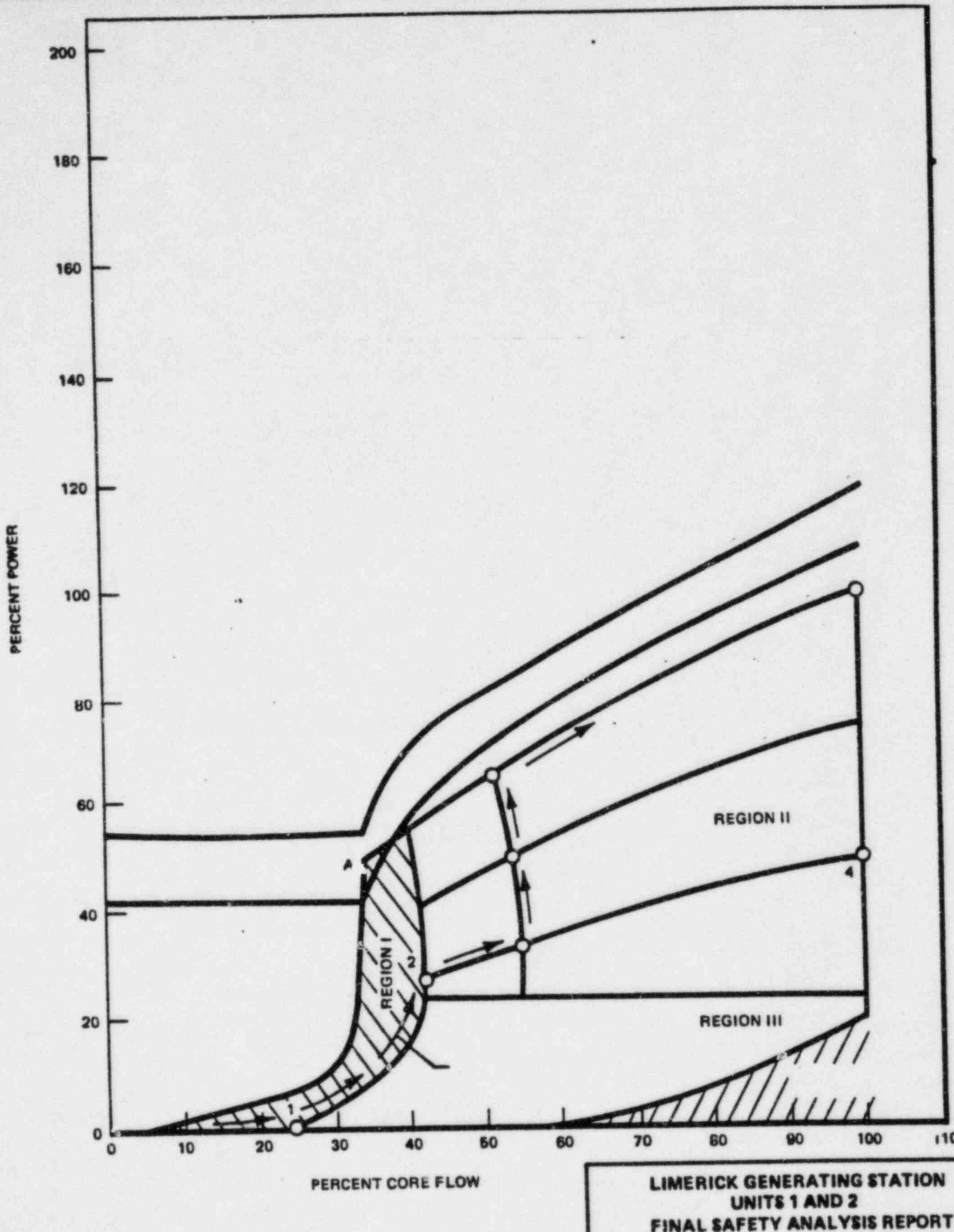
With the plant operating at steady state conditions, 100% power, the I&C Supervisor informs you that one of the pressure switches associated with the Turbine Control Valve Fast-Closure Scram circuitry was found to be INOPERABLE during a surveillance test, and will have to be replaced. It will take three (3) days to procure and install a new switch.
IN THIS SITUATION, WHAT ACTION(S) ARE YOU REQUIRIED TO TAKE IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS ? (3.0)

QUESTION 8.09 (3.00)

* NOTE: USE THE ATTACHED SECTION OF THE TECHNICAL SPECIFICATIONS TO *
* ANSWER THE FOLLOWING QUESTION. FULLY REFERENCE ALL SECTIONS YOU USE. *

During a shift turnover, with the plant operating at 75% power, you are informed that the MSIV Full Closure Time Surveillance Test HAS EXCEEDED the maximum allowable extension interval and will be performed on your shift. Halfway through the test, the 'C' Outboard MSIV FAILS to meet the specified closing time. In accordance with the Tech Specs:

a. What situation exists due to continued plant operation in the above condition ? (1.0)
b. What actions must be taken due to the fact that the MSIV has failed it's closing time test ? (2.0)



LIMERICK GENERATING STATION
UNITS 1 AND 2
FINAL SAFETY ANALYSIS REPORT

POWER–FLOW OPERATING MAP

FIGURE 4.4-2

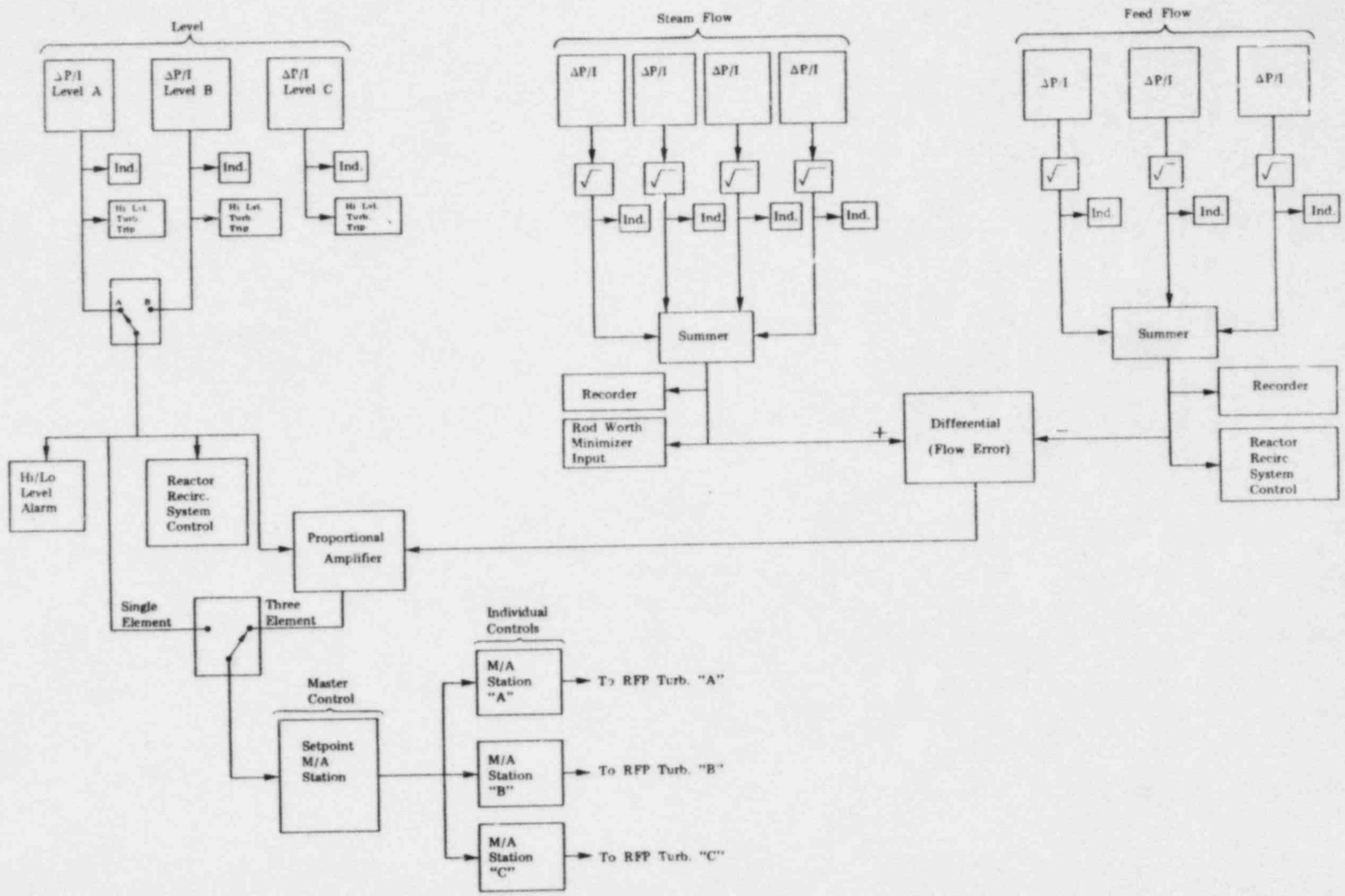
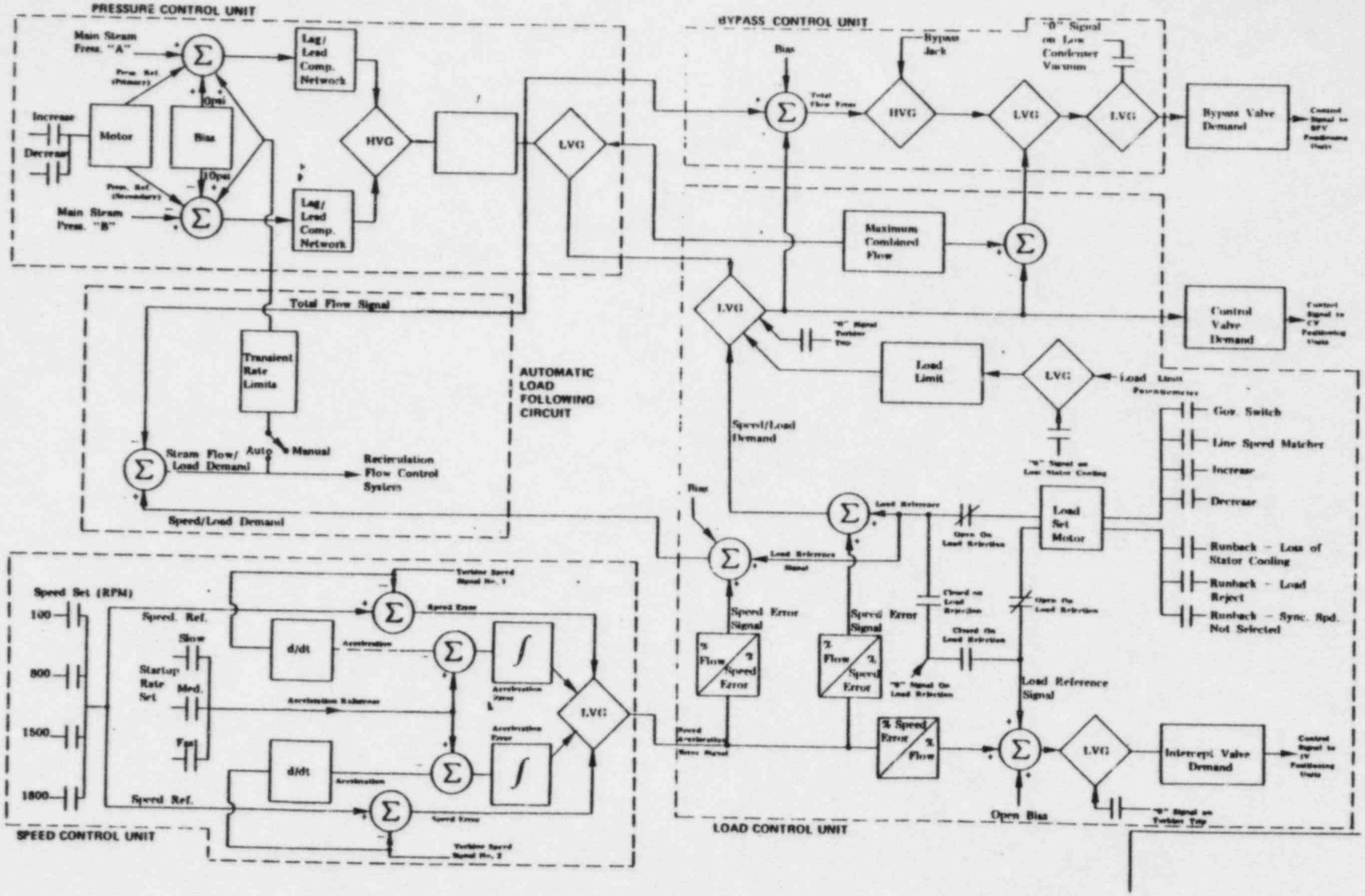


Figure 23-II-C3
Feedwater Level Control System
Simplified Block Diagram



Electrohydraulic Control System
Simplified Control Diagram

ANSWER 5.01 (1.00)

answer B.
Less than double the original flow [0.5] when delivering water into a piping system that offers frictional resistance, 2 pumps operating in parallel will encounter greater resistance to flow. The increased frictional resistance lowers the total flow to less than twice the original flow. [0.5]

REFERENCE
Fluid Flow

ANSWER 5.02 (3.00)

a. Farther from cavitation (0.5). As the reactor water level increases, the static head of water component in the NPSH determination is also increasing which adds NPSH. (0.5)
b. Farther from cavitation (0.5). If a feedwater heater is lost, then the temperature of the water entering the reactor is lower, which brings the water farther from the saturation temperature. (0.5)
c. Closer to cavitation (0.5). As pump speed increases, the pressure in the eye of the impeller decreases, which will cause the pump to cavitate earlier with the same NPSH. (0.5)

REFERENCE
Thermodynamics

ANSWER 5.03 (3.00)

DECREASE.[0.5]
REASONS: (2 of 3 required at 1.25 each)

1. Immediately the loss of feedwater flow causes a decrease in moderator subcooling which introduces negative dk/k into the core.
2. When feedwater flow drops below 20%, the recirc. pumps will auto runback to 20%. The decrease in core flow causes an increase in voiding which also adds negative dk/k into core.
3. Decreasing level in the downcomer will reduce the available head for core circulation and will result in decreased core flow, and thus reactor power will decrease.

REFERENCE
Rx Theory
Recirculation System
Feedwater System

ANSWER 5.04 (3.00)

1. MCPR - protects against the onset of transition boiling
2. LHGR - protects against exceeding 1% plastic strain on the clad due to excessive heat generation in the fuel.
3. MAPLHGR - ensures that peak fuel clad temperature will not exceed 2200 degrees during a DBA LOCA.

(0.5 for limit and 0.5 for reason)

REFERENCE

Heat Transfer - page 44

ANSWER 5.05 (2.00)

The most important factor in thermal diffusion length, and the only one with an easily measureable affect is REACTOR COOLANT TEMPERATURE. Increasing coolant temperature decreases moderator density and increases thermal diffusion length. The rod will therefore have a higher worth at high temperature. (2.0)

REFERENCE
Reactor Theory, page I-113

ANSWER 5.06 (2.00)

a. 1-Air pockets in a line. (0.5)
   2-Fast closing a valve in a line where water or steam is flowing (0.5)

b. 1-Venting lines
   2-Use of a keep-fill system
   3-Regulating closing time on valves
   (2 of 3 at 0.5 each) (other reasonable answers for part 'b' will be accepted for credit.)

REFERENCE
Thermohydraulics and Fluid Flow

ANSWER 5.07 (2.50)

a. This area is the transition region between natural circulation operation and 20% pump speed operation.(0.5) Steady state conditions cannot exist in this region because the recirc pumps cannot be operated below 20% speed.(0.5) [Normal startup is along the 20% pump speed boundary of this region.] Bracketed sentence not required
25% actual plant value
b. This is the normal operating region of the map (0.5)
c. Damage can be expected to the recirculation pumps and jet pumps from cavitation. (0.5) Damage is prevented by recirc pump trips to 20% speed when feedwater flow is less than 20% of rated. (0.5)

REFERENCE
Limerick Generating Station FSAR

ANSWER 5.08 (3.00)

a. 1-Increase (0.5)
 2-Void coefficient, due to the collapse of voids from the presssure spike (0.5)

b. 1-Increase (0.5)
 2-Moderator Temperature Coefficent, due to the decrease in moderator temperature and increase in density (0.5)

c. 1-~~Decrease~~ Increase (0.5)
 2-Doppler Coefficient, due to increased fuel temperature (0.5)
 part 2 - Rx ... acceptable

REFERENCE
General Physics Reactor Theory, Part 12 & 13 (Coefficients of Reactivity)

ANSWER 5.09 (3.00)

a.) The two events for which the EOC/RPT protective feature will function are; 1.) Closure of the turbine stop valves.
 2.) Fast closure of the turbine control valves.
b.) The physical phenomenon involved is that the void reactivity feedback due to a pressurization transient can add positive reactivity to the reactor system at a faster rate than the control rods can add negative scram reactivity. By tripping both recirculation pumps,coolant flow is reduced thus reducing the void collapse in the core.

REFERENCE
L.G.S. Technical Specifications Sec. 3/4.3.4 EOC-RPT.

ANSWER 5.10 (2.50)

Indicated vessel level will INCREASE (1.0)
Due to: -Decreased suction in the annulus (0.75)
-Voiding in the core (0.75)

Due to wording of the question only one reason required for full credit
JE 8/17

REFERENCE:

ANSWER 6.01 (3.00)

a. YES (0.5) - The control rods will be inserted in this condition since it is reactor pressure that is the driving force which inserts the CRDs. The accumulators only assist in initiating the inward motion.(1.0) The scram times may be longer, but the rods will scram. (This statement not required for full credit.)

b. NO (0.5) - This switch is only active in the refuel or shutdown mode switch positions. (1.0)

REFERENCE
CRD System
RPS System, (page 15-5)

ANSWER 6.02 (3.00)

a. New reading on range 6 is 2.5 (0.75)
IRM downscale rod block will be in (0.5)

b. New reading on range 5 is 39 (0.75)
IRM high rod block will be in (0.5)
IRM hi-hi half scram will be in (0.5)

REFERENCE
Nuclear Instrumentation-IRMs-Chapter 17b

ANSWER 6.03 (3.00)

1. A 25% mismatch exists between total steam flow and total feed flow [.3]. This mismatch signal is compared to the normal level signal by the level vs. flow network [.3].
2. The feedwater pumps will reduce speed, thus reducing feed flow, in an attempt to rectify the error signal [.3].
3. Since actual steam flow hasn't changed, level starts to decrease [.3]. Decreasing level will cause feedwater pumps to increase speed again until feed flow and steam flow are equal [.3]
4. The total steam flow indicated 75% [.3], the actual steam flow is still 100% [.3]. Total feed flow 100% [.3]. Reactor power is 100% [.3]. Reactor water level is ~18 inches [.3]. (Decreased water level is acceptable). (3.0)

REFERENCE
Feedwater and Level Control System, Chapter 23

ANSWER 6.04 (3.50)

a.

1. NO [0.5]
2. Decreases [0.5]
3. The CVs stay at full open and BPVs open ~~5%~~ 15% (limited by MCF set at 1[illegible]5%) [0.5] causing reactor pressure to decrease, thus reactor power will decrease. [0.25]
4. Yes [0.25] Due to ~~950~~ 836 psig steam pressure in RUN [0.5]
   Possible alternate answer - scram due to high water level from swell on depressurization

b. Nothing, [0.25] With the generator output breakers shut [0.25] the system will bypass all pushbuttons but the 1800 RPM [0.5]

REFERENCE
EHC, Turbine Control Logic, Chapter 21b

ANSWER 6.05 (3.00)

a) No. [0.25] The high drywell pressure signal seals in and will not reset, even if the manual reset is attempted, until it clears. [0.75]

b) - Auto blowdown will not initiate if the timer has not timed out [0.2] because the timer will reset and not restart until level drops below the setpoint [0.3].
   - If the timer has timed out, auto blowdown will be initiated [0.25] and will continue until completion (or reset) [0.25]

c) No. [0.25] Power to the DC solenoids and logic initiation circuitry is powered from 125 VDC. [0.75]

REFERENCE
ADS, Chapter 8

ANSWER 6.06 (3.00)

a. Remains constant [0.25]. Flow is controlled by the RCIC flow controller which will attempt to maintain a constant output flow regardless of reactor pressure [0.75]. (1.0)

b. Decreases [0.25]. The flow controller functions to maintain a constant flow, thus pump discharge pressure is decreased along with the decreasing reactor pressure to maintain constant flow. OR Since the flow controller maintains a constant flow to the reactor, as reactor pressure decreases, the pump discharge head must decrease to maintain a constant flow (constant NPSH) [0.75]. (1.0)

c. Decreases [0.25]. Since pump discharge head is decreasing to maintain a constant flow, turbine RPM must also decrease [0.75]. (1.0)

REFERENCE
Pumps, Fluid Flow, and RCIC System

ANSWER 6.07 (3.00)

No (1.0). When transferring RPS power supplies, the RPS is momentarily deenergized because the transfer is break before make. This would result in a scram due to the 1/2 scram already present (2.0). If AC to AC switch, there would be no break before make, therefore YES is acceptable.

REFERENCE
RPS

ANSWER 6.08 (1.00)

Choice B is the correct answer (1.0)

REFERENCE

General Physics Design Lecture Series, Volume 2, Chapters 50 & 31

ANSWER 6.09 (2.50)

Yes.(1.0) The loss of the 125Vdc battery will cause a loss of control power to the diesel generator which will render it inoperable. (1.0)

REFERENCE

Diesel Generators and Emergency AC power Sources, Chapter 32

ANSWERS -- LIMERICK 1 -84/08/14-BERRY, J.A.

ANSWER 7.01 (3.50)

a. 1) RPV level below -38 inches or unknown (0.5)
   2) DW Pressure above 2 psig (C.5)
   3) Group I Isolation (0.5)
   4) Scram condition with power above 3% or unknown (0.5)
b. 1) Indicating lights (0.5)
   2) SPOTMOS (0.5)
   3) SRV Tailpipe Temperature (0.5)
   NOTE: Other reasonable answers for part 'b' will be given credit.

REFERENCE
TRIP Procedure T-101, RPV Control

ANSWER 7.02 (2.25)

1. CMFLPD = LHGR actual/ LHGR limit. A value of less than 1.0 means that the highest LHGR value in the core is less than the limit of 13.4 KW/ft. (0.75)
2. CMFLCP = CPR lim/CPR actual. A value less than 1.0 means that the lowest value of CPR in the core is above the CPR limit (0.75)
3. CWT= sum of the jet pump flows. It is used as the value of total core flow to ensure it is less than 100 MLB/Hr. (0.75)

REFERENCE
GP-5
Process Computer

ANSWER 7.03 (1.75)

a. These steps are designated as Tech Spec requirements (1.0)
b. Shift Supervision is to be notified immediately (0.75)

REFERENCE
Surveillance Test Procedures

ANSWER 7.04 (3.00)

1. His observations of plant conditions and equipment indicates a safety hazard
2. When RPS parameters have been exceeded without subsequent automatic action
3. Appropriate procedures so direct.
[3 of 4 responses at 1.0 points each]
4. When there is doubt as to when safe conditions exist.

ANSWERS -- LIMERICK 1 -84/08/14-BERRY, J.A.

REFERENCE
LGS Procedure A-7 'Shift Operations'

ANSWER 7.05 (2.50)

a. 1) 75 R
   2) 25 R
   3) 5 R
   4) 10CFR20 Guidelines
   5) Station Administrative Guidelines

REFERENCE
Limerick Generating Station Emergency Plan Implementation Procedures

ANSWER 7.06 (3.00)

Montgomery County Dispatcher

a. Linfield Fire Company and/or Limerick Fire Company. (0.5 each)

Other actions DCALL control room acceptable.

b. The Fire Brigade Leader (0.5)
c. ANY TWO
   1. Fire Brigade Equipment Cage (Elv 269, Turb Building)
      -full turn out gear
      -spare hose
      -nozzles
      -smoke ejectors
   2. Emergency Fire Cabinet (Elv 217 in Rad Waste Building)
      -same as above
   3. Emergency Fire Cabinet (ELv 283 in Reactor Building)
      -same as above
   (0.5 for location, 0.5 for equipment)

REFERENCE
Limerick Generating Station Procedure SE-8, Rev. 0

ANSWER 7.07 (3.00)

a. 1-Document the change on the procedure (0.33)
   2-Obtain approval. Two plant staff members, one of whom is a SS (0.33)
   3-Submit the change to PORC as per A-4 (0.33)
b. Two members of plant staff knowledgable in the affected area(s), one of whom shall be an SRO, Shift Superintendent, or Shift Supervisor.(1.0)
c. YES. (0.25). The words 'Telephone Approval' shall be written on the procedure. (0.25)
d. If the task being authorized for performance is more limited in scope than the procedure being used.(0.5)

ANSWERS -- LIMERICK 1 -84/08/14-BERRY, J.A.

REFERENCE
Limerick Generating Station Procedure A-3, Rev.0

ANSWER 7.08 (3.00)

a. 1-Scram the reactor (0.5)
2-Trip the main turbine (0.5)
3-close the MSIVs (0.5)

} may indicate multi-unit actions.

b. RCIC (any 3 at 0.25 each)
-Barometric condenser condensate pump will no longer operate in AUTO
-Hi-level trip bypassed
-min flow valve no longer function in AUTO
-No auto initiation
-steam inlet no longer interlocked with exhaust valve
RHR (any 3 at 0.25 each)
-no auto initiation
-injection valve interlock defeated
-shutdown cooling interlocks defeated
-containment spray interlock defeated
-minimum flow bypass valve will not function automatically
-HX service water outlet Hi-Rad will not auto isolate HX

RHRSW actions need to be substituted

REFERENCE
Limerick Generating Station Procedure SE-1, Rev 0

ANSWER 7.09 (3.00)

a. Decrease
b. Decrease
c. Increase
d. Decrease
(4 @ 0.75 each)

REFERENCE
Limerick Off-Normal Procedure ON-100

ANSWER 8.01 (3.00)

T.S. 3/4.7.8 requires that the turbine bypass system be operational when thermal power is greater than or equal to 25% of rated.
With the system INOP, and unrestorable within one hour, take the action required by T.S. 3.2.3
T.S. 3.2.3 requires MCPR to be determined to be greater than or equal to the MCPR limit as a function of average scram time as shown in Fig. 3-2.3.1 times the Kf shown in Fig 3.2.3-2
If these conditions are met, T.S. 3.0.4 is not applicable, and operation can continue.

REFERENCE
L.G.S. Technical Specifications

ANSWER 8.02 (3.00)

NO.(1.0) You must have Suppresion Pool water temp less than 95 degrees F before entering Operational Condition 2(1.0) because Tech. Spec. 3.0.4 does not allow you to enter an operational condition while relying on an action statement.(1.0)

REFERENCE
Technical Specification 3.0.4
Technical Specification 3.6.2.1

ANSWER 8.03 (3.00)

a. A system, sub-system, train, component or device shall be operable when it is capable of performing its specified function and when all necessary attendant instrumentation and controls, electrical power, cooling water, lubrication or other auxillary equipment that are required for the system (etc) to perform its functions are also operable. (1.0)
b. The amount of reactivity by which the reactor is subcritical, or would be subcritical, assuming all control rods are fully inserted except for the single control rod of highest reactivity worth which is assumed to be fully withdrawn, and the reactor is in the shutdown condition; cold. (i.e. - 68 degrees F and Xenon free) (1.0)
c. Shall be a pattern which results in the core being on a thermal hydraulic limit. i.e. - operating on a limiting value for APLHGR, LHGR, or MCPR. (1.0)

REFERENCE
Limerick Generating Station Technical Specifications

ANSWER 8.04 (2.50)

The occurance of eight inoperable control rods could be indicative of a generic problem and the reactor must be shutdown for investigation and resolution of the problem. (2.5)

REFERENCE
L.G.S. Technical Specification 3/4.1.3. Bases. Control Rods.

ANSWER 8.05 (2.50)

a.) See table 6.2.2-1 of Technical Specifications. (2.0)
b.) Shift Technical Advisor. (0.5). Any other position not required during refuel or shutdown is acceptable

REFERENCE
Technical Specfications Sec.6.0 Administrative Controls.

ANSWER 8.06 (2.00)

a. Thermal Power should be 25% (0.25)
   Reactor Vessel Steam Dome Pressure, not turbine first stage (0.25)
b. Shall not be less than instead of shall be less than (0.25)
   Core flow 10%, not 20 % (0.25)
c. 1325 vice 1375 (0.5)
d. above the top of the irradiated fuel (0.5)

REFERENCE
Limerick Generating Station Technical Specifications, Section 2.0

ANSWER 8.07 (3.00)

INITIAL ACTIONS: Attempt to match the speed vs the speed demand for the B pump, and try to reset the lock-out again. (0.5)
NOTE: ANY REASONABLE INTIAL ACTION(S) WILL BE ACCEPTED FOR CREDIT.

T.S. ACTIONS: If the speed of the recirc pumps cannot be restored within two hours to the specifed limits of 3.4.1.3 (a), then declare the recirc loop of the pump with the slower speed INOP, and take the Action required by T.S. 3.4.1.1 Section 3.4.1.1 states to immediately initiate measures to place the unit in at least hot shutdown within the next 12 hours. Due to the inop recirc loop and the B M.G. set locked out, action 'b' of 3.4.1.1 is more limiting due to two inop recirc loops, and the unit shall be in at least startup within 6 hours and in hot shutdown within the next 6 hours. (2.5)

MAY NOT DECLARE 'B' INOP. Action 'a' may be acceptable

REFERENCE
L.G.S. Technical Specifications

ANSWER 8.08 (3.00)

Technical Specification Table 3.3.1-1 requires that the minimum number of operable channels per trip system for the Fast-Closure scram be two (2).
Section 3.3.1 requires tripping of the inoperable channel within one hour.(1.5)
Table 3.3.1-1 (K), also indicates that this trip function activates the EOC-RPT. Action 'b' of 3.3.4.2 requires placing the inop channel in the tripped condition within one hour. This is satisfied via the action taken per 3.3.1 (1.5)

REFERENCE
L.G.S. Technical Specifications

ANSWER 8.09 (3.00)

a. ~~The LCO for the MSIVs are stated in Section 3.4.7. Two main steam line isolation valves per main steam line shall be operable with closing times greater than or equal to 3 secs and less than or equal to 5 secs. Operating outside of this specification is a violation of T.S. and therefore is a reportable occurance. (1.0)~~

b. Action 'a' of 3.4.7 states that with the "C" MSIV INOP due to exceeding the allowable closing time, the affected steam line shall be isolated if the problem is not corrected within 8 hours, or be in Hot Shutdown within the next 12 hours and cold shutdown within the follwing 24 hours. (2.0)

a. Reportable occurance due to being outside the maximum allowable surveillance time interval. (1.0)

Reviewers → [illegible]

Ed Brohl [illegible]

U.S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

Facility: Limerick Generating Station

Reactor Type: BWR

Date Administered: August , 1984

Examiner: Brian K. Hajek

Candidate: MASTER COPY

INSTRUCTIONS TO CANDIDATE:

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

Category Value	% of Total	Candidate's Score	% of Category Value	Category
24.5	24.5			1. Principles of Nuclear Power Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow
25.5	25.5			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				TOTALS

Final Grade _______ %

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

____
Candidate's Signature

1. PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER, AND FLUID FLOW (24.5)

1.1 Water is used in three physical states at the Limerick Generating Station. For each of the following specific system locations, indicate whether the water is subcooled, saturated, or superheated.

a. Inlet to the recirculation pumps, (0.5)
b. Outlet of the core, (0.5)
c. Moisture separator drain lines, (0.5)
d. Control Rod Drive System HCU Accumulator outlet, (0.5)
e. Feedwater at outlet of the Number 4 heaters, (0.5)
f. Circulating water at the inlet of the LP shell condenser. (0.5)

1.2 Solids transfer heat by conduction and fluids almost always transfer heat by convection. However, in the core of a BWR there are two exceptions to heat transfer by convection where fluids are concerned.

a. Briefly describe these two exceptions (ten or twelve words each). (1.0)

b. How do these exceptions affect the operating temperatures of the fuel? What physical property of the fluid causes this effect? (1.0)

1.3 The HCU accumulators are charged with nitrogen to assure rapid insertion of the control rods.

a. The pressure to which the accumulators are <u>precharged</u> varies. Why does this pressure vary, and what is a typical pressure to which the accumulators are precharged? (1.0)

b. Precharge pressure should not be determined or set immediately after charging. What is the reason for this? (1.0)

c. What is the accumulator nitrogen pressure during normal reactor operation? Why is it so different from the precharge pressure? (1.0)

Category Continued on Next Page

1.4 During recirculation system and reactor startup and heatup, several temperature limits must be observed.

a. What two temperature differentials must not be exceeded before an idle recirculation loop may be started. Give both the values and the components between which the temperature differentials are monitored. (1.0)

b. What is the nominal heatup rate which is to be used during a plant heatup? (0.5)

1.5 Boiling which occurs in the core of the BWR affects both the nuclear and hydraulic characteristics of the core.

a. Does boiling increase or decrease the resistance to flow? (0.5)

b. The average quality of reactor coolant at the core outlet is about 0.13 (13 percent). Is the void fraction greater than, equal to, or less than this value? Briefly explain your answer using appropriate definitions or explanations of quality and void fraction. (1.5)

1.6 Control rod worth is a function of several variables that change during a core operating cycle.

a. One of these is pitch, which involves the effect of the worth of one control rod on the worth of another control rod. (1) What is pitch? (2) Give two examples of values for pitch, including a description of the specific operating configuration that results in these values. (1.5)

b. Will an increase in the thermal diffusion length cause the control rod worth to increase or decrease? Give two examples that will cause the thermal diffusion length to increase. (1.5)

Category Continued on Next Page

1.7 After operating at 75 percent power for three days, the reactor is increased in power to 100 percent.

a. Sketch the average Xenon-135 concentration in the core for the next three days. Include approximate times for significant changes in slope. (1.0)

b. If the reactor is shutdown after these three days at full power, in what part of the core will the Xenon concentration be highest? Why? (1.0)

1.8 The Doppler coefficient of reactivity is important in the limiting of transients during reactor operation.

a. Briefly describe what is meant by Doppler broadening. (1.0)

b. How are K-effective and reactivity affected by Doppler broadening? (0.5)

c. For each of the following conditions, indicate whether the Doppler <u>coefficient</u> increases (becomes more negative), decreases (becomes less negative), or remains the same:

(1) Fuel temperature increases (0.5)
(2) Core void fraction increases (0.5)
(3) The core ages (0.5)

1.9 Your Tech Specs and procedures list strict limits within which primary water purity must be maintained.

a. Give two reasons for maintaining high purity in the reactor coolant. (1.0)

b. Why is conductivity the parameter which must be monitored continuously and on which limits are placed? (1.0)

c. Why are chloride and conductivity limits permitted to change as a function of operational mode? (1.0)

Category Continued on Next Page

1.10 The concept of subcritical multiplication is used to describe the behavior of the reactor during a startup or during refueling.

a. In a subcritical reactor, if the source level doubles, what will happen to the neutron level? (0.5)

b. In a subcritical reactor, if a reactivity of 0.003 dk/k is added to the reactor, will it take longer to reach equilibrium if the initial k-effective is 0.92 or if k-effective is 0.992? Explain the reason for your answer. (1.5)

End of Category

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

2.1 For the Main Steam Isolation Valves diagrammed in Figure 2.1, briefly describe the operation of the valve operating air system. Using the figure, and identifying the specific components, explain how this system operates for

a. Opening the MSIVs, (1.0)
b. Closing the MSIVs, including assuring closure of the MSIVs in case of failure of the air supply system, and (2.0)
c. Periodic testing of the MSIVs. (1.0)

2.2 The Standby Liquid Control System is used to inject sodium pentaborate into the reactor system in the event of a failure of the CRD System.

a. Where is the standby liquid injected into the vessel? (0.5)

b. When SLC is initiated, another system is automatically isolated. What is this system, and why is it required to be isolated? (1.0)

c. Two heaters are provided to heat the solution in the storage tank. (1) Why must the solution be heated, (2) what is the specific purpose for each of the two heaters, and (3) how is each heater controlled? (1.5)

2.3 The recirculation pumps are provided with a cartridge type seal assembly.

a. Both the Control Rod Drive and the Reactor Enclosure Cooling Water Systems provide water to the seals. What is the purpose of each, and where does the water go after passing through the seal cartridges to satisfy this purpose? (1.0)

b. What is the pressure in each seal cavity and what are the flow rates through each seal cavity under normal full power operating conditions? (1.0)

c. What would the pressures and flow rates be if only the No. 1 (internal) seal failed? (1.0)

Category Continued on Page 7

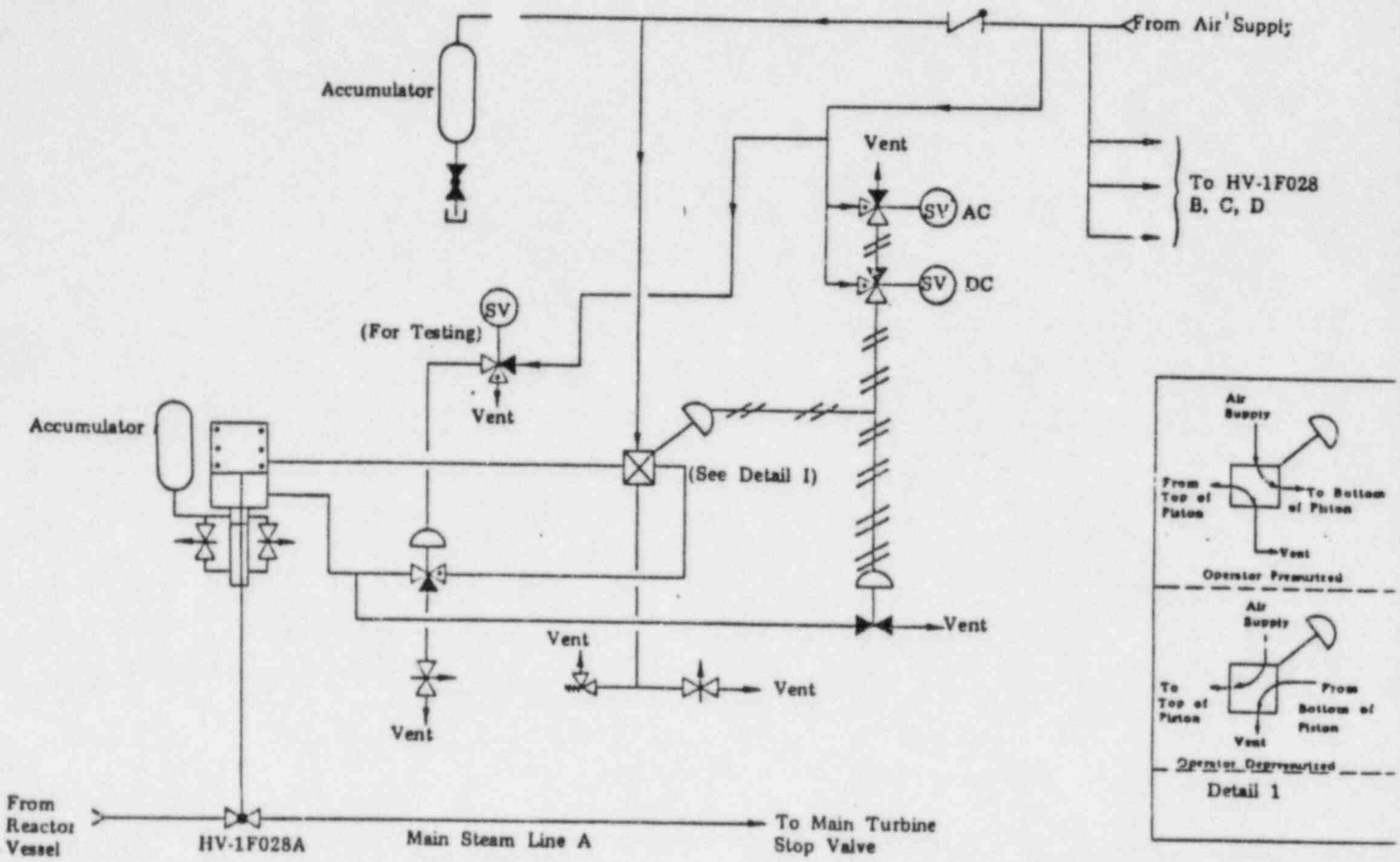


Figure 2.1 MSIV Control Air Simplified Diagram

2.4 The Scram Discharge Volume is provided to receive water from the Control Rod Drives in the event of a reactor scram. To fulfill this function, it must remain empty.

a. What will be the first indication the operator will receive indicating a high level in the SDV? (0.5)

b. If you receive the above indication that a high level exists in the SDV, what are you required to verify immediately? (1.0)

c. If the level continues to increase, what further automatic actions, including alarms, will occur. Be sure to include the levels at which these actions occur. (1.5)

2.5 Several precautions must be observed when performing a local or remote manual start of a Diesel Generator.

a. Why is a local manual startup to be performed on only one diesel at a time? (1.0)

b. Why shouldn't the engine be run unloaded? (1.0)

2.6 The 4.16 KV Safeguard Buses may receive power from any one of three sources.

a. Label Figure 2.2. Include labels for the power sources, all major ACBs and transformers, and indicate which breakers are normally open or closed. (Remove the figure from the examination and include it with your answer sheets.) (3.0)

b. For the D11 Bus, if the normal supply breaker should trip, what position must the alternate supply breaker control switch be set at for the automatic fast transfer function to operate? (0.5)

c. If the alternate feeder breaker does not close, when will the Diesel Generator start, and when will the Diesel Generator Breaker close? (1.0)

Category Continued on Page 9

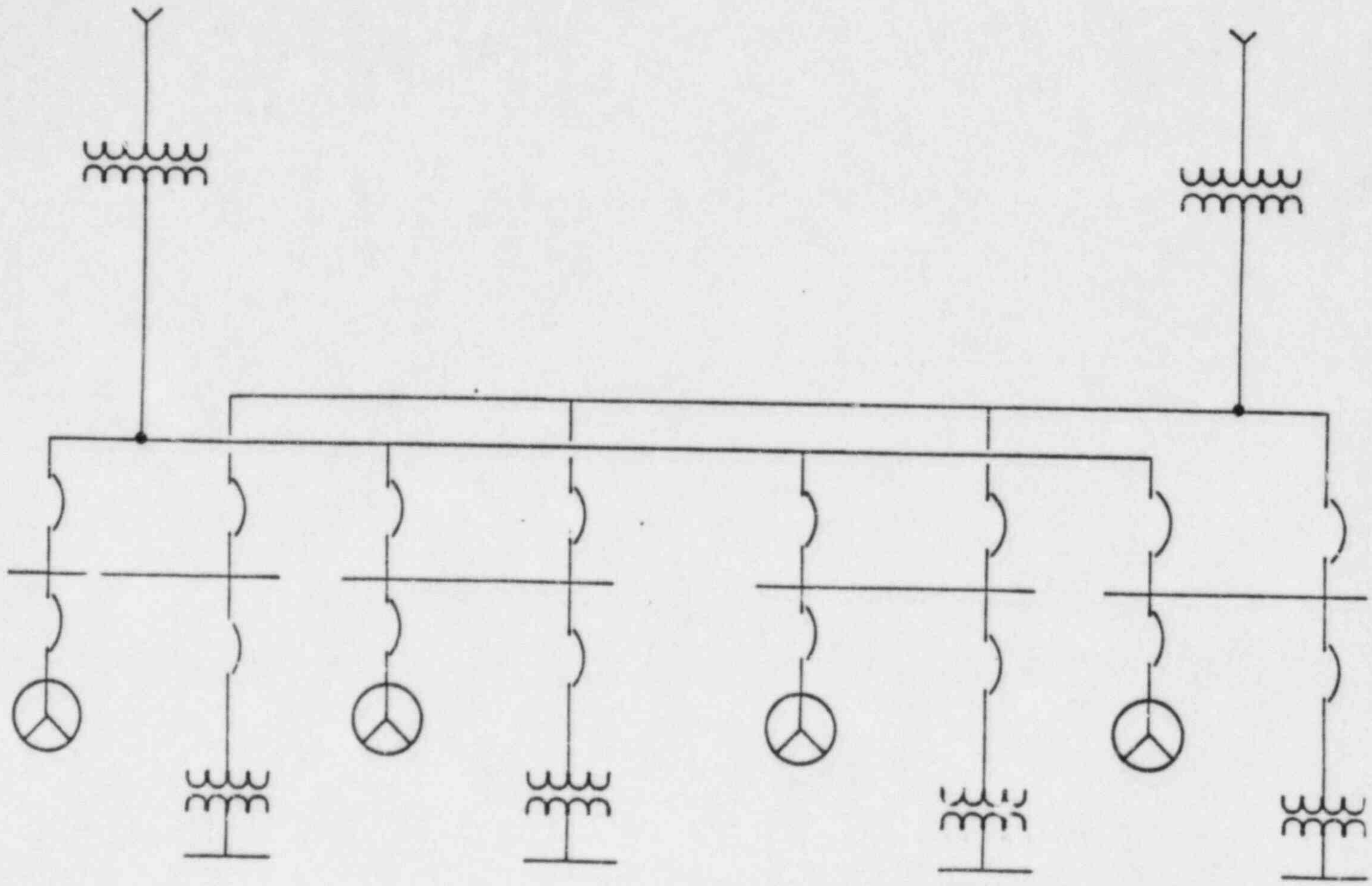


Figure 7.7 4160 Volt Distribution System Simplified

2.7 The Water Fire Protection System contains two water supply pumps.

a. What is the purpose of each of these pumps, and what signals will cause each pump to auto start? (1.5)

b. How is system pressure maintained when the fire pumps are not operating? (1.0)

2.8 The Remote Shutdown System provides an alternate method for system cooldown and pressure control.

a. What systems are assumed to be unavailable for this purpose? (1.0)

b. How is reactor pressure to be controlled? (0.5)

c. What system is used to maintain water inventory? (0.5)

2.9 a. For what Loss of Coolant Accident conditions is the HPCI System designed? (0.5)

b. List four of the seven conditions that will operate the HPCI Turbine Trip Solenoid. (1.0)

End of Category

3. INSTRUMENTS AND CONTROLS (25)

3.1 The recirculation pump speed control system contains two speed limiters in the Manual/Automatic Transfer Station. For each speed limiter, give:

a. Give the purpose for each speed limiter. (1.0)

b. Draw a diagram of the circuit for the two speed limiters that includes the conditions or setpoints that will cause each limiter to be functional. (2.0)

3.2 Five indicating ranges are provided for monitoring vessel water level, and eight levels are specified for controlling normal and abnormal operating functions.

a. For Level 2 at -38", complete the following two sentences:

1) The setpoint shall be low enough so that . . . . (0.5)

2) The setpoint shall be high enough so that . . . . (0.5)

b. List the four actions that automatically occur when this level is reached. (1.0)

c. Which level instrument channel provides the trip functions listed in Part b? (0.5)

Misunderstanding of Lesson Plan - Clarification during exam asked only for the fact that no overlap existed

d. Which other level channel could you use to verify the level readings you obtain from the channel listed in Part c? Would you expect the two channels to read exactly the same? Explain why or why not. 0· (1.5)

3.3 Each control rod drive contains a position indicating probe with 53 reed switches to provide control rod position information to the RPIS. Forty-nine of these switches provide the "00" through "48" indications.

a. Where are the other four switches located in the probe, (1.0)

b. What rod position do they indicate, and (1.0)

c. What control board indications would you expect to have from each of them? (1.0)

Category Continued on Next Page

3.4 The APRMs receive and average signals from individual LPRMs.

a. How are the LPRMs arranged in the core, and how are they used in each of the APRM channels? (1.0)

b. Gamma discrimination is used for both the SRM and the IRM detectors, but not for the LPRMs. Give two reasons for gamma compensation not being required for the LPRMs used in the APRM channels. (1.0)

c. How would you determine the flux level for a single LPRM? Give two methods. (1.0)

d. Unlike SRMs and IRMs, the sensitivity of LPRMs changes during core life. Yet all three detectors are of similar construction. Why does the sensitivity of the LPRMs change, and what method is used to compensate for the change in sensitivity? (1.0)

3.5 Air pressure is normally applied to the Scram Inlet and Exhaust Valves to hold them closed to prevent a reactor scram from occurring. If a trip signal is received in either RPS System A or B, signals are sent to the Scram Pilot Valves and to the Backup Scram Valves to cause air to be removed from the Scram Inlet Valves.

a. Use a drawing to indicate where the Scram Pilot Valves and the Backup Scram Valves are located in the system that supplies air to the Scram Inlet and Outlet Valves. Show the signal connections to the RPS. Do not include the additional RRCS valves in this drawing. (2.0)

b. Are the Scram Pilot Valves and Backup Scram Valves normally energized or normally deenergized? (0.5)

c. What signals are required to cause the Scram Pilot valves and the Backup Scam Valves to change state? (1.0)

d. If one of the Backup Scram Valves should fail to operate on receipt of the appropriate signal, what assures that the other valve can perform the necessary function? (0.5)

Category Continued on Next Page

3.6 What two systems receive inputs from the Main Steam Line Radiation Monitors, and what actions will result in each system if the trip setpoint is exceeded? (2.0)

3.7 The Redundant Reactivity Control System will initiate a Feedwater Control System Runback.

a. What signals (including logic) will cause an RRCS feedwater runback? (1.0)

b. When may the runback be reset? (0.5)

c. Why is this action (the runback) effective in mitigating an ATWS event? (0.5)

3.8 Protection functions are provided by the IRMs.

a. What conditions will result in an IRM INOP, and what trip action will occur? (1.5)

b. When are the above IRM trip functions bypassed? (0.5)

3.9 A time delay for resetting any reactor scram is automatically imposed. How long is this time delay, and what is its purpose? (1.0)

End of Category

4. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY, AND RADIOLOGICAL CONTROL (25)

4.1 The Reactor Water Cleanup System may be used for vessel blowdown during reactor startup, according to S44.4.A, RWCU System Blowdown.

Better to ask for reasons for blowdown being required

a. Give two sources of the water that is being rejected. (1.0)

b. Excess water may be rejected to any one of three plant locations. <u>In order of highest quality water to lowest quality water</u>, what are these three locations. (1.5)

c. What two conditions will result in a Group III isolation? (1.0)

4.2 If a sudden loss or failure of the primary containment is suspected while operating at full power, according to ON-110, Loss of Primary Containment,

a. List two symptoms you would notice. (1.0)

b. Give three possible causes that would need to be investigated immediately, and explain why each of them would result in a symptom leading you to suspect a loss of primary containment integrity. (1.5)

c. How much time do you have to re-establish primary containment integrity before action to lower reactor power is required? (0.5)

4.3 ON-102, Air Ejector Discharge High Radiation, provides actions to be taken in the event of an Off Gas alarm.

a. What is the most probable cause of an "Off Gas Hi Radiation" alarm? (0.5)

b. If this alarm is received, the Off-Normal procedures require that the off-gas post treatment and north vent stack radiation levels be monitored. Why would these two monitors indicate elevated readings? (1.0)

Category Continued on Next Page

4.4 In Procedure GP-2 Appendix I, a warning is given in the section on Approach to Critical concerning possible extremely short periods experienced at other facilities.

a. What are the two conditions for which the procedure warns against? (1.0)

b. Who by title shall be notified if unusually high notch worths are observed? (0.5)

4.5 According to OT-114, if a relief valve should inadvertently open:

a. What single immediate action should you take? (0.5)

b. What two conditions would require you to place the mode switch in "SHUTDOWN" and enter T-102? (1.0)

c. List five indications you would have that would indicate an open relief valve? (2.0)

d. A followup action is to reduce the turbine inlet pressure to 900 psig. Why must care be taken while performing this action? (0.5)

4.6 A-26 specifies the procedures to be followed for corrective maintenance. Indicate whether the following statements concerning corrective maintenance are true or false.

a. Operations personnel who become aware of equipment problems should not make any adjustments to the equipment without first initiating an Equipment Trouble Tag. (0.5)

b. Equipment problems should not be reported until complete data can be collected to clearly identify the problem. (0.5)

Category Continued on Next Page

4.7 In the event of a recirculation pump trip, the only immediate action specified in OT-112 if a scram does not occur is to fully drive in deep rods as required to prevent a scram.

a. What are deep rods? (1.0)

b. Explain why it is necessary to drive in the deep rods, and what measure you would use to determine when you have driven in a sufficient number of them. (2.0)

c. Prior to restarting the recirculation pump, additional deep rods must be inserted. Why is this necessary? (1.0)

4.8 Consider operation of the RHR System in the Shutdown Cooling Mode as specified in S51.8.B, Shutdown Cooling Operation (Startup and Shutdown).

a. What two signals will cause an isolation of the Shutdown Cooling Mode? (1.0)

b. Why is it required that the recirculation pump discharge valve be closed in the loop selected for injection? (0.5)

c. The minimum flow valve is to be closed and prevented from opening.

(1) Why is this necessary? (1.0)

(2) With this valve closed, what additional precaution must be exercised and why? (1.0)

4.9 On a loss of the RECW as indicated by a "REAC BLDG COOLING WATER HTX OUT LO PRESS" alarm, ON-113, Loss of RECW, states that (1) the RWCU will isolate, and (2) it may be necessary to trip the recirculation pumps.

a. What automatic actions must be verified when the RWCU isolates? (1.5)

b. How much time do you have to restore RECW before you are required to trip the recirculation pumps? (0.5)

c. What action is required when the recirculation pumps are tripped to minimize the reactor transient? (1.0)

End of Examination

EQUATION SHEET

$f = ma$

$v = s/t$

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

$w = mg$

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

$E = mc^2$

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

$KE = 1/2\ mv^2$

$a = (V_f - V_o)/t$

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

$PE = mgh$

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

$V_f = V_o + at$

$w = \theta/t$

$\Delta E = 931\ \Delta m$

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

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

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

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

$\dot{Q} = \dot{m} C p \Delta t$

$TVL = 1.3/\mu$

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

$SUR = 26.06/T$

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

$HVL = -0.693/\mu$

$Pwr = W_f \Delta n$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$I_1 d_1 = I_2 d_2$

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

$\Sigma = \sigma N$

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

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)

#1	#2		#3		#4	
States of Water in Systems	MSIVs	4	Recirc Pump Spd Limiters	3	RWCU Normal S44	3.5
HT by Convection + Conduction in Fluids/Rods	SLC	3	Level 2 actions + considerations	4	Loss of PCI Off Normal ON-110	3
HCU N_2 charging	Recirc Pump Seals	3	CRD position Indicators	3	Off Gas Hi Rad ON-102	1.5
Heatup temp limits	SDV drains	2.5	LPRMs - calibration APRM inputs	4	High notch worth sequence Startup GP-2	1.5
Boiling/quality	DG Jacket Cooling	2.0 14.5	RPS signals to scram vlvs	4	Open Relief Valve OT-114	4
CRD worth Pitch/Lpm	Emergency AC buses	4.5 19	MSL Rad Monitor Trips	2	Equipment Trouble A-26	
Xenon transients	Fire Protection	2.5 21.5	FW-RRCS Runback	2	Recirc Pump Trip OT-112	4
Doppler	RSS and cooldown	2 23.5	IRM Inops	2	RHR in S/D Cooling S51	3.5
Conductivity	HPCI	25	RPS Reset time delay	1	Loss of RECW ON-113	3
Subcritical Multiplication						

6.5

8

All items in square brackets [ ] are for information only and not part of the required answer.

Normals	III
Off Normals	III
Oper Transients	II
Admin	I

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

1.1	a. Subcooled	Ref: LP. Chap 4, pg 4.1
	b. Saturated	LP, pg 1.7-1.8
	c. Saturated	LP, pg 22a + Fig 22a-II-A1
	d. Subcooled	LP, pg 5a-12
	e. Subcooled	LP, pg 4.1
	f. Subcooled	LP, pg 20.2

Ref: LP Thermodynamics, Chap II.1

1.2 a. ① Heat transfer across the He gap between fuel + cladding

② Heat transfer across the film layer on outside of fuel pins

They may not recognize a gas as a fluid

b. Because of low thermal conductivity (the property), the operating temperatures are higher. .25 .75

Ref: L.P. Heat Transfer, pg 6

1.3 a. The precharge pressure varies as a function of ambient temperature per curve in procedure. 0.5

575 psig @ 70°F → 598 psig @ 90°F ± (Any pressure in range is acceptable) 0.5

⇒ outside this range also ok – but much less than 1100 required

b. Because gas expansion during initial charging results in low N_2 temperature.

[Must wait about 1/2 hour]

c. About 1100 psig

Charging water decreases N_2 volume by about half.

Ref: Proc #547.8.A

1.4 a. ① ΔT between the P.V. Steam space coolant and the bottom head drain coolant shall be ≤ 145°F

② ΔT between the operating + idle loops ≤ 50°F [Operating loop must be at <50% flow]

③ Also accept in place of ② - ΔT between loop to be started + vessel ≤ 50°F

Ref: T.S. § 3.4.1.4, pg 3/4 4-4 and Proc# S43.1.A § 3.0

Questioned use of "nominal"

b. [① Max heatup rate = 100°F/hr]

② Nominal heatup rate = 90°F/hr (less than 100 ok)

Ref: T.S. § 3.4.6.1, pg 3/4 4-18 Proc # GP-2 App I, § 3.2.7

1.5 a. Boiling increases the resistance to flow.

Ref: LP BWR Thermal Hydraulics pg 24+30

b. Quality is a ratio of $\frac{\text{mass of steam in a mixture}}{\text{total mass in the mixture}}$ 0.4

Void fraction is a ratio of $\frac{\text{Volume of steam in mixture}}{\text{Volowme of the mixture}}$ 0.4

When boiling occurs, volume expansion is large compared to the mass of steam in the voids. 0.5

Void fraction is > quality 0.2

The question may not elicit both definition and an explanation

Ref: LP BWR Thermal Hydraulics, pg 28-

1.6 a. Pitch is the center to center distance between control rods. .5

① With all rods in, pitch is 12" .5

② At ~~50% rod density~~ Black + White, pitch is 24" .5

[Other examples acceptable.]

b. As L↑, rod worth ↑ .5

[Rod worth is proportional to $\frac{KAL}{P^2}\left(\frac{\varphi_{local}}{\varphi_{avg}}\right)^2$ Ref Fig 14-3]

① Temperature increase in coolant => less density

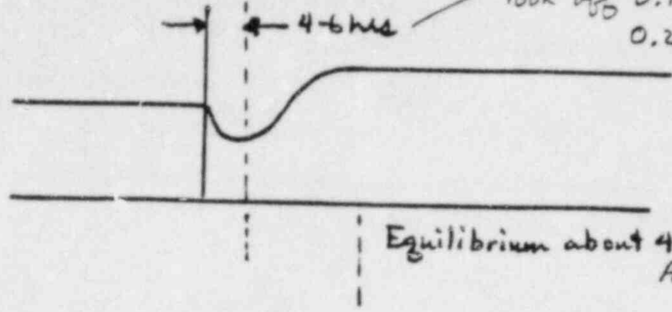
② Voids

③ Removal of absorbers s.a. rod withdrawal or fuel burnup.

.5 per expl

Ref: L.P. Rx Th pg I-112 - I-113

1.7 a.



Ref: LP RxTh pg I-127-129, Fig 16-6

b. The Xenon concentration will be highest where the flux was highest - probably in the lower center of the core.

Ref: LP RxTh pg I-126

1.8 a) Doppler broadening is the effect of lowering and widening the resonance peak. This results in greater absorption in the target as the temperature increases.

Ref: LP RxTh pg I-22 + Fig 3.5-3.7

b) As the resonance peak broadens + more neuts are absorbed, this has an effect of decreasing resonance escape (primary effect), causing K_{eff} ↓ and therefore ρ to decrease

Ref: LP RxTh pg I-105

c) ① As fuel temp increases Δρ/°F decreases — pg I-105 + Fig 13.2
② As the core void fraction increases Δρ/°F increases (becomes more negative) — pg I-106 + Fig 13.3
③ As the core ages, Δρ/°F increases [due to buildup of ^{240}Pu] — pg I-106

Ref: LP RxTh pg I-105-106, Figs 13.2+13

1.9 a) ① Minimize deposition on fuel surfaces => less heat transfer
② Minimize deposition on sfc that could hinder maintenance (crud buildup) => increased radiation hazard
③ Minimize rad levels from carryover
④ Minimize corrosion

b) Changes in this parameter are an indication of abnormal conditions. When conductivity is within limits, pH, chlorides, and other impurities affecting conductivity must also be in limits

c) Stress corrosion cracking require high temp + high O_2. At power have low O_2 (boiling/steaming) At S/D + refueling, have low temperature. — ok if say to reduce corrosion

[Conductivity may exceed 2 μmho @ S/U periods because of initial evolution of gases and the initial addition of dissolved metals.]

Ref: T.S. pg B 4-2 and pg 4-12 - 4-14

1.10 a) $\left[N = S \frac{1}{1-K}\right]$ ← not required

If S doubles, then N doubles.

b) The case when $K_{eff} = 0.992$ will take longer to reach equilibrium. 0.5

The reason for this is that one must wait for the last term in the series expansion to become insignificant. That is, until K^n becomes insignificant. This takes more terms as $K \rightarrow 1$. } 1.0

waiting for # of generations

Ref: LP pg I-63 – I-65

End of Category

2. PLANT DESIGN, INCLUDING SAFETY AND EMERGENCY SYSTEMS (25)

2.1 a. Opening

When one or both of the solenoid valves (AC or DC) [Items ① + ②] are energized, air is supplied to the valve operator [Item ③]. Air is directed to the bottom side of the piston to open the valve. At the same time, air is vented from the upper piston area to atmosphere.

b. Closure

Normal – When both of the solenoid pilots are deenergized, air to the control valve operator is blocked. The control valves reposition, venting the under piston volume and pressurizing the upper piston volume.

It is then spring + air to close.

Loss of Air – On loss of air supply

① The accumulator [Item 7] provides sufficient air to stroke the vlv. through one-half cycle (open to close)

② If total loss of air, including the accumulator, the spring will close the valve.

c. Testing – Slow closure to the 90 percent position

The testing solenoid valve [Item 8] is energized. This repositions the slow closure test valve (Item 9) and normal air is block ! While the under piston air is vented through the vent throttle valve [Item 10]

Also need Fast closure →

1. AC solenoid valve
2. DC solenoid valve
3. Control valve operator
4. Control valve (s)
5. Atmospheric Vent Line
6. MSIV Air cylinder
7. Accumulator
8. Test Solenoid Valve
9. Slow Closure Test Valve
10. Test line vent [+ vent throttle valve]
11. Underpiston vent valve

Ref: L.P. 19 – 13+14 and Fig 19-II-C1

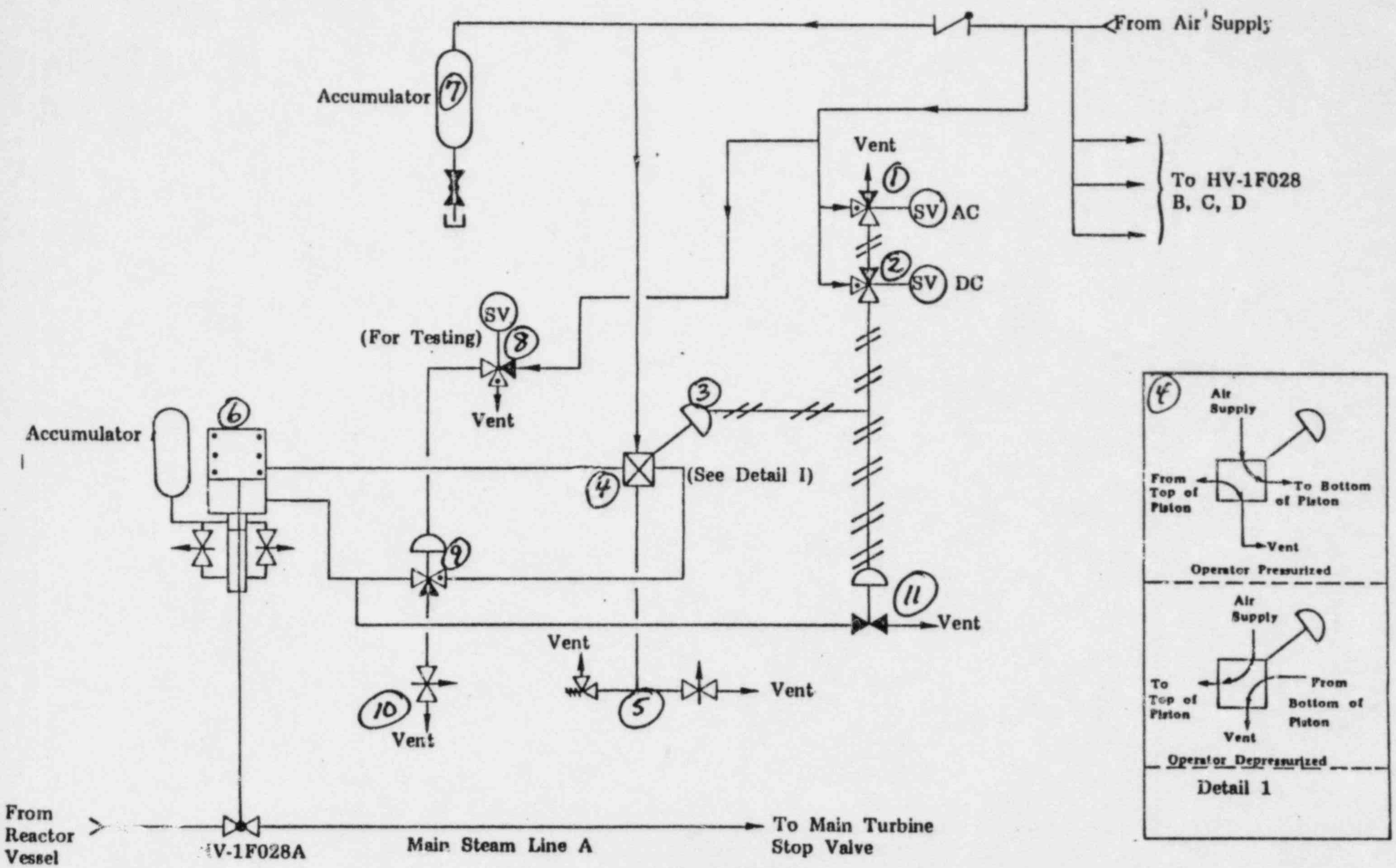


Figure 19-II-C1
Main Steam Isolation Valve
Control Air Simplified Diagram
(Typical of 8)

2.2 a. Through the [B] Core Spray Sparger [A change to design.]

Ref: L.P. SLC DLS pg 1 §C.1

b. RWCU .5

To prevent removal of the boron just injected into the vessel. .5

Ref: L.P. SLC LST pg 14.6

c. ① Heating required to preclude precipitation

② "A" heater auto controlled to maintain tank temperature

③ "B" heater for maintenance only. Manually controlled for use when adding chemicals.

Ref: L.P. SLC LST pg 14.5

2.3 a. ① CRD provides seal cooling + purging. Most goes into the primary, the rest goes to the D/W Equipment Drain Tank.

② RECW is for cooling the seals. It returns to the RECW System

Ref: L.P. LST pg 4.2, P+ID M-43

b. Pressures: #1 Cavity 1000 psig .25
#2 Cavity 480 psig – about half of Rx .25

Flow Rates: 2.5 - 3 gpm from CRD per Recirc pump .25
The total of which goes through Seal cavity # 1.
.75 of which is for seal staging and therefore .25
goes through Seal Cavity #2

Ref L.P. DLS pg 2
LST pg 4.2

c. Pressure in both seal cavities would go to Rx pressure (~1000 psig)
Seal leakage / Flow rate ~~through #2~~ would increase > 0.9 gpm & alarm

Ref L.P. LST pg 4.2

2.4 a. "SCRAM DISCHARGE VOLUME NOT DRAINED" alarm

b. Verify that the SDV vent and drain valves are open

c. [3 gal above alarm]

18 gal	Rod Block	Control Rod Withdrawal Block
36 gal	Scram	SDV Hi level Trip Rod Block

CAF for alarms not listed in Lesson Plan

Ref: a + b. OT-105

c. L.P. pg 5a-15

Comment - won't know this in S procedure

2.5 a. With the Local-Remote Selector Switch in the LOCAL position, the DG will not start on a LOCA or a Dead Bus signal and so must be considered not available.

b. The engine will not come up to temperature and oil will accumulate in the exhaust system.

on the last exam - exhaust fires was the only answer accepted

Ref: S.92.1.0, § 8.2 + 3 + § 7.3

2.6 a See attached figure

Ref: L.P. Figures 31a.I.D1 + 31b.I.C2

b. Must be set in the Normal After Trip position

c. DG will start 0.5 sec after the fault

[Alternate breaker (201-D11) should close in 0.25 sec]

The DG D11 breaker will close when ① DG voltage is >90% of normal and ② Engine is at rated speed

Ref: L.P. LST pg 32.12 for b and c

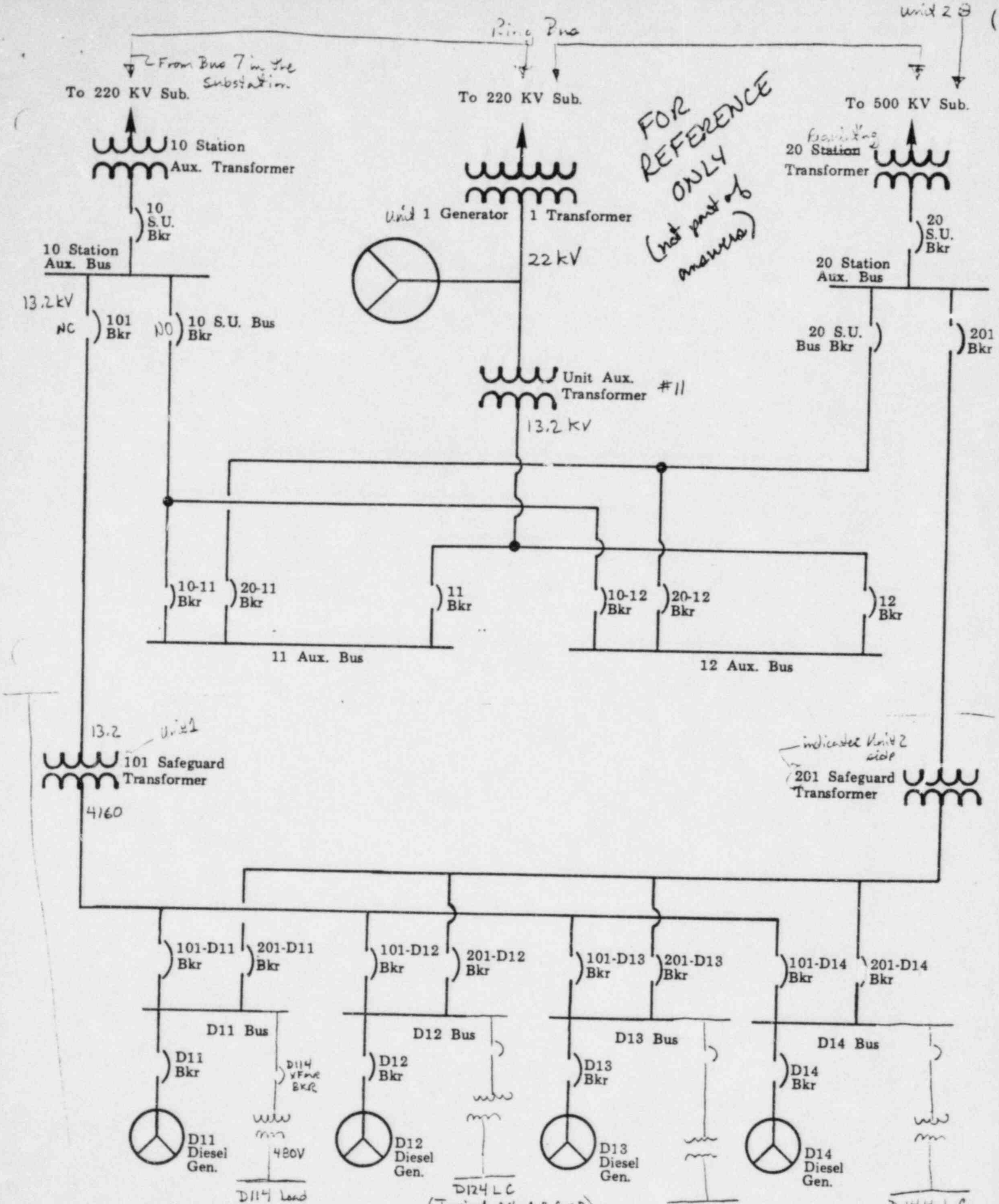


Figure 31a-I-D1

Main Power System

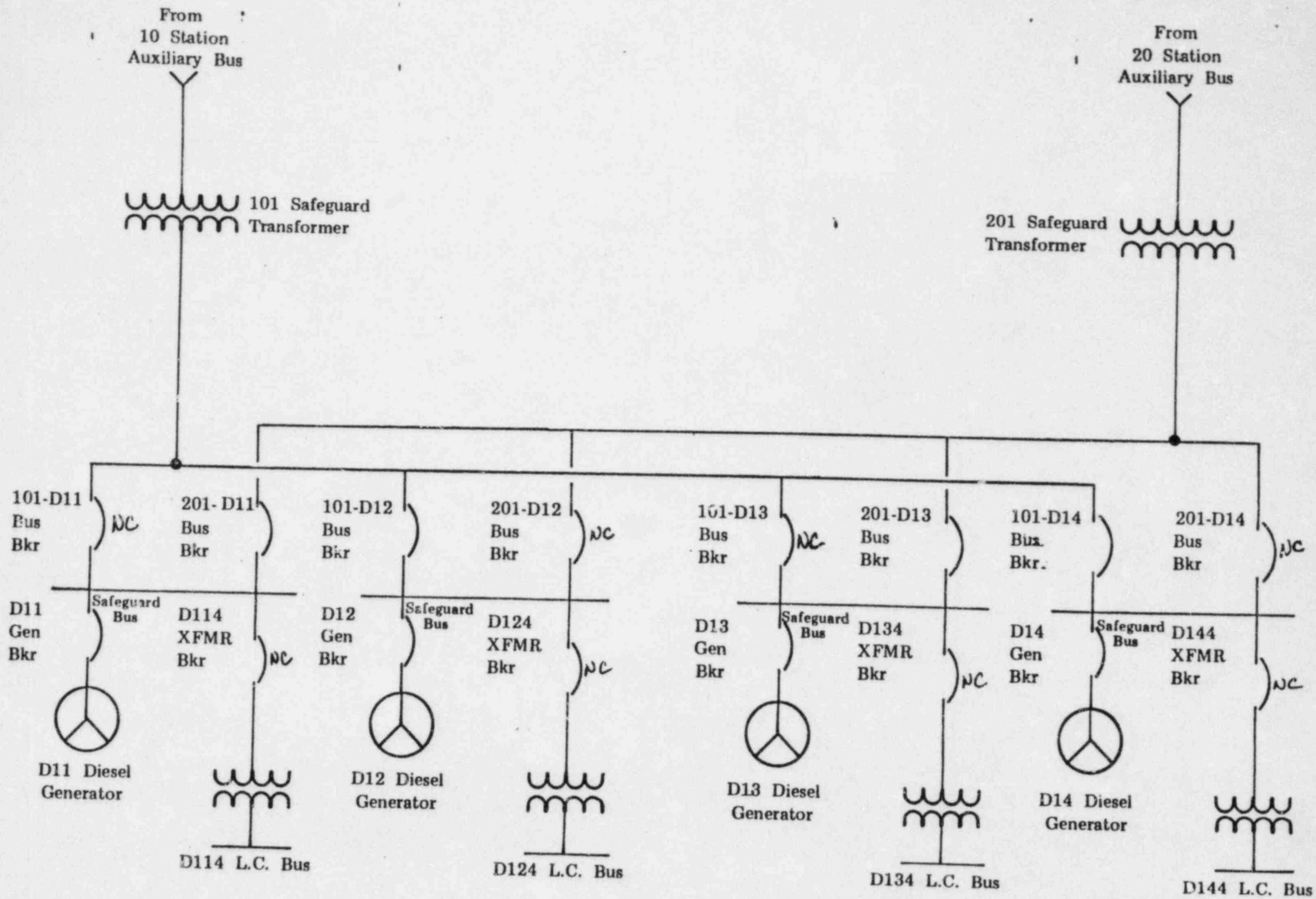


Figure 31b-I-C2

4160 Volt Distribution System

2.7 a. Electric Motor Driven Pump is the main pump — Each: Name .25, Main/B/U .25, Pressure .25
Starts at 100 psig

Diesel Engine Fire Pump is the Backup
Starts at 95 psig

b. System pressure is maintained [at 109 psig] by a 2 in line from connection from each] service water system.

Ref: L.P. DLS 44 pg 4

2.8 a. It is assumed the feedwater is unavailable + the normal heat sinks (turbine + condenser) are lost.

b. Rx pressure is controlled by heat rejection to the suppression pool through the relief valves A, C, and N

c. Makeup by RCIC.

Note that the procedure calls for the MSIVs + trip all condensate pumps before leaving the control room (SE#1)

Ref: L.P. DLS 45, pg 2-3

2.9 a. Small break not resulting in rapid depressurization

Ref: L.P. LST 9, pg 1

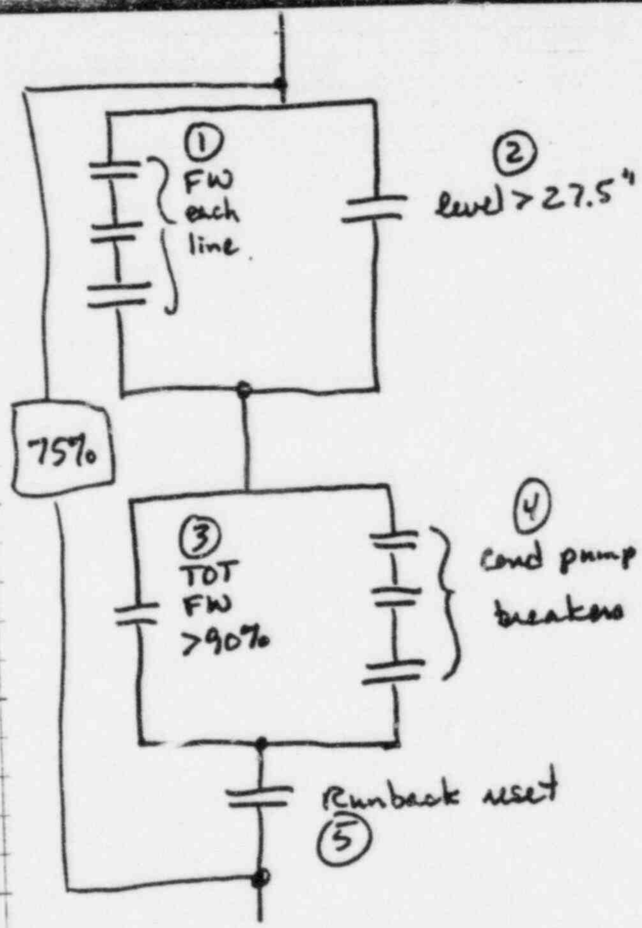
b. 1. High turbine exhaust pressure (150 psig)
2. Low HPCI booster pump suction pressure (15" Hg vacuum)
3. Rx vessel hi water level (+54")
4. Low HPCI System steam supply pressure (100 psig)
5. HPCI Isolation Logic Division 2 actuated
6. " " " " 4 "
7. Manual Trip initiation

Div 4 — Div 2
Turbine exhaust rupture disc hi P (10 ps
Hi HPCI Stm line flow (120 psid)
Hi HPCI area temperatures
Hi Ventilation differential temp
Lo HPCI Steam supply pressure
Manual

End of Category

Ref: LP LST 9 pg 3,4,5

NSTL Nuclear Services and Training Laboratory



The Ohio State University, 1298 Kinnear Road, Columbus, Ohio 43212
Telephone: 614/422-6755

3. INSTRUMENTS AND CONTROLS (25)

3.1. a. 28% Limiter - To assure NPSH of pumps

75% Limiter - To reduce power under conditions of decreasing water level due to a FW or condensate malfunction ⇒ allows additional time to recover level prior to reaching the low level scram setpoint

b. See next pg.

Ref: L.P. DLS Recirc, pg 10-11 + Figure

3.2 a. 1) low enough so that RCIC + HPCI will not falsely initiate after a scram due to low water level, provided FW flow has not been terminated.

2) high enough so that for complete loss of FW, RCIC will be sufficient to prevent Level 1 initiation of ECCS. - RHR, Core Spray, ADS, S/B DG

Ref: L.P. DLS Ch 3, pg 5

b. 1. Initiates HPCI
2. " RCIC
3. " RRCS (Redundant ρ Control Sys)
4. Closes Primary System isolation valves except for a. MSIVs
b. RHR S/D cooling vlvs
c. D/W Chilled Water isol vlv
d. Inst Gas System isol vlvs

Vlvs in Groups I, III, 6, + 7

Gr 1 - MSL Ivs, dr, Sam, Rx Water Sample Vlvs
Gr 3 - RWCU
Gr 6 - Prim Cont Atmos Control Vlvs, Initiate SBGT
Gr 7 - TIP w/drawal Iso, D/W Ch Water Vlvs, Radwaste Sys VlVS

Also have ATWS trip of Recirc Pumps after 10sec time delay from RRCS - L.P. pg 4?

Ref: L.P. DLS Ch 3, pg 10

Ref LP DLS pg 16-10

c. Wide Range

d. Could use fuel Zone Range indicators located on RHR panels.

However, the readings will not be the same because the

Wide Range instrumentation is calibrated for Hot conditions [1000 psig in vessel, 135°F in D/W, 20 Btu/lbm subcooling]

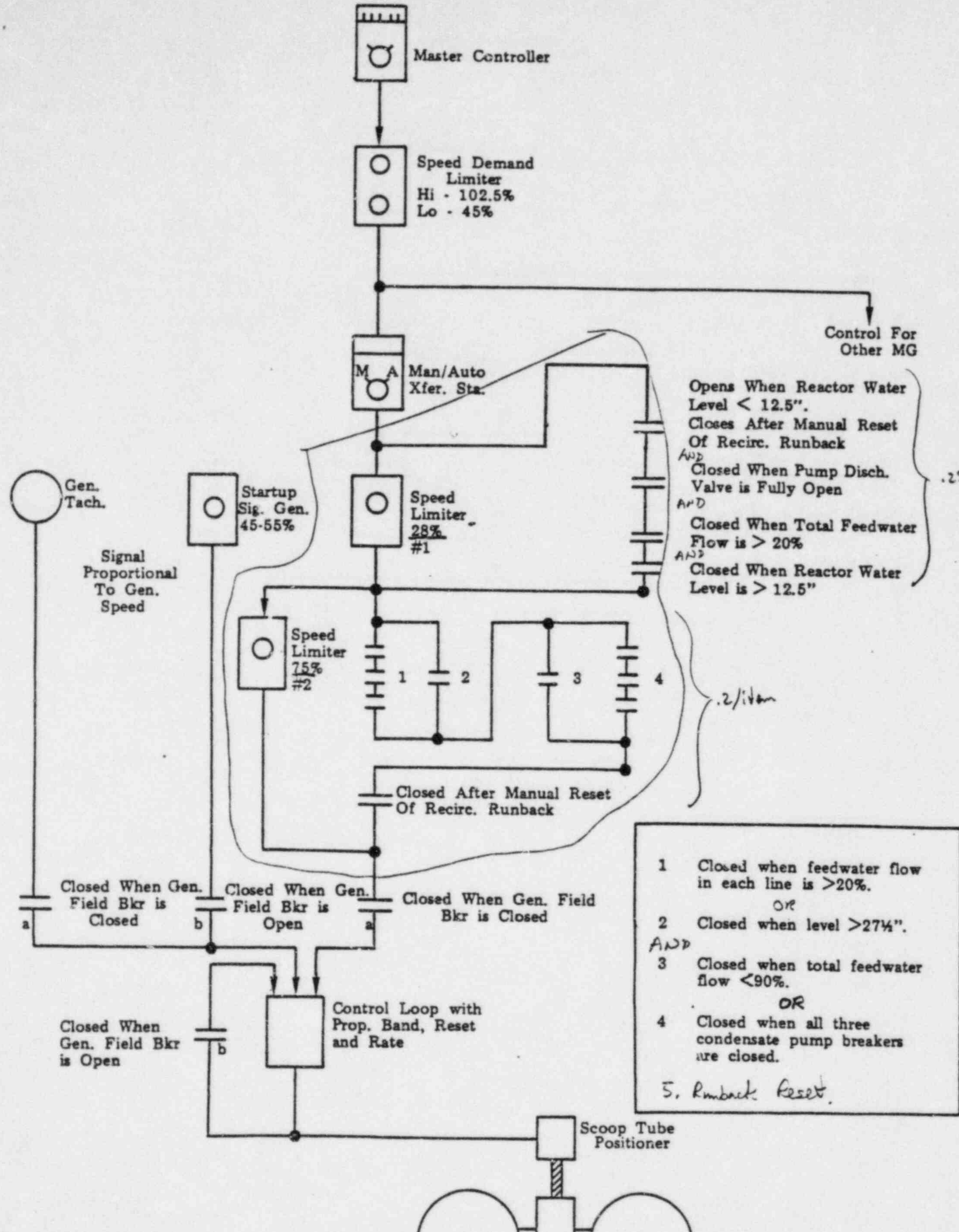
Fuel Zone is calibrated for cold conditions [0 psig in vessel and D/W]

[Both with no jet pump flow]

Ref: L.P. DLS Ch 3, pg 2-3, DLS Fig 1

XO forget

NO overlaps
↑
OK answer But points taken off for extra info that is wrong



Recirculation Flow Control System

3.3.		(a)	(b)	(c)
	[S-49]	[Redundant with "48" (Parallel to it)] @ Bottom of probe	Normal full out latched	Red light "48" indication
	[S-52]	[Redundant with "00" (Parallel to it)] @ Top of probe	Normal full in latched position	Green light "00" indication
[This switch is a spare. The simulator and plant work differently.]	[S-51]	[Above the S-52 + S-00 positions] @ Top of probe	Overtravel beyond full in	Green Light No position readout
	[S-50]	[Below the normal full out position 48] @ Bottom of probe	Overtravel beyond full out	Overtravel Annun.

[Switch numbers not required.]

Ref: L.P. LST pg 5b-4 + 5

3.4 a. [Total # = 172] arranged in strings (43) of 4 each, A @ bottom

APRMs A, C, + E have 21 inputs each
APRMs B, D, + F have 22 inputs each

Each APRM receives signals from all four axial locations and a representative radial distribution.

Ref: LP LST pg 17c-1 and Figure 17d-I-I pg 17d-1

[Enough for method] b. ① The total signal is proportional to fission gamma + neutrons. At the power levels at which LPRMs are used, this is
a) much greater than background gamma
b) and the fission neutron signal is much greater than fission gamma

② The ~~LPRMs signals are fed into the APRMs which are calibrated and adjusted according to a plant heat balance which accounts for gamma and neutron signals~~

Ref: LP LST pg 17c-4

[The only direct flux reading is from the computer, the most any this or give two]

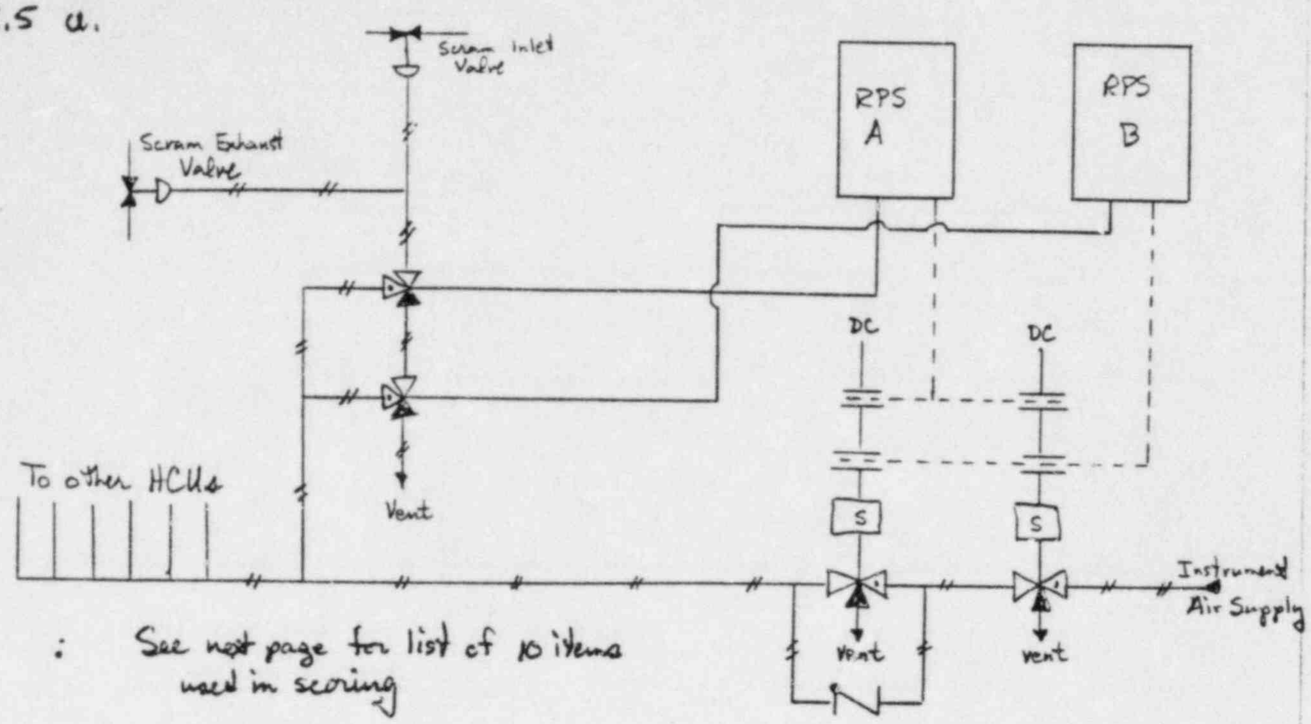
c. 1. Use the 4-rod display
2. Obtain a computer readout (pg 17c-6)
3. Obtain a TIP trace (pg 17c-4)
4. Select on a rear panel meter

[Credit for any two]

d. SRMs and IRMs are removed from the core when not in use. LPRMs are left in at all times and undergo significant burnup. They are calibrated monthly using TIPs and amplifier gain is adjusted.

Ref: LP LST pg 17c-4

3.5 a.



: See next page for list of 10 items used in scoring

Ref: L.P. DLS Ch 15, Figure 4

b. Scram Pilot Valves - normally energized

Backup Scram Valves - normally de-energized

c. Scram Pilot Valves – One changes state on receipt of signal from RPS-A
– Other " " " " " " " RPS-B

Backup Scram valves must receive signals from <u>both</u> RPS-A + RPS-B to energize.

d. The bypass check valve around one of the two valves.

Ref: L.P. LST Ch 15 pg 6-7
DLS Ch 15 pg 6

Scoring on 3.5 a

1 Scram B/U Valves

a. On main air supply line
b. In series
c. Bypass check vlv around one only
d. Check Vlve in correct direction
e. Are 3 way vlvs
f. RPS A + B give signals to both

2. Scram Pilot Vlves

a. Shown as one set for each HCU
b. Are in series on air line (either/or)
c. Air leaves one or the other to go to both scram valves
d. RPS A deenergizes one and RPS B deenergizes the other

0.2/item

3.6 ① RPS .7

⇒ Scram .2

② NS[4] .4

① Closure of MSIVs
② Closure of MSL sample vlves
③ Closure of MSIV drain isolation valves
④ Closure of Rx Water Sample Line isolation valves
⑤ Trip the Mechanical Vacuum Pump
} .2/

Ref: L.P. Ch 18, pg 11-12

3.7 a. Rx high pressure combined with a 25 sec time delay
and
APRM power not downscale
} Ref L.P. Ch 47 pg 5

b. [May be manually overridden 30 sec after runback initiation]
*See below

c. It reduces inlet subcooling ⇒ increased boiling
or Reduces power increase on cold water injection.

Ref: L.P. Ch 23, pg 2 (DLS)

3.8 a) ① Low detector voltage
② Drawer internal module unplugged
③ Channel mode switch not in operate
} ⇒ Rod Block + Scram (most limiting)

b) ① Mode switch in RUN
② Channel bypass switch in BYPASS

Ref: L.P. Ch 17b, pg 9

3.9 ① 10 Sec 0.25

② Assures all control rods are fully inserted.

Ref L.P. Ch 15, pg 8

* 3.7 b) The FW runback may be reset when the following conditions have been met

① 58 sec + 10 min timers timed out
② FW Sys actuation signals reset
③ Channel RRCS Reset PB depressed

Ref: L.P. 47 pg 4-5

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

Mayaet bottom head drain and { 4.1 a. ① CRD cooling water

② Thermal expansion of vessel water during heatup

b. ① CST ← requires a manual lineup ← this is not a normal valve lineup ← cont. either may
② Condenser
③ Radwaste
If condenser volume increases, it will go to CST anyway

need to accept any Gr III { c. ① Non-regen Hx outlet temp ≥ 200°F

② Differential flow across the system reaches 25 gpm

↑ Ic Rx water level -38"
SBLC init
ΔFlow 55gal for 45sec

Ref: Proc # S44.4.A, pg 1+2

4.2 a. ① Sudden drop in primary containment pressure

② Abnormally high N_2 makeup

③ Observation of a primary containment breach

any

b. ① Decrease in suppression pool level - effectively increases D/W volume requiring additional N_2
② Increase in barometric pressure - all D/W pressure instruments are referenced to atmosphere. As P_{AT} ↑, readings ↓
③ Decrease in D/W or chilled water temperature - increased cooling capacity leads to lower pressure.
④ Open valves & others that would reasonably decrease pressure

This is a Tech Spec item → c. One hour

Ref: Proc # ON-110 BASES, pg 1

4.3 a. Fission product leak into primary coolant

b. ① Off Gas Post Treatment - filters will become expended

② North vent stack - leakage through the off gas system, particularly in the recombiner
- the Off-gas that goes thru the filters that are clogged also goes into the same stack

Ref: Proc # ON-102 BASES pg 1

4.4 a. ① Withdrawal of the first rods in a new group - especially Groups 3 and 4

② During startups under peak xenon - all rods, especially edge rods.

b. Reactor Engineer.

The RO would notify the Shift Supervision who would then notify the Rx Engineer

Ref: Proc. GP-2 App I, pg 2

4.5 a. Place **both** loops of suppression pool cooling in service (Step 2.1)

b. ① If pool temp reaches 95°F (Step 2.2)

② If valve cannot be closed in 2 min (Step 2.3)

c. ① Generator load reduction or bypass valve closure

② "ADS/SAFETY VALVE LEAKING" or "SAFETY RELIEF VLV OPEN" alarm

③ Relief Valve position lights

④ Steam Flow / Feed Flow mismatch

⑤ Increasing suppression pool temperature

⑥ MWth will increase also due to subcooling increase.

Step 3.1

d. If pressure is allowed to drop to 831 psig while in RUN, a Group I isolation would occur.

Ref: OT-114 + OT-114 BASES

4.6 a. False

b. False

Ref: A-26, pg 3 NOTES

4.7 a) Deep rods are defined as those between positions 08 and 26. } Must consider & a deep rod can be @ 00-08

b) As recirc flow is reduced with a fixed rod pattern, the margin between actual Rx power and the APRM scram setpoint is reduced due to the increased influence of natural circulation on total core flow.

May get How to do OK

The rods need to be inserted to establish an adequate scram margin.

The operator need only to insert sufficient rods to prevent a scram.

c) A flux spike of about 10% can be expected from the first opening jog of the recirc pump dischg valve following a pump restart.

Therefore more rods need to be inserted to provide additional scram margin.

Ref: OT-112 BASES, pg 1+2

4.8 a) [Group II isolation] at reactor water level of +12.5" or reactor pressure ≥ 96 psig (§7.2)

b) To prevent bearing damage due to reverse flow through the pump. (§8.2)

c) (1) ① to assure flow goes to the Rx vessel

② This prevents inadvertent draining of the Rx vessel to the suppression pool. ← MAJ. POINT

(2) Min Flow protection to the RHR pump is eliminated and ∴ the pump must be operated with flow > 1500 gpm to prevent overheating

(§8.3)

Ref: S51.8.B pg 2+3

4.9 a) ① 1F004 closed (isolation vlv from Recirc line to Pumps)

② RWCU pumps trip

③ RWCU demin hold pumps start (§ 2.1)
(This needs to be verified locally.)

b) 5 min [A Note says trip w/in 10 min, but step says 5 min] (§ 2.2)

c) ① Run back pumps to minimum

Should not be required since ON's don't need to be mem. ized → ② Trip pumps 10 sec apart. (§ 2.2)

Ref: ON-113 + BASES, pg 1+2

END OF EXAMINATION