U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-254/OL-84-01

Docket Nos. 50-254; 50-265 Licenses No. DPR-29; DPR-30

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

Facility Name: Quad Cities Nuclear Power Station

Examination Administered At: Quad Cities Nuclear Power Station

Examination Conducted: November 14, 1984

Examiners: L. Dimmock L. Dimmock 1/3/85
Date

D. Hill J. McMillen for. 1/3/85
Date

Approved By: J. I. McMillen, Chief J. I. McMillen 1/3/85
Operator Licensing Section Date

Examination Summary

Examination administered on November 14, 1984 (Report No.50-254/OL-84-01)
Results: Five utility candidates took both the written and oral examinations. One utility candidate took only the written examination. In addition, one General Electric employee took both the written and oral examinations for an Instructor Certification. The final results showed that five candidates passed the oral examinations and four passed the written examination.

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## REPORT DETAILS

1. Examiners

   D. Hill, EG&G
   L. Dimmock, Region III

2. Examination Review Meeting

   The review of the examinations resulted in twenty-three comments which were directed to the answer key. Since the review was held after the exam, it was not possible to change the questions. The comments and their resolutions are listed in Attachment A.

3. Exit Meeting

   During the exit meeting the facility was informed that five of the six candidates taking the oral examination had clearly passed the oral examination.

# QUAD CITIES REVIEW COMMENTS
## RO/SRO

November 14, 1984

## RO EXAM

### Question 1.01

Facility Comment - Answer has core flow explanation going to natural recirc because recirc pump trips. Our pumps do not trip on a turbine trip.

Answer under vessel level, there is no mention to scram causing void collapse.

Answer under feed flow - note that we do not use three element control. Feed flow responds to level changes and scram signals only.

Resolution - Core flow - will accept a recirc pump runback to minimum speed due to feedwater flow dropping to $<2x10^6$ lbm/hr.

Vessel level - will accept a level decrease due to the void collapse caused by the scram.

Feed flow - will accept feed flow increasing in response to level decreasing and then decreasing as level increases.

### Question 1.05b

Facility Comment - The "40%" of fissions stated in answer at EOL was not really asked for in the original question.

Resolution - The value of 40% is not required for full credit.

### Question 1.06a

Facility Comment - At Quad Cities, we talk in terms of one notch between position 14 & 16 - therefore I would expect all answers to be .053 vice .0267.

Resolution - Answer changed to 0.053 dK/K/notch.

### Question 2.01b

Facility Comment - Other acceptable answers should be

1. hotwell (either unit)
2. B or C Condensate Pump Suction
3. Other unit Torus
4. See attached 1 line drawing.

Resolution - Comment accepted.

RO EXAM (Cont.d)

Question 3.01

Facility Comment - Part A. The setpoint for a gen. load reject is 10% actuation of the fast acting solenoids.

Part C. Answer - Logic answer says "3 or more valves"... Reference copy of QOS-5600-4 page 1 "caution". One valve will cause a half scram. The second valve may cause an additional 1/2 scram (completes full scram). Stated ref. lesson plans may lead a student to wrong logic.

Resolution - Part A - answer changed to "10% actuation of the fast acting solenoids.

Part C - answer changed to "one valve will cause a half scram and a second valve may cause an additional half scram (full scram), OR one out two twice."

Question 2.04

Facility Comment - Part 'C'. Answer states ...motor coolers...". This should be motor bearing cooler. Ref. Q.C. lesson plan CIC 0202-1.

Resolution - Answer changed to "recirc pump motor bearing cooler.

Question 3.06a

Facility Comment - Additional acceptable answer should include electrical limit switches.

Resolution - "Electrical limit switches" added to answer key for full credit.

Question 3.07b

Facility Comment - Given answer of wide range GE/mac or -42 to + 358 in. is incorrect - as indicated on page 8.

On page 6 - Narrow Range GE/MAC'S 0 to +60 in. are compensated.

Resolution - Answer changed to "Narrow Range GE/MAC OR 0 to 60 inches."

RO EXAM (Cont.d)

Question 4.01

Facility Comment - According to stated reference (QAP1120-6 page 2) answer '3' is incomplete and should include the words about highly visible areas.

Resolution - Answer changed to "Personnel entering the sample hood fenced areas where the area is clearly visible to personnel from outside the R area".

Question 4.02

Facility Comment - #5 students may indicate feedbreakers to control room panels 15 and 17. (Ref. QGA 17 page 3)

Resolution - Answer changed to "Trip RPS breakers in Electrical Equipment Room which feed RPS distribution panels (901-15 & 17)."

Question 4.05

Facility Comment - Answer states only core spray pumps. The same reference (QOA 1000-2) also states the CRD system can be used. CRD suction is from CCST. This answer should be accepted as full credit.

Resolution - Using CRD pumps with the suction from the CCST will be accepted for full credit.

Question 4.06

Facility Comment - Please also see attached:

Attachment 3

Response to IE Bulletin 79-27 (Revised Copy)

Resolution - Referenced additional answers will be accepted for full credit, however indications must be given.

SRO EXAM

Question 5.01

Same as 1.01.

Question 5.07

Facility Comment - Answer "A" answer does not allow the listing of two reasons both of which address thermal limits. Increased allowance is needed to accept the possibility of the above (example: prevent exceeding peaking limits, prevent exceeding MCPR limits, etc.).

Resolution - Comment is not accepted. Quad Cities lesson plan states two important reasons for flux shaping - prevent exceeding thermal limitations and optimize fuel burnout.

Question 5.08

Facility Comment - Reference Quad Cities Theory lesson plan defines shutdown margin as SDM=1-Keff. This answer is not listed on the answer sheet.

NOTE: Students might respond with a Tech. Spec. definition concerning concepts of how far the reactor is sub-critical with the strongest rod full out during the most reactive time in core life.

Resolution - The T.S. definition for SDM will be accepted for full credit. The formula, SDM=1-Keff, will not be accepted unless explained.

Question 6.04

Same as 2.01

Question 6.02

Same as 3.01

Question 6.05

Same as 2.04

Question 7.01

Same as 4.01

Question 7.02

Same as 4.02

Question 7.05

Same as 4.05

SRO EXAM (Cont'd.)

Question 7.09

Facility - Answer only states 68%
Comment - Our Tech Specs state 50% after 24 hours. Students may write this answer.

Resolution - Either answer, 50% after 24 hours OR 68% is acceptable for full credit.

Question 7.06

Same as 4.06

# MASTER COPY

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: QUAD CITIES 1&2

REACTOR TYPE: BWR-GE3

DATE ADMINISTERED: 84/11/14

EXAMINER: HILL, D.

APPLICANT: _____

INSTRUCTIONS TO APPLICANT:

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

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

FINAL GRADE _____%

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

_____
APPLICANT'S SIGNATURE

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

QUESTION 1.01 (4.00)

Unit 2 is operating at 100% power. A fire is reported in the Front Standard of the Main Turbine. The Reactor Operator depresses the 'TRIP' pushbutton on the EHC control panel. A failure occurs at this time. Using the attached traces of the various plant parameters, Figure 1, indicate WHAT FAILURE has occurred with the Main Steam and Turbine System. Justify your answer by BRIEFLY discussing the predominant response of EACH trace. (4.0)

NOTE: 1. Time intervals are 30 seconds.
2. The operator depresses the "TRIP" push button at +25 seconds.

QUESTION 1.02 (3.50)

Concerning the core thermal limits:

a. For each condition (1-4) given below, INDICATE whether it will cause an INCREASE, a DECREASE, or have NO EFFECT on CRITICAL POWER.
   1) Local peaking factor (LPF) INCREASES (0.5)
   2) DECREASE in inlet subcooling (0.5)
   3) INCREASE in reactor pressure (0.5)
   4) Axial power peak shifts from BOTTOM to TOP of channel (0.5)

b. With regard to MAPRAT:
   1) WHAT is the relationship between MAPRAT and MAPLHGR? (0.5)
   2) IS a MAPRAT of 1.05 acceptable? (.25)
   3) WHAT physical consequence could occur if the MAPRAT limit is exceeded? (.75)

QUESTION 1.03 (2.80)

The tabulation below illustrates REACTIVITY COEFFICIENT VARIATIONS due to increases in several core parameters. For each condition (a-h) listed below, INDICATE how the VALUE of that coefficient varies (MORE OR LESS NEGATIVE) if the indicated parameter is INCREASED. (2.8)

| CORE PARAMETER / COEFFICIENT | MODERATOR TEMP | CORE VOIDING | ROD DENSITY | FUEL TEMP | CORE AGE |
|---|---|---|---|---|---|
| Void Coefficient | | (a) | (b) | (c) | (d) |
| Moderator Temp. Coefficient | (e) | | | | (f) |
| Fuel Temperature Coefficient | | (g) | | (h) | |

QUESTION 1.04 (1.20)

Steam leaving the steam separators and entering the steam dryer has a quality of 90% and is at a pressure of 1000 psia. Using the attached Mollier Diagram, determine the steam SPECIFIC ENTHALPY. (1.2)

QUESTION 1.05 (3.00)

As core exposure increases, plutonium-239 (Pu-239) concentration increases:

a. Briefly explain the processes by which this buildup occurs. (Note: a reaction-decay chain equation may be used.) (1.0)

b. Explain HOW and WHY the buildup of Pu-239 effects reactor behavior. (2.0)

QUESTION 1.06 (3.00)

The reactor has just gone critical at BOL on rod R-9 from notch 14 to 16. The moderator temperature is 118 F. The count rate on the SRM is observed to increase from 2000 cps to 4200 cps in 90 seconds.

Note: State any assumptions you make and show all calculations.

a. Determine the notch worth of the control rod at that position. (2.0)

b. An infinite period is reestablished when the moderator temperature reaches 133 F. What is the value of the moderator temperature coefficient, alpha T. (1.0)

QUESTION 1.07 (2.00)

The reactor has been operating at 95% power for several days. An operator RAPIDLY reduces reactor power to 60% by reducing the speed of the recirculation pumps. During the next FEW MINUTES the operator notices that reactor power slowly increases approximately 3%. EXPLAIN the cause of this effect. (2.0)

QUESTION 1.08 (2.00)

The reactor has just scrammed from extended full power operation. Ten (10) hours later cooldown is complete, and the SDM is measured at that time to be 1% dk/k. Describe the changes, if any, to the SDM for the NEXT 20 hours. (Include in your discussion any adverse conditions). (2.0)

QUESTION 1.09 (1.50)

WHAT are THREE (3) sources of neutrons OTHER THAN Installed Sources. (1.5)

QUESTION 1.10 (2.00)

a. Describe the method used at Quad Cities to extend cycle operations. (1.0)

b. WHAT are TWO (2) ways (other than the method in 'a' above) that could be used to extend cycle operation? (1.0)

QUESTION 2.01 (2.75)

a. DESCRIBE the flow path for fuel pool water during the 'FPCC ASSIST' mode of the RHR system. (A drawing may be used) (1.75)

b. The RHR system can also be used to increase or decrease level in the suppression pool. WHAT are TWO (2) places suppression pool water can be pumped to if you wanted to DECREASE suppression pool level? (1.0)

QUESTION 2.02 (3.00)

a. INDICATE the TWO (2) sources of control rod scram hydraulic pressure. (1.0)

b. DISCUSS HOW these two sources (in 'a' above) are effective in causing a scram at:

1) Zero reactor pressure (.66)

2) 400 psig reactor pressure (.66)

3) 1000 psig reactor pressure (.67)

QUESTION 2.03 (2.00)

Concerning the Standby Liquid Control System:

a. WHY is it necessary for the system to be capable of injecting the contents of the SLC tank in a MINIMUM time of 90 minutes? (1.0)

b. WHAT are TWO (2) OTHER uses of the nozzle used for vessel penetration by SLC sparger? (1.0)

QUESTION 2.04 (4.00)

For the following systems listed below, discuss how they INTERFACE WITH the Recirculation System. Be specific as to interface PURPOSE and LOCATION where applicable.

a. Residual Heat Removal (RHR) (NOTE: Discuss TWO modes of RHR) (2.0)
b. Reactor Water Cleanup (RWCU) (0.5)
c. Reactor Building Closed Cooling Water (RBCCW) (1.0)
d. Average Power Range Monitor (APRM) (0.5)

QUESTION 2.05 (2.00)

Regarding the Reactor Water Cleanup System (RWCUS):

a. WHAT POTENTIAL problem exists when opening the motor-operated demineralizer bypass valve (MO-1201-133)? Include in your answer WHY the problem exists. (1.0)

b. WHAT is the LIMITING COMPONENT in the system for flow AND temperature? (0.5)

c. WHAT would be an ADVERSE RESULT of opening the hotwell AND radwaste (MO-1201-78, MO-1201-77) reject valves simultaneously while at power? (0.5)

QUESTION 2.06 (3.50)

In reference to the Heater Drain System:

a. WHAT are TWO (2) differences between the 'C' and 'B' LOW PRESSURE heaters OTHER THAN location? (1.5)

b. The drain cooler (downstream of the flash tank) is a water-to-water heat exchanger which _____ (increases, decreases) the temperature of the feedwater. (Fill in the blank) (0.5)

c. WHAT problem will develop if a 'C' or 'D' heater is removed from service AND WHY doesn't the problem develop when a 'A' or 'B' heater is removed from service. (1.5)

QUESTION 2.07 (4.00)

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

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

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

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

d. The DC motor controlling the Motor Speed Changer (MSC) has burned out. (1.0)

QUESTION 2.08 (1.25)

Concerning the Quad Cities Air Systems:

a. \T is the 'Little Joe' valve? (.25)

b. T are the TWO (2) BACKUP supplies to Drywell Pneumatic air? (1.0)

QUESTION 2.09 (2.50)

a. WHY does the scram outlet valve open FASTER than the scram inlet valve AND HOW is the faster opening accomplished? (1.0)

b. For EACH of the valves listed below, STATE whether the valve is ENERGIZED or DEENERGIZED to scram AND LIST what the power supply to the valve is.
   1) Backup Scram Valves (0.5)
   2) Scram Pilot Solenoid Valves (0.5)
   3) Vent and Drain Pilot Valves (0.5)

QUESTION 3.01 (2.00)

Answer the following with respect to the Turbine Generator Load Reject Scram:

a. WHAT is the SETPOINT for the scram? (.75)

b. WHEN is the scram BYPASSED? (Include applicable sensing point). (.75)

c. WHAT is the LOGIC for the scram? (0.5)

QUESTION 3.02 (3.00)

The reactor is operating at 40% power with the Feedwater Control System in single element control, and level channel 'A' selected for input. The reference leg isolation valve to the channel 'A' NR GEMAC develops a significant packing leak and the associated reference leg starts to gradually decrease. DESCRIBE WHAT will happen to the plant and WHY? Assume NO operator action. (3.0)

NOTE: LIMIT your answer to effects on and of the FWLC, RPS, ECCS, PCIS, and actual vessel level. Include any applicable set-points.

QUESTION 3.03 (3.00)

a. When a select error occurs on the RWM, CAN the operator still move the rod? (RWM is NOT BYPASSED and NO rod blocks existed prior to selecting the rod). ANSWER YES OR NO. (0.5)

b. In reference to part 'a' above, EXPLAIN your answer (ie. if the operator CAN move the rod, HOW FAR can it be moved and WHY; if the operator CANNOT move the rod, WHY NOT). Consider both an attempted insert and withdraw action. (2.5)

QUESTION 3.04 (3.50)

With the plant operating at 100% power with the recirc in Master Manual, an operator inadvertently DECREASES the "Pressure Set" by 5 psi. WHAT will be the INITIAL response and FINAL status of the following parameters due to this action? Briefly EXPLAIN. Assume NO operator action. See attached Figure 6, Speed and Acceleration Control Unit. ANSWER on the attached handout page.

a. TCV position

b. BPV position

c. Power

d. Pressure

QUESTION 3.05 (2.50)

a. WHAT TWO (2) combinations of radiation instrument trip signals will cause the start of a 15 minute time delay and subsequent auto isolation of the OFF-GAS system? (1.0)

b. WHICH OFF-GAS system valves close following the 15 minute time delay in 'a' above? (1.5)

QUESTION 3.06 (3.00)

Refer to attached Figure 5, Recirculation Speed Control Network, for the following:

a. The plant is operating at 30% power with both recirc pump M/A transfer stations in MANUAL. FOR EACH of the following instances, INDICATE HOW the speed of Recirc Pump 'A' would change (increase, decrease, or remain the same) AND WHICH component(s) of the control system is(are) limiting.
   1) Recirc Pump 'A' M/A transfer station is placed in 'AUTO'. (1.0)
   2) The generator speed tachometer output feedback signal fails low due to a loss of continuity through the field breaker contacts. (1.0)

b. WHAT action must be taken by the control room operator prior to resetting a 'LOCKED OUT' scoop tube? WHY? (1.0)

QUESTION 3.07 (2.50)

a. WHICH level transmitter arrangement (temperature compensated or uncompensated) is more likely to reach boiling in the reference columns in the event of a Drywell temperature increase and reactor pressure decrease? (0.5)

b. WHICH level indication(s) at Quad Cities are TEMPERATURE compensated? (0.5)

c. At 100% power, WHAT is the relationship between indicated level and actual level in the core? EXPLAIN your answer. (1.0)

d. The reference '0' used in the vessel level indicating system is __(1)__ inches above the vessel bottom. (Fill in the numbered blank). (0.5)

QUESTION 3.08 (3.50)

Consider the Rod Block Monitor system (RBM):

a. WHAT are TWO (2) reasons why the gain of the RBM channel is increased? (2.0)

b. WHAT are THREE (3) ways the RBM trips are BYPASSED? (1.5)

QUESTION 3.09 (2.00)

a. WHAT TWO (2) parameters will initiate the loop select logic for the LPCI mode of RHR? Include setpoints. (1.0)

b. EXPLAIN HOW the loop chosen for injection is determined by the LPCI loop select logic. (1.0)

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

QUESTION 4.01 (2.00)

WHAT are TWO (2) exceptions to the requirement that 'Individuals are prohibited from entering a high radiation area unless they notify the control room OR have a safety man present'? (2.0)

QUESTION 4.02 (2.50)

One of the IMMEDIATE actions after recognizing an ATWAS event is to scram the reactor manually by depressing both manual trip actuators. Should this fail, there are alternate methods to scram the reactor. In accordance with QOA-17, ATWAS Event, WHAT are FIVE (5) of these alternate methods? (2.5)

QUESTION 4.03 (2.50)

Concerning QGP-1-3 for Unit Hot Standby to Power Operation:

a. WHEN is the use of NOTCH OVERRIDE control rod withdrawal NOT ALLOWED? (1.5)

b. WHAT action should be taken when unusual vibration on the turbine is noted at low speed? (1.0)

QUESTION 4.04 (3.50)

A report was just received that the strainer spool piece on the Stator Winding Cooling Water system was leaking. A few minutes later the Stator Cooling Panel Trouble alarm annunciates:

a. WHAT are THREE (3) conditions associated with a loss of stator cooling that will cause the turbine to runback? (Setpoints are not required) (.75)

b. In accordance with QOA 5300-1, Loss of Stator Cooling, WHAT are FIVE (5) of the immediate operator actions? (2.5)

c. WHAT will occur if stator amps ARE NOT runback to 7380 amps within 3 minutes? (.25)

QUESTION 4.05 (3.00)

In reference to QOA 1000-2, Loss of Shutdown Cooling:

a. WHAT are THREE (3) Immediate Operator Actions OTHER THAN notification of the Shift Engineer? (2.0)

b. HOW is vessel level maintained if the feedwater headers ARE NOT available for transferring water to the vessel from the condensate system? Include in your answer WHERE water is taken from AND WHAT pump(s) is(are) used to transfer water to the vessel. (1.0)

QUESTION 4.06 (3.50)

The plant is operating at 100% power when a complete loss of ESSENTIAL SERVICE occurs:

a. WHAT are FOUR (4) automatic actions that occur which will immediately and significantly affect your abilty to operate and protect the plant from the control room? (2.0)

b. WHAT are FIVE (5) CONTROL ROOM indications which have been disabled due to the loss of essential service? (1.5)

QUESTION 4.07 (2.50)

QGA-3 Major Steam Line Break (Outside the Drywell), discusses procedures to be taken if 'The shutdown cooling suction piping has failed due to inadvertent opening of MO-1001-50 and MO-1001-47 ...'. EXPLAIN WHAT is unique about these valves that they are mentioned in this procedure, AND WHAT could cause them to inadvertently open. (2.5)

QUESTION 4.08 (3.00)

During testing of main steam relief valves during power operations:

a. WHAT are THREE (3) symptoms you can expect to see if a main steam relief valve was STUCK OPEN? (1.5)

b. In accordance with QOA 201-2, Failure of a Relief Valve to close or Reseat Properly, WHAT are THREE (3) or your immediate actions? (1.5)

QUESTION 4.09 (2.50)

A scram and Group 1 isolation have just occurred. Reactor pressure is increasing and likely to exceed the relief valves lowest setpoint:

a. At WHAT PRESSURE will auto-relief valve actuation begin? (0.5)

b. WHAT time limitation is placed on SUCCESSIVE actuations of a single relief valve AND WHY is this time delay imposed on the relief valve? (1.5)

c. WHY would you alternate actuations of the 3B and 3C relief valves when several blowdowns are necessary? (0.5)

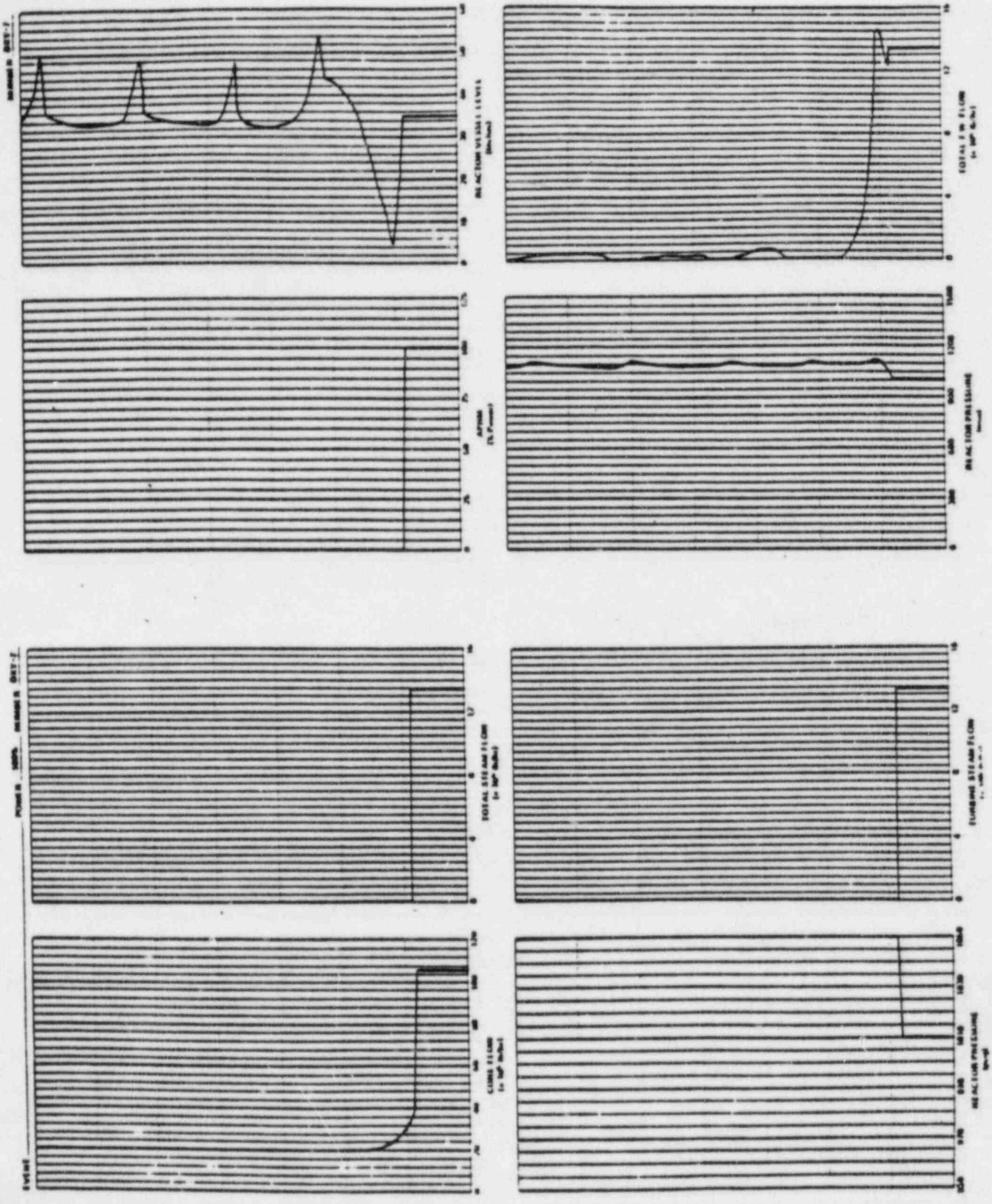
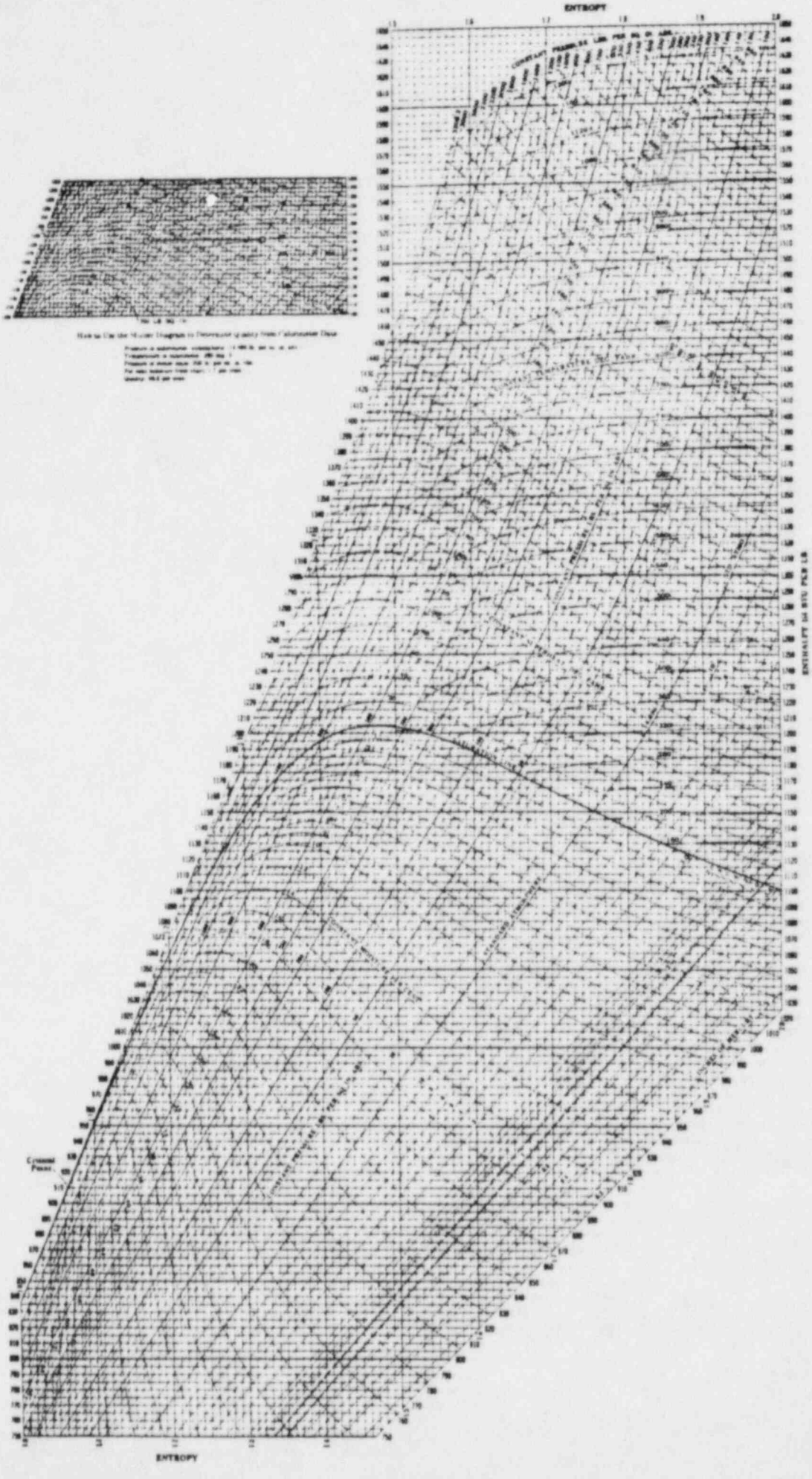


FIGURE 1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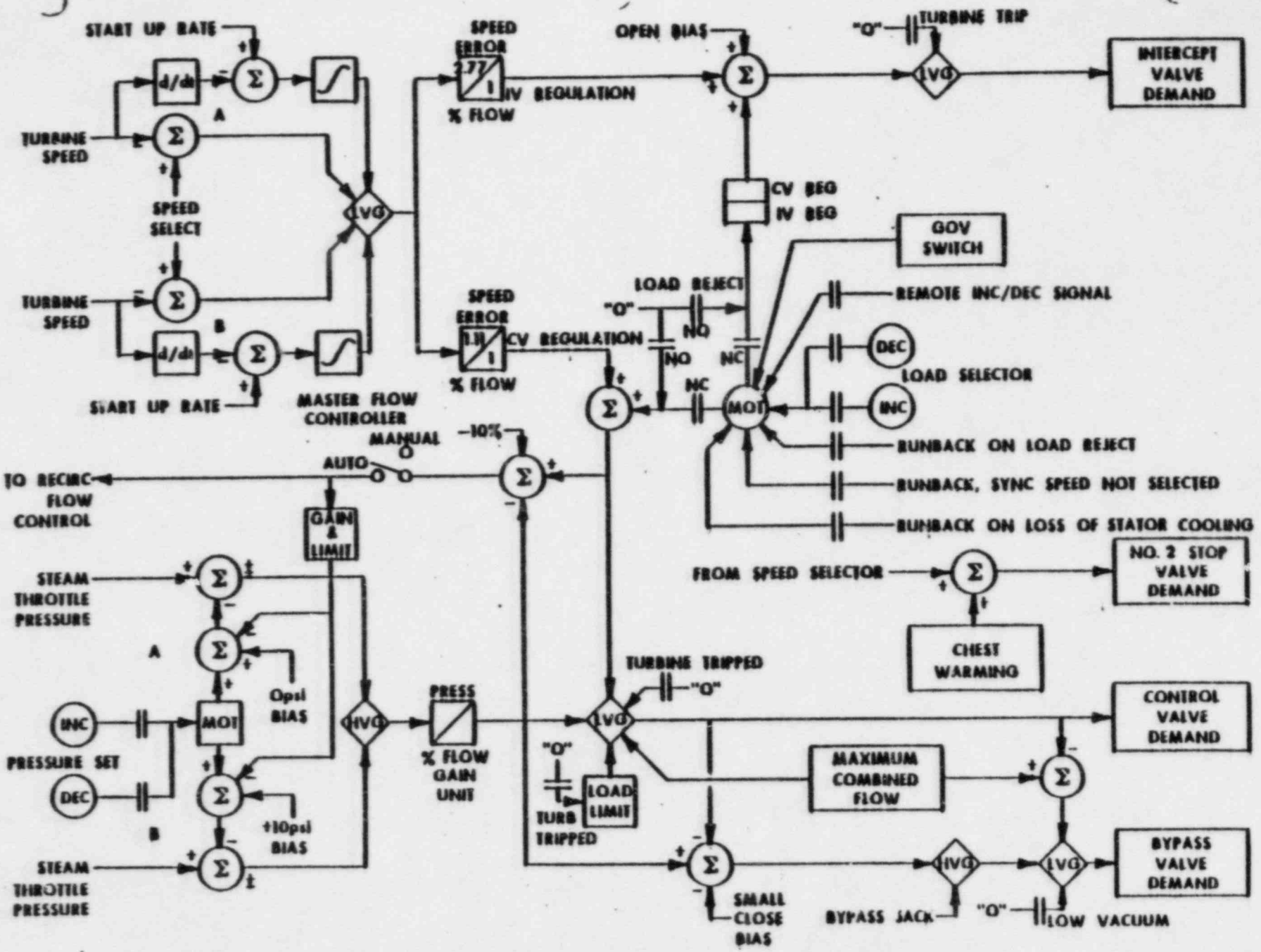


***Figure 6. Speed and Acceleration Control Unit***

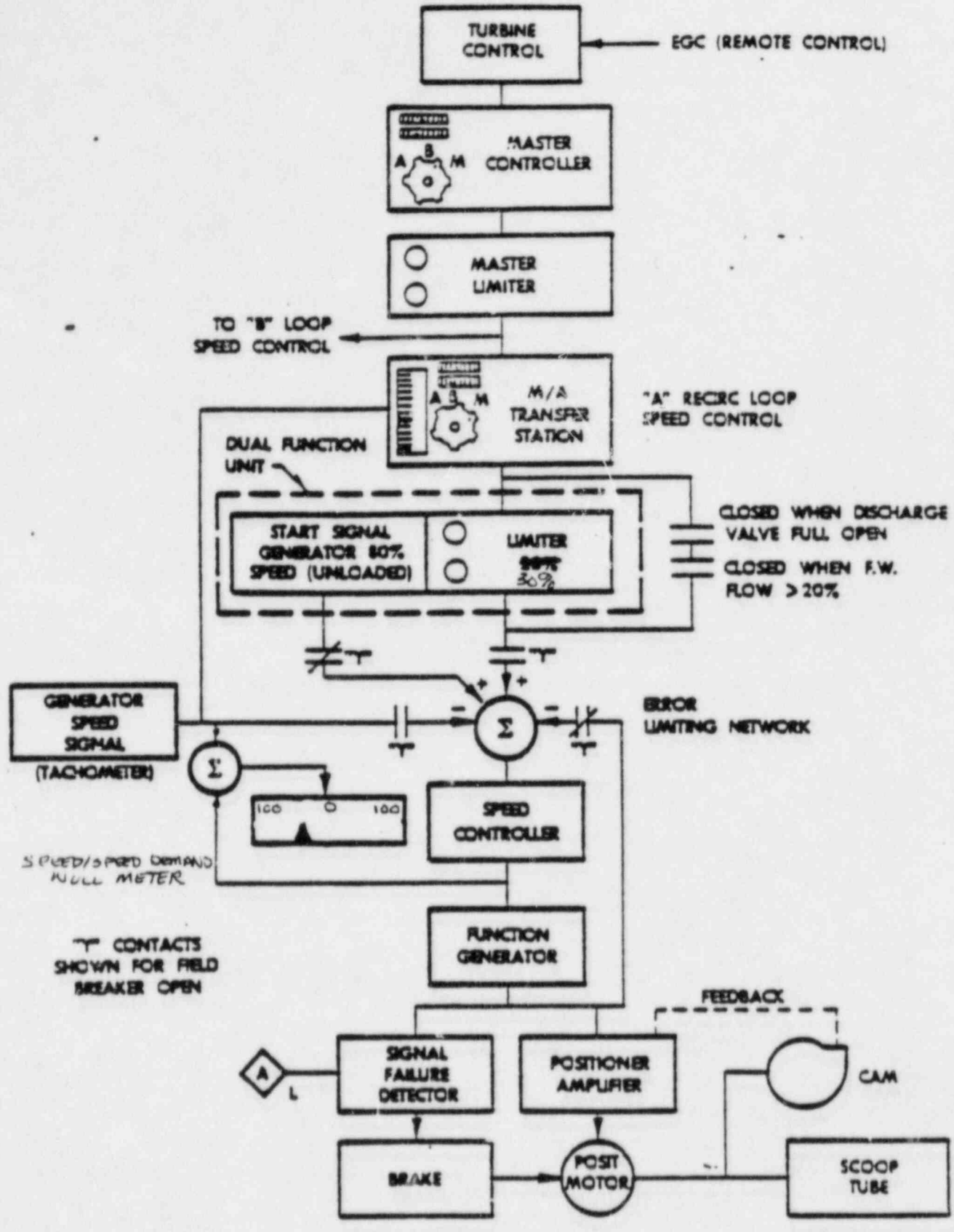


*Figure 5. Recirculation Speed Control Network*

ANSWER SHEET for Question 3.04

INITIAL RESPONSE:

a. TCV position _____ (in % steam flow demand)

b. BPV position _____ (in % steam flow demand)

c. Power _____

d. Pressure _____

} (increase, decrease, or remain the same)

Reason: _____

_____

_____

FINAL STATUS:

a. TCV position _____ (in % steam flow demand)

b. BPV position _____ (in % steam flow demand)

c. Power _____

d. Pressure _____

} (higher than, lower than, or the same as the initial value)

Reason: _____

_____

_____

# EQUATION SHEET

$f = ma$

$v = s/t$

Cycle efficiency = (Net work out)/(Energy in)

$w = mg$

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

$E = mc^2$

$KE = 1/2\ mv^2$

$a = (V_f - V_o)/t$

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

$PE = mgh$

$\omega = \theta/t$

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

$V_f = V_o + at$

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

$W = v\ \Delta P$

$A = \dfrac{\pi D^2}{4}$

$\Delta E = 931\ \Delta m$

$\dot{m} = V_{av} A \rho$

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

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

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

$Pwr = W_f \Delta h$

$I = I_o e^{-ux}$

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

$TVL = 1.3/u$

$HVL = -0.693/u$

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

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

$SUR = 26.06/T$

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

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

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

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

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

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

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

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

$T = (\beta - \rho)/(\bar{\lambda}\rho)$

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

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

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

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

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

$I_1 d_1 = I_2 d_2$

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

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

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

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

$\Sigma = \sigma N$

## 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.
1 ft. $H_2O$ = 0.4335 lbf/in.

## Miscellaneous Conversions

1 curie = $3.7 \times 10^{10}$ dps
1 kg = 2.21 lbm
1 hp = $2.54 \times 10^3$ Btu/hr
1 mw = $3.41 \times 10^6$ Btu/hr
1 in = 2.54 cm
°F = 9/5°C + 32
°C = 5/9 (°F-32)
1 BTU = 778 ft-lbf

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ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 1.01 (4.00)

Failure-- Bypass valves fail to open (.25)

Turbine Steam and Total Steam Flow- Turbine steam flow goes to zero as stop valves close on turbine trip [0.5]. Total steam flow goes to near zero as bypass fail to open [0.5]. (1.0)

Vessel Level- decreases due to void collapse caused by the stop valve closure [.25] and the scram [.25]. (0.5)

Core Flow- decreases ~~to natural circulation after recirc pump trip.~~ due to recirc pump runback to minimum speed due to feedwater flow dropping to < 2x10⁶ lbm/hr. (0.5)

Feed Flow- ~~FWCS initially cuts back on feedwater flow to follow steam flow [.25] but then increases due to low vessel level [.25]. As level returns to normal, the FWCS reduces feed flow to control level [.25]~~ Increases in response to level decreasing and then decreasing as level increases. (.75)

Pressure- Pressure increases following the turbine trip and failure of bypass valves to open. The SRV's control pressure in the area of 1100 psig. Several SRV actuations occur. (0.5)

APRM- sharply drops because of anticipatory scram. (0.5)

REFERENCE
BWR Transients

ANSWER 1.02 (3.50)

a. 1. Decreases (0.5)
2. Decreases (0.5)
3. Decreases (0.5)
4. Decreases (0.5)

b. 1. MAPRAT is the ratio of APLHGR TO Lim APLHGR OR the ratio of APLHGR(act) to MAPLHGR(LCO) (0.5)
2. NO (.25)
3. The clad temperature can exceed 2200 degrees F. during a DBA LOCA (.75)

REFERENCE
HT&FF, pg. 16,17; GE Thermodynamics, HT&FF, pg. 9-85 to 9-89

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 1.03 (2.80)

a. More negative
b. More negative
c. More negative
d. Less negative
e. More negative
f. Less negative
g. More negative
h. Less negative
[0.35 each] (2.8)

REFERENCE
Theory Review, pg. 48,50,54,56, Fig. 46

ANSWER 1.04 (1.20)

Since steam quality is given, find moisture content.
M=1-x or
M=1-.90 = .10 = 10%
Use 10% constant moisture line and 1000 psia constant pressure line to find specific enthalpy of wet steam.
h=1127 BTU/lbm (1.2)

REFERENCE
GE Thermodynamics, Heat Transfer and Fluid Flow; pg. 4-83

ANSWER 1.05 (3.00)

a. Pu-239 is produced by a sequence of neutron absorption by U-238 and two subsequent b- decays to Pu-239.
--OR--
U-238 + 0N1 ---->U-239 ---(B-)--->Np-239 ---(B-)--->Pu-239 (1.0)

b. Pu-239 is a fissile material and accounts for a percentage of the fissions at EOL [0.5]. The delayed neutron fraction for Pu-239 is 0.0021. This coupled with its significant fission fraction causes the effective delayed neutron fraction for the core to decrease over core life [0.5]. As the fraction of delayed neutrons decreases, the effective generation time is shorter and the period resulting from a given reactivity insertion is shorter near EOL [1.0]. (2.0)

REFERENCE
Theory Review, pg. 40,54

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 1.06 (3.00)

a. $P2 = P1\, e^{t/T}$ ----> $T = t/\ln(P2/P1)$
T= 90sec/ln (4200/2000) = 90 sec/.742 = 121.3 sec. (0.5)

T= B-p/ p; (l* = ~10E-04 so l*/p term can be neglected)
p= B/(1+ T); Near BOL B=0.0070 and =.1sec-1 (0.5 for assumption)
--Since we were just critical, heating effects can be neglected.--
p= 0.0070/1+(.1 sec-1)(121.3sec)= 0.00053 dK/K = 0.053% dK/K (0.5)

p= dp(rods); rods= dp/#notches= 0.053% dK/K/ 2 notches=
~~0.0267%~~ dK/K/notch
0.053%
(0.5)

b. when T= infinity ----->p(net)= 0 ----->dp(mod)= -dp(rods)
133 - 118 = 15 degrees (.25)
0.00053 dk/k / 15 degrees F. = 0.000035 = 3.5E-05 dk/k/deg.F (.75)

REFERENCE
Theory Review, pg. 36-48

ANSWER 1.07 (2.00)

The reactor is now producing less steam to go to the turbine [0.5]. With less steam to the turbine, there will be less extraction steam going to the feedwater heaters [0.5]. Therefore less feedwater heating will occur which will result in colder feedwater entering the vessel [0.5] which will cause reactor power to increase slightly from the positive reactivity addition (alpha T) [0.5]. (2.0)

REFERENCE
Feedwater/Condensate L.P, pg. 52

ANSWER 1.08 (2.00)

The time SDM was measured to be 1% dk/k was at a period of peak xenon [0.5], therefore the SDM will decrease [0.5] as xenon decays. Since the xenon peak is greater than the 1% dk/k [0.5] a reactor restart could occur [0.5]. (2.0)

REFERENCE
Theory Review, pg. 68,70

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 1.09 (1.50)

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

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

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

REFERENCE
Theory Review, pg. 28,30

ANSWER 1.10 (2.00)

a. In coastdown [0.5], 100% core flow is maintained and power slowly decreases as the fuel is depleted [0.5]. (1.0)

b. 1. Derating
2. Feedwater temperature reduction
3. Excess core flow
[2 required @ 0.5 each] (1.0)

REFERENCE
Theory Review, pg. 83,84

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 2.01 (2.75)

a. Water flows from:
Fuel pool to skimmer surge tanks [.25], through a removable spool piece [.25], to the suction or the RHR pump [.25], through the RHR HTX [.25] (or bypass valve) to the RHR cross-tie header [.25], through a removable spool piece [.25] back to the fuel pool [.25]. (1.75)

b. 1. Waste surge tank
2. Waste collector tank
3. Radwaste ~~(C&F)~~
4. Either unit hotwell
5. Other unit torus
6. B or C condensate pump suction
[2 required @ 0.5 each] (1.0)

REFERENCE
RHR Lesson Plan, SRO-1000-1, pg. 10,11

ANSWER 2.02 (3.00)

CRD accumulator pressure (0.5)
Vessel water (0.5)

a. At low reactor pressure, the vessel has minimal effect and scram is accomplished only by the accumulator. (.66)

b. As the vessel pressure rises, the accumulator is assisted on the upper end of the stroke. As water is forced from the accumulator, accumulator pressure falls below reactor pressure and causes the ball check valve to open allowing reactor pressure to complete the scram. (.66)

c. By 1000#, the accumulator is not necessary and reactor pressure will provide enough hydraulic pressure to meet scram insertion times. (.67)

REFERENCE
Control Rod Blade and Drive Mechanism, LIC-0300-1, pg. 24,34,35,Fig.6

ANSWER 2.03 (2.00)

a. Too rapid of a insertion rate results in a lack of proper mixing [0.5] and reactivity 'chugging' [0.5]. (1.0)

b. 1. Jet pump differential pressure tap (0.5)
2. Core plate dp (0.5)

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

REFERENCE
SLC Lesson Plan, LIC-1100, pg. 12,16

ANSWER 2.04 (4.00)

a. RHR- 1.Shutdown cooling mode- provides decay heat removal capability. Takes a suction from recirc pump B suction line and returns to either recirc pump discharge line. (1.0)
2.LPCI mode- provides flooding of the core at lower pressures to maintain the core covered on a LOCA by discharging to both recirc pump discharge lines. OR Jet pump riser dp and recirc. pump dp input to the LPCI loop select logic. (1.0)

b. RWCU- takes its suction from the 'B' recirc loop (.5)

c. RBCCW- provides cooling to recirc pump motor bearing coolers [0.5] and seal cavity coolers [0.5]. (1.0)

d. APRM- Recirc loops A and B flow elements serve as inputs to the APRM flow converters. (.5)

REFERENCE
Recirc. Sys. Lesson Plan, LIC-0202-1, pg. 6,34,36

ANSWER 2.05 (2.00)

a. Flow indication is not correct [0.5] and opening the valve too far could lead to pump runout [0.5]. (1.0)

b. The filter demineralizers (0.5)

c. Vacuum in the condenser would be lost to radwaste (0.5)

REFERENCE
RWCU Lesson Plan, LIC-1200, pg. 6,8,10

ANSWER 2.06 (3.50)

a. 1. The heater drains come from the 'D' heaters and flow into the 'C' heaters, then from the 'C' heater into the 'B' heater. (.75)
2. Extraction steam comes from the 8th stage of the LP turbine for 'C' and from the 10th stage for 'B' OR operate at different temperature and pressure. (.75)

b. Increases (0.5)

c. An unbalanced axial thrust on the turbine shaft will develop [0.5] due to the 'C' and 'D' heaters receiving extraction steam from opposite sides of the LP turbine [0.5]. The 'A' and 'B' heaters receive extraction steam from both ends of the LP turbine so there is no net axial thrust [0.5]. (1.5)

REFERENCE
Feed Condensate Lesson Plan, LIC-3200-3300, pg. 24,28,50

ANSWER 2.07 (4.00)

a. Will inject [0.25]. Turbine seal leakage resulting in potential air-borne activity in the HPCI room [0.75]. (1.0)

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

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

d. Will not inject [0.25]. The normal shutdown position for the MSC is the LSS and without the MSC to control ramp rate, the governor valve will not open and the turbine will not roll [.75]. CAF (1.0)

REFERENCE
HPCI Lesson Plan, LIC-2300-1, pg. 14,18,22,24,46,54

ANSWER 2.08 (1.25)

a. The cross-tie valve from service air to instrument air (.25)

b. Instrument Air (0.5)
Nitrogen (0.5)

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

REFERENCE
Inst. Air Drywell Pneumatic Air, LIC-4700-1, pg.12

ANSWER 2.09 (2.50)

a. To assure that a discharge path is available for the water displaced during the scram. (0.5)
By the outlet valve having a stronger spring and a shorter run of air piping (faster air bleed-off) Eitner acceptable. (0.5)

b. 1. 125 VDC [.25], Energized [.25] (0.5)
2. 120 VAC (RPS) [.25], Deenergized [.25] (0.5)
3. 120 VAC (RPS) [.25], Deenergized [.25] (0.5)

REFERENCE
RPS Lesson Plan: LIC 0500-1, pg. 8,12,14

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 3.01 (2.00)

a. ~~Equal to or greater than a 40% [.25] mismatch between turbine first stage pressure [.25] and generator stator amps [.25].~~ 10% actuation of the fast acting solenoids. (.75)

b. Not in RUN [.25] and when in RUN if less than 45% rated steam flow [.25] as measured by turbine first stage pressure [.25]. (.75)

c. ~~Operation of three or more valves cause a full scram, operation of two valves may cause a scram.~~ One valve will cause a half Scram and a second valve may cause an additional half scram (full scram) OR 1 out 2 taken twice. (0.5)

REFERENCE
Scrams and Isolations, LIC-Scram, pg. 6,8 CAF

ANSWER 3.02 (3.00)

1. Level channel 'A' will indicate increasing water level (0.5)
2. FWLCS will close the FRVs to try to maintain level (0.5)
3. Actual vessel level is decreasing (0.5)
4. Reactor will scram @ +8" due to low reactor water level (0.5)
5. PCIS Group 2 and 3 isolations also @ +8" (0.5)
6. Recirc pump trip, PCIS Group 1 isolation, HPCI and RCIC initiation all @ -59" (0.5)

REFERENCE
Reactor Level and Pressure, LIC-0263, pg. 12

ANSWER 3.03 (3.00)

a. Yes (0.5)
b. It can be moved out one notch [0.5] before a withdraw error will block further movement [0.5]. If the rod was inserted, it will move as far as the operator wants [0.5] as long as it is not the third insert error [0.5]. If it were the third insert error, it would only go one notch [0.5]. (2.5)

REFERENCE
Rod Worth Minimizer, LIC-0207, pg. 22

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 3.04 (3.50)

INITIAL RESPONSE:

a. TCVs - Remain at 100% open (or open to 100%) [.35].

b. BPVs - Open 5% [.35].

c. Power - Decreases [.35].

d. Pressure - Decreases [.35].

REASON: Above caused by PCU calling for ~115% steam flow ((950-915) x 3.3) and limited by MCF limit of 105% [.35] (1.75)

FINAL STATUS:

a. TCVs - At 100% position (or initial) [.35].

b. BPVs - Shut [.35].

c. Power - Slightly lower [.35].

d. Pressure - Slightly lower [.35].

REASON: Above caused by the decrease in pressure and power causing BPVs to shut -- PCU cycling to new equilibrium state ((945-915) x 3.3) [.35]. (1.75)

REFERENCE
EHC Pressure Control and Logic, LIC-5650-2, pg. 4-9

ANSWER 3.05 (2.50)

a. Both detectors indicate radiation levels greater than the high-high setpoint [0.5] or when one detector indicates high-high and the other detector is downscale [0.5]. (1.0)

b. 1. Pressurized drain tank valve closes (0.5)
2. The chimney isolation valve closes (0.5)
3. The off-gas line drain valve closes (0.5)

REFERENCE
Off-Gas, LIC-5450, pg. 22

ANSWER 3.06 (3.00)

a. 1. Increase [0.5]. Master limiter, low speed limit [0.5]. (1.0)
2. Increase [0.5]. Scoop tube positioning unit, [0.5]. (1.0)
OR electrical limit switches.

b. The null voltmeter is used to match the speed from the tachometer with the speed demand from the speed controller [0.5], to prevent a flow transient during reset [0.5]. (1.0)

REFERENCE
Recirc Flow Control, LIC-0202-2, pg. 10,12,14,34

ANSWER 3.07 (2.50)

a. Compensated (0.5)

b. Narrow ~~Wide~~ Range GE/MAC OR ~~-42 to +358~~ 0 to +60 inches (0.5)

c. Indicated level in the annulus is greater than actual level [0.5] ("7") due to the pressure drop across the steam drying components [0.5]. (1.0)

d. 503" - Elevation of the bottom steam separator lower skirt. (Either acceptable) (0.5)

REFERENCE
Reactor Level and Pressure, LIC-0263, pg. 6,8,14,16,18

ANSWER 3.08 (3.50)

a. 1. The local power may be significantly lower than the core avg. [0.5] which could result in withdrawing a rod of abnormally high worth [0.5]. The gain is increased to restrict the rate of power rise. (1.0)
2. Several of the highest reading LPRMs might be bypassed [0.5]. Gain increased to compensate for lower core average [0.5]. (1.0)

b. 1. Joystick on 90x-5
2. Edge rod selected
3. Reference APRM <30%
[3 required @ 0.5 each] (1.5)

REFERENCE
Rod Block Monitor, LIC-0700-5, pg. 6,14

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 3.09 (2.00)

a. 2 psig DW pressure or (0.5)
-59" Reactor level (0.5)

b. Loop selection is made by comparing the jet pump riser pressures [0.5]. If Loop A > B, A is the intact loop and if B >or= A, B is the intact loop [0.5]. (1.0)

REFERENCE
RHR Lesson Plan, pg. 9

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 4.01 (2.00)

1. Operators and other personnel on R-rounds
2. Jobs when radio or sound powered communications with the control center is possible.
3. Personnel entering the sample hood (forced) area where the area is clearly visible to personnel outside the R area. [2 required @ 1.0 each] (2.0)

REFERENCE
QAP 1120-6, Rev. 5, Entering a locked high radiation area without a timekeeper; pg. 2

ANSWER 4.02 (2.50)

1. Place the mode switch in SHUTDOWN
2. Initiate alternate rod insertion manually by arming and depressing both pushbutton actuators for either Channel A or Channel B
3. Trip RPS BUS BKR
4. Individually scram control rods from CR back panel 901/902-16
5. Trip RPS breakers in Electrical Equipment Room which feed RPS dist. panels (901-154
6. Trip RPS MG Set Breakers at MCC's
7. Valve out and bleed off instrument air to scram solenoid valves [5 required @ 0.5 each] (2.5)

REFERENCE
QGA-17, Rev. 9, ATWAS Event; pg. 3

ANSWER 4.03 (2.50)

a. Not allowed between position 04 and 12 on arrays 3 and 4 [0.5] and between positions 00 and 24 from half control rod density [0.5] until the reactor pressure reaches 920 psig with at least one by-pass valve partially open [0.5]. (1.5)

b. Turbine should be immediately shutdown [0.5] and placed on the turning gear [0.5]. (1.0)

REFERENCE
QGP-1-3, Rev. 19, Unit Hot Standby to Power Operation; pg. 2,3,9

ANSWER 4.04 (3.50)

a. 1. Cooling water pressure at the stator inlet drops (to 13 psig)
2. Water temperature at the stator outlet increases ( to 95 degrees C.)
3. Stator cooling water low flow
[3 required @ .25 each] (.75)

b. 1. Reduce reactor power during the runback to avoid a neutron flux scram.
2. Send operator to stator cooling panel to check stator cooling water conductivity just prior to the loss.
3. Reduce VARS on generator to zero in order to reduce stator amps.
4. If conductivity >10 umhos/cm, trip the unit.
5. If conductivity >0.5 umho/cm, reduce generator load to zero and trip unit within 3 minutes.
6. If conductivity <0.5 umho/cm, continue operation at less than or equal to 25% of rated load for 60 minutes if desired.
7. If stator amps are not less than 25% of rated after runback, reduce generator load further until stator amps are <25%.
8. Remove Generator Core Monitor Sample
[5 required @ 0.5 each] (2.5)

c. A turbine trip (.25)

REFERENCE
QOA 5300-1, Rev. 4, Loss of Stator Cooling; pg. 1

ANSWER 4.05 (3.00)

a. 1. Monitor the reactor coolant temperature
2. Reduce heat input to the reactor by tripping the reactor recirc. pumps.
3. Increase heat removal from the reactor vessel by
a. Utilizing maximum flow on the cleanup NRHXs
b. Increasing reactor cleanup system reject and replacing water inventory with the CRD and/or condensate system
4. If possible maintain primary containment integrity
5. If reactor coolant temperature cannot be maintained below 212 degrees F, verify no personnel are in the drywell.
[3 required @ .667 each] (2.0)

b. By using the core spray pumps [0.5] and taking a suction from the CCSTs [0.5] OR using the CRD pumps and taking a suction from the CCSTs. (1.0)

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

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

REFERENCE
QOA 1000-2, Rev. 4, Loss of Shutdown Cooling; pg. 1,3

ANSWER 4.06 (3.50)

a. 1. RFP minimum flow valves fail open
2. HPCI and RCIC automatic control functions are inop
3. Feedwater regulating valves lockup
4. Recirc MG scoop tubes lockup
5. SJAE suction valve closure and off-gas isolation
[4 required @ 0.5 each] (2.0)

b. 1. RWM
2. RPIS
3. Rod select logic
4. Neutron Monitoring recorders
5. Process computer
6. Process radiation recorder
7. Yarway narrow range level (Unit 1)
8. Yarway narrow and wide range level (Unit 2)
9. Acoustic Monitor
~~10. CAF~~
[5 required @ 0.3 each] (1.5)

REFERENCE
QOA 6800-3, Rev. 6, 120/240 VAC Essential Service Bus Failure; pg. 2,3,4

ANSWER 4.07 (2.50)

MO-1001-47 and MO-1001-50 are the only high-low pressure interface with only motor-operated valves [1.0]. The necessary cables for these valves are routed through some identical fire zones [0.5]. Theoretically a postulated fire in one of these zones could cause the valves to open, resulting in a fire-initiated LOCA [1.0]. (2.5)

REFERENCE
QGA-3, Rev. 7, Major Steam Line Leak (Outside Drywell); pg. 3

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 4.08 (3.00)

a. 1. Valve may not indicate closed (on 901-3/902-3)
2. Discharge temperature indication does not return to value prior to testing
3. Torus water temperature indication does not return to value prior to testing
4. Bypass valve position remains closed
5. Acoustic position detector shows valve open
[3 required @ 0.5 each] (1.5)

b. 1. Attempt to properly close or seat the valve by opening and re-closing it
2. If the valve does not properly close, SCRAM the reactor
3. If the suppression pool temperature exceeds 95 degrees F., place the suppression pool cooling mode of RHR into service
4. Closely monitor suppression pool temperature
[3 required @ 0.5 each] (1.5)

REFERENCE
QOA 201-2, Rev. 8, Failure of a Relief Valve to Close or Reseat Properly; pg. 1

ANSWER 4.09 (2.50)

a. 1115 psig (0.5)

b. The 10 second time delay [0.5] is used to prevent excessive containment loads [0.5], due to a high water leg in the relief valve discharge line [0.5]. (1.5)

c. To distribute the cooling load more equally around the suppression chamber. (0.5)

REFERENCE
QOA 201-10, Rev. 2, Reactor Pressure Control Using Manual Relief Valve Actuation; pg. 1,2

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

FACILITY: QUAD CITIES 1&2

REACTOR TYPE: BWR-GE3

DATE ADMINISTERED: 84/11/14

EXAMINER: HILL, D.

APPLICANT: _____

INSTRUCTIONS TO APPLICANT:

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

| CATEGORY VALUE | % OF TOTAL | APPLICANT'S SCORE | % OF CATEGORY VALUE | CATEGORY |
|---|---|---|---|---|
| 25.00 | 25.00 | _____ | _____ | 5. THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS |
| 25.00 | 25.00 | _____ | _____ | 6. PLANT SYSTEMS DESIGN, CONTROL, AND INSTRUMENTATION |
| 25.00 | 25.00 | _____ | _____ | 7. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL |
| 25.00 | 25.00 | _____ | _____ | 8. ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS |
| 00.00 | 100.00 | _____ | _____ | TOTALS |

FINAL GRADE _____%

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

_____
APPLICANT'S SIGNATURE

## 5. THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS

QUESTION 5.01 (4.00)

Unit 2 is operating at 100% power. A fire is reported in the Front Standard of the Main Turbine. The Reactor Operator depresses the 'TRIP' pushbutton on the EHC control panel. A failure occurs at this time. Using the attached traces of the various plant parameters, Figure 1, indicate WHAT FAILURE has occurred with the Main Steam and Turbine System. Justify your answer by BRIEFLY discussing the predominant response of EACH trace. (4.0)

NOTE: 1. Time intervals are 30 seconds.
2. The operator depresses the "TRIP" push button at +25 seconds.

QUESTION 5.02 (3.50)

Concerning the core thermal limits:

a. For each condition (1-4) given below, INDICATE whether it will cause an INCREASE, a DECREASE, or have NO EFFECT on CRITICAL POWER.
   1) Local peaking factor (LPF) INCREASES (0.5)
   2) DECREASE in inlet subcooling (0.5)
   3) INCREASE in reactor pressure (0.5)
   4) Axial power peak shifts from BOTTOM to TOP of channel (0.5)

b. With regard to MAPRAT:
   1) WHAT is the relationship between MAPRAT and MAPLHGR? (0.5)
   2) IS a MAPRAT of 1.05 acceptable? (.25)
   3) WHAT physical consequence could occur if the MAPRAT limit is exceeded? (.75)

QUESTION 5.03 (2.80)

The tabulation below illustrates REACTIVITY COEFFICIENT VARIATIONS due to increases in several core parameters. For each condition (a-h) listed below, INDICATE how the VALUE of that coefficient varies (MORE OR LESS NEGATIVE) if the indicated parameter is INCREASED. (2.8)

| CORE PARAMETER / COEFFICIENT | MODERATOR TEMP | CORE VOIDING | ROD DENSITY | FUEL TEMP | CORE AGE |
|---|---|---|---|---|---|
| Void Coefficient | | (a) | (b) | (c) | (d) |
| Moderator Temp. Coefficient | (e) | | | | (f) |
| Fuel Temperature Coefficient | | (g) | | (h) | |

QUESTION 5.04 (1.20)

Steam leaving the steam separators and entering the steam dryer has a quality of 90% and is at a pressure of 1000 psia. Using the attached Mollier Diagram, determine the steam SPECIFIC ENTHALPY. (1.2)

QUESTION 5.05 (2.00)

Explain HOW it is possible to WITHDRAW a control rod and still have a bundle power DECREASE (Reverse Power Effect). (2.0)

QUESTION 5.06 (3.00)

Regarding the xenon transient following a significant DECREASE in reactor power from high power operation:

a. Briefly, EXPLAIN WHY the xenon concentration will peak following the manuever. (1.0)

b. HOW will peripheral control rod worth be affected (INCREASE, DECREASE, REMAIN THE SAME) during the xenon peak? BRIEFLY EXPLAIN your answer. (1.5)

c. If the decrease in reactor power was from 100% to 50%, would the new (50% power) equilibrium xenon reactivity be MORE THAN, LESS THAN OR EQUAL TO one half the 100% equilibrium value. (0.5)

QUESTION 5.07 (2.50)

a. WHAT are TWO (2) reasons why flux shaping is performed? (1.0)

b. If flux shaping was NOT PERFORMED at BOL, WHAT problem can occur at EOL? (1.5)

QUESTION 5.08 (2.00)

a. WHAT is SHUTDOWN MARGIN? (1.0)

b. The SDM test assurs the minimum shutdown margin is R + 0.25%. WHAT is 'R'? (1.0)

QUESTION 5.09 (1.00)

The following is a list of flow patterns which could occur in a BWR. SELECT the answer which places them in the correct order of occurance. (1.0)

1. Bubble flow
2. Single phase forced convection
3. Slug flow
4. Subcooled boiling
5. Annular flow

a. 2,4,1,5,3
b. 2,4,1,3,5
c. 2,1,4,3,5
d. 1,2,4,3,5

QUESTION 5.10 (3.00)

A fuel pin, over a period of time, has a uniform coating of corrosion products of about 0.001 inches thick buildup on the surface of the pin. Assume that power output(MWt) within the fuel pin REMAINS CONSTANT during the time of the buildup. For each of the temperatures listed below, WOULD the temperatures INCREASE, DECREASE, or REMAIN THE SAME? BRIEFLY EXPLAIN EACH ANSWER.

a. Fuel temperature (1.0)

b. Cladding temperature (1.0)

c. Coolant temperature surrounding the lower portion of the fuel pin (prior to the onset of boiling). (1.0)

QUESTION 6.01 (3.00)

The reactor is operating at 40% power with the Feedwater Control System in single element control, and level channel 'A' selected for input. The reference leg isolation valve to the channel 'A' NR GEMAC develops a significant packing leak and the associated reference leg starts to gradually decrease. DESCRIBE WHAT will happen to the plant and WHY? Assume NO operator action. (3.0)

NOTE: LIMIT your answer to effects on and of the FWLC, RPS, ECCS, PCIS, and actual vessel level. Include any applicable set-points.

QUESTION 6.02 (3.00)

Answer the following with respect to the Turbine Generator Load Reject Scram:

a. WHAT is the SETPOINT for the scram? (.75)

b. WHEN is the scram BYPASSED? (Include applicable sensing point). (.75)

c. WHAT is the LOGIC for the scram? (0.5)

d. WHAT is the BASIS for the scram? (1.0)

QUESTION 6.03 (3.50)

With the plant operating at 100% power with the recirc in Master Manual, an operator inadvertently DECREASES the "Pressure Set" by 5 psi. WHAT will be the INITIAL response and FINAL status of the following parameters due to this action? Briefly EXPLAIN. Assume NO operator action. See attached Figure 6, Speed and Acceleration Control Unit. ANSWER on the attached handout page.

a. TCV position

b. BPV position

c. Power

d. Pressure

QUESTION 6.04 (2.75)

a. DESCRIBE the flow path for fuel pool water during the 'FPCC ASSIST' mode of the RHR system. (A drawing may be used) (1.75)

b. The RHR system can also be used to increase or decrease level in the suppression pool. WHAT are TWO (2) places suppression pool water can be pumped to if you wanted to DECREASE suppression pool level? (1.0)

QUESTION 6.05 (4.00)

For the following systems listed below, discuss how they INTERFACE WITH the Recirculation System. Be specific as to interface PURPOSE and LOCATION where applicable.

a. Residual Heat Removal (RHR) (NOTE: Discuss TWO modes of RHR) (2.0)
b. Reactor Water Cleanup (RWCU) (0.5)
c. Reactor Building Closed Cooling Water (RBCCW) (1.0)
d. Average Power Range Monitor (APRM) (0.5)

QUESTION 6.06 (3.50)

In reference to the Heater Drain System:

a. WHAT are TWO (2) differences between the 'C' and 'B' LOW PRESSURE heaters OTHER THAN location? (1.5)

b. The drain cooler (downstream of the flash tank) is a water-to-water heat exchanger which _____ (increases, decreases) the temperature of the feedwater. (Fill in the blank) (0.5)

c. WHAT problem will develop if a 'C' or 'D' heater is removed from service AND WHY doesn't the problem develop when a 'A' or 'B' heater is removed from service. (1.5)

QUESTION 6.07 (2.00)

The Reactor Water Cleanup System (RWCUS) drain flow regulator will automatically close when either of TWO (2) conditions exist. WHAT are these conditions? Include in your answer the purpose for each closure. (2.0)

QUESTION 6.08 (1.25)

a. HOW can you prevent getting an alarm, rod block, or half scram when taking the IRM function switch out of operate? (.25)

b. WHAT ROD BLOCKS are associated with the IRMs AND WHEN is EACH Rod Block BYPASSED? (1.0)

QUESTION 6.09 (2.00)

Concerning the Service Water System:

a. WHAT type of radiation detector(s), if any, is(are) on the two discharge headers (King Hole and Queen Hole)? (1.0)

b. WHY is Service Water considered an Engineered Safeguard System? (1.0)

QUESTION 7.01 (2.00)

WHAT are TWO (2) exceptions to the requirement that 'Individuals are prohibited from entering a high radiation area unless they notify the control room OR have a safety man present'? (2.0)

QUESTION 7.02 (2.50)

One of the IMMEDIATE actions after recognizing an ATWAS event is to scram the reactor manually by depressing both manual trip actuators. Should this fail, there are alternate methods to scram the reactor. In accordance with QGA-17, ATWAS Event, WHAT are FIVE (5) of these alternate methods? (2.5)

QUESTION 7.03 (2.50)

Concerning QGP-1-3 for Unit Hot Standby to Power Operation:

a. WHEN is the use of NOTCH OVERRIDE control rod withdrawal NOT ALLOWED? (1.5)

b. WHAT action should be taken when unusual vibration on the turbine is noted at low speed? (1.0)

QUESTION 7.04 (3.50)

A report was just received that the strainer spool piece on the Stator Winding Cooling Water system was leaking. A few minutes later the Stator Cooling Panel Trouble alarm annunciates:

a. WHAT are THREE (3) conditions associated with a loss of stator cooling that will cause the turbine to runback? (Setpoints are not required) (.75)

b. In accordance with QOA 5300-1, Loss of Stator Cooling, WHAT are FIVE (5) of the immediate operator actions? (2.5)

c. WHAT will occur if stator amps ARE NOT runback to 7380 amps within 3 minutes? (.25)

## 7. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL

QUESTION 7.05 (3.00)

In reference to QOA 1000-2, Loss of Shutdown Cooling:

a. WHAT are THREE (3) Immediate Operator Actions OTHER THAN notification of the Shift Engineer? (2.0)

b. HOW is vessel level maintained if the feedwater headers ARE NOT available for transferring water to the vessel from the condensate system? Include in your answer WHERE water is taken from AND WHAT pump(s) is(are) used to transfer water to the vessel. (1.0)

QUESTION 7.06 (3.50)

The plant is operating at 100% power when a complete loss of ESSENTIAL SERVICE occurs:

a. WHAT are FOUR (4) automatic actions that occur which will immediately and significantly affect your ability to operate and protect the plant from the control room? (2.0)

b. WHAT are FIVE (5) CONTROL ROOM indications which have been disabled due to the loss of essential service? (1.5)

QUESTION 7.07 (2.50)

QGA-3 Major Steam Line Break (Outside the Drywell), discusses procedures to be taken if 'The shutdown cooling suction piping has failed due to inadvertent opening of MO-1001-50 and MO-1001-47 ...'. EXPLAIN WHAT is unique about these valves that they are mentioned in this procedure, AND WHAT could cause them to inadvertently open. (2.5)

QUESTION 7.08 (3.50)

An electrical fire causes heavy and toxic smoke in the control room and you decide the control room must be IMMEDIATELY EVACUATED. NO operator immediate actions are taken.

a. As the Shift Engineer, WHERE is your assigned station AND WHAT OTHER stations are to be manned? (2.0)

b. WHAT are THREE (3) actions that are performed after the main turbine has been tripped locally? (1.5)

QUESTION 7.09 (2.00)

a. WHAT is the reactor power limit for one recirculation pump operation with the equalizing cross-tie valves closed? (0.5)

b. WHY SHOULDN'T you attempt to isolate the idle recirc pump by closing the suction valve AFTER the discharge valve is closed? (1.0)

c. WHAT action must be taken if the tripped pump CANNOT be restarted in 5 minutes? (0.5)

QUESTION 8.01 (3.00)

WHAT is the minimum Technical Specification shift manning requirements for the following conditions?

a. Both Unit 1 and Unit 2 at power (1.5)

b. Both Unit 1 and Unit 2 in Cold Shutdown (1.5)

QUESTION 8.02 (3.00)

a. Access to the Drywell IS NOT limited if FOUR (4) conditions exist simultaneously. WHAT are these FOUR (4) conditions? (2.0)

b. Under WHAT condition(s) can any of the restrictions, listed in "a" above, be waivered? (1.0)

QUESTION 8.03 (3.00)

The approvals required for Temporary changes to NORMAL OPERATING PROCEDURES (QOP) depends on whether the "intent" of the procedure was changed.

a. WHAT are THREE (3) conditions that constitute a change of "intent" to a procedure? (2.25)

b. WHO (by title) must approve a temporary change to a Normal Operating Procedure (QOP)? (.75)

QUESTION 8.04 (2.00)

During normal full power operation while conducting HPCI surveillance testing, the HPCI turbine stop valve failed to open after the aux. oil pump was started. Subsequently, during the required daily surveillance testing of the ADS, the B side ADS logic timer failed to start due to a reset switch failing to reset the timer and logic. In accordance with the Technical Specifications, WHAT ACTION MUST YOU TAKE IN THIS SITUATION? (2.0)

**********
* NOTE: USE THE ATTACHED SECTIONS OF TECHNICAL SPECIFICATIONS TO ANSWER *
* THIS QUESTION. FULLY REFERENCE ALL APPLICABLE SECTIONS OF T.S. *
* THAT YOU USE TO DEVELOP YOUR ANSWER. *
**********

QUESTION 8.05 (3.00)

a. Under WHAT condition is a special movable dunking type detector permitted to be used in place of normal detectors? (Assume a major core alteration is taking place). (1.0)

b. WHAT are T&O (2) conditions when the requirement that the "SRM or dunking type detector have a minimum of 3 cps with all rods fully inserted in the core" is NOT NECESSARY? (2.0)

QUESTION 8.06 (2.00)

Regarding the Unit 1 POWER - FLOW OPERATING MAP (next page of the exam):

a. WHAT prevents operation below the Minimum Power Line? (1.0)

b. WHY is operation below the Minimum Power Line undesirable? (1.0)

QUESTION 8.07 (2.50)

Concerning the tagging of equipment in the station:

a. Personnel Protection Cards can only be used in conjunction with a __(1)__ card. (Fill in the numbered blank). (0.5)

b. In the event that the supervisor in charge of the work is not on-site and cannot be reached, WHO can authorize a return-to-service of equipment AND WHAT requirement must be met prior to granting the return-to-service? (1.0)

c. WHAT is your RESPONSIBILITY (as Shift Engineer) if a mechanic requests a temporary lift of out-of-service cards to test a pump that is out-of-service for more than one group? (1.0)

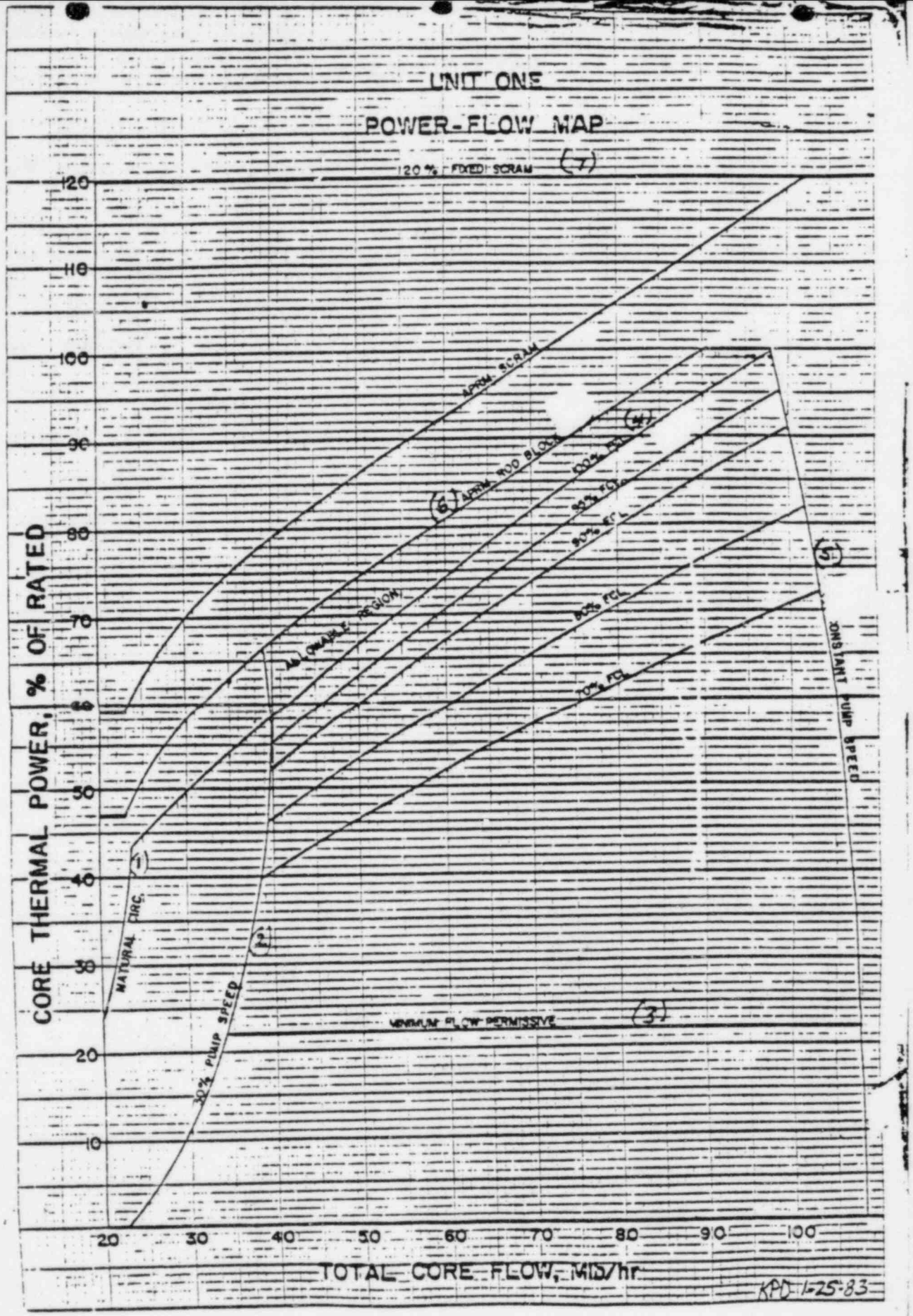
QUESTION 8.08 (3.00)

For the suppression pool water temperatures listed below, WHAT ACTION(S) is(are) required by the Quad Cities Technical Specifications?

a. 105 degrees F., during HPCI testing (1.0)

b. 110 degrees F. (1.0)

c. 120 degrees F., following a scram with the MSIVs shut (1.0)


UNIT ONE
POWER-FLOW MAP
120 % FIXED SCRAM
APRM SCRAM
APRM ROD BLOCK
100% FCL
95% FCL
90% FCL
80% FCL
70% FCL
OPERABLE REGION
CONSTANT PUMP SPEED
NATURAL CIRC.
30% PUMP SPEED
MINIMUM FLOW PERMISSIVE
CORE THERMAL POWER, % OF RATED
TOTAL CORE FLOW, MLB/hr
120
110
100
90
80
70
60
50
40
30
20
10
20
30
40
50
60
70
80
90
100
(1)
(2)
(3)
(4)
(5)
(6)
(7)
KPD 1-25-83

F169

QUESTION 8.09 (3.50)

According to the TECHNICAL SPECIFICATIONS for the Control Rod System (3.3/4.3 REACTIVITY CONTROL):

a. At all operating pressures, a rod accumulator may be inoperable provided that no other control rod in the nine-rod square array around this rod has a: (LIST THREE (3) conditions which must be met) (2.0)

b. WHAT is a "REACTIVITY ANOMALY" and LIST its LCO value. (1.5)

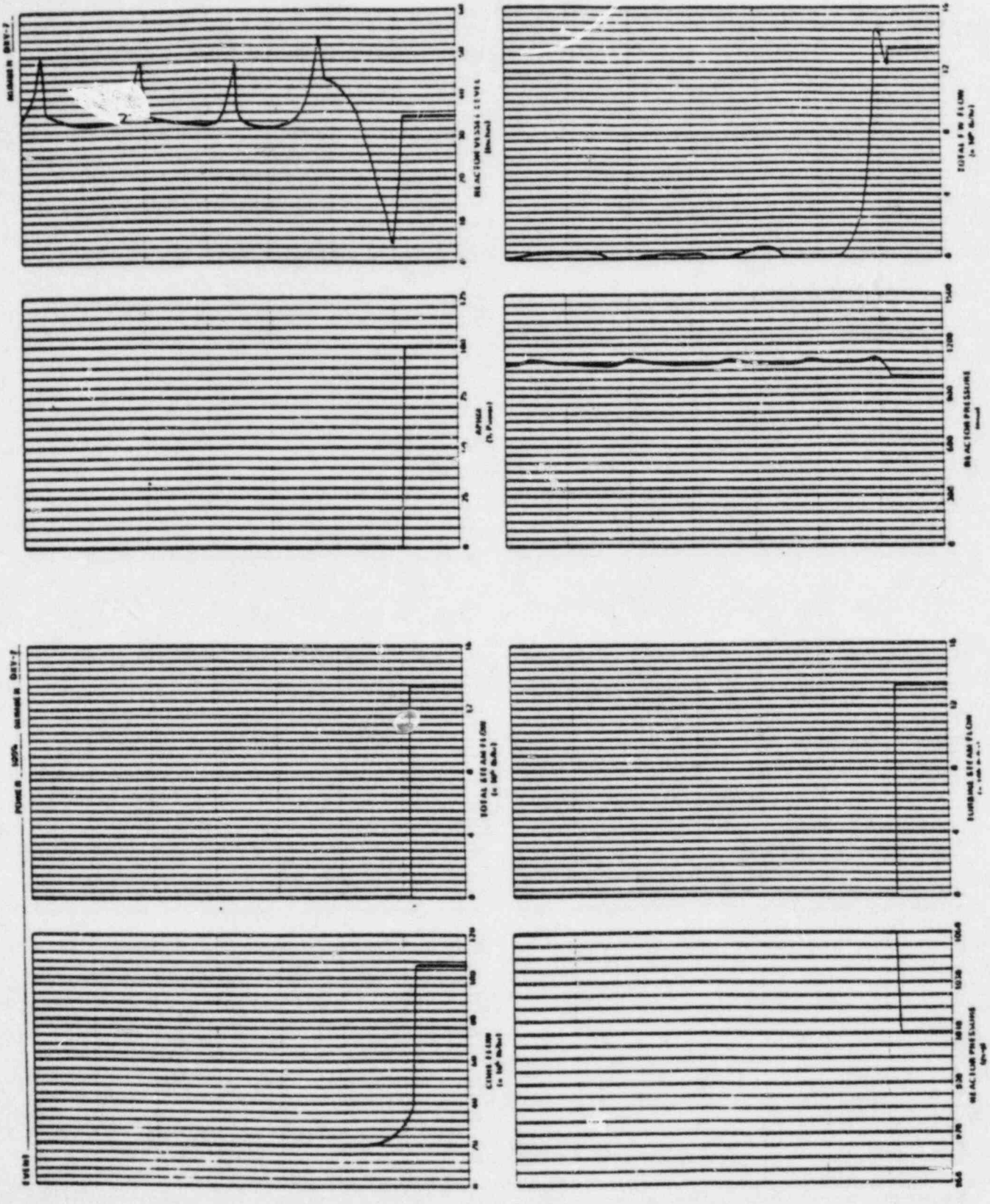
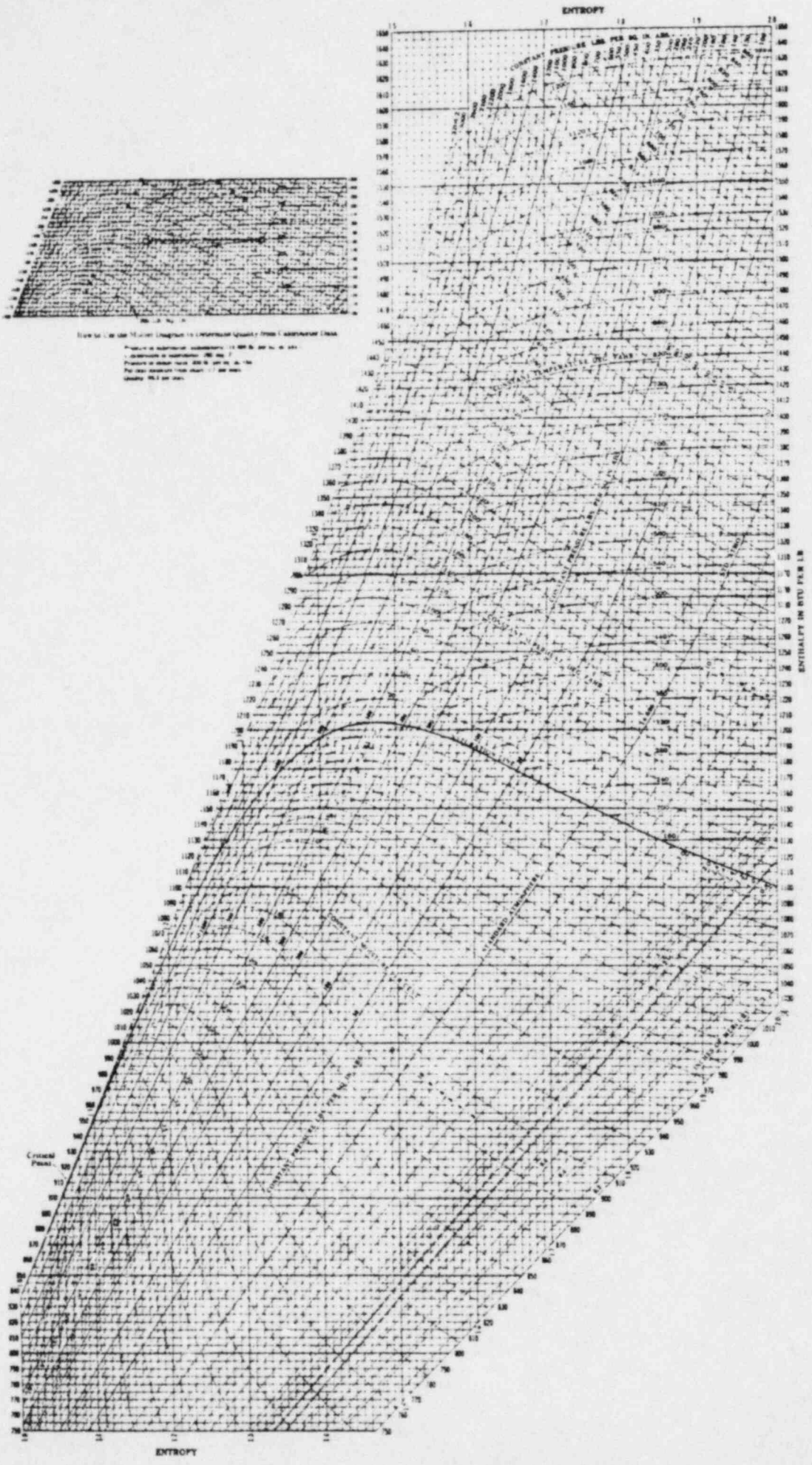


FIGURE 1


ENTROPY
ENTHALPY IN BTU PER LB
ENTROPY

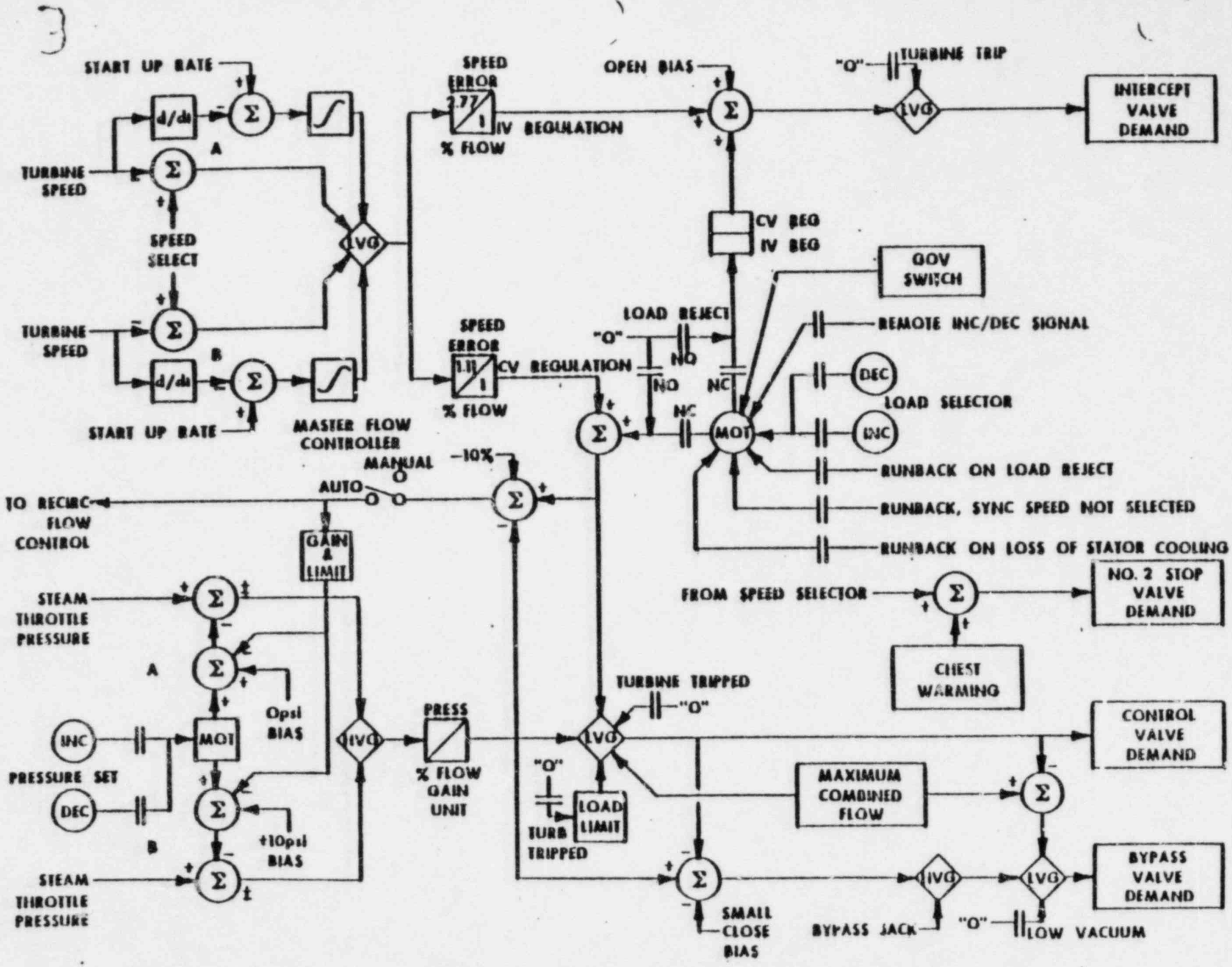



***Figure 6. Speed and Acceleration Control Unit***

ANSWER SHEET for Question 6.C3

INITIAL RESPONSE:

a. TCV position _____ (in % steam flow demand)

b. BPV position _____ (in % steam flow demand)

c. Power _____

d. Pressure _____

} (increase, decrease, or remain the same)

Reason: _____

_____

_____

FINAL STATUS:

a. TCV position _____ (in % steam flow demand)

b. BPV position _____ (in % steam flow demand)

c. Power _____

d. Pressure _____

} (higher than, lower than, or the same as the initial value)

Reason: _____

_____

_____

# EQUATION SHEET

$f = ma$

$w = mg$

$E = mc^2$

$KE = 1/2\ mv^2$

$PE = mgn$

$V_f = V_o + at$

$W = v\ \Delta P$

$\Delta E = 931\ \Delta m$

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

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

$Pwr = W_f \Delta h$

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

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

$SUR = 26.06/T$

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

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

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

$T = (\beta - \rho)/(\bar{\lambda}\rho)$

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

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

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

$\Sigma = \sigma N$

$v = s/t$

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

$a = (V_f - V_o)/t$

$w = \theta/t$

$A = \frac{\pi D^2}{4}$

$\dot{m} = V_{av} A \rho$

Cycle efficiency = (Net work out)/(Energy in)

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

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

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

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

$I = I_o e^{-ux}$

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

$TVL = 1.3/u$

$HVL = -0.693/u$

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

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

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

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

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

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

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

$\bar{\lambda} = 0.1$ 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
1 Atm = 14.7 psi = 29.9 in. Hg.
1 ft. $H_2O$ = 0.4335 lbf/in.

## Miscellaneous Conversions

1 curie = $3.7 \times 10^{10}$ dps
1 kg = 2.21 lbm
1 hp = $2.54 \times 10^3$ Btu/hr
1 mw = $3.41 \times 10^6$ Btu/hr
1 in = 2.54 cm
°F = 9/5°C + 32
°C = 5/9 (°F-32)
1 BTU = 778 ft-lbf

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ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 5.01 (4.00)

Failure-- Bypass valves fail to open (.25)

Turbine Steam and Total Steam Flow- Turbine steam flow goes to zero as stop valves close on turbine trip [0.5]. Total steam flow goes to near zero as bypass fail to open [0.5]. (1.0)

Vessel Level- decreases due to void collapse caused by the stop valve closure [.25] and the scram [.25]. (0.5)

Core Flow- decreases ~~to natural circulation after recire pump trip.~~ due to recirc pump runback to minimum speed due to feedwater flow dropping to < 2 x $10^6$ lbm/hr. (0.5)

Feed Flow- ~~FWCS initially cuts back on feedwater flow to follow steam flow [.25] but then increases due to low vessel level [.5]. As level returns to normal, the FWCS reduces feed flow to control level [.25]~~ Increases in response to level decreasing and then decreasing as level increases. (.75)

Pressure- Pressure increases following the turbine trip and failure of bypass valves to open. The SRV's control pressure in the area of 1100 psig. Several SRV actuations occur. (0.5)

APRM- sharply drops because of anticipatory scram. (0.5)

REFERENCE
BWR Transients

ANSWER 5.02 (3.50)

a. 1. Decreases (0.5)
2. Decreases (0.5)
3. Decreases (0.5)
4. Decreases (0.5)

b. 1. MAPRAT is the ratio of APLHGR TO Lim APLHGR OR the ratio of APLHGR(act) to MAPLHGR(LCO) (0.5)
2. NO (.25)
3. The clad temperature can exceed 2200 degrees F. during a DBA LOCA (.75)

REFERENCE
HT&FF, pg. 16,17; GE Thermodynamics, HT&FF, pg. 9-85 to 9-89

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 5.03 (2.80)

a. More negative
b. More negative
c. More negative
d. Less negative
e. More negative
f. Less negative
g. More negative
h. Less negative
[0.35 each] (2.8)

REFERENCE
Theory Review, pg. 48,50,54,56, Fig.46

ANSWER 5.04 (1.20)

Since steam quality is given, find moisture content.
M=1-x or
M=1-.90 = .10 = 10%
Use 10% constant moisture line and 1000 psia constant pressure line to find specific anthalpy of wet steam.
h=1127 BTU/lbm (1.2)

REFERENCE
GE Thermodynamics, Heat Transfer and Fluid Flow; pg. 4-83

ANSWER 5.05 (2.00)

Steam bubbles generated by withdrawal of a shallow rod [0.5] are carried upward through the remainder of the bundle thus increasing void fraction in the top of the bundle [0.5] which will generally decrease power in that region [0.5]. Overall bundle power depends on the relative magnitude of the power increase in the bottom of the bundle compared to the power decrease and can result in a decrease in bundle power [0.5]. (2.0)

REFERENCE
Theory Review, pg. 62

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 5.06 (3.00)

a. The decrease in the burnout term [0.5] with the production of xenon from iodine still at the higher power rate dominates [0.5] causing the xenon concentration to increase. (1.0)

b. Peripheral rod worth will increase [0.5] because the highest xenon concentration will be in the center of the core where the highest flux existed previously [0.5]. This will suppress the flux in the center of the core and increase the flux in the area of the peripheral rods, thereby, increasing their worth [0.5] (1.5)

c. More than one half the value at 100%. (0.5)

REFERENCE
Theory Review, pg. 66-70

ANSWER 5.07 (2.50)

a. 1. To optimize fuel burnout (0.5)
2. To prevent exceeding thermal limitations (0.5)

b. The bottom of the core would be excessively reactive [0.5] and shallow rods would have to be inserted to control peaking [0.5]. These rods would be difficult if not impossible to withdraw later resulting in a short cycle [0.5]. (1.5)

REFERENCE
Theory Review, pg. 62,66

ANSWER 5.08 (2.00)

a. That amount of reactivity which must be added in order to make the reactor critical. OR SDM must be ≥ 0.25% + R in the most reactive condition during the operating cycle with the strongest operable control rod at its full out position and all other operable rods fully inserted. (1.0)

b. The difference in reactivity between that calculated at BOL [0.5] and the most reactive time in core life [0.5]. (1.0)

REFERENCE
Theory Review, pg. 74

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 5.09 (1.00)

The correct answer is B (1.0)

REFERENCE
GE Thermodynamics, Heat Transfer and Fluid Flow, pg. 9-15,16

ANSWER 5.10 (3.00)

a. Fuel temperature would increase [0.5] to get the needed delta T to transfer the heat to the coolant. The corrosion layer will require some delta T across it to transfer heat [0.5]. (1.0)

b. Cladding temperature would increase [0.5] because the pin temperature increased and the cladding is now transferring heat to the corrosion film instead of the coolant [0.5]. (1.0)

c. Coolant temperature remains the same [0.5] since it is a function of pressure, which is maintained constant by the EHC system [0.5]. (1.0)

REFERENCE
Quad Cities Exam Bank

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 6.01 (3.00)

1. Level channel 'A' will indicate increasing water level (0.5)
2. FWLCS will close the FRVs to try to maintain level (0.5)
3. Actual vessel level is decreasing (0.5)
4. Reactor will scram @ +8" due to low reactor water level (0.5)
5. PCIS Group 2 and 3 isolations also @ +8" (0.5)
6. Recirc pump trip, PCIS Group 1 isolation, HPCI and RCIC initiation all @ -59" (0.5)

REFERENCE
Reactor Level and Pressure, LIC-0263, pg. 12

ANSWER 6.02 (3.00)

a. ~~Equal to or greater than a 40% [.25] mismatch between turbine first stage pressure [.25] and generator stator amps [.25].~~ 10% actuation of the fast acting solenoids (.75)

b. Not in RUN [.25] and when in RUN if less than 45% rated steam flow [.25] as measured by turbine first stage pressure [.25]. (.75)

c. ~~Operation of three or more valves cause a full scram, of two valves may cause a scram.~~ operation One valve will cause a half scram and a second valve may cause an additional half scram (full scram) or 1 out 2, twice (0.5)

d. Provided to anticipate [.25] the rapid increase in pressure and neutron flux [.25] resulting from the closure of the control valves due to a load reject [.25] and subsequent failure of the bypass valves [.25]. (Prevents MCPR from becoming less than the safety limit). (1.0)

REFERENCE
Scrams and Isolations, LIC-Scram, pg. 6,8 CAF

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 6.03 (3.50)

INITIAL RESPONSE:

a. TCVs - Remain at 100% open (or open to 100%) [.35].

b. BPVs - Open 5% [.35].

c. Power - Decreases [.35].

d. Pressure - Decreases [.35].

REASON: Above caused by PCU calling for ~115% steam flow ((950-915) x 3.3) and limited by MCF limit of 105% [.35] (1.75)

FINAL STATUS:

a. TCVs - At 100% position (or initial) [.35].

b. BPVs - Shut [.35].

c. Power - Slightly lower [.35].

d. Pressure - Slightly lower [.35].

REASON: Above caused by the decrease in pressure and power causing BPVs to shut -- PCU cycling to new equilibrium state ((945-915) x 3.3) [.35]. (1.75)

REFERENCE
EHC Pressure Control and Logic, LIC-5650-2, pg. 4-9

ANSWER 6.04 (2.75)

a. Water flows from:
Fuel pool to skimmer surge tanks [.25], through a removable spool piece [.25], to the suction or the RHR pump [.25], through the RHR HTX [.25] (or bypass valve) to the RHR cross-tie header [.25], through a removable spool piece [.25] back to the fuel pool [.25]. (1.75)

b. 1. Waste surge tank
2. Waste collector tank
3. Radwaste ~~(CAT)~~
4. Either unit hotwell
5. Other unit torus
6. B or C Condensate pump suction
[2 required @ 0.5 each] (1.0)

REFERENCE
RHR Lesson Plan, SRO-1000-1, pg. 10,11

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 6.05 (4.00)

a. RHR- 1.Shutdown cooling mode- provides decay heat removal capability. Takes a suction from recirc pump B suction line and returns to either recirc pump discharge line. (1.0)
2.LPCI mode- provides flooding of the core at lower pressures to maintain the core covered on a LOCA by discharging to both recirc pump discharge lines. OR Jet pump riser dp and recirc. pump dp input to the LPCI loop select logic. (1.0)

b. RWCU- takes its suction from the 'B' recirc loop (.5)

c. RBCCW- provides cooling to recirc pump motor bearing coolers [0.5] and seal cavity coolers [0.5]. (1.0)

d. APRM- Recirc loops A and B flow elements serve as inputs to the APRM flow converters. (.5)

REFERENCE
Recirc. Sys. Lesson Plan, LIC-0202-1, pg. 6,34,36

ANSWER 6.06 (3.50)

a. 1. The heater drains come from the 'D' heaters and flow into the 'C' heaters, then from the 'C' heater into the 'B' heater. (.75)
2. Extraction steam comes from the 8th stage of the LP turbine for 'C' and from the 10th stage for 'B' OR operate at different temperature and pressure. (.75)

b. Increases (0.5)

c. An unbalanced axial thrust on the turbine shaft will develop [0.5] due to the 'C' and 'D' heaters receiving extraction steam from opposite sides of the LP turbine [0.5]. The 'A' and 'B' heaters receive extraction steam from both ends of the LP turbine so there is no net axial thrust [0.5]. (1.5)

REFERENCE
Feed Condensate Lesson Plan, LIC-3200-3300, pg. 24,28,50

ANSWER 6.07 (2.00)

1. 140# sensed downstream [0.5] to protect low pressure piping to Radwaste and the Main Condenser [0.5]. (1.0)

2. 5# sensed upstream [0.5] to prevent draining of the cleanup system [0.5]. (1.0)

REFERENCE
RWCU Lesson Plan, LIC-1200, pg. 8

ANSWER 6.08 (1.25)

a. By depressing the INOP INHIBIT switch (Red pushbutton) OR Bypassed(.25)

b. Downscale - Bypassed in Range 1 and RUN
High - Bypassed in RUN
INOP - Bypassed in RUN
Det Wrong Pos. - Bypassed in RUN
[.15 for block and .1 for byp] (1.0)

REFERENCE
IRM Lesson Plan, LIC-0700-2, pg. 18,20

ANSWER 6.09 (2.00)

a. King Hole - scintillation
Queen Hole - None
[.75 for which header has the detector and .25 for type] (1.0)

b. Provides an inexhaustible supply of water to the condenser for each unit (via MO-3901,3902). (1.0)

REFERENCE
Service Water Lesson Plan, LIC-3900, pg. 6,8

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 7.01 (2.00)

1. Operators and other personnel on R-rounds
2. Jobs when radio or sound powered communications with the control center is possible.
3. Personnel entering the sample hood fenced area where the area is clearly visible to personnel outside the RP area. [2 required @ 1.0 each] (2.0)

REFERENCE
QAP 1120-6, Rev. 5, Entering a locked high radiation area without a timekeeper; pg. 2

ANSWER 7.02 (2.50)

1. Place the mode switch in SHUTDOWN
2. Initiate alternate rod insertion manually by arming and depressing both pushbutton actuators for either Channel A or Channel B
3. Trip RPS BUS BKR
4. Individually scram control rods from CR back panel 901/902-16
5. Trip RPS breakers in Electrical Equipment Room which feed RPS dist. panels (901-15&17)
6. Trip RPS MG Set Breakers at MCC's
7. Valve out and bleed off instrument air to scram solenoid valves [5 required @ 0.5 each] (2.5)

REFERENCE
QGA-17, Rev. 9, ATWAS Event; pg. 3

ANSWER 7.03 (2.50)

a. Not allowed between position 04 and 12 on arrays 3 and 4 [0.5] and between positions 00 and 24 from half control rod density [0.5] until the reactor pressure reaches 920 psig with at least one by-pass valve partially open [0.5]. (1.5)

b. Turbine should be immediately shutdown [0.5] and placed on the turning gear [0.5]. (1.0)

REFERENCE
QGP-1-3, Rev. 19, Unit Hot Standby to Power Operation; pg. 2,3,9

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 7.04 (3.50)

a. 1. Cooling water pressure at the stator inlet drops (to 13 psig)
2. Water temperature at the stator outlet increases ( to 95 degrees C.)
3. Stator cooling water low flow
[3 required @ .25 each] (.75)

b. 1. Reduce reactor power during the runback to avoid a neutron flux scram.
2. Send operator to stator cooling panel to check stator cooling water conductivity just prior to the loss.
3. Reduce VARS on generator to zero in order to reduce stator amps.
4. If conductivity >10 umhos/cm, trip the unit.
5. If conductivity >0.5 umho/cm, reduce generator load to zero and trip unit within 3 minutes.
6. If conductivity <0.5 umho/cm, continue operation at less than or equal to 25% of rated load for 60 minutes if desired.
7. If stator amps are not less than 25% of rated after runback, reduce generator load further until stator amps are <25%.
8. Remove Generator Core Monitor Sample
[5 required @ 0.5 each] (2.5)

c. A turbine trip (.25)

REFERENCE
QOA 5300-1, Rev. 4, Loss of Stator Cooling; pg. 1

ANSWER 7.05 (3.00)

a. 1. Monitor the reactor coolant temperature
2. Reduce heat input to the reactor by tripping the reactor recirc. pumps.
3. Increase heat removal from the reactor vessel by
a. Utilizing maximum flow on the cleanup NRHXs
b. Increasing reactor cleanup system reject and replacing water inventory with the CRD and/or condensate system
4. If possible maintain primary containment integrity
5. If reactor coolant temperature cannot be maintained below 212 degrees F, verify no personnel are in the drywell.
[3 required @ .667 each] (2.0)

b. By using the core spray pumps [0.5] and taking a suction from the CCSTs [0.5]. OR using the CRD pumps and taking a suction from the CCSTs. (1.0)

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

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

REFERENCE
QOA 1000-2, Rev. 4, Loss of Shutdown Cooling; pg. 1,3

ANSWER 7.06 (3.50)

a. 1. RFP minimum flow valves fail open
2. HPCI and RCIC automatic control functions are inop
3. Feedwater regulating valves lockup
4. Recirc MG scoop tubes lockup
5. SJAE suction valve closure and off-gas isolation
[4 required @ 0.5 each] (2.0)

b. 1. RWM
2. RPIS
3. Rod select logic
4. Neutron Monitoring recorders
5. Process computer
6. Process radiation recorder
7. Yarway narrow range level (Unit 1)
8. Yarway narrow and wide range level (Unit 2)
9. Acoustic Monitor
~~10. CAF~~
[5 required @ 0.3 each] (1.5)

REFERENCE
QOA 6800-3, Rev. 6, 120/240 VAC Essential Service Bus Failure; pg. 2,3,4

ANSWER 7.07 (2.50)

MO-1001-47 and MO-1001-50 are the only high-low pressure interface with only motor-operated valves [1.0]. The necessary cables for these valves are routed through some identical fire zones [0.5]. Theoretically a postulated fire in one of these zones could cause the valves to open, resulting in a fire-initiated LOCA [1.0]. (2.5)

REFERENCE
QGA-3, Rev. 7, Major Steam Line Leak (Outside Drywell); pg. 3

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 7.08 (3.50)

a. Instrument racks (2201-5,6 and 2202-5,6) (0.5)
   1. Bus 11 and 12 switchgear
   2. Auxiliary electrical room
   3. Feedwater regulating valves
   4. Turbine building main floor
      [3 required for full credit] (1.5)

b. 1. Verify that the generator field breaker opens within a few minutes or manually trip the generator field breaker
   2. Locally start oil pumps and monitor the turbine until it is on the turning gear
   3. Verify that auxiliary power has transferred
      [3 required @ 0.5 each] (1.5)

REFERENCE
QOA 010-5, Rev. 4, Plant Operation with the Control Room Inaccessible; pg. 1,2

ANSWER 7.09 (2.00)

a. 68% OR 50% after 24 hours (0.5)

b. Due to the eventual large differential pressure across the valve plug [0.5], the valve may not close completely [0.5]. (1.0)

c. Open the pump discharge valve. (0.5)

REFERENCE
QOA 202-4, Rev. 4, Loss of Flow - Single Pump; pg. 2
QOA 202-6, Rev. 1, Recirc Pump Seal Failure; pg. 2

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 8.01 (3.00)

| | : | (a) | (b) |
|---|---|---|---|
| SRO | : | 2 | 1 |
| RO | : | 3 | 2 |
| Rad. Prot. Man | : | 1 | 1 |
| Non-Licensed | : | 4 | 3 |
| STA | : | 1 | None |

[10 @ 0.3 each] (3.0)

REFERENCE
Technical Specifications, Fig. 6.1-3

ANSWER 8.02 (3.00)

a. 1. Reactor is subcritical
2. Mode switch is in Shutdown or Refuel
3. Reactor is vented
4. TIP system is out of service
[4 required @ 0.5 each] (2.0)

b. May be waived for management personnel [0.5], provided permission from the Operating Assistant Superintendent has been obtained [0.5]. (1.0)

REFERENCE
QAP 1150-2, Rev. 6, Access to the Drywell or Suppression Chamber; pg. 1,2

ANSWER 8.03 (3.00)

a. 1. The procedure is a new procedure being implemented with the temporary procedure request sheet. (.75)
2. The temporary change to a permanent procedure is "less conservative" with respect to T.S. or the FSAR. (.75)
3. The temporary change alters the content or order of the "principle" steps. (.75)

b. Tech. Staff Supervisor and (.25)
Op. Asst. Superintendent OR Operating Engineer and (.25)
Station Superintendent (.25)

REFERENCE
Technical Specifications, Proc. Org. Lesson Plan; pg. 12
QAP 1100-T1, Rev. 1

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 8.04 (2.00)

T.S. 3.5.C.2 [0.5] states that if HPCI is found to be inoperable for any reason, continued reactor operation is permissible only during the succeeding 7 days provided that during such 7 days ADS is tested [0.5]. By ADS not being operable, 3.5.C cannot be met and 3.5.C.3 [0.5] states an orderly shutdown shall be initiated, and the reactor pressure shall be reduced to 90 psig within 24 hours [0.5]. (2.0)

REFERENCE
Technical Specifications, 3.5/4.5, pg. 4,5

ANSWER 8.05 (3.00)

a. Can be used as long as the detector is connected into the proper circuitry which contains the required rod blocks. (1.0)

b. 1. No more than two fuel assemblies are present in the core quadrant associated with the SRM. AND (1.0)
2. While in core, these fuel assemblies are in locations adjacent to the SRM. (1.0)

REFERENCE
Technical Specifications, 3.10/4.10, pg. 2

ANSWER 8.06 (2.00)

a. The feedwater flow interlock enforces the minimum power line. (1.0)

b. The minimum power line prevents cavitation of the recirc pumps [0.5] during low power operation [0.5]. (1.0)

REFERENCE
Recirc Sys. Lesson Plan, Rev. 1/84, pg. 28

ANSWERS -- QUAD CITIES 1&2 -84/11/14-HILL, D.

ANSWER 8.07 (2.50)

a. Master Out-of-Service (0.5)

b. Immediate supervisor OR somebody of higher authority with respect to the work involved [0.5] after having made sure no one will be endangered by the operation of the equipment [0.5]. (1.0)

c. To check with all other persons having out-of-service cards on the equipment to get clearance for the temporary lift for testing. (1.0)

REFERENCE
QAP-300-14, Equipment Out-of-Service, Rev. 6, pg. 5,6
QAP-300-13, Tagging Equipment, Rev. 5, pg. 1

ANSWER 8.08 (3.00)

a. Pool temperature reduced to below normal power operation limit (95 degrees F.) [0.5] within 24 hours [0.5]. (1.0)

b. Scram reactor [1.0](and reduce pool temperature below the normal power operation limit of 95 degrees F.) (1.0)

c. Depressurize to less than 150 psig [0.5] at normal cooldown rates [0.5]. (1.0)

REFERENCE
Technical Specifications, 3.7/4.7, pg. 2,3

ANSWER 8.09 (3.50)

a. Provided no other rod has a:
   1. Inoperable accumulator. (.66)
   2. Directional control valve electrically disarmed while in a non-fully inserted position. (.67)
   3. Scram insertion time greater than maximum permission insertion time. (.67)

b. The reactivity equivalent of the difference between the actual critical rod config. and the expected config. during power operation.[1.0] It shall not exceed 1% dk.[0.5] (1.5)

REFERENCE
Technical Specifications 3.3/3.4-5