U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-263/OL-85-01

Docket No. 50-263

Licensee: Northern States Power
414 Nicollet Mall
Minneapolis, MN 55401

Facility Name: Monticello

Examination Administered At: Monticello, MN

Examination Conducted: Week of July 8, 1985

Examiners: E. Plettner — 8/23/85 Date

J. Morgan — 8/23/85 Date

Approved By: J. I. McMillen — 8/23/85 Date

Examination Summary

Examination administered on July 8-12, 1985 (Report No.55-263/OL-85-01)
Examinations were administered to six candidates.
Results: Four candidates passed the examinations.

REPORT DETAILS

1. Examiners

   E. Plettner, Region III, Chief Examiner
   T. Morgan, EG&G

2. Examination Review Meeting

   At the conclusion of the written exam, the examiners met with plant staff to review the RO and SRO written exams. Attachments A and B contain the resolution of the facility comments on the RO and SRO examinations, respectively.

3. Exit Meeting

   At the conclusion of the site visit, Mr. E. Plettner met with the plant staff to indicate those candidates who clearly passed the oral and simulator examination.

ATTACHMENT A

Resolution of Facility Comments
Monticello RO Examination
July 9, 1985

Question 1.02:

Facility Comment: Answer may be referenced to (SIC) to c. 2, page 21

Resolution: Comment acknowledged. No change to answer necessary.

Question 1.05b:

Facility Comment: May answer as if <450 psig where as pressure increases, critical power increases.

Resolution: Comment accepted and answer modified to accept the answer with the qualification.

Question 2.02b:

Facility Comment: May get -48" for low-low level setpoint per technical specifications.

Resolution: Comment acknowledged; because setpoints were not required in the answer, the answer key was not modified.

Question 2.04c:

Facility Comment: RMW LP. pg. 11.

Resolution: Comment accepted and answer key modified to accept the definition of alternate withdrawal limit for a possible answer.

Question 2.06b:

Facility Comment: May get #1 AR transformer locked out per B9.6, pg. 12.

Resolution: The comment was incorporated into the answer key and accepted as a possible answer.

Question 2.07:

Facility Comment: Look at objectively when grading.

Resolution: Comment acknowledged; the facility did not provide additional references concerning the answer on the master key and, therefore, no change to answer is necessary.

Question 2.08a:

Facility Comment: Fourth condition for lo-lo set is SRV discharge line d/p less than 50 psid.

Resolution: The comment was incorporated into the answer key and accepted as a possible answer.

Question 3.05:

Facility Comment: a. Only have a couple LPRM's (≥170) have U-234.

Resolution: Comment acknowledged; no change to answer necessary.

Facility Comment: b. One of the indications which the operators use at the plant is a piece of tape placed over the thumbwheel. Also P-1 indicates which LPRM's are bypassed.

Resolution: Comments accepted and answer key modified to accept as a possible answer.

Facility Comment: c. Rod Block monitor back panel, APRM back panel four rod display on C05.

Resolution: Comment accepted and answer key modified to accept as a possible answer.

Question 3.07:

Facility Comment: Question should be deleted, system is not operational, the operator has no available indication available to him, and only the detectors have been installed.

Resolution: The examiner did not know the system was not operational when the exam was prepared. Because the system is not operational, the question was deleted.

Question 4.01:

Facility Comment: May give the answer for when the shift supervisor shall initiate SBLC: control rods have not fully shutdown the reactor and either:

1. Power is increasing as indicated by nuclear instruments and steam flow, or

2. Calculations indicate that criticality will occur within 1 hour, or

3. A hazard exists to plant, personnel, or environment as determined by ranking supervisor in the control room. Ref.: C.4, pg. 70.

Resolution: Comments acknowledged no change to the answer key necessary because the SRO requirements are not being asked on the RO exam.

Question 4.02:

Facility Comment: The question does not lead the examinee to the answer. They may key in on low pressure ECCS injecting.

Resolution: Not accepted because the question asks for all of the automatic actions per the Primary Containment procedure.

Question 4.08:

Facility Comment: "B" and "c" for conditions state, both (SIC) list on c.4, pg. 156 and c.4, pg. 161 apply.

Resolution: Not accepted because, point "b" is asking for auto controller (all) and part "c" is asking for ECCS systems being shut off and cannot be combined.

ATTACHMENT B
Resolution of Facility Comments
Monticello SRO Examination
July 9, 1985

Question 5.05:

Facility Comment: Answer may have departure from nucleate boiling for onset of transition boiling.

Resolution: Comment accepted. No change to answer key needed as DNB and OTB are the same.

Question 5.07:

Facility Comment: The question as written is asking for the reactivity contribution from voids not for total reactivity feedback from all sources as is expressed in the answer.

Resolution: Comment accepted; however, it was agreed that to answer the question as stated would require discussion of the feedback from other sources. No change to answer key.

Question 5.10:

Facility Comment: Answer "d" is correct. The required suction head for the pump would be less; however, the available suction head will increase.

Resolution: Comment accepted and answer key changed to "d" since question did not specify ideal condition.

Question 6.02:

Facility Comment: May receive 460 psig as answer to setpoint instead of 450.

Resolution: Comment accepted. No change on answer key.

Question 6.03c:

Facility Comment: Answer states 45% which is the minimum setting; however, the setting could be up to 105%.

Resolution: Comment accepted and answer key changed to a range of 45% to 105%.

Question 6.10:

Facility Comment: Answer key shows answer for only open cycle; however, question doesn't state for open cycle only. Other possible answer in reference material provided.

Resolution: Comment accepted and answer key changed to accept other answers provided in reference material.

Question 7.04:

Facility Comment: Answer contains pump discharge bypass valves which have been removed from the system. Reference material provided.

Resolution: Comment accepted and answer key changed to correct answer.

Question 7.10:

Facility Comment: Answer "b" should be accepted Carcinogen based on reference material provided.

Resolution: Comment accepted and answer key changed to correct answer.

Question 8.01b:

Facility Comment: Answer "b" can be Site Superintendent which is a new position in addition to Shift Superintendent. Site Superintendent can perform many of the same duties as Shift Superintendent. Reference material provided.

Resolution: Comment accepted and answer key changed to accept Site Superintendent as possible answer.

Question 8.02b:

Facility Comment: Answer "b" can be to issue a volume F memo which supersedes management memo. Reference material provided.

Resolution: Comment accepted and answer key changed to accept Volume F memo as possible answer.

Question 8.06:

Facility Comment: Answer only pressurizing station will not depressurize the loop. Each loop has two stations plus the loops are crosstied.

Resolution: Comment noted, but no change to answer key since the question asked was dealing with Technical Specification requirement on operability.

Question 8.09:

Facility Comment: Answer "e" is not an action to take. Also question is three points, however, answers total is only 2.5 points.

Resolution: Comment accepted. Agreed that answer "e" is not an action in the usual usage of the world. Answer "e" is not to take action until authorized to do so. The point value discrepancy was resolved by increasing answer (a) by (0.5). The answer key was changed to the increased value.

Question 8.11:

Facility Comment: Answer "c" and "e" to include senior shift supervisor with Shift Superintendent reference material provided.

Resolution: Comment accepted and answer key changed to include Senior Shift supervisor as possible answers in "c" and "e."

Reviewed by:

1.

2.

3.

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

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FACILITY: MONTICELLO

REACTOR TYPE: BWR-GE3

DATE ADMINISTERED: 85/07/09

EXAMINER: MORGAN, T.

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~~ 25.51	________	________	1. PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW
25.00	~~25.00~~ 25.51	________	________	2. PLANT DESIGN INCLUDING SAFETY AND EMERGENCY SYSTEMS
~~25.00~~ 23.00	~~25.00~~ 23.47	________	________	3. INSTRUMENTS AND CONTROLS
25.00	~~25.00~~ 25.51	________	________	4. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL
~~100.00~~ 98.00	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 1.01 (3.00)

With regard to moderator temperature coefficient answer the following questions:

a. Per degree change in the moderator temperature, WHEN is more reactivity added, at 50 F or 200 F? Explain your choice. (1.5)

b. HOW and WHY does the core age affect the coefficient? (1.5)

QUESTION 1.02 (2.00)

Explain HOW it is possible to see reactor power DECREASE, when a control rod is withdrawn two notches.

QUESTION 1.03 (3.00)

Explain what happens in the core and WHY, when recirculation flow is DECREASED, while at power and with no control rod movement.

QUESTION 1.04 (3.00)

Indicate HOW each of the coefficients are effected [Increase, Decrease or Remain the same] by each of the three parameters listed? Consider each parameter seperately.

a. Rod Worth (delta K/K/Bank) by:
   1. Moderator temperature INCREASES
   2. Voids DECREASE
   3. Fuel temperature INCREASES [3 @ 0.33 ea]

b. Alpha Doppler (delta K/K/ F fuel) by:
   1. Core age INCREASES
   2. Fuel temperature DECREASES
   3. Voids DECREASE [3 @ 0.33 ea]

c. Alpha Voids (delta K/K/ % voids) by:
   1. Fuel temperature INCREASES
   2. Core age INCREASES
   3. Control Rod Density INCREASES [3 @ 0.33 ea]

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

QUESTION 1.05 (1.50)

For each condition (a-c) given below, indicate whether it will cause an INCREASE, a DECREASE, or have NO EFFECT on CRITICAL POWER:

a. Increasing fuel bundle flow (0.5)

b. Increasing coolant pressure (0.5)

c. Increasing inlet subcooling (0.5)

QUESTION 1.06 (2.00)

For each of the events listed below, state which reactivity coefficient will respond first, why it responds first, and whether it adds positive or negative reactivity.

a. SRV opening at 100% power (1.0)

b. Rod drop from 100% power (1.0)

QUESTION 1.07 (2.50)

Describe the operating principles of the jet pump used in your recirculation system.

QUESTION 1.08 (3.00)

Describe HOW and WHY a centrifugal pump's discharge head is affected for each of the following. (Consider each condition seperately and assume NPSH is maintained in all cases.)

a. Suction pressure increases. (1.0)

b. The discharge valve is throttled closed. (1.0)

c. The temperature of the fluid, being pumped, increases. (1.0)

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

QUESTION 1.09 (2.00)

Match four (4) of the following eight terms with its definition.

TERMS:

a. Cavitation

b. Pump runout

c. Head

d. Shutoff head

e. Water Hammer

f. Recirculation Ratio

g. Net Positive Suction Head

h. Pipe Whip

DEFINITIONS:

1. The quantity utilized as a measure of how close the system fluid is to saturation conditions.

2. The pressure developed when a pump is filled with fluid to be pumped and operated at normal speed with its discharge valve shut.

3. When insufficient pressure at the inlet to a pump results in the static pressure being less than the staturation pressure of the fluid, the liquid begins to boil, forming thousands of tiny vapor pockets, which collapse when in the region of higher pressure.

4. The resultant loss of back pressure on the pump causes the impeller to increase in speed. The pump motor amps increase as impeller speed and the high current can damage the motor windings.

[4 @ 0.5 ea] (2.0)

QUESTION 1.10 (3.00)

Match the FAILURE MECHANISM and the LIMITING CONDITIONS to the associated POWER DISTRIBUTION LIMITS (A-C) below. (Example D-4-W)

POWER DISTRIBUTION LIMITS

A. Linear Heat Generation Rate [LHGR]
B. Average Planer Linear Heat Generation Rate [APLHGR]
C. Minimum Critical Power Ratio [MCPR]

FAILURE MECHANISM	LIMITING CONDITIONS
1. Fuel Clad Cracking Due to Lack of Cooling Caused by DNB	x. Limit Clad Temp to 2200 F
2. Fuel Clad Cracking Due to High Stress from Pellet Expansion	y. Prevent Transient Boiling
3. Gross Clad Failure Due to Decay Heat and Stored Heat Following a LOCA	z. 1% Plastic Strain

(***** END OF CATEGORY 01 *****)

QUESTION 2.01 (3.50)

In order for the Residual Heat Removal system to accomplish the function for each of its modes, it can take a suction from four (4) sources and discharge to nine (9) areas.

a. WHAT are three (3) of the suction sources? (1.5)

b. With the crosstie open, WHAT are four (4) of the nine (9) areas that each loop is capable of suppling water? (2.0)

QUESTION 2.02 (3.50)

Answer the following questions regarding the Main Steam System.

a. 1. WHAT are two (2) functions of the flow restrictors? (1.0)

2. What control and protection features use the output from the restrictors? (0.5)

b. When in Startup, WHAT are the four (4) parameters, if exceeded, that will cause the MSIV's to automatically isolate? [Setpoints not required] (1.0)

c. Describe, in detail, how the MSIV closes if the exercise push-button is depressed. (1.0)

QUESTION 2.03 (2.00)

While operating at 75% power, with all systems in their normal at power lineup, a steam flow elements fails low. Describe the transient this will cause on the reactor level control system.
Assume no reactor scram and no operator action.

QUESTION 2.04 (3.00)

When discussing the Rod Worth Minimizer (RWM) software, WHAT is meant by each of the following and WHAT is shown on the RWM display panel when each has occured or is in progress?
[Examples can be used.]

a. The computer functions in an operator follower mode. (0.75)

b. Selection Error (0.75)

c. Error Threshold (Explain both insert and withdrawal) (0.75)

d. Transition Zone. (0.75)

QUESTION 2.05 (3.00)

When a scram signal occurs at power, describe IN DETAIL how the Control Rod Drive and its associated Hydraulic Control Unit function to insert the control rod. As a MINIMUM in your answer include which components open, close, energize, deenergize, and motive force for the entire rod travel.

QUESTION 2.06 (3.50)

Answer the following questions about the Emergency Diesel Generators.

a. What happens when each of the below starting singals are initiated?
   1. Local Manual [0.5]
   2. Remote Manual [0.5]
   3. Emergency Automatic [1.0] (2.0)

b. What six (6) conditions must be satisfied for automatic closure of ACB 152-602 (4.16 KV source breaker to supply bus 16 from #12 diesel generator)? (1.5)

QUESTION 2.07 (2.00)

For the following situations concerning the Reactor Water Cleanup (RWCU) system, WHAT will be the Adverse result of each situation below?

a. RWCU is being operated in the reject mode to the main condenser, when a RWCU system isolation occurs and the Excess Flow to Condenser valve (MO-2404) is not promptly shut by the operator. (1.0)

b. During operations at 50% Reactor Power, both the Excess Flow to Condenser valve (MO-2404) and Excess Flow to Waste Surge Tank (MO-2405) are opened simultaneously while changing Excess Flow discharge path. (1.0)

QUESTION 2.08 (2.50)

a. WHAT are the three (3) conditions necessary for the low-low set SRV's to automatically open? (1.5)

b. After the low-low set SRV has opened, WHAT would you expect to see before the valve can auto open again? (Assume normal operation.) (1.0)

QUESTION 2.09 (2.00)

What are four (4) of the five (5) loads on the recirculation pump motor that are cooled by Reactor Building Closed Cooling Water System (RBCCW)?

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

(3.5)

QUESTION 3.01 (3.00)

Answer the following questions on the Core Spray Cooling System:

a. WHAT are all the plant conditions that will cause an automatic initiation? (1.5)

b. If the torus temperature reaches 130 F, the inboard isolation valve must be manually throttled, WHY and to WHAT flow rate? (0.5)

c. There is instrumentation provided to initiate an alarm in the event of a break in the core spray piping. Specifically, WHAT section of piping is monitored and HOW is the monitoring accomplished? (1.0)

d. WHY is there a 450# interlock between the discharge inboard and outboard isolation valves? (0.5)

QUESTION 3.02 (3.00)

Describe the reactor core isolation cooling (RCIC) system RESPONSE and WHY the system response as it does. Consider each item seperately. Assume the failure is present prior to the system receiving an initiation signal and all other system components function properly.

a. The ramp generator is failed at minimum. (1.5)

b. The equalizing valve on the flow controller dP cell is open. (1.5)

QUESTION 3.03 (3.00)

For each of the following conditions, describe the response of the recirculation system. Assume the plant is in a normal configuration lineup and controlling at 30% power.
(Consider each condition seperately.)

a. One of the individual manual/automatic transfer stations is placed in automatic. (1.0)

b. A MG set tachometer fails resulting in a zero indication. (1.0)

c. The switch for one of the loop discharge valves is monentarilly placed in the close position, then to the open position, then released. (1.0)

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

QUESTION 3.04 (2.50)

a. What three (3) conditions will cause an INOP trip on an Average Power Range Monitor (APRM) channel? (1.5)

b. Why are APRM channels 2 and 5 or 1 and 6 left in the bypassed state when not otherwise needed? (1.0)

QUESTION 3.05 (2.50)

Answer the following questions concerning the Local Power Range Monitors.

a. What is used in the detector to extend the neutronic lifetime? (0.5)

b. Where are ~~the~~ three (3) indications that the thumbwheel mode selector switch is in the bypass position? (1.0)

-> c. Where is the signal of the flux amplifier fed when the mode seletor switch is in operate? (Four required for full credit.) (1.0)

QUESTION 3.06 (2.50)

The following statements can be used when explaining the relationship between the two linear scales used for IRM readings.
Complete the following statements. [5 @ 0.5 ea]

1. 10% reactor power corresponds to about __A__/125 on range 9.

2. There is a factor of __B__ difference between every other range.

3. If the same scales are used, there is a factor of __C__ between ranges; i.e., 30/125 on range 7 is equal to __D__/125 on range 6 and 35/40 on range 7 is equal to __E__/40 on range 8.

QUESTION 3.07 (2.50) Deleted

With regard to the Accidient Neutron Monitoring System (ANMS) answer the following questions.

a. WHAT are the two (2) functions of ANMS? (1.5)

b. Idenitify the two (2) types of monitors that make up the Wide Range Flux Monitor (WRFM) and HOW many of each type are utilized? (1.0)

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

QUESTION 3.08 (3.00)

The reactor is operating at 50% power when there is a sudden electrical load decrease of approximately 80 MWE (~15%) on the grid.
HOW will the Main Steam Pressure Control system compensate for this loss of load?
[Assume that all reactor systems are in their normal at power lineups, no reactor scram occurs and no operator action is taken.]
Limit your explanation to the response of the Main Steam Pressure Control system and take it to the final steady state conditions.

QUESTION 3.09 (3.00)

Regarding the LPCI LOOP SELECT LOGIC:

a. HOW does the logic determine how many recirc pumps are running? (0.5)

b. HOW does the logic determine which is the UNDAMAGED recirc loop? (1.0)

c. How does the logic select the loop if only one Recirc pump is running? (1.5)

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

QUESTION 4.01 (3.50)

a. WHEN must the Standby Liquid Control system be manually initiated? (1.0)

b. WHAT are the five (5) indications that the Standby Liquid Contol system has properly initiated (is injecting), after a manual initiation? (2.5)

QUESTION 4.02 (3.50)

According to the Primary Containment Isolation Procedure, when a reactor Low-Low level occurs and pressure is less than 450 psig, list all of the automatic actions that are to be verified.

QUESTION 4.03 (3.50)

a. What are three abnormal conditions that would require the use of the Emergency Power Reduction Procedure? (1.5)

b. In accordance with the Emergency Power Reduction procedure, HOW is power reduces? (2.0)

QUESTION 4.04 (2.50)

What are all of the primary and secondary indications, per C.4 Reactor, that indicate an ATWS event has occurred?

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

QUESTION 4.05 (3.00)

At what pressure will each of the following be performed or occur during a reactor startup from cold conditions?

a. The mechanical pressure regulator is allowed to open the Main Steam Bypass valve #1 to verify regulator operation.

b. The RCIC Automatic isolation signal is reset.

c. The HPCI Automatic isolation signal is reset.

d. The mechanical pressure regulator Override is adjusted to open the #1 Main Steam Bypass valve 10 - 15%.

e. Electric pressure regulator is verified to assume pressure control.

f. The Air Ejector Suction Isolation Valve Control Switch is placed in the Auto postion.

[6 @ 0.5 ea] (3.0)

QUESTION 4.06 (3.50)

In accordance with the approach to criticality steps in the cold startup procedure, C.1, answer the following.

a. What are the RO's required actions if criticality does not occur within the predicted critical rod pattern band indicated on Predicted Critical for Plant Startup form #2159? (0.75)

b. When is the reactor considered critical? (0.75)

c. What five (5) items are recorded, in the reactor log and on the predicted critical form, when criticality is established? (1.0)

d. What are three (3) ways, that reactor period may be determined? (Not read off period meter.) (1.0)

QUESTION 4.07 (2.00)

The requirements for personnel contamination monitoring states "Upon exiting a Contaminated area, individuals shall frisk themselves for presence of external contamination".

a. What is the definition of a contaminated area? (1.0)

b. At what count level is an indiviual determined to be externally contaminated and what actions are required if contamination is identified? (1.0)

QUESTION 4.08 (3.50)

Answer the following with regard to LOCA procedure, C.4.VII.

a. What are three (3) of the four (4) basic objectives the operator is to achieve in the event of a pipe break, with respect to the core and containment? (1.5)

b. What are two (2) conditions that can allow placing an automatic controller in manual during a pipe break inside or outside the containment? (1.0)

c. When, during a LOCA, can an emergency core cooling system be shut off? (1.0)

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

EQUATION SHEET

$f = ma$

$v = s/t$

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

$w = mg$

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

$E = mc^2$

$KE = 1/2\ mv^2$

$a = (V_f - V_o)/t$

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

$PE = mgh$

$V_f = V_o + at$

$w = \theta/t$

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

$W = v\ \Delta P$

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

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

$\Delta E = 931\ \Delta m$

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

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

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

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

$Pwr = W_f \Delta h$

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

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

$TVL = 1.3/\mu$

$HVL = -0.693/\mu$

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

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

$SUR = 26.06/T$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$I_1 d_1 = I_2 d_2$

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

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

$\Sigma = \sigma N$

$R/hr = (0.5\ CE)/d^2$ (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 = 3.7×10^{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 BTU = 778 ft-lbf

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ANSWER 1.01 (3.00)

a. 200 F [0.5] The moderator density change per degree F, at the higher temperature, is greater [1.0]. (1.5)

b. As core age increases alpha T decreases, (less negative) [0.5]. Control rods are withdrawn to compensate for fuel burnup (long term rod withdrawal). The Moderator to fuel ratio increases such that the plant is less undermoderated [1.0]. (1.5)

REFERENCE

Monticello, Reactor Theory L.P., BWR Inherent Reactivity Coefficients #M8102L-016 Rev 0 pg 8 & 12 of 53

ANSWER 1.02 (2.00)

The control rod being withdrawn is a shallow rod (<1/3 into the core, notch 32 to 48) [0.67]. When a shallow rod is withdrawn, the power rise in the area of the withdrawal will be large, the axial power increase will be limited due to shadowing [0.66]. The increased power will generate more steam bubbles which are then carried upward through the rest of the bundle. The increased void fraction in the top of the bundle will generally decrease the power in that region [0.67].

REFERENCE

Monticello, Reactor Theory L.P., BWR Inherent Reactivity Coefficients, #M8102L-016 Rev 0 pg 48 & 49 of 53

ANSWER 1.03 (3.00)

The boiling boundary moves down increasing the void fraction [0.5] This adds negative reactivity and power level starts to decrease [0.5]. As power decreases, the fuel and water cool raising the boiling boundary [0.5]. When the reactivity is balanced the boiling boundary will be at a lower level than initially [0.5] because the void coefficient (negative reactivity) must offset the positive reactivity added by the doppler coefficient [1.0].

REFERENCE

Monticello, Reactor Theory L.P., BWR Inherent Reactivity Coefficients, #M8102L-016 Rev 0

ANSWER 1.04 (3.00)

a.1. increase
a.2. increase
a.3. remains the same
b.1. increase
b.2. increase
b.3. decrease
c.1. increase
c.2. decrease
c.3. increase [9 @ 0.33 ea]

REFERENCE
Monticello, Reactor Theory L.P., # M8102L-043 Rev 0, Figure 43 pg 43 of 43

ANSWER 1.05 (1.50)

a. Increases (0.5)

b. Decreases (Increase if press <450 psig) (0.5)

c. Increases (0.5)

REFERENCE
Monticello Thermodynamics, Heat Transfer and Fluid Flow
pg. 9-85 to 9-89

ANSWER 1.06 (2.00)

a. Void coefficient [0.25], decreased pressure causes increased voids [0.5] would add negative reactivity [0.25] first. (1.0)

b. Fuel temperature coefficient [0.25], the rapid addition of positive reactivity due to rod removal causes power to increase and fuel temperature to increase [0.5] would add negative reactivity [0.25]. (1.0)

REFERENCE
Monticello Reactor Theory

ANSWER 1.07 (2.50)

In the nozzle, the high static head is converted to a high-velocity jet at a low static pressure [0.6]. The low pressure at the nozzle discharge draws the surrounding fluid into the throat where it is mixed [0.6]. A pressure rise occurs in the mixer section due to velocity profile rearrangement and momantum transfer in the mixing process [0.6]. The fluid enters a diffuser section which slows the relatively high velocity mixture and converts the dynamic head into static head [0.7].

REFERENCE
Monticello, Thermodynamics and Fluid Flow, ch 9 pg 38

ANSWER 1.08 (3.00)

a. Head increases [0.5] the pump is still putting the same amount of work into the fluid, therefore the same delta pressure increase across the pump, so as suction pressure increases so will the discharge head [0.5].
b. Head increases [0.5] as system resistance to flow increases, pump head increases [0.5].
c. Head decreases [0.5] as temperature increases system resistance to flow decreases (lower viscosity); therefore head decreases [0.5].

REFERENCE
Monticello, Thermodynamics and fluid flow ch 7 pg 111

ANSWER 1.09 (2.00)

a. - 3.
b. - 4.
d. - 2.
g. - 1.

REFERENCE
Monticello Heat Transfer and Fluid Flow, Ch 7 pg 9, 123 & 124

ANSWERS -- MONTICELLO -85/07/09-MORGAN, T.

ANSWER 1.10 (3.00)

PWR DIST LIMITS	FAILURE MECH	LIMITING COND	
A. LHGR	2	z	
B. APLHGR	3	x	
C. MCPR	1	y	
		[9 @ 0.33 ea]	(3.0)

REFERENCE
Monticello Thermodynamics and Fluid Flow ch 9 pg 70, 75, 77 & 78

ANSWER 2.01 (3.50)

a. 1. Torus Ring Header
   2. Condensate Storage Tank
   3. #11 Reactor Recirculation Loop
   4. Fuel Pool Skimmer Surge Tank (Temporary spool piece required).
   [3 @ 0.5 ea] (1.5)

b. 1. Reactor Vessel Head
   2. #11 Reactor Recirculation Pump Discharge piping
   3. #12 Reactor Recirculation Pump Discharge piping
   4. Upper Drywell Spray Header
   5. Lower Drywell Spray Header
   6. Torus Spray Header
   7. Torus
   8. Radwaste Surge Tank
   9. Fuel Pool Spargers (Temporary spool piece required)
   [4 @ 0.5 ea] (2.0)

REFERENCE
Monticello, System Description, B.3.4, Residual Heat Removal, pg 2 & 3

ANSWER 2.02 (3.50)

a. 1. The restrictors protect the fuel barrier by limiting the loss of water from the reactor vessel before the MSIV closure [0.25] in case of a main steam line rupture (outside the primary containment) [0.25]. The restrictors also serve as flow elements for the main steam flow instrumentation [0.5] (1.0)
   2. The restrictors instrumentation is used in the primary containment isolation [0.25] and reactor water level control system [0.25] (0.5)

b. 1. Reactor vessel low-low water level (-47 ")
   2. High steamline flow (120-129 psid)
   3. High temperature in the main steam line tunnel (195-200 F)
   4. High Radiation in the main steam line tunnel (5XNormal)
   [4 @ 0.25 ea] (1.0)

c. Depressing the exercise button (energizes a A-C solenoid valve) allowing air to a 3-way poppet valve [0.25] which interrupts the air supply to the MSIV air cylinger and vents the air cylinder (through a 1/2 inch exhaust restrictor) [0.25]. (Since no air pressure is applied to the top of the air cylinder,) the valve closing spring provides the main valve closing force [0.25]. (This combined with the restriction of the poppet valve in the venting path from the bottom of the air cylinder causes the MSIV closing speed to be much slower than normal) [0.25]. (1.0)

ANSWERS -- MONTICELLO -85/07/09-MORGAN, T.

REFERENCE
Monticello, System Description, B.2.4, Main Steam, pg 3, 12 & 13

ANSWER 2.03 (2.00)

The system will see (approximately 19%) a decrease in steam flow signal [0.5]. This results in the master controller calling for less feed and shutting down on the feedwater control valves [0.5]. Since the steaming rate is still at 75% the reactor water level will start to decrease developing a level error which will call for the feedwater control valves to be opened [0.5]. The level will continue to decrease until the level error signal developed offsets the steam flow feed flow mismatch [0.5].

REFERENCE
Monticello, System Description, B.5.7, Reactor Level Control, pg 24 & 32

ANSWER 2.04 (3.00)

a. By following the movement of control rods, the computer knows which group the operator is driving [0.~~25~~ 5], the appropriate group is displayed on the RWM display Panel [0.25]. When operating below the Low Power Set Point (LPSP), the computer displays the lowest possible group [0.25]. When operating in the transition zone, the group displayed is the highest possible group having less than three insert errors ~~[0.25]~~ (0.75)
b. The selection of a control rod inconsistent with the latched sequence [0.5]. The select error light will illuminate [0.25]. (0.75)
c. A rod is at the withdrawal error threshold when it is withdrawn one notch behond the nominal position [0.25]. A rod is at the insert error threshold when it is inserted two notches beyond the nominal position [0.25]. The rod at the threshold will be displayed in the insert or withdrawal error window. For withdrawal the withdrawal block light will illuminate [0.25]. (0.75)
d. The reactor power range is above the Power Level Set Point (PLSP) (20% of rated) and below the Power Level Alarm Point (PLAP) (35% of rated) [0.25]. While operating in the transition zone the RWM will display the highest possible group that could be latched with less than three insert errors. Existing insert errors will be identified on the RWM display panel [0.25]. If there are any withdrawal errors in this group, the Low Power Light on the RWM display panel will illuminate [0.25]. (The display will be updated every five seconds.) (0.75)

c. accept alternate withdrawal and insert limit - all are defined as being one notch position less than the corresponding nominal limit

REFERENCE
Monticello, System Description, B.5.2, Rod Worth Minimizer, pg 5, 7, 8 & 10
Lesson plan M8107L-001, pg 11

ANSWER 2.05 (3.00)

A scram signal deenergizes the scram pilot valves(0.5), venting air from the scram inlet and outlet valves, allowing them to open(0.5). This vents water from the overpiston area of the CRD to the SDV(0.5) and applies HCU accumulator water to the underpiston area of the CRD(0.5). This dp provides the initial motive force for the rod(0.5). As accumulator pressure drops below reactor pressure, a ball check valve in the CRD opens to apply reactor pressure to the CRD to complete the scram stroke(0.5).

REFERENCE
Monticello, System Description, B.1.3, CRD Hydraulic,

ANSWER 2.06 (3.50)

a. 1. Local manual start signal will cause both banks of starter motors to crank the engine. (0.5)
   2. Remote manual start signal will cause only the selected bank of start motors to crank the engine. (0.5)
   3. Emergency automatic start signal causes:
      i. One bank of dual air start motors (selected) to crank the engine. [0.33]
      ii. After a 1/2 sec pause, both banks of dual air start motors crank the engine. [0.33]
      iii. After a 1/2 sec pause, the other bank of dual air start motors (opposite of i) crank the engine. [0.33] (1.0)

b. 1. Diesel generator at voltage.
   2. # 1 AR transformer deenergized (or locked out)
   3. All source breakers to the bus are open (ACB's 152-610, 601, 408)
   4. Bus and breaker lockout relays reset (186-6 and 186-602)
   5. Breaker control switch on C08 in auto
   6. Bus transfer lockout switch in Set Up [6 @ 0.25 ea] (1.5)

REFERENCE
Monticello, System Description B.9.8, Diesel Generators, pg 10 & 15

ANSWER 2.07 (2.00)

a. Flashing, depressurizing and water hammer in the RWCU with Excess Flow Control valve (MO-2403) cycling due to the 5 psig pressure trip. (1.0)
b. During power draining operations, the condenser vacuum can be lost due to the direct flow path to atmosphere via radwaste. (1.0)

REFERENCE
Monticello, System Description, B.2.2, RWCU, pg 21 and print M-128

ANSWER 2.08 (2.50)

a. 1. Reactor Scram
   2. Reactor Pressure is greater than setpoint
      [1040 psig-opens SRV H, 1050 psig-opens SRV H & G, and
      1060 psig-opens SRV H, G & E] 4. < 50 psid in SRV discharge pipe
   3. Control switches are in automatic X [3 @ 0.5 ea] (1.5)
b. After an 80 psig blowdown of reactor pressure the valve will close [0.34]. After the discharge line pressure decreases to 50 psig (valve closure is detected) [0.33] a time delay relay prevents reopeing of the SRV for at least 10 sec [0.33]. (1.0)

REFERENCE
Monticello, System Description, B.3.3 Auto Press Relief, pg 13

ANSWER 2.09 (2.00)

1. Motor upper thrust and guide bearing cooler
2. Motor lower guide bearing cooler
3. Lower seal system heat exchanger
4. Seal region cooling jacket
5. Upper seal system heat exchanger [4 @ 0.5 ea] (2.0)

REFERENCE
Monticello, System Description, B.1.4, Recirculation Sys, pg 9

ANSWERS -- MONTICELLO -85/07/09-MORGAN, T.

(3.5)

ANSWER 3.01 (3.00)

a. High drywell pressure [0.25] of >2 psig [0.25]
OR
Low-Low Reactor Water Level [0.25] of -48" (6'7" above active core) [0.25]
AND
Low Reactor Vessel Pressure [0.25] of 450 psig [0.25] (1.5)

b. To prevent pump cavitation [0.25] 3800 gpm [0.25] (0.5)

c. Core spray piping between the vessel and the shroud [0.25]. One side of a dP switch sees the pressure above the core plate. The other side sees the pressure in the core spray line at the vessel wall [0.25]. If the core spray line is intact the dP across these points will be about zero since the sparger line is only open at its nozzles which are also located inside the core shroud above the core [0.25]. If the line has a leak in the area between the vessel and the shroud, the dP across the core shroud will be seen, initiating the alarm [0.25]. (1.0)

d. To prevent high pressure coolant from entering the low pressure piping of the core spray cooling system. (0.5)

REFERENCE
Monticello, System Description, B.3.1, Core Spray Cooling, pg 1, 6 & 19

ANSWER 3.02 (3.00)

a. (With the ramp generator failed at minimum) the turbine speed will increase to 2000 rpm and remain constant [0.5] because the low signal selector selects whichever signal at its input is calling for minimum turbine speed, (i.e., either the ramp generator or signal converter) and passes that signal on to the EG-M control box. The ramp generator is calling for 2000 rpm (min) and the signal converter is calling for maximum speed [1.0]. (1.5)

b. (With the flow controller indicating zero flow) the turbine would increase speed to its maximum (horse power limited or may trip on overspeed) [0.5] because the flow controller would be calling for max flow, the turbine would ramp up in speed following the ramp generator signal because it is the lower signal to the low signal selector. Also the min flow valve will remain open because of the less than 40 gpm signal [1.0]. (1.5)

REFERENCE
Monticello, System Description, B.2.3, RCIC, pg 10

ANSWER 3.03 (3.00)

a. The effected recirc pump will start increasing its speed (at 2%/sec) until it is operating at the master controller's min setting of 45%. (1.0)

b. The effected recirc pump will increase speed until its control signal increases above 32% then the mismatch of >10% will cause a scoop tube lockup. (1.0)

c. The discharge valve will commence closing and at (<10%) open, the drive motor breaker trips open, shutting down the effected recirc pump. (1.0)

REFERENCE
Monticello, System Description, B.1.4, Recirculation System, pg 5, 29 & 75

ANSWER 3.04 (2.50)

a. 1. The number of LPRM input signals below the required minimum.
   2. APRM channel mode switch out of the operate position.
   3. Removal of any of the modular plug-in APRM circuit boards.
   [3 @ 0.5 ea] (1.5)

b. The LPRM's of APRM's 1 and 5 and APRM's 2 and 6 are shared, it is possible to have a failure that can trip both scram channels. (For instance, an LPRM that fails high in APRM 1 may fail high enough to bring both APRM's 1 and 5 to the scram setting.) (1.0)

REFERENCE
Monticello, System Description, B.5.1.2, Power Range Monitoring, pg 16, 19 & 20

ANSWER 3.05 (2.50)

a. U234 is added to the coating (0.5)
b. 1. Bypass light on panel C37 ~~[0.33]~~, 2. in the four-rod group display [~~0.33~~] ~~and~~ 3. the LPRM Bypass indicator on the APRM front panel meter ~~[0.33]~~. 4. tape on thumbwheel, 5. P-1 printout (3 @ 0.33 ea) (1.0)
c. 1. LPRM upscale trip circuit.
   2. LPRM downscal trip scircuit.
   3. The associated APRM channel.
   4. Plant Process computer (analog input).
   5. Rod Block Monitor. [4 @ 0.25 ea] (1.0)
   6. four rod display on C05

REFERENCE
Monticello, System Description, B.5.1.2, Power Range Monitoring, pg 3, 6 & 7

ANSWER 3.06 (2.50)

a. 80 =/-10
b. 10
c. square root of 10
d. 95
e. 11

REFERENCE
Monticello, System Description, B.5.1.1 Startup Range Monitors, pg 18

ANSWER 3.07 (2.50) Deleted

a. 1. Provide the RO with power level indication under all conditions (excepting loss of both 1 E AC power supplies), including LOCA (fully qualified). [0.75]
   2. Provide the RO with an alternate reactor water level indication (at 1.5 ft and 4 ft blow TOAF). [0.75] (1.5)
b. Two [0.25] extended range startup monitors [0.25] and two [0.25] local power range monitors [0.25]. (1.0)

REFERENCE
Monticello, System Description, B.5.1.3 Accidient Neutron Monitoring System, pg 1

ANSWER 3.08 (3.00)

With the sudden load decrease the turbine/generator would increase speed. This would upset the balance of summer #3 [0.5]. (As turbine speed increases) this decreases the output of the summer to the speed governor [0.25]. The speed governor in turn would start decreasing its signal to LVG 2 which would be the controlling signal because the load limit is at 100% [0.25]. The turbine error will have to continue to increase until it demands for less control valve position than the pressure control [0.5]. At approximately 45 rpm overspeed, the signal will become the controlling signal for LVG 3 and start closing the control valves [0.5]. When this occurs the pressure control signal will start to increase and when the difference between the control valve and the pressure control signal is 3% the bypass valves will start to open [0.5]. Bypass valves will open about 12% and the control valves will close by the same amount [0.5]. The turbine speed will be approximately 1856 rpm.

REFERENCE
Monticello, System Description, B.5.9, Main Steam Pressure Control, pg 9 & Figure 3

ANSWER 3.09 (3.00)

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

b. By comparing the pressure in the riser pipes on one recirc loop with the pressure in the riser pipes of the other loop. The undamaged loop will have a higher pressure than the damaged loop. (1.0)

c. If only one recirc pump is running, the operating pump is tripped. (This closure causes maximum pressure differential to be developed between the two loops) An interlock (is provided which prevents any futher action) until reactor pressure decreases to 900 psig [0.5]. (Once pressure permissive interlock is satisfied,) the loop select signal reaches the 2 second time delay (to develope full differential press), then a 0.5 second time delay is initiated (while the break detection circuit is checked)[0.5]. The riser dP indicates (which loop is not broken or) loop # 12 if neither is broken that will be selected for LPCI injection [0.5]. (1.5)

REFERENCE
Monticello, System Description, B.3.4, Residual Heat Removal, pg 16 & 17

ANSWERS -- MONTICELLO -85/07/09-MORGAN, T.

ANSWER 4.01 (3.50)

a. The control rod system is unable to maintain the reactor in a subcritical condition [0.34]

AND

RPV water level cannot be maintained [0.33]

OR

Suppression pool water temperature cannot be maintained below the scram temperature limit. [0.33] (1.0)

b. 1. The red pump running light is on
2. The white squib indicating light is out
3. The standby liquid control tank level is decreasing
4. Neutron flux is decreasing (may show a slight increase initially)
5. Steam flow from the vessel is decreasing

[5 @ 0.5 ea] (2.5)

REFERENCE

Monticello, System Description, B.3.5, Standby Liquid Control, pg 20 & Abnormal Procedures C.4, Reactor Scram, pg 9

ANSWER 4.02 (3.50)

1. Verify reactor scram, groups 2 and 3 isolation and SGTS start occurred previously at reactor low level
2. Group I isolation
3. HPCI Initation
4. RCIC Initation
5. LPCI and CS pumps start if reactor pressure is below 450 psig
6. Diesels start
7. Reactor Recirc pumps and MG sets trip [7 @ 0.5 ea] (3.5)

REFERENCE

Monticello, Abnormal Procedure, C.4, Primary Containment Isolation, pg 23

ANSWER 4.03 (3.50)

a. 1. Activation of turbine runback circuitry
   2. Recombiner trip   or any reasonable reason to rapidly reduce pow
   3. Low condenser vacuum [3 @ 0.5 ea] (1.5)

b. 1. Reduce recirculation flow to minimum
   2. Insert the group of rods closest to being full-in.
      Insert the next group of rods closest to being full-in to 00.
   3. If all rods are full-out, insert the highest numbered group from 48 to 00.
   4. Trip recirculation pumps, if needed.
   [4 @ 0.5 ea] (2.0)

REFERENCE
Monticello, Abnormal Procedures, C.4, Emergency Power Reduction, pg 195 & 196

ANSWER 4.04 (2.50)

If two or more adjacent control rods [0.5] or thirty or more non adjacent control rods [0.5] fail to insert further than the 06 position [0.5] and the ATWS trip annunciators have alarmed [0.5]. Secondary indicators are containment high pressure and/or temp (containment radiation may also increase) [0.5]. (2.5)

REFERENCE
Monticello, Abnormal Procedures, C.4 Reactor Scram, ATWS event, pg 14

ANSWER 4.05 (3.00)

a. 150 psig
b. 80 psig
c. 130 psig
d. 500 psig
e. 900 psig
f. 200 psig [All pressures + or - 10%] [6 @ 0.5 ea] (3.0)

REFERENCE
Monticello, Startup Procedure, C.1, Heating and Pressurization, pg 34, 35, 36, 40 & 41

ANSWER 4.06 (3.50)

a. 1. Discontinue rod withdrawal
   2. Maintain the reactor subcritical
   3. Notify the Shift Supervisor [3 @ 0.25 ea] (0.75)

b. Neutron Flux rises [0.25] with a constant (stable) period [0.25] without additional control rod withdrawal [0.25]. (0.75)

c. 1. the time
   2. rod position
   3. period
   4. reactor water temperature
   5. srm reading [4 @ 0.25 ea] (1.0)

d. o Decade rise divided by 2.3 or multiplied by .435
   o Doubling time divided by .693 or multiplied by 1.445
   o Time for IRM scale reading to increase by a factor of 2.718
   [3 @ 0.33 ea] (1.0)

REFERENCE
Monticello, Startup Procedures, C.1, Cold Startup, Approach to Critical, pg 22

ANSWER 4.07 (2.00)

a. Contaminated area - any area, accessible to personnel [0.25], in which the smearable or readily removable beta activity is >/= 500 dpm/100 cm2 [0.25], the alpha activity is >/= 50 dpm/100 cm2 [0.25], or the fixed contamination, when measurable, is >/= 50,000 cpm [0.25], (measured with a thin-window GM pancake probe). (1.0)

b c. Contamination levels >/= 100 cpm above background levels are identified [0.34], take steps to minimize contamination spread [0.33] and contact the nearest available RPS [0.33]. (1.0)

REFERENCE
Monticello, Administrative Control, 4 AWI 11.1.5 pg 1 & 11.1.6 pg 10

ANSWER 4.08 (3.50)

a. 1. Maintain core cooling to prevent excessive cladding heatup and oxidation.
2. Limit the release of off-site radiation by maintaining the integrity of the primary and secondary containments.
3. Place the reactor in a safe, stable condition
4. Keep the suppression pool bulk temperature below 160 F to prevent excessive loads to the suppression pool boundary and structures during SRV discharges, and maintain peak allowable temperatures within cooling equipment and containment structure design limits. [3 @ 0.5 ea] (1.5)

b. 1. Misoperation in automatic mode is confirmed by at least two independent process parameter indications.
2. Core cooling is assured, and the procedures state specifically to do otherwise. [2 @ 0.5 ea] (1.0)

c. If there are multiple confirming process parameters indications that the core and containment are in a safe stable condition. (1.0)

REFERENCE
Monticello, Abnormal Procedures C.4, LOCA, pg 155, 156 & 157

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U.S. NUCLEAR REGULATORY COMMISSION
~~REACTOR~~ Senior OPERATOR LICENSE EXAMINATION

FACILITY Monticello

REACTOR TYPE: BWR-GE-3

DATE ADMINISTERED: July 9, 1985

EXAMINER: E. Plettner

APPLICANT: ________________

INSTRUCTIONS TO APPLICANT:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category and a final grade of at least 80%.

Category Value	% of Total	Applicant's Score	% of Category Value	Category
25	25	___	___	5. Theory of Nuclear Power Plant Operation, Fluids, and Thermodynamics
25	25	___	___	6. Plant Systems Design, Control, and Instrumentation
~~25~~ 24.5	25	___	___	7. Procedures - Normal, Abnormal, Emergency, and Radiological Control
25	25	___	___	8. Administravive Procedures, Conditions, and Limitations
100	100	___	___	TOTALS

Final Grade ____ %

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

____
Applicant's Signature

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

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

5.02 a. What is decay heat and how is it produced? (1.0)

b. Does this power INDICATE on the SRM instrumentation? WHY or WHY NOT? (1.0)

5.03 a. What is the significance of a rod that is HI-LITED and circled on the roller tape? (1.0)

b. What criteria are established to withdraw these rods? (1.0)

5.04 The tabulation below illustrates REACTIVITY COEFFICIENT VARIATIONS due to increases in several core parameters. For each condition (a-h) listed below, INDICATE on your answer sheet how the VALUE of that coefficient varies (MORE OR LESS NEGATIVE) if the indicated core parameter coefficient is INCREASED. (2.0)

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)	

5.05 a. What is the difference between critical heat flux and critical power? (1.0)

b. Which is more appropriate for BWR conditions and why? (By Tech Spec) (1.0)

5.06 a. Define: Net Positive Suction Head. (1.0)

b. What effect does increasing suction pressure have on cavitation? (1.0)

c. What effect does increasing fluid temperature have on cavitation? (1.0)

5.07 a. Power level is increased from 40 to 50 percent by increasing recirculation flow. Would you expect the steady state negative reactivity contribution due to voids to change between these two power levels? Explain. (2.0)

b. If the change was from 90 to 100 percent would it affect the magnitude of the change discussed in part a? Explain. (2.0)

5.08 a. What are two reasons to shape flux in a boiling water reactor? (1.0)

b. How is flux shaping accomplished in a boiling water reactor? (1.0)

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

a. 40

b. 160

c. 80

d. 120

5.10 A motor driven centrifugal pump is operating at rated flow. You start closing down the discharge valve. Which of the following statements best describes the parameter changes under rated conditions that will occur with this action? (1.0)

a. Flow remains constant, discharge pressure remains constant, motor amps increase, net positive suction head increases.

b. Flow decreases, discharge pressure increases, motor amps increase, net positive suction head increases.

c. Flow decreases, discharge pressure increases, motor amps decrease, net positive suction head decreases.

d. Flow decreases, discharge pressure increases, motor amps decrease, net positive suction head increases.

5.11 Boiling water reactors are designed to have "under moderated cores." Which statement best describes under moderated? (1.0)

a. The ratio of moderator to fuel is such that the temperature and void coefficient will both be the same (both positive or both negative).

b. The ratio of moderator/fuel is such that increasing moderator density increases K eff.

c. The ratio of moderator to fuel is such that the amount of under moderation increases during core life.

d. The ratio of fuel to moderator is such that increasing moderator density will decrease K eff.

5.12 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 (assuming NPSH remains constant) (1.0)

c. RCIC turbine RPM (1.0)

END OF SECTION 5 QUESTIONS

Section 6 - Questions - Plant Systems Design, Control, and Instrumentation.

6.01 Regarding the LPCI Loop Select Logic:

a. How does the logic determine how many recirculation pumps are running? (1.0)

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

c. If the logic determines that neither loop is damaged, WHICH LOOP WILL IT SELECT for LPCI injection? (0.5)

6.02 a. What signals (including setpoints) will automatically start the Core Spray Pumps? (1.5)

b. What protection to the Core Spray pump is provided until injection into the vessel takes place? (0.5)

c. If a Core Spray loop is to be isolated, following an initiation and a pump failure, why does the Outboard Isolation Bypass switch have to be taken to "Bypass" before closing the Outboard Isolation valve? (0.5)

d. How can the Core Spray pump be stopped if the initiation signal is still present? (0.5)

6.03 Concerning the Recirculation Flow Control System:

a. What are two (2) of the three (3) speed control components that use the speed signal from the MG set tachometer? (1.0)

b. What are two of the three conditions that will PREVENT a signal mismatch scoop tube lock? Include applicable setpoints. (1.0)

c. With the plant operating at >23% (greater than) power and minimum flow, an operator inadvertently shifts the M/A transfer station for recirc. pump "A" from "Manual" to "Auto." Assuming NO further operator action, BRIEFLY EXPLAIN what will happen to the speed of "A" recirc. pump. Continue your discussion to the final steady state speed. (1.0)

6.04 a. Explain the operation of the Feed Heater Level Control system for an Increasing Level in High Inter. Pressure Heater E-14A. Assume the level increase continues to the high level setpoint. (1.5)

b. Why are the condensate feedwater block valves interlocked to open the spill valves when the block valve is not fully opened? (1.0)

6.05 a. Describe the response of the TIP system, if performing TIP scans and a PCIS Group II isolation is activated. (1.5)

b. What is the purpose of the common channel? (0.5)

6.06 With regard to Reactor Protection System (RPS):

a. The term ONE-OF-TWO-TAKEN-TWICE logic could be used to describe the RPS logic system. What is meant by this term? (2.0)

b. Give two (2) reasons why this type of logic is used? (1.0)

6.07 a. List two (2) conditions that will cause the RWCU Excess Flow Control Valve (CV-2403) to AUTO CLOSE. Include setpoints. (1.0)

b. Should the RWCU Excess Flow Bypass valve (MO-2401) be open at high pressure? Explain your answer. (1.0)

c. What problem, if any, is associated with the RWCU Holding Pumps re-starting automatically after a loss of power to MCC's 22 and 32 for greater than 5 seconds? (1.0)

6.08 With regard to the Standby Liquid Control (SBLC) System:

a. What portion(s) of the SBLC system is "Heat Traced?" Why? (1.0)

b. Where does the relief valve on the pump discharge relieve to and why was this location chosen? (1.0)

6.09 Regarding the steam jet air ejectors:

a. What three (3) conditions will cause the suction valves to close? (1.5)

b. Why do the suction valves close under the conditions in (a) above? Two (2) required for full credit. (1.0)

6.10 What will cause a cooling tower pump to trip automatically? Two (2) required for full credit. (If used again make it open cycle) (1.0)

END OF SECTION 6 QUESTIONS

Section 7 - Questions - Procedures: Normal, Abnormal, Emergency, and Radiological Control.

7.01 What is the reason for each of the following precautions pertaining to the RHR system?

a. When starting the RHR pumps in the shutdown cooling mode, the pumps should not be run with the discharge valve closed for extended periods of time. (1.0)

b. Do not control the rate of reactor cooldown during the shutdown cooling mode of RHR by alternately stopping and starting the RHR Service Water pumps. (1.0)

7.02 a. List the conditions that will initiate an ATWS trip and the action(s) it produces. (1.0)

b. The ATWS event procedure instructs the LPE&RO to initiate the SBLC system if certain conditions exist. What are these conditions? (1.5)

c. Once SBLC is initiated when can you terminate the injection? WHY? (1.0)

7.03 List the two (2) reasons that prolonged operation in HOT STANDBY is undesirable AND EXPLAIN WHY each IS NOT a problem during power operations. (3.0)

7.04 The reactor is operating at high power when one recirculation pump trips. What actions should be taken and WHY (also assume the lower seal temperature increases to 193° F)? (~~3.5~~ 3.0)

7.05 a. Following a pipe break inside the primary containment, it is permissible to exceed the maximum reactor cooldown rate if it appears that WHAT CONDITION will be exceeded? (1.0)

b. What are four (4) available high pressure systems that can be used to try and maintain reactor vessel level following the LOCA? (1.0)

c. If vessel level cannot be maintained by the high pressure systems, what two (2) conditions should be verified prior to using the TURBINE BYPASS VALVES and main condenser to depressurize the reactor? (1.0)

7.06 WHAT ACTIONS MUST BE INITIATED during normal plant operation as SUPPRESSION POOL TEMPERATURE INCREASES to the following values?

a. 90°F (0.5)

b. 100°F while testing HPCI (0.5)

c. 110°F (0.5)

7.07 According to your fuel handling procedures, what three (3) actions are to be taken in the event of a dropped fuel assembly either in the fuel pool or the reactor vessel? (2.5)

7.08 According to your fire fighting procedures what are three (3) of the six (6) actions control room personnel perform upon receiving information that a fire exists? (1.5)

7.09 With regard to the main turbine:

a. Why should operation below 5% load be held to a minimum? (0.5)

b. What action must you take if ROTOR LONG as indicated on the red band on recorder 1717 is exceeded? (0.5)

c. What is the limiting parameter when making load changes from one steady state load to another? Include in your answer any alternative parameters that you are allowed to use. (0.5)

7.10 What are two (2) hazards that potassium chromates in the RBCCW system present to personnel during system maintenance? (1.0)

7.11 Concerning operation of the RWCU (Reactor Water Cleanup) system:

a. Why are you cautioned to closely monitor cleanup water temperature to the filter/demins during reactor startup? (1.0)

b. Why must the filter/demins be MANUALLY isolated prior to starting backwashing and precoating? (1.0)

END OF SECTION 7 QUESTIONS

Section 8 - Questions - Administrative Procedures, Conditions and Limitations.

8.01 Concerning the use of SAFETY TAGS:

a. What criteria is used to determine whether a HOLD CARD or a SECURE CARD should be used for a clearance? (1.0)

b. Whose is responsible for maintaining the HOLD and SECURE CARD record? (0.5)

c. Who must give FINAL APPROVAL for RELEASE of a HOLD CARD? (0.5)

8.02 a. List two conditions where a Plant Restart Checklist may be used. (1.0)

b. How are changes to the Control Rod Withdrawal Sequence implemented? (0.5)

c. If criticality WAS NOT achieved during a reactor startup and subsequent shutdown; under what condition would a startup NOT be assigned a new number? (0.5)

d. If a Reactor Protection System checklist for a specific reactor startup was STARTED at 0800, COMPLETED at 1500, and the REACTOR STARTUP COMMENDED at 2200; would the checklist be valid? EXPLAIN your answer. (1.0)

8.03 Briefly explain WHY each of the following RECIRCULATION SYSTEM LIMITATIONS are necessary.

a. With both pumps running, the speed of the faster pump may not exceed 130% of the speed of the slower pump for a core power less than 80%. (1.0)

b. The operating pump must be reduced to 50% speed or less prior to restarting the tripped pump. (1.0)

c. Recirculation flow shall not be increased unless the coolant temperature difference between the bottom head region and upper region of the vessel is less than 145°F. (1.0)

8.04 According to the TECHNICAL SPECIFICATIONS for the CONTROL ROD SYSTEM:

a. When must the RWM be operable? (0.5)

b. What restrictions are placed on rod withdrawal when a limiting control rod pattern exists? (0.5)

8.05 Regarding the TECHNICAL SPECIFICATION curves for MINIMUM TEMPERATURE FOR CRITICAL operation:

a. What could happen if critical operation was conducted at less than the minimum temperature specified? (1.0)

b. Is this temperature expected to change over core life and if so, why? (1.0)

8.06 For each of the following conditions, STATE WHETHER YOU WOULD CONSIDER THE APPLICABLE SYSTEM OPERABLE OR INOPERABLE per the Technical Specifications AND for each you consider inoperable, briefly STATE WHY you determined the system to be INOPERABLE (i.e., why it cannot perform its intended function).

a. The condensate pressurizing station for a LPCI loop is out of service. (1.0)

b. HPCI suction valves will not automatically shift to the Suppression Pool from the CST on high suppression pool level. They will shift automatically on low CST level. (1.0)

8.07 What is PRIMARY CONTAINMENT INTEGRITY according to the Technical Specifications? (2.5)

8.08 What are two (2) of the five (5) safety limits as identified in Technical Specifications? (2.0)

8.09 What actions shall be taken if a safety limit is exceeded as specified in Technical Specification? (3.0)

8.10 List four (4) scrams which must be OPERABLE when the reactor is subcritical, irradiated fuel is in the vessel, and the reactor temperature is less than 212°F. Include any applicable setpoints. (2.0)

8.11 Who, in order of succession, can assume the duties of operations Group Leader (Five (5) required for full credit)? (2.5)

END OF SECTION 8 QUESTIONS

$f = ma$

$v = s/t$

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

$w = mg$

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

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

$E = mc^2$

$KE = 1/2\ mv^2$

$a = (V_f - V_o)/t$

$A = \lambda N$

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

$PE = mgh$

$V_f = V_o + at$

$w = \theta/t$

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

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

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

$\Delta E = 931\ \Delta m$

$I = I_o e^{-Ex}$

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

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

$Pwr = W_f \Delta h$

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

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

$TVL = 1.3/\mu$

$HVL = -0.693/\mu$

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

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

$SUR = 26.06/T$

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

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

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

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

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

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

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

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

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

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

$\Sigma = \sigma N$

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

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

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

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

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

$I_1 d_1 = I_2 d_2$

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

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

Water Parameters

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

Miscellaneous Conversions

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

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

Press. psia	Temp. F	Volume, ft³/lbm Water v_f	Evap. v_{fg}	Steam v_g	Enthalpy, Btu/lbm Water h_f	Evap. h_{fg}	Steam h_g	Entropy, Btu/lbm × R Water s_f	Evap. s_{fg}	Steam s_g	Energy, Btu/lbm Water u_f	Steam u_g
1800.0	621.02	0.02472	0.19390	0.21861	648.5	503.8	1152.3	0.8417	0.4662	1.3079	640.3	1079.5
1780.0	619.47	0.02463	0.19734	0.22197	646.1	507.5	1153.6	0.8395	0.4703	1.3098	638.0	1080.5
1760.0	617.90	0.02454	0.20084	0.22538	643.7	511.2	1154.9	0.8374	0.4744	1.3118	635.7	1081.5
1740.0	616.33	0.02445	0.20442	0.22887	641.3	514.9	1156.2	0.8352	0.4785	1.3137	633.4	1082.5
1720.0	614.73	0.02437	0.20806	0.23243	638.9	518.5	1157.4	0.8331	0.4826	1.3157	631.1	1083.4
1700.0	613.13	0.02428	0.21178	0.23607	636.5	522.2	1158.6	0.8309	0.4867	1.3176	628.8	1084.4
1680.0	611.51	0.02420	0.21558	0.23978	634.0	525.8	1159.8	0.8287	0.4909	1.3196	626.5	1085.3
1660.0	609.87	0.02411	0.21945	0.24357	631.6	529.5	1161.0	0.8265	0.4950	1.3215	624.2	1086.2
1640.0	608.22	0.02403	0.22341	0.24744	629.1	533.1	1162.2	0.8243	0.4992	1.3235	621.8	1087.1
1620.0	606.55	0.02395	0.22745	0.25140	626.7	536.7	1163.4	0.8221	0.5034	1.3255	619.5	1088.0
1600.0	604.87	0.02387	0.23159	0.25545	624.2	540.3	1164.5	0.8199	0.5076	1.3274	617.1	1088.9
1580.0	603.17	0.02378	0.23581	0.25960	621.7	543.9	1165.7	0.8176	0.5118	1.3294	614.8	1089.8
1560.0	601.45	0.02370	0.24014	0.26384	619.2	547.6	1166.8	0.8153	0.5160	1.3314	612.4	1090.6
1540.0	599.72	0.02362	0.24456	0.26818	616.7	551.2	1167.9	0.8131	0.5203	1.3333	610.0	1091.5
1520.0	597.97	0.02354	0.24909	0.27263	614.2	554.8	1169.0	0.8108	0.5245	1.3353	607.6	1092.3
1500.0	596.20	0.02346	0.25372	0.27719	611.7	558.4	1170.1	0.8085	0.5288	1.3373	605.2	1093.1
1480.0	594.41	0.02338	0.25847	0.28186	609.1	562.0	1171.2	0.8061	0.5332	1.3393	602.7	1094.0
1460.0	592.61	0.02331	0.26334	0.28665	606.6	565.6	1172.2	0.8038	0.5375	1.3413	600.3	1094.8
1440.0	590.78	0.02323	0.26833	0.29156	604.0	569.2	1173.3	0.8014	0.5419	1.3433	597.8	1095.6
1420.0	588.53	0.02315	0.27345	0.29660	601.4	572.9	1174.3	0.7990	0.5463	1.3453	595.3	1096.3
1400.0	587.07	0.02307	0.27871	0.30178	598.8	576.5	1175.3	0.7966	0.5507	1.3474	592.9	1097.1
1380.0	585.18	0.02300	0.28410	0.30710	596.2	580.1	1176.3	0.7942	0.5552	1.3494	590.3	1097.9
1360.0	583.28	0.02292	0.28965	0.31256	593.6	583.7	1177.3	0.7918	0.5597	1.3515	587.8	1098.6
1340.0	581.35	0.02284	0.29534	0.31818	590.9	587.4	1178.3	0.7893	0.5642	1.3535	585.3	1099.4
1320.0	579.40	0.02277	0.30119	0.32396	588.3	591.0	1179.3	0.7868	0.5688	1.3556	582.7	1100.1
1300.0	577.42	0.02269	0.30722	0.32991	585.6	594.6	1180.2	0.7843	0.5733	1.3577	580.1	1100.9
1290.0	576.43	0.02265	0.31029	0.33295	584.2	596.5	1180.7	0.7831	0.5757	1.3587	578.8	1101.2
1280.0	575.42	0.02262	0.31341	0.33603	582.9	598.3	1181.2	0.7818	0.5780	1.3598	577.5	1101.6
1270.0	574.42	0.02258	0.31658	0.33916	581.5	600.1	1181.6	0.7805	0.5803	1.3608	576.2	1101.9
1260.0	573.40	0.02254	0.31980	0.34234	580.2	601.9	1182.1	0.7793	0.5826	1.3619	574.9	1102.3
1250.0	572.38	0.02250	0.32306	0.34556	578.8	603.8	1182.6	0.7780	0.5850	1.3630	573.6	1102.6
1240.0	571.36	0.02247	0.32637	0.34884	577.4	605.6	1183.0	0.7767	0.5874	1.3640	572.3	1103.0
1230.0	570.32	0.02243	0.32973	0.35216	576.0	607.4	1183.5	0.7754	0.5897	1.3651	570.9	1103.3
1220.0	569.28	0.02239	0.33314	0.35554	574.6	609.3	1183.9	0.7741	0.5921	1.3662	569.6	1103.7
1210.0	568.24	0.02236	0.33661	0.35897	573.2	611.1	1184.4	0.7728	0.5945	1.3673	568.2	1104.0
1200.0	567.19	0.02232	0.34013	0.36245	571.9	613.0	1184.8	0.7714	0.5969	1.3683	566.9	1104.3
1190.0	566.13	0.02228	0.34371	0.36599	570.5	614.8	1185.3	0.7701	0.5993	1.3694	565.5	1104.7
1180.0	565.06	0.02225	0.34734	0.36958	569.0	616.6	1185.7	0.7688	0.6017	1.3705	564.2	1105.0
1170.0	563.99	0.02221	0.35103	0.37324	567.6	618.5	1186.1	0.7674	0.6042	1.3716	562.8	1105.3
1160.0	562.91	0.02217	0.35478	0.37695	566.2	620.3	1186.6	0.7661	0.6066	1.3727	561.4	1105.6
1150.0	561.82	0.02214	0.35859	0.38073	564.8	622.2	1187.0	0.7647	0.6092	1.3738	560.1	1106.0
1140.0	560.73	0.02210	0.36247	0.38457	563.3	624.1	1187.4	0.7634	0.6115	1.3749	558.7	1106.3
1130.0	559.63	0.02206	0.36641	0.38847	561.9	625.9	1187.8	0.7620	0.6140	1.3760	557.2	1106.6
1120.0	558.52	0.02203	0.37041	0.39244	560.5	627.8	1188.2	0.7606	0.6165	1.3771	555.9	1106.9
1110.0	557.40	0.02199	0.37449	0.39648	559.0	629.6	1188.7	0.7592	0.6190	1.3783	554.5	1107.2
1100.0	556.28	0.02195	0.37863	0.40058	557.5	631.5	1189.1	0.7578	0.6216	1.3794	553.1	1107.5
1090.0	555.14	0.02192	0.38285	0.40476	556.1	633.4	1189.5	0.7564	0.6241	1.3805	551.7	1107.8
1080.0	554.00	0.02188	0.38714	0.40902	554.6	635.3	1189.9	0.7550	0.6266	1.3817	550.2	1108.1
1070.0	552.86	0.02184	0.39150	0.41335	553.1	637.1	1190.3	0.7536	0.6292	1.3828	548.8	1108.4
1060.0	551.70	0.02181	0.39594	0.41775	551.6	639.0	1190.7	0.7522	0.6318	1.3840	547.4	1108.7
1050.0	550.53	0.02177	0.40047	0.42224	550.1	640.9	1191.0	0.7507	0.6344	1.3851	545.9	1109.0
1040.0	549.36	0.02174	0.40507	0.42681	548.6	642.8	1191.4	0.7493	0.6370	1.3863	544.5	1109.3
1030.0	548.18	0.02170	0.40976	0.43146	547.1	644.7	1191.8	0.7478	0.6396	1.3874	543.0	1109.6
1020.0	546.99	0.02166	0.41454	0.43620	545.6	646.6	1192.2	0.7463	0.6423	1.3886	541.5	1109.9
1010.0	545.79	0.02163	0.41941	0.44103	544.1	648.5	1192.6	0.7449	0.6449	1.3898	540.0	1110.1
1000.0	544.58	0.02159	0.42436	0.44596	542.6	650.4	1192.9	0.7434	0.6476	1.3910	538.6	1110.4
990.0	543.36	0.02155	0.42942	0.45097	541.0	652.3	1193.3	0.7419	0.6503	1.3922	537.1	1110.7
980.0	542.14	0.02152	0.43457	0.45609	539.5	654.2	1193.7	0.7404	0.6530	1.3934	535.6	1111.0
970.0	540.90	0.02148	0.43982	0.46130	537.9	656.1	1194.0	0.7389	0.6557	1.3946	534.0	1111.2
960.0	539.65	0.02145	0.44518	0.46662	536.3	658.0	1194.4	0.7373	0.6584	1.3958	532.5	1111.5
950.0	538.39	0.02141	0.45064	0.47205	534.7	660.0	1194.7	0.7358	0.6612	1.3970	531.0	1111.7
940.0	537.13	0.02137	0.45621	0.47759	533.2	661.9	1195.1	0.7342	0.6640	1.3982	529.4	1112.0
930.0	535.85	0.02134	0.46190	0.48324	531.6	663.8	1195.4	0.7327	0.6668	1.3995	527.9	1112.2
920.0	534.56	0.02130	0.46770	0.48901	530.0	665.8	1195.7	0.7311	0.6696	1.4007	526.3	1112.5
910.0	533.26	0.02127	0.47363	0.49490	528.3	667.7	1196.1	0.7295	0.6724	1.4019	524.8	1112.7
900.0	531.95	0.02123	0.47968	0.50091	526.7	669.7	1196.4	0.7279	0.6753	1.4032	523.2	1113.0
890.0	530.63	0.02119	0.48586	0.50706	525.1	671.6	1196.7	0.7263	0.6782	1.4045	521.6	1113.2
880.0	529.30	0.02116	0.49218	0.51333	523.4	673.6	1197.0	0.7247	0.6811	1.4057	520.0	1113.4
870.0	527.96	0.02112	0.49863	0.51975	521.8	675.6	1197.3	0.7230	0.6840	1.4070	518.4	1113.7
860.0	526.60	0.02109	0.50522	0.52631	520.1	677.6	1197.7	0.7214	0.6869	1.4083	516.7	1113.9
850.0	525.24	0.02105	0.51197	0.53302	518.4	679.5	1198.0	0.7197	0.6899	1.4096	515.1	1114.1
840.0	523.86	0.02101	0.51886	0.53988	516.7	681.5	1198.2	0.7180	0.6929	1.4109	513.4	1114.3
830.0	522.46	0.02098	0.52592	0.54689	515.0	683.5	1198.5	0.7163	0.6959	1.4122	511.8	1114.5
820.0	521.06	0.02094	0.53314	0.55408	513.3	685.5	1198.8	0.7146	0.6990	1.4136	510.1	1114.8
810.0	519.64	0.02091	0.54052	0.56143	511.6	687.6	1199.1	0.7129	0.7020	1.4149	508.4	1115.0

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

Press. psia	Temp. F	Volume, ft³/lbm Water v_f	Evap. v_{fg}	Steam v_g	Enthalpy, Btu/lbm Water h_f	Evap. h_{fg}	Steam h_g	Entropy, Btu/lbm × R Water s_f	Evap. s_{fg}	Steam s_g	Energy, Btu/lbm Water u_f	Steam u_g
200.0	381.80	0.01839	2.2689	2.2873	355.5	842.8	1198.3	0.5438	1.0016	1.5454	354.8	1113.7
198.0	380.96	0.01838	2.2912	2.3095	354.6	843.6	1198.2	0.5428	1.0035	1.5463	353.9	1113.6
196.0	380.12	0.01836	2.3139	2.3322	353.7	844.4	1198.1	0.5417	1.0054	1.5471	353.0	1113.5
194.0	379.26	0.01835	2.3370	2.3554	352.8	845.1	1197.9	0.5406	1.0074	1.5480	352.1	1113.4
192.0	378.40	0.01834	2.3606	2.3790	351.9	845.9	1197.8	0.5395	1.0094	1.5489	351.2	1113.2
190.0	377.53	0.01833	2.3847	2.4030	350.9	846.7	1197.6	0.5384	1.0113	1.5498	350.3	1113.1
188.0	376.65	0.01832	2.4093	2.4276	350.0	847.5	1197.5	0.5373	1.0133	1.5507	349.4	1113.0
186.0	375.77	0.01831	2.4344	2.4527	349.1	848.3	1197.3	0.5362	1.0153	1.5516	348.4	1112.9
184.0	374.88	0.01830	2.4600	2.4783	348.1	849.1	1197.2	0.5351	1.0174	1.5525	347.5	1112.8
182.0	373.98	0.01828	2.4862	2.5045	347.2	849.9	1197.0	0.5339	1.0194	1.5534	346.5	1112.7
180.0	373.08	0.01827	2.5129	2.5312	346.2	850.7	1196.9	0.5328	1.0215	1.5543	345.6	1112.5
178.0	372.16	0.01826	2.5402	2.5585	345.2	851.5	1196.7	0.5316	1.0236	1.5552	344.6	1112.4
176.0	371.24	0.01825	2.5681	2.5864	344.2	852.3	1196.5	0.5305	1.0257	1.5562	343.6	1112.3
174.0	370.31	0.01824	2.5966	2.6149	343.2	853.1	1196.4	0.5293	1.0279	1.5571	342.7	1112.2
172.0	369.37	0.01823	2.6258	2.6440	342.2	853.9	1196.2	0.5281	1.0300	1.5581	341.7	1112.0
170.0	368.42	0.01821	2.6556	2.6738	341.2	854.8	1196.0	0.5269	1.0322	1.5591	340.7	1111.9
168.0	367.47	0.01820	2.6861	2.7043	340.2	855.6	1195.8	0.5256	1.0344	1.5601	339.7	1111.8
166.0	366.50	0.01819	2.7173	2.7355	339.2	856.5	1195.7	0.5244	1.0367	1.5611	338.6	1111.6
164.0	365.53	0.01818	2.7493	2.7674	338.2	857.3	1195.5	0.5232	1.0389	1.5621	337.6	1111.5
162.0	364.54	0.01817	2.7820	2.8001	337.1	858.2	1195.3	0.5219	1.0412	1.5631	336.6	1111.3
160.0	363.55	0.01815	2.8155	2.8336	336.1	859.0	1195.1	0.5206	1.0435	1.5641	335.5	1111.2
158.0	362.55	0.01814	2.8498	2.8679	335.0	859.9	1194.9	0.5194	1.0458	1.5652	334.5	1111.0
156.0	361.53	0.01813	2.8849	2.9031	333.9	860.8	1194.7	0.5181	1.0482	1.5662	333.4	1110.9
154.0	360.51	0.01812	2.9210	2.9391	332.8	861.6	1194.5	0.5168	1.0506	1.5673	332.3	1110.7
152.0	359.48	0.01810	2.9579	2.9760	331.8	862.5	1194.3	0.5154	1.0530	1.5684	331.2	1110.6
150.0	358.43	0.01809	2.9958	3.0139	330.6	863.4	1194.1	0.5141	1.0554	1.5695	330.1	1110.4
149.0	357.91	0.01808	3.0151	3.0332	330.1	863.9	1194.0	0.5134	1.0566	1.5700	329.6	1110.3
148.0	357.38	0.01808	3.0347	3.0528	329.5	864.3	1193.9	0.5127	1.0579	1.5706	329.0	1110.3
147.0	356.84	0.01807	3.0545	3.0726	329.0	864.8	1193.8	0.5120	1.0591	1.5712	328.5	1110.2
146.0	356.31	0.01806	3.0746	3.0927	328.4	865.2	1193.6	0.5114	1.0604	1.5717	327.9	1110.1
145.0	355.77	0.01806	3.0950	3.1130	327.8	865.7	1193.5	0.5107	1.0616	1.5723	327.4	1110.0
144.0	355.23	0.01805	3.1156	3.1337	327.3	866.2	1193.4	0.5100	1.0629	1.5729	326.8	1109.9
143.0	354.69	0.01805	3.1365	3.1546	326.7	866.6	1193.3	0.5093	1.0642	1.5734	326.2	1109.8
142.0	354.14	0.01804	3.1577	3.1757	326.1	867.1	1193.2	0.5086	1.0655	1.5740	325.6	1109.7
141.0	353.59	0.01803	3.1792	3.1972	325.5	867.5	1193.1	0.5079	1.0668	1.5746	325.1	1109.7
140.0	353.04	0.01803	3.2010	3.2190	325.0	868.0	1193.0	0.5071	1.0681	1.5752	324.5	1109.6
139.0	352.48	0.01802	3.2230	3.2411	324.4	868.5	1192.8	0.5064	1.0694	1.5758	323.9	1109.5
138.0	351.92	0.01801	3.2454	3.2634	323.8	868.9	1192.7	0.5057	1.0707	1.5764	323.3	1109.4
137.0	351.36	0.01801	3.2681	3.2861	323.2	869.4	1192.6	0.5050	1.0720	1.5770	322.7	1109.3
136.0	350.79	0.01800	3.2912	3.3091	322.6	869.9	1192.5	0.5043	1.0733	1.5776	322.1	1109.2
135.0	350.23	0.01799	3.3145	3.3325	322.0	870.4	1192.4	0.5035	1.0747	1.5782	321.5	1109.1
134.0	349.65	0.01799	3.3382	3.3562	321.4	870.8	1192.2	0.5028	1.0760	1.5788	320.9	1109.0
133.0	349.08	0.01798	3.3622	3.3802	320.8	871.3	1192.1	0.5020	1.0774	1.5794	320.3	1108.9
132.0	348.50	0.01797	3.3866	3.4046	320.2	871.8	1192.0	0.5013	1.0788	1.5800	319.7	1108.8
131.0	347.92	0.01797	3.4113	3.4293	319.6	872.3	1191.9	0.5005	1.0802	1.5807	319.1	1108.7
130.0	347.33	0.01796	3.4364	3.4544	319.0	872.8	1191.7	0.4998	1.0815	1.5813	318.5	1108.6
129.0	346.74	0.01795	3.4619	3.4799	318.3	873.3	1191.6	0.4990	1.0829	1.5819	317.9	1108.5
128.0	346.15	0.01794	3.4878	3.5057	317.7	873.8	1191.5	0.4982	1.0843	1.5826	317.3	1108.4
127.0	345.55	0.01794	3.5141	3.5320	317.1	874.3	1191.3	0.4975	1.0858	1.5832	316.7	1108.3
126.0	344.95	0.01793	3.5407	3.5586	316.4	874.8	1191.2	0.4967	1.0872	1.5839	316.0	1108.2
125.0	344.35	0.01792	3.5678	3.5857	315.8	875.3	1191.1	0.4959	1.0886	1.5845	315.4	1108.1
124.0	343.74	0.01792	3.5953	3.6132	315.2	875.8	1190.9	0.4951	1.0901	1.5852	314.8	1108.0
123.0	343.13	0.01791	3.6232	3.6411	314.5	876.3	1190.8	0.4943	1.0915	1.5858	314.1	1107.9
122.0	342.51	0.01790	3.6516	3.6695	313.9	876.8	1190.7	0.4935	1.0930	1.5865	313.5	1107.8
121.0	341.89	0.01790	3.6804	3.6983	313.2	877.3	1190.5	0.4927	1.0945	1.5872	312.8	1107.7
120.0	341.27	0.01789	3.7097	3.7275	312.6	877.8	1190.4	0.4919	1.0960	1.5879	312.2	1107.6
119.0	340.64	0.01788	3.7394	3.7573	311.9	878.3	1190.2	0.4911	1.0975	1.5885	311.5	1107.5
118.0	340.01	0.01787	3.7697	3.7875	311.3	878.8	1190.1	0.4903	1.0990	1.5892	310.9	1107.4
117.0	339.37	0.01787	3.8004	3.8183	310.6	879.3	1189.9	0.4894	1.1005	1.5899	310.2	1107.3
116.0	338.73	0.01786	3.8316	3.8495	309.9	879.9	1189.8	0.4886	1.1021	1.5906	309.5	1107.2
115.0	338.08	0.01785	3.8634	3.8813	309.3	880.4	1189.6	0.4877	1.1036	1.5913	308.9	1107.0
114.0	337.43	0.01785	3.8957	3.9136	308.6	880.9	1189.5	0.4869	1.1052	1.5921	308.2	1106.9
113.0	336.78	0.01784	3.9286	3.9464	307.9	881.4	1189.3	0.4860	1.1067	1.5928	307.5	1106.8
112.0	336.12	0.01783	3.9620	3.9799	307.2	882.0	1189.2	0.4852	1.1083	1.5935	306.8	1106.7
111.0	335.46	0.01782	3.9960	4.0138	306.5	882.5	1189.0	0.4843	1.1099	1.5942	306.1	1106.6
110.0	334.79	0.01782	4.0306	4.0484	305.8	883.1	1188.9	0.4834	1.1115	1.5950	305.4	1106.5
109.0	334.11	0.01781	4.0658	4.0837	305.1	883.6	1188.7	0.4826	1.1132	1.5957	304.7	1106.3
108.0	333.44	0.01780	4.1017	4.1195	304.4	884.1	1188.5	0.4817	1.1148	1.5965	304.0	1106.2
107.0	332.75	0.01779	4.1382	4.1560	303.7	884.7	1188.4	0.4808	1.1165	1.5972	303.3	1106.1
106.0	332.06	0.01779	4.1753	4.1931	303.0	885.2	1188.2	0.4799	1.1181	1.5980	302.6	1106.0
105.0	331.37	0.01778	4.2132	4.2309	302.2	885.8	1188.0	0.4790	1.1198	1.5988	301.9	1105.8
104.0	330.67	0.01777	4.2517	4.2695	301.5	886.4	1187.9	0.4780	1.1215	1.5995	301.2	1105.7
103.0	329.97	0.01776	4.2910	4.3087	300.8	886.9	1187.7	0.4771	1.1232	1.6003	300.4	1105.6
102.0	329.26	0.01776	4.3310	4.3487	300.0	887.5	1187.5	0.4762	1.1249	1.6011	299.7	1105.4
101.0	328.54	0.01775	4.3717	4.3895	299.3	888.1	1187.3	0.4752	1.1267	1.6019	299.0	1105.3
100.0	327.82	0.01774	4.4133	4.4310	298.5	888.6	1187.2	0.4743	1.1284	1.6027	298.2	1105.2

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

5.01 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).

Reference: Theory Review, Page 62

5.02 a. Heat produced at some time after the fission event (0.5) is decay heat. It is produced by the radioactive decay of the fission products (0.5).

b. No. (0.25) The nuclear instrumentation indicates neutrons, while the decay heat power is from beta and gamma decay of the fission fragments (0.75).

Reference: G.E. Reactor Fundamentals

5.03 a. Analysis of these rod increments indicates the potential to insert reactivity beyond the capability of the operator to respond to. (1.0)

b. The rod is left as an insert error until steam flow through the bypass valves is established which diminishes the worth due to voids in the core. (1.0)

Reference: C.1.21

5.04 a. More negative (0.25)

b. More negative (0.25)

c. More negative (0.25)

d. Less negative (0.25)

e. More negative (0.25)

f. Less negative (0.25)

g. More negative (0.25)

h. Less negative (0.25)

Reference: Theory Review, Pages 48, 50, 54, 56, Figure 46

5.05 a. Critical heat flux is the local heat flux which will cause OTB. (0.5)
Critical power is the bundle power at which OTB occurs somewhere in the bundle. (OTB is onset of transition boiling.) (0.5)

b. Critical power is more appropriate since it does not imply that OTB is dependent only on local conditions and the local heat flux. (1.0)

Reference: GE Thermodynamics, HT&FF Problem Solution No. 10 Page 9-2

5.06 a. The difference in pressure between the total pressure at the eye of a pump and saturation pressure. (1.0)

b. Increasing suction pressure will reduce the possibility of cavitation. (1.0)

c. Increasing fluid temperature will bring the fluid closer to saturation and increase the possibility of cavitation. (1.0)

Reference: GE Thermodynamics, HT&FF Problem Solution No. 31 Page 7-6

5.07 a. To return to steady state at 50% reactivity must return to zero. (2.0)
Part of the negative contribution that terminates the power level increase at 50% is due to the increased fuel temperature resulting from increased power level. This is caused by the doppler coefficient. Since part of the negative insertion is due to doppler the negative contribution due to voids cannot be as large as the original positive insertion that resulted from the void reduction that started the power level increase.

b. The difference will be smaller in the higher power case. This is a result of the slight non linearity of the doppler coefficient. As temperature increases the role of reactivity loss per degree decreases. The resonances do not broaden as much at high temperatures as they do at lower temperatures. (2.0)

Reference: NSP Nuclear Theory Plan M-8102 L-016 Page 28

5.08 a. 1. To prevent exceeding specific thermal limitations. (0.5)

2. To optimize the fuel burnout. (0.5)

b. Flux shaping is accomplished by establishing a specific rod pattern (0.5) consisting of deep and shallow rods, and avoiding intermediate rods. (0.5)

Reference: NSP Nuclear Theory Lesson Plan M-8102 L-016 Page 47

5.09 (b) (1.0)

Reference: Standard Nuclear Principles

5.10 (c) or (d) is correct depending if you are talking actual or required NPSH actual is d (required NPSH is c) (1.0)

Reference: Standard Thermal Hydraulic Principles

5.11 (b) (1.0)

Reference: Standard Nuclear Theory

5.12 a. Remains constant (.25). Flow is controlled by the RCIC flow controller which will attempt to maintain a constant output flow regardless of reactor pressure (.75). (1.0)

b. Decreases (.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) (.75). (1.0)

c. Decreases (.25). Since pump discharge head is decreasing to maintain a constant flow, turbine RPM must also decrease (.75). (1.0)

Reference: NUS Pumps and Fluid Flow, and MNGP Ops, Manual, B.2.3

END OF SECTION 5 - ANSWERS

Section 6 - Answers - Plant Systems Design, Control, and Instrumentation.

6.01 a. By monitoring the differential pressure across each recirc pump for a 2 psid or greater dp, indicating the pump is running. (1.0)

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

c. Loop No. 12. or B (0.5)

Reference: MNGP Ops, Manual, B.3.4 - 10 and 11

6.02 a. High Drywell Pressure at 2 psig OR Low Low Reactor Water Level at 6'7" above TAF (47" or 48") AND Low Reactor Vessel Pressure at 450 psig. (1.5)

b. Each loop includes an orificed minimum flow pump discharge line back to the suppression pool. (0.5)

c. Bypass cancels the automatic signal to that valve. (0.5)

d. By placing the control switch in P-T-L. (0.5)

Reference: MNGP Volume B.3.1-2, 4-6 and B.1.1-22, 117

6.03 a. 1. M/A Transfer Station

2. Mismatch Summer

3. Error Signal Limiting Network

(Two (2) required at 0.5 each) (1.0)

b. 1. Recirc Pump discharge valve shut

2. Feedwater flow <20%

3. Output of M/A Transfer station <25%

(Two (2) required at 0.5 each) (1.0)

c. Pump speed will increase to ~~45%~~ range between 45-50% at which time the Master Controller low speed limiter will be limiting. (1.0)

Reference: MNGP Volume B.1.4-3, B.5.8-2, 4, 9

6.04 a. The level controller will first open the heater drain (CV-1017) (0.5). As level continues to increase, the heater dump valve (CV-1018) will open draining the heater to the condenser (0.5). At the high level alarm point, the bleeder trip valve (BTV-10) will close (0.5).

b. This insures continuous removal of moisture from the turbine extraction stages when feedwater heaters are out of service. (1.0)

Reference: MNGP Volume B.6.5-14, 16, 21

6.05 a. ALL in use TIP detectors are withdrawn. (0.5) Once detectors are withdrawn the TIP ball valves close. (0.5) The TIP N2 purge valve is closed. (0.5)

b. The common channel allows cross calibration of the TIP outputs. (0.5)

Reference: NSP Section B.5.3

6.06 a. Each of two (2) sensors supply a signal to a logic trip channel. A signal from either of the two (2) sensors will result in a trip of that channel. (1.0) (ONE-OUT-OF-TWO LOGIC) The RPS consists of two (2) separate channels, each operating as described above. It takes a trip of both channels to produce a system trip. (1.0) (TAKEN TWICE) NOTE: Will accept a drawing as an answer.

b. Single failure of a sensor will not cause or prevent a scram (0.5) and allows for more through testing of the system during operations ~~(0.5)~~ and increased reliability. (0.5)

REFERENCE: NSP Section B.5.6

6.07 a. Low Pressure upstream at 5 psig decreasing OR (0.5)
High pressure downstream at 140 psig increasing (0.5)

b. No (.25), the orifice bypass valve is opened when the influent pressure is low. This would increase the flow rate (.75). The purpose of the orifice is to limit flow rates to the condenser or radwaste when the influent pressure is high. (1.0)
(Also acceptable - To prevent unnecessary throttling and possible cutting of valve seat on Dump FCV (CV-2403)).

c. Since the filter cake falls off the tubes on a loss of flow; when flow resumed, migration of the filter cake would take place and contaminate the system. (1.0)

Reference: MNGP Volume B.2.2-3, 14, 23, 42

6.08 a. Storage tank to test tank outlet, to suction of pump and the pump plunger casing. (0.5) To prevent the boron from coming out of solution. (0.5)

b. The reliefs discharge to the SBLC storage tank. (0.5) This ensures that if a relief was to lift no boron solution would be lost from the system. (0.5)

Reference: MNSP Section B.3.5

6.09 a. 1. Excessive off-gas system pressure (0.5) or temperature. (0.5)

2. Main steam header pressure is less than 100 psig. (0.5)

b. 1. Isolates the flow of an explosive mixture to the condenser. (0.5)

2. To prevent off-gas back flow into the condenser at low ejector efficiencies. (0.5)

Reference: MNSP Section B.3 Page 9

6.10 a. Motor overload electrical fault. (0.5)

b. Low basin water level. or accept * (0.5)

Reference: MNSP Section B.4 Page 16

END OF SECTION 6 ANSWERS

* To prevent possible undervoltage conditions during a Loss of Coolant Accident (LOCA), a CT pump load shed is provided. The Core Spray initiation logic will trip cooling tower pumps P101A and P101B on high drywell pressure or reactor low level and low pressure. Manual tripping of any cooling tower fan from Control Switches CS-100A or CS-100B will also trip both CT pumps.

Section B.6.4 page 23a

+ Associated circulating water pump trips when in closed cycle

Section B.6.4 page 24

Section 7 - Answers - Procedures: Normal, Abnormal, Emergency, and Radiological Control.

7.01 a. The minimum flow valve opens and reactor water is pumped to the torus. (1.0)

b. The RHR service water pumps must be in continuous operation to ensure no leakage of potentially radioactive water to the RHRSW system. (1.0)

Reference: RHR B.3.4-33, Main Steam B.2.4-25

7.02 a. 1135 psig (0.25) or Low-Low Rx water (-47" or -48") level after a 9 sec. time delay. (0.25) The ATWS trip opens the recirc MG field breakers (0.25) and opens the ARI valves. (0.25)

b. Unable to maintain the reactor subcritical (0.5) and

1. RPV water level cannot be maintained (0.5) OR

2. Suppression pool water temperature cannot be maintained less than 110°F. (0.5)

c. Once SBLC is initiated the complete charge is to be injected. (0.5) To ensure S/D margin maintained as C/D, dilution, poison decay and reactivity coefficient feedback take place. (0.5)

Reference: NSP OP MAN. C.4.I-11 and B.3.5

7.03 1. Buildup of oxygen in the reactor coolant due to radiolytic decomposition of water. Oxygen is removed at high steaming rates (deaeration by boiling). High oxygen concentration at high temperature is conductive to stress corrosion. (1.5)

2. Increased feedwater nozzle thermal fatigue cycling due to low feedwater temperatures, cycling of feed flow due to minimum resolution of the Feedwater Control System at low flows, incomplete mixing, and "unstable flow cycling" within the sparger. During power operations, feed flows and temperatures are increased. (1.5)

Reference: MNGP Volume C.1-0062

7.04 Close the discharge valve (0.5) (and the discharge valve bypass (0.5)) on the tripped pump. This is to allow the pump to stop and prevent reverse rotation (0.5). Shut the seal injection valve (0.5) to prevent overpressurizing the pump (0.5) when the suction valve is shut (0.5) to isolate the pump (0.5).

no longer part of the system.

only 3.0

(3.0) Total for question NOT (3.5)

Reference: Recirculation System, Recovery from Trip of One Pump B.1.4-51

7.05 a. If it appears that the suppression pool temperature will exceed 160°F. (1.0)

b. Feedwater, HPCI, RCIC, CRD Hydraulics. (0.25 each) (1.0)

c. No fuel damage exists. (0.5) A low pressure ECCS pump or condensate pump is running. (0.5)

Reference: C.4 Loss of Coolant Accident Pages 112, 113, 116

7.06 a. Initiate all AVAILABLE RHR in the SUPPRESSION POOL COOLING MODE. (0.5)

b. Secure HPCI testing. (0.5)

c. Scram the reactor. (0.5)

Reference: MNGP Ops, Manual, B.4.1.

7.07 If it occurs that a fuel assembly or bundle is dropped, either in the fuel storage pool or the reactor vessel, the actions below are to be taken:

1. Immediately clear the refueling floor of all personnel, even if the evacuation siren has not sounded. Do not attempt to pick up the fuel or move it to another orientation. (1.0)

2. Notify Plant Management to allow complete evaluation of the situation. (0.5)

3. Attempts to move the fuel to a stable orientation will be made only after evaluation of the specific situation has been made and directions to proceed have been issued by plant management. (1.0)

Reference: D.3

7.08 a. Notify on shift Fire Brigade and/or Emergency Teams instructing them as to nature, type, location and severity of the fire.

b. Notify the duty Shift Supervisor, instructing him of the details of the fire.

c. Notify Monticello Fire Department requesting assistance, if needed. Instructions should be given to the Monticello Fire Department as to the nature of the fire, the type, location and severity of the fire.

d. If the Monticello Fire Department's assistance is requested, notify Security Lieutenant that they will be coming and that they will need to be escorted.

e. Equipment may have to be removed or placed in service as deemed necessary to cope with the fire situation.

f. Ambulance service and/or hospital assistance may be required as dictated by the event.

Any three (3) at 0.5 each

Reference: MNGP Fire Fighting Procedures A.3-2

7.09 a. Because of increased rates of erosion on the later stage buckets. (0.5)

b. Shutdown the turbine and place on the turning gear to allow temperatures to equalize. (0.5)

c. First stage bowl metal temperature differential OR the temperature difference on the control valve casing. (0.5)

Reference: MNGP Volume B.6.1-136, 137

7.10 a. Toxic to personnel (chemically) cause skin burn. (0.5)

b. ~~Radioactivity from activation~~. Suspected carcinogen. (0.5)

Reference: MNGP B.2.5 page 15.1.0

7.11 a. RWCU high temperature isolation can occur (0.5) due to lack of cooling flow through the regenerative heat exchanger (0.5).

b. To prevent high pressure reactor water from leaking past the air operated filter/demin inlet and outlet valves (0.5) into the low pressure backwash and precoat piping (0.5).

Reference: MNGP Volume B.2.2

END OF SECTION 7 ANSWERS

Section 8 - Answers - Administrative Procedures, Conditions and Limitations.

8.01 a. A hold card is used when human life or injury is involved a secure card is not. (1.0)

b. Shift Supervisor or Site Supervisor (0.5)

c. Shift Supervisor or Site Supervisor (0.5)

Reference: MNGP Ops, Manual, B.9.1.

8.02 a. 1. When plant is expected to be restarted after a short duration shutdown when no major maintenance has been performed. (0.5)

2. After a scram, if the nature of the scram is known and the cause remedied. (0.5)

b. By a Management Memo or by a Volume F memo (0.5)

c. If rod withdrawal is re-initiated within four (4) hours after reaching the all-rods-in condition. (0.5)

d. No, the elapsed time from start of performance to initial rod withdrawal exceeds the 12 hour time limit. (1.0)

Reference: MNGP Volume C.1-1, 3

8.03 a. To enhance the capability of the LPCI Loop Selection Logic to detect some limited low probability breaks in the recirc loop. (1.0)

b. To prevent excessive jet pump vibration. (1.0)

c. To preclude excessive thermal stresses on the reactor bottom head-to-support skirt transition and/or CRD stub tubes. (Either component for full credit). Cold water reactivity accident for 0.25 (partial credit). (1.0)

Reference: MNGP Ops, Manual, B.1.4.

8.04 a. Whenever the reactor is in the startup or run mode below 10% rated thermal power. (0.5)

b. Designated control rods only when the RBM is operable. (0.5)

Reference: Technical Specifications Page 80

8.05 a. Brittle fracture of the reactor pressure vessel could occur. (1.0)

b. Yes. Due to neutron embrittlement of the reactor vessel metal. (1.0)

Reference: Technical Specifications and Ops Manual B.1.1.

8.06 a. Inoperable LPCI loop (0.33). Potential for water hammer in discharge piping and possible discharge piping damage as a result. (0.67) (1.0)

b. Inoperable HPCI (0.33). HPCI suction must automatically transfer to the Suppression Pool on high level to maintain an adequate air space in the Suppression Pool. (0.67) (1.0)

Reference: MNGP Technical Specifications

8.07 The drywell and pressure suppression chamber are intact and all of the following are satisfied. (0.5)

1. All manual containment isolation valves on lines connecting to the RCS or containment which are not required to be open during accident conditions are closed. (0.5)

2. At least one door in the airlock is closed and sealed. (0.5)

3. All automatic containment isolation valves are operable or are deactivated in the closed position or at lease one valve in each line having an inoperable valve is closed. (0.5)

4. All blind flanges and manways are closed. (0.5)

Reference: Technical Specifications Page 3

8.08 a. With pressure >800 psia and core flow >10% MCPR $\geq$1.07

b. With reactor pressure $\leq$800 psia and core flow $\leq$10% thermal power shall not exceed 25% of rated.

c. Each scram shall be initiated by its primary source signal.

d. Level $\geq$12 inches above the top of the active fuel whenever the reactor is shutdown with irradiated fuel in the vessel

e. Pressure shall not exceed 1335 psig at any time when irradiated fuel is in the vessel.

(any two (2) at 1.0 each)

Reference: Technical Specifications 2.1 and 2.2

8.09 a. Reactor shall be shutdown immediately. 1.0 (~~0.5~~)

b. Immediate report shall be made to the commission and General Manager Nuclear Plants. (0.5)

c. A complete analysis of circumstances, leading up to and resulting from the situation with recommendations. (0.5)

d. Within 14 days a complete report shall be submitted to NRC and GMNP. (0.5)

e. Operations shall not be resumed until authorized by NRC. (0.5)

Reference: Technical Specifications 6.4

8.10 a. Mode Switch in Shutdown (0.5)

b. Manual Scram (0.5)

c. High Flux IRM (120/125) (0.5)

d. Scram Discharge Volume High Level (56 gallons) TS PLANT 53 gallons (0.5)

Reference: MNGP Technical Specifications Table 3.1.1 and Notes Pages 28 and 29

8.11 a. Operation Superintendent (0.5)

b. Senior Site Superintendent present, not on duty shift (0.5)

c. Senior Shift Superintendent present, not on duty shift (0.5)

d. Duty Site Superintendent (0.5)

e. Duty Shift Superintendent (0.5)

Reference: MNGP Volume A.2-001 Pages 1-6

END OF SECTION 8 ANSWERS