07-189-91

NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT NUCLEAR STATION

UNIT II OPERATIONS

02-REQ-001-201-2-02 Revision 5

TITLE: REACTOR MANUAL ROD CONTROL SYSTEM

	SIGNATURE	DATE
PREPARER		10/16/90
TRAINING SUPPORT SUPERVISOR		10-22-90
TRAINING AREA SUPERVISOR		10/23/90
PLANT SUPERVISOR/ USER GROUP SUPERVISOR		11/5/90

Summary of Pages

(Effective Date: 11/5/90)

Number of Pages: 18

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THIS LESSON PLAN IS A GENERAL REWRITE

TRAINING DEPARTMENT RECORDS ADMINISTRATION ONLY:

VERIFICATION:

DATA ENTRY:

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19pp.

5/4/23

I. TRAINING DESCRIPTION

A. Title of Lesson: Reactor Manual Rod Control System

B. Lesson Description: Provide a review of the Reactor Manual Control System for licensed operators.

C. Estimate of the Duration of the Lesson: Approximately 2 hours

D. Method of Evaluation, Grade Format, and Standard of Evaluation: Open reference written exam $\geq$ 80%.

E. Method and Setting of Instruction: Classroom

F. Prerequisites:

1. Instructor:
   a. Shall be qualified in accordance with NTP-16.
2. Trainee:
   a. Meet eligibility requirements per 10CFR55, or
   b. Be recommended for this training by the Operations Superintendent or his designee.

G. References:

1. NMP2 Technical Specifications
   a. 3/4.1.4.1 Rod Worth Minimizer
   b. 3/4.1.4.2 Rod Sequence Control System (RSCS)
   c. 3/4.10.2 RSCS - Special Test Exceptions
   d. 3/4.1.3.7 Control Rod Position Indication
   e. 3/4.1.3.6 Control Rod Drive Coupling
   f. 3/4.3.6 Control Rod Block Instrumentation
2. N2-OP-95B Rod Sequence Control System
3. N2-OP-96 Reactor Manual Control and Rod Position Indication System
4. GEK 83320A Reactor Manual Control System
5. GEK 83317 Control Rod Drive
6. GE791E406TY
7. SOER 84-2 Control Rod Mispositioning
8. Unit 2 LER 90-12

II. REQUIREMENTS AND PREREQUISITES

A. AP-9, Administration of Training

B. NTP-11, Licensed Operator Retraining and Continuing Training

III. TRAINING MATERIALS

A. Instructor Materials:

1. N2-OP-95B
2. N2-OP-96
3. Related T/S
4. SOER 84-2
5. Unit II LER 90-12

B. Trainee Materials:

1. N2-OP-95B
2. N2-OP-96
3. Tech. Specs. as designated by Instructor
4. Prints as determined by Instructor

IV. EXAM AND MASTER ANSWER KEYS

A. Contain with the cycle records.

V. LEARNING OBJECTIVES

Upon completion of this training the trainee will have reviewed the knowledge required to perform the following tasks.

A. Terminal Objectives:

TO-1.0 Bypass a control rod in the Reactor Manual Control System. (2010170101)

TO-2.0 Perform the actions required for a loss of rod position indication.

TO-3.0 Bypass and unbypass a control rod in the Rod Sequence Control System.

TO-4.0 Substitute a rod position in the RSCS.

TO-5.0 Perform the actions required for a mispositioned control rod. (2000390401)

TO-6.0 Perform the actions required for an uncoupled control rod.

B. Enabling Objectives:

EO-1.1 State the three purposes of the Reactor Manual Control System.

EO-1.2 State the four RXMC subsystems, including their purpose and principles of operation.

EO-1.3 Describe the three modes of operation of the RXMC system.

EO-1.4 Describe the purpose and principle of operation for the following:

a. Rod Select Module
b. Activity Control Section
c. Analyzer Section
d. Branch Junction Module
e. Transponders
f. Display Memory Module
g. Rod and Detector Display
h. Four Rod Display

EO-2.1 Describe the operation of the rod position indication system.

EO-3.1 Describe the operation of the RSCS System to include all available controls.

EO-4.1 Given a faulty rod position, discuss how to substitute a rod position in the RSCS System.

EO-5.1 Given indications of a mispositioned control rod, discuss the actions required in accordance with procedures.

EO-5.2 For automatic functions of the RXMC, list the signals and their setpoints which would cause the automatic function.

EO-6.1 Given N2-OP-95B and 96, use the procedure to identify appropriate actions for proper system operation under all conditions.

EO-6.2 Given Technical Specifications, identify the appropriate actions and locate information relating to LCO's, bases and surveillance requirements for the RXMC System.

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
I. INTRODUCTION		
A. Review SOER 84-2, "Control Rod Mispositioning Events".	Discuss adverse consequences of operation with a mispositioned rod. Review how these types of events are addressed at NMP2.	
B. Review of plant events.	Review NMP2 LER 90-12. Discuss with class the root cause and corrective actions. (If more recent events are applicable, use them).	
C. Review Learning Objectives.	Review objectives as listed in the front matter.	EO-1.1
D. Purpose		
1. The Reactor Manual Rod Control System allows the operator to select and move control rods as needed for efficient fuel management and varying reactor power level. The RXMC monitors a variety of conditions pertaining to control rods and gives individual indications and summaries of those conditions. Also limits the worth of any control rod to reduce effects from a control rod drop accident or a rod withdrawal error by enforcing adherence to predetermined control rod patterns through use of control rod blocks.		

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES

II. GENERAL DESCRIPTION — EO-1.2

A. Consists of four subsystems:
   1. Rod Drive Control System (RDCS)
   2. Rod Position Information System (RPIS)
   3. Rod Sequence Control System (RSCS)
   4. Rod Worth Minimizer System (RWM)

B. RDCS Accomplishes all rod movements except scram. Cannot cause or prevent scram.

C. RPIS furnishes rod vertical position.

D. RSCS imposes restrictions on rod movement to limit undesirable consequences of rod drop accident.

E. RWM is a process computer program that works in conjunction with RSCS. Monitors and enforces adherence to start-up, shutdown and low power level control rod procedures to limit consequences of a rod drop accident. RXMC includes interlocks that inhibit rod movement.

NOTE: RWM is reviewed under its own lesson plan.

F. Use Fig. 1 and identify major components, inputs, outputs and instrumentation.

III. ROD DRIVE CONTROL SYSTEM

A. Three modes of operation.
   1. Operator follow mode - used to move rods.
   2. Scan mode - gathers hydraulic control unit data. — EO-1.3

3. Test mode - tests all functions of transponder cards and related command circuitry.

B. Major Components

1. Rod Select Module — EO-1.4a
   a. Contains push buttons for selecting control rods, stabilizer valve set, drift test and movement commands.
   b. Forms the request word.
   c. Request word goes to the Activity Controls.

Q: What information does the request word contain.

A: Rod I.D. and rod. motion request.

2. Activity Control Card - monitors present state of plant to determine if rod motion requested by the operator is permissible. If requested motion is permissible the activity control card will start the rod motion timer card. — EO-1.4b

3. Rod Motion Timer Card - produces a precise sequence of time intervals designed to move a control rod exactly one notch. Crystal controlled oscillator is primary timing source.

4. Output of the Activity Control Section is a command word which contains the rod identification and the driving commands for the directional control valves.

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
C. Analyzer Section		EO-1.4c
1. Compares the command words from the activity controls section. If command words are equivalent then the channel 1 command word is sent to the transponders while the channel 2 command word is retained as a reference.		
2. System will also produce operator request words, scan words and self test words. Acknowledge words are received and compared to the expected response to see if an error has occurred.		
3. If an error occurs the analyzer will remember the error and continue with is program. If a large number of errors are found the system will INOP, holding in the display registers all of the data available when the decision to stop is made.	Q: Will the full core display update when RXMC System INOP annunciator is energized? A: No data is updated on the display during this condition.	
4. Fault Map Card - If the self test system discovers a fault associated with any of the transponders, it will light the corresponding spot on the fault map.	Using a T.P. of the Analyzer Display review all panel indications.	

a. The scan counter will send a scan request out to the system. This will update the full core display on accumulator pressure and level, scram valve position and scram test switch position.

b. When the entire core has been scanned the self test counter will test the next transponder. In the self test mode the analyzer generates a rod select and motion command signal. The HCU solenoids are energized long enough to check continuity but not long enough to move the valve.

D. Branch Junction Module — EO-1.4d

1. Mounted at the end of a cluster of HCU's.
2. Branch amplifier card contains a power supply and logic circuit for the following:
   a. Receives the command words, shapes and amplifies, then re-transmits them.
   b. Receives the acknowledge words from downstream BJM's and HCU's within its cluster and transmits them upstream.

E. Transponder — EO-1.4e

1. Receives the command word from the BJM.

2. Controls directional control valve (DCV) power.
   a. DCVs control rod motion via the CRDM.
3. Generates ACKNOWLEDGE word for return to Analyzer via BJMs. ACKNOWLEDGE word contains information about
   a. State of DCV circuits
   b. Accumulator pressure and liquid level
   c. Scram valve position
   d. Scram test switch positions

F. Display Memory Module
1. Accepts information from the RDCS and from RPIS via the RSCS cabinet and prepares it for display. EO-1.4f
2. Display memory module contains the Rod Data Receiver Card, Source Selector Card and the Display Clock Card. Main function is to recover the incoming information and reformat it for storage on Rod Data Memory Cards.
3. There is one rod data memory card for each four rod group of rods in the core. Each rod data memory card has two identification cards associated with it.

G. Rod and Detector Display — EO-1.4g

1. Selected
   a. White light if rod is selected on RSM.
2. Drift
   a. Red light if rod moves to odd contact when rod does not have COMMAND to move.
3. Full-In
   a. Green light if rod is fully inserted.
4. Full-Out
   a. Red light if rod is fully withdrawn from core.
5. Accum
   a. Amber light if N_2 pressure is low or water level on gas side is high in accumulator associated with the rod.
6. Scram
   a. Blue light indicates both scram valves on HCU are open.
7. LPRM Display XX-YY-A-D DNSC or UPSC.
   a. White light if LPRM rods downscale.
   b. Amber light if LPRM reads upscale.

H. Four-Rod Display — EO-1.4h

1. Selected rod is backlit
2. Vertical position indicated (even reed switches)
3. "00" Full-in
4. "48" Full-in
5. "--" - odd reed switch
6. "XX" - RPIS receiving abnormal data

Q: What actions are required if the position display for the selected rod indicates "XX".

A: Review OP-96 off-normal section which addresses this. Include in the discussion the affected tech. specs.

IV. ROD POSITION INFORMATION SYSTEM — EO-2.1

A. Magnetic reed switches open and close as magnet on bottom of index tube pass giving vertical position.
   1. Information provided to:
      a. 4-Rod Display
      b. RDD
      c. RWM
      d. RSCS

B. 185 position probes and RPIS cabinet (P615).

C. Receives REQUEST word to identify selected rod.

D. Rod drift alarm if odd reed switch on and rod not being driven or selected.

E. Drift Test available, drift reset.

F. RPIS interfaces with Process Computer System.

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
V. ROD SEQUENCE CONTROL SYSTEM		EO-3.1
A. RSCS limits the effect of a rod drop event by providing withdrawal and insert motion blocks and continuous insert and withdrawal blocks if programmed rod sequence is not followed.		
B. Rods sequenced for start-up and shutdown.		
C. Withdrawal sequence restrictions up to 20% power (LPSP) Low Power Setpoint.		
1. Minimizes control rod worths.		
2. Avoids high notch worths.		
3. Maintains proper power distribution.		
Above LPSP RSCS is automatically bypassed.		
D. Reverse rod moving procedure from start-up is used for shutdown.		
E. Components		
1. RSCS Cabinet (P659)		
a. Rod Pattern Controller (RPC)		
1) Monitors operators request for rod motion and blocks, if necessary.		
2) Determines continuous or single notch motion permissive.		
2. Rod Bypass File		
a. 8 Rod Bypass Switches Provide bypassing of faulty rod position data to the RPC for up to 8 rods.	Using N2-OP-95B discuss how a rod is bypassed in RSCS and associated tech. specs.	

b. Only 3 rods allowed from any RSCS group.

3. RSCS Display Panel — EO-4.1

a. Interface between operator and RSCS cabinet.

Review procedure for substituting rod position in RSCS, OP95B.

b. Core map with amber and red LED

1) Amber indicates either ALL RODS are in that rods group, or FREE RODS in its group are free to move.

Q: How many times can a rod position be substituted.

A: Once

2) Red indicate RODS FI or rods BYPASSED.

c. Select between INSERT or W/DRAW and SEQ A or SEQ B.

d. Substitute select allows you to substitute rod position information.

VI. INSTRUMENTATION, CONTROLS AND INTERLOCKS

A. Instrumentation

1. Pressure

a. Sensed at turbine first stage pressure.

b. Used to bypass RSCS at 20% power.

2. Flow

a. Total Steam Flow

b. Used to bypass RWM at 20% power.

B. Controls

1. Pushbuttons for:

a. Rod motion (P603)

b. RSCS display information
c. Substituting position data
d. Sequencing determination
e. Initializing RWM
f. Diagnostic Test
g. Rod Test Mode

C. Indications — EO-5.1

1. RDCS status on RDD, RSM, RDCC
2. 4-Rod Display Rod Position
3. RPIS status on RPIS control cabinet

Review indications and actions required for a mispositioned control rod using N2-OP-96.

D. Interlocks — EO-5.2

1. Rod blocks Table 1 and 2
2. Rod select blocks
   a. Rod selected and movement cycle not complete.
   b. Rod select keylock fully clockwise.
   c. Rod selected and withdrawn in REFUEL mode.
3. RSCS Blocks
   a. Substitute position data.
   b. Notch restraint from 75% rod density to LPSP.
4. RWM applies block permissive signals to RDCS to generate block or permissive signals.

5. Permissive state for control rod when
   a. Two or less insert errors.
   b. No withdrawal error.
6. Rod Test Sequence
   a. Entered when no more than one rod not fully inserted.
   b. Rod block (withdrawal) on any other rod selected.
   c. Test button applies insert and withdrawal blocks.
      1) Repush test button to return to normal.

VII. SYSTEM OPERATIONS

A. Operator Follow Mode

1. WITHDRAW pushbutton
   a. Inserts for .6 seconds
   b After brief delay withdraw for 1.5 seconds.
   c. 6 seconds settle
2. INSERT pushbutton
   a. 2.9 second insertion
   b. 5.3 second settle
   c. Holding down causes continuous cycles.
3. CONTINUOUS INSERT (No settle mode)

4. CONTINUOUS WITHDRAWAL
5. RSCS is normally operated during reactor startup and shutdown when power is <20% as sensed by first stage of HP turbine.
6. RWM operation is essentially automatic once initiated.

B. Scan Mode

Accumulator pressure and level, scram valve position and scram test switch positions are checked for each of the 185 control rods.

C. Self Test Mode

The analyzer generates a rod select and motion command signal. The HCU solenoids are energized long enough to check continuity but not long enough to move the valve. The ACKNOWLEDGE work is check for the correct response. Cycle of all 185 rods is continuously repeated.

VIII. POWER SUPPLIES

A. All RXMC System components are powered from 2VBS-PNLA101

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
IX. PROCEDURE REVIEW		EO-6.1
A. N2-OP-95B, RSCS		
1. Review procedure with emphasis on precautions and off normals.		
B. N2-OP-96, RXMC and RPIS		
1. Review procedure with emphasis on precautions and off normals.		
X. TECHNICAL SPECIFICATIONS		EO-6.2
A. Review the listed specifications		
1. 3/4.1.4.2 RSCS		
2. 3/4.1.3.7 Control Rod Position Indication		
3. 3/4.1.3.6 Control Rod Drive Coupling		
4. 3/4.3.6 Control Rod Block Instrumentation		