Φ7-186-91

NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT NUCLEAR STATION

02-LOT-001-201-2-02 Revision 6

TITLE: REACTOR MANUAL ROD CONTROL SYSTEM

	SIGNATURE	DATE
PREPARER		5-16-91
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Summary of Pages

(Effective Date: 6/19/91)

Number of Pages: 37

Date	Pages
May 1991	1 - 37

THIS LESSON PLAN IS A GENERAL REWRITE

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I. TRAINING DESCRIPTION

A. Title of Lesson: Reactor Manual Rod Control System

B. Lesson Description: This lesson contains information pertaining to the Reactor Manual Rod Control System. The scope of this training is defined by the learning objectives and in general covers the knowledge required of a Licensed Control Room Operator.

C. Estimate of the Duration of the Lesson: 6 hours

D. Method of Evaluation, Grade Format, and Standard of Evaluation: Written exam, passing grade of 80% or greater.

E. Method and Setting of Instruction: This lecture should be conducted in the classroom.

F. Prerequisites:

1. Instructor:
   a. Certified in accordance with NTP-16.
2. Trainee:
   a. Initial License Candidate - In accordance with the eligibility requirements of NTP-10
   b. Licensed Operator Requal - In accordance with the requirements of NTP-11

G. References:

1. 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. Procedures
   a. N2-OP-95A, Rod worth minimizer
   b. N2-OP-95B, Rod sequence control system
   c. N2-OP-96, Reactor manual control and rod position indication system
3. NMP-2 FSAR
   a. Design Basis, Vol. 16, Section 7.7, Pg. 7.7-1

II. REQUIREMENTS

A. AP-9 Administration of training

B. NTP-10 Training of Licensed Operator Candidates

C. NTP-11 Licensed Operator Requalification Training

D. NTP-12 Unlicensed Operator Training

III. TRAINING MATERIALS

A. Instructor Materials:

1. Classroom
2. Lesson Plan
3. TR
4. Transparency package
5. Overhead projector
6. Applicable references
7. Trainee handouts
8. Course Evaluation Sheets

B. Trainee Materials:

1. Handouts (can include text, drawings, objectives, procedures, etc.)
2. Pens, pencils, papers
3. Course Evaluation

IV. EXAMS AND MASTER ANSWER KEYS

A. Exams will be generated and administered as necessary.

B. Exams and master answer keys will be on permanent file in the records room.

V. LEARNING OBJECTIVES

A. Terminal Objectives:

Upon completion of this lesson, the trainee will demonstrate the knowledge to:

TO#	Terminal Objective	Task Number
TO-1.0	Perform the actions for a stuck/inoperable control rod	2000360401
TO-2.0	Perform the actions required for a loss of rod position indication	2000370401
TO-3.0	Perform the actions required for a mispositioned control rod	2000390401
TO-4.0	Perform the actions required for a control rod drift	2000490501
TO-5.0	Conduct Rod Worth Minimizer operability test, N2-OSP-RMC-@002	2010010201
TO-6.0	Conduct Rod Sequence Control operability test, N2-OSP-RMC-@004	2010050201
TO-7.0	Bypass a control rod in the reactor manual control system	2010170101
TO-8.0	Bypass and unbypass a control rod in the rod sequence control system	2019020101
TO-9.0	Substitute a rod position in the rod sequence control system	2019040101
TO-10.0	Perform actions in response to loss of rod position indication or control rod display	2019080101
TO-11.0	Perform actions for a mispositioned control rod	2019270101
TO-12.0	Respond to an inoperable rod worth minimizer (at less than 20% power)	2019320101
TO-13.0	Place the Rod Worth Minimizer in operate	2019340101
TO-14.0	Confirm reactor shutdown using the Rod Worth Minimizer	2019350101

TO-15.0	Substitute a control rod position using the Rod Worth Minimizer operator display assembly	2019360101
TO-16.0	Place the Rod Worth Minimizer in the rapid power reduction sequence mode of operation	2019370101
TO-17.0	Identify control rod drift using the Rod Worth Minimizer	2019380101
TO-18.0	Operate the Rod Worth Minimizer in the rod test mode	2019390101
TO-19.0	Operate the Rod Worth Minimizer in the rod timing monitor mode	2019400101
TO-20.0	Bypass the Rod Worth Minimizer	2019410101
TO-21.0	Return the Rod Worth Minimizer to normal from any other mode of operation	2019420101
TO-22.0	Bypass control rod input to the Rod Worth Minimizer	2019430101
TO-23.0	Unbypass control rod input to the Rod Worth Minimizer	2019440101
TO-24.0	Align the Rod Worth Minimizer for shutdown margin testing	2019450101
TO-25.0	Use the Rod Worth Minimizer to determine proper sequence alignment when operating above the low power setpoint (LPSP)	2019460101
TO-26.0	(SRO ONLY) Authorize bypassing a control rod position indication	3410560303
TO-27.0	(SRO ONLY) Direct the actions required for a stuck control rod	3449240503
TO-28.0	(SRO ONLY) Direct the actions required for an inability to drive control rods	3449250503
TO-29.0	(SRO ONLY) Direct the actions required to respond to a control rod drop accident	3449390503
TO-30.0	(SRO ONLY) Respond to a control rod drift	3449740403
TO-31.0	(SRO ONLY) Direct actions for alternate rod insertion	3449880403
TO-32.0	(SRO ONLY) Authorize control rod bypass	3450330103
TO-33.0	(SRO ONLY) Recover from control rod misalignment	3450610103

B. Enabling Objectives

EO-1.0 Explain the purpose and function of the Reactor Manual Rod Control System.

EO-2.0 Describe the purpose and function of each of the following major components of the Reactor Manual Rod Control System.

a. Rod select module
b. Activity control section
c. Analyzer section
d. Branch junction modules
e. Transponders
f. Rod and detector display
g. Four rod display

EO-3.0 Describe how the Rod Position Information System (RPIS) generates rod position indication.

EO-4.0 Describe the purpose of the Rod Sequence Control System.

EO-5.0 Describe the purpose and function of each of the following major components of the rod sequence control system.

a. RSCS Cabinet
b. Rod bypass file
c. RSCS display panel

EO-6.0 Describe the purpose and function of the Rod Worth Minimizer (RWM).

EO-7.0 Describe the following RWM modes of operation.

a. Operate mode
b. Bypass mode
c. Inop mode
d. Test mode

EO-8.0 Describe the Rod Bypass options of the RWM.

EO-9.0 Describe the Confirm Shutdown function of the RWM.

EO-10.0 Describe the Rapid Power Reduction function of the RWM.

EO-11.0 Describe the Rod Drift function of the RWM.

EO-12.0 Describe the Substitute options of the RWM.

EO-13.0 Describe the Sequence Alignment function of the RWM.

EO-14.0 For the automatic functions of the Reactor Manual Control System (withdraw blocks, insert blocks):

a. List all signals which would cause the automatic function

b. State the setpoint (if any) at which the signal will cause the automatic function

c. State when and how the automatic function is bypassed (either automatically or manually)

EO-15.0 Describe the interrelationship between the Reactor Manual Rod Control System and the following ~~is a~~ list of systems. rw 5/17/91

a. Neutron monitoring

b. Control Rod Drive Hydraulic System

c. Reactor Protection System

d. Control rod drive mechanisms

e. Plant Electrical distribution

f. Fuel handling and servicing equipment

g. Feedwater Level Control System

EO-16.0 (SRO ONLY) Determine the appropriate bases, limiting conditions for operation, and limiting safety system settings, and/or action statement as applicable given the NMP2 Technical Specifications and a set of plant conditions.

EO-17.0 Explain the basis for each precaution and limitation listed in N2-OP-95A, 95B and 96.

EO-18.0 Describe the immediate operator actions required given a specific set of plant conditions.

EO-19.0 Determine and use the correct procedure to identify the actions and/or locate information related to the following Reactor Manual Rod Control System operations:

a. Startup

b. Shutdown

c. Normal Operations

d. Off-Normal Operations

e. Annunciator Responses

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
I. INTRODUCTION		
A. INTRODUCTION		
1. Have students fill out TR.		
2. Explain purpose of Course Evaluation and how to use it.		
3. Explain method of evaluation.	Describe daily quizzes/weekly exams.	
4. Review Student Learning Objectives.		
B. System Purpose		EO-1.0
1. The Reactor Manual Rod Control System allows 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.		
C. General Description		
1. Consists of four subsystems:		
a. Rod Drive Control System (RDCS)		
b. Rod Position Information System (RPIS)		
c. Rod Sequence Control System (RSCS)		
d. Rod Worth Minimizer System (RWM)		

2. RDCS Accomplishes all rod movements except scram. Cannot cause or prevent scram.
3. RPIS furnishes rod vertical position.
4. RSCS imposes restrictions on rod movement to limit undesirable consequences of rod drop accident.
5. RWM is a 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.

II. DETAILED DESCRIPTION

A. Rod Drive Control System (RDCS)

1. Three modes of operation — Show T.P.-1
   a. Operator follow mode - used to move rods
   b. Scan mode - gathers hydraulic control unit data
   c. Test mode - tests all functions of transponder cards and related command circuitry.
2. Major Components — EO-2.0a
   a. Rod Select Module (RSM)
      1) Contains push buttons for selecting
         a) Control rods

b) Stabilizer valve set (A or B)
c) Drift Control (Test or Reset)
d) Movement Commands (Insert, Withdrawal, Continuous Withdrawal, or Continuous Insert)

2) Forms REQUEST WORD

b. Rod Drive Control Cabinet (RDCC)

1) Activity Control Section

EO-2.0b

a) Receives REQUEST word from RSM
b) Provides two COMMAND words if not blocked to move rod one notch
c) Outputs blocked for withdrawal without meeting permissives.
d) Permissive inputs:
RPIS
Neutron Monitoring System
RSCS
RWM
Service and Refuel Platforms
e) Rod blocks, setpoints and overrides.

2) Analyzer Section — EO-2.0c

a) Compares COMMAND words from Activity Controls for equivalency.

b) If equivalent one sent to transponders as COMMAND word, and one retained in analyzer as REFERENCE word.

c) ACKNOWLEDGE word from transponders compared to REFERENCE word.

d) If error occurs, all rod motion prevented due to loss of 120VAC to HCU transponders.

c. Branch Junction Module (BJM) — EO-2.0d

1) Mounted at end of a cluster of HCUs

2) Transmits COMMAND word to transponder and downstream BJM

3) Transmits ACKNOWLEDGE word to RDCC or upstream BJM

d. Transponder — EO-2.0e

1) Receives COMMAND from 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.

4) 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

e. Display Memory Module

1) Prepares information from RDCS and RPIS for display on Rod and Detector Display and 4-Rod Display

f. Rod and Detector Display (RDD)

EO-2.0f

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 in core

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

g. Four-Rod Display

EO-2.0g

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

B. Rod Position Information System (RPIS) — EO-3.0

1. Magnetic reed switches open and close as magnet on bottom of index tube pass giving vertical position.
   a. Information provided to:
      1) 4-Rod Display
      2) RDD
      3) RWM
      4) RSCS
2. 185 position probes and RPIS cabinet (P615)
3. Receives REQUEST word to identify selected rod
4. Rod drift alarm if odd reed switch on and rod not being driven or selected
5. Drift Test available, drift reset
6. RPIS interfaces with Process Computer System

C. Rod Sequence Control System (RSCS)

1. 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. — EO-4.0
2. Rods sequenced for start-up and shutdown.

3. Withdrawal sequence restrictions up to 20% power (LPSP) Low Power Setpoint
   a) Minimizes control rod worths
   b) Avoids high notch worths
   c) Maintains proper power distribution
4. Above LPSP RSCS is automatically bypassed.
5. Reverse rod moving procedure from start-up is used for shutdown.
6. Components
   a. RSCS Cabinet (P659) — EO-5.0a
      1) Rod Pattern Controller (RPC)
         a) Monitors operators request for rod motion and blocks, if necessary.
         b) Determines continuous or single notch motion permissive.
      2) Rod Bypass File — EO-5.0b
         a) 8 Rod Bypass Switches
         b) Provides bypassing of faulty rod position data to the RPC for up to 8 rods
         c) Only 3 rods allowed from any RSCS group

b. RSCS Display Panel — Show T.P.-2 — EO-5.0.c

1) Interface between operator and RSCS cabinet

2) Core map with amber and red LED

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

b) Red indicate RODS FI or rods BYPASSED.

3) Select between INSERT or W/DRAW and SEQ A or SEQ B

c. Turbine First-stage Pressure Transmitters

1) Two Transmitters

2) RSCS bypass signal when >LPSP

D. Rod Worth Minimizer (RWM) — EO-6.0

1. The RWM functions to minimize the efforts of a rod drop accident by enforcing start-up, shutdown, and low power control rod patterns which minimize the maximum rod worth of any rod. The rod worth minimizer performs its function by inhibiting rod movement through rod blocks.

a. Tech. Spec. Bases - The RWM is intended to mitigate the effect of a postulated rod drop accident below the low power setpoint (LPSP) [20% steam flow] by limiting the peak fuel enthalpy to less than 280 calories/gram.

b. The postulated rod drop accident assumes a rod was uncoupled during startup and was stuck fully inserted. Later on during power ascension, the rod drops and exits the core.

Above the LPSP the RWM no longer causes blocks because above this power level there is no single rod with a high enough worth to generate fuel damaging heat flux.

2. The RWM enforces rod pattern constraints below the LPSP. Above the LPSP the RWM does not enforce rod pattern constraints, although the blocks are displayed by the RWM.

Uses steam flow signal transmitters from the Feedwater System.

3. In addition to the LPSP the RWM has a low power alarm point (LPAP) associated with it. The LPAP is set at 35% steam flow and serves as a warning point to operators when decreasing power. At this point the operator needs to be sure that the rods are in accordance with RWM blocks otherwise he may bet blocks once power is lowered to less than the LPSP. (Frequently referred to as "Locked up").

4. Operators Display
   a. Located at P603.
   b. Consists of a display screen, four softkeys, and an operate/bypass/test mode switch. — Show T.P.-3
5. Computer Display
   a. Located at panel 615 in Control Room.
   b. Consists of a display screen, four softkeys, and operate/inop mode switch, cursor keypad, and a number keypad. — Show T.P.-4
6. Modes of Operation
   a. Operate Mode — EO-7.0a
      1) Both the computer display switch and the operator display switch are in the operate position.
      2) This is the normal mode of operation for operation of the plant at all power levels.
      3) Rod Block constraints will be in effect below the LPSP.
   b. Bypass Mode — EO-7.0b
      1) Computer display switch is in operate, operator display switch is in bypass.
      2) This mode of operation can be used if the RWM is malfunctioning.

3) In this mode:
   - All RWM blocks are bypassed
   - All displays and functions are identical to the operate mode menus except mode will be displayed as "BYPASS".
   - All self tests will continue.
   - The bypass switch provides a hardware bypass to the rod select module so no blocks or annunciation are applied.

c. Inop Mode

EO-7.0c

1) The RWM System is in inop, ode anytime the computer display switch is in the inop position regardless of the operator display switch position.

2) Various tasks are performed in the inop mode which include:
   - Rod bypassing
   - Checking display pixels
   - Softkey checks
   - A more intricate and controlled self test function

- System programming through the 3D Monicore Computer
- Selection of which sequence to enforce

d. Test Mode — EO-7.0d

1) Computer display switch in the operate position and the operator display switch in the test position.

2) In the test mode:

- Rod test function may be performed
- A shutdown margin test may be performed however, this is not the shutdown margin test we perform and we will not use this function.

This test is for a 2 rod SDM test.

7. System Displays

a. The displays at panels 603 and 615 are the same in appearance although some function can only be performed at the operators display while others can only be performed at the computer display.

Show T.P.-5
Worst case default screen is used so that all mid displayed parameters may be shown.

b. The Displays are divided into three sections.

1) Upper Display

a) This is the portion of the display above the line.

b) The upper display parameters are always the same regardless of the mode of operation.

c) Self test - shows the status of self test operations (OK or FAULT).

d) Blocks - shows present blocks (INSERT and/or WITHDRAW or NONE).

e) Sequence - shows the sequence selected for rod movement.

f) Step - shows the step that you are presently at in the selected sequence. RWM steps may only be one rod movement but in most cases will be a multitude of movements.

Steps are subdivisions of groups.

g) Mode - shows the RWM mode of operation (OPERATE, INOP, BYPASS, OR TEST).

h) Power - shows power level as either:

BELOW LPSP when steam flow is <20%.

Above LPAP when steam flow is >35%.

TRANSITION when steam flow is >20% but <35%, TRANSITION is always displayed in reverse video.

Explain that reverse video is white letters on a black background.

2) Mid Display

a) The portion of the display below the line and above the menu selection options.

b) This section of the display can look many different ways depending on the menu option selected.

c) The default screen will come up anytime the system is turned on and no other screens are selected through the menu selection keys.

3) Lower Display
   a) Lowest portion of the display screen.
   b) Shows possible menu selection options. The options are selected by pressing the softkey directly under the option shown on the display.
4) Default Screen Description
   a) SR - shows selected rod coordinates and notch position.
   b) WE - shows withdraw error rod
   c) IE- shows the last rod for which an insert error occurred. The smaller two IE's in the lower right portion of the screen show the two previous blocks.
   d) SE - select error is present.
   e) IB - insert block is present.
   f) WB - withdraw block is present.
   g) A1-145 - shows sequence and step.

SE, IB, & WB pertain to selected rod.

8. RWM Bypass Options

a. Rod Bypass

1)	If a rod is out of position and cannot be moved or ha a faulty position indication in two consecutive notches then its position must be bypassed in the RWM System.	Point out that this display shows the number of rods bypassed, bypassed rods coordinates, and ID of rod selected to bypass or unbypass. If you are not in the INOP mode at the computer display you will not be offered the bypass softkey option.
2)	The RWM will always show which rods are bypassed (in any mode), but you may only bypass rods at the computer display in the inop mode.	
3)	No more than eight rods may be bypassed.	No more than three rods in any RSCS group may be bypassed (Admin Control T.S. 3.1.4.2.b.2).
4)	The position must also be bypassed in the RSCS System because the systems are redundant.	
5)	A rod is bypassed by selecting inop on the computer display mode switch, selecting the bypass rods menu, selecting the ord using the up/down cursor, and then selecting the bypass rod softkey. The rod will then appear on the screen as a bypassed rod.	

9. Check Display
   a. Available at both displays in the inop mode only.
   b. Checks pixels on the screen.

   Show T.P.-6
   Show screen being filled during the check display function.

10. Check Keys
   a. Available at both displays in the inop mode only.
   b. Gives indication of softkey continuity.

   Show T.P.-7

   EO-9.0

11. Confirm Shutdown
   a. The RWM System automatically detects a Reactor SCRAM by sensing three open scram valve positions and displays the confirm shutdown screen. From this screen the operator can quickly assess the status of the reactor scram.
   b. The confirm shutdown screen displays the following:
      1) All Rods in - "YES" if all rods are detected to be full in by the full in reed switch closure. "NO" if any full in reed switch is not closed.
      2) Shutdown - "YES" if all rods are in to at least position 02.

   Show T.P.-8
   Uses both full in and "00" position switches.

3) Rods Not Full In - Shows number of rods not full in as detected by lack of full in reed switch closures.

c. The "list rods" softkey function is available on the confirm shutdown screen. Depressing the softkey will give you a display showing all the rods which are not full in (16 at a time), and their positions.

Show T.P.-9

This display does not update while it is selected. However if there is a change in rod status the confirm shutdown display will automatically return to give an update on how many rods are not in.

d. Depressing the exit softkey will return you to the default screen.

12. Display Off

a. Available in all modes; selected from the default screen. Depressing the display off softkey will blank the display. The screen will automatically come back on if any of the following occur:

If none of the above conditions have occurred in the past 30 minutes, the computer display will automatically turn off.

1) A front panel key is pressed.
2) A change of power level occurs; except when the ABOVE LPAP region is entered while increasing power.
3) A change of mode occurs.
4) A change in self test status occurs.

13. Help	
a. Depressing the softkey for "help" will present displays which show the different RWM operations which are available to you along with a brief description of the operation for the present mode.	Refer to section 5 of N2-OP-95A for information on the help screen.
14. Inferred Position	
a. Appears automatically whenever a data fault occurs while moving a control rod.	Show T.P.-10
b. The inferred position uses its knowledge of the rod's past indication along with the direction of movement to determine the rod's present position.	
c. This information will be used to substitute the control rod at the correct position.	
15. Messages	
a. The messages screen is available at both displays at all times.	Show T.P.-11
b. This allows the display of the last five RWM messages on the screen.	
c. All messages are logged on the plant computer (demand typer).	Use Attachment 7 of OP-95A to show all available messages.

16. Rapid Power Reduction — EO-10.0

a. The Rapid Power Reduction (RPR) function is available at the operators display only in the operate or bypass modes. — Show T.P.-12

b. Rapid Power Reduction gives the operator the rod coordinates and present positions of rods which should be driven in if power must be reduced quickly. Also shown are the positions to which the rods must be driven.

c. The first screen of the RPR screen only shows two rods at a time, but this screen updates automatically. The second screen shows the next 16 rods which must be driven in but does not update.

d. The RPR sequence is automatically calculated each time a rod moves.

17. Rod Drift — EO-11.0

a. The Rod Drift screen comes up automatically in the event of a rod drift. — Show T.P.-13

b. The screen displays the number of rods drifting and at least one of the rods which are drifting. (Random choice)

c. A second screen which will list the drifting rods is available. This screen is not dynamic and if the number of drifting rods changes the display will automatically shift back to the main rod drift screen.

Rod drift annunciator is driven from NUMAC, but rod drift lights on the full core display still come from reactor manual control.

d. RWM rod drift will detect a single rod scram 100% of the time.

e. Rod Drift is still reset by pressing the drift reset pushbutton on the RDCS console.

18. Rod Timing Monitor

a. The RWM has a rod timing function which has the capability of timing total drive time and switch time (the time for movement between each reed switch closure, including odd contacts).

Show T.P.-14

Switch times can be used for course needle valve adjustments without requiring full strokes between adjustment.

b. The rod timing function is also useful for recording rod motion when the rod is being driven, it is <u>not</u> useful for recording scram times, the GETARS will be used for that.

c. If the arm record softkey is depressed the rod's time will be recorded and stored in NUMAC battery backed RAM (Random Access Memory).

1) If the data is recorded it can be transferred to the 3D Monicore computer for further analysis.
2) Only one set of data for a rod may be stored. If the arm record function is selected, the previous data for the rod is overwritten.
3) After arm record is selected then disarm record is available to cancel the arm record command.

d. The timing display comes up showing the rod position and an arrow, as soon as rod movement begins the timers will start recording.

e. After the rod is stopped the final position and times are displayed.

f. Once the rod is stopped the display plot softkey function is available. If selected a plot of the rod timing switch positions will be displayed.
1) Movement using softkeys allows access to specific switch times.

19. Rod Test

a. Rod test function allows movement of the control rod for testing. Only one rod may be withdrawn in this mode and in order to enter the mode all rods must be in or only one rod withdrawn.

Show T.P.-15

Keylock switches should not be operated while in rod test because this may prevent you from reentering rod test and result in a rod which is interlocked out.

20. Substitute Options

EO-12.0

a. Substitute options allows a substitute position to be entered for rods.

Show T.P.-16, 17, 18 & 19

b. Display shows rods which have substitute data and the position at which substitute data is entered. Also shown are the selected rod position and new position to substitute to data. Inferred position may be used to aid identify the position to substitute to.

Point out that substitute data information can be displayed anytime, but substitute data can only be utilized at the operator display when in the operate, test, or bypass modes.

c. Substitute position is lost as soon as position is a valid signal.

When a rod is at 48 and substituted, it must be resubstituted after each rod exercising because momentarily moved to a valid (46) position.

d. Data may be substituted only if the position has a data fault (invalid position information) and less than eight rods have substitute data.

21. Self Test

a. The NUMAC RWM is constantly running a self test of itself. Information dealing with status of the self test can be displayed at the computer display. Also in the INOP mode technicians may take some control of the self test feature to aid in troubleshooting the system.

Show T.P.-20

Discussion of self test should be limited because it is an item which will primarily be used by the maintenance department.

22. Sequence Alignment

EO-13.0

a. The operating alignment function is used to assist the reactor operator while bringing the plant down in power. This function determines the step that can be aligned to with no rod withdrawals and the minimum number of rod insertions.

Show T.P.-21

b. The Optimal step is the step which will bring the plant into sequence with minimal rod motion. The RWM System assumes the alignment step and the optimal step to be the same, however you can select a different alignment step if you wish by using the increment/decrement softkey.

c. Once the alignment step is chosen the screen will display the rods, present position, and target position.

Show T.P.-22

d. Sequence alignment is available only at the operator display in the operate and bypass modes.

e. The sequence alignment may be printed out on the 3D Monicore computer.

23. Sequence Options

a. The sequence options selection allows downloading of rod control sequences from the 3D Monicore computer.

Discussion of sequence options should be limited because it will be used primarily by the reactor engineering group.

24. Set Parameters

a. The set parameters function programs the RWM for NMP-2 specific purposes. Once the system is initially set up these parameters should not change.

Discussion of set parameters should be limited because it will be used primarily during initial system set up.

III. 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. Diagnostic Test
   f. Rod Test Mode

C. INDICATIONS

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

D. INTERLOCKS

1. Rod blocks Table 1 and figure 7
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.

EO-14.0

IV. 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

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 checked for the correct response. Cycle of all 185 rods is continuously repeated.

V. SYSTEM INTERRELATIONS

EO-15.0

A. Plant Electrical Distribution

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

B. Neutron Monitoring System - provides power level signals to RxMC and status signals

C. Control Rod Drive Hydraulic System - provides scram discharge volume levels and RxMC control signals

D. Reactor Protection System

The RPS discharge volume high vessel level bypass switches send position signals to the RxMC

E. Control Rod Drive Mechanisms - provide position information signals to the RxMC

F. Fuel Handling and Reactor Servicing Equipment - signals are sent to RxMC from:
   1. Refuel platform
   2. Service platform
   3. Grapple
   4. Frame hoist
   5. Trolley hoist

G. Feedwater Level Control System - provides total steam flow signal to RWM for the LPSP and LPAP.

VI. DETAILED REFERENCE REVIEW

Review the following referenced documents with the class.

A. Technical Specifications — EO-16.0
   1. 3/4.1.4.1 Rod Worth Minimizer
   2. 3/4.1.4.2 Rod Sequence Control System
   3. 3/4.10.2 RSCS Special Test Exceptions
   4. 3/4.1.3.7 Control Rod Position Indication
   5. 3/4.1.3.6 Control Rod Drive Coupling
   6. 3/4.3.6 Control Rod Block Instrumentation

B. Procedures
   1. N2-OP-95A Rod Worth Minimizer — EO-17.0
   2. N2-OP-95B Rod Sequence Control System — EO-18.0
   3. N2-OP-96 Reactor Manual Control and Rod Position Indication — EO-19.0

VII. WRAP-UP

A. Review the Student Learning Objectives