MASTER CONTROLLED DOCUMENT

NINE MILE POINT NUCLEAR STATION

UNIT II OPERATIONS

02-189-91

LESSON PLAN

02-REQ-001-215-2-06-4

LOCAL POWER RANGE MONITORING SYSTEM (LPRM)

Prepared by: Unit #2 Training Department

APPROVALS	SIGNATURES	DATE AND INITIALS REVISION 4
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Summary of Pages

Revision: 4 (Effective Date: 6/17/88)

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NIAGARA MOHAWK POWER CORPORATION

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Attachment "A"

OBJECTIVE APPROVAL

Author: UNIT II OP's TRAINING

Training Dept: Unit II OPS.

Lesson Title: LOCAL POWER RANGE MONITORING SYSTEM

Lesson Plan #: NZ-OLP-28

Training Setting(s): Classroom

Purpose: INSTRUCTOR shall present information for the student to meet each Student Learning Objective, Additionally, he shall provide sufficient explanation to facilitate the student's understanding of the information presented.

Trainee Job Title: LICENSED OPERATOR CANDIDATE
NON-LICENSED OPERATOR TRAINING
LICENSED OPERATOR REQUALIFICATION

Approvals/Review	Signatures	Date
Training Supervisor	[signature]	6/16/88
Plant Supervisor	[signature]	6/16/88
Training Analysts Supervisor	[signature]	5-26-88

When complete, attach this form to the master lesson plan.

LESSON PLAN

I. TRAINING DESCRIPTION

A. TITLE: Local Power Range Monitoring System (LPRM)

B. PURPOSE: In a lecture presentation, the instructor shall present information for the student to meet each Student Learning Objective. Additionally, he shall provide sufficient explanation to facilitate the student's understanding of the information presented.

C. TOTAL TIME:

1.5 hours

D. TEACHING METHODS:

- Classroom Lecture
- Assign the Student Learning Objectives as review problems with the students obtaining answers from the text, writing them down and handing them in for grading.

E. REFERENCES:

1. Technical Specifications
   a. NMP-2 Technical Specifications 3/4.3.1 Reactor Protective System Instrumentation

2. Procedures
   N2-OP-92, Neutron Monitoring

3. NMP-2 FSAR
   Design Basis Vol. 16, Chapter 7.6.1.4, Page 7.6-3

4

II. REQUIREMENTS AND PREREQUISITES

A. REQUIREMENTS FOR CLASS:

1. AP-9, Rev. 2, Administration of Training
2. NTP-10, Rev. 03, Training of Licensed Operator Candidates
3. NTP-11, Rev. 04, Licensed Operator Retraining and Continuous Training
4. NTP-12, Rev. 02, Unlicensed Operator Training

B. PREREQUISITES

1. Instructor
   a. Demonstrated knowledge and skills in the subject, at or above the level to be achieved by the trainees as evidenced by previous training or education <u>or</u>
   b. SRO license for Nine Mile Point Unit Two or a similar plant, or successful completion of SRO training including simulator certification at the SRO level for Nine Mile Point Unit Two.
   c. Qualified in instructional skills as certified by the Training Analyst Supervisor.
2. Students
   a. Meet eligibility requirements per 10CFR55 <u>or</u>
   b. Be recommended for this training by the Operations Superintendent or his designee or the Training Superintendent.

III. TRAINING MATERIALS

A. TEACHING MATERIALS:

1. Transparency Package
2. Overhead Projector
3. Whiteboard and Felt Tip Markers
4. N2-OLP-28
5. N2-OLT-28
6. See Section I.E.1
7. See Section I.E.2

B. STUDENT MATERIALS:

1. N2-OLT-28
2. See Section I.E.1
3. See Section I.E.2

IV. QUIZZES, TESTS, EXAMS AND ANSWER KEYS

Will be generated and administered as necessary. They will be on permanent file in the Records Room.

V. LEARNING OBJECTIVES FOR LOCAL POWER RANGE MONITORING SYSTEM (LPRM) | 4

Upon completion of this chapter, mastery of the required system knowledge will be demonstrated by performing the Enabling Objectives listed below.

28-1 State the purpose of the Local Power Range Monitoring System.

28-2 Describe the locations of LPRM detectors within the core.

28-3 Explain why gamma discrimination is not necessary for LPRM's.

28-4 List the LPRM System indications available to the operator including setpoints for annunciators.

28-5 List three (3) systems which receive inputs from the Local Power Range Monitor System.

28-6 Explain the operation of an LPRM fission chamber including design differences between this type of fission chamber and the others used in the Neutron Monitoring System.

28-7 State the LPRM Power supplies for:

a. LPRM Group A
b. LPRM Group B
c. APRM A,C, and E
d. APRM B,D, and F

28-8 Given N2-OP-92, Neutron Monitoring, use the procedure to identify the appropriate actions and/or locate information related to:

a. Startup
b. Normal Operations
c. Shutdown
d. Off-Normal Operations
e. Procedures for Correcting Alarm Conditions

28-9 SRO Only 4

Given Technical Specifications, identify the appropriate actions and/or locate information relating to Limit Conditions for Operation, Bases, and Surveillance Requirements for the LPRM system.

VI. LESSON CONTENT

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.	
I. INTRODUCTION				|4
Student Learning Objectives	i			|
A. Purpose	1		1	|
1. Provides signals proportional to local neutron flux over the full power range (0-125%) at specific locations in core.				
2. The signals are used by protection systems to ensure protection of the cladding and to aid in evaluating the nuclear and thermal-hydraulic performance of the core.				
B. General Description		1		
1. Use figure 1 to discuss system operation.				
2. Name each major component.				
3. LPRM system consists of 172 detectors, each containing a fission chamber, power supply, and flux amplifier.				
II. DETAILED DESCRIPTION	2			
Describe the following components, indicators, control devices, etc.				
A. LPRM Detector Assembly			2	|4
1. Physical location - in core (see Figures 1 & 2) in the alternate water gaps diagonally adjacent to the control rods.				

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.
2. Internal parts - Enclosed in the Instrument Tube are 4 separate fission detectors with cables, and a calib. tube for TIP. Each detector is in a dry tube.	2	1	
3. Design Parameters - Instrument Tube has:			
a. Evenly spaced holes drilled along its length for cooling (above and below core plate).			
4. Core Installation		1,2	
a. Radial distribution - one LPRM assembly in every 4th uncontrolled water gap.	3	2	2
1) Controlled gap - water gap containing a control rod			
2) Uncontrolled gap - water gap without rods.			
b. Axial distribution-At 43 axial locations there are 4 detectors in each LPRM string (total = 172).			2
1) Each detector is 36 in. apart			
2) Bottom detector (A) approx. 18 in. above the Bottom of the Active Fuel (BAF). Active fuel is 150" of a 160" full rod.			
3) Top detector (D) approx. 24 in. below the Top of the Active Fuel (TAF).			

4

Activity		Text Ref. Page	Text Ref. Fig.	S.L.O.
	4) Identified by core coordinate locations (x-y-z). Ex.--LPRM detector 16-09-A in Figure 2 is at x-y 16-09; Z specifies the vertical position (A, B, C, D), A the lowest, D the highest, so A is the 16-09 string's detector that is 18" above the Bottom of Active Fuel.			
	c. LPRM assemblies are installed from above RPV.	2		
	d. The assembly passes vertically thru the core, the core support plate, and then into the guide tube where it mates with the detector in-core housing and guide tube at the lower vessel closure head.			
	e. The top of the assembly is locked to the upper grid by means of a spring-loaded plunger integral to the detector string, and gives lateral support.			
	f. The in-core detector housing provides vertical support for the LPRM assembly, and provides water seal for the LPRM string.			

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.

g. The guide tube is braced at intervals along its length by a stainless steel framework.

h. Detector guide tube laterally aligns and guides the detector string, and protects against flow impingement.

B. LPRM Detector

1. Miniature fission chamber
2. Physical description
   a. Overall dimensions are 3.25 in. long, (sensitive length is 1.0 in.) and 0.23 in. diameter — 4
   b. Case and collector are Titanium, and insulated from each other by a ceramic material
   c. Inner surface of the case is coated with U_3O_8:
      1) 18% U^{235}
      2) 78% U^{234}
      3) 4% U^{238} and other uranium isotopes
   d. The fill gas is Argon.
   e. A 100 vdc electrode voltage potential is applied between the center electrode and the case, which allows the LPRM to operate in the ionization region.

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.
3. <u>Operation</u>	3		6
a. Thermal neutrons have a high probability of capture by the U^{235} in coating.			
b. When a neutron is captured, the resultant fission event releases into detector volume:			
1) Fission fragments			
2) Gamma radiation			
c. These cause:			
1) Ionization of gas and			
2) Electrical discharge between cathode and anode.			
d. Gamma radiation also causes ionization of detector gas.			
4. <u>Regenerative Characteristics</u>			6
a. U^{235} depletes (burns-up) at power due to fission events.			
b. Detector sensitivity decreases			|4
c. With the addition of U^{234}, the U^{235} is replaced/regenerated.			
d. Without U^{234}--have a non-regenerative detector with sensitivity decreasing rapidly	3		
e. U^{234} has:			
1) Low probability of capturing neutrons and fissioning, but has			

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.
2) Good probability of Thermal neutron absorption.	4		
$_{92}U^{234} + {_0}n^1 \rightarrow {_{92}U^{235}}$			
f. By selecting the proper ratio of U^{235} to U^{234}, the life of the detector is extended; slows sensitivity loss rate.			
C. Gamma discrimination			3
1. Not necessary for the LPRM's due to:			
a. Composite effect of neutrons and fission gamma overshadows background gamma.			
b. Fission gamma signal is proportional to Reactor power.			
c. Power range monitoring system is calibrated using data from a heat balance (calorimetric). The APRM's are adjusted (in conjunction with the TIP and PCS systems) to indicate true power. Therefore, it is unnecessary to gamma discriminate.	4		
D. Circuitry Block Diagram-			3
1. Detector output - small DC current propor. to neutron and fission gamma flux.			

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.
2. DC is sent to a Flux Amp, where			
a. The LPRM channel ckt. converts DC current to a 0 to 10VDC voltage. The signal string consists of the detector, Ion Chamber Power Supply, and Flux Amp.	5		
3. After amplification, signal is sent to:			5
a. APRM averaging circuits:			
1) Inputs give APRM Flux signals at each axial level (A, B, C, and D), and a			
2) Representative radial distribution.			2
3) LPRM inputs to APRM channel are permanently assigned: APRM channels A, C, E each have 21 inputs APRM channels B, D, F each have 22 inputs Total for APRM's = 129			
b. LPRM groups A, B consist of those LPRM's not selected for APRM averaging. LPRM Gp. A - 21 inputs LPRM Gp. B - 22 inputs	5		5
c. RBM's receive signals from each LPRM detector:			
a. Signals from axial positions A, C are sent to RBM channel A			
b. Axial positions B, D are sent to RBM channel B			

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.	
d. The Process Computer receives signals from each LPRM, where data is used to evaluate power distribution, local heat flux, MCPR, fuel burnup rate.				
e. Upscale alarm trip circuit- receives signals from <u>each</u> LPRM detector			4	
1) Compares output of flux amp to a ref. voltage, and				|4
2) If ref. voltage exceeded:				
1) Upscale light on P608				
2) Annunciator on P603				
3) Amber Light on P603				
3) Setpoint is 100 percent			4	
f. Downscale alarm trip circuit- works same as upscale trip circuit. (Downscale alarm lights are white.) Setpoint is 5 percent.				|4
E. LPRM Power Supply	6		7	
1. Uninterruptable Power Supplies (UPS) 2VBB-UPS3A and UPS3B feed:				|4
a. 120 VAC Inst. Bus 2VBS*Pnl. A100				
1) For LPRM's assigned to APRM's A, C, E				
2) LPRM Gp. A				|4
b. 120 VAC Inst. Bus 2VBS*Pnl. B100				
1) For LPRM's assigned to APRM's B, D, F				
2) For LPRM Gp. B				|4

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.	
III. INSTRUMENTATION, CONTROLS AND INTERLOCKS	7			
A. Indications				
1. Panel 603 (Reactor Control Panel)				
a. 16 LPRM output meters which indicate 0-125 percent from LPRMs around selected rod.				
b. The LPRM strings which are displayed on the meters are determined by the Four Rod Display.				
c. If any of the 16 detectors are not being used a White Detector A,B,C and/or D Bypassed light comes on.				
d. This shows that the RBM flux amplifier input is not being processed.				
e. Any of the 172 LPRM outputs can be indicated on the four rod display.				
2. Panel 608 (Power Range Monitoring Cabinet)	7		7	
a. Indication for LPRM Group A or B, or APRM channels A through F.				
1) 0-10V full scale (Black)				
2) 0-125 percent power full scale (RED)				
3. Position A,B,C and/or D white Downscale lights illuminate when the detector channel output is <5 percent and the LPRM is not bypassed.			4	|4
4. Position A,B,C, and/or D amber Upscale lights illuminate when the detector channel output is >100 percent and is not bypassed. Upscale alarm before thermal limits reached.			4	|4
5. LPRM Bypassed indicates the LPRM selected on panel 608 is either bypassed or calib. mode.				

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.
6. Meter Expand light indicates the meter switch on panel 608 is either in expand or reverse position.			
B. Controls	8		
1. Operate mode, the channel functions as previously described.			
2. BYPASS mode, the output is removed from use and the alarm trips are bypassed.			
3. CALIBRATE mode, the output is removed from use and a calibrator current is substituted for detector input.	8		
4. A reset button resets any seal-in trip circuit if trip has returned to normal.			
5. A meter switch is used to display normal or reverse polarity outputs.			
a. Provides x10 magnification in expand or reverse.			

IV. SYSTEM OPERATION

A. Normal Operation

The LPRM System is primarily used during power operations to provide local heat flux information and to provide inputs to the APRM and RBM Systems. The APRM's and RBM's use these inputs to provide average core power indications and to protect against fuel damage.

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.
During operation, the LPRM System provides an indication of local power adjacent to a control rod which is being moved, as well as alarms to warn the operator of an LPRM channel malfunction (fail upscale or downscale) or high local flux level.			
B. Infrequent Operation	9		
LPRM Calibration			
The LPRMs are always located in the reactor core. As the core ages, the U_3O_8 in the detector depletes (burns-up). This "burn-up" causes the sensitivity of the detector to decrease. For this reason the LPRM channels must be calibrated periodically.	9		
To perform this calibration, the Traversing In-Core Probe System (TIP) is used in conjunction with the Process Computer System (PCS) (covered in the TIP and PCS chapters).			

V. SYSTEM INTERRELATIONS

A. Average Power Range Monitor System (APRM's)

APRM's use 129 LPRM channels to yield a signal proportional to the bulk thermal power.

B. Traversing In Core Probe System (TIP)

Traversing In Core Probe System permits placement of a moveable fission chamber at any axial position along an LPRM string.

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.

C. Process Computer System (PCS)

Process Computer System receives inputs from all LPRM's for calibration, thermal limit calculation, and fuel depletion calculations.

D. Rod Block Monitor System (RBM)

Rod Block Monitor System receives inputs from all LPRMs to determine neutron flux levels around the selected rod. The RBM will prevent rod withdrawal if local flux levels are exceeded.

E. Plant Electrical Distribution

Plant Electrical Distribution uninterruptable power supplies Bus 1 (2VBS*PNLA100) and Bus 2 (2VBS*PNLB100) provide 120 VAC power to the LPRM. 10

|4

VI. DETAILED SYSTEM REFERENCE REVIEW

Review each of the following referenced documents with the class.

A. Technical Specifications 9

1. 3/4.3.1 Reactor Protection System Instrumentation SCRAM

B. Procedures 8

1. N2-OP-92 Neutron Monitoring System

C. NMP-2 FSAR

1. Design Basis Vol. 16, Chapter 7.6.1.4, page 7.6-3

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.
VII. RELATED PLANT EVENTS			4
A. Refer to Addendum "A" and review related modifications with class (if applicable).			
VIII. SYSTEM HISTORY			
A. Refer to Addendum "B" and review related modifications with class (if applicable).			
IX. WRAP-UP			
A. Review the Student Learning Objectives			