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NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT NUCLEAR STATION

02-LOT-001-215-2-06 Revision 6

TITLE: LOCAL POWER RANGE MONITORING SYSTEM (LPRM)

	SIGNATURE	DATE
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TRAINING SUPPORT SUPERVISOR	[signature]	5-24-91
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Summary of Pages

(Effective Date: 5/29/91)

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MASTER CONTROLLED DOCUMENT

TRAINING DEPARTMENT RECORDS ADMINISTRATION ONLY

VERIFICATION:

DATA ENTRY:

RECORDS:

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I. TRAINING DESCRIPTION

A. Title of Lesson: Local Power Range Monitoring System (LPRM) 6

B. Lesson Description: This lesson contains information pertaining to the Local Power Range Monitoring System. The scope of this training is defined by the learning objectives and in general covers the knowledge requirements of a Licensed Control Room Operator.

C. Estimate of the Duration of the Lesson: 1.5 Hours

D. Method of Evaluation, Grade Format, and Standard of Evaluation: Written examination: Passing grade of 80% or greater. 6

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

F. Prerequisites:

1. Instructor:

    a. The instructor shall be familiar with the lesson materials and have achieved the necessary instructor certification in accordance with NTP-16.

2. Trainee: In accordance with eligibility requirements of NTP-10.

G. References:

1. Technical Specifications

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

2. Procedures

    a. N2-OP-92, Neutron Monitoring

    b. N2-OP-101D, Power Changes

3. NMP-2 FSAR

    a. Design Basis Vol. 16, Chapter 7.6.1.4, Page 7.6-3

4. Station Nuclear Engineer Manual

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II. REQUIREMENTS

III. TRAINING MATERIALS

A. Instructor Materials:

1. Training Record 6
2. Instructor's working copy of the lesson plan.
3. Whiteboard and Markers
4. Overhead Projector
5. Transparencies as needed
6. Flip Chart (if necessary)
7. Copy of trainee handouts
8. Trainee Course Evaluation Forms

B. Trainee Materials:

1. Handouts 6
2. Paper or Notebook
3. Pen or Pencil

IV. EXAM AND MASTER ANSWER KEYS

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

V. LEARNING OBJECTIVES

Upon completion of this training, the trainee will have gained the knowledge to: 6

A. Terminal Objectives:

TO-1.0 Perform lineups on the Nuclear Instrumentation System in the Control Room. 21500101012

TO-2.0 Locate the Nuclear Instrumentation Power Supplies. 21500501012

TO-3.0 Operate the Nuclear Instrumentation System during a reactor startup. 21501901012 6

B. Enabling Objectives:

EO-1.0 State the purpose of the Local Power Range Monitoring System.

EO-2.0 Describe the locations of LPRM detectors within the core.

EO-3.0 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.

EO-4.0 Explain why gamma discrimination is not necessary for LPRM's.

EO-5.0 List three (3) systems which receive inputs from the Local Power Range Monitor System.

EO-6.0 List the LPRM System indications available to the operator including setpoints for annunciators.

EO-7.0 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

EO-8.0 Given NMP2 Technical Specifications and a set of plant conditions, determine the appropriate bases, limiting condition for operations, limiting safety system setting, and/or action statement as appropriate.

EO-9.0 Given a specific set of plant of conditions, describe the immediate operator actions required.

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
I. INTRODUCTION	Preliminary Activity 1. Introduce self to trainees (if unfamiliar). 2. Circulate and explain Training Record 3. Explain Method of Evaluation. 4. Pass out Course Evaluation Forms	6
Student Learning Objectives	Pass out copies of Learning Objectives.	6
A. Purpose 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.		EO-1.0
B. General Description 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

Describe the following components, indicators, control devices, etc.

A. LPRM Detector Assembly — EO-2.0 |6

1. Physical location - in core (see Figures 1 & 2) in the alternate water gaps diagonally adjacent to the control rods.

2. Internal parts - Enclosed in the Instrument Tube are 4 separate fission detectors with cables, and a calib. tube for TIP. Each detector string is in a dry tube. |6

3. Design Parameters - Instrument Tube has:

   a. Evenly spaced holes drilled along its length for cooling (above and below core plate).

4. Core Installation

   a. Radial distribution - one LPRM assembly in every 4th uncontrolled water gap.

      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). EO-2.0 |6

1) Each detector is 36 in. apart

2) Bottom detector (A) approx. 18 in. above the Bottom of the Active Fuel (BAF). Active fuel length is 150". |6

3) Top detector (D) approx. 24 in. below the Top of the Active Fuel (TAF).

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 lowest detector in the string located at position 16-09. |6

c. LPRM assemblies are installed from above RPV.

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.

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

There are currently two types NA300 detectors loaded for test purposes |6

- Better seals
- Nuclear lite should now be limiting

EO-3.0

a. Detector type NA200

2. Physical description

a. Overall dimensions are 3.25 in. long, (sensitive length is 1.0 in.) and 0.23 in. diameter

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.

3. Operation — EO-3.0 |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 — Point out the fission fragments are ionized |6
      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. Regenerative Characteristics
   a. U^{235} depletes (burns-up) at power due to fission events.
   b. Detector sensitivity decreases
   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
   e. U^{234} has:
      1) Low probability of capturing neutrons and fissioning. |6
      2) Good probability of Thermal neutron absorption.

         $_{92}U^{234} + _0n^1 \rightarrow X\ _{92}U^{235}$ |6
   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 EO-4.0 |6
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.

D. Circuitry Block Diagram

1. Detector output - small DC current proportional to neutron level |6

2. DC is sent to a Flux Amp |

   a. The LPRM channel ckt. converts DC current to a 0 to 10VDC voltage single. The signal string consists of the detector, Ion Chamber Power Supply, and Flux Amp. |6

3. After amplification, signal is sent to: EO-5.0, |6

   a. APRM averaging circuits: EO-6.0 |

      1) Inputs give APRM Flux signals at each axial level (A, B, C, and D). |6

      2) Representative radial distribution.

      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

c. RBM's receive signals from each LPRM detector:

Proper selection made from the rod ID number when selected. 6

a. Signals from axial positions A, C are sent to RBM channel A

b. Axial positions B, D are sent to RBM channel B

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

1) Compares output of flux amp to a reference voltage. 6

2) If ref. voltage exceeded:

1) Upscale light on P608

2) Annunciator on P603

3) Amber Light on P603

3) Setpoint is 100 percent

f. Downscale alarm trip circuit works same as upscale trip circuit. (Downscale alarm lights are white.) Setpoint is 5 percent.

E. LPRM Power Supply EO-7.0 |6

1. Uninterruptable Power Supplies (UPS) 2VBB-UPS3A and UPS3B feed:

a. 120 VAC Inst. Bus 2VBS*PNL A103 |6

1) For LPRM's assigned to APRM's A, and E |6

2) LPRM Gp. A

b. 120 VAC Inst. BW 2VBS*PNL A104 feeds LPRM's assigned to APRM C |6

c. 120 VAC Inst. Bus 2VBS*PNL B103

1) For LPRM's assigned to APRM's B, and F |6

2) For LPRM Gp. B

d. 120 VAC Inst. BW 2VBS*PNLB104 feeds LPRM's assigned to APRM D |6

III. INSTRUMENTATION, CONTROLS AND INTERLOCKS

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)

   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. 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.

5. LPRM Bypassed indicates the LPRM selected on panel 608 is either bypassed or calib. mode.

6. Meter Expand light indicates the meter switch on panel 608 is either in expand or reverse position.

B. Controls

1. Operate mode, the channel functions as previously described.

   1 through 3 is located on the card inside the cabinets. 6

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.
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

1. 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.

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.

2. Also, the LPRM's provide input into the process computer for core thermal limit evaluation. |6

B. Infrequent Operation 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.

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. — Each APRM uses either 21 or 22 inputs. |6

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.

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 applicable LPRMs to determine neutron flux levels around the selected rod. The RBM will prevent rod withdrawal if local flux levels are exceeded. |6

E. Plant Electrical Distribution

Plant Electrical Distribution uninterruptable power supplies Bus 1 (UPS 3A) and Bus 2 (UPS 3B) provide 120 VAC power to the LPRM. |6

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
VI. DETAILED SYSTEM REFERENCE REVIEW		
Review each of the following referenced documents with the class.		
A. Technical Specifications		
1. 3/4.3.1 Reactor Protection System Instrumentation		EO-8.0 |6
B. Procedures		EO-9.0 |
1. N2-OP-92 Neutron Monitoring System		
2. N2-OP-101D Power Changes	Explain use of LPRM's in OP101D Section H.2.0	|6
C. NMP-2 FSAR		
1. Design Basis Vol. 16, Chapter 7.6.1.4, page 7.6-3		
VII. RELATED PLANT EVENTS		
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		