NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT NUCLEAR STATION

UNIT II OPERATIONS

07-190-91

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TITLE: OPTICAL ISOLATOR TECHNICAL SEMINAR

	SIGNATURE	DATE
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Summary of Pages

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TRAINING DEPARTMENT RECORDS-ADMINISTRATION ONLY:

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I. TRAINING DESCRIPTION

A. Title of Lesson: Optical Isolator Technical Seminar

B. Lesson Description:

1. This lesson is to provide Reactor Operators with a background knowledge of Optical Isolators so that they understand the effects of isolator failure and are able to read electrical prints which contain Optical Isolators.

C. Estimate of the Duration of the Lesson: 3 hours

D. Method of Evaluation, Grade Format and Standard of Evaluation: Attendance only

E. Method and Setting of Instruction: Classroom/lecture

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:

Licensed operator at NMP-2

G. References:

1. GE Isolator Card Manual N20402
2. Plant ESK Drawings
3. GE Drawings
4. Panel Wiring Diagrams

II. REQUIREMENTS

A. Requirements:

1. none

III. TRAINING MATERIALS

A. Instructor Materials:

1. Copy of this lesson plan
2. Whiteboard and markers
3. Overhead projector
4. Student handouts
5. Isolator cards
6. Optical isolator casing

B. Trainee Materials:

1. Student handouts

IV. EXAM AND MASTER ANSWER KEYS

A. None

V. LEARNING OBJECTIVES

A. Terminal Objectives

TO-1.1 Recognize how a failed or removed Optical Isolator Card effects plant operation.

B. Enabling Objectives

EO-1.1 State the function of an Optical Isolator.

EO-1.2 Explain why Optical Isolators are used at NMP2.

EO-1.3 Given any NMP2 Optical Isolator mark number, state the effects on plant equipment and controls if the card must be removed.

VI. LESSON CONTENT

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
A. What is an Electronic Optical Isolator?		
1. An Electronic Optical Isolator is a device which physically isolates electrical wiring and conveys the electrical signal optically (use of LED's).	Show physical cards and optical isolator casing.	EO-1.1
B. Why and where are they used at NMP2?		
1. Optical Isolators are used at NMP2 to isolate safety related wiring from non-safety related wiring.		EO-1.2
2. Optical Isolators are largely used at NMP2 to separate the annunciator panels and process computer (non-safety) from the safety related instrumentation and switches feeding these components.	If a fire or large current overload occurred in the process computer the fault will not be fed back through to the safety related wiring and controls of safety related equipment.	
a. It would be disadvantageous to make the process computer and annunciator boards safety related because then you would need two different systems.		
1) Safety related annunciator panels.		
2) Non-safety annunciator panels.		
C. How do Optical Isolators work?		
1. Digital input Optical Isolators.		
a. Input card		

1) Block Diagram Description. The field contact input isolator card contains ten identical circuits. A typical hookup to one of these circuits is shown in Figure 1-1 (a). The input to the circuit is applied through remote switch or relay contacts, and may be either an AC or a DC voltage, representing a "1" or a "0" logic level, as follows:

Logic "1"	Logic "0"
±20 Vdc to ±28 Vdc	0 to ±4 Vdc
or	or
20 Vac to 28 Vac	0 to 4 Vac

Use TP-1, elementary drawing of input isolator card, to describe operation.

The field contact input isolator card may be used in applications involving external logic "1" voltages of up to 125 volts, AC or DC. However, in any such application, the card must be used in conjunction with one of terminal board assemblies 112D1935, G1 through G6. The terminal board assembly contains external dropping resistors connected in series with the card inputs, which ensure that the voltage levels seen at these inputs will be within the limits given above.

2) When the remote switch or relay contacts are closed, the input voltage is applied to a full wave bridge rectifier and filter circuit. The resulting DC output of this circuit forward biases an LED, which conducts with approximately a 1.2 volt and generates an infra-red signal output. Figure 1-1 (b) shows a variation in hookup, where the input signal voltage is taken from the card itself, and the common connection for this voltage is routed through remote switch or relay contacts to the rectifier circuit. (Pin numbers and letters used in Figure 1-1 are for explanatory purposes only.)

Review AC to DC conversion within a full wave rectifier.

b. Output Card

1) The high level output isolator card receives up to ten infra-red signal inputs via "light pipes", which are small quartz cylinders situated in the isolator assembly between the input and output isolator cards. Each of the ten separate isolator circuits on the card will produce a logic "1" electrical output when an infra-red signal is present at its input, and will produce a logic "0" output in the absence of an infra-red input. The card circuitry is packaged on a printed circuit card which mounts inside an isolator assembly.

Show light pipes using an optical isolator casing.

2) Circuit Operation. The high level output isolator card contains ten separate channels, or isolator circuits, which are identical. Components identified in this discussion will be those in the circuit shown in the upper left corner of the schematic diagram. When the photosensitive input transistor (Q31) is excited by infra-red light impinging on it from the adjacent light pipe, it conducts, creating a voltage drop across resistor R4 which turns on transistor Q1. Conduction of Q1 in turn forward biases the output transistors Q2 and Q3, which are connected in a Darlington configuration to provide more driving capability than would be possible with a single output transistor. The output transistors then conduct through the external load connected at P1-B, producing a positive voltage (i.e., a logic "1") at P1-B which will equal the supply voltage minus the drop across the output transistor circuit.

Use TP-2, drawing of output isolator card to explain operation of card. Students may follow along with HO-2, schematic of optical isolator card.

3) Power Requirements. If the high level output isolator card is used for annunciator circuit isolation, the annunciator circuit supplies the power, which is usually +125 Vdc. If the card is used for computer circuit isolation, the computer supplies +28-Vdc power to the card.

4) 1-8 Pin Correspondence between input and output cards. Lowest pin numbers on the inputs of the input isolator cards correspond to the lowest pin letters on the outputs of the output isolator cards.

Use ESK's and GE prints to show pin mating.

2. Analog input optical isolators.

a. Input card

1) The analog input isolator accepts up to four 0 to 10 volt analog inputs and converts this to serialized digital information, which it passes via infra-red LEDs to a light pipe (a cylindrical piece of quartz about 1 inch by 1/4 inch) which transmits this information to the analog output isolator module, to be changed back to analog data.

Use TP-3, block diagram of input analog isolator card to describe basic operation. Students may follow with HO-3.

2) Basically what happens in the analog input isolator is that the signals which are applied to differential operational amplifiers AR1 through AR4 are separately switched into the A/D converter, which then passes serialized data to the output transistor circuit containing an LED. The LED then passes this data (now infra-red), to a quartz "light pipe" which transmits it to the next (remote) circuit, the analog output isolator. A clock circuit in conjunction with a program counter generates the timing pulses necessary for the conversion.

b. Output card

1) The input photo - sensitive transistor circuits Q1 through Q6 pick up infra red signals via "light pipes," small quartz rods, from corresponding circuits Q1 through Q6 in the analog input isolator (Q1 to Q1, Q2 to Q2, and so on).

2) A digital to analog converter converts the incoming signal from Q6 to an analog signal. The signal is then gated through the demultiplexer/ selector to one of the four outputs.

D. How do optical isolators fail?

1. Both digital and analog isolators may fail in a multitude of different ways.
2. Normally an isolator card failure is detected by eliminating all of the other components within a loop as being the faulty component.
3. The faulty isolator card is then replaced by a good card.

EO-1.3

Use wiring diagrams and ESK's to demonstrate effects of pulling and replacing an isolator card.