NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT NUCLEAR STATION

UNIT II OPERATIONS

02-REQ-002-305-2-11-0 Revision 0

Q7-191-91

TITLE: CIRCUIT BREAKERS

	SIGNATURE	DATE
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MASTER

CONTROLLED DOCUMENT

Summary of Pages

(Effective Date 2/5/90)

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Date	Pages
February 1990	1 2

TRAINING DEPARTMENT RECORDS ADMINISTRATION ONLY:

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RECORDS: _____ _____

I. TRAINING DESCRIPTION

A. Title of Lesson: Circuit Breakers

B. Lesson Description: This lesson is intended to provide adequate knowledge to operations personnel so that they can safely perform tasks on circuit breakers.

C. Estimate of the Duration of the Lesson: 4 hours

D. Method of Evaluation, Grade Format, and Standard of Evaluation: Written Examination, with a grade of 80% or greater.

E. Method and Setting of Instruction: Classroom/Lecture

F. Prerequisites:

1. The instructor shall be familiar with the lesson materials and have achieved the necessary Instructor Certification in accordance with NTP-16.
2. The student shall be a licensed operator at NMP-2.

G. References:

1. Circuit Breaker ODI (N2-ODI-5.11)
2. GE Technical Manuals
   a. Type ML 13 Mechanisms
   b. GEI 88762
   c. GEF 439
   d. GEH 1802U
3. Niagara Mohawk "Accident Prevention Rules"
4. SER 37-87
5. LER 88-50
6. SOER 82-16
7. Lesson Plan EM-305
8. N2-OP-71
9. N2-OP-72

II. REQUIREMENTS

A. AP-9.0, "Administration of Training"

B. NTP-11, "Licensed Operator Training and Retaining"

III. TRAINING MATERIALS

A. Instructor Materials:

1. Copy of this lesson plan
2. Whiteboard and markers
3. Overhead projector
4. Student handouts
5. Copy of SOER 82-16
6. Copy of N2-ODI-5.11
7. Copy of SER 37-87
8. Copy of internal correspondence letter-file code NMP23014

B. Trainee Materials:

1. Handouts attached to Master Lesson Plan
2. Reference Material listed in reference section as chosen by instructor.

IV. EXAM AND MASTER ANSWER KEYS

These are filed in the Records Room.

V. LEARNING OBJECTIVES

A. Terminal Objectives:

TO-1.1 Rack in/out a 480V/600V MCC circuit breaker.

TO-1.2 Rack in/out a high voltage circuit breaker.

TO-1.3 Operate breakers and disconnects from the Control Room.

B. Enabling Objectives

EO-1.1 State the three major potential safety hazards associated with performing operations on circuit breakers.

EO-1.2 List the major items to be checked for a properly racked in circuit breaker. (LER 82-16 & SER 37-87)

EO-1.3 List the major items to be checked for a properly racked out circuit breaker. (SER 37-87)

EO-1.4 State what items should be tagged in order to markup a circuit breaker at NMP2.

EO-1.5 List the NMP2 circuit breaker control power sources.

EO-1.6 State the effects on breaker operability in the event of a loss of control power.

EO-1.7 State the effects of pulling the trip and/or closing fuses on a 4.16 KV or 13.8 KV circuit breaker.

EO-1.8 State the reasons that breakers which have tripped should not be reclosed if the cause of the trip is unknown. (Internal transmittal memo from NMP1 to NMP2)

A. Safety - It is virtually impossible to cover every possible situation that can be encountered in the field.

1. <u>It is the responsibility of the individual performing the task to ensure his or her own personal safety</u>!!!

With this in mind; it is extremely important for the individual performing the particular task to become familiar with the potential safety hazards associated with that particular task.

If you think something looks odd, asking questions won't hurt as much as getting shocked, loosing your eyes or hands.

The three <u>major</u> potential safety hazards associated with performing operations on circuit breakers are:

a. High voltage primary circuit (on main stabs) EO-1.1

b. 125 VDC control circuit (on terminals and relays)

c. Stored energy devices

1) 125 VDC Control Circuit even though the circuit breaker itself is de-energized when it is removed from the cubicle; the circuitry internal to the cubicle can still be energized! Care must be taken as not to come in contact with the exposed conductors.

(springs, capacitors and inductors)

(fuse blocks or terminal blocks)

Some circuit breaker cubicles are equipped with 120 VAC strip heaters to keep the cubicle warm and dry. Care must be taken not to come in contact with the heater or the exposed terminals.

2) Stored Energy Devices

Many NMP2 circuit breakers utilize stored energy devices to provide for fast closing and opening operations.

(closing springs, and opening springs)

Do not put your hands into a breaker even if it is removed from the cubicle; these springs are very powerful.

B. Circuit breakers provide a convenient means to switch a circuit open and closed.

1. Power Circuit Breaker

A power circuit breaker is a device for closing, maintaining and interrupting an electrical circuit between separable contacts. In addition to carrying and interrupting normal load current, the circuit breaker must be capable of interrupting fault or short circuit current as well.

Read and review correspondence (Accident Report Unit I) Attachment 1

2. During normal load conditions the impedance of load will limit the value of current flowing in the circuit. In a fault or short circuit condition the circuit impedance (resistance) decreases tremendously, allowing for extremely high values of current to flow.

Normal
4KV - z10L
400 amps
Short
4KV - z.1L
40,000 amps

C. Design

1. There are numerous types of breakers in the plant, a few of the major types are:
   a. Molded Case Circuit Breakers
   b. Air Circuit Breakers
   c. Magnetic Air Circuit Breakers
   d. Magna - Blast Circuit Breakers

   Air circuit breakers are used for 600 VAC applications.

   Magne-Blast are used for 13.8 and 4.16 KV applications.

2. Molded Case Circuit Breaker
   Molded Case Circuit Breaker is completely enclosed in a plastic molded frame/enclosure.

   Example: Breaker in your house or in the MCC's.

3. Air Circuit Breaker
   An air circuit breaker is a circuit breaker in which the movement of the contacting members and the circuit closing or interruption occurs in air.
   a. Air circuit breakers rely on the separating of it's contacts quickly to a distance where current flow will stop. The speed at which the contacts separate and the distance that they have to move will be determined by the voltage at which the contacts operate and the magnitude of current that the breaker is expected to interrupt.

   High voltage will attempt to arc over contacts.

b. While this works fine in low voltage applications (600 VAC and less) it is not feasible to build an air circuit breaker to operate at higher voltages such as 5 kVAC. This would require moving the separable contacts a large distance and at an extremely fast rate of speed. Even if this approach would work for interrupting normal load current, it is doubtful that short circuit currents at 5 kVAC could be successfully interrupted without causing substantial damage to the circuit breaker. It is for this reason that another method is required to assist in the interrupting of the circuit.

Arc path could not be broken. Arc welding would occur along with probable electrical fire.

4. Magnetic Air Circuit Breaker

A magnetic air circuit breaker is a breaker whose contacts operate in air under the influence of magnetism at atmospheric pressure.

5. "GE AM 4.16 MAGNE-BLAST"

Magnetic field helps break arc.

The Magne-Blast breaker is of the magnetic air circuit breaker type. This breaker utilizes magnetic blow out coils and ceramic arc chutes (interrupters) to assist in the circuit interruption.

Magne-Blast Arc Interruption

As the breaker starts to open, the arc is first developed across the arching contacts. At the same time a small blast of air from the puffer tube is directed toward the arc, which transfers the arc to the upper and lower arc runners located on the arc chutes. As the arc (ionized particles of air) bridges the gap between the upper arc runner and the lower arc runner, a complete path for current is made from the line side of the breaker through the "blow out coils", to the load side of the breaker. This complete path for current allows for full line current to flow through the blowout coils thus developing a strong magnetic field to force the arc deeper into the arc chute. As the magnetic field forces the arc deeper into the arc chute along the widening arc runners, the field is intensified by inserting additional blowout coils into the circuit.

As the arc is drawn deeper into the arc chute, it is elongated and broken up by the interleaving ceramic fins; thus adding increasing resistance to current flow until at a zero crossing, current flow stops and the circuit is interrupted. It should be noted that the strength of the magnetic field will increase as circuit current increases.

Show TP of Tech Manual Dwg. of Arc Chute.

Motor action caused by a magnetic field (the current carrying conductor is ionized particles of air).

LESSON CONTENT	DELIVERY NOTES
6. Mechanical Description	Show T.P. of Figure 1 and handout copy to students.
a. The following parts comprise the mechanical portion of the circuit breaker:	
1) Closing coil	
2) Closing spring	Point to each part on Figure 1 T.P.
3) Main contacts	
4) Arcing contacts	
5) Arc chute	
6) Blowout coils	
7) Air blast cylinder	
8) Spring charging motor	
9) Trip coil	
10) Opening (tripping) spring	
b. Closing Operation	
1) The closing coil is energized, thus allowing the shaft to rotate.	Point out pivot points and operation on T.P.
2) The closing spring rotates the shaft, which pushes upon the latch mechanism.	
3) The opening spring is charged as the main contacts close.	
4) The latch holds the contacts closed while the closing spring is recharged.	
5) The recharging motor charges the closing spring via the rachet mechanism.	
c. Trip Sequence	Reverse of close - show operation on T.P. Figure 1
1) The trip coil is energized, thus unlatching the mechanism.	

2) The opening spring opens the main contacts and actuates an air blast.

3) The main contacts open first, followed by the arcing contacts, which causes the arc to be drawn on the arcing contacts.

4) The air blast blows the arc into the arc chute.

Arcing contacts are easier and cheaper to replace.

5) The blowout coils create a magnetic field, thus forcing the arc further into the arc chute.

6) The arc chute cools and extinguishes the arc, thus opening the circuit.

D. Component Description

1. Mechanical Components (Figure 1)

(Device 52X)

a. Closing Coil

1) The closing coil is a solenoid coil which releases the closing spring.

2) The coil is powered from 125 VDC control power.

Show closing coil on physical breaker if possible.

b. Closing Spring

1) The closing spring provides the motive force to close the contacts and charge the opening spring.

2) At the end of the closing cycle, the closing spring is recharged by the motor within 3 to 5 seconds, or they can be charged by manually rotating a rachet wrench/socket attached to the eccentric cam.

Demonstrate manual recharging.

3) The condition of the spring (whether it is charged or discharged) is indicated by a flag on the breaker front panel.

Mechanically actuated.

c. Main Contacts

1) The main contacts carry the major portion of the load current.

2) The main contacts open before and close after the arcing contacts open and close, so as to protect the contact surfaces from arcing.

d. Arcing Contacts

Allows easier, cheaper maintenance on breakers.

1) The arcing contacts carry only a small portion of the load current.

2) The arcing contacts open after the main contacts open, such that the arc is drawn on the arcing contacts.

3) The arcing contacts are easily replaced and much cheaper when they become burnt by arcing.

e. Arc Chute

1) The arc chute is an asbestos or ceramic labyrinth which cools and lengthens the arc so that the arc will extinguish.

2) One arc chute is provided for each phase, making a total of three arc chutes.

f. Blowout Coils

1) The blowout coils create a magnetic field to force the arc into the arc chute.

Air helps to break arc and allows the arc chute to function better.

2) The coils are arranged in series with the arc when the arc jumps from the lower arcing contact to the arc runner.

g. Air Blast Cylinder

1) The air blast cylinder contains a piston, which creates a blast of air.

2) The blast of air blows the arc towards the arc chute.

h. Recharging Motor.

(Device 52SM on 4.160 and 13.8 KV breakers)

1) The recharging motor recharges the closing spring at the end of the closing cycle by means of a rachet mechanism.

2) The motor is driven by 125V DC control power.

Show physical charging motor.

3) During a charging operation (3 to 5 seconds), any reclosure attempt is electrically prohibited.

E. Breaker Control Circuits

1. Magna-Blast control circuitry

a. Breaker is shut by energizing the 52x closing coil which trips a latch and allows the closing spring to discharge closing the breaker. 125 VDC control power comes from pin 4 on the secondary coupler through a 52 IS contact, two 52y contacts, a 52b contact, the 52x coil and out pin 8 of the secondary coupler in order to close the breaker.

Use 1P-1, circuit breaker wiring diagram and 1P-2, ESK drawing of a circ. water pump breaker to explain control circuit operation.

1) The 52 IS contacts are shut when the breaker is fully raised or lowered.

Point out that this switch prevented a fast transfer from taking place.

2) The 52y contacts are closed when the 52y coil is de-energized.

Explain that electrical components are drawn in a shelf state.

3) The 52b contact is closed when the breaker is open. Once the breaker goes shut, the 52b contact will open causing the 52x coil to de-energize.

4) Once the closing spring is discharged, the 52 SM/LS (spring motor/latching switch) will shut this contact allows the 52y relay to energize with a current flow from pin 1 to pin 8. The relay will seal in energized through 52y seal in contact with current flow from pin 4 to pin 8. The 52y relay is part of the anti-pump feature of the breaker.

Explain how the breaker would continuously try to close on a closing operation with a trip signal present if the 52 y relay did not energize.

5) The 52 SM (spring motor) is the motor which charges the closing spring.

Explain that the opening spring is charged mechanically by the breaker closing movement.

6) Once the closing spring is recharged, the 52 CL/MS (closing latch monitoring switch) will open de-energizing the motor. The breaker is now ready for another closing operation.

b. Breaker is opened by energizing the 52 TC (trip coil) through two 52a contacts and a trip contact. The trip coil releases a latch which allows the opening springs to open the breaker.

The trip coil has some current flow through it with the breaker shut through the red indicating lights. therefore, these lights not only indicate that the breaker is shut, they also indicate that trip power is available to the coil.

2. 600 V Switchgear

   a. Breaker is closed by energizing the 52x closing coil. Power comes through a LS limit switch which is closed when the closing spring is charged, a 52b contact which is closed when the breaker is open, and a 52y anti-pump contact.

      1) When the spring discharges, a separate LS contact (between terminals 12 & 13) closes which energizes the 52y anti-pump relay. Also, the LS contact between terminals 8 & 9 close which energize the spring charging motor and charge the closing spring.

   b. The breaker will open when the trip coil is energized. As with the magne blast breakers, the trip coil will always have some current flowing through it from the red light indicator.

Use TP-3, ESK drawing of Turbine Building ventilation fan to explain breaker control circuit.

3. 600 Volt Motor Controllers

   a. The 600 volt motor controllers actually consist of two parts, a molded case circuit breaker much like what you have in your home and a contactor which is a coil and contact relay device.

Use TP-4, ESK drawing 6DRS04 and TP-5, ESK drawing 6ESS03 to describe Motor Controllers.

1) The switch on the front of the MCC is the manual breaker portion of the MCC. When you turn this switch to on, it only energizes the control section of the MCC. It alone doesn't send power to the load.

If the breaker trips on high instantaneous current, the switch will go to the tripped position and power to the load will be interrupted. This condition is reset by going to off then to on with the switch.

2) Inside the breaker is a coil and contact relay device most often called a 42 device. When the 42 device is energized, it connects power from the source to the load. Control power to the 42 relay comes from line power to the load which is transformed down from 600 VAC.

If the thermal overload trips, the 42 device will de-energize causing power to be lost to the load. This condition is reset by pushing the reset switch on the front of the MCC.

F. Circuit Breaker Rack In

1. High Voltage Breaker Rack In

Use latest revision of ODI 5.11 to discuss breaker rack in.

a. Magne-Blast breakers are racked in per ODI-5.11

b. The following items should be verified for a properly racked in circuit breaker.

Operators should check and recheck that breakers are open prior to attempting rack in.

EO-1.2

1) Secondary coupler is completely connected

2) Positive interlock roller is centered in the upper vee of the elevator clutch mechanism.

3) Positive interlock switch is depressed

4) Trip and control fuses are properly installed.
5) Spring indicates charged.
6) Relay targets are reset after cubicle door is closed.

A fast transfer failed to occur at NMP2 because the positive interlock switch was not depressed.

2. 600 V Breaker Rack In

No procedure exists at NMP2 for 600 V breaker rack in. Mechanical interlocks should prevent racking in a closed breaker.

a. Rack in steps
1) Insure breaker is open.
2) Use racking tool to recess breaker into the panel.
3) Remove tags.
4) Turn on spring charging motor and ensure spring charged indicator comes up.

Discuss SOER 82-16, Incident at Fort St. Vrain dealing with a de-energized breaker spring charging motor.

b. The following items should be verified for a properly racked in 600 Volt circuit breaker.
1) Breaker is fully recessed in the panel.
2) Spring is charged.
3) Spring charging motor switch is on.
4) Green indicator light is on.

Ask for other items which students feel should be verified.

EO-1.2

G. Circuit Breaker Rack Out

1. High Voltage Breaker Rack Out

Use latest revision of ODI 5.11 to discuss breaker rack out.

a. Magne Blast breakers are racked out per ODI 5.11.

b. The following items should be verified for a properly racked out circuit breaker. — EO-1.3

1) Mechanical breaker position indicates open.
2) Control ruses are removed (close and trip).
3) Springs are discharged.

2. 600 V Breaker Rack Out

No procedure exists at NMP2 for 600 V breaker rack out, Mechanical interlocks should.

a. Rack out steps

1) Insure breaker is open.
2) Insert racking tool and rack out breaker to the disconnect position.
3) Turn charging motor off.

b. The following items should be verified for a properly racked out 600 volt circuit breaker. — EO-1.3

1) Breaker is open.
2) Breaker is racked out to the disconnected position.
3) Spring charging motor is off.

H. Breaker Tag Out — EO-1.4

1. High Voltage Breaker Tagging
   a. Fuses are hung off the fuse box and tagged.
   b. Remote switch for breaker is tagged.
2. Low Voltage Breaker Tagging
   a. Tag the pull-out handle.
   b. Remote switch for breaker is tagged.

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
I. Control Power Sources		EO-1.5
1. Non-safety Related Switchgear get their control power from battery bus "A" or battery bus "B".		
a. Power can be fused into the breakers from either bus.	Performed inside panel in normal switchgear room.	
2. Safety related switchgear get their control power from the safety related DC buses.		
3. 600 V switchgear receive control power from the line source, the power is transformed down to 120 VAC.		
J. Loss of Control Power		
1. Loss of Control Power to Switchgear		EO-1.6
a. Effect on breaker position		
1) Breaker will remain in as is condition because both the closing coil and trip coil need power to operate the breaker.	Use drawings of breaker control circuitry to show effects of loss of control power.	
2) Operations personnel should try to regain control power as rapidly as possible because until control power is regained no auto breaker trips may occur.	Point out that control room indicating lights are off. Stress that during a loss of control power all breaker operations must be performed locally and closing springs must be recharged manually.	

2. Pulled or blown control fuses on switchgear — EO-1.7
   a. If the closing fuses are blown, this will only prevent the breaker from closing, the breaker will still trip electrically.
      1) Additionally, the charging motor will be de-energized.

   Closing fuses are the smaller of the two sets of fuses (usually 15 amps).

   Show loss of current paths on ESK Drawings.

   b. If the trip fuses are blown, the breaker will neither close or trip, a blown trip fuse is equivalent to a loss of control power to the breaker.

   No red or green breaker position indicating lights will be present.

   Stress that no overcurrent protection exists during this time.

3. Pulled or blown control fuses on motor controllers — EO-1.7
   a. Motor controllers receive their control power from the load line supply, therefore, a loss of control power from the line also results in a loss of power to the load.
   b. If the loss of control power to the MCC is from a blown control power fuse, then the load will also de-energize.

   Emphasize that the contactor portion of the motor controller must energize to close contacts and allow power to the load.

K. Resetting Breakers which have Tripped on Overcurrent — EO-1.8
   1. Only in seven emergency situations should a breaker be reclosed if the overcurrent fault is unknown or uncorrected.

   Discuss internal correspondence letter from NMP1 to NMP2 on personnel injury due to closing in a breaker to a high current.

2. The following problems have been noted when a breaker is closed in a load.
   a. Personnel injury
   b. Breaker degradation

L. Review Objectives