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NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT NUCLEAR STATION

UNIT II OPERATIONS

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TITLE: CIRCUIT BREAKERS

	SIGNATURE	DATE
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Summary of Pages

(Effective Date: 10/24/89th)

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MASTER CONTROLLED DOCUMENT

TRAINING DEPARTMENT RECORDS ADMINISTRATION ONLY:

VERIFICATION: _____ _____

DATA ENTRY: _____ _____

RECORDS: _____ _____

I. TRAINING DESCRIPTION

A. Title of Lesson: Circuit Breaker Operation

B. Lesson Description: This course 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 Training: 4 hrs

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:

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

G. References:

1. Circuit Breaker ODI (N2-ODI-5.11)
2. GE Technical Manuals
   a. Type ML 13 Mechanisms
   b. GEI 88762
   c. GEF 4439
   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. Requirements:

1. AP-9.0, "Administration of Training"
2. NTP-10, "Training of Licensed Operator Candidates"

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

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

TO-1.0 At the completion of this training, the trainee will be able to safely perform tasks on circuit breakers.

EO-1.1 State the three (3) major potential safety hazards associated with performing operations on circuit breakers.

EO-1.2 Describe the purpose of the following major breaker parts, main contacts, arcing contacts, arc chutes, trip and close springs.

EO-1.3 Describe the purpose of the trip free mode of operation on various circuit breakers utilized on site.

EO-1.4 Describe the conceptual purpose of sequential fuse installations when putting a circuit breaker into service.

EO-1.5 Recognize the effects of pulling the trip fuses or the closing fuses when a circuit breaker is in service.

EO-1.6 Given a schematic diagram of various circuit breakers, identify the anti-pump portion of the circuit and its related contacts.

EO-1.7 Identify the proper method of installing various types of circuit breakers into their cubicle compartments.

EO-1.8 Recognize the most effective method of assuring the main contacts of a circuit breaker are open. (SER 37-87)

EO-1.9 List the number of indications that are found on a 4.16 KV or 13.8 KV circuit breaker.

EO-1.10 Describe the basic steps of racking out or in a breaker. (SER 37-87)

EO-11.0 List the six (6) basic steps of self-verification. (LER 88-50; SER 37-87)

EO-12.0 Describe the methods used to verify that the breaker charging spring motor circuits are energized. (SOER 82-16)

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
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)

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

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

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
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.

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.

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"

   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 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.

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).

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.

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.

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 125V DC control power.

b. Closing Spring

1) The closing spring rovides 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.

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

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

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 replaceable 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.

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.

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

4) If the recharging motor is not energized, the breaker may operate ONCE due to the stored energy from a previous operation. However, if the springs are not recharged the breaker will not close the next time it is called upon.

THIS SECTION IS IN RESPONSE TO S.O.E.R. 82-16

Knowledge of the methods to be used to verify that the breaker charging spring motor circuits are energized is vital to preventing its recurrence.

REVIEW SOER 82-16 WITH THE CLASS.

EO-1.12

a) Precaution 8.0 of N2-OP-71 and Precaution 4.0 of N2-OP-72 state: Before installing a breaker into the switchgear, verify spring charging motor circuit fuses installed and when applicable, switches are on. After closing breakers, verify springs are changed".

b) Closing springs not charged following a closing operation could be an indication of a problem with the charging motor.

c) N2-ODI-5.11 (Operations Department Instruction) section 3.6.8 addresses installing the control fuses and verifying the closing springs charged.

Performance of these steps will ensure that a breaker will not be left inoperable due to a de-energized recharging motor.

i. Trip Coil

1) The trip coil trips the linkage free of the closing mechanism, thus allowing the opening spring to open the main contacts.

2) The trip coil is powered from 125V DC control power.

3) In a "trip free" condition, the trip coil will release the closing mechanism at any time, including during a closing cycle; on the other hand, when a trip signal is present, the breaker will not close.

EO-1.3

j. Opening (Tripping) Spring (Device 52-TC)

1) The opening spring is charged during a closing cycle, so that there is no delay before the breaker is ready to trip.

2) The opening spring provides the motive force to open the contacts.

LESSON CONTENT	DELIVERY NOTES
k. Anti-Pump Relay (Electrically trip-free) (52Y relay) The anti-pump relay, mounted at the bottom of the operating mechanism, operates to allow for only one close attempt for any close signal initiation.	To be covered in detail, later, of how this works on ESK-5CWS01.
l. Auxiliary Switch The auxiliary switch, mounted at the front of the breaker, operates as the breaker opens and closes, to indicate breaker position.	
m. Secondary Coupler (Disconnect) The secondary disconnect serves to connect the breaker control circuit to the cubicle when the breaker is elevated to the connected position.	Also known as the auxiliary stabs (front left of 13.8 KV breaker)
n. Circuit Breaker Nameplate Ratings The nameplate contains data that details the design limitations of the breaker.	Nice to know information is on nameplate - the engineers that bought them considered this.
2. Cover the electrical control circuit operation on an ESK-5 series print for a 4160V or 13.8KV AC breaker.	Use TP - of ESK-5CWS01 to cover circuit operation. (52IS - an interlock switch on front, top left - indicates breaker is fully racked up or in test position) (switch is
a. Point out that the close light (red) circuit goes through the trip coil to verify continuity.	

b. Stress that the trip fuses are the larger fuses. If they are pulled, all breaker control power is lost. When installing or removing a breaker one of the biggest concerns is that it is open. Thus remove the trip fuses last and install the trip fuses first.	operated by roller on right hand side of breaker and linkages).	EO-1.4 EO-1.5
c. Go through the operation of the 52Y relay (52Y).	(Use TP still) Allows the breaker to close once per handle turning.	EO-1.6
d. Limit Switch (LS)		
1) The LS is open when the closing spring is fully charged, and it is closed when the closing spring is partially or completely discharged.	(Device 52SM/LS)	
2) During a closing cycle, the LS energized the recharging motor and the Y-coil.		
3) This prevents the breaker from trying to reclose before the closing spring is compressed sufficiently to complete the closing cycle.		
E. Breaker Racking		
1. Always verify that the circuit breaker is open before racking the breaker either up into the connected position or down into the disconnected position.	Read to class SER 37-87	EO-1.8

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
The circuit breaker incorporates a safety interlock to prevent engaging the racking motor unless the breaker is open; <u>however</u>, if this mechanical safety interlock <u>fails</u> or is disabled somehow, it is possible to raise or lower a closed circuit breaker.		
2. Cover in detail, line for line, the Operations Department Instruction (ODI) for breaker racking.	Handout copy of breaker racking ODI to each trainee.	
3. Highlights of breaker racking		
a. Installing/removing breakers from cubicle.		
1) Use extra caution - there is still power in the cubicle.	Heater circuit and interlocks with other equipment.	EO-1.7
2) Be careful of relays/wires on door.		
b. Prior to racking, insure breaker is open (check lights; mechanical position flag; ammeter; closing and trip springs).	All these indications are found on most 4.16 and 13.8 KV breakers.	EO-1.8
c. Actual racking steps		EO-1.9
1) Wear rubber gloves with leather protective gloves - check prior to and after use; remove all metal on your body.	As sated in N.M. Accident Prevention Rules	EO-10.0

2) Remove close and trip fuses.

3) Line up elevate motor with elevate mechanism before operating electrically (raise/lower toggle switch is not designed for any arc at all according to the manufacturer).

4) If operating elevate mechanism with hand crank, a face shield is highly recommended. Work with a second person as your "safety man".

5) After fully raising insure the interlock switch lever fell into the V-notch and micro switch is compressed.

6) When placing breaker in test position install "dog bone", do not over adjust only adjust to make-up for distance between breaker and switch; place "pigtail" snuggly on auxiliary.

4. Cover importance of consistent use of self-verification.

   a. Factors such as interruption, distraction, overconfidence, and complacency routinely lead to human performance errors. Self-verification is a barrier that can be used to provide for safe and consistent performance (LER 88-50).

Checks: air test in accordance with Niagara Mohawk Accident Prevention Rules Section 126.09 (Revised 9/88)

LESSON CONTENT	DELIVERY NOTES	CTIVES/ NOTES
An effective self-verification strategy contains the following steps:	This is also in response to SER 37-87.	EO-1.11
1) Stop - think about the task - are you prepared?	(These 6 steps come word for word from the simulator lesson plans).	
2) Locate - physically locate device of intended action		
3) Touch - place hand on the device, do not operate		
4) Verify - compare label to work document	Activity: (optional) take students to Electrical Lab to see examples of types of breakers and racking up and down of breakers.	
5) Anticipate - consider expected results of intended action		
6) Manipulate - perform action		
F. Recent LER/SER/SOER's	Copies attached to the master lesson plan.	
1. SER 37-87 (covered in lesson plan Section E.1.)	Briefly review	
2. SOER 82-16 (covered in lesson plan) Section		
3. Review attached accident Report and Internal Correspondence. (Covered in lesson plan Section VI.B.1)	Briefly review	
	Quick review (Unit I operator reclosing tripped molded case circuit breaker possibly leading to a bigger problem.)	EO-12.0