

# **NRC Medium Voltage Circuit Breaker Training**



## **CHAPTER 5**

### **CIRCUIT BREAKER MAINTENANCE**

# Learning Objectives



- Understand the difference between preventive maintenance (PM) and overhauls.
- Understand the elements of a good preventive maintenance process.
- Explain the three elements of a preventive maintenance inspection.
- Understand differences in overhaul levels.
- Have a general understanding of the lubrications used by breaker manufacturers.
- Understand the uses for penetrating oils in the preventive maintenance process.
- State the three common potential breaker failure causes.
- Understand the use of breaker timing analysis and the potential failures it can uncover.
- Understand the benefits and potential misinterpretation of contact resistance testing

# MAINTENANCE RULE



- Medium voltage circuit breakers meet the maintenance rule criteria and qualify for monitoring under the Maintenance Rule program.

# WHY BREAKERS FAIL



- The cause of most breaker failures can be attributed to one or more of the following areas:
  - lubrication failure
  - improper maintenance process not
    - not performing maintenance
    - Improper maintenance
  - component failure

# **Medium Voltage Circuit Breaker Maintenance**



- Routine inspection, testing, and maintenance ensures that:
  - a circuit breaker is operating properly
  - the breaker adjustments are within specification
  - potential component failure can be detected
  - data is available to better evaluate the condition of the breaker

# PM vs. Overhaul



- PM's are basic short term maintenance to make sure a breaker is working properly
- Overhaul is a major service to renew lubrication and will require a greater degree of disassembly and inspection to perform an evaluation of breaker components

# **Preventive Maintenance (PM)**



- Plant personnel normally perform
- On set schedule
- Other considerations - operations and environment conditions

# PM Inspection



- A good preventive maintenance inspection should consist of:
  - Good visual inspection
  - Adjustment verification
  - Electrical and mechanical testing



# **Who is performing plant overhauls**



- Plant personnel
- Original breaker manufacturers (OEM's)
- Other service shops

# Overhaul Process



- All overhaul processes to be effective at a minimum should address:
  - lubrication
  - component evaluation
  - and industry recommended replacement parts
- All of the following overhaul levels will.

# Three overhaul levels



- Level 1 - Minimum
  - Disassembly of operating mechanism, and contact pivots
  - Cleaning, and lubrication
  - Replace industry recommended components
  - Evaluate breaker components for wear and damage
  - Replace as required.

# Three overhaul levels



- Level 2
  - Complete disassembly of the breaker
  - Replate mechanism metal components
  - Evaluate silver plating and replate as required
  - Clean and lubricate
  - Replace industry recommended components
  - Evaluate breaker other components for wear and damage and replace as required.

# Three overhaul levels



- Level 3
  - Complete disassembly of the breaker
  - Replate mechanism metal components
  - Silver plate all copper bus and contacts
  - Clean and lubricate
  - Replace industry recommended components
  - Replace all potential high wear items
  - Evaluate breaker other components for wear and damage and replace as required

# **How frequently should overhauls be performed?**



- OEM standard
- EPRI - User group recommendations
- Individual plants

# **BREAKER INSPECTION PROCESS**



- Visual inspection
  - Exterior and interior appearance
  - Racking mechanism if applicable
  - Ground stab, and interlock
  - Arc chutes and insulation barriers (After removal)
  - Main and arcing contacts and arc puffer
  - Primary Bushings
  - Primary Contacts (Used to connect to the cubicle)
  - Secondary Contacts (Used to connect the control contacts to the cubicle)
  - Wiring, relays, coils, switches and charging motor,
  - Operating mechanism,

# **BREAKER INSPECTION PROCESS**



## Adjustments

- Mechanism adjustments
- Contact adjustments



# **Breaker electrical and mechanical testing**



- Breaker timing
- Time travel analysis
- Contact resistance measurement (micro-ohm)
- Insulation testing (meggering)
- Over potential (hipot) testing
- Vacuum bottle Interrupter integrity test
- Power factor testing (doble)

# LUBRICATION



- The 1998 INPO SOER 98-2 on Circuit Breaker Reliability siteded degraded lubrication as the largest single contributor to breaker failures.

# Lubrications used on breakers



- General Electric - Mobil 28 - mechanism and contact structure
- ABB - Anderol mechanism NO-OX-ID contact structure. Mobile 28 has recently been approved for operating mechanisms
- Westinghouse/Cutler Hammer use several lubrication
  - BR2 Plus, Graphite/Alcohol mixture , application), Lubriplate 130A, and Poxylube, and special formulation graphite grease.
- Siemens/Allis: uses Beacon P290, 325 or Anderol 732.

# **Penetrating oils and spray lubrications**



- it is not recommended to use penetrating oils and spray penetrating formulas as a lubricant on circuit breakers

# Lubrication considerations:



- If it has not been overhauled - should be overhauled immediately.
- If a breaker is in a high cycle function, wear and loss of lubrication become an issue. These breakers need to be constantly evaluated and should be on an aggressive overhaul cycle.
- If a breaker sits in a static position for a long period it should be cycled at least every 18 months.
- Most Synthetic greases have a longer operational life but can still deteriorate over time.