Real-Time Circuit Breaker Health Diagnostics

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AEP Is Largest Transmission Owner in U.S.!

- 11 states
- 5.4 million customers
- 3 regional transmission operators
- 200,000 square miles
- 40,000 miles of transmission lines
- 3,500 substations
- 5,500 transformers
- 14,000 circuit breakers
AEP’s Aging Assets

- Circuit Breakers: 33% >30 years old
- Transformers: 33% >50 years old, 18% >60 years old
- Transmission Lines: 38% >50 years old
Time-Based Circuit Breaker Maintenance

Monthly
SF6 Gas Inspection

Yearly
Operational Checks

6 Years
External Inspections

12 Years
Comprehensive Inspections
Circuit Breaker Monitoring Provides Great Benefits

- Safety
- Maintenance Optimization
- Failure Prevention
Collect Asset Data

- All Data Sources
  - Sensors
  - Historian
  - Databases
  - Spreadsheets

Make it Intelligent

- Prebuilt Performance Models
- Third-Party Models

Process it

- Data Processing and Analytics

Make it Available

- Advanced Operational Intelligence

AHC Architecture

Enterprise Asset and Work Management

Make it Actionable
Collecting Data From Circuit Breaker

Substation

Event Record

Virtual Monitoring Through IED

Station Computer

Corporate Network

Multiple Event Records

SDR Servers

Event Record History

Network Topology

Event Parsing

Real-Time Trend Data

Transformed Data

AHC Algorithms and Dashboards

Other Custom Dashboards

Collecting Data From Circuit Breaker
Collecting Data From Circuit Breaker

Circuit Breaker Monitor → Breaker Relay → Mechanical Wear, Dielectric Accessories → AHC
Circuit Breaker Components
Real-Time and Event-Driven

**Accessories**
- Cabinet and tank heaters
- Hydraulic pump starts
- Compressor run times

**Mechanical**
- Close / trip time and velocity
- Interrupter travel
- Resistor preinsertion time

**Wear**
- Contact and interrupter
- Main and auxiliary nozzles
- Trip / close coils

**Dielectric**
- SF6 gas
- Rated vs. applied voltage
- Rated vs. applied current
69 kV Breaker Monitor Pilot System

- **125 Vdc Battery**
- **Breaker Relay**
  - **IN101 TCM**
  - **Monitor Vdc (DC1)**
- **Trip Coils**
  - **52TC1**
  - **52-1**
  - **35.5 Ohms**
- **Trip Bus**
  - **52a**
  - **52b**
- **CBM**
Simplified Trip / Close Coil Circuit

- 125 V
- Relay
- CT
- PT
- Circuit Breaker

Induced Field Inside Coil
Current

+– RELAY –+}

- S

IN

Current

+– 125 V –+
Trip Coil Current Reveals Health Characteristics

1. Current Rise
2. Armature Movement
3. Post-Armature Movement
4. Current Decay
69 kV Breaker Energization Test

Bus Voltage

Motor Current Run Time = 3 Seconds
AHC Software

See All Asset Details in One Place

Monitor Gas Density in Real Time

Prioritize Asset Replacement
AHC Provides Great Economic Benefits for AEP

- Improved maintenance costs
- Real-time and condition-based O&M
- Improved scheduling and budget allocation
- Predictive maintenance
The Future Is Bright for AHC

- Continue improving AHC
- Establish standard for circuit breaker monitoring
- Move from high-voltage to low-voltage breakers
Questions?