

Advanced Pattern Recognition Technology Applied to T&D Equipment



An Exelon Company

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ComEd T&D Project Objectives

- Investigate on-line advanced predictive analysis technology, i.e. advanced pattern recognition (APR), as a tool to identify transformer problems at an early stage
- Determine how APR technology might complement existing PdM technologies – where does it fit with current & future processes?
- Stimulate creative thinking related to extracting more value from mountains of data being acquired
- Determine Cost / Benefit of APR usage
 - Nature of early warnings provided and associated value
 - Cost of Ownership technology / personnel
- Formulate ideas on how APR might be applied to other T&D equipment





Application of APR at ComEd

Leverage the tremendous investment in data acquisition and storage to produce actionable warnings of equipment degradation and provide:

- ... an efficient way of managing process degradation information for equipment and systems
- ... a way to reduce dispatch center alarms by addressing equipment and instrument problems early
- ... reduced likelihood of catastrophic failures resulting in injury or loss of property
- ... the ability to shift unplanned outages into planned maintenance work
- ... a means to schedule material and labor proactively to address known faults
- ... additional capabilities for existing condition monitoring efforts





The ComEd APR Deployment Project

- Model 100 Transformers
- Select a mix of well instrumented, typically instrumented, and minimally instrumented
- Train the models with a year + of historical data from 2008/2009
- Monitor the models Apr Oct 2009
- Add/revise/remove models based on lessons learned resulting from alarms and maintenance requirements
- Investigate models for different "control volumes" beyond individual transformers







The PdP (APR) Process and Tools







APR Real Time Process







Deployment Challenges

- Selecting which critical assets to monitor
- Signal selections and eliminations for models
- Allocation of time and resources to perform model configurations, updates, and findings review
- Validation of APR technology's value
- Corrective action follow through based upon PdP findings







Some Examples - Bad Sensors







Unbalanced Thermal Conditions on LTC







Gassing Transformer







Undesirable Paralleling







Undesired Paralleling 2







Undesirable Cooling (Fans) Situation







Bad Oil Temps





A Big Save

Situation [300MVA Transformer]

- PdP provided alert to unusual cyclic temperature condition
- Operator misunderstanding caused incorrect cooling control setting

Findings

Control Company

SCIENTECH

- PdP identified unusual cyclic temperature condition
- History review indicated new and undesirable condition
- SCADA system showed no problem

Outcome

- Prompted modification to temperature control process
- Potential transformer failure; Savings >\$500K







What Was Learned From Applying APR

- Findings
 - Phase Imbalances due to LTC Contact Failures
 - Voltage Regulation / Undesirable Paralleling situations
 - Sensor problems
 - Improper operation of cooling equipment (including big save)
 - Problems associated with cooling equipment (e.g. loss of subset of fans)
 - Sensor failures
- Less instrumented transformer models can still produce actionable findings
- Online gas analyzers are not ideal for APR modeling, but still are still worth the effort to include





Possible Future Efforts

Based on the demonstrated ability to successfully predict and highlight condition changes, other types of models that are being considered (if data is or can be made available)

- HPFF Cables Pumping Plants
- RTU Scan Performance Monitoring
- Temperature Profiling of Transmission Lines with Embedded Fiber Optics
- Generic Models / Templates and training sets for similar model equipment across the system





Moving Forward with APR Technology

- Expand the number of transformers that will be monitored by the APR technology
- Pursue better integration of APR usage into existing T&D equipment condition monitoring practices
- Improve process for addressing equipment anomalies and APR finds
- Investigate usage of APR for other T&D type equipment
- Pursue integration with maintenance management activities







Questions



Effectiveness, not efficiency, is the key.