Panel session: On-line Condition Monitoring - Value for Present and Future Grids

Turning data collected by monitoring and condition assessment into transformer reliability information

Craig L Stiegemeier
Business Development & Technical Director; ABB TRES (Transformer Remanufacturing & Engineering Services)
North America
Craig.Stiegemeier@us.abb.com

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Strategic Drivers

Aging Workforce
- Difficult to attract younger workers into the workforce across Asset Intensive Industries
- Younger workers have different expectations and a lower threshold with respect to systems they use

Aging Assets
- Life extension programs in place to extend life of assets and so the systems required to maintain them need to adapt
- Regulatory pressures to improve environmental and safety standards

Cost Pressures
- Need to do more with less
- Improve return on assets without impacting production/service delivery
Market Trends

- **Aging Infrastructure and fleet**
  Many transformers are 40+ years

- **Increasing complexity of grid**
  Utility break-up, IPP’s, new load & types of load

- **Lack of expert knowledge**
  Downsizing, retirees not being replaced, etc.

- **Cost of an unexpected failure can be at least $4.5 MUSD and beyond**
  - CIGRE Brochure 248, WGA2.20, 2003

- **Smart Grid initiatives**
  Better knowledge, faster information, desire to maximize performance

- **Increased Data Gathering**
  Need an efficient way to utilize the massive amounts of data being gathered today
Background of Development

Dynamic Transformer Management Program: DTMProgram™

1. The Mature Transformer Management Program (MTMProgram™) provided a “snapshot” power transformer condition evaluation through algorithms that calculate the Risk of Failure (RoF).
2. Create algorithms to dynamically calculate operational RoF (based on load, temperatures, oil, maintenance info, etc).
3. Have the algorithms to dynamically handle new type of data (online gas sensors, moisture sensors, bushing monitoring, partial discharges, vibration, LTC condition, etc).
4. Provide adequate data handling capability to support human judgment in multiple scenarios (trend analysis, outliers, etc).
5. Have an adequate platform to implement the solution with useful dashboards, multiple database communication capability, etc. IT Requirements.
6. **Enterprise or Fleet Wide Application**
Smart Grid Building Blocks

DISTRIBUTION

SMALL POWER

MPT

LPT

Reliability

Fast Restoration

New Data Centers

Protection Control

Intelligent Monitoring

CBM
Smart Grid Building Blocks

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Asset Health Center – Information Flow and Analysis

AHC Applications

Advanced Diagnostic Support

Digital Dashboards

Summaries & Aggregations (ROLAP)

Facts & Dimensions (Warehouse)

Performance Model Analysis

Data Aggregation

Alerts & Notifications

Recommended Actions

Work Order Initiation

Workflow Dashboard

Maintenance Management Systems

External Communications & Notifications

AHC Applications

Packaged SME

Performance Model Analysists

Real-Time

Near Real-Time

Facts & Dimensions (Warehouse)

External Data

Mapping

Identification

Extract/Transform Load

Filtering

Cleansing

End-to-End

Forecast

Schedule

Dispatch

Mobile

Reporting

Continual Feedback to AHC

Thermal Winding Risk
Short Circuit Risk
Dielectric failure Risk
Etc.

SME Support

Internet

IEEE Power & Energy Society

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**Online Sensors**
- Gas Sensor
- H₂O Sensor
- Bushing
- LTC
- PD
- FRA/Transients

**Offline Databases**
- Off line DGA
- Off line SOT
- Routine tests
- FRA, DFR, Z, etc.
- Maintenance actions
- MTMP Risk of Failure

**Performance Metrics**
- Static data or information
- Dynamic data/information
- On going development

**Future**
- Trxf. 1
- Trxf. 2
- Trxf. 3
- …
- Trxf. n

**New Data Repositories**
- ABB

**Equations**
- Expertise
- Utility / Industrial Headquarters Statistics

**Computation**
- \[ \sum \]

**Utilization**
- SCADA
- Online Sensors
- Offline Databases
- Future
- New Data Repositories

**IEEE PES**
- Power & Energy Society

**IEEE**
- Future
Asset Health Center – Visibility of Asset RoF
Benefits of Equipment Risk and/or Life Assessments as part of the Condition Monitoring process

- Allows a response to the decreasing reliability of aged transformer fleet
- Establishes proper planning and budgeting for replacements and refurbishments
- Identifies and helps capitalize on uprating opportunities and capabilities
- Improved maintenance process (RCM) by focusing on assets needing attention
- Better utilization of significant assets
- Avoid huge costs of unexpected failures
- Better predictability of performance
What is missing or can be improved?  
On-line Condition Monitoring Value for Present and Future Grids

• What is missing or can be improved regarding ..
  – Standards or guides for on-line condition monitoring needs?
    • Agreement on data necessary for condition evaluation of important assets
    • Knowledge that data for specific equipment is unique and not common across different types of equipment
  – Monitoring system features or sensors?
    • Open architecture where new sensors are easily incorporated
    • Accurate design-based models for specific equipment
    • Ability to process large amounts of data and turn into actionable conditional improvement actions
  – Monitoring systems data
    • Environment where both on and off-line data are readily available
    • Ability to gather information without a significant communication structure investment