

ComEd Reports Monitoring Success

Comprehensive on-line transformer-monitoring system provides improved reliability and reduced maintenance costs.

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ON-LINE TRANSFORMER MONITORING HAS BEEN IN USE FOR SEVERAL YEARS WITH GOOD SUCCESS at the ComEd division of Exelon Corp. The key to capturing all the benefits transformer monitoring offers is in recognizing all of the elements needed to gain bottom-line benefits. Using a four-step process, ComEd is improving its transformer reliability while reducing operation and maintenance costs.

STEP 1: DEFINE THE OBJECTIVES

ComEd has defined its objectives in an engineering practice document that defines the following:

- *Why will it be installed?* ComEd's primary objective for installing on-line monitoring is to improve the reliability of its transformers and cut costs. The utility also can help prevent failures by detecting problems that wouldn't normally be caught because of the short problem gestation time. Early intervention can resolve many problems before they escalate and require other more costly repairs. Also, having all of the transformer data consolidated into one system allows faster problem diagnosis.

Eliminating unnecessary maintenance can increase reliability. ComEd has set the stage to transition from



Monitoring is installed on more than 130 transformers over 40 MVA. The left insert shows the dissolved gas-in-oil and moisture-in-oil sensor. The right insert shows an engineer using the Dynamic Ratings system control panel.

time-based maintenance to condition-based maintenance. Although it may seem counter-intuitive, the research confirms that less maintenance can result in higher reliability. The maintenance process can be an intrusive task, because the oil must be drained out of the load tap changer and the components must be removed to facilitate proper inspection. Therefore, it is understandable that the probability of failure goes up immediately following an intrusive maintenance procedure. This concept is most aptly captured by the old adage: "If it ain't broke, don't fix it." With a condition-

based maintenance strategy, maintenance personnel can focus on real problems instead of looking for problems or creating new ones.

- *Where will it be installed?* At ComEd, the scope was defined as any standard circular winding transformer 40 MVA and larger. This definition provides coverage and protection on a population that is large enough that operators and engineers will have enough exposure to the system to feel comfortable using the system and relying on the benefits.

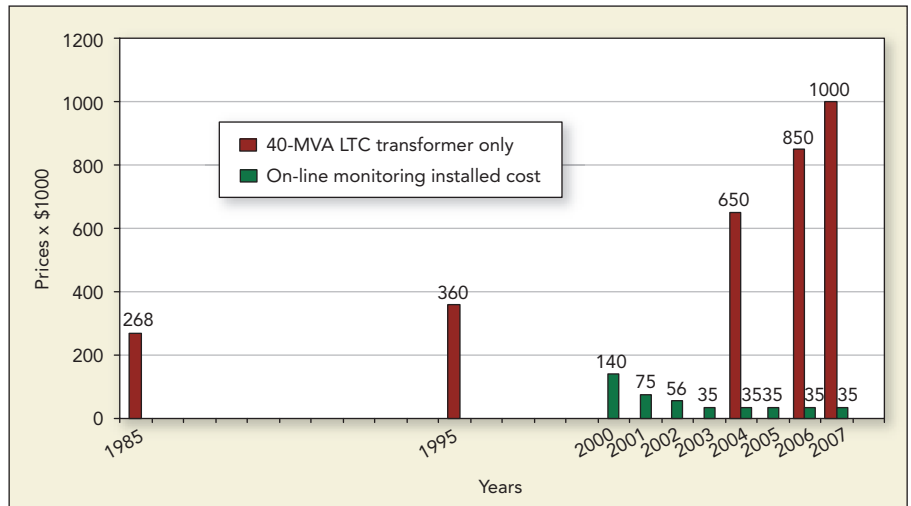
- *When will it be installed?* The initial deployment of transformer monitoring is on new transformers. Given the increases in transformer prices, along with the cost reductions in the monitoring equipment available, the addition of a comprehensive transformer-monitoring package as part of the initial purchase has a minor effect on the total price and is considered a prudent investment.

As part of a new transformer, it avoids the budget battle. Many utilities have justified the retrofit of transformer-monitoring equipment as a capital investment. However, this decision can be challenged. When it is purchased as part of a new transformer, there is no question that it will be a capital investment.

The addition of the system on new transformers is also easier for the asset manager. By simply modifying the transformer specification, the equipment is supplied with the desired system. Once the specification is written and refined, each new transformer will be the same. An additional engineering cycle is not required, and the monitoring is better integrated into the transformer.

For these reasons, ComEd elected to have standardized equipment supplied as part of the transformer specification starting in 2003. ComEd has installed more than 130 transformers with on-line monitoring. The five different transformer suppliers each provide the same transformer-monitoring hardware solution.

ComEd has employed a risk-assessment analysis model for the selection of retrofit sites ensuring that they will



Price trends for transformers and on-line monitoring.

be able to add monitoring systems to those sites with the greatest risk first. ComEd is using benefits gained from the systems it already has installed to drive the justification for retrofit installations.

- *What each monitoring parameter will be used for?* The list of monitored parameters and the benefit of each is also defined in the ComEd engineering practice document. The development of this document was achieved through a collaborative process with the monitoring system supplier (see figure).

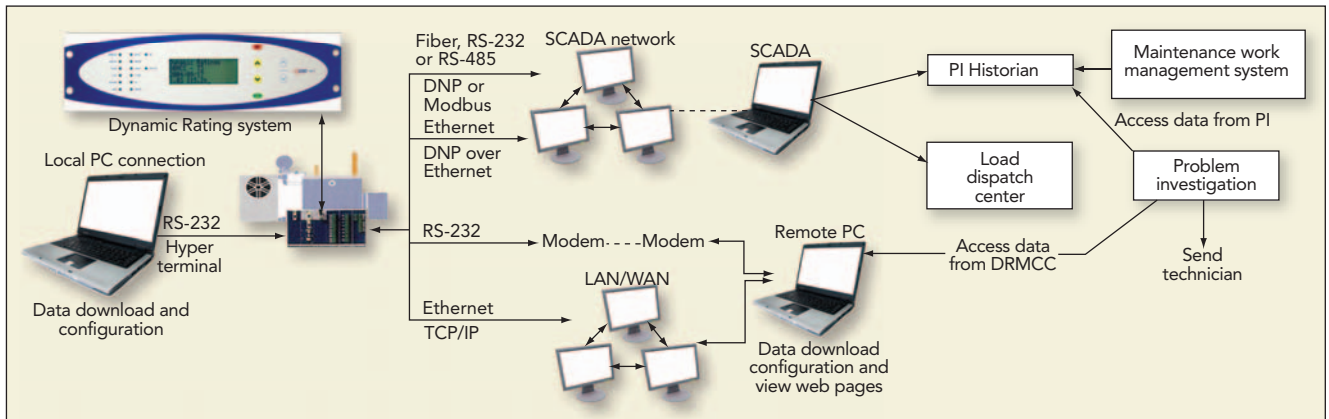
- *How the information will be distributed?* The final aspect of the engineering practice document is a flow chart identifying what information is distributed, to whom it is distributed and the level of detail.

ComEd's monitoring system is able to provide information in a variety of different communication protocols. It can be provided in either serial format or via Ethernet, and the connection can be made over hard wire, fiber-optic or wireless connections.

The method of getting the data into the control building depends on the installation site. For new installations, fiber-optic cables provide a serial connection to a remote terminal unit (RTU) in the control building. Older substations that do not have fiber infrastructure use a wireless connection to bring the serial data to the RTU. In those installations where the RTU does not have the capability to accept an additional serial connection, alarm contacts from the monitoring system are used to provide a hard-wired connection.

The transformer-monitoring equipment supplier provides the complete system, including on-site support. Having one supplier responsible for the complete system provides greater accountability and better system integration.

The data sent to the RTU is provided in both a detailed format that gets logged into the PI Historian data warehouse and also in a summary format that is sent to the load-dispatch center. The summary data is grouped into major and minor alarms. The definition for the major and minor



Data and information flows for the ComEd on-line monitoring system.

alarm groups was developed in a collaborative manner with the transformer monitoring system supplier.

STEP 2: DEFINE THE EQUIPMENT

Equipment specification is the next step in the process. ComEd reviews the monitoring section of the transformer specification with the monitoring equipment supplier before the bid request is sent out. This will ensure that all necessary details are covered and will prevent the need to have bid addendums resulting from unclear scope issues.

The real benefit of developing the equipment specification based on the engineering practice document is the ability to link data to results. In addition to identifying the points to be monitored, the document also identifies the benefits to be achieved by the information. ComEd specifies a transformer-monitoring system that uses a variety of specialized algorithms to screen the data for abnormalities in real time. When abnormalities are found, the monitoring system immediately triggers an alarm and identifies the source of the transformer problem.

Here are four lessons ComEd learned during equipment specification.

1. The monitor needs to provide information, not just data. If the data is not filtered and presented in the appropriate level of detail, end users will be overwhelmed, and they will not be able to gain any benefit.

2. The intangible issue of product support is extremely important. ComEd's first attempt at transformer monitoring resulted in limited success, primarily because of poor product support. After changing suppliers, the effectiveness of the total system improved. The equipment specification should define the supplier of choice for the monitoring equipment. Because the support is just as important as the hardware itself, it is essential to specify the hardware supplier by name.

3. Be consistent in the hardware selected. If the brand of monitoring equipment changes from one site to another, the complexity of the training, documentation and supply becomes very difficult to manage. Select a system that is modular. By using a modular monitoring system, ComEd

has the ability to use the same core system for a wide variety of installations. The product can be easily expanded to include additional monitoring features and functions as appropriate.

4. Given the goals defined in the engineering practice document and the lessons learned through the equipment specification process, ComEd selected the Dynamic Ratings transformer-monitoring system, which was complemented by the Morgan Schaffer Calisto dissolved gas-in-oil and moisture-in-oil-sensor. Using only two main equipment components keeps the package simple, while offering a significant number of capabilities. The Dynamic Ratings system integrates all intelligent electronic devices and sensors, and acts as the communication center for all of the transformer information. All of the transformer data is received through one connection through a standardized SCADA interface.

STEP 3: SCADA ALARM-RESPONSE PROCEDURE

The SCADA alarm-response procedure clearly identifies the roles, expectations, response times and actions. The alarms from the monitoring system are grouped into major and minor alarm groups. The alarm groups are then used to define the acceptable response time.

STEP 4: REFINE THE PROCESS

In addition to the immediate cause-and-effect response defined in the SCADA alarm-response procedure, the monitoring system also stores data for future use and analysis. By sharing this information with the monitoring equipment supplier, new algorithms have been developed to identify problematic conditions earlier in the failure gestation process. Revisions to the algorithms can be installed into the controls via remote connections or through direct connection to the control.

The monitoring system supplier also tracks installations by the transformer serial number and substation name. System wiring diagrams, a firmware version and a hardware version are retained for every installation for detailed support. When any system change or feature addition needs

to be implemented, the monitoring equipment supplier provides and maintains the revision tracking. This makes the monitoring supplier accountable in the early stages of implementation, but provides the basis for continuous product refinement over time.

RESULTS

Since the implementation of the monitoring system, ComEd has caught many transformer-related problems. While it is difficult to identify the cost savings associated with preventing failures, ComEd has adopted a cost-justification model based upon a conservative estimate of 50% improvement in reliability due to prevention of catastrophic failures.

Over the years since ComEd has employed monitoring, the collaborative work with the monitoring equipment supplier and transformer OEMs has allowed ComEd to add more

features and capabilities to the system. New algorithms have been developed and implemented to continually refine the ability to screen for potential problems. ComEd's successful implementation of transformer monitoring is bringing many benefits to the organization. **TDW**

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