MOUNT SINAI HOSPITAL UPGRADES ITS TRANSFORMERS

By Colleen Winter

Transformers are critical components of a distribution system, yet due to the high connection voltages, their maintenance and monitoring often falls in a gray area between the utility and the facility where the upkeep and overall health of the transformer goes unnoticed. Without any kind of monitoring, a transformer could be operating at risk for considerable periods of time without personnel being aware of the potential harm.

When a failure occurs or replacement is required, the downtime, installation costs and capital expenditures become an expensive endeavour and a scheduling nightmare. In light of this, when Mount Sinai Hospital in Toronto needed to replace eight PCB transformers in its 1.1 million square foot facility, the building services department used the opportunity to re-engineer the distribution system to include power monitoring.

The primary concern for Mount Sinai engineering staff is up-time or system reliability. As with any hospital, a failure in the power system could cripple the operation and cause a life threatening situation. For this reason, the project scope was extended to not only include the replacement of the transformers, but also put in place a network of devices that would assist in the reliability and security of the distribution

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system as a whole.

By installing the power monitoring system, the operators planned to extend the life of the system by providing information that would help mitigate the effects of harmonics that are created from the grid or from within their own facility.

The monitoring system chosen for the project was the ION Enterprise system, supplied by Langford & Associates and manufactured by Power Measurement. The architecture included a head-end system installed on a server that communicates directly with the 38 ION meters that are specifically designed to monitor Power Quality in real-time. Each meter was chosen for a specific purpose and strategically located on the distribution system to perform a specified task.

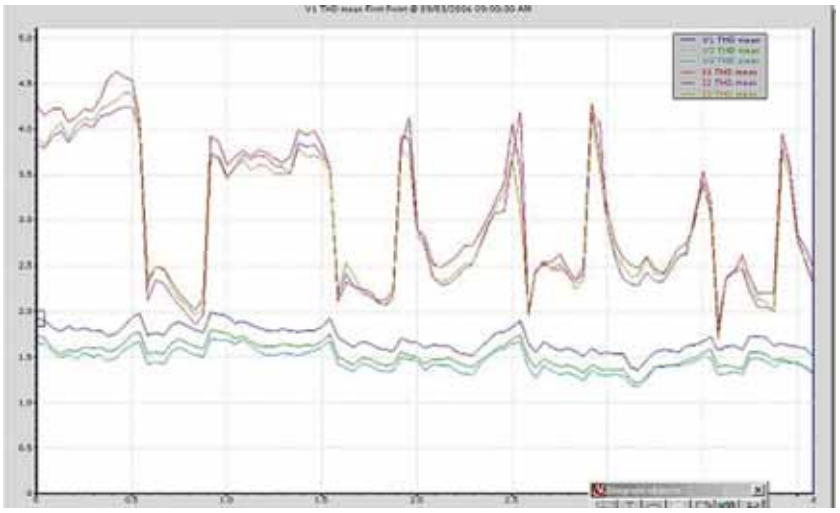
On the main incoming feeders the meters were installed to perform three major functions: sample the power 256 times per cycle and monitor the power quality and alert operators to deviations from an acceptable limit; collect data from a thermocouple installed in the transformer on the internal temperature; and provide a communications gateway to the downstream devices in order to simplify the communication back to the server in the building services control room.

On each of the 28 feeders, a power quality meter that samples at 96 samples per cycle collected data on the individual loads throughout the distribution system. Communication to the main meters is through a 10baseT connection with a hardwired half duplex RS485 connection to the distribution meters.

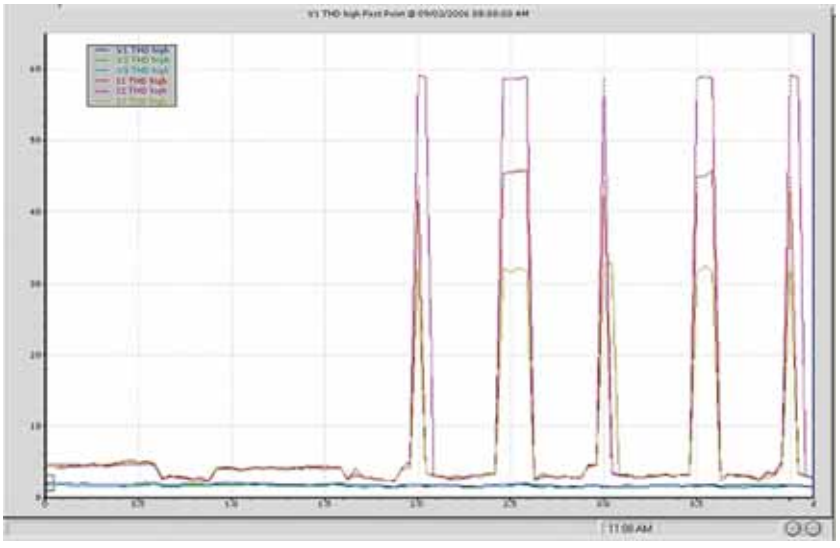
All this information is routed back to the display on the head-end system for a real-time view of the facility that updates every second.

ESTABLISHING A BASELINE

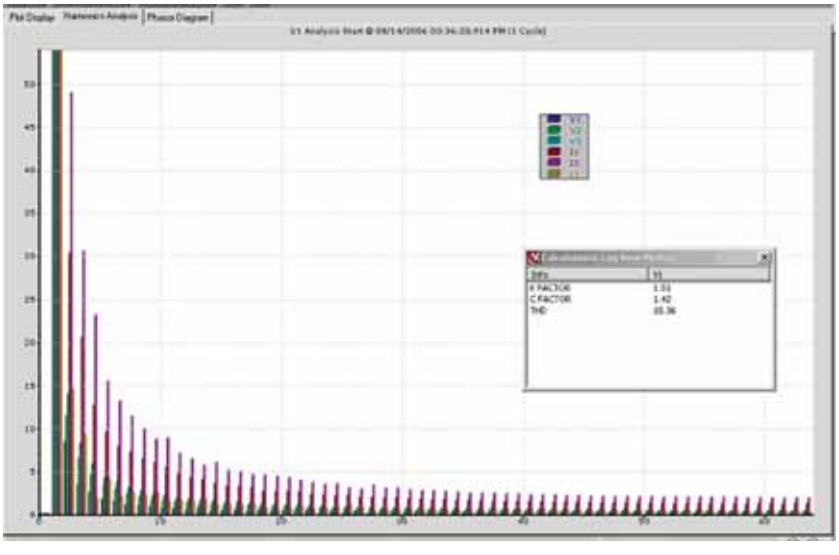
Viewing the system real-time is important from an operational perspective, but the true power of the system is in the data that resides in a SQL database. The information that each meter is constantly channeling to the database will be used to establish a Power Quality baseline for the distribution system including information on how the system reacts to disturbances, load imbalances and



Trending of total harmonic distortion of less than 5% from ION enterprise software.



Total harmonic distortion showing highs and associated peaks from ION software.



Associated harmonics of disturbance above shown in ION enterprise software.

uncharacteristic harmonics. With the baseline in place, a maintenance planner will have more detailed information on the health of the system and will be able to schedule shut-downs rather than suffer an outage.

HARMONICS

The goal of the Mount Sinai electrical system is to supply power to loads at the fundamental frequency (only fundamental frequency current can provide real power). Since current delivered at harmonic frequencies doesn't deliver any real power to the load and has detrimental effects on the transformer, the percentage of these must be monitored.

In a modern facility like Mount Sinai, equipment contains onboard processors, patients are monitored 24/7 by computers and each desk is outfitted with a workstation or PC. With the increase in computers come more nonlinear loads.

The effect of this can increase the neutral current to levels higher than the phase current due to the additive nature of the 3rd harmonic. These currents will circulate in the primary side of the transformer, then dissipate as heat. The effects of the harmonics continue on to the 5th harmonic which will heat the windings 5 times more than comparable current at the fundamental frequency. The more of this harmonic current the transformer has to supply the less capacity it has to sup-

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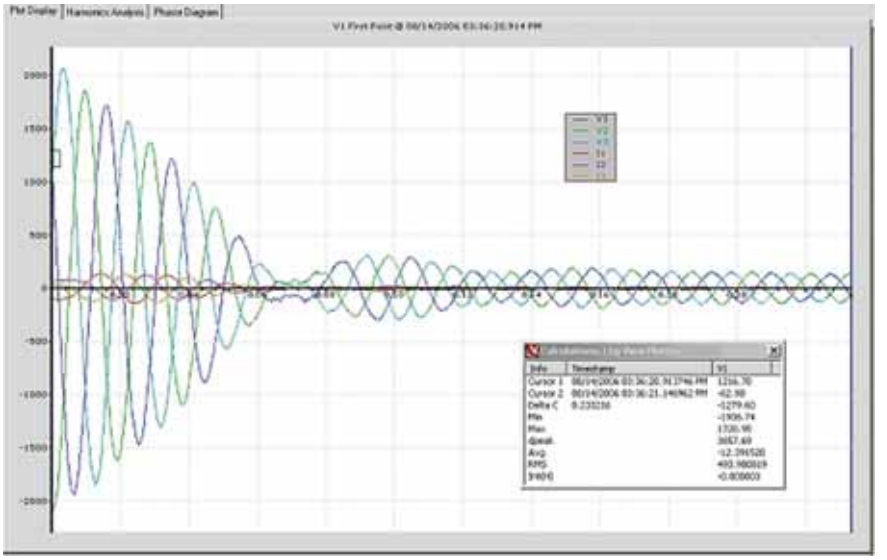

Voltage and Current waveforms of an actual disturbance in ION enterprise software.

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ply current at the fundamental harmonic and the more heat that is generated in the transformer.

By monitoring the percentages of harmonic content and comparing these against pre-determined levels for given periods of times, an operator can be alerted and each downstream meter can be analyzed to locate the source of the problem. Once located, the wave shape can be cleaned up using a harmonic mitigating device such as a UPS, a harmonic mitigating transformer or a power conditioning unit before putting it through to the load. In severe cases, where high harmonic content combines with a rapid increase in the internal temperature, the operator can elect to transfer known loads to a parallel feeder in order to free up capacity of the transformer and, hopefully, bring the unit within the designed operating range.

In addition to complex monitoring of harmonics and disturbances, the facility operators can also use the system for standard items such as load balance, voltage fluctuations and power consumption.

LOAD BALANCING

Transformers are designed to operate under balanced load where each phase carries an equal portion of the facility demand. By monitoring each phase, building services staff can ensure that no undue strain is placed on a single phase of the transformer and when lighting or a new single phase load is added it is connected to the appropriate phase to maintain balance.

POWER CONSUMPTION

Part of the Mount Sinai facility is Princess Margaret Hospital, a teaching and research hospital of the University of Toronto that leases 17,000 square feet at the facility. Before the upgrade, there was no accurate metering data to determine the utility costs of the leased space. Now, with the measurement Canada approved Ion meter on the main feed to the leased space, building services has a clear picture of their energy usage and are able to accurately bill Princess Margaret for their energy use.

In addition to billing information, operators now understand the energy use in the facility. The system was completed in April 2006 and during times of peak energy usage they've been able to see what areas are contributing the largest loads and at what time of day.

Using the ION energy monitoring software, changes in energy usage can be tracked and problems pinpointed quickly.

To date, Mount Sinai has used the monitoring system for tracking the harmonics, load balancing and for energy cost allocation. Significant capacity remains in the system if and when the facility decides to monitor their 2500 kVA of generation or to tie in controls for a complete system. With the retirement of the Regulated Price Plan in 2008 and increased energy costs, the data collected from the Power Monitoring system will be an invaluable tool when the facility is considering a purchasing strategy for their energy.