North American Electricity Policies and Technologies

Electricity Transmission & Distribution Today

The Electricity Forum

Automation 2006
The AMRA International Symposium
October 22-25, 2006
Nashville Convention Center, Tennessee

September 2006
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Electricity Today

Volume 18, No. 7 September 2006

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Electricity Today Magazine is published 9 times per year by The Electricity Forum [a division of The Hurst Communications Group Inc.], the conference management and publishing company for North America's electric power and engineering industry.
Distribution: free of charge to North American electrical industry personnel who fall within our BPA request circulation parameters. Paid subscriptions are available to all others.
Subscription Enquiries: all requests for subscriptions or changes to free subscriptions (i.e. address changes) must be made in writing to:
Subscription Manager, Electricity Today
215-1885 Clements Road,
Pickering, Ontario, L1W 3V4
or on-line at www.electricityforum.com.

Canada Post - Canadian Publications Mail Product Sales Agreement 40051146
ISSN 0843-7343
Printed in Canada.

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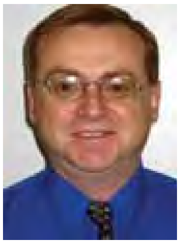

CON EDISON HAS BIG BROTHER LOOKING OVER ITS SHOULDER

By Don Horne

Consolidated Edison has Big Brother looking over its shoulder in the Big Apple, following blackouts in the middle of July that affected thousands in western Queens.

Blackouts have happened before in New York City, and they'll happen again. But what tweaked the nose of NYC's Office of Emergency Management – and especially commissioner Joseph F. Bruno – was that Con Ed's original estimate of 2,500 customers going without power was woefully underestimated.

In actuality, it took Con Ed four days to acknowledge that 25,000 customers were in the dark.

The Queens' blackout affected some 100,000 people in total.

The commissioner admitted that Con Ed has never erred on the numbers before, and Con Ed has stated that their original estimate was based on the number of phone calls that were coming through on their hotline.

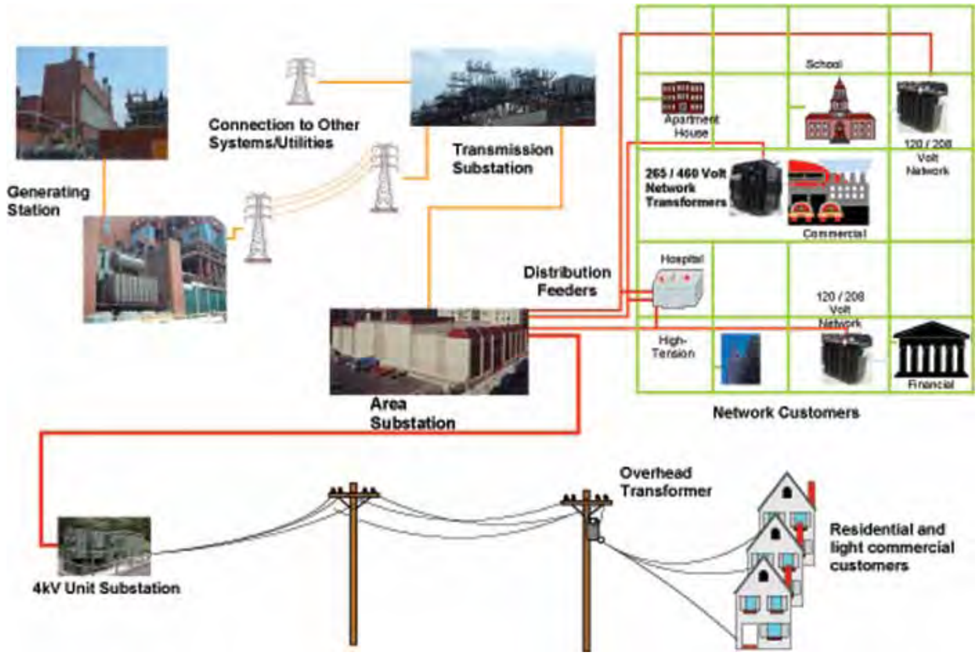

Figure 1: Con Ed's power delivery system

The blackout – which began on July 17 – came close to affecting the entire Long Island City network two days later (some 100,000 customers, or 300,000 residents in Queens).

The scene was set for a blackout when 10 of the 22 high-voltage feeder cables that supply power to the network went down: from 8:38 to 8:53 p.m. on July 18 and from 11:33 a.m. to 1:10 p.m. on July 19. In most situations, customers begin to lose power when more than two feeders fail.

At one point early in the afternoon, Con Edison warned the commissioner that it was considering a shutdown of the network to pre-empt a breakdown and further damage to equipment.

Naturally the commissioner was concerned for people becoming trapped in subway tunnels, and wanted a minimum warning time to allow people to go to safety.

The creation of the Power Outage Response Team in the wake of the July blackout is the city's first response to the blackout. Comprised of representatives of the police and fire departments, the Office of Emergency Management and the mayor's Community Assistance Unit, the team has been utilized seven times to investigate outages of "significant impact" (or affecting at least 1,000 customers), going door-to-door to estimate the number of people affected.

Harsh words have been directed at Con Edison by the commissioner, stating that "they are the entity required to provide electric service to our city. They have the authority to do that. I'm

Continued on Page 8

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very unimpressed with the way they've done that."

Coming to the defense of Con Ed, the director of the Office of Electricity and Environment at the State Public Service Commission James T. Gallagher, which is investigating the blackout, said that Con Edison had doubled its annual spending on transmission and distribution equipment since 2001 to more than $1 billion (not including an additional $100 million a year to rebuild secondary power lines).

But the damage has been done, and Con Edison now has New York City looking over its shoulder as to how they are delivering – or should be delivering – electricity.

Con Edison delivers electricity to 3.2 million customers in New York City and Westchester County – a service territory of 660 square miles with a population of approximately 9 million people. Electricity is delivered through approximately 95,000 miles of underground cable and 33,000 miles of overhead cable.

As shown in figure 1, the electric power system comprises three distinct sub-systems: generation, transmission, and distribution.

OVERVIEW OF THE LONG ISLAND CITY (LIC) NETWORK

The Long Island City (LIC) network serves northwest Queens and includes the neighborhoods of Long Island City, Astoria, Sunnyside, Woodside, and Hunters Point. The area is bounded by the East River on the west and north, the Brooklyn-Queens Expressway on the east, and Newtown Creek on the south (see figure 2).

The network is supplied by the North Queens substation through 22 primary feeders, totaling approximately 290 circuit miles in length, and 1,194 network transformers. They supply electricity in an extensive underground system of 4,400 manholes, 11,000 service boxes, and 1,700 miles of secondary cable, and on 3,000 utility poles, all of which combine to deliver power to approximately 115,000 customers.

In 2006, the forecasted peak demand for the Long Island City network is 395 MW. Commercial customers' electric demand is estimated to be 300 MW and residential customers' electric demand is estimated to be over 100 MW. The two demands, however, do not occur at the same time. The weekday demand cycle is shown below and the network generally peaks between 14:00 and 18:00 (see figure 3). Weekend customer demand in the network is estimated to be 269 MW, approximately 68% of the weekday peak. The demand cycle reflects the increase in consumption over the course of a given weekday or weekend as customers use more or less electricity.

Figure 2: Map of Con Edison's Long Island City Network Boundaries

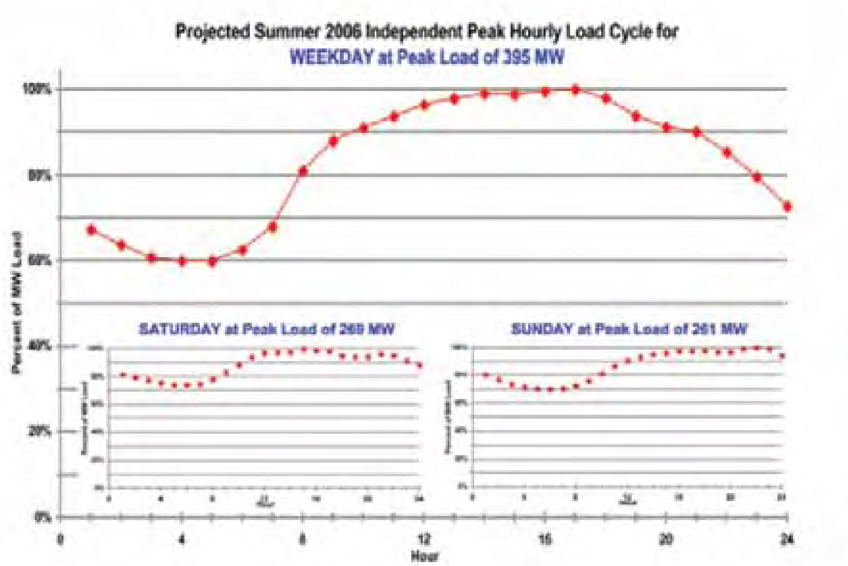

Figure 3: Long Island City Network Hourly Demand Cycle

OHIO STATE UNIVERSITY MEASURES UP FOR HIGH-VOLTAGE LABORATORY TESTING

By Professor Stephen E. Sebo

In the U.S.A., only a handful of high voltage laboratories can be found that are operated by universities. The High Voltage Laboratory at The Ohio State University was designed and constructed in the 1990s. Its major facilities are related to the generation and measurements of high voltage AC, DC and surges.

The laboratory has high-voltage DC sources (up to 150,000 volts), high-voltage AC sources (up to 250,000 Vrms), a 1,000,000 volt surge generator, and a high-voltage Tesla transformer (up to 3 million volts). Test capabilities include withstand-, partial discharge- and breakdown tests on gases, liquids and solids, electric and magnetic field tests, reduced-scale model tests, fog chamber tests (accelerated aging), and shielding and attenuation experiments. The laboratory is used for education (teaching high voltage courses), research and independent testing.

1. HISTORICAL DEVELOPMENT

The Department of Electrical Engineering of The Ohio State University (OSU) has offered electric power engineering courses continuously since 1895. The HV activities were started in the 1950s by Prof. Neal A. Smith. The initial building of the HV Lab was an old structure with brick walls and saw-tooth roof, without any electromagnetic shielding. Its neighbor in the same building was the studio of the OSU Radio Station. The area occupied by the HV Lab became much larger after the Station moved to a building dedicated to radio and TV communication functions.

Since the initial building was in poor condition and it was scheduled for demolition, a new location for the HV Lab had to be found. When the HV Lab had to leave the initial building in 1990, another brick building was found (also without electromagnetic shielding) and used for four years as the temporary home of high voltage activities.

Its floor area was significantly smaller than that lab in the initial building. The temporary HV Lab was in service for four years. Planning and design of the new HV Lab started in the early 1990s. Several design and operation ideas could be tested in the temporary HV Lab. Construction of a new building, used jointly by the Departments of Computer and Information Science, and Electrical Engineering, started in 1992. The building and the new HV Lab in it have been in service since 1994.

2. MAJOR EQUIPMENT IN THE HIGH VOLTAGE LABORATORY

The laboratory has two DC sources. Their maximum voltages are 60 kV and 150 kV. There are several AC sources in the laboratory. The highest voltage is supplied by a 250 kVrms, 25kVA transformer. Other transformers available are at 69, 34.5 and 20 kVrms. A high voltage three-phase system is available with the interconnection of three potential transformers. The maximum voltage supplied is 69 kVrms, line-to-line. The 250 kV transformer is connected to two high voltage buses, suspended at 3.6 m elevation. There are two current limiting resistors between the transformer and the high voltage buses. The buswork and the resistors are suspended by composite insulators. The 60 Hz test area of the HV Lab is shown in Fig. 1.

Figure 1. View of the 250 kV transformer, current limiting resistors and high voltage buses.

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Ohio State
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The surge generator (donated by American Electric Power Co.) has ten stages. Its ratings are 1000 kV, 25 kjoule, maximum charging voltage output 100 kV. The surge test area of the HV Lab is shown in Fig. 2.

A unique source is a Tesla transformer (donated by Battelle Memorial Institute), whose maximum rating is 5000 kV. For safety reasons, the Tesla transformer is used “only” up to 3000 kV. Its test area is shown in Fig. 3.

A fog chamber has been built (sponsored by The Ohio Brass Co.) for polymer insulator testing purposes. Its volume is 9.5 m3, its maximum voltage is 69 kVrms. Either clean fog or salt fog (at the desired conductivity) can be applied in the chamber. Steam fog generation is also available. The fog chamber test area of the HV Lab with the supply transformer is shown in Fig. 4.

Other main facilities available for high-voltage experiments: a 50 kV partial discharge detector, a transformer ratio arm (ε and tan δ) bridge, a 50 kV oil tester, sphere gaps, potential dividers, cylindrical corona testers, oscilloscopes, instruments, etc.

3. EDUCATIONAL ACTIVITIES

Lectures and laboratory experiments related to High Voltage Engineering are available for undergraduate and graduate students. Special projects, individual studies, master’s thesis and dissertation topics are also parts of the educational activities.

4. TEST CAPABILITIES

Withstand-, partial discharge- and breakdown tests on gases, liquids and solids can be performed. Special instrumentation, including scale models, are available for electric and magnetic field distribution measurements. Facilities are available for fog chamber (insulator accelerated aging) tests, shielding and attenuation tests. Some thermal tests can also be performed.

5. CONSIDERATIONS OF THE PLANNING AND DESIGN OF THE NEW HIGH-VOLTAGE LABORATORY

Many papers, studies, reports and books related to the planning and design of high-voltage laboratories were reviewed first. Also, discussions with many fellow engineers interested in high voltage activities and visits of several operating high-voltage labs have been very useful. By 1990, it was relatively easy to list the basic requirements for the new HV Lab. It had to be large enough to house major facilities already owned and planned, it had to be an indoor lab, of course. Ground level location, air cleaning and conditioning, complete electromagnetic shielding, accessible grounding, safety, a suitable number and level of auxiliary services were all items that were discussed during the planning and design stage.

Figure 2. View of the 1000 kV surge generator.

6. DESCRIPTION OF THE HIGH VOLTAGE LABORATORY

Floor area of the HV Lab is 18.3 x 18.3 sq. m (60 x 60 sq. ft). The ceiling-to-floor clearance is 8.5 m (28 ft). It has an adjacent upper level observation room, and an adjacent floor level storage room. The main hall (high bay area) is completely shielded electromagnetically. That was essential not only because of the high level of use of computers and instruments literally everywhere around the HV Lab, but also because the next-door neighbor is a division of the OSU Computer Center. The power supply lines are filtered. The laboratory has its own “internal” shielded enclosure to protect the computers and sensitive instruments used. The entire area (laboratory

Figure 3. View of the Tesla transformer.

and observation room) is air conditioned. Departmental shop facilities are available in the building next door, but the laboratory is equipped with an appropriate number of tools and small parts. A pneumatically operated person-lift is available. The mechanical load capability of each one of the 20 suspension points is about 1 ton (2000 pounds).

7. SAFETY

Safety is one of the most important requirements in a high-voltage laboratory. Proper operation of the OSU HV Lab includes the presence of qualified personnel, the use of systematic procedures, safety ropes, signs, visual and audible warnings and alarms, the use of grounding rods, the periodic review of safety rules, the availability of fire extinguishers, emergency phone numbers, first aid kit, and smoke alarm system.

8. SHIELDING OF THE HV LAB

The walls, two supporting pillars and ceiling of the HV Lab are shielded with a system of interconnected modular steel sheet elements mounted on wood framework. It is a single shield system with the shielding sheets stretched over the outer surface of the wooden frames and bolted together. The thickness of the

Continued on Page 14

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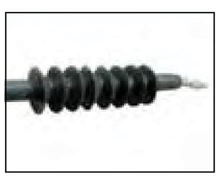

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Ohio State

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steel sheet is 0.76 mm (22 gauge). The sheets are galvanized on both sides. The modular elements are tied to threaded bolts embedded in the concrete walls, pillars and ceiling of the high voltage hall. There is a fiberglass insulating element at each tie point, therefore, the shielding system is electrically insulated from the steel structure of the parent building. This modular shielding system is fully connected to the extended edges of the ground plane of the HV Lab along the wall/floor line. The ground plane is a copper sheet embedded in the concrete floor of the laboratory. Thickness of the concrete is 15 cm (6 in) over the copper sheet. The copper sheet is connected at one point to the grounding system of the building power supply.

9. SHIELDING INTEGRITY CONTROL

Each of the penetrations had special design and construction requirements. All doors are special precision metal clad doors with metal door frames. The door frames are tied to the shielding system. Spring temper bronze contact finger strips are used along the entire door/frame contact line. High visibility double radio frequency (RF) screens are built into the observation shielded windows. The screens are extended over the glass and connected to the window frame and to the shielding system. Honeycomb waveguide air vents are used in the air conditioning system intake and exhaust connections to maintain the integrity of the shielding system. Piping-to-shielding seals (insulation) or an insulating section in the piping are supplied at the points of penetration by the air ducts, water pipes and sprinkler system. Power line filters are used for full 60 Hz power supply of the HV Lab. The single-phase and three-phase power transformers and their switchboards are located inside the laboratory. Also, telephone line, data line, and fire alarm line filters are employed.

10. SHIELDED ROOM IN THE HV LAB

A Lindgren-type double electrically isolated RF enclosure (a Faraday cage) is available for the housing of the data acquisition computer and sensitive instruments. A see-through double copper screen system, a special RF door, a power line filter, incandescent lighting and a 20-terminal coaxial cable service panel are employed.

11. SHIELDING PERFORMANCE REQUIREMENTS AND MEASUREMENTS

Shielding efficiency requirements in the 14 kHz - 10 MHz range were specified as 80 dB for electric field strength (E) attenuation and 60 dB for magnetic flux density (B) attenuation for the main HV hall. These figures are 120 dB for E and 68 dB for B for the shielded room in the HV Lab. Measured attenuation values for the HV hall are 87 dB for E at 10 MHz, and 63-68 dB for B at 14 kHz - 10 MHz. For the shielded room, at 14 kHz, these values were 126 dB for E and 71 dB for B.

Figure 4. View of the 69 kV fog chamber.

12. LIGHTING

In order to minimize the electromagnetic noise emitted by light sources and their accessories, high intensity incandescent light bulbs are used for general purpose indoor lighting. A secondary red lighting system is provided in the HV Lab and in the adjacent observation room, for night adaptation purposes. A remote controlled spotlight is available in the HV Lab. There is an emergency lighting system in case of power failure.

13. UTILITIES, SERVICES

120 V and 240 V single-phase voltages are supplied at many receptacles in the laboratory. 208/120 V three-phase receptacles are also available at several places. Double sink with hot and cold water supply is available in the laboratory. A water deionizing system has been added. There are several floor drains that can be utilized in case of wet tests. High pressure air is available from a compressor located in the HV Lab. Telephone, clock and computer lines have been provided. There is an intercom between the main floor and the observation room. Storage shelves, storage cabinets and work benches are available.

14. FLOOR STATION SYSTEM

There are 12 floor stations in the laboratory. Each floor station is equipped with two 120 V and one 240 V receptacles, a connection bar to the grounding system, and two coaxial cable terminals. Each cable is located in a separate steel conduit. The coaxial cables of the 12 floor stations, as well as 3 cables from the observation room and 5 cables from the shielded room, end at a patch panel. The patch panel makes the interconnections of the floor stations with the shielded room (or with each other) possible, without employing a maze of cables above the floor.

15. ACOUSTIC PANELING

In order to eliminate the sound reverberation and echo in the HV Lab, acoustic paneling has been added to the walls and pillars. They are perforated, corrugated galvanized steel wall panels, with baked-finish epoxy paint, attached to the shielding system via noise absorbing pads. The performance of the paneling is excellent. The color of two walls and the ceiling is off-white. The color of two other walls, behind most of the experiments, is green, in order to make the observation of discharges easy.

Dr. R. Malewski set up the design guidelines of the shielding system of the OSU HV Lab. His valuable contributions are appreciated very much. Dr. E. Sebo was the color coordinator for the HV Lab.

A ROAD MAP TO THE BEST PRACTICES FOR UTILITY WIRELESS COLLOCATION

Condensed from a Research Report prepared for the benefit of members of the United Telecom Council and Wireless Business Opportunities Committee (WBOC)

As utilities continue to look for ways to make best use of assets, many are finding that reserve space on transmission towers and communications antenna structures can be a source of useful revenue.

The wireless communications industry continues to develop, requiring new sites for existing networks as well as for new technologies. While most utilities have left the competitive telecommunications arena in recent years, wireless collocation is becoming a relatively simple way to add to the bottom line using existing assets. What this niche industry has not had before now, however, is information on "how the other guys do it" that may lead to more efficiencies, better carrier relationships and a more successful business.

Members of the United Telecom Council's Wireless Business Opportunities Committee (WBOC), made up of utilities of various ownership types and sizes operating Utelco (a utility owned competitive, commercial telephone/IT services entity that may utilize existing utility private communications infrastructure) collocation businesses, are interested in finding ways in which to standardize wireless collocation practices in order to improve the business climate. The objectives of the WBOC include a better understanding of the needs of carrier customers and determining ways in which utilities can become better partners in the wireless siting effort. Thus, this Road map to Best Practices for Utility Wireless Collocation study is created as a first step in gathering information in order to establish industry consensus and define "best practices" for utility collocation businesses. As part of the study, a survey was generated and distributed to United Telecom Council (UTC) members seeking input on the current state of their business and construction practices with regards to wireless collocation in North America and internationally. Aggregated data from the survey is shown in Appendix A.

The results are also presented throughout the body of the text, with various analyses and recommendations for "best practices". The note must be made that common consensus is an evolving effort and, therefore, this document is but a starting point for what is hoped to be a continuing effort.

An individual utility's collocation business is influenced by numerous forces forming unique requirements for the particular business:

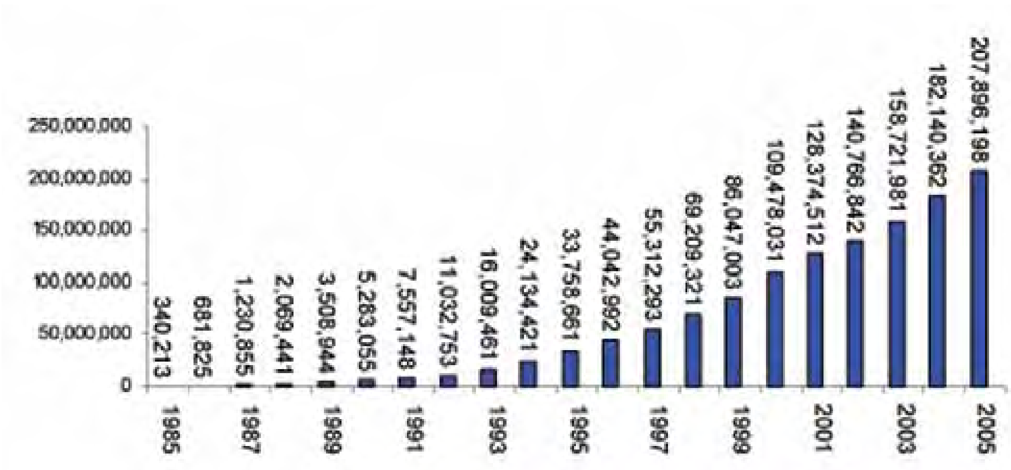
Finding common consensus across an entire industry is a challenging but worthwhile endeavor. What we have discovered thus far: while some elements of standardization already exist among utility wireless collocation processes, there is room for greater improvement; this will facilitate better communication with carrier customers resulting in greater speed to market.

THE BUSINESS CASE FOR UTILITY WIRELESS COLLOCATION

While using utility assets, especially transmission towers, can have downsides for commercial wireless carriers, the utility's expertise in strong and reliable infrastructure build out is a plus. The leasing of internal assets for commercial wireless infrastructure siting and the utilization of utility personnel/talent to provide design, construction, installation and management of wireless antenna solutions positions utilities as very strong niche competitors in the large and competitive wireless siting market.

a. Defining Opportunities

The wireless industry experienced a banner year in 2005, with subscribers increasing by 12.3%. The number is but the latest addition to a rapid growth pattern for the wireless carrier industry; this in turn offers continuing and steady collocation



Year-end 2005 Estimated Wireless Subscribers
Highest Growth Year Ever: Up More than 25.7 Million from December 2004

opportunities for Utelcos.

But the growth of cellular subscribers is only one consideration and factor in concluding that wireless collocation business will continue to be viable for the foreseeable future.

Some of the larger wireless carriers boast extensive "national" coverage, but all providers are driven to establish additional cellsites/base stations by several factors, including providing new service in geographic areas and filling in areas where existing signals are weak. The reuse of spectrum or bandwidth to meet the needs of increasing population and to accommodate the higher speeds of emerging technologies also drive collocation opportunities through the resulting need for "capacity" sites.

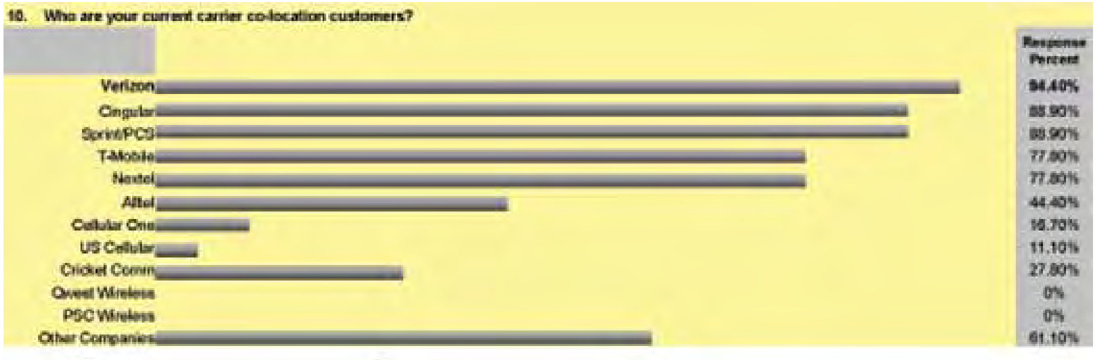
Therefore, a second indicator of continued collocation business is the need for wireless carriers to constantly improve quality and range of coverage.

Even when a carrier offers coverage in a certain geographic area, calls can be dropped due to limitations in network architecture (a dropped call can occur when there are too few antennas in a particular area), capacity (how many callers are using the airwaves/antenna at a given time), and topography (buildings, man-made clutter, foliage and terrain). The effects of topography can be a localized "dead spot" caused by signal blockage between the handset and the cell tower. Link budget used for path loss and margin fade may become insufficient as a result of topographical changes. Carriers are constantly working to improve and upgrade their networks in order to minimize dropped calls, busy signals, and dead spots. Each attempt to mitigate faulty service offers a local utility an opportunity to lease infrastructure to commercial wireless service providers.

While wireless carriers are understandably close-mouthed about their specific business plans, insights may be gained into potential collocation opportunities by monitoring sites such as www.deadcellzones.com. This particular service relies upon consumer reports of specific trouble spots for Verizon, Cingular, Sprint/Nextel, T-Mobile, Alltel, Cellular One, US Cellular, Cricket Comm, Qwest Wireless and PSC Wireless.

Respondents to the UTC survey for this report indicated that they currently work with the following wireless carrier companies:

As would be expected, most U.S. survey respondents lease to the top five large wireless carrier companies, regardless of regional locations, reflecting the carriers' goals of national coverage. However, both U.S. domestic and international data was gathered, as this business opportunity is one that may be of interest to utilities nearly everywhere.



"Other Companies" named by survey respondents as business partners are N-Tellos, Suncom, Clear Wire, RAM Comm, TAMA Comm, Clearwire, Newpath, Startouch and Cellnet. Our Irish respondent named Vodaphone/Verizon, British Telecom (BT), Meteor, Irish Broadband, DigiWeb, Clearwire and Last Mile Wireless. Many respondents stated that leases are also provided to small paging companies, Police, emergency services, state and local governments, various radio stations and municipalities. Interestingly, tower consolidator companies, Crown Castle and American Towers, normally competitors of utility collocation businesses, are also named as lease customers.

Wireless Capital Partners'

Investment Committee Chairman, Rich Grimes sees evolving wireless broadband technologies as offering significant lease up opportunities for utility members, "In addition to the major wireless carriers and tower companies, there are evolving alternative broadband wireless technologies that have the potential to become a significant new source of siting revenue for Utility Companies. Some examples of these new technology deployments are WiMAX and companies like MediaFLO… (which is) a Qualcomm venture, a dedicated multicast mobility delivery system that is very complementary to carriers because it allows them to provide multicast mobility without utilizing the carriers' own network capacity. We see these evolving broadband technology deployments creating increased demand for space on strategically located infrastructure in the future".

Marc Ganzi, CEO of Global Tower Partners, points to much carrier business driven by capacity build outs in the future and a "predictable, steady cash flow…." Further, he notes that carriers are moving concentrically away from (population) centers and from roaming partners into new markets with site construction.

This is especially true for Verizon and Cingular. Other factors that are expected to drive carrier network growth are demand from public safety, homeland security and network portability. Jim Eisenstein, CEO of Optasite, explains that carriers are focusing beyond commuter corridors now that people can take their phone numbers with them to a competing carrier service. This forces companies to build out their networks. He also points to potential billion-dollar sales driven by the Patriot Act, which will spur the deployment of new government sites and technologies, and by the Coast Guard.

b. The Business View from the Wireless Carrier's Perspective

Lending great impetus to the WBOC's efforts to achieve consensus on streamlined and consolidated business processes are the motivating words of wireless carriers and associated industry partners such as Justin F Marron, Senior Vice President of WCP Utilities, "Most utility co-location procedures are viewed by the wireless carriers as overly complex and far too time consuming to consider as a viable primary candidate. Consequently, carrier tenants typically view utilities as backup candidates for cell sites. The need for utilities to implement efficient streamlined procedures to ease this point of pain is paramount to driving new wireless revenue to the utility. Understanding both the wireless and utility industries, and knowing their respective needs, is critical to creating, effective and efficient co-location procedures that will bring new revenue to both parties. At the end of the day both the utilities' and the carriers' goals must be aligned for the new procedures to function correctly and generate revenue."

An additional insight for utility consideration was provided by Neil Boyer, director of Cingular Sites, at the 2006 Tower Technology Summit in April.

He emphasized that speed of deployment is more important to a carrier company than pricing, "Speed is still king, getting on the air as fast as possible.…" Brian Fliss, T-Mobile's director of national development concurred, saying, "Everyone is looking for speed…." These comments were made in the context of reciprocal tower leasing agreements between carrier companies themselves; however, the concept can be extracted for utility company collocation businesses.

From the carrier's point of view, speed to market is often the most important element in a new cell site lease decision. Therefore, it is in the best interest of utility collocation businesses to streamline business processes and practice superior communications with carrier customers in order to speed-up implementation. The ability to deploy equipment rapidly can tip the scale in favor of utility infrastructure collocation.

Top Tower Consolidator Companies

	American Towers	Crown Castle	SBA Communications	Global Signal
2005 Sales ($mil.)	$944.8	$676.8	$260	$368.1
Largest Customers	Wireless carriers, radio and TV broadcasters	Cingular, Optus, Sprint Nextel, Verizon	Cingular and Sprint Nextel	Wireless carriers, Government, radio and TV broadcasters
Number of Towers	~22,000 - broadcast & communications	~12,000 radio towers	> 3,300	~ 3,000 towers
Locations (Primary)	US, Brazil, & Mexico	US & Puerto Rico	Eastern US, Puerto Rico, US Virgin Islands	Southeast & Mid-Atlantic US, Canada & UK
Additional Comments	The company sold off its tower, construction unit. It merged with SpectraSite (2005)	Also in Australia (Vodaphone customers)	Leading independent owner and operator of wireless communications towers.	Formerly called Pinnacle Holdings

Source: Hoovers On-line

c. Traditional Collocation Business for Utilities and Competitors

Cellular service providers at first primarily constructed and owned their own towers; allowing competitors to share space on their assets was never a consideration. Carriers later saw the opportunity to reduce infrastructure investments and free up cash for other uses by leasing space from "Tower Consolidators", huge companies that cater to multiple service providers. This trend was reinforced by local government ordinance preferences for fewer towers with more carriers using each (collocation).

The current top companies in this industry sector are:

Tower consolidator companies are the primary competitors of utility collocation businesses, but certain market forces are steering wireless carriers away from traditional collocation of antennas and other cell site equipment at large consolidator sites. These include:

• Utility assets often are located in hard-to-reach places ideally suited to cell site expansion;

• Abundant, available utility infrastructure lends itself to rapid cell site deployment;

• Utility property owners own their infrastructure and generally do not need multiple tenants on their towers (or other infrastructure), as do tower consolidators, in order to realize a positive return on their investment;

• Increasing resistance to the construction of new towers in some areas has played a role in steering carriers towards utilization of existing infrastruc-

Continued on Page 20

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continued from Page 18

ture for new equipment mounting.

Therefore, in recent years the practice of locating wireless equipment on non-tower property including utility infrastructure has become a dominant implementation strategy. According to representatives of the wireless carrier community, "Utilities are an ideal choice for carrier tenants as they are the largest infrastructure owners in any given area; typically have power and backhaul at or near every site, and most regulatory bodies favor this type of co-location as an alternative to a new tower."

Crown Castle International Corp., the nation's second largest tower consolidator, said in March of 2006 that its average annual tenant income was $18,000, representing a monthly lease rate of $1,500, with average three percent (3%) annual escalation. For the tower consolidator sector the following broad estimates are given:

Monthly rates for Personal Communications Service (PCS, or second-generation cellular) carriers must now factor in voice/data convergence and increased minutes of use (MOU). "Calls per hour" is less frequently used as a measurement for leasing analyses; however, these figures give a general idea of collocation competitors' price points.

Type of Corridor:	Calls Per Hour:	Lease Per Month:
Secondary Highway	600 or less	$1,200 to $1,400
Primary Highway	600 - 1,200	$1,400 to $1,900
Expressway/Freeway	1,200 - 1,600	$1,900 to $2,100
Prime Locations	1,600 +	$2,100 +

Source: Wireless Estimator

The point is that utility wireless collocation businesses may enjoy some pricing advantages, since the infrastructure already exists for power delivery and there is an easier ROI (return-on-investment).

However, pricing is a complicated matter dependent on many factors.

Interestingly, carriers themselves are competitors to utility IOUs in the traditional tower leasing business. That is, companies such as Cingular are engaged in dual roles as entities that rent space for antennas from others, while at the same time serving, as are site landlords that rent tower space to others (Cingular owns 7,000 towers or structures with leased space). This enables reciprocal pricing agreements to be struck. T-Mobile owns 4,500 towers that are available to Sprint and other companies in leasing agreements with reciprocal pricing. To complicate matters further, respondents to the UTC-generated Wireless Collocation Survey stated that tower consolidators American Towers and Crown Castle also are customers of utility IOUs, as stated above. There are many ways to slice up the wireless siting business pie, and with the development of new wireless technologies with different technical requirements, the scene will only become more complex. Utilities interested or involved in this business are advised to think imaginatively!

d. New Business Opportunities

Non-traditional wireless business opportunities spring from the implementation of new technologies such as Wi-Fi, Distributed Antenna systems (DAS) and soon, WiMAX. With the advent of new lines of business in wireless collocation, utilities may wish to review current business practices to determine whether they make sense in the new arenas.

• Distributed Antenna Systems (DAS)

Municipalities are key players in implementing newer wireless infrastructure. In a sense, if a utility is not municipally owned and operated, the city may be a competitor of the area utility for wireless collocation. This is especially true of so-called "disruptive" technologies such as Distributed Antenna Systems (DAS), which brings the wireless infrastructure as close as possible to the consumer and whose equipment can be mounted almost anywhere. For such systems, utility infrastructure is only one of many property options. A primary reason for deploying DAS is to improve coverage and capacity where conventional towers are not feasible (dense urban, suburban, residential and hard-to-zone areas). Antennae for DAS have become so "stealthy" that they are almost impossible to detect, whether for in-building or outdoor systems.

Jack MacLeod, Principal Vice President and Chief Technology Officer for Bechtel Communications, cautions the tower industry that, "We better start paying attention to our customers. They don't want the big old huge towers in their back yards."

Laura Altschul, director of National Siting Policies & Programs at T-Mobile USA, works with municipalities closely and notes that as technology moves to smaller and smaller cell-sites, municipalities are loath to give up revenues from traditional structures. She notes that city officials are wondering how to initiate permits for in-building or outdoor DAS networks. This would defeat one of the main attractions to DAS; with towers there are multiple hearings and permits required and currently things go much more smoothly for the lower profile DAS.

A multitude of factors such as cost, zoning constraints, number of potential carriers sharing a system the system can tilt a carrier's decision in a given case to deploy a Distributed Antenna System vs. conventional cell sites. Laura Altschul asserts that the challenge is to make sure that jurisdictions understand that DAS is not the only solution: "Carriers are interested in the systems, but not at the exclusion of other technical solutions that improve networks and the ability to improve customer service."

Magnus Friberg, Chief Operating Officer for MobileAccess Networks, has overseen the deployment of major DAS and WiFi systems throughout the United States, including the Microsoft headquarters campus and SeaTac Airport, and has been a thought leader in distributed antenna technology design and adoption. Magnus believes that "Distributed Antenna Systems, both in-building and outdoor, provide the opportunity to leverage one common infrastructure for several different wireless technologies deployed at different times. With greater demand for cell density to support the capacity required from multiple bands of technology, DAS becomes compelling."

For utility wireless collocation businesses, regardless of the type of utility, the challenge of implementation of emerging wireless technologies such as DAS is to determine the best business model and to arrange processes in such a way as to make collocation profitable.

V. SUMMARY

Utility collocation entities can look forward to continuing business with carrier customers in years to come, both in the form of tradition tower siting and in the siting of emerging technologies' equipment such as DAS, Wi-Fi and WiMAX. Wireless communications is now a part of daily life and the cellular business is not slowing down. Wireless carriers are constantly improving their networks in order to accommodate growing populations and the greater bandwidth needs of next generation wireless. Although steadily profitable, niche collocation Utelcos businesses are generally considered to be just a nice addition to the core business of power delivery by parent utilities. From the Carrier's perspective, utility infrastructure is often viewed as a last choice among leasing options due to the perceived difficulty in doing business. But by streamlining processes and improving communications with carrier customers, wireless siting Utelcos can improve profitability and make significant contributions to the utility's bottom-line.

From the wireless carriers' point of view, speed to market is often the most important element in a new cell-site lease decision. Therefore, the ability to rapidly deploy equipment can tip the scale in favor of utility infrastructure collocations. Utility collocation businesses also enjoy pricing advantages over competitors that make them attractive to carriers.

Tower companies were the original suppliers of leased space to the carriers and are the primary competitors of the utility wireless siting business. However, Utelcos are well positioned to compete:

- Utilities own assets located in hard-to-reach places, ideally suited to cell site expansion;
- Utilities' abundant, available infrastructure lends itself to rapid cell site deployment;
- Since private property owners possess existing infrastructure to capitalize upon, they do not need to have multiple tenants on their towers (or other infrastructure), as do tower consolidators, in order to realize a positive return on their investments;
- Increasing resistance to the construction of new towers in some areas has played a role in steering carriers towards utilization of existing infrastructure for new equipment mounting.

Utilities should also bear in mind that emerging technologies may eat into the tradition tower siting business. This is counter balanced by the fact that as wireless technologies evolve to smaller and smaller cell sites, utilities also possess many alternative infrastructure options (such as lamp posts, roof tops, water towers) to offer for leasing arrangements.

This will necessarily drive changes in business and construction processes associated with utility wireless collocation activities.

Courtesy of WCP Utilities, Justin F. Marron, Senior Vice President and Allen Garrison, WBOC Chairman, Salt River Project, Wireless Project Manager.

FERC IMPROVES SECURITY OF THE POWER GRID

In an initiative put forth by the Edison Electric Institute (EEI), a group of transmission owners has established the Spare Transformer Equipment Program (STEP), designed to increase the industry's inventory of spare electric transformers.

The Federal Energy Regulatory Commission (FERC) has approved the innovative agreement among electric utilities on electric transformer sharing that will maintain the integrity of the nation's transmission system in the event of a future terrorist strike.

"Since the attacks on our country five years ago, the Commission has taken a number of important steps to improve the physical security of our energy infrastructure," FERC Chairman Joseph T. Kelliher said. "The industry is to be congratulated, for this voluntary agreement is a significant first step, but only a first step, in addressing critical reliability issues. We will encourage further innovations to help assure the robust reliability of our nation's power grid."

According to the application, this will ensure that the industry has sufficient capability to restore service in the event of "coordinated, deliberate destruction of utility substations."

Any investor-owned utility, government-owned utility or rural electric cooperative in the United States or Canada that owns transformers may participate in the program. At present, 43 entities have signed on to the Spare Transformer Sharing Agreement, representing more than 60 percent of the Commission-jurisdictional bulk-power transmission system.

"The industry's efforts to voluntarily coordinate the sharing of spare transformers will enhance the reliability of the transmission system and security of our energy supply infrastructure in the event of an act of deliberate destruction," FERC said.

FERC has urged participants to improve the program, including the method of calculating spare transformer requirements, and the Commission encouraged other entities owning high-voltage transformers to participate in STEP "so that the benefits may be spread to more of the bulk power system."

Participating utilities were also encouraged to expand the scope of emergency situations, such as natural disasters, under which the transfer of spare transformers will be required.

Under the Agreement, each participating utility is required to maintain and, if necessary, acquire a specific number of transformers in various voltage classes. Applicants estimate that for the total of 43 utilities already signed up, between 72 and 105 spare transformers will be required. However, because these participants already own a number of spares, only 21 to 31 new units will need to be purchased, at a total cost of between $50 million to $75 million.

The agreement requires each participating utility to sell its spare transformers to any other participating utility that suffers a triggering event, defined as an act of terrorism that destroys or disables one or more substations and results in the President of the United States declaring a state of emergency.

Under section 203 of the Federal Power Act the Commission must approve the sale or disposition of jurisdictional assets in excess of $10 million. Noting the importance of responding quickly to an emergency and the long lead times involved in ordering new transformers, EEI, on behalf of the 41 jurisdictional participants, requested and the Commission approved blanket authorizations for future transfers of transformers under the agreement. The Commission conditioned its authorization on public utility participants in the program filing the information required by the Commission's Part 33 regulations initially within 30 days of any transformer transfer and again when final sales terms have been established.

To encourage participation in STEP, the Commission also granted Applicants' requests to declare participation in the Agreement prudent, find that the costs of participation qualify for single issue rate treatment, and accords all future jurisdictional signatories to the Agreement the same benefits as current signatories.

Participation in this sharing program will increase transmission owners' emergency recovery capabilities by providing access to more spare transformers at lower cost.

AMRA MEMBERSHIP GROWS TO RECORD LEVELS THANKS TO STRENGTH OF UTILITY AUTOMATION INDUSTRY

AMRA, the international voice of the automatic meter reading industry, announced a 39% growth in membership since this time last year. This strong upward trend is attributed to the strength of the utility automation industry and the value of AMRA's new member services.

"Our membership continues to grow, which is a great sign for the industry," says AMRA President Brian Pollom. "Especially as utilities work to comply with the Energy Policy Act of 2005, AMRA is poised to help them better understand and apply AMR technologies."

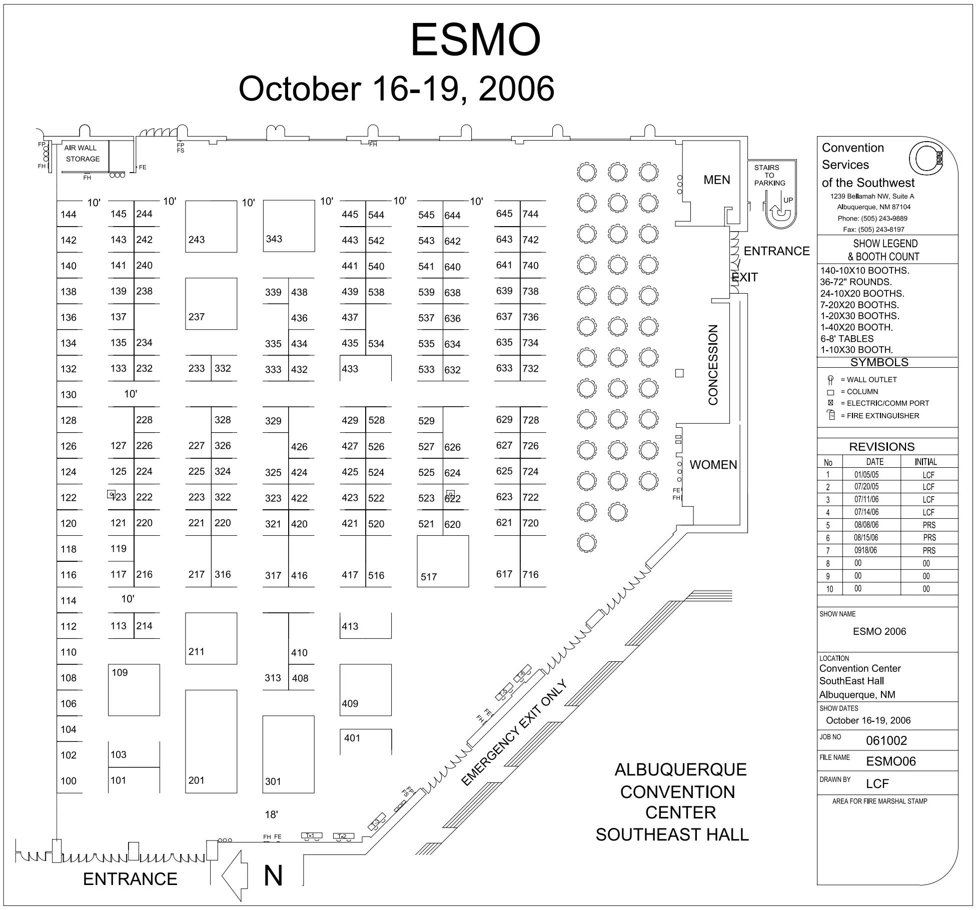
AMRA members increased from 726 members in October 2004 to 1,010 members in October 2005, marking the organization's largest-ever membership count.

AMRA offers new and improved services to help members connect and learn, including public policy updates delivered regularly so members stay up-to-date on legislative initiatives that may affect utility automation. Also, AMRA's Web-based seminars feature presentations by AMR experts who share knowledge about industry fundamentals as well as advanced topics. The new online message posting service, AMRA Forums, helps utility members quickly and easily get in touch with their colleagues, share experiences and seek solutions to AMR technology and business questions.

Members got another taste of the new and improved AMRA at Autovation 2005: The AMRA International Symposium, in Long Beach, Calif., Sept. 18-21, 2005. Educational programming for this event featured many sessions about advanced uses of AMR, and included utility-only sessions for an even more open exchange of experiences.

"Autovation was better than ever this year, and AMRA services throughout the year are delivering real value to our members," says Pollom. "We're looking forward to 2006 — the industry continues to grow and AMRA will serve and grow with it."

ALL ROADS LEAD TO ALBUQUERQUE FOR ESMO 2006



In October 2006, utility professionals from more than 40 countries will converge in Albuquerque, New Mexico for the IEEE Power Engineering Society's 11th International Conference on Transmission & Distribution Construction, Operation and Live-Line Maintenance (ESMO 2006). This important event will be held at the Albuquerque Convention Center from Sunday, October 15 to Thursday, October 19, 2006. As a member of the dynamic electric utility industry, you cannot afford to miss the opportunity to attend the event that is sure to be a thorough knowledge-building experience.

ESMO 2006 is devoted to the practical, hands-on aspects of construction, operation, maintenance and safety of overhead and underground transmission and distribution lines, including substations. The conference program spans four days, featuring two days of outdoor field demonstrations/exhibits and a two-day technical program combined with an indoor exhibit area. Attendees will gain the knowledge and expertise required to effectively build, operate and maintain the world's power-delivery systems.

As host utility of ESMO 2006, PNM (Public Service Company of New Mexico) will hold all activities at its outdoor facilities in Albuqerque. The outdoor program truly makes this conference a one-of-a-kind event.

The PNM outdoor site features various voltages on its transmission and distribution lines; and substation facilities, including power transformers. The outdoor portion of the conference will feature live-line demonstrations, construction techniques, safety demonstrations, operation activities, right-of-way management techniques and equipment, and a heavy equipment display area.

TECHNICAL PROGRAM

The landscape of today's electric utility is being altered and the traditional operating procedures are continually being reviewed. Many companies realize they can no longer do business as usual. More cost-effective methods of operation are being deployed every day. New tools are increasing work management, productivity and safety. Updated equipment and management techniques are providing more efficient means of power delivery. Utility managers, engineers and operating professionals must learn about every changing aspect of the industry.

Through individual paper presentations and group panel sessions, the ESMO 2006 technical program examines new methods and procedures for operating and maintaining power-delivery systems at peak levels. The conference has attracted a significantly large number of individual paper presentations from professionals around the world. In addition, panel sessions have been organized by industry experts highlighting the latest advances in the construction, operation, and maintenance power-delivery facilities.

IT'S ALL A MATTER OF TIMING: CIRCUIT BREAKER MOTION TESTS - PART II

By Fouad Brikci, Ph.D., Zensol Automation Inc.; Emile Nasrallah, P.Eng., Circuit Breaker Specialist

Editor's Note: This is the second part of this article from the previous issue:

2.5 Displacement curve

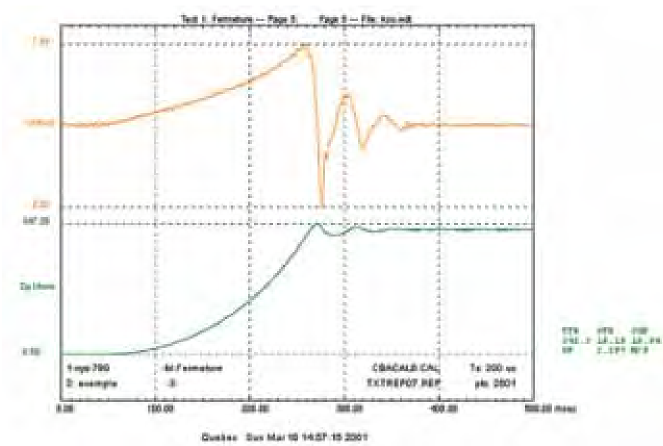
The displacement curve is generally drawn with the unit of measurement (millimeters – mm) on the vertical axis and the time in milliseconds on the horizontal axis.

2.5.1 Velocity

The speed of the contacts on opening, as on closing, is an important parameter in the operation of high-voltage circuit breakers. The displacement curve also serves to calculate the speed of the contacts at a specific moment, or instantaneous velocity, or it may serve to calculate the average speed for a predetermined time interval, or average velocity.

2.5.2 Instantaneous velocity curves

The CBA Win software draws a curve of the instantaneous velocities, calculated by deriving the data in the displacement curve. Below is an example of the derivation of a displacement signal (in green) that produced a curve showing the evolution of the displacement velocity (in orange).



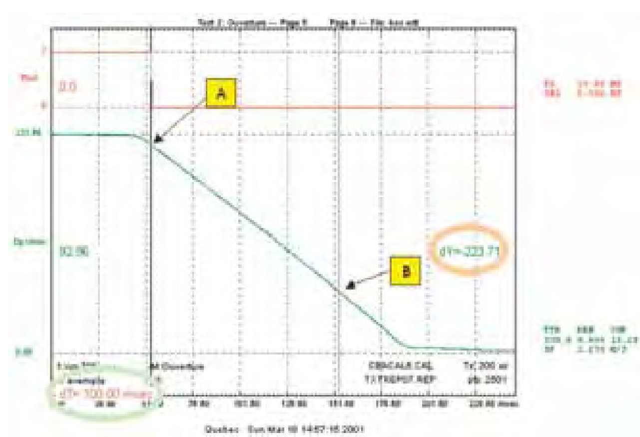
2.5.3 Average velocity

The velocity usually sought is at the moment the breaker contacts make (on Close) or break (on Open). However, since it is difficult to obtain a consistent speed for each operation, it is better to calculate an average speed over a time interval extending before and after this point.

The exact calculation method must be obtained from the circuit breaker's manufacturer so the measured values may be compared to the reference specification of the manufacturer.

2.5.4 Average velocity calculation example for OPEN operation

To calculate the average speed on Opening, point A on the displacement curve, which is the exact moment the main contacts separate, must be determined. Point B is determined by adding dT milliseconds (ms) to the time of Point A.

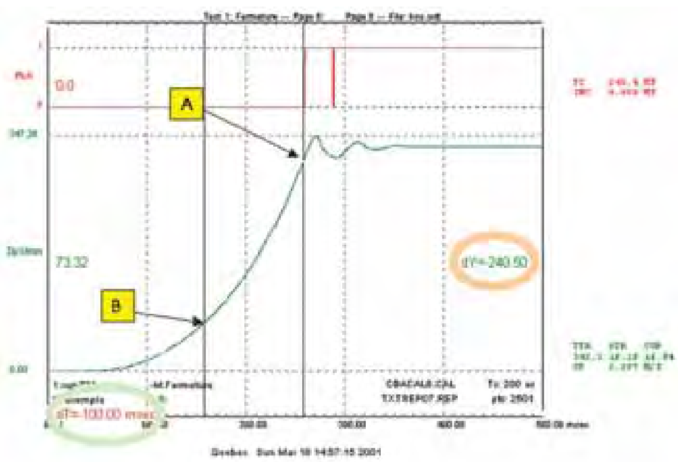


Displacement axis value of point A = YA mm
Time axis value of point A = XA ms
Displacement axis value of point B = YB mm

The average velocity on Opening, in meters per second (m/s), is calculated using the following formula:

Vo(m/s) = (YA-YB) (mm)/ (XB-XA)(ms)
In this case XB-XA = dT = 100 ms
YA-YB = dY = 223.71 mm, so:
Vo = 223.71 / 100 = 2.24 m/s

2.5.5 Average velocity calculation example for CLOSE operation



To calculate the average velocity for a Close operation, point A on the displacement curve, which is the exact moment the main contacts make contact, must be determined. Point B is found by subtracting dT milliseconds (ms) from the time of point A.

Displacement axis value of Point A = YA mm
Time axis value of Point A = XA ms
Displacement axis value of Point B = YB mm
Time axis value of Point B = XB ms

The average velocity on Closing, in meters per second (m/s), is calculated using the following formula:

Vo(m/s) = (YA-YB) (mm)/ (XA-XB)(ms)
In this case XA-XB = dT = 100 ms
YA-YB = dY = 240.5 mm, so :
Vo = 240.5 / 10 = 2.4 m/s

2.5.6 GENERAL PRECAUTIONS

Certain precautions are to be observed when the transducer is installed and the cables are connected:

2.5.6.1 Inverted curves

In general, displacement curves show the CLOSED position higher than the OPEN position. To observe this rule, the wires must not be interchanged between terminals 2 and 3 of the transducer. Otherwise, the curve will be drawn upside down (see figures 2.5.6a and b)

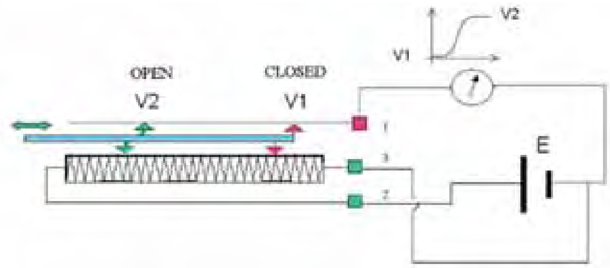


Fig 2.5.6a Connections causing an inverted displacement curve

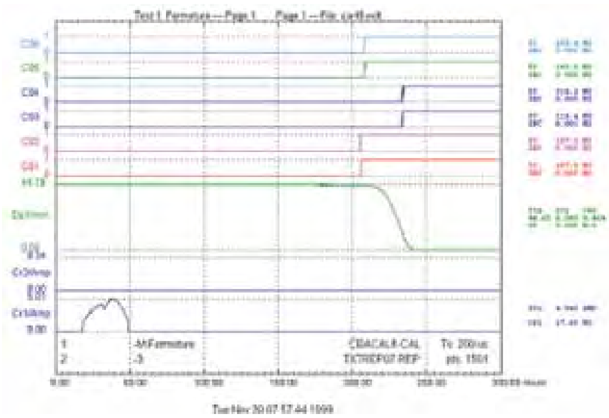


Fig 2.5.6b Inverted displacement curve example (Close)

2.5.6.2 Transducer capacity

When the transducer is installed, it must be ensured that the motion measured does not exceed the capacity of the transducer or it will be damaged and the curve shown will not represent the true motion of the circuit breaker. The following graphic shows an example of what happens when the transducer « bottoms out » before the breaker attains the end of its movement, as seen by the sharp angle at the bottom of the graphic.

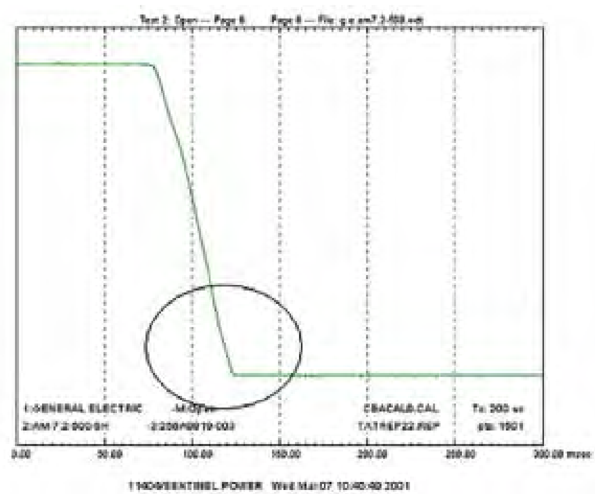


Fig. 2.5.6.2 Example of a displacement curve exceeding a transducer's range

AVOIDING POWER OUTAGES BY FOCUSING ON THE MARGIN WITH MICRO GRIDS

By Guy Warner

During August's brutal heat wave, record power use crashed the electric distribution system in downtown Stamford, Connecticut. The life-sustaining services of an elder care facility were among the operations that went dark for more than nine hours. Financial and pharmaceutical companies, who lose millions per hour without electricity, also had no power.

On average, the central power systems delivering electricity to Stamford and other U.S. cities achieve a remarkable level of performance, often reaching a reliability rate exceeding 99 percent. As shown during the heat wave in Stamford - and other cities including New York City, Chicago, St. Louis and Los Angeles - central power failures at very particular times and places can threaten lives and wreak enormous financial damage.

Central power systems generate electricity with large plants that cannot be easily fired up on short notice. They convey that power to cities over lines which can be easily knocked down by Mother Nature or human mischief and often take many years to upgrade. Moreover, regulation does not encourage deregulated utility companies to invest in improving local distribution systems at their weakest points.

While it vies to build new coal-fired generating plants and billions of dollars of transmission lines, Stamford's utility, Connecticut Light and Power ("CL&P"), is investing only $150 to $250 per year in local distribution property and much of that to add new customers as opposed to upgrading the quality of the system.

CL&P estimates that upgrading distribution systems will take another five years to accomplish. As Stamford residents and businesses anxiously await heat waves next summer, there seems little hope that there will be a solution coming from the central power system any time soon.

Many experts now agree that solving marginal power problems at particular times and places will be better met by a new type of decentralized micro-grid system. In his brilliant new book, “From Edison to Enron,” Richard Munson has described the promise of micro-grids: “... a growing number of engineers argue that the August 2003 power cascade should provoke a dramatically new approach to delivering electricity.

“They draw a comparison to computers and their evolution from centralized mainframes of the 1960s to today’s decentralized web of networked laptops. These engineers foresee a radical new power network - one that’s adaptive, self-healing and compatible with distributed on-site energy sources. It would have sophisticated sensors to anticipate crises, electronic circuits to redirect wayward currents and a computerized ‘brain’ to power down non-critical electricity loads when the system is nearing its capacity. One innovation, the micro-grid, already links small generators and sophisticated software based on neural networks can increase power quality and reduce the risks of overloads,” Munson writes.

As outlined in figure A on page 34, the micro-grid approach recognizes there are clear benefits to taking the same spatial “foot print” where costly area- and time-specific failures occur and installing a source of environmentally benign, high quality micro-generation at or near its point of use.

Unlike a conventional plant, micro-grids have an economic and environmental benefit in being able take advantage of the excess thermal energy from power generation to heat and cool buildings. From about 30 percent energy efficiency at a conventional power plant (some 70 percent of the energy goes up a smoke stack and adds to global warming or is lost during the electricity’s journey from the central plant to where it is used), micro-generation can achieve up to 85 percent efficiency.

The decentralized micro-grid also creates an optimal situation to introduce a variety of renewable energy and alternative energy technologies, particularly solar, solar thermal and solar photovoltaic power. Small, on-site fuel cell power plants can also provide additional peaking and crucial back-up power for uninterrupted energy service.

As opposed to the distant and detached state and federal organization of the central power system, new, more agile community groups are emerging to plan and finance micro-grids.

Taking a cue from the model by which self-taxing business improvement districts solved crime and sanitation problems in the 1980s, for instance, pending legislation in Connecticut would enable municipalities and their businesses to take local control of electric power in an innovative organization called the Energy Improvement District (EID). Under the legislation, EIDs would be able to use municipal bonds to plan, finance and install micro-grids.

As opposed to the slow, cumbersome, and environmentally negative central power approach, a micro-grid planned and financed by an EID could deliver more reliable and cleaner power in less than one year. Experience with micro-grid systems on U.S. military bases and other residential communities in the United Kingdom has demonstrated that micro-grids can be developed much faster and more economically than central power upgrades.

As opposed to the slow, cumbersome, and environmentally negative central power approach, a micro-grid planned and financed by an EID could deliver more reliable and cleaner power in less than one year. Experience with micro-grid systems on U.S. military bases and other residential communities in the United Kingdom has demonstrated that micro-grids can be developed much faster and more economically than central power upgrades.

Continued on Page 34

HIGH-PERFORMANCE CONDUCTOR MEANS MUCH GREATER CAPACITY

By Doug Johnson, Product Development Specialist, 3M

A high-performance conductor that can provide transmission capacity up to two to three times greater than that of existing transmission lines is finding its way onto the nation's power grids.

Relying on a core of aluminum matrix composite wires surrounded by temperature-resistant aluminum-zirconium wires, 3M's Aluminum Conductor Composite Reinforced (ACCR) can operate at elevated temperatures with reduced sag. Since sag due to thermal expansion is a major factor limiting capacity, reducing sag increases the amount of current the line can carry while maintaining required clearances. It can be installed quickly and easily as a replacement conductor on existing transmission lines, with little or no modifications to towers or foundations and minimal environmental impact, saving time and cost.

The tremendous advantages of ACCR are due to innovations in the core material (see Figure 1). Compared to steel, the core has:

- less weight,
- equivalent strength,
- greater corrosion resistance,
- lower thermal expansion, and
- higher electrical conductivity.

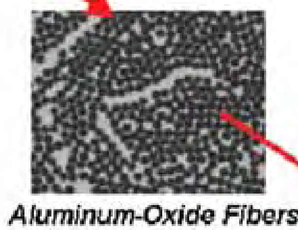
MATERIAL PROPERTIES AND ADVANTAGES

Metal Matrix Core

The core contains metal matrix composite wires infused with pure aluminum. The core wires have the strength and stiffness of steel, but with much lower weight, higher conductivity, and half the thermal expansion. Each core wire contains many thousands of small-diameter, ultra-high-strength aluminum oxide fibers, as shown in Figure 2. The core wires look like traditional aluminum wires, but exhibit superior mechanical and physical properties.

Outer Strands

The outer strands of ACCR are composed of a hardened, temperature-resistant aluminum-zirconium alloy that permits operation at high temperatures (210ºC continuous, 240ºC emergency). The Al-Zr alloy has properties and hardness similar to standard 1350-H19 aluminum; however, its microstructure is designed to maintain strength after operating at high temperatures — that is, it resists annealing.



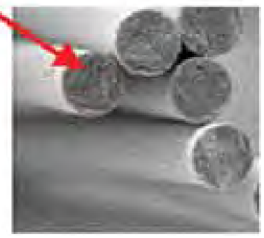


Figure 2: ACCR Composite Core

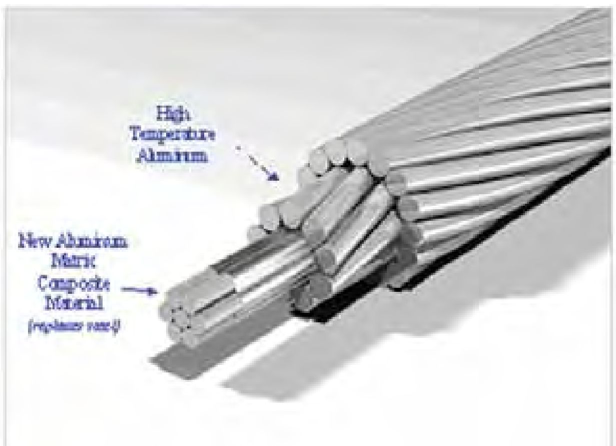


Figure 1: ACCR Core and Outer Strands

ACCR BENEFITS AND APPLICATIONS

The unique combination of an aluminum matrix core and heat resistant Al-Zr outer strands provides many advantages over other conductors.

• First, the rated design temperature of 3M ACCR is 210ºC continuous, 240ºC emergency. In contrast, Aluminum Conductor Steel Reinforced, or ACSR, is rated to 100ºC continuous, 150ºC emergency.

• Second, both the outer strands and the core can each carry the full design load of the conductor. The use of hardened aluminum results in a partition of load between the core and the outer aluminum, which offers redundancy in design.

• Third, the composition of the core is corrosion resistant. Further, there is no galvanic coupling between the core and the stranded aluminum wires. No protective coatings are required for the core, unlike steel cores, which require galva-

Continued on page 32

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Greater Capacity

continued from Page 30

nized coatings, or carbon composite core, which requires a glass barrier between the core and outer strands.

• Fourth, the composition is unaffected by ultraviolet light or humidity and retains strength after long-term exposure to both.

• Fifth, the aluminum in the outer strands is heat resistant, retaining its strength while operating at high temperatures.

Benefits of 3M ACCR are summarized in Table 1.

ACCR CAN RELIABLY INCREASE AMPACITY BY TWO TO THREE TIMES WITHOUT INCREASING SAG OR REQUIRING STRONGER TOWERS AND FOUNDATIONS

3M's ACCR can substantially increase the capacity of existing lines simply by replacing existing conductors on the existing towers, often avoiding the need for new easements and rights-of-way, simplifying what can be lengthy and costly proceedings.

A primary application of the ACCR is for thermal upgrades of existing transmission lines. As an upgrade conductor, ACCR with the same diameter as the existing conductor can generally be installed to increase capacity without increasing sag or requiring new or larger structures (see Figure 3).

The improved sag and strength performance may also allow further design options such as use of a larger ACCR conductor with existing structures and rights-of-way, higher ice loads, long span crossings with shorter or fewer towers, and reduced tower heights in new construction.

Utilities and Sites where 3M ACCR Is Being Used...		Operating Since
Xcel Energy	Minneapolis/St. Paul, Minnesota	2001
Hawaiian Electric Company	Oahu, Hawaii	2002
Western Area Power Administration	Fargo, North Dakota	2002
Bonneville Power Administration	Washington State	2004
National Grid	New York	2004
WAPA	Phoenix, Arizona	2004
Salt River Project	Phoenix, Arizona	2004
Pacific Gas & Electri	Santa Clara, California	2005
San Diego Gas & Electric	San Diego, California	2005
Xcel Energy	Minneapolis/St. Paul, Minnesota	2005
Arizona Power Service	Phoenix, Arizona	2006
Western Area Power Administration	Arizona/California Border	Winter 2006-2007
Alabama Power	Alabama State	TBD

Table 1: Advantages of 3M ACCR

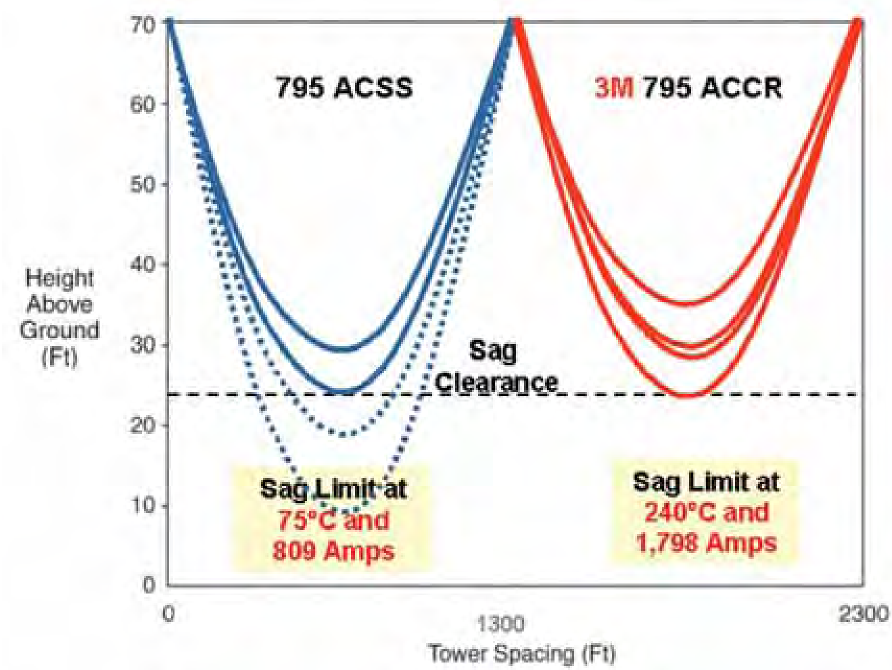

Figure 3: Increase in Ampacity without Increased Sag Using ACCR

ACCR Saves Time and Money

Because using ACCR avoids the cost of new tower construction and the delay and expense of permitting and siting new lines and rights-of-way, shortens the time to increase capacity (allowing power to be available sooner) and reduces bottlenecks (permitting utilities to reach more markets with available capacity), 3M's ACCR saves time and money on the total cost of a line upgrade. In actual customer installations, 3M ACCR has saved customers from 4 to 16 months' installation time, avoiding long outages and FERC penalties.

Permitting and Land Acquisition

Upgrading a system and building new structures often require lengthy permitting processes involving various government agencies and public hearings, outages, land acquisition and many other activities that create uncertainty and cost. ACCR can be used to simply replace existing conductors and towers, minimizing the need to acquire additional rights-of-way and involvement in lengthy proceedings.

Installation

The industry is built on standard constructions of ACSR that have been used for decades. 3M's ACCR does not deviate from this basic and proven approach. Therefore, the installation of the ACCR is similar to conventional conductors, as shown in Figure 4.

There are similar accessories to ACCR, like that of ACSR. Terminations (also called dead-ends) and joints (also called mid-span splices or full-tension splices/joints) helical-rod hardware are available, and are rated for high-temperature operation.

Figure 4: ACCR Larger Outer Sleeve, Which Is Similar to Conventional Conductor Accessories

ACCR Mitigates Environmental Impact

In many areas of the world, building or upgrading transmission lines means building towers in environmentally sensitive, protected or densely populated areas. ACCR can substantially increase the capacity of existing lines simply by replacing existing conductors on the existing towers, often avoiding the need for new easements and rights-of-way. Installation is quick, the ampacity gains are large, and the outstanding strength-to-weight ratio and low thermal expansion enables long spans and fewer structures across rivers, canyons and other sensitive areas with no change to the look of the existing line.

ACCR OFFERS RELIABLE PERFORMANCE

Product Testing

ACCR was developed and tested over a number of years by a 3M-led team of industrial companies, the Department of Energy, independent test laboratories, and utilities with a focus on reliability. This includes key laboratory measurements of high temperature creep and other key conductor properties, validated at an outdoor test facility at Oak Ridge National Laboratory, as well as various field installations. The complete set of test results is available at www.3M.com/accr.

Installations and Commercial Applications

ACCR is installed and operational on a number of critical utility sites. These include installation sites where ACCR has been used to interconnect different types of generation, such as combined cycle generators and hydro-electric dams, to the transmission network, as well as installations in which ACCR is the primary path to serve rapidly growing urban areas, including downtown businesses and large commercial airports. Figure 5 lists some of these installations.

Utilities and Sites where 3M ACCR Is Being Used...		Operating Since
Xcel Energy	Minneapolis/St. Paul, Minnesota	2001
Hawaiian Electric Company	Oahu, Hawaii	2002
Western Area Power Administration	Fargo, North Dakota	2002
Bonneville Power Administration	Washington State	2004
National Grid	New York	2004
WAPA	Phoenix, Arizona	2004
Salt River Project	Phoenix, Arizona	2004
Pacific Gas & Electri	Santa Clara, California	2005
San Diego Gas & Electric	San Diego, California	2005
Xcel Energy	Minneapolis/St. Paul, Minnesota	2005
Arizona Power Service	Phoenix, Arizona	2006
Western Area Power Administration	Arizona/California Border	Winter 2006-2007
Alabama Power	Alabama State	TBD

Figure 5: Locations of the ACCR Installations

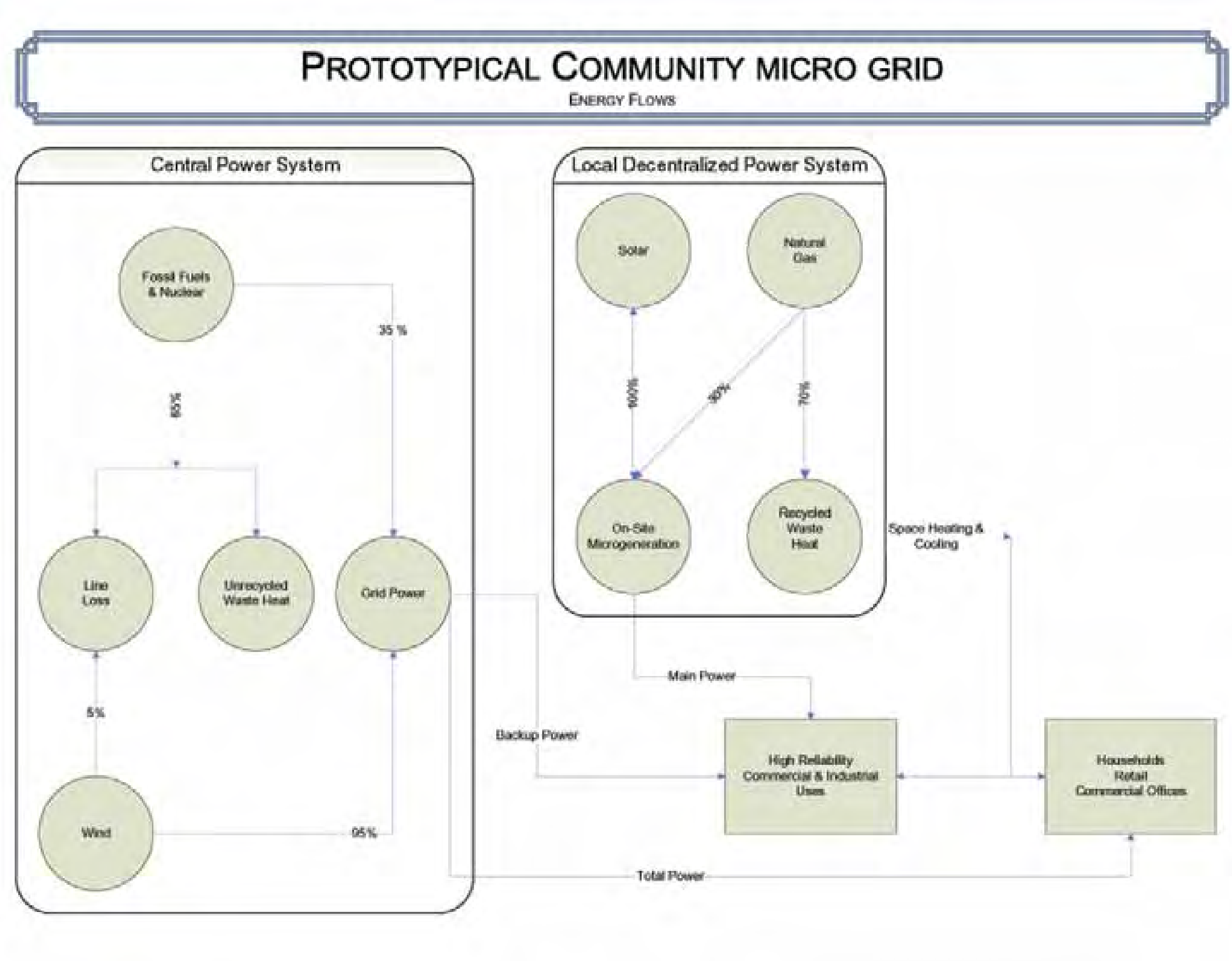

Figure A

Micro Grids

continued from Page 29

The Economist magazine likens the emergence of micro power to previous trends towards smaller, more customized services in telecommunications and predicts that the U.S. market for micro generation may exceed $60 billion.

Taking local control of key electric system upgrades, putting 70 percent of waste heat to work in space heating and cooling, eliminating line loss and poor power quality due to wires, and installing electric power generators compatible with the environmental and economic tenor of the community are all common sense objectives which can be achieved much better with a decentralized micro-grid approach. Benefits will reverberate from local communities to entire states and geographic regions as robust economic development and electric power grid stabilization result.

Guy Warner is the CEO of Pareto Energy, www.paretoenergy.com; and has worked with cities, small countries and several multinational utilities on new energy efficiencies, renewable energy and on-site power project strategic planning.

VACUUM BOTTLE TECHNOLOGY AND TESTING

By Rick Youngblood, American Electrical Testing Co.

Vacuum technology has been in existence for over 60 years but has only become common since 1965 when Eaton and Toshiba placed the first vacuum interrupters in commercial service. Since that time many other manufacturers of interrupters, such as the joint venture of Meidensha, Fuji, and Hitachi, manufacturing the JAEPS (Japan AE Power Systems Corp), ABB, and others, have begun production.

Figure 1

These interrupters or bottles, as they are commonly called in the United States, are employed by manufacturers such as Eaton Cutler Hammer, Square D, GE, ABB, Federal Pioneer, Rheinhausen, Turner Electric, and are used in everything from motor starters to circuit switchers.

In the utility industry the most common applications are circuit breakers, load tap-changers, reclosers, capacitors, and line switches. Their main features are high reliability, excellent switching capabilities with long electrical and mechanical life, short contact operating stroke, very low contact resistance, no arc, flash or noise, and low chop. They are also very universal in application, and virtually maintenance free with operation counts between 5,000 and 1,000,000 before end of life. Just as in conventional contacts, electrical degradation is limited by increased fault duty rating and arc resistant contact materials. Voltage designs range from 3.3 to 72.5 kV with a BIL/LIL of up to 325 kV and current ranges as low as a few hundred amperes to 63 kA.

CONSTRUCTION

Basic design encompasses two conducting rods with a contact on the end, one stationary and one moveable. The stationary rod utilizes a flange in the end of the ceramic tube helping to offset any heat developed due to I2R losses. The moveable rod operates through the use of a bellows design and moves longitudinally in a ceramic tube. The tube is hermetically sealed on each end by the flange and bellows, then is evacuated of air forming the main switching device. The moveable shaft is designed to provide anti-twist protection to prevent the bellows from cracking during installation or operation. (Fig. 1)

Unlike interrupters that use oil or gas as the interruption medium, vacuum interrupters have contacts that are designed to work under vacuum. Since there is no oil or gas, the arcing between the contacts consists entirely of charge carriers produced by evaporation and ionization of the contact material. The vacuum arc is essentially a metal vapor arc. If an electric arc burns in gas or oil, it creates decomposition products. In a vacuum interrupter, pure metals are vaporized and afterwards redeposited on the surface of the contact when the arc is interrupted at current zero.

The inherent advantages of vacuum interrupters are minimal maintenance and environmental friendliness, primarily due to the fact that they have fewer and simpler parts than other types of interrupters and are sealed for life. Most are rated for ten years but typically have a life of 20 or more. Contact materials vary depending on the use of the vacuum interrupters but are typically made from copper tungsten, chromium copper, or alloys utilizing stainless steel. The softer of the alloys are used in lower to medium-voltage switching and have excellent current breaking capabilities, whereas the harder materials are used in the higher voltage applications. The type of load to be interrupted controls the type of contact design needed. Softer materials designed in a spiral configuration (Fig. 2) are used in standard medium voltage vacuum circuit breakers and have excellent current breaking capabilities. The current is spread across the face of the contact by the spiral magnetic action due to the contact design. Their advantage is in simple physical structure and low power loss at nominal currents.

Harder materials are designed in a configuration called axial magnetic field and are used in higher voltages and capacitor switching. They employ designs where the magnetic field is parallel to the current flow increasing switching capacity of the interrupter.

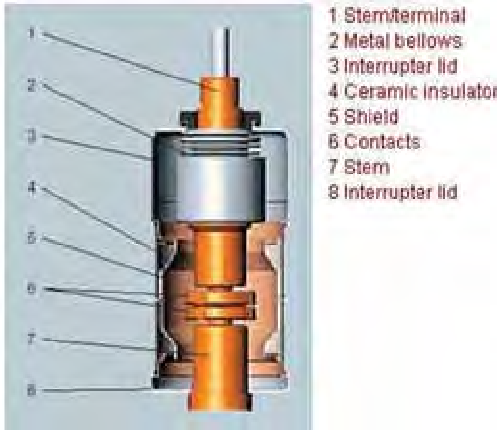

Figure 2

Vacuum breakers have less than 30 percent as many parts as comparable SF6 breakers and an even lower percentage when compared to the older air breakers. More significantly, vacuum breakers have only 10 percent as many inaccessible moving parts. Fewer parts with lower energy mechanisms and totally enclosed breaking contacts mean less maintenance, fewer failures, and higher reliability.

TESTING

For most of us charged with maintenance of systems that use vacuum technology, the design of the bottle is of little concern until it is time to test or replace one. At that time, understanding vacuum interrupter technology becomes more important. ANSI/IEEE C37.60 for production testing and C37.61 for maintenance testing are two sources. NETA uses these standards as a reference in MTS-2005 in the specifications for in-service testing of vacuum interrupters installed in electrical equipment.

Testing procedures can be broken into two categories — Visual/Mechanical and Electrical.

Operation counter including fault adjusted operation from the last maintenance cycle should be known prior to performing any vacuum interrupter (VI) tests. Total life count should additionally be known.

Mechanical operation and alignment should be checked in accordance with the manufacturer's instruction book for that apparatus. Mechanism failures and lubrication issues are more common than VI failure. Insure both the closing and opening operation are free and smooth and operate according to design. Compare bolted resistance values with those of previous tests or similar bolted connections. More than 50 percent deviation should be investigated and corrected. Bolt torques should be in accordance

Continued on Page 38

A CLOSE LOOK AT FAULT ZONE ANALYSIS

By Amy Dalrymple, PdMA Corporation, Technical Support & Training and Product Development

INTRODUCTION

The most highly stressed area in a 3-phase AC induction motor is the rotor. The in-rush current realized by a single rotor bar is unequaled by any other component. The purpose of this article is to identify causes of rotor and rotor bar failure.

We will suggest the best possible testing methods used for finding problems. This article is directed towards the 3-phase squirrel cage induction motor, but can be applied to most other motor types.

Various stresses can cause rotor failures: thermal, magnetic, dynamic, environmental, mechanical, and residual. When the motor is installed and operated as designed, the stresses remain within tolerance and the motor operates properly for years. When any of these stresses are above allowable levels, the life of the motor is reduced.

DETERMINING CAUSES OF ROTOR FAILURE

Finding the cause of rotor failures can be a long, detailed process and you must take into account how the rotor failed, the rotor appearance, application, and the history of the motor. Many times, some of the information you need, such as the motor's maintenance history, will be difficult, if not impossible, to find. When analyzing a rotor failure, inspect the shaft, bearings, lamination, rotor cage, ventilation system and, of course, the stator. Any information gathered during the inspection process will help in determining the method of failure.

Looking at Figure 1 can you determine what caused the motor failure?

Figure 1: Squirrel Cage Rotor

The end result in this picture is that the motor is completely destroyed, but what started it? Was it a bearing fault, excessive starts, or a poor ventilation system? In this example, the rotor was locked when it started and could not reach running speed. The resultant high currents overheated the rotor, stator, shaft, and other components in the motor. Inspection later revealed that the overloads in the power circuit had failed and did not trip the motor, resulting in complete destruction of the motor.

Broken rotor bars do not normally result in an immediate failure of the motor. Broken bars can cause a loss of torque and increased heating and stressing of adjacent bars. Being able to detect broken bars early reduces downtime and lowers repair costs since the repairs are usually only for the rotor. If the bars are not repaired and the motor continues to operate, additional bar breakage is likely, as well as damage to other components in the motor.

The more rotor bars that break, the larger the loss of torque and the higher the current in adjacent bars. The higher current causes higher temperatures in the area near the broken bars and will also cause stator damage due to excessive heat. Oscillations in speed and torque are indications of broken rotor bars which can cause increased wear of other motor components. Use of the MCEMAX tester can provide for early detection of rotor problems.

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Figure 2: Satisfactory RIC Results

Vacuum Bottle Testing

continued from Page 36

with the manufacturer's published data or, in absence of those values, the appropriate values from standard published data for the type and material being used.

Thermographic pictures should be taken before shutdown and the results used to help determine high resistance connections.

Thermographic pictures should be taken before shutdown and the results used to help determine high resistance connections.

Travel and velocity measurements can be taken and compared to the manufacturer's published data and also to previous test data to determine trends.

Measurements of pretravel, travel, overtravel, and contact thickness help determine integrity and remaining contact life. Most manufacturers of interrupters design in measurements that can be taken on the moveable assembly to determine contact erosion and thickness limits. Many manufacturers use a form of GO/NOGO gauge that comes with the equipment into which the interrupter is designed.

Low resistance readings should be taken across each bottle in the closed position and compared to the manufacturer's limits. If not available, use comparisons to previous history or adjacent poles. Additionally, readings of like bottles in equipment of the same make, model, and age can be used.

Prior to the next set of tests, a thorough cleaning of each bottle and bushing should take place.

Insulation resistance values should be taken from ground to each bottle in the closed position in accordance with the manufacturer's published data if available, or standard values for the kV class of the interrupter can be used. If below expected values are obtained, open the interrupter and repeat the test to determine if the insulation readings can be isolated to one side or the other. Cleanliness is very important here. Overpotential testing should not occur until the insulation resistance values meet minimum acceptable levels.

VI integrity tests (overpotential) should be performed across each bottle in the open position in strict accordance with the manufacturer's specifications. Do not exceed the voltage stipulated for this test. Provide adequate barriers and protection against X-radiation during this test (See C37.85-1972 and C37.85a-1972). Do not perform this test unless the contact separation of each interrupter is within the manufacturer's tolerance. Be aware that some high potential test sets are half wave rectified and may produce peak voltages in excess of the switch manufacturer's recommendations. Flashover across the external portion of the VI is commonly due to dirt and contamination and should not be mistaken for a failed bottle. If this should occur, reclean the external surfaces and repeat the test. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application, the test specimen is considered to have passed the test.

SUMMARY

As vacuum interrupter technology continues to progress, the uses in the utility field are limited only by the maximum kV and fault duty ratings that can be designed into the bottles. For those of us having many air circuit breakers and network protectors on our systems, the process of converting to vacuum technology will greatly improve the system reliability without having to totally replace and reengineer the systems.

Direct one-for-one replacements make conversions simpler. Additionally, distribution utilities can convert to vacuum technology and reduce the risks involved with oil spills from oil circuit breakers, or greenhouse emissions when handling SF6. The combined safety in use, environmentally sound construction, and long life help provide justification for their use by utility planners.

Special thanks go to the following companies for providing information or references for this paper:

- ABB Global
- American National Standards Institute
- Eaton Electrical
- General Electric
- InterNational Electrical Testing Association
- Institute Electronics and Electrical Engineers
- Omnicor

Rick Youngblood graduated from Indiana State University in 1973 after leaving active duty in the Air Force. Rick joined Cinergy Corporation in 1982 then known as Public Service of Indiana. Rick joined American Electrical Testing Company in August of 2004 as Regional Manager heading up the Midwest office located in Indiana. Rick holds a Level III NETA test technician certification.

DATA SHEET

QUICK-TRIP™

ARC FLASH REDUCTION SWITCH

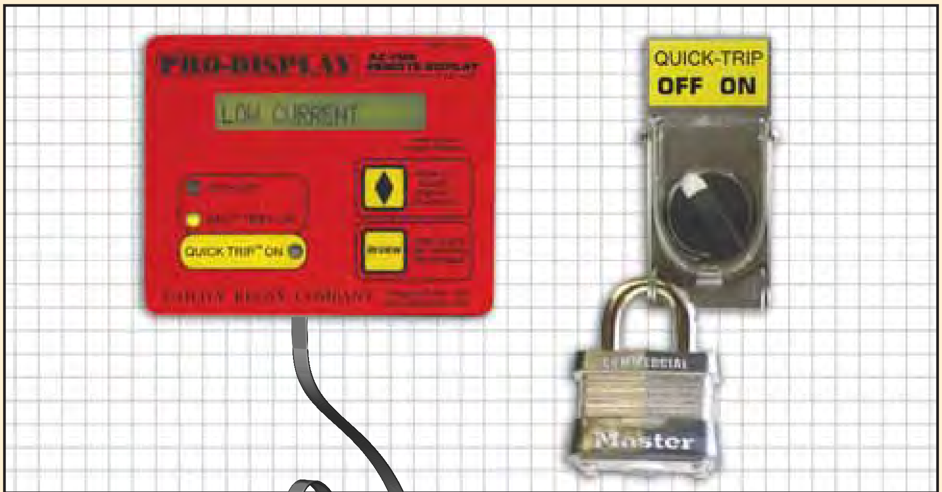
Providing a safer working environment for people working on energized electrical equipment

Since arcflash potential is directly related to breaker clearing time, the QUICK-TRIP system provides an easy and safe method to reduce fault-clearing time without opening a cubicle door to reprogram the trip unit.

The QUICK-TRIP system is activated by means of a padlockable selector switch. When enabled, two additional settings are activated in the AC-PRO trip unit to provide enhanced protection:

- ❑ QT Instantaneous
- ❑ QT Ground Fault

These two individually programmable settings are designed to provide faster clearing times in the event of a fault.

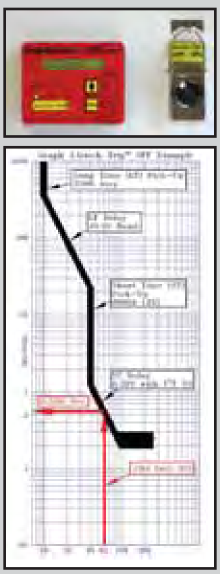


Practical Example

A technician needs to rack out a feeder breaker for maintenance. In so doing, he is the minimum 18" away from any potential arc flash source in the cubicle. As the breaker is being racked out, a 12,000 amp arcing fault occurs inside the cubicle. The 2000A main breaker sees the fault and trips, subsequently clearing the fault in the feeder breaker cubicle.

The two graphs below illustrate the dramatic impact that arc-clearing time has on incident energy levels.

Given that: **F = 12kA** and **D = 18 in.**

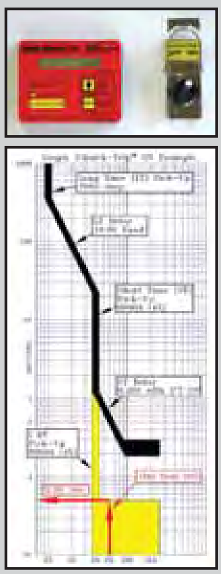


Graph 1:
QUICK-TRIP: **OFF** shows the trip time characteristics of the main breaker.

- ❑ The AC-PRO will cause the main breaker to clear the 12kA fault in .556 seconds (based on a Short-Time Delay of .20 seconds with I^2t ON). The resulting arc duration will be: **t = .556**
- ❑ The resulting incident energy is: **E_I = 25.8022**
- ❑ The Hazard Risk Category is: **4**

Graph 2:
QUICK-TRIP: **ON** shows the trip time characteristics of the main breaker.

- ❑ The AC-PRO will now cause the main breaker to clear the 12kA fault .05 seconds (based on the Instantaneous QT or I QT Pick-Up setting of 8000 amps). The resulting arc duration will be: **t = .05**
- ❑ The resulting incident energy is: **E_I = 2.3203**
- ❑ Hazard Risk Category reduced to: **1**



System Features

The QUICK-TRIP system is as easy to use as it is to install, with the additional personnel safety features:

- ❑ Installation uses standard punches.
- ❑ Wires in minutes without cutting into existing wiring harness.
- ❑ QT settings are only active when the selector switch is in the ON position (during maintenance).
- ❑ Reduction in arc flash incident energy levels may permit lower PPE clothing for maintenance personnel.
- ❑ Padlocking switch can be incorporated into a lock-out tag-out procedure.
- ❑ QUICK-TRIP ON LED confirms operation.
- ❑ SELF-TEST LED verifies trip unit operation.
- ❑ PICK-UP LED indicates overcurrent situations.
- ❑ QUICK-TRIP settings can be reviewed on the external PRO-DISPLAY.
- ❑ Last Trip Data and all settings can be reviewed on the PRO-DISPLAY.
- ❑ 3-phase currents are displayed continuously on the PRO-DISPLAY.
- ❑ The system is fully powered by the trip unit's CTs. No aux power or batteries.
- ❑ Extra contacts on the selector switch are available for external annunciation.

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Fault Zone Analysis

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MCE ANAYSIS

The MCE tester has two tests that address the rotor fault zone. The Rotor Influence Check (RIC) and the AC Standard Test.

The MCE RIC utilizes inductance measurements to create a graphical representation of the rotor-stator relationship. Figure 2 is an example of satisfactory results for a RIC test. Positioning the rotor through 18 points of one complete pole face in specific increments, determined by the amount of poles of the motor, allows us to analyze not only winding condition, air gap eccentricity, but rotor bar condition as well.

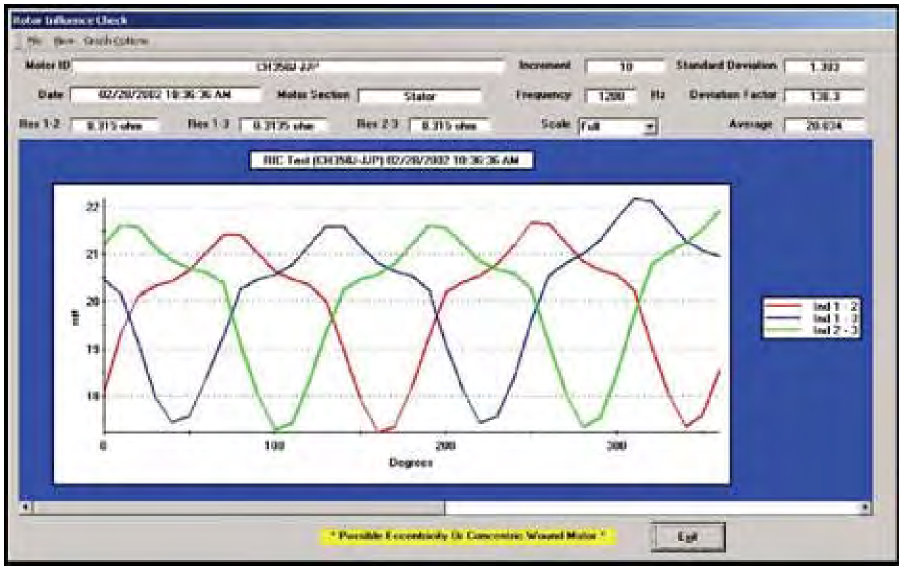

Figure 3: Broken/High Resistance Rotor Bars

High resistance and broken rotor bars will reveal themselves as repeated distortions in all three phases of the RIC graph of an AC induction motor. An example of this is shown in Figure 3. This is the result of the distorted residual magnetic flux that develops in the area of the cracks or high resistance connections of the squirrel cage rotor.

A NOTE ABOUT RIC TESTING:

With regard to 3-phase AC induction motors, there are two basic types of rotor construction. There is a cast aluminum/alloy type and a copper/alloy bar fabricated type. Along with being different types of construction, they also have different characteristics when testing.

Cast rotor:

- Rotor holds a strong residual magnetism
- Rotor develops a sinusoidal graph of inductance (RIC)
- Some defects (porosity) are common from the manufacturing process

Fabricated rotor:

- Rotor does not hold a strong residual magnetism
- Rotor develops a straight line graph of inductance (RIC)
- Very high quality from the factory, but more susceptible to failure from external stresses

AC STANDARD TEST

Variations in a motor's B/I over time, coupled with a steady upward trend in IAVG in the MCE Standard Test, indicate the possibility of rotor cage degradation. An unexplained change in these values over time should be an indication to perform or increase the frequency of the RIC testing on the specific motor.

EMAX ANALYSIS

The EMAX tester has several additional tests addressing the rotor fault zone. The High and Low Resolution, Advanced Spectral Analysis, and In-Rush/Start-Up capture, all help us determine the condition of the motor's rotor.

In the High and Low Resolution Current Spectrums, we must first determine pole-pass frequency (FP). Pole-pass frequency is directly related to the operating speed of the induction motor. Simply put, pole-pass frequency is the rate at which the rotor bars are being passed by the synchronous magnetic pattern developed by the stator. The more slip as the load increases, the higher the pole-pass frequency. The following formula shows this relationship.

$$FP = \frac{(SynRPM - RPM)(\#POLES)}{60}$$

By identifying the speed of the motor, either through the EMAX Demod test or the use of a tachometer, the technician determines the FP. Rotor bar issues reveal themselves as FP sidebands at the fundamental line frequency. Figure 4 shows these FP sidebands at the 60 Hz line frequency peak for a 4-pole induction motor. The FP in this test was 1.29 Hz. Once identified, the amplitude of these sidebands in relation to the line frequency peak is used to diagnose rotor condition.

SWIRL EFFECT

In addition to evaluating the amplitude of the FP in relation to the line frequency to determine rotor health, a damaged rotor will also cause a phenomenon called swirl effect. This swirl effect is an additional indication of a damaged rotor and appears in the spectrum just below the 5th harmonic. It appears as three evenly spaced spikes in the current spectrum to the left of the 5th harmonic. The spacing between these spikes will be the same as the pole-pass frequency. There is no specific amplitude evaluated.

The presence of the swirl effect is an additional indication of possible rotor problems. Note the swirl effect in the motor current spectrum shown in Figure 5 from the same 4-pole motor discussed earlier. The frequency span between the swirl peaks is 1.29 Hz, which is equal to the FP identified in Figure 4.

IN-RUSH

With the In-Rush capture, over time and with trended information, we look for changes in the In-Rush current characteristics. Increases in acceleration time for the same load, current modulation at the crest of the graph, and the increase in running current are all possible signs of rotor degradation. Figure 6 shows In-Rush current captures performed on a test stand to demonstrate the changes that occur after two of 44 bars are opened in the cage rotor.

SUMMARY

Motors can fail for many reasons. Sometimes the cause of the failure isn't determined until the failure has occurred several times. For this reason, it is imperative that as much investigation as possible be performed to determine the cause of the failure in order to prevent future failures and lost revenue. By examining all of the evidence gathered, the cause of the failure should be identified, corrected, and prevented from re-occurring.

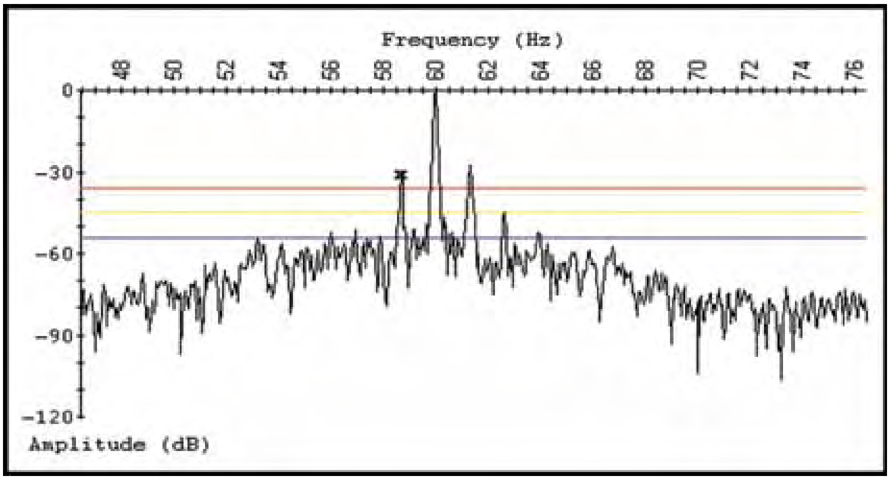

Figure 4: Motor Current Spectrum

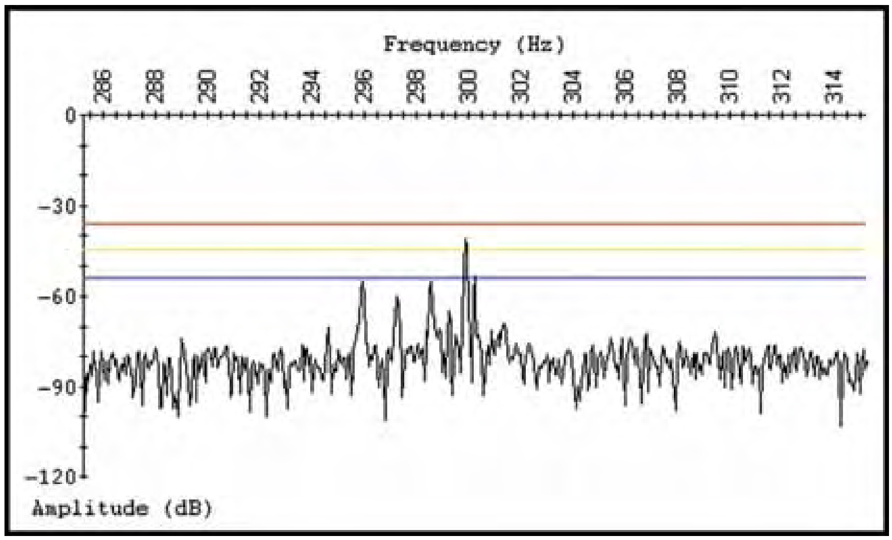

Figure 5: Swirl Effect

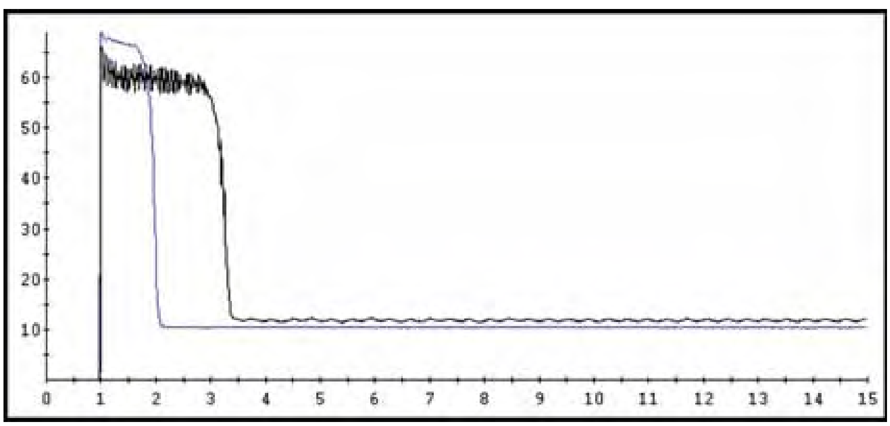

Figure 6: In-Rush Tests Results

MAKING THE SWITCH TO FIRE-RESISTANT, ENVIRONMENTALLY FRIENDLY OIL

United Rural Electric Membership Cooperative (REMC), electrical provider to approximately 10,000 customers in a seven-county area in Northeast Indiana, confirmed it will be the state's first utility to use a substation with a fire-resistant, biodegradable, vegetable-based coolant made by Cooper Power Systems.

The utility announced it will install a new substation with the safer soy-based product, eliminating the need for a hazardous petroleum-based coolant. Approximately 3,000 gallons of soy-based fluid will be used to serve an industrial park that provides power to several new housing developments and numerous local businesses, including the new corporate center for handbag and accessory designer, Vera Bradley.

Cooper Power Systems' Envirotemp FR3 transformer fluid is made from soybeans, one of the largest agricultural cash crops in the United States. In addition to public safety and environmental benefits, United REMC's switch to the FR3 fluid will reduce the need for imported petroleum, while supporting soybean farmers in Indiana, one of the nation's leading soy-producing states.

Petroleum-based fluids are flammable at 311 degrees Fahrenheit, costlier to clean up in the case of spills, harmful to the environment and contain known carcinogens. FR3 fluid has the highest flash (626 F) and fire (680 F) points of any fluid currently on the market.

"Cooper's FR3 fluid will not only positively impact our electrical system and utility business, but the environment all around us," said John Klingenberger, corporate relations manager, United REMC. "The added safety benefits will bring ease to our workers and the public at large."

Transformer filled with new soy-based fluid.

In the early 1990s, Cooper Power Systems began the development of a vegetable-based transformer oil. In 2004, it partnered with Cargill Inc. to produce and distribute the FR3 fluid that was designed to enhance transformer performance, increase worker and improve environmental safety, all essentially lowering costs for utilities. Due to its very high fire-ignition temperature, no transformers with FR3 fluid have caught fire.

Envirotemp FR3 fluid received the U.S. Environmental Protection Agency's Environmental Technologies Verification, confirming its environmental attributes. In addition, the FR3 fluid has shown to be non-toxic, and has the highest EPA classification for biodegradability. Because the fluid also has excellent fire-resistant qualities, Underwriters Laboratories (UL) and Factory Mutual (FM) allow the FR3 transformer installations outdoors and indoors, typically without costly fire protection and insurance devices required of petroleum-filled transformers.

"With a high biodegradability rate and non-toxicity, Envirotemp FR3 fluid can be safely installed in different types of highly populated areas such as neighborhoods, parks and shopping centers, reducing the likelihood of harming the general public or the environment," said Patrick McShane, Cooper Power Systems' dielectric fluids product line manager.

The fluid extends paper insulation life, lowering life-cycle costs. The increased insulation life translates to extended and enhanced transformer life, or the ability to carry higher loads during peak demand periods without leading to premature insulation failure.

More than 15,000 new and retro-filled transformers in more than 70 municipal and rural electric cooperatives are using Envirotemp FR3 fluid today. Utilities including Alabama Power, Baltimore Gas & Electric, Monroe County (St. Louis, Mo.), Sacramento Municipal Utility District, and Seattle City Light are using soy-based transformer fluids on their systems.

RURAL ELECTRIC CO-OPS BENEFIT FROM NEW SOY-BASED TRANSFORMER FLUID

Americans use more than 1.06 billion kilowatt-hours of electricity a year for residential purposes alone. Most of this electricity passes through thousands of power and distribution transformers, which can fail and result in potential fires. To counteract these dangers, Cooper Power Systems developed Envirotemp FR3, a high-fire-point soy-based fluid. Cooper recently joined with Cargill to manufacture the fluid worldwide. The soybean checkoff helped fund research done cooperatively by Cargill's Industrial Oils and Lubricants division, Waverly Light and Power, and the Electric Research and Manufacturing Cooperative.

Tipmont Rural Electric Cooperative in Indiana is one of the first electric co-ops to convert to 100 percent use of Envirotemp FR3 fluid and has reported great results. Because Envirotemp FR3 draws out retained moisture and absorbs water from aging transformer paper, the paper life is extended and transformer life cycle costs are lower. Tipmont Rural Electric Co-op projects extended life for all of their Envirotran transformers, making them more cost-effective and a better option than conventional transformer fluids.


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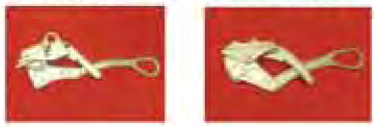

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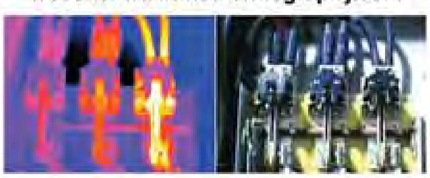

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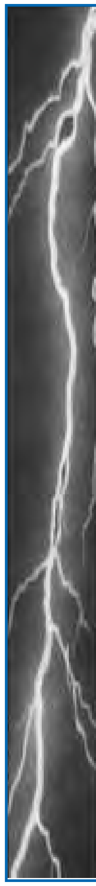

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