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Electrical Business

FEBRUARY 2013

High-voltage soil modelling & measurement

Also in this issue…

- The 2013 release of CSA Z463
- Worklight safety
- Canadian Electrical Code, Appendix B

PM # 40065710

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Are you a progressive company that gives its employees wings, or do you shackle them with boredom and drudgery?

Winning the war ~~on~~ for talent

Last month, Acklands-Grainger (AGI) hosted The Works 2013, which it calls "Canada's largest MRO and safety trade show", and they may not be far off, as the event drew over 2200 invited customers, 250 supplier partners and 850 AGI team members from across the country.

EBMag was invited to Calgary to take in the action and chat with various AGI reps, including lunch with the following company brass: president, Eric Nowlin; VP & GM Eastern Canada, George McClean; VP sales & marketing, Sandro Verrelli; VP & GM Western Canada, John Kaul; and CFO, Jason Moore. They spoke about the company breaking $1 billion in sales, new distribution centres and other initiatives in Canada.

They also spoke of the importance of their employees, and I wondered whether this was true; I hear this statement so often that I wonder whether it is just lip-service. So I put the question to Nowlin, who affirmed employee retention is very key. In the war for talent, he said, "We want to make sure we're the best place to be", adding, "We're a growing company, and folks often want to hitch a ride with a company going forward".

Fair statement, but how about the rank and file? What would they say?

I interviewed Chris Choquette, GM National Accounts West, who started with AGI five years ago, then left for a year to pursue an entrepreneurial interest, and returned to AGI three years ago. He loves the entrepreneurial spirit in his team, where they enjoy their individuality and job ownership. "We can't outsource accountability," he said.

Sean Grasby

Chris Choquette

I also spoke with Sean Grasby, director of services, who has been with the firm for three years, and enjoys the fact his position has given him the opportunity to touch a lot of Canadian businesses. "AGI is a great place for me," he said. "My responsibilities have grown... I've never wanted for a challenge."

Seems to me AGI is doing something right. Now let me turn the conversation away from AGI and ask you: What are you doing to win the war for talent? Are you a progressive company that gives its employees wings, or do you shackle them with boredom and drudgery? Do you create exciting opportunities for them, give them more responsibility and ownership, and fire their imaginations, or do you let them languish? Do you truly value your employees, or do you pay lip service? EB

On the cover and page 14

High-voltage soil modelling and measurement techniques

This article provides an industrial application of the development of the grounding grid to the testing of the installed grid itself.

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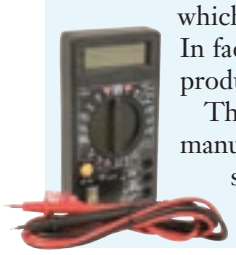
RECALL - Princess Auto 19-position digital multimeter

Ontario's Electrical Safety Authority (ESA, www.esasafe.com) says Princess Auto (www.princessauto.com) has announced a voluntary recall of 19-position digital multimeter (DMM) #700249 or #DT830D, which has not been tested for compliance with Canadian standards for product safety. In fact, one electrical shock has been reported. Consumers should stop using the recalled product immediately.



The unit is black with a PowerFist logo on the front, and includes two test leads. It was manufactured in China by Shenzhen Jintengwei Industry Co. Ltd. The recall involves 9589 units sold by Princess Auto back in 1999. Customers can bring the defective unit to a Princess Auto location for a refund, or contact them for more information at (800) 665-8685.

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Editor
Anthony Capkun - acapkun@annexweb.com

Publisher
John MacPherson - jmacpherson@annexweb.com

Account Manager
Scott Hoy - shoy@annexweb.com

Associate Editor
Alyssa Dalton - adalton@annexweb.com

Art Director
Svetlana Avrutin - savrutin@annexweb.com

Production Manager
Kathryn Nyenhuis - knyenhuis@annexweb.com

Subscriber Customer Service Representative
Marie Weiler - mweiler@annexweb.com

President
Mike Fredericks - mfredericks@annexweb.com

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e-mail: mweiler@annexweb.com
Tel: 1-866-790-6070 • Fax: 1-877-624-1940
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Canada

CCAB BPA WORLDWIDE BUSINESS

Franklin Empire set to acquire Ontor's ISD Division

PHOTO COURTESY FRANKLIN EMPIRE.

Left to right: Clifford Backman, vice president and owner of Franklin Empire, and Rob Elder, president of Ontor.

Franklin Empire (www.feinc.com) has announced it is set to acquire Ontor's ISD Division (Industrial Systems Division, www.ontor.com). Ontor's ISD division is a national supplier of automation and industrial controls, motion, drives and machine safety products with sales locations in Ontario, Quebec and Alberta.

In conjunction with this acquisition, Franklin Empire will become the Siemens EID (Exclusive Industrial Distributor) for Ontario's GTA (Greater Toronto Area), Mississauga/Brampton and Oakville/Hamilton/Niagara. Franklin Empire is already the Siemens EID for Southwestern Ontario, Ottawa and the province of Quebec.

"This is really an excellent fit for two family-operated businesses. The management of both companies are extremely excited about the opportunities this acquisition will provide to their combined staff, customers and vendors moving forward," said the companies. "Ontor's customers will have access to a vastly larger basket of electrical products and Franklin Empire staff will gain new market opportunities and forge new supplier relationships."

After the sale closes, all of Ontor's ISD staff and inventory will merge into Franklin Empire's nearest locations.

The remaining Ontor divisions, HVAC and Romark, are not a part of this acquisition and will continue under Ontor Ltd.

Solar power prices to continue falling (maybe) through 2025, says Near Zero

A new survey (bit.ly/ZPEISV) argues that solar power will become much cheaper through 2025, while expanding greatly but, for these trends to continue for the long-term, a commitment to funding research is required.

To get a sense of what future prices for solar power are likely to be, as well as other challenges and bottlenecks the industry faces, Near Zero says it conducted a formal, quantitative survey that drew on from industry, universities and national labs. The survey asked their expectations about future prices for modules, as well as the expenditures for other parts of solar power systems. Respondents were also asked how much solar power they expected would be installed in the coming years.

Respondents expect the price of solar power systems will fall sufficiently that it will be far more competitive than today, forecasting a large expansion of the amount of installed solar power—increasing more than 10 times over the decade from 2010 to 2020 (an expansion that will continue at a similar rate until at least 2025).

However, this success story depends on solar power prices continuing to fall, which will require continued and possibly increased levels of spending on R&D. Were prices to hold steady rather than fall, then the same expansion of solar power over the period 2012 to 2025 would cost at least 50% more, adding up to several hundred billion dollars.

OCS says mandatory WSIB coverage combats underground economy

Ontario's recent change to make Workplace Safety & Insurance Board (WSIB, www.wsib.on.ca) coverage mandatory in the construction industry is an important component "in combating the pervasive underground economy", says the Ontario Construction Secretariat (OCS, www.iciconstruction.com).

As of January 1, 2013, almost every construction worker in Ontario is required to be covered by WSIB, says OCS, adding this "closes a loophole that allowed many contractors to style their employees as independent contractors".

"Before mandatory WSIB coverage, many Ontario construction workers were able to not only evade their taxes—which fund important public services—but to also avoid making contributions to the funds that compensate injured workers," said Sean Strickland, CEO of OCS. "By closing this loophole, the government has taken an important step in prohibiting the underground economy in Ontario construction."

OCS says it has conducted several studies on the underground construction economy in response to "growing concerns expressed by contractors and construction unions", which show underground construction activity amounts to between $1.4-$2.4 billion in evaded taxes and WSIB fees. The secretariat adds that classing employees as 'independent operators' provides contractors with an "unfair and illegitimate competitive advantage", ranging from 20% to 50% of labour costs.

WSIB has developed www.beregisteredberready.ca to provide information for construction employers on mandatory coverage.

Coulomb Technologies officially changes name to ChargePoint

Coulomb Technologies Inc. has officially changed its name to ChargePoint Inc. (www.charge-point.com) and, today, announced their electric vehicle (EV) charging station network has reached several major milestones.

ChargePoint has more than 10,000 charging station spots in North America, says the company, adding that more than 25,000 EV drivers use ChargePoint to charge their EVs.

"The ChargePoint name change reflects the focus to our core business as the world's largest electric vehicle global charging network," said Pat Romano, president and CEO of ChargePoint. "We are extremely proud to announce these EV charging station milestones. Our EV charging station network went live nearly four years ago, well before the first mass market EV was commercially available."

FortisBC signs energy agreement with B.C. First Nations Energy & Mining Council

FortisBC (www.fortisbc.com) says it has signed a memorandum of understanding (MOU) with the B.C. First Nations Energy & Mining Council (FNEMC) making energy self-sufficiency for First Nations communities a priority. It is the first time a privately held energy company has signed such an agreement, says FortisBC.

"This is a first-of-its-kind

agreement that will strengthen the relationship between FortisBC and B.C. First Nations," said Doug Stout, vice-president, energy solutions and external relations for FortisBC. "It gives us the opportunity to work with B.C. First Nations to optimize energy delivery to communities throughout the province, resulting in energy efficiency."

Under the terms of the agreement, FNEMC and FortisBC agree to cooperate to develop energy opportunities for B.C. First Nations communities, including increasing energy efficiency on First Nation land and paving the way to hire a certified energy auditor to assist communities with energy efficiency programs. Approximately $100,000 annually will be earmarked to go toward conservation efforts.

"We are very excited to be working with FortisBC, since this is the first time B.C. First Nations have signed an agreement with a private energy company," said Dave Porter, chief executive officer for First Nations Energy and & Mining Council.

Major highlights of the agreement include:

- Open and honest communication throughout all aspects of working together.
- Agreement that the consent of First Nations must be obtained before developing projects and activities affecting their communities.
- Working with the Canadian and provincial governments to develop policy and implement solutions affecting First Nations' energy issues.
- Helping the B.C. government meet its environmental and energy goals for the future.
- Monitoring and evaluation energy program and policy effectiveness.
- Undertaking First Nations community relations and communications programs to inform First Nation's leadership of energy developments. EB


Rodd Ruland

Rodd Ruland, president of **Burndy LLC** (www.burndy.com), an affiliate of **Hubbell Inc.** (www.hubbell.com), now has added responsibilities for both Hubbell Canada LP and Hubbell de Mexico, S.A. de C.V., where these operations serve as the "focal point through which many Hubbell products are marketed to Canadian and Mexican customers", said the company. Ruland was managing the Burndy division of FCI in October 2009, when it was acquired by Hubbell. "During the past three years, he has successfully integrated Burndy LLC operations, significantly grown sales and consistently delivered strong operational results," said the company. In 2011, he led the business development initiative to expand Burndy with the acquisition of the Wiley product line, the player in solar grounding products.


Steve Douglas

Steve Douglas, senior technical code specialist for Toronto-based **QPS Evaluation Services Inc.** (www.qps.ca), has been named the 2012–2013 international president of the **International Association of Electrical Inspectors** (IAEI, www.iaei.org)—a membership-driven, non-profit association promoting electrical safety throughout the industry. Douglas joined IAEI in 1990 and attended his first Canadian Section meeting in 1991 in Kingston, Ont. "At that time," he recalls, "I did not understand the full impact IAEI has on the electrical safety infrastructure in North America. I was, however, very impressed with the technical program." Presently, he is the vice-chair of the CE Code Part I, chair of CE Code Part I Subcommittees for Sections 2, 12 and 50, and a member on Sections 40, 64, 68, 76 and Appendix D, representing IAEI. In addition, he is the chair of CSA Standards C22.2 No. 273 Cablebus, C22.6 No. 1, Electrical Inspection Code for Existing Residential Occupancies committee, the chair of the SPE-1000 Working Group, and a member on committees for the Objective Based Industrial Electrical Code, Safety Management Systems, Solar Photovoltaic Modules, Photovoltaic Cable, Fuel Cells, Wind Turbines, Distribution Transformers, Outlet Boxes, and Wiring Fittings Hardware and Positioning Devices... to name a few. In total, he is active on 53 technical codes and standards committees.


Jean-Philippe Granger


Sharanjit Singh


Nancy Ambtman

Glenn Keenan, VP of Power Systems & Energy for **Toromont CAT** (www.toromontpowersystems.com), announced several changes in the organization. **Jean-Philippe (J.P.) Granger** is assuming the industry manager role for the Electric Power business. He and his team will serve the standby power systems and power quality segments, leveraging Caterpillar products as the foundation. **Sharanjit Singh** is assuming the product support manager role, and will provide leadership and support to "close to 100 technicians and eight dedicated regional centres". This team services and supports gensets, automatic transfer switches, switchgear and UPS products. Finally, **Nancy Ambtman** is assuming the rental manager role, where she will leverage her years of experience with the dealership. EB

Making 'cents' out of circuit problems

André Rebelo

When diagnosing electrical problems, you often must investigate like Sherlock Holmes; clues may reveal antiquated wiring, amateur installations or overloaded circuits. Many of these circumstances result in electrical problems related to poor power quality originating right inside the home or building.

Beyond the adverse effects of home or commercial electrical assets operating inefficiently or failing altogether due to power quality problems, wiring problems or errors can lead to a range of issues. Grounding problems can put users at risk for electrical shock; high resistance in a circuit can cause electrical fires.

A word about voltage drop

For electrical contractors, a constant challenge is dealing with voltage drop. As current passes through a conductor, some voltage is lost. How much voltage drop occurs in a circuit depends on several factors: how much current; the diameter and length of wire feeding the circuit; and the integrity of all connections.

Specific examples of victims to voltage drop include sensitive electronics like computers, laser printers and, for residential customers, even A/V equipment. Also consider Energy Star appliances that use microprocessors to manage electrical consumption more shrewdly—these may shut down or behave erratically.

Overheating can occur with inductive loads, including motors and ballasts. The result is a shorter service life and higher operating costs.

Resistive loads are everywhere. Beyond, heaters and cooking appliances, don't forget incandescent lighting, which hasn't quite disappeared. Voltage drops can result in notably inefficient operation. In one test, a voltage drop of 10% caused an incandescent light bulb to lose 30% of its normal light levels.

Industry standards for voltage drop describe branch circuit conductors to be sized to ensure voltage drop does not exceed 3%, or a total drop of 5% when factoring feeder losses.

Right tools for the job

How do you find the source of insidious power quality problems like voltage drop? Electrical test equipment companies recently introduced a tool designed for one explicit purpose: to analyze circuit and outlet conditions. This new generation of sophisticated outlet circuit testers can be plugged into any available outlet on a circuit to get an instant snapshot of the condition of that circuit, even simulating loads comparable to components that it should be capable of supporting.

Outlet circuit load testers can provide valuable insights on issues related to grounding. For example, did humidity in a basement or mechanical room cause corrosion of electrical connections on the circuit, diminishing its ground as a result? Or, was a circuit absent-mindedly grounded to a copper pipe that itself was connected to a plastic main pipe?

When wiring is deteriorated or was never installed properly, power quality might suffer causing electronics to fail prematurely or blower motors in an air-handling unit, for example, to operate at slower or intermittently variable revolutions. Solid-state motor controls can malfunction due to flicker in the electrical signal.

Electrical contractors investigating circuit-related problems routinely discover that a lot of facility assets are plugged into existing outlets (versus hard-wired). They may not require dedicated circuits and instead are equipped with a power supply cord and use standard NEMA 5-15 or 5-20 outlets.

Why a circuit outlet tester makes sense

Beyond a multimeter, a circuit load tester offers a quicker and safer plug-n-play approach that instantly performs a comprehensive analysis and provides results on a range of factors, helping to immediately determine whether an issue is circuit related, and what that issue may be.

Find problems such as poor ground impedance, false grounds, missing ground fault protection, low voltage availability under load, and high ground-to-neutral voltage. In addition, test GFCI and EPD circuits.

Real-world examples

An AC load tester can provide selectable loads of 12, 15 and 20 amps. Both loaded and unloaded AC line voltages are measured, as well as voltage drop percentage, line impedance, peak line voltage and frequency. Outlet tester functions can include: AFCI and GFCI trip time and current measurements; neutral-to-ground voltage testing; hot, neutral and ground impedance testing; and open or reversed wiring detection.

For example, you'll be able to find problems like reversed hot and neutral wires. Perform a GFCI test and determine the number of milliseconds before the circuit was interrupted (along with the sample load value). Use circuit load testers to identify frequency on a particular circuit along with voltage.

Make 'cents' and upsell customers

Remember that an outlet circuit tester can also help you identify undiscovered problems at a customer site. Electrical contractors can use such testers as a valuable tool for increasing business and improving your reputation for service by offering a quick, thorough inspection of all circuits while at a jobsite. Your customer will be happy to have the added complimentary inspection and you have an opportunity to identify additional repairs throughout a home or facility.

You may find faulty wiring, improperly installed or slow-responding GFCIs, a swapped hot and neutral, or a bootleg (false) ground. Use the tester to apply a 12, 15 or 20 amp load to the circuit and check the corresponding voltage drop. In residential work, you might find several circuits that exceed an acceptable value of 5%.

Sometimes, even without a layman's explanation of the problems you find, simply showing a customer the flashing red screen of a circuit load tester will tell the whole story that something is wrong. More importantly, it will get you the "Yes!" for additional work.

On the extreme side, while few homes will present a circuit that exceeds a 10% voltage drop, it is very plausible—especially as larger homes are built. A circuit load tester will help you find it. Longer cable runs with increased resistance can lead to problems that can only be remedied with larger, right-sized wiring. Longer runs also generally imply more connections along the way. Stab-back connections on receptacle outlets are notorious sources of high resistance. The cumulative resistance can have a negative impact on voltage levels.

Having an outlet circuit tester is useful to more quickly and efficiently find problems in circuits. As you can see, it can also be a visually high-impact tool to show customers about other repairs they should consider. An outlet circuit tester can help you make sense of concealed problems and help you make cents out of every customer site. EB

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Final steps to 2013 release of CSA Z463

Industrial and Commercial Electrical System Maintenance

John Hodson

In March 2011, the vision of creating a CSA electrical maintenance guideline and, possibly, a future standard took its formative steps during a meeting at CSA's offices in Toronto. This was to be a 'greenfield' (from scratch) document with representative input from various stakeholders, balanced by CSA mandated representation. This predetermined cross section requires minimum voting membership from the following sectors:

- **General interest:** 4 members
- **Producer interest:** 5 members
- **Regulatory authority:** 5 members
- **User, labour:** 4 members
- **User, management:** 4 members

Even though the committee is fairly heavily weighted with subject matter experts from the field-testing industry, the membership balance is well maintained through this matrix.

Getting things underway

One of the first tasks of the group was to ensure that industry was aware of the document concept and to raise interest and funds for the project from within and outside the membership. The committee structure also needed to be formed, with executive and technical leads appointed. A list of the recognized financial supporters and committee structure has been appended to the article (Sidebar A). It is important to point out that the CSA process is a volunteer one, and the time and financial resources are provided by employers or on a personal basis by self-employed participants.

After the group nucleus was solidified during the first meeting in Toronto, the second meeting was held in Edmonton in June 2011. This meeting established the general outline of the document and clarified its content and direction. It was determined that CSA Z463 would be issued as a guideline in its first release, then be considered for issuance as a standard in future revisions.

The initial concept called for 8 Sections, which later expanded to 9. Each section was assigned a working group leader; then volunteers from the committee joined each group to support the leadership. In some cases, members decided to participate in more than one group, which is a significant commitment. The membership is diversified, with senior management, electricians, engineering, supervision, regulatory and similar expertise from many areas of industry, and representation from almost every area of Canada.

Working group leads took responsibility for the content of their section and delegated specific responsibility to working group volunteers, usually based on area of interest or expertise. Over the span of the next 12 months (with meetings in Saskatoon, Toronto and Quebec City, interspersed with group conference calls) the document took form. Each working group operated somewhat independently, with review and clarification of content and direction at each meeting. During the most recent meeting in Calgary in November 2012, section overlap concerns—along with an itemized review of public input—was performed.

This really was the final opportunity to change technical content and move information from one section to another. There was some consensus that the document was not as complete as possible, but it was also realized that—despite two timeline extensions—it was unlikely that significant change would or could be achieved in this first release.

Upon completion of the Calgary meeting, some working groups had some short-term tasks to complete related to specific decisions made by the committee. The document was then turned over to the editorial committee on December 21 to assure consistent and normative use of language, standardized formatting and general improvement of document flow. By no means is this a small task, and it was agreed at the meeting that one more volunteer would be added to the editing committee, bringing the total to four.

CSA Z463 takes shape

The final document consists of the following sections:

- Terms of Reference
- Introduction
- 1.0 Scope
- 2.0 Reference Publications
- 3.0 Definitions/Abbreviations
- 4.0 Electrical Maintenance as part of a Quality Management System
- 5.0 Maintenance Practices
- 6.0 Electrical Maintenance as part of Workplace Safety
- 7.0 General Maintenance Practice
- 8.0 Equipment-Specific Maintenance Practices
- 9.0 Specialized Equipment Maintenance
- Annex

A tremendous amount of information has been reviewed and discussed during the creation process, and the final document was submitted to the CSA editorial

group at year-end 2012. Original expectations were for a 100-page document, but the anticipated final page count is likely around 150. Regardless of page count, this document contains information that will prove useful to operations, electricians, engineers, designers, maintenance personnel, asset managers and technicians involved in the purchase or care and custody of electrical power equipment.

How is CSA Z463 to be used?

The CSA Z463 guideline is not meant to replace existing references, but to resource them and advise utilization where benefit is realized. It has been created as an instruction set and directions for building an electrical maintenance plan for small- to medium-sized companies. The document does not address residential and personal use electrical equipment, nor is it targeted for large corporations or utility equipment companies. It is perceived that larger corporations will already have access to the majority of the information in this document and possess the experience to use it. Notwithstanding this, the document should prove useful to anyone looking at starting or upgrading an electrical maintenance program, and may have application for anyone looking at the proper care and use of electrical equipment.

The methodology for use of the document is well explained and will not need to be read in its entirety for the user to benefit. The front end explains the scope and application, and cites important references and key definitions. CSA Z463-2013 has been developed in line with—and as a companion to—CSA Z460-2010 and CSA 462-2012: now an electrical trilogy for the safe and effective operation and maintenance of electrical equipment. Each of these documents addresses an important and key component of electrical power equipment utilization.

The main body of CSA Z463 has sections pertaining to effectively and correctly establishing an electrical maintenance program, and how it will fit into existing company management systems. Safety is an important and relevant issue when working with lethal electrical energy—one section has been dedicated to safety as it pertains to maintenance. Even as this guideline does not attempt to describe all the necessary procedures or required analysis in detail, it does provide a fairly solid overview of power equipment components and suggested tests and inspections.

Consideration is also provided to online diagnostics and newer, condition-based maintenance strategies. Many reference documents—such as ANSI/NETA MTS 2011, NFPA 70B 2010 and FM Global Insurance recommended practice publications—will provide a full and comprehensive set of instructions and anticipated acceptable results for the majority of equipment assets that may be under your care.

The final section of the guideline addresses some very specialized areas of industry where unique and single-purpose distribution equipment is utilized. Applications include airports, electric vehicle power centres and photovoltaic power generation. This section is also where new technology will be addressed, such as cryogenic superconductors and EHV solid dielectric cable. As this section was added later in the document's development, it will be given more attention in the 2016 release of CSA Z463.

The Annex is a valuable repository of technical information. One of the primary sections that should

be reviewed is Annex M, as it contains new tables for testing and inspection based on Section 8 committee input. Reference material from other documents, and assistance for properly selecting internal and external resources and partners in document development and execution, are also found here.

CSA Z463 will prove to be a valuable tool for the electrical maintenance professional. When considered alongside companion CSA standards, it provides a comprehensive set of directions, policies and procedures to allow for safe, effective and reliable utilization of electrical energy, and the associated equipment necessary to transfer and utilize that power. These documents work well as part of an overall OH&S management plan such as described in CSA Z1000-2011.

Moving forward

When CSA Z463 is published for the first time, the committee membership will change and evolve as thoughts go to developing the next release. To facilitate this transition, the group will be looking for new sponsorship and membership, as we look at taking feedback and input from industry toward improving this document in preparation of the next publication.

Our committee has a contact email list in both English and French, as well as a group page on LinkedIn and a website. With this connectivity, we are reaching over 200 industry professionals, companies and federal and provincial associations. Our intent is to continue to grow this network. Should any company or individual want to be included, simply find our group on LinkedIn (Search "CSA Z463") and ask to be a member. EB

John Hodson has spent over 30 years in the field service industry with Magna IV Engineering Ltd. (www.magnaiv.com). He is still active in the industry, mentoring, training and working to promote advanced electrical diagnostics hardware and software, and their integration into power systems. He was a member of CSA Z462-08 and continues to be an active member of CSA Z463.

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- Vale

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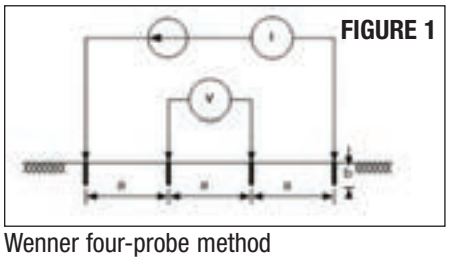
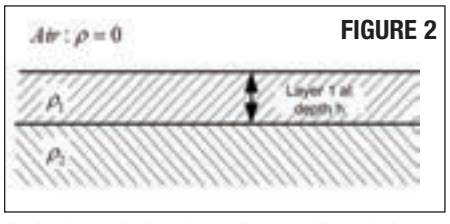
High-voltage soil modelling & measurement techniques

Dr. Gary Gilbert, CD, P.Eng.



Wenner four-probe method



Author's optimized two-layer soil model

Actual demarcation between soil layers at new substation location

The main objective of grounding electrical systems is to provide a suitably low resistance connection to the substations above them. This low resistance is required to limit the potential rise of the substation from the potential of the surrounding earth. This potential rise must be limited so there is no danger to anyone walking on the ground or touching metallic objects above the grounding grid itself.

To ensure this ground potential rise, and touch and step voltages are within safe limits—as defined by both IEEE 80-200 and the Canadian Electrical Safety Code—an accurate soil model is needed to perform calculations that ensure the resistance of the grounding grid design through the earth is sufficiently low. This soil model comes from the tested soil structure at the proposed grid location. This article provides an industrial application of the development of the grounding grid to the testing of the installed grid itself.

The earth's electric properties

The geoelectric parameters are used in the determination of the soil model when defining the electric properties of the earth. The soil's electrical properties are determined by the thicknesses of layers and their changes in resistivity. Resistivity is dependent upon water and chemical content, as well as soil texture. There are usually several soil layers, each having a different resistivity, in which case the soil is said to be non-uniform.

The engineered interpretation of the measurements consists of establishing a simple equivalent function to yield the best approximation of soil resistivities to determine the layer model. In the case of this substation, the optimization soil modelling technique developed by the author was implemented due to the severity of the soil measurements themselves, due to a pre-existing coal layer that was found there 70 years ago when the plant started. (It should be noted the plant has long since gone to more sustainable energy methods for producing the power required to produce synthetic rubber.)

Soil resistivity measurement and grounding grid development

In the case of this install, the Wenner 4-probe method was deployed due to consistent results in the author's past experiences while reviewing grounding studies at the Electrical Safety Authority (ESA). In the Wenner method (Figure 1), all four probes are moved for each test, with the spacing between each adjacent pair remaining the same, as outlined in IEEE 80-2000. In the Wenner 4-probe method, it is possible to measure the average

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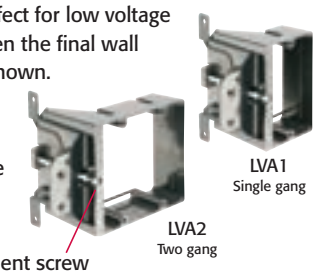

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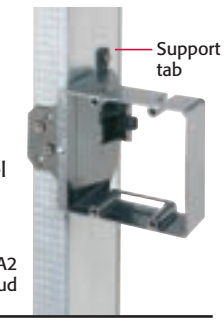

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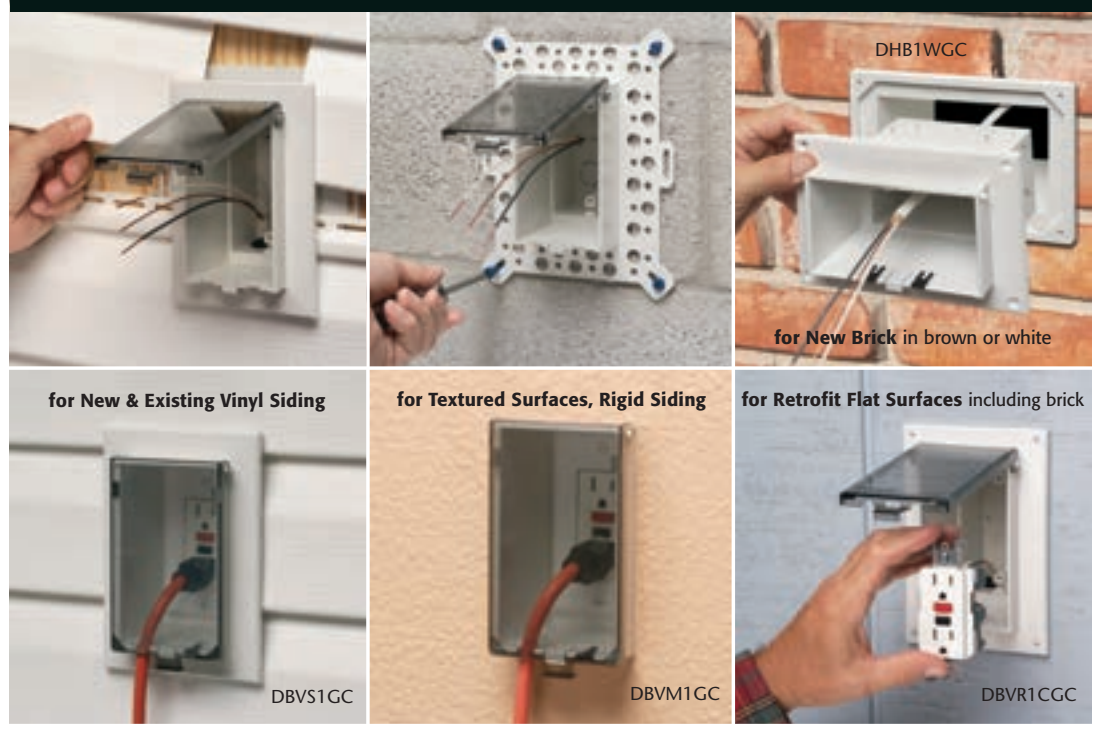

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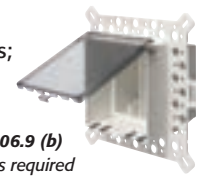

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resistivity of the soil between the two centre probes to a depth equal to the probe spacing between adjacent probes.

A curve-fitted optimization technique was then used after the measurements were taken, in both the North-South and East-West directions spanning the intended area of the grounding grid itself. In the case of this station grounding system, a two-layer soil model (Figure 2) was determined to be the optimal model for developing the grounding grid.

The optimized soil structure determined that the depth of the first soil layer was 2 ft, and $_p1$ was 100Ωm and $_p2$ was 256Ωm. When installing the author's designed grounding grid, it was quite clear that the optimization soil model—which that shows a demarcation split between the two soil layers—was physically and visually achieved as one can see in both Figures 2 and 3, with that being a 2-ft depth where the resistivities change drastically in both colour and value.

Next, SKM software was used to develop the grounding grid to ensure the safety objectives outlined in both IEEE 80-2000 and the Canadian Electrical Safety Code were achieved. It was determined that the grounding grid from SKM needed to be 0.85Ω and, when validated by Siemens' field service group, it was determined the grounding grid was 0.8Ω in value at several locations utilizing a clamp-on grounding resistance meter.

Conclusion

This article provided a discussion of the parameters that affect grounding grid design, the importance of a good soil model, and a survey of existing techniques used to find this model. There are other soil measurement techniques, and they can be found in IEEE 80-2000.

The full circle of grounding measurements—to grounding grid development and subsequent grounding grid measurements—must always be done. In this industrial application, the author's optimized soil model was proven when Siemens' field service group measured the SKM projection of the grounding grid resistance to ensure both equipment protection but, more importantly, worker safety in the event of a ground fault. EB

Dr. Gary Gilbert, CD, P.Eng. is Lanxess Sarnia site high-voltage engineer, responsible for a distribution system. He is also a member of the IAEI, IEEE and PES organizations.

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THREE STEPS to saving energy—and money

What business opportunities do *you* see?

Scott McKenzie

In cooperation with community and environmental organizations in the Ottawa area, Tucker House conducted a "Get Energy Smart!" campaign in 2009 that provided a comprehensive set of recommendations for how people could lower their carbon footprints and save money in the process. The effort addressed all aspects of life, including transportation, food, heating and electricity.

At the time, the programmable thermostat was the most advanced means of managing energy in homes. Since then, smart thermostats and home energy gateways have dramatically increased the savings that can be achieved by energy-smart consumers.

This article provides an update to the previous "Get Energy Smart!" project with enhanced recommendations for reducing consumption of electricity based on the use of modern home energy management systems. The basic approach remains the same, however, with three progressive steps to saving energy—and money.

STEP 1: Simple changes that result in immediate savings

Most people waste a considerable amount of electrical energy. So there are a number of things nearly everyone can do to save energy with little or no investment required. Even simple changes can result in significant reductions in energy consumption. Here are just some of the ways people can take this first step toward immediate savings:

- Turn up the air-conditioning to 25C in the summer, and turn down the heat to 20C during the day and 16C at night in the Fall, Winter and Spring. Better yet, install a programmable thermostat that automatically changes temperatures at designated times of the day and night throughout the year.
- Use fans to stay cooler in the summer, and layers of clothing to stay warmer in the winter.
- Replace frequently used and burnt-out incandescent light bulbs with energy-efficient CFLs or LEDs.
- Form a habit of turning off lights, computers, TVs and other electrical equipment when not being used to reduce phantom load. Buy an inexpensive power strip that makes it easier to turn off multiple devices, such as a TV, cable box and sound system, which also ensures these are not consuming any phantom power overnight.
- Buy a monitoring device capable of calculating the energy consumption (in watts and kilowatt-hours) of plug-in appliances.

Another suggestion is to turn these and other energy conservation efforts into a game or contest. My family had a competition with my brother's family, and that helped engage our children in the project (read: game). Both families were able to reduce energy consumption by some 30% just by changing habits. And children are particularly gifted at pointing out the mistakes and missed opportunities their parents make!

STEP 2: Invest the initial savings to save even more short-term

Step 1 involves things most people can do on their own. The options in Step 2 often require working with the local utility. Nearly all utilities now offer energy conservation programs with financial incentives to encourage consumers to participate, and governments may offer certain additional tax advantages.

For example, many utilities offer rebates for replacing older appliances with newer, more energy-efficient models, as well as incentives for adding insulation to the walls and/or attic space. And when the local electric utility offers a net-metering or feed-in tariff program, consider installing a solar panel on the roof or in the backyard.

The growing gap between the demand and supply of electrical energy has motivated a growing number of utilities to implement residential demand-response programs. These programs encourage customers to reduce energy consumption during periods of peak demand,

which normally occur late in the afternoon and early evenings on hot summer days. These programs can also have a time-of-use (TOU) rate structure that is high during periods of peak demand, and low the remainder of the day to promote off-peak usage.

To encourage participation, utilities often provide an in-home display, smart thermostat and/or home energy gateway for no charge. Some utilities even offer comprehensive home energy management systems capable of controlling both the thermostat and other loads, such as an electric water heater or pool pump.

In April 2007, the Ontario Power Authority (OPA) launched the Peaksaver residential demand-response program, describing it as follows:

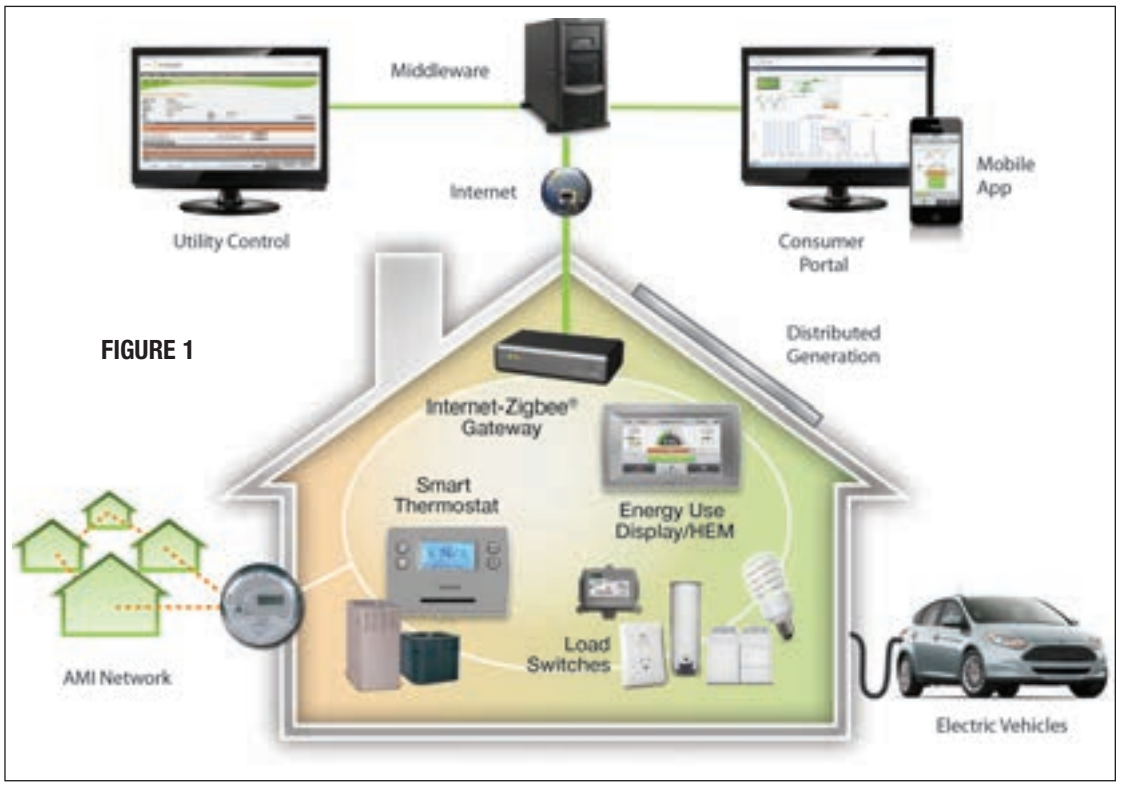

FIGURE 1

This program assists qualified Ontarians, and their local electricity utility, to install a device in their home that allows the utility to briefly control their central air conditioning system during 'critical' peak times—typically weekday afternoons during the hottest days of the summer.

Peterborough Distribution Inc. is one of many local distribution companies participating in Ontario's enhanced PeaksaverPLUS program. Participants receive an Energate Pioneer Z100 smart thermostat and/or a ZEV50 in-home display (IHD), along with a ZigBee-equipped Energate ZIP Connect internet gateway. The gateway provides secure two-way communications with the utility, as well as a means for participants to monitor and control their smart thermostats remotely via an ordinary browser or smartphone application. Some residents may also receive an optional Energate LC301 load switch for controlling other major loads. And all of these systems are provided at no charge to the customer.

Figure 1 shows a complete home energy management system like the one being offered via the PeaksaverPLUS program in Ontario. The smart thermostat communicates with the gateway to the utility, the in-home display and load switches via a wireless network.

In addition to adjusting the temperature on hot summer days, Peterborough's PeaksaverPLUS customers can also receive the current price of electricity. The rate is displayed on the smart thermostat, and a yellow LED indicates when higher TOU rates are in effect. People quickly learn to turn off lights, and postpone doing laundry or running the dishwasher when the yellow LED is On. Some have even begun to anticipate the high-rate periods, and are pre-cooling the home in preparation for the higher setting made automatically by the thermostat.

Programs like these have been so successful at reducing peak demand, saving Ontario an estimated 230MW of energy, the energy minister decided invest in a "Consumer Engagement for the Smart Grid" demonstration project of smart energy innovations for up to 1000 homes across the province. The project will provide and evaluate state-of-the-art solutions that allow consumers to manage their home energy use with next-generation home energy gateways, advanced smartphone applications, portable energy dashboards and informative web portals.

STEP 3: Make long-term investments that minimize energy consumption

Step Three involves major investments and potential lifestyle changes, and very few people may be ready today for this level of commitment. As energy becomes increasingly expensive and energy conservation incentives expand, more people are likely to be willing to take Step 3.

The ultimate third step is the Green Home of the future with a much smaller physical footprint and a zero carbon footprint. Its building-integrated photovoltaic (BIPV) construction materials produce more electricity than the home consumes. The home is heated mostly by the sun, and cooled mostly with the ground's thermal mass. Low-flow fixtures and a grey water system minimize the use of water, which is also heated by solar energy.

Many of these changes can be made today without buying a new home, of course. Every appliance that needs to be replaced (including the air-conditioner, furnace and water heater) provides an opportunity to make an investment in future savings. Every major upgrade or remodel provides a similar opportunity to be more environmentally friendly. When timed right, the additional cost of being green can usually be justified by the long-term savings. EB

Scott McKenzie is director of operations at Energate, a provider of home energy management solutions. He and his family have spent the last few years greening their home and adjusting their lifestyle to reduce their total energy consumption by over 50%.

WORKLIGHT SAFETY:

The dangers of the quartz halogen worklight

Brian Astl

PHOTO 1

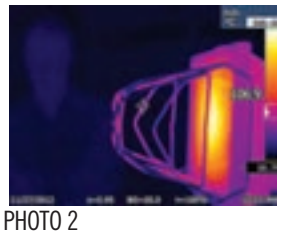

PHOTO 2

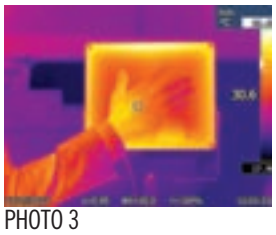

PHOTO 3

PHOTO 4

500W quartz halogen portable worklights are everywhere, and why not? They are cheap, easily moved and put out a lot of light to help you work. And while they come in a couple of different styles (e.g. tripods, floor stands, magnet mounts), at their core they are all the same: dangerous tools that harm workers, start fires and set off explosions. In our experience working with contractors, electricians and plant workers, we hear the same complaint everywhere we go: quartz halogen worklights are too hot and people are getting hurt.

A look at the data reveals why everyone is complaining. We measured a 500W quartz halogen portable worklight using an infrared camera for over four hours. What we found was that, within the first hour, the 500W quartz halogen had already reached its maximum temperature of over 300C (>570 F). This temperature will ignite paper and wood, and is the melting point of pewter. Styrofoam will become liquid at this temperature. We haven't even begun to discuss what this would do to human flesh.

Feeling hot, hot, hot

Photo 1 is infrared picture of the 500W quartz halogen light after one hour. The different colours represent the varying temperature levels in the picture. In the upper right corner, you can see the maximum temperature present in the picture. In this case, it's the 329C number that represents the hottest point on the 500W quartz halogen light. The number in the middle-right represents the temperature at the point where the crosshairs are situated. In this case, 314C somewhere near the middle of the light.

When we think about touching this with our hands or any other part of our bodies, that's when the real danger of a heat source like this becomes apparent. Skin will burn at about 100C, which means that the 500W quartz halogen is an imminent and immediate danger just by being in the same room.

When we analyzed the infrared images closely, we found that even the guard that is meant to protect the user from the hottest part of the light achieved temperatures of over 100C. You can see this in Photo 2: the crosshairs are centred over one of the guard wires, and the number in the middle-right of the screen shows 106C. So, really, there is no safe spot to touch a quartz halogen worklight once it has been powered up for any reasonable length of time.

High heat = fire

The additional danger of using a light that becomes this hot is the fire hazard. Many types of flammables, including common gasoline, will ignite at temperatures less than what the quartz halogen can produce. One of our customers told us a story about a quartz halogen light being left out overnight and burning through the wood planks on a scaffold. In the morning, they found the light burning through its second set of planks a full storey down from where it was left the night before.

Stories like this are not uncommon, and that customer was simply lucky that the quartz halogen light didn't start a broader fire. Another customer of ours tells the story of a quartz halogen light being wrapped in a fire blanket and, because the light was so hot, the fire blanket began to smolder and smoke.

So why do workers continue to use a worklight that is clearly dangerous? The answer is that, sadly, they rarely have other choices. As mentioned earlier, the 500W quartz halogen light gives off a lot of light, and is small and portable. These advantages have made it popular, and a low cost has helped it become ubiquitous. Everyone knows they are dangerous, but put up with the risk because there were no other options that could give off that much light in such a small, portable unit.

Enter the LED worklight

However, there are now alternative technologies in the market that are attracting considerable attention. For example, LED technology has developed to the point where an LED floodlight can give off the same useable light as a 500W quartz halogen with none of the downside risks. At this point, most people are quite familiar with the concept of LEDs. They never require bulb changes, are much more energy efficient than other lighting technologies, and they run cool. The last benefit tends to be overplayed, as LEDs generate heat, but even with a moderate amount of heat sink design, an LED light will come nowhere close to the heat generated by a 500W quartz halogen light.

A look at the data will once again help to inform this argument. We ran a 500W quartz halogen worklight side-by-side with a 50W LED portable floodlight. The 50W LED floodlight gave off the same amount of usable light in the same light flooding pattern, so it is an excellent unit for an apples-to-apples comparison. The lights were left to run, and periodic infrared readings were taken of both to compare the operating temperatures.

Like the quartz halogen light in our first test (mentioned above), the 50W LED portable floodlight reached its maximum temperature in under an hour. However, unlike the quartz halogen light, the 50W LED portable floodlight continued to operate in a temperature range that was not dangerous and would not start a fire. The maximum temperature of the LED light was just about 35C.

Interestingly, the temperature reading of a human hand is just below 31C, meaning the LED floodlight was only slightly warmer than a firm handshake. In Photo 3, you can see the maximum temperature in the upper right (35.3C) and the temperature of the hand where the crosshairs are pointed at the middle-right (30.6C).

When viewed together using a composite visual and infrared image, the LED floodlight thermal signature almost disappears due to the extreme heat of the quartz halogen light on the left (Photo 4).

The advancement of LED lighting technology is a gamechanger that will save lives and reduce injuries in the workplace, let alone dramatically reduce energy usage and downtime associated with bulb replacement. Perhaps now that workers finally have a choice for a bright, portable worklight, they will make the decision to stay away from lights that may send them home with serious burns. EB

Brian Astl is the vice-president, sales and marketing for Lind Equipment, a manufacturer of portable electrical products. He can be reached at bastl@lindequipment.net.

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Handling mine trailing cables

Part two

Dave Smith

There are four types of tests typically done on the insulation of these cables. The first is a manufacturer's test, then an acceptance test once the cable has reached the field. After that there will be maintenance tests on a recurring basis, followed by tests that are done when a failure occurs and the cable has been repaired.

Causes of failure include too much tension when moving the cable, mechanical damage, overloading the cable, or poor splices and terminations. The fault location will have an effect on the amount of energy released. When it is at the end of the cable, close to the mining machine, then the impedance of the cable will limit the fault current and potentially delay the reaction of the protective device. When it is close to the supply end of the cable, then there will be more current and, therefore, a faster response—but also a larger failure.

An internet search, especially of the American Mine Safety & Health Administration, shows numerous electrocutions that have occurred over the years on these cables. It is important to identify the parts of a cable to determine where the faults could happen. The parts of a cable could be described as:

1. The end junctions or terminations.
2. In the length of the cable where there is damage.
3. Splices in the cable.
4. In the length of the cable where there is no damage.

No. 1 is the domain of the electrical workers and definitely dangerous. Safety in this area is outside the scope of this article, although it is important to note the danger of junction boxes in wet areas. I had a supervisor describe a 15kV junction box that was completely submerged yet did not trip their system. (If you are under the impression that water and electricity do not mix, try submerging a live trouble light in a plastic pail of water. It would be good to bring your shaver as you will grow a beard before a 15A breaker trips. The water will be energized as hundreds of milliamps will be flowing, creating a definitely lethal situation, but water and electricity, unprotected by a GFCI, mix quite completely.)

Damage in the length of the cable, No. 2, could be external or internal. External damage would generally be caused by a machine or materials damaging the outer sheath. External damage, whether in an open pit or an underground mine, can be caused by vehicles or

Causes of failure include too much tension when moving the cable, mechanical damage, overloading the cable, or poor splices and terminations.

equipment driving over the cables. In the dark, it is very easy to make a mistake and drive over one of these cables.

This damage could be on the outer protective covering, or down into the shield, or it could even be through the shield and into the internal insulation around the conductor. When the damage goes through the shield and insulation to the conductor, then there will be a fault from that phase to the shield; the protective relay should detect this and trip the system out. When the damage does not go that deep, then the cable is permanently weakened and is likely to eventually fail at that point. This external damage can be detected by keen observation given sufficient light.

There is a concern that a cable could be damaged and energize the ground around it, but this is unlikely. If the cable had the conductor insulation violated and the conductor exposed, the system would soon trip. General contamination would infiltrate the violated area causing tracking current; this would rapidly increase to a flashover and trip the protective system. You can expect, though, that damage through to the conductor would cause an immediate flashover and immediate trip.

It would be highly unlikely for one of these cables to be damaged to such a point that the external covering, plus the sheath, plus the primary conductor insulation could all be damaged and a live cable exposed to atmosphere, without having tracking current cause a flashover and trip the relay. In this highly unlikely circumstance, workers would encounter tingle voltages on the circumference of the subsequent ground gradient surrounding the fault. It is unfortunate that these would be masked by insulated boots.

Splice failures, No. 3, occur from high-resistance connections that can cause electrocution, hand burns and fires. These poor connections are easily detected in their early stages by feel or infrared scanning. Splices also fail due to internal short circuits and, again, it is highly unlikely to have leakage current external to the splice... but common sense dictates to stay away from them, other than for inspections.

More on this in my next column. Until next time, be ready, be careful and be safe.© EB

Canada Training Group has been providing consulting services to industry since 1980; Dave Smith, the president, can be reached at davesmith@canada-training-group.ca. At www.canada-training-group.ca, you will find this article (and others) to help support your own safety initiatives.

New Standard Products LED low voltage tape light

The new Standard Products LED low voltage tape light is offered in offered in cool white, warm white and colour changing RGB, and can be cut to size at marked intervals of 10cm. Users can use quick connectors to rejoin various lengths and work around corners. The tape light features 3M adhesive backing for solid installation and a silicon cover for exposure to damp locations. The kit includes tape light, 1 power supply, remote control (for RGB kit only), and RGB controller (for RGB kit only).
STANDARD PRODUCTS
www.standardpro.com

Standard Products unveils LSG Roadway luminaries

Standard Products has introduced LSG Roadway luminaries, claiming to offer a variety of direct replacements for traditional HID (high-intensity discharge) Roadway luminaires. Optical systems are sealed and carry IP66 rating. According to the company, the internal thermal management system eliminates the need for external fins and maintains a low, smooth profile. The luminaires are cULus and ETL certified, and are suited for applications such as roadways, parking lots, and city and residential streets.
STANDARD PRODUCTS
www.standardpro.com

Universal Lighting Everline LED drivers for track and downlight applications

The new Everline LED drivers and modules from Universal Lighting Technologies for track and downlight applications boast versatile light output and control, delivering up to 90+ lumen-per-watt system performance. Everline's round LED modules offer 1,000 to 10,000 lumens, with colour temperature options of 2700K, 3000K, 3500K, and 4000K models. The drivers provide control capabilities for track and downlight luminaires ranging from 15W-150W—with 350mA, 700mA, and 1,050mA options available.
UNIVERSAL LIGHTING TECHNOLOGIES
www.unvlt.com

Philips removes heat sink fins from 60W A-19 LED bulb

Using 11W of power while outputting 830 lumens, the latest generation of Philips' 60W A-19 LED bulb uses 10% less energy than its 12.5W predecessor, while increasing brightness by nearly 5%, says the company. The new lamp also replaces heat sink fins with a more streamlined appearance, and is designed to reduce energy usage by 85% compared to the traditional 60W incandescent. Dimming capabilities, with the potential to dim down to 2% of light level, are also available.
PHILIPS
www.lighting.philips.com

Venture Lighting debuts RIO system

Venture Lighting's new RIO system (Retrofit Integrated Optics) boasts up to 120 lumens per watt, a rated lamp life of up to 30,000, and 95% optical efficiency. According to the company, the system also offers a total energy savings of almost 50%. By repurposing existing fixtures, the waste, time, cost and labour at each job are all greatly reduced, adds Venture.
VENTURE LIGHTING
www.venturelighting.com/Canada

NexTraq works to help fleets stop distracted driving

In a concerted effort to discourage distracted driving among electrical service fleets and drivers, NexTraq has released DriveGuard—a solution that blocks or restricts calls, texts, emails, web browsing, and other distractions while driving. NexTraq DriveGuard is powered by Cellcontrol, a distracted driving technology which uses a Bluetooth Trigger Unit coupled with a mobile application on a mobile device to block such mobile functions. Users can also select automated SMS responses to callers noting that the driver is driving and will return calls and messages at a later time. The solution works on phones, smartphones, laptops, handhelds and tablets using, among others, BlackBerry, Android, Windows, Java and iOS systems.
NEXTRAQ
www.nextraq.com

Hendrix develops HPI-LP-14 line post insulators

Hendrix Molded Products has released its HPI-LP-14 line post insulators for the utility industry—constructed from Hendrix's polyethylene blend, the insulators claim they won't chip, crack or break. With a leakage distance of 31.4-in., the line posts have flashover values of 128Kv dry, and 94Kv wet. Featuring a molded-in "F" neck design, no metal top is needed for the insulator.
HENDRIX MOLDED PRODUCTS
www.hendrix-wc.com

Fulham website now available in French

A visit to www.fulham.com reveals a major addition to the company's global website—now French-speaking visitors in Quebec and elsewhere can navigate the newly-translated version of the site 'en français'. "Quebec represents an important and growing segment of Fulham's Canadian business," said Todd Hughes, VP sales at Fulham Canada. "This site expansion to include French demonstrates our commitment to the region, particularly as we prepare to launch a series of our RaceHorse brand 347V electronic fluorescent ballasts by February of 2013." In addition to these 347V items soon to be included, Fulham's website features other various cULus and cURus items.
FULHAM
www.fulham.com

New Agilent U1273AX digital multimeter operates in -40ºC

Agilent Technologies' new U1273AX OLED handheld digital multimeter operates in temperatures as low as -40ºC, boasting no warm-up time is required even in such frigid conditions. Its operating temperature range also extends up to 55ºC, while featuring a CAT IV/600 V safety rating. When paired with the U1583B AC current clamp, the U1273AX supports current measurements without breaking the circuit under test, says Agilent. The multimeter presents 4-1/2-digital resolution on an OLED display that provides readings with a 2000-to-1 contrast ratio and 160º viewing angle.
AGILENT TECHNOLOGIES
www.agilent.com

Milwaukee launches milliamp clamp meter 2231-20

Milwaukee Electric Tool has expanded its test and measurement line with its new milliamp clamp meter, designed for measuring 4mA-20mA signals used in control panels to collect and send data. The clamp meter also measures 0mA-99mA to cover a range of control signals if needed. According to Milwaukee, the clamp allows users to measure milliamps without having to break the loop, preventing the shutdown of equipment and saving valuable time. The tool features a long clamp wire, narrow jaw profile, a white-on-black display and an on-board clamp storage.
MILWAUKEE ELECTRIC TOOL
www.milwaukeetool.com

ADVERTISER INDEX

Les Stoch, P.Eng.

Canadian Electrical Code, Appendix B

Many of the Canadian Electrical Code rules display the note "See Appendix B". This Appendix provides important information on interpreting and applying the rules. To be sure you're on the right track, it's always a good idea to find out what Appendix B has to say.

RULE 10-700 defines an in-situ grounding electrode as a part of the existing infrastructure, buried a minimum 600 mm below grade and having a surface area equivalent to a manufactured grounding electrode (two-rod electrodes or a plate electrode).
Appendix B provides a list of acceptable in-situ grounding electrodes such as 3 m of metal water piping, concrete reinforcing rods and iron pilings. It also provides a cautionary note: metal treated with non-conducting corrosion protection does not satisfy the requirements for an in-situ grounding electrode.

RULE 12-120(4) now requires that the internal conductors of long vertical runs of armoured or sheathed cable must be supported at intervals not exceeding the distances specified in Table 21. Alternative methods of support include a 90º bend or several bends totalling 90º at intervals not exceeding the Table 21 intervals, or a horizontal run not shorter than the vertical run or a cable designed for vertical runs.
Appendix B explains that a horizontal run that equals or exceeds the vertical length or incorporates a 90º bend or several bends equal to 90º reduces the strain on the conductor terminations.

RULE 12-902 permits pulling armoured cables into raceways with a number of conditions.
Appendix B warns that armoured cables may be damaged when pulled into conduit or tubing. Calculations and specifications are required to determine maximum cable lengths. Cable manufacturers should also be consulted for minimum bending radii.

RULES 12-1104, 1154 AND 1508 refer to temperature limitations for PVC conduit, duct and tubing, and specify that PVC must not be subjected to temperatures in excess of 75C. However, 90C-rated conductors may be installed at their assigned ampacity ratings.
Appendix B justifies this exception on the basis that continuously loaded 90C conductors under conditions of 50% fill and 30C ambient do not result in temperatures above 75C. Conductors with insulation temperature ratings above 90C are also acceptable, so long as their ampacities are derated to 90C.

RULE 12-714 requires that mineral-insulated box connectors must be used for mineral insulated cables.
Appendix B explains that mineral-insulated cables may have copper, aluminum or stainless steel sheaths. Therefore, mineral-insulated cable box connectors suitable for use with sheath materials are to be used.

RULE 12-012 requires that allowance must be made for the expansion and contraction of PVC conduit due to changes in temperature by using approved expansion joints.
Appendix B identifies the PVC coefficient of expansion as .0520 and provides a sample calculation. For a 20m run of rigid PVC conduit, where temperatures range from -40C to +30C, the change in conduit length is 20 x (40 + 30) x .0520 = 73 mm.

RULE 14-510 specifies that manually operated general-use switches must be approved and marked for each purpose.
Appendix B requires general-use switch markings as follows:

- "T" - A switch for controlling tungsten AC or DC filament lamps up to 125V.
- "L" - An AC/DC switch for controlling AC lamps up to 125 volts.
- "AC, frequency or phase markings" - A general-use switch for use only on AC circuits.

RULES 18-108 AND 18-154 specify that cable seals must be provided where cables enter an explosion-proof or flame-proof enclosure, or where first terminating in a Zone 1 explosive gas atmosphere.
Appendix B explains that cables are not tested for their ability to withstand an internal explosion and, therefore, seals are needed to prevent the passage of gases, vapours or flames through the cables.

I hope I have convinced you Appendix B holds a wealth of invaluable information. Spending a few moments to find out what it has to say can provide big dividends. EB

Les Stoch is president of L. Stoch & Associates, specialists in quality management/engineering services. He is a member of PEO, OEL and IAEI, and develops and delivers electrical code and technical workshops for Dalhousie University. He also developed the Master Electrician training program and exam (Ontario) for the Electrical Contractor Registration Agency. Visit L. Stoch & Associates online at www.lstoch.ca.

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Tackle The Code Conundrum... if you dare!

Answers to this month's questions in March's Electrical Business.

How did you do with the last quiz? Are you a...

Master Electrician ? (3 of 3)
Journeyman ? (2 of 3)
Apprentice ? (1 of 3)
Plumber ?! (0 of 3)

Question 1

A separate bonding conductor shall be installed in rigid RTRC conduit.

a) True **c)** False

Question 2

Solid-state devices are permitted to be used as isolating switches but not as disconnecting means.

a) True **c)** False

Question 3

The supply conductors for a deep well submersible pumps installed in wells shall be suitably supported at maximum intervals of [___] to the discharge pipe.

a) 1.0m **c)** 2.5m
b) 1.5m **d)** 3.0m

Answers: EBMag January 2013

Q-1: For general power and lighting circuits, the maximum rating of overcurrent protection for No. 12AWG copper conductor is:

b) 20A. Ref. Rule 14-104 (2).

Q-2: Renewable energy systems with a maximum system voltage in excess of [___] shall comply with Section 36.

b) 750 V dc. Ref. Rule 64-034.

Q-3: For a circuit fed with a 3 conductor No. 6 AWG copper TW75 cable, the bonding conductor size for this circuit shall be [___] copper.

c) No. 8 AWG. Ref. Rule 10-814.

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12:37 PM
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2:45 PM
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3:12 PM
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7:15 AM
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