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Electrical Business

NOVEMBER 2012

These electrical flyboys keep our airports humming

Also in this issue...

- Myths about reconditioned electrical equipment
- EV charging systems and the code
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These electrical flyboys keep our airports humming

Those of you who follow our travels know we attend and report from as many electrical events as possible to bring you news and views from across the country. We all have varying perspectives, be they from the largest tradeshows to the smallest dinner meetings.

I had a particularly enjoyable and eye-opening experience while attending the Canadian Airports National Electrical Workshop (CANEW). As a first-time delegate, I didn't quite know what to expect. Who are these guys? Where do they work? What do they *work on*?

These airport electricians work on airfields as busy and bustling as YYC and YYZ, to smaller regional airports like Campbell River in British Columbia, to a host of Department of National Defence facilities... and among the things they have in common are keeping the (runway) lights on, and workplace electrical safety. Yes, while their world seems far removed from our own, they also take CSA Z462 very seriously.

And while their annual budgets vary from several thousand dollars into the millions, they are unique electrical professionals working on unique, purpose-built systems. For example, did you know that, much like Christmas tree light strings, runway lighting is built around series rather parallel circuits?

Discussions revolved around the technologically advanced, such as the PAPI system (Precision Approach Path Indicator) for pilots of incoming aircraft (which is shown on our cover) to the basics, such as keeping critters out of the electrical system. Other topics of discussion included power quality and conservation, PV systems, grounding and airport construction projects.

Perhaps most enjoyable to me—as both EBMag editor and a Canadian—were the war stories coming the furthest reaches of our great land; tales of wolves in Alert, Nunavut, that will wander up to you and try to tug the leather gloves out of your back pocket,

to stories of polar bears wandering onto the runway and around the maintenance buildings in Churchill, Man.

A common feeling among many of the delegates was the desire to see more electrical contractors attending CANEW. This is a highly specialized market, they say (meaning hard to break into) but attending CANEW is a great way to get the ball rolling on developing and adding airport expertise to your repertoire.

Meantime, check out EBMag.com for photos and videos from the latest installment of CANEW—the only workshop of its kind in North America. EB

Anthony Capkun

On the cover

These electrical flyboys keep our airports humming

As a first-time delegate to the Canadian Airports National Electrical Workshop (CANEW), editor Anthony Capkun didn't quite know what to expect. See above.

Photo A. Capkun.

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The world's largest corporations know it, but do you? Extending the lifetime of capital equipment through reconditioning and remanufacturing saves time and money. This paper breaks down eight popular myths surrounding the billion-dollar industry.

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In British Columbia, workers who are not Red Seal-certified electricians can perform electrical installations following an agreement between BC Safety Authority (BCSA) and Applied Science Technicians & Technologists of BC (ASTTBC). However, the Electrical Contractors Association of BC (ECABC) has been in a long debate with BCSA about this matter.

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This article discusses line-line fault and its protection in solar photovoltaic (PV) arrays. Depending on fault locations, the magnitude of line-line faults in PV arrays could be high enough to damage PV modules and conductors.

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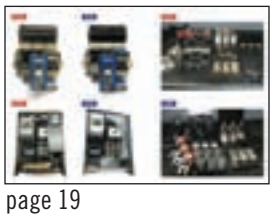

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Siemens exiting solar business, focusing on wind and hydro power

Siemens (www.siemens.com/energy) says it will "modify its business strategy and organizational setup" by divesting its solar business activities and focusing its renewable energy activities on wind and hydro power. As part of this reorganization, the Energy Sector will be slimmed down and the Solar & Hydro Division will be discontinued. The company cites changed framework conditions, lower growth and strong price pressure in the solar markets for the decision.

Siemens will continue to offer suitable products for solar thermal and photovoltaic power plants, it says, such as steam turbines, generators, grid technology and control systems, which are produced outside of the Solar & Hydro Division.

Electrical Business

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Canada

UL awards the first UPS product Energy Star certificate to APC by Schneider

UL (www.ul.com) awarded the first uninterruptible power supply (UPS) Energy Star certificate to APC by Schneider Electric (APC, www.apc.com). According to UL, the Environmental Protection Agency (EPA) added UPS products to its scope of regulated products. To qualify for the Energy Star program, APC UPS units met the world's most stringent energy efficiency standards.

"The fact that UL awarded the first UPS product Energy Star certificate for APC demonstrates its determination to pursue sustainable development, and is also testimony of its long-term strategy in the field of energy efficiency," said Michael Shows, global business manager for energy efficiency, UL Verification Services.

In recent years, UL says it has been accelerating the expansion the testing and certification in the field of energy efficiency services and capabilities, including the extension to UPS products, which also "help enhance the authority and popularity" of the Energy Star program and "advocacy of energy saving and environmental protection".

Two million hours of safety at Ascent

It has been more than 17 years since there has been a lost-time injury at energy solutions provider, Ascent (www.ascent.ca)—a feat representing more than one million work hours for Ascent and another million work hours for its local energy distributor, St. Thomas Energy (www.sttenergy.com), it says.

According to Ascent, St. Thomas Energy also has the distinction of being the smallest utility in Ontario to have ever achieved one million hours without a compensable injury.

"For a company of our size to meet this milestone, it is quite an accomplishment and a true testament to the commitment to occupational health and safety shown by every person working for our company," said Brian Hollywood, CEO of Ascent. "We're very proud."

The company's achievement was recognized earlier this year with a President's Award from the Infrastructure Health & Safety Association (IHSA, www.ihsa.ca).

Accomplishing this required a program of great teamwork, communication, and training to create a culture of safety across the company, said Ascent.

"One of the most important things any company can do is ensure that employee and customer safety is paramount," added Hollywood. "As one of the five main pillars of our company, employee and public safety is a strong focus at Ascent."

Photo A. Capkun

IBM unveils Canada Leadership Data Centre in Barrie

EBMag was there as IBM—together with the Governments of Canada and Ontario and the City of Barrie—unveiled "one of the nation's most advanced computing facilities": the IBM Canada Leadership Data Centre. The Barrie, Ont.-based centre has been designed from the ground-up with the latest advancements in, among other things, energy efficient data centre management.

The data centre represents a $90-million investment from IBM and will establish 20 skilled jobs in Barrie. This is a portion of the $175 million IBM invested and 145 jobs created through the April 2012 launch of the IBM Canada Research and Development Centre network.

IBM says the highly efficient, modular centre is uniquely designed to a set of global best-practice metrics that best demonstrate productivity and effectiveness in space, energy and data management. The new facility will provide 25,000 sf of initial capacity with the ability to grow to 100,000 sf.

Our tour guide, Doug Stirling, said the facility is pursuing LEED Gold certification.

Record-number of scholarships for 2012 EFC Scholarship Foundation

Electro-Federation Canada (EFC) has announced the 2012 EFC Scholarship Foundation recipients. Each year, the foundation provides Canadian post- secondary students with funding support for their education. This year, 40 organizations in the electrical and consumer electronics sectors have provided financial support.

"This year, the foundation has provided a record-number of scholarships due to strong industry support from Electro-Federation Canada members," said Jim Taggart, president & CEO, EFC. "Investing in Canadian university and college students ensures a bright future for our industry as we continue to offer a wide-range of exciting career opportunities."

Supporting students for 17 years, the EFC Foundation Scholarship Program encourages Canadian youth to pursue a career in the electrical, electronics and telecom industries. To date, EFC says it has invested over $600,000 in post-secondary technical training and education.

The scholarships are awarded to post-secondary students studying in an electrical or electronics field, including electrical apprenticeship, electrical engineering technology, electrical technician, electrical engineering, supply chain management or business administration. Scholarships are also awarded on the basis of academic achievement, areas of study, leadership and career interests.

To view the list of recipients, organizations supporting this initiative and for more information on the EFC Foundation Scholarship Program, visit www.electrofed.com/scholarship-program. Congratulations to everyone!

Electro-Federation Canada is a national, not-for-profit industry association. Together, its councils represent 300 member companies that manufacture, distribute and service electrical, electronics and telecom products that contribute over $50 billion to the Canadian economy and employ more than 130,000 workers in more than 1400 facilities across the country.

Applications for the 2013 program will be accepted in January 2013. Stay tuned!

New Acuity Brands Canada facility showcases lighting and controls technology

EBMag was invited for an exclusive tour of the new 60,000-sf Acuity Brands Canada facility (www.acuitybrands.com), which combines the company's lighting and controls offices. Located in Thornhill, Ont., the facility includes offices, a warehouse distribution centre and showroom.

12 offices incorporate a variety of Acuity products to illustrate lighting solutions in office applications. Additionally, the entire building is networked with nLight controls from Sensor Switch.

"This new work environment shows customers first-hand what they can achieve when specifying lighting and controls solutions from Acuity Brands," said Gregory Holm, VP and GM, Acuity Brands Lighting Canada Inc. "Centralizing our operation allows us to provide more resources to customers and agents, and the community, while providing the best work environment for our employees."

Acuity Brands Canada says it will offer a full calendar of training modules—as well as custom training sessions—for sales agency partners and their customers. A lab space will allow the controls division to pre-program and test products, and offer hands-on training.

One year later, Nova Scotia seeks feedback on COMFIT

The Province of Nova Scotia is asking for feedback on how to improve its Community Feed-in Tariff (COMFIT, www.nsrenewables.ca) program, which aims to encourage community participation in renewable energy projects.

Introduced in the 2010 Renewable Electricity Plan, COMFIT officially launched last September. Since then, more than 45 projects have been approved and dozens more are finalizing business plans.

"From the beginning, we committed to continual improvement of the program and a review once we had some experience under our belt," said energy minister Charlie Parker. "We consider this a tune-up to ensure the program is meeting its objectives and is aligned with operational realities."

The review will include public consultation and discussions with those in the program and will examine applicant eligibility, geographical distribution, eligible technologies, quantity of energy being offered, community engagement and support, things learned from previous projects and administration.

COMFIT provides municipalities, First Nations, co-operatives, not-for-profit and other eligible groups an established price-per-kWh for projects that produce electricity from renewable sources, such as wind, biomass, in-stream tidal and river tidal developments.

During the review, the department will not accept applications for wind projects of more than 50 kilowatts. Projects already in the application system will be processed.

Concept Electric helps donate $50,000 to Kids Cancer Care Foundation of Alberta

Buck'n Up for Kids Cancer Ltd., an Alberta-based not-for-profit organization comprised partly of volunteers from Concept Electric, has donated $50,000 to the Kids Cancer Care Foundation of Alberta (KCCFA). The donation will go toward KCCFA's Capital Campaign to re-build Camp Kindle just west of Water Valley, Alta.

The $50,000 donation was collected at the most recent event in the campaign –the Stampede BBQ fundraiser– hosted at Concept Electric on July 6.

"It was our first kick at the can in terms of putting this party on as a fundraiser," said Susan Williams, chair. "There were definitely a few bumps in the road, but with hard work, support from the community and dedication of the group, we got over those hurdles and it paid off big time in the end."

The campaign first began in 2011 with the reconstruction of the camp, as Concept Electric was awarded the electrical and controls contract for the site. The camp officially opened its doors on July 13 to kids battling the effects of cancer, along with their families.

"We have a few events lined up such as a head shave to support KCCFA's 'Shave Your Lid for a Kid' campaign. One of our very own board members is going to shave her head for this cause," added Williams. "It gives our group goosebumps just thinking of the passion to helping out this cause. We also plan to double our donation for next year during Stampede. We're already in the early planning stages to make it bigger and better."

Formed in January 2012, Buck'n Up for Kids Cancer is also maintained by individuals from Cana Construction; Vero Energy; Shaw GMC Lease; and members of the public and private sector.

"Major construction and electrical players came together by putting aside the business of competition and joining together for this cause in the spirit of camaraderie," said Buck'n Up for Kids Cancer. "The outpouring of donations and volunteers from all of these industries was more than expected."

Industrial electricians... this one's for you!

A reader writes with a number of questions relating to becoming an industrial electrician. The best answer will be published in the next issue, and will win a prize from Electrical Business!

I have been working as an automation technician for the last 10 years, working in industrial settings and doing maintenance and service on equipment. My current job focuses on PLC and robot programming/configuration, as well as communication networking, but my other duties include wiring safety circuits, installing and troubleshooting motor control circuits, replacing and updating lighting circuits/fixtures, etc.

I have always taken great pride in my work and try to work both safely and professionally, always following the rules set in both the Ontario Electrical Safety Code as well as the Canadian Electrical Code.

I am interested in getting licensed as an industrial electrician (442A), but I continually get conflicting information as to what I am able to challenge, and what the requirements are to do so. My questions include:

1. Can I challenge the actual exam directly and, if I pass, I am a licensed industrial electrician)?
2. Can I only challenge the schooling portion of the apprenticeship (Apprenticeship Exemption Test [APPR]) doing each level individually?
3. I've heard that I need a letter from my employer verifying that my job duties include the same tasks as that of an industrial electrician. Are there any specific details that must be in that letter?
4. What are the requirements for hours worked in the field?
5. I have a 442A apprenticeship book and have had the opportunity to work with many great electricians who have taught me much, and are willing to sign me off on much of the content in the book. Is there any requirement to have any portion of this book signed off to be able to challenge?

I have contacted the Ministry of Training, Colleges & Universities directly about this, but the response I got was that challenging was basically just for immigrants who worked as electricians in their country of origin (which contradicts what I've heard from others in the field).

What I would like—and would greatly appreciate—is some direction on whether someone in my position can challenge the 442A Industrial Electrician exam and, if so, the requirements.

I think an article in your magazine would be a great way to share this information with other technicians who are as perplexed as I on this topic.

— Craig R., Ontario

Photo A. Dalton. Visit bit.ly/VPjXq7 to see our photos from the event.

Congratulations to this year's ESA Electrical Safety Award recipients!

EBMag was pleased to attend the Electrical Safety Authority's (ESA, www.esasafe.com) annual Ontario Electrical Safety Awards last month. Each year, several individuals and organizations are recognized for "incredible achievements in advancing electrical safety and demonstrating their firm commitment to building a safety culture across the province".

This year's winners are:

- Powerline Safety - Burlington Hydro (www.burlingtonhydro.com)
- Worker Safety - Electrical Safety for Emergency Responders Committee
- Product Safety - Doug Geralde of Canadian Standards Association (CSA, www.csa.ca)
- Consumer/Home Safety - Enersource Mississauga (www.enersource.com)
- Special Recognition by Chief Public Safety Officer - Ewa Kozlowska of the Toronto Transit Commission (TTC, www.ttc.ca)

The need for collaborative efforts in advocating electrical safety was echoed in a number of speeches that evening. One of the evening's emcees, ESA's chief public safety officer Doug Crawford, says there are no electrical safety accidents.

"These incidents are preventable," he said.

Putting rumours to rest! Wesco International acquiring EECOL Electric

Wesco International Inc. (www.wesco.com), through a wholly owned subsidiary, has entered into a definitive agreement to acquire EECOL Electric Corp. (www.eecol.com), headquartered in Calgary, Alta., and various affiliated companies for a purchase price of about $1.14 billion CDN.

The transaction is subject to certain conditions, including approval under the Canadian Competition Act. Closing is expected to occur in the fourth quarter 2012.

Founded in 1919, EECOL Electric is a full-line distributor of electrical equipment, products and services with about $0.9 billion in annual sales, 57 locations across Canada and 20 in South America, and more than 20,000 customers.

Mr. John J. Engel, Wesco's chair, president and CEO, stated, "The addition of EECOL expands Wesco's presence in Canada and broadens our international footprint, specifically our capabilities in South America".

"We are very pleased to have reached this agreement with Wesco. We have known the Wesco management team and organization for years and are confident it will be a great home for our business and our team," said Mr. Tom Crist, EECOL's president and CEO.

"We have had great respect for EECOL for many years and are pleased to have EECOL become part of Wesco. Together we will expand our sales and service capabilities and capitalize on the strong supplier relationships of each company for MRO, OEM, and capital project-related opportunities," said Stephen A. Van Oss, Wesco's SVP and COO.

Eaton launches online authentication tool to combat counterfeiting

Eaton Corp. (www.eaton.com) claims it has introduced the first online tool to promote awareness and detection of counterfeit electrical products. Eaton's new online Circuit Breaker Authentication (CBA) tool is designed to enable customers to identify counterfeit moulded case circuit breakers (MCCBs) up to 400A in an attempt to "thwart potential danger and allow for authorities to be informed of fraudulent distribution".

By entering the bar code, part number and date code found on the circuit breaker, CBA is intended to immediately detect a counterfeit. The tool is accessible via any web or mobile browser at www.eaton.com/counterfeit.

"Counterfeiting of electrical products is a growing issue that hits all regions of the world, including Latin America," said Tom Grace, brand protection manager, Eaton's Electrical Sector. "The launch of Eaton's online Circuit Breaker Authentication tool will further aid the identification of potentially dangerous counterfeit products and their distributors on a global scale."

The company made the announcement at the 2012 International Law Enforcement Intellectual Property (IP) Crime Conference in Panama City, Panama, co-hosted for the first time in Latin America by Interpol and the National Police of Panama, in partnership with Underwriters Laboratories.

"Our sponsorship of this conference enables us to expand awareness of electrical safety and, more specifically, the dangers of counterfeit electrical products," said Ramiro Alvarez, Eaton business unit manager, Central America and the Caribbean.

Hotter might be better at energy-intensive data centres

New research from the University of Toronto-Scarborough suggests turning up the temperature in data centres could save energy with little or no increased risk of equipment failure.

"We see our results as strong evidence that most organizations could run their data centres hotter than they currently are without making significant sacrifices in system reliability," said Bianca Schroeder, a UTSC assistant professor of computer science.

Data centres typically operate at temperatures from 20ºC to 22ºC, said the researchers. Estimates show that increasing the temperature by just 1 degree could save 2-5% of the energy the centres consume. Schroeder said that most data centres could probably increase temperatures much more than that.

To conduct the study, the researchers collected data from data centres run by Google, Los Alamos National Labs and others. They also directly tested the effect of temperature on performance in their lab. Their data showed higher temperatures either weren't associated with negative effects, or else the negative effects were smaller than predicted.

Visit EBMag.com and click Calendar to see an extensive list of upcoming events.

IN CASE YOU MISSED IT...

VIDEO • Canada must invest in IT to maintain its standard of living. Visit bit.ly/PTmmxz.
GALLERY • EBMag attends Canadian Utilities Equipment & Engineering Show (CUEE). Visit bit.ly/OoKeMp.
GALLERY • Scenes from IIDEX Canada 2012 in Toronto, Ont. Visit bit.ly/OWDeB1.
VIDEO • Who are the electrical flyboys keeping our airports running? Visit bit.ly/Pt3OCe.
GALLERY • Siemens Canada HQ unveiling & 100th Anniversary (August 2012) Oakville, Ont. Visit bit.ly/U9f3U6.

OSP Expo International Summit
November 13-15, Denver, Colo.
Visit www.ospmag.com/expo

EFC E-Tech Marketing Forum II: High Performance Buildings
Electro-Federation Canada
November 14, Brampton, Ont.
Visit www.electrofed.com/newsroom/events
EB WILL BE THERE!

AEL ECO-Conference
Alberta Electrical League
November 20, Calgary, Alta.
November 22, Edmonton, Alta.
Visit www.elecleague.ab.ca

RETScreen Training Institute
November 20, *Montreal, Que. - 201: Analyse de projets d'efficacité énergétique*
December 4, *Toronto, Ont. - 202: Heating & Cooling Project Analysis*
Visit www.retscreen.net/ang/training_institute.php

BICSI Canadian Region meetings
November 22, Ottawa, Ont.
Visit www.bicsi.org

Construct Canada
EB WILL BE THERE!
SHOW INCLUDES: Construct Canada, PM Expo, DesignTrends, HomeBuilder & Renovator Expo and Concrete Canada
November 28-30, Toronto, Ont.
Visit www.constructcanada.com

CanSIA's Solar Canada
EB WILL BE THERE!
Canadian Solar Industries Association
December 3-4, Toronto, Ont.
Visit www.cansia.ca

17th Annual Fraud & Anti-Counterfeiting Conference
Hosted by Lorne M. Lipkus of Kestenberg Siegal Lipkus LLP
December 5-7, Toronto, Ont.
Visit bit.ly/O8wuV0

2013

RETScreen Training Institute
January 15, 2013, *Montreal, Que. - 202: Analyse de projets de production de chaleur et de froid*
February 12, 2013, *Toronto, Ont. - 203: Power Project Analysis*
March 19, 2013, *Montreal, Que. - 203: Analyse de projets de production d'électricité*
Visit www.retscreen.net/ang/training_institute.php

EDIST 2013 Conference & Exhibition
Electricity Distributors Association (EDA) & The MEARIE Group
January 16-18, 2013, Markham, Ont.
Visit www.edist.ca
EB WILL BE THERE!

BICSI Winter Conference & Exhibition
(30th Anniversary Year)
January 20-24, 2013, Tampa, Fla.
Visit www.bicsi.org
EB WILL BE THERE!

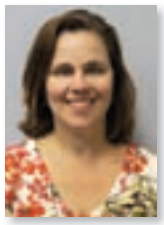
Smart Cities Canada Summit
January 23-24, 2013, Toronto, Ont.
Visit www.smartcitiescanada.com


Stuart Dack

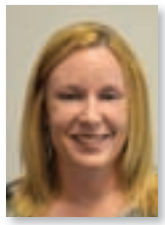
Lind Equipment (www.lindequipment.net) has appointed **Stuart Dack** to the role of product manager, where he will be responsible for leading the company from a technical standpoint, including directing new product design and product customizations. "We are very excited to have Stuart join our team," said **Sean Van Doorselaer**, VP operations for Lind Equipment. "His technical leadership will be an extremely valuable addition to our growing team." His appointment adds "enhanced capabilities to ensure that Lind Equipment continues to be the innovation leader in portable lighting, cord reels, GFCIs and static bonding and grounding", said the company. He holds a Masters in Science from York University, and a Bachelor of Engineering (Electrical) degree from McGill University.


Michel Champoux

Steve Parent, district manager, **GE Lighting Professional Sales** (www.gelighting.com) has announced **Michel Champoux** to the position of lighting sales representative, where he will be responsible for regions in Southern Ontario, including Kitchener, Waterloo, London, Windsor, and Niagara. In this role, Champoux will be responsible for sales to distribution channel partners, as well as to end-user customers.


Judy Travers

Judy Travers has been promoted to the position of VP of human resources for **Legrand Data Communications** and **Legrand Canada** (www.legrand.ca). Travers joined the company in August 2004 as human resources manager for Legrand/Wiremold. In July 2006, she moved up to become director of human resources for Legrand/Wiremold, and later assumed responsibility for the West Hartford facility (Wiremold and Legrand North America) in June 2009. Meanwhile, **Tracy Broad** is the newest addition to the Legrand Canada marketing team as marketing and communications specialist. "Tracy brings with her a results-oriented approach and experience in advertising, creative, copywriting, training, events and execution of marketing plans," said the company.


Tracy Broad

Chris Evans has joined the **Intralec Electrical Products** (www.intralec.com) sales team as specification sales rep, alternate energy. He was most recently employed at Nedco, as its solar business development specialist. Prior to that, Evans held positions at True North Power, Matrix Energy, groSolar, and Carmanah Technologies. "Chris will enhance Intralec's presence in the alternate energy market," said the company. Established in 1977, Intralec is a manufacturer's representative operating in Ontario.


Chris Evans


Roy McCrimmon

Roy McCrimmon, president of **Soler & Palau Canada** (www.solerpalaucanada.com), has named **Glenn Curtis** to the position of national sales manager. "Mr. Curtis joins our team with a wealth of experience and a dedication to exceptional customer service," he said. "Heading up our sales team, Mr. Curtis will be a valued asset to Soler & Palau Canada."

EBMag has learned of some recent organizational changes at **Hubbell Canada Lighting** (www.hubbellonline.com):


Rick Blasl

Rick Blasl has been appointed national sales manager. Hubbell welcomes Blasl back to the sales management team after 15 years of progressive sales management experience across Canada with Acuity Brands (Lithonia). "I am excited about the opportunities we have today to grow our lighting brands and am confident that Rick will build and lead a focused team of sales managers and agents toward achieving our full potential in Canada," said **Dave Syer**, VP marketing & sales for Hubbell Canada.


Dave Edgson

Dave Edgson has been appointed national accounts manager. He possesses 16 years of experience in the construction industry, with seven years of sales experience in the lighting and controls industry. Edgson joins Hubbell from Acuity Brands Lighting where he recently served as controls sales manager for the Greater Toronto Area (GTA). "Dave's experience and knowledge in our industry will be key to Hubbell Canada developing long-term relationships nationwide through national accounts," said Blasl.


Mark Killoran

Mark Killoran has been appointed central region sales manager. Killoran returns to Hubbell after nine years of sales experience in the GTA with the Juno Lighting Group (Schneider Electric). "Mark will be a valuable addition to our team and will play an essential role in both Hubbell and our agents achieving our full potential in Canada," said Blasl.


Tony Vaccarino

Tony Vaccarino was appointed eastern region sales manager. Based in St-Leonard, Vaccarino will focus on developing new opportunities and supporting lighting agents in Eastern Canada. "I am enthusiastic about growing our lighting brands in Eastern Canada, and I am confident that Tony will be a key part in developing and maintaining long term relationships in the industry," said Blasl.

There is a ton of additional information at EBMag.com, and be sure to follow our Tweets (twitter.com/ebmag) to learn about web updates, live event reporting and more!

Dave Smith

Face every conductor as though it were live

The job was simple. Lock, tag and isolate a motor at the disconnect, open up the junction box, apply safety grounds, and test the motor. The senior electrician was very close to retirement and was noted for his commitment and continuous promotion of safety. He was partnered with electrician #2 whom he had trained and mentored.

After helping lock out the disconnect, #2 went to get the voltage detector. #1 was in front of the junction cabinet; when #2 returned with the voltage detector, #1 asked him to unlock the cabinet. #2, concentrating on the voltage detector, reached over and unlocked the cabinet—no questions asked—then went back to proving the voltage detector. #1, at that moment, opened the door and, for some impulsive, unknown reason—and before #2 realized what was happening—reached in and touched C phase.

He was instantly electrocuted because he had gone to the wrong cabinet, and #2 did not double check the cabinet lamacoid.

A death like this is ugly to experience and the horror of it cannot be described. Suffice to say, pandemonium ensued and, in a case like this, when you cry for help, everyone runs into the room asking the same question: What happened?

The human mind stores information in short-term memory and, when something dramatic like this happens, it completely obliterates your short-term memory. When asked what happened, you will have no way of actually describing what happened. Your mind will be blank, and you will also suffer terrible feelings that cannot be described.

With every person who came in, the same question was asked: What happened? Then comes the supervisor, one level up the testosterone ladder, then the facility manager, further up the testosterone ladder. Then come the police, the provincial safety inspectors and, somewhere down the line, senior corporate people arrive... all asking the same question.

At some point, a smart aleck will ask: "Why didn't you stop him?". At that point you have no answer and, in the numbness of your mind, you will be grieving over the same question. The reality is there is no way that you can stop someone from doing something so impulsively and smoothly and fluidly when you cannot even imagine they would do it.

You will be in therapy for months with guilt, shame and survivor syndrome coursing through your soul. As an electrical safety instructor, I have pondered many times how to prevent accidents like this. Were I to tell a group of electricians "Never reach inside a 5kV cabinet with your bare hands and touch any of the phases until you have established an electrically safe work condition", they would all look at me and think, "This is a good course for apprentices, but does not apply to me". Yet when a journeyman with 25 years of experience does exactly that, then it actually does apply to everyone.

In discussing accidents like this with psychologists, we have been told they happen because the victims do not think for a minute they could possibly be wrong. When we teach electricians, we drill into them that everyone is capable of mistaking a cabinet, making an impulsive movement and taking a shortcut around a procedure.

Your personal job is to make enough money to pay the bills, go home safe and sound every day, build a nest egg for a decent retirement and enjoy the journey of your life with your family, so adjust your performance to accomplish that.

> To work in a physical world and not make any mistakes is an incredible challenge. We must all recognize we are just one mistake away from the burn unit or the morgue.

Every time you go to a cabinet, pretend it is the wrong one and you will triple your precautions. Imagine it is actually going to blow up the moment you open the door, and you will ensure your PPE, body position, safe work practices are correct, and that you are carefully following your safe work procedures.

And, when you are faced with any conductor—whether it is a wire, terminal, bus bar, etc.—tell yourself every time "I bet this damn thing is still live!", and you will act differently... certainly not impulsively. To work in a physical world and not make any mistakes is an incredible challenge. We must all recognize we are just one mistake away from the burn unit or the morgue.

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.

PHOTOS FROM SHUTTERSTOCK

Attack of the Big Zapper!

The story of the 'Chain Gang' leader and millions in lost production

Patrick J. Lynch, P.Eng.

In this corner, wearing the red trunks, is... our client: a heavyweight class lawyer from one of the largest legal firms representing the electrical utility, which was embroiled in a heavy-duty legal fight with a multi-national, state-of-the-art manufacturing company that fabricated semi-conductor computer chips.

In the other corner, wearing the black trunks, is... the opposing lawyer, representing the fabrication plant and claiming its client had continuously lost millions of dollars of semi-conductor production due to bad power being supplied by the utility.

This was truly a mega-multi-million dollar lawsuit launched against the utility. As part of the initial mediation agreement, we were retained to perform a preliminary electrical engineering forensic investigation.

Problem description

These semi-conductor fabrication plants are extremely well-run and seem to control every part of the process. Lighting, heating, pressure, humidity levels, etc., are all precisely controlled within a 100% clean-room environment. All the workers enter through a clean-room filter chamber and wear white clean-room suits and face masks to prevent any foreign contamination from entering the semi-conductor manufacturing process.

The problem area appeared to be centred around one of the final processes, where hundreds of computer chips are manufactured simultaneously on a 12-in. diameter silicon wafer. One of the final processes is to cut off or 'dice' each individual computer chip from this wafer. A very sophisticated, fully automated, microscopic scanning machine is used to analyze the layout of all these computer chips on the wafer. Without damaging the adjacent chips, this dicing machine cuts off each chip from the wafer.

It appeared these dicing machines would randomly go wild (with scrambled machine computer operational code instructions) and directly cut through all of these chips and damaging the wafers. All this wafer production would then have to be scrapped. All machines were being randomly affected on all three shifts.

The usual first steps had already been implemented by this facility. The machine service techs were constantly called in to investigate and re-calibrate, if required. Each time they left the site reporting "No problem found" and machines working "A-OK". This vicious cycle had gone on for the last nine months and production damage was mounting. It would occur at all times of the day and night.

There appeared to be no correlation between any utility switching events, yet these production wafers continued to be damaged. Each production machine was supplied with its own conditioned pure power supply and heavy-duty grounding system. These machines, however, would continue to randomly fail one to two times per day.

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We had captured our first 'heart flutter'—we were ecstatic. After four days of nothing, we had finally received 100% correlation and confirmation of machine failure and power supply flutter.

Site investigative results

Directly outside this clean-room we installed high-speed (1 µs) powerline monitors on the main power system feeding this area to capture any electrical power system anomalies. The machines still continued to randomly fail with no significant power events captured.

We then used our high-frequency antennas and spectrum analyzers to capture any rogue RF transmissions that could possibly create computer operational havoc. Again, no events captured, but the machines still continued to fail.

Finally, we requested to bring in our own specialized diagnostic equipment into this clean-room environment to directly monitor for any electrical activity. Due to the possibility of product contamination, the clean-room managers insisted that all our equipment covers had to be removed, blown out and wiped down with alcohol wipes. This was a full one-day exercise. (If nothing else, our equipment could leave this site in a sterile condition!)

We got suited up in our clean-room garb and entered the room with our now-sterilized diagnostic test equipment. All the fab workers were extremely efficient, moving about back and forth knowing precisely what to do at each step of the fabrication process. I stepped back in amazement and watched them work: it was poetry in motion! Everything was perfectly quiet, except for the constant hum of the machines. There was no talking between these workers as they effortlessly performed their tasks.

It was time to get back to work. One of the first things a doctor checks for on an ailing patient is the condition of their heart. I connected our equipment's 'stethoscope' directly to the 5-volt 'heart' supply of the main microprocessor for the dicing machine. We found nothing. The heart appeared to be normal, yet we knew the heart of this machine randomly goes wild. I placed our equipment on high-speed voltage transient capture mode, pulled up a chair to wait and again casually watched each worker as they went about performing their designated work regime.

Then it happened!

Our equipment suddenly went into high-speed voltage transient capture mode. At this exact same time, one of the dicing machine workers stood up, cursed out loud, breaking the silence with his obscenities. The machine had failed once again! They had lost their production again. But, we had captured our first 'heart flutter'.

We were ecstatic. After four days of nothing, we had finally received 100% correlation and confirmation of machine failure and power supply flutter.

Does this patient now need to be rushed away for heart bypass surgery?

We quickly analyzed the results: a voltage spike of 25 volts peak-to-peak, 250-ns long had appeared on this 5-volt computer logic supply at the exact same time as the dicing machine failure.

We needed to answer the following questions:

- Is this a machine defect that requires a massive recall?
- Is the utility delivering electrical system disturbances to this equipment?
- Is it *something else?*

At about the same time as the failure, I had noticed one of the workers had just sat down at the dicing machine's keyboard after returning from another product station. I asked him to repeat that exact scenario.

He walked about 10 feet away from this failed machine to the product station, returned and sat back down at the keyboard. Our equipment immediately sprang to life and recorded another voltage transient (heart flutter) on the 5-volt power supply. I took out our ESD (electrostatic discharge) meter, then asked the same tech to walk back to the product station and return... and then I measured him.

He had generated over 40,000 volts of static electricity!

Even after standing still after 20 seconds, he still had 40,000 volts of electrical charge on him; it was not 'draining off' his body. I touched his arm, received the anticipated electrical jolt, and his charge instantly drained off of him through me. The other workers in this area were then measured as they walked about in their clean-room garb. The maximum electrostatic charge they generated was less than 3000 volts, which was quickly 'drained down' when they stopped moving for a couple of seconds.

There was definitely something unique about the 'Big Zapper'. We had him electrically discharge himself by tapping his metal ring against the metal corner of the dicing machine. Each time, a voltage spike appeared on the machine's 5-volt power supply and the machine's computer operational logic code became scrambled.

Apparently, the Big Zapper worked on rotating shifts and could be found working at any one of these dicing machines. This explained why failures occurred randomly on all dicing machine across all three shifts.

But the Big Zapper phenomenon needed to be explored further. With a little discreet probing, we found out he had a very serious foot alignment problem. His doctor had sent his foot impressions to France so that special shoes could be made for him. The shoe materials they had used in France employed a unique blend of extra-thick rubber materials in the shoe soles. The Big Zapper had become a perfect walking electrical insulator, generating huge amounts of electrostatic electricity within a critical clean-room environment.

The Big Zapper could be compared to these portable heart defibrillator machines that are used to restart a patient's heart but, in our case, the electric charges from Mr. Zapper were stopping the machine's heart!

As a temporary measure, we connected small metal chains around the Big Zapper's ankles that dragged along the floor and electrically discharged him.

In the end...

The patient was dying each time from electrical shock. This fab plant kept shooting themselves in the proverbial foot. Safeguards were implemented at this facility, and the Big Zapper now became known as the group leader of the Chain Gang at this plant. The final outcome? Problem solved, lawsuit dropped and production levels back up to 100%. EB

Patrick J. Lynch, P.Eng., has been the president of Power Line Systems Engineering Inc. since 1986. He graduated Electrical Engineering from the University of Waterloo in 1975, and has successfully directed Power Line's completion of over 1100 complex electrical engineering site disturbance investigations around the globe. Visit www.powerlinesystems.ca.

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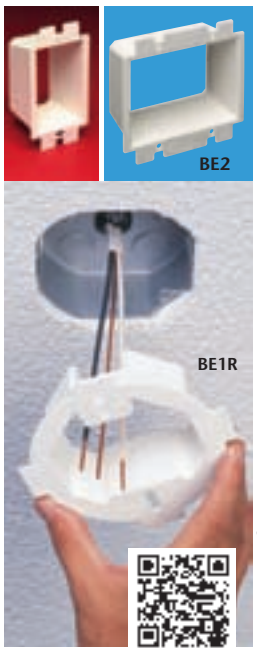

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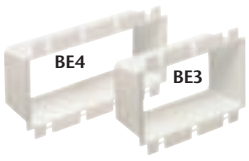

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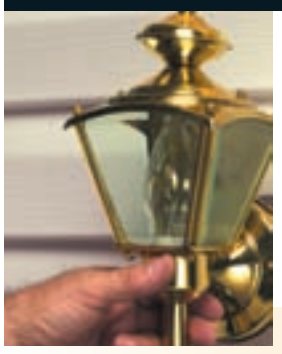

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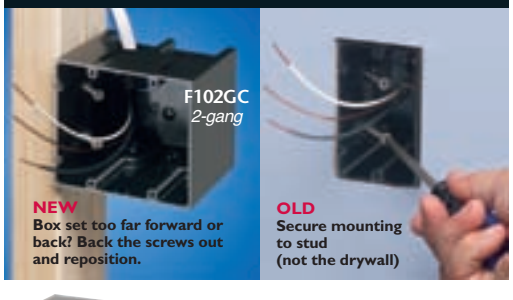

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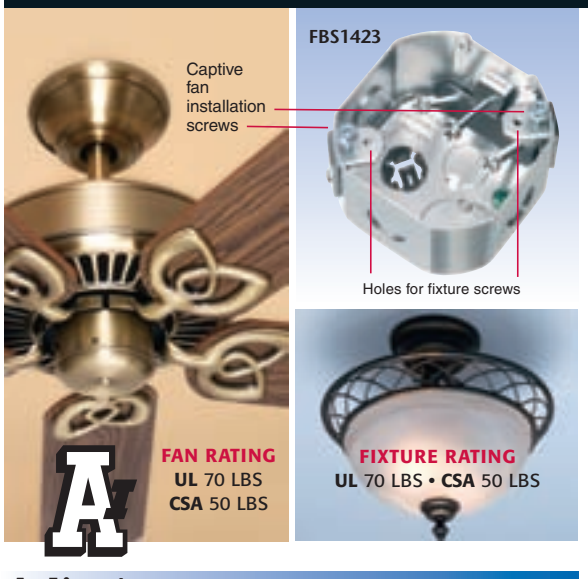

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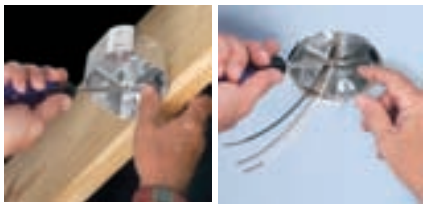

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YOU CANNOT ESCAPE TECHNOLOGY, SO TAKE ADVANTAGE OF IT!

Bob Johnson

Regulatory requirements governing fuel economy, emissions and safety have turned today's work trucks into rolling computers. At the same time, pressure to reduce operating costs has led manufacturers to add even more electronics to vehicles and truck equipment to improve operational efficiency. The net impact of these technological advancements is that fleet managers need to re-think every aspect of how they design, maintain and manage their fleets.

Embedded technology and beyond

Much of the technology to which fleet managers are exposed on a daily basis is embedded in the vehicles and equipment that they purchase.

This technology offers numerous opportunities to improve the way work trucks are designed and managed. For example, data that can be retrieved from vehicle powertrain control modules (PCMs) can be useful both in vehicle maintenance and in helping fleet managers design better, more efficient replacement vehicles.

By adding telematics to vehicles, fleet managers can get real-time or near-real-time information on how their trucks are performing, and can use that information to define individual vehicle drive cycles. The GPS tracking and *geo-fencing* features (a virtual perimeter for a real-world geographic area) associated with telematics systems can be used to improve the operational efficiency of a fleet and reduce fuel consumption—both of which directly help the bottom line. Telematics systems can also be

used to influence driver behaviour.

Other available technologies, both electronic and mechanical, may allow fleets to limit idling time, reduce rolling resistance, improve vehicle aerodynamics and reduce vehicle weight—all of which will improve a fleet's fuel economy and may reduce maintenance costs.

Vehicle upfitting

The productivity of a work truck is directly tied to the way it is designed and built. In many cases, truck equipment and component manufacturers now find it advantageous, if not necessary, to interface their products with the truck chassis. In the process, they can often provide features and capabilities that were prohibitively expensive, or even impossible, in the past.

Likewise, truck equipment upfitters are discovering that OEM components and system capabilities, which are often accessed through the vehicle's multiplex wiring system, can help them upfit a vehicle more efficiently. The knowledgeable fleet manager leverages these capabilities when specifying new work trucks to both reduce upfitting costs and improve vehicle productivity.

Most chassis manufacturers offer multiple upfitter component packages. One popular example is pre-installed switch packages in the dashboard that can be programmed to provide specific functionalities. This eliminates the need for the upfitter to work under the dash of a truck or to cut into the vehicle wiring system.

Remember that upfitter package availability and multiplexing capabilities vary between manufacturers, and from model to model. Fleet managers need to be knowledgeable of these variations and should evaluate the impact the variations may have on final upfitting costs.

In the maintenance shop

Technology makes it possible to track every replacement part that goes into a vehicle; a vehicle's mileage and/or number of operating hours accumulated between failures; vendor part numbers for replacement parts; and very accurate maintenance labour costs. This data gives fleet managers the ability to:

- Accurately track failures by vehicle make and model.
- Track failures by both application and operating environment.

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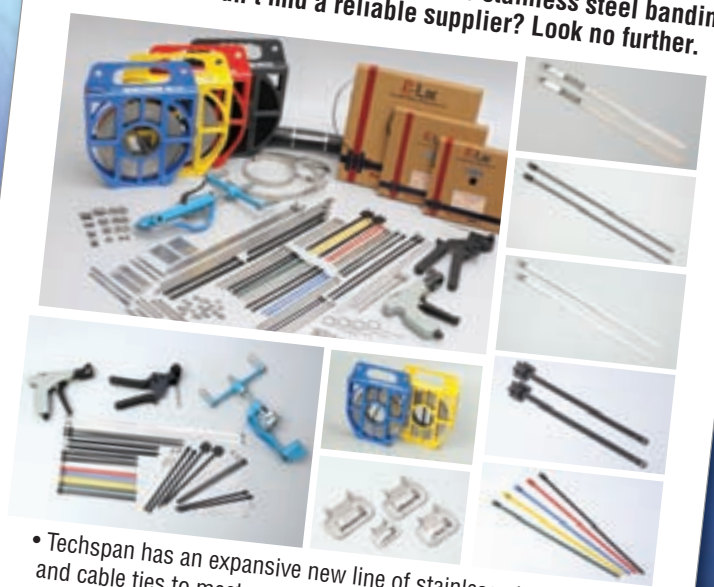

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This information can then be used to further optimize vehicle specifications and make better purchasing decisions for chassis, vehicle-mounted equipment and replacement parts.

Let's go even further

As a fleet manager, it's important to review your maintenance program every year. In the process, you will probably discover that you need significantly different maintenance schedules for vehicles based on their age. But again, computer technology can make it an easy task to generate multiple maintenance schedules based on individual vehicle requirements.

In the case of vehicles classified as 'commercial', government-mandated service intervals may become the controlling factor. The technology-driven improvements in equipment have led industries such as aviation and railroads to petition the government for adjustments in required maintenance and inspection schedules. There may be a similar movement in the commercial truck segment in the coming years as suppliers provide increasingly better equipment.

Be proactive

The technology to improve your fleet's operations is out there. Take the time to learn what is available, then determine how you can utilize it in your fleet. This means reading articles in trade magazines, attending trade events and talking to your peers. In many cases, you will have to sell your ideas to upper management, so be sure to do your homework before approaching them.

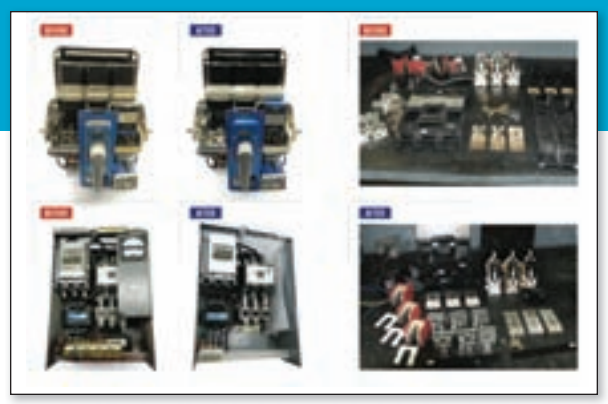
Keeping up with the latest technology developments and how they can improve your fleet operations is not easy. However, if you make the effort, you will likely discover that, in the long run, it will make your job easier, reduce your costs and improve your operational efficiency. All in all, that is not a bad return on your time. EB

Robert (Bob) Johnson is a former fleet manager and currently serves as director of fleet relations for the National truck Equipment Association (NTEA). He also regularly contributes to Electrical Business. Visit www.ntea.com.

Want to learn more?

The technology applications mentioned in this article and many others will be addressed in educational sessions at The Work Truck Show 2013, which runs March 6-8 in Indianapolis, Ind., or the associated Green Truck Summit, which kicks off March 5. For a complete Work Truck Show schedule, visit www.ntea.com. In addition to the educational sessions, more than 550 companies will exhibit the latest vocational trucks and technologies on the show floor.

BUSTING MYTHS about reconditioned electrical equipment



The world's largest corporations know it. Caterpillar knows it. The automotive industry knows it. And so does every major airline and global defence agency around the world. Extending the lifetime of capital equipment through reconditioning and remanufacturing saves time and money.

Know the difference between fact and fiction when it comes to how reconditioned electrical equipment can save you big bucks while helping your company meet environmental goals.

Reconditioning and remanufacturing require special knowledge on both sides of the transaction. This paper provides guidance about what to look for when shopping for reconditioned electrical equipment or reconditioning services. It tackles myths surrounding the billion-dollar electrical reconditioning industry, giving you the knowledge to make cost-effective decisions on how to keep the lights on and lines running with the least amount of downtime.

THE MYTHS:

- Reconditioned electrical equipment could be counterfeit.
- Reconditioned electrical equipment is not as safe as new.
- Reconditioned electrical equipment is less reliable and of lower quality than new.
- Reconditioned electrical equipment costs less to buy but more to operate.
- Reconditioned electrical equipment increases liability concerns.
- Only OEMs can properly recondition electrical equipment.
- Reconditioning electrical equipment invalidates the Underwriter Laboratories (UL) mark.
- Myths make for good business decisions.

Reconditioned product could be counterfeit product

Companies that make this argument, such as electrical original equipment manufacturers and their licensed distributors, lump reconditioned electrical equipment into the same 'grey market' category as surplus and counterfeit to scare potential customers into buying only OEM products. Their business reasons for making the argument are sound, even when their logic is not.

Reconditioned electrical product is limited to used, usually older, electrical components and systems; that is, equipment that is often no longer supported by OEMs. *Surplus* equipment refers to new, unused electrical equipment, often still in the original packaging materials. *Counterfeit* product is exclusively new-model equipment and generally limited to low-cost residential moulded case circuit breakers (MCCBs).

So while a customer might mistake a new-model counterfeit breaker with a surplus new-model breaker, a customer cannot mistake an older model reconditioned breaker with a new-model counterfeit breaker. And should a counterfeit breaker be brought to a certified electrical reconditioning shop, a standards-based reconditioning procedure would reveal its counterfeit origins.

Reconditioned product is not as safe as new electrical equipment

When you buy electrical equipment that is reconditioned to industry standards developed internally by the electrical OEMs or the electrical industry at large—such as Professional Electrical Apparatus Recyclers League (PEARL) reconditioning standards—you can be sure your reconditioned electrical equipment will work just as well as it did when it was brand new.

This is because both OEM reconditioning service centres and PEARL-certified companies use a multistep process that ensures the equipment performs to the original OEM specifications. Standards-based reconditioning processes follow the same general procedure:

- Conduct initial test
- Disassemble, inspect and clean
- Replace/recondition worn and aging components
- Reassemble
- Perform verification test
- Document
- Certify

In fact, the reconditioned equipment may be safer than the original because OEMs are only required to batch test their products, while reconditioning standards require 100% device testing. And when the reconditioning procedure includes a retrofit—such as converting a thermal magnetic breaker to a solid-state overcurrent protection system—the reconditioned device can be considerably safer than the original while allowing the customer to avoid the re-cabling, enclosure and downtime costs that go along with upgrading electrical service equipment.

Reconditioned product is less reliable and of lower quality than new

When a piece of electrical equipment was reliable and high quality when it was new, then older electrical equipment reconditioned to perform as good as—or better—than the original must also be considered reliable and of high quality. Quality isn't a question of new versus reconditioned but rather can you trust the source of the equipment?

When you're familiar with an OEM brand, you probably trust them to manufacture high-quality electrical equipment because it is in their business interests to do so and because they provide a warranty with new product that opens them to liability.

Trusted electrical reconditioners that belong to industry trade groups like PEARL also have a compelling business interest and warranties to support. In addition, certified PEARL members also publicly sign a code of best business practices that includes minimum levels of revenue, insurance, test equipment, calibration procedures and much more, as well as periodic site certification, complaint resolution procedures and penalties in the event of non-compliance.

Reconditioned products costs less to buy but more to operate

While a few types of electrical equipment such as high-efficiency electric motors and TP-1 transformers use less energy than their predecessors, the majority of electrical equipment does not reduce energy consumption. Most equipment used to supply electrical service is passive, meaning it does not consume electric energy to do its job.

Newer or upgraded equipment may consume electricity to enhance functionality, such as circuit breakers with solid-state trip technology or zone alarms. So, while this argument is

valid for a few types of electrical equipment, it is not relevant for the majority of the 21 types of standard electrical equipment covered by PEARL's reconditioning standards.

Regardless of whether the equipment is new or reconditioned, both types will require regular maintenance and field-testing by qualified individuals. In fact, training maintenance professionals in the proper care and maintenance of new equipment means new electrical equipment can cost more to purchase and to operate.

Reconditioned product increases liability concerns

Ask yourself: Does knowing that one out of the 100 circuit breakers that rolled off the line before yours was tested make you feel safer than knowing *your* circuit breaker was tested?

Electrical equipment reconditioned to industry standards are tested twice—before and after reconditioning—100% of the time. There is no better protection against liability than the testing built into industry-wide electrical reconditioning standards. Whether an OEM reconditioned the electrical equipment or a trusted source certified by an industry-wide association such as PEARL, customers can rest assured that their operations are protected to the highest level possible.

Only OEMs can properly recondition electrical equipment

OEMs that make this claim say that a company needs to understand the electrical engineering behind an electrical device to return it to its original operating condition, and this is why customers should only purchase reconditioned product or services from OEMs.

However, the main difference between private OEM reconditioning services versus public PEARL reconditioning standards is that PEARL uses independent, third-party electrical engineers to review its standards, while OEMs do not. Also, PEARL makes its standards available to the public for review and comment through an open and transparent process. OEMs do not.

Reconditioning electrical equipment invalidates the Underwriter Laboratories (UL) mark

According to official positions from UL, the independent testing and certification company takes no position on equipment and the validity of UL marks after the equipment leaves the factory. A UL mark states that a device was manufactured using UL-listed designs and manufacturing processes.

Myths make for good business decisions

By debunking myths and focusing on facts, customers can be sure to develop the most competitive solution for their electrical needs and purchase the highest-quality electrical equipment at the best possible price and with the least amount of lead-time. EB

Article submitted by the Professional Electrical Apparatus Recyclers League (PEARL), an organization of companies that supply surplus and remanufactured electrical equipment, apparatus and components. Visit www.pearl1.org.

Electrical Workers in B.C. are at risk due to relaxed standards

Electrical contractors are experts in the electrical services required in any construction project. The work they do every day has inherent safety risks, so it is critical that they are properly trained and certified.

In British Columbia, workers who are not Red Seal-certified electricians are allowed to perform electrical installations following an agreement between BC Safety Authority (BCSA) and Applied Science Technicians & Technologists of BC (ASTTBC).

The Electrical Contractors Association of BC (ECABC) has been in a long debate with BCSA about this matter, which signed an agreement with ASTTBC to certify restricted licences for electrical work in June 2011.

ECABC and its members have been very concerned with this initiative from the beginning and the effect it will have on both workers and public safety. The result of this agreement would have workers who are not Red Seal-certified electricians performing work on electrical installations under these restricted licences. This includes installations of 30 amps, 3-phase and up to 250 volts; it also includes work on critical life safety systems.

"These workers are at risk despite our efforts to improve regulations," says ECABC president Deborah Cahill. "This decision is unacceptable to us. And the recent accident in Ontario is evidence for what could happen in B.C."

On July 24, 2012, ThyssenKrupp Industrial Services Canada Inc. was convicted in court of violating Ontario's Electricity Act by hiring an unlicensed individual to do electrical work. The individual suffered serious arc flash injuries while attempting to remove conductors from an electrical panel. A fine of $70,000 was imposed, which included $50,000 to Electrical Safety Authority (ESA) to be used for electrical safety education.

An arc flash occurs when electrical current moves through the air creating a fiery explosion. A worker will be engulfed in a ball of flame in a split second, and is also typically struck by molten metal shrapnel from exploding electrical equipment.

"Obviously, this could have been avoided, saving a devastating injury," comments Cahill. "Ignoring regulations is one thing; however, putting workers at risk is the main issue here. I hope the BC Safety Authority is paying attention to what can happen when unqualified, unlicensed electrical workers attempt to go beyond their training and expertise."

Bill Strain, president of Villa Electric (1980) Ltd. says the decision puts the responsibility of approving electrical installations under the jurisdiction of field service representatives.

"FSRs work for contractors throughout the province. With less than 10% of all inspections done by BCSA safety officers, who is going to be verifying that installations completed by restricted licence-holders are safe and meet the standards of the Canadian Electrical Code?"

Strain adds: "This was supposed to come into effect over a year ago until the stakeholders—who were not consulted in the process—pointed out there was no process in place to verify and certify the restricted licence-holder. It was only then that the implementation was pulled off the table and that, to this day, we have not seen any documentation that lays out the training, verification and certification of these restricted licence-holders".

"This agreement between the BCSA and the ASTTBC should be suspended until such time as our concerns are acknowledged and addressed," Cahill concludes. "We have attended numerous meetings with representatives from both BCSA and ASTTBC to put forward our viewpoint. In most of these meetings it was apparent that the outcome had been predetermined and our concerns were not being considered. One of the most disconcerting aspects of this issue is that the agreement was signed without a verified training and certification process being in place. Without these measures there is considerable risk. The Ontario incident proves our argument." EB

Article submitted by the Electrical Contractors Association of British Columbia (www.eca.bc.ca). For more information, contact Deborah Cahill, ECABC president, at dcahill@eca.bc.ca or (604) 294-4123.

Line-line fault analysis and protection in PV ARRAYS

Ye Zhao and Robert Lyons Jr.

Line-line fault and its protection in solar photovoltaic (PV) arrays are discussed in this paper. Depending on fault locations, the magnitude of line-line faults in PV arrays could be high enough to damage PV modules and conductors. To better understand the fault scenarios, an example of typical line-line faults in PV arrays is introduced, followed by PV current flow explanation and current versus voltage (I-V) characteristics analysis.

To protect PV arrays from overcurrent damages, Article 690.9 of the U.S. National Electrical Code (NEC) requires overcurrent protection devices (OCPD) in PV arrays. Fuses are often utilized as OCPDs in series with PV modules. The NEC passages related to fuses in PV arrays are given in this paper. Finally, this paper will briefly explain how to choose the right size of fuses and fuse protection characteristics.

A line-line fault is an accidental low-resistance connection established between two points of different potential in an electric network or system. In PV systems, a line-line fault is usually defined as a short-circuit fault among PV modules or array cables with different potential. In this paper, it is assumed that line-line faults do not involve any ground points. Otherwise, a line-line fault with any ground points can be categorized as a ground fault.

Line-line faults in PV arrays may be caused by the following reasons:

- Insulation failure of cables e.g. an animal chewing through cable insulation.
- Incidental short circuit between current-carrying conductors e.g. a nail driven through unprotected wirings.
- Line-line faults within the DC junction box, caused by mechanical damage, water ingress or corrosion.

Typical PV systems and code requirements related to fuses

A typical grid-connected PV system is schematically shown in Figure 1. It mainly consists of a PV array, a grid-connected inverter, connection wirings and protection devices, such as overcurrent protection fuses and GFPDs. The PV array shown in Figure 1 has n parallel PV strings, and each string has m modules in series.

Grounding

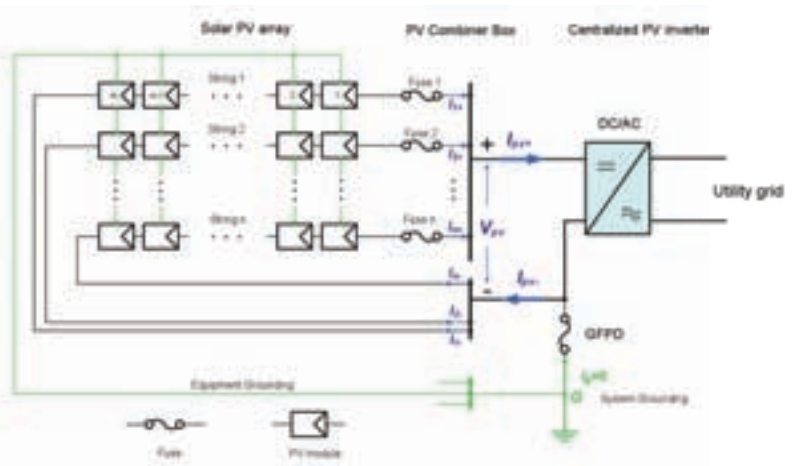
In the requirement of the NEC Article 690.41 and 690.43, there are two types of groundings in PV arrays. The first one is system grounding: the PV system with system voltage over 50 volts should be solidly system-grounded. To achieve that, the negative conductor usually is grounded via the GFPD in the PV inverter at point G (Figure 1). The other one is the equipment grounding: the exposed non-current-carrying metal parts of PV module frames, electrical equipment and conductor enclosures should be grounded.

Normal operating condition

When the PV array is working under normal conditions, each PV string is generating current. The current flowing out of the ith string is I_{i+}, where $i = 1 \ldots n$. When PV strings are all electrically identical and have the same environmental working condition, then $I_{1+} = I_{2+} = \ldots = I_{n+}$. The total current flowing out of the array is $I_{pv+} = I_{1+} + I_{2+} + \ldots + I_{n+}$.

Similarly, the current coming back to each string is $I_{1-}, I_{2-}, \ldots I_{n-}$. Thus, the total current coming back to the array is I_{pv-} which should be equal to I_{pv+}. Since no external ground point is involved,

FIGURE 1
Schematic diagram of a typical grid-connected PV system under normal conditions.



the current flowing through the GFPD (I_g) should be zero. Notice the PV array is supplying power while the PV inverter absorbs the power and feeds it into the utility grid.

Kirchhoff's Current Law (KCL) requires that at any node (or junction) in an electrical circuit, the sum of currents flowing into that node is equal to the sum of currents flowing out of that node, where a node is any spot where two or more wires are joined. From this point of view, a ground-fault point, positive/negative bus bar—or even the inverter—can be viewed as a node (or junction) in PV systems. Therefore, the current relationships of the normally operating PV array are summarized in the following equations:

- At the positive busbar
  $I_{pv+} = I_{1+} + I_{2+} + \ldots + I_{n+}$
- At the negative busbar
  $I_{pv-} = I_{1-} + I_{2-} + \ldots + I_{n-}$
- At the system grounding point (G)
  $I_g = I_{pv-} - I_{pv+} = 0$
- At the inverter
  $I_{pv+} = I_{pv-}$

Overcurrent protection devices: fuses

In the grounded PV system, where the PV negative conductor is grounded, a single OCPD at every PV string is enough to give overcurrent protection, since the OCPD will always be in the fault path. In the ungrounded PV system, however, where both PV positive and negative conductors are not grounded, two OCPDs should be put on the top and bottom of each PV string. Therefore, in the case of faults, at least one OCPD will be in the fault path.

According to the NEC Article 690.8, the maximum current for a specific circuit in PV arrays shall be the sum of parallel module rated short-circuit current (I_{sc}) multiplied by 125%. In the PV system in Figure 1, the maximum current of each PV string shall be $1.25I_{sc}$. Also, NEC requires that overcurrent devices shall be rated no less than 125% of the maximum current ($1.25I_{sc}$). Consequently, by multiplying two factors together, the resulting rating of OCPDs should be no less than $1.56I_{sc}$ of PV modules.

Line-line fault analysis in PV arrays

As shown in Figure 2, a line-line fault occurs in the PV array, which may have resulted from a short circuit between the points *F1* at String 1 and *F2* at String 2. Therefore, the fault will cause electrical imbalance in the PV array, resulting in overcurrent into the faulted string. The fault current flowing into the faulted string is usually called backfed current (I_{back}, or reverse current), which is in the opposite direction of normal string current I_{1+}.

Generally speaking, every module, string and entire array—whether in normal or fault condition—has its own I-V characteristics and unique maximum power point (MPP). When PV modules are connected together, their performance is determined by the interactions among them. For this reason, PV modules perform together like a chain that is only as strong as the weakest link, which is the most faulted string in the fault scenarios.

In our analysis, it is considered that the PV array is the only source of fault current. In other words,

FIGURE 2
Schematic diagram of the PV system under a line-line fault.

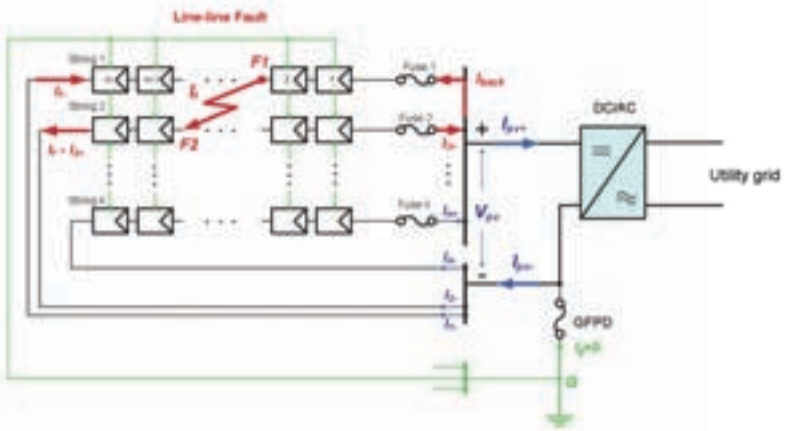


FIGURE 3
I-V characteristics of the PV array during a line-line fault.

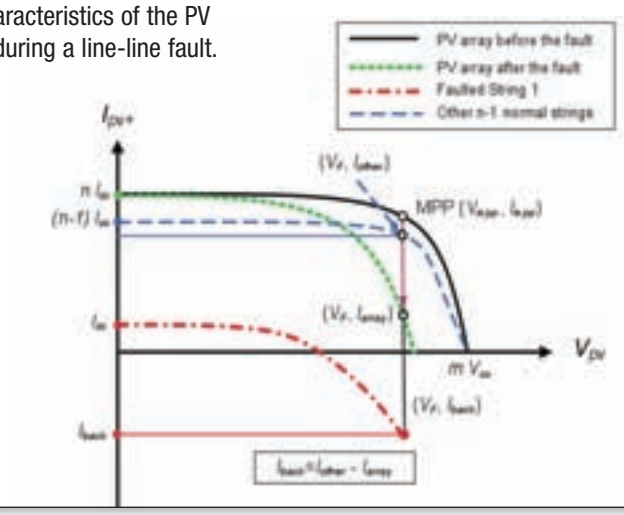


FIGURE 4
I-V characteristics of the PV array during the worst case of a line-line fault.

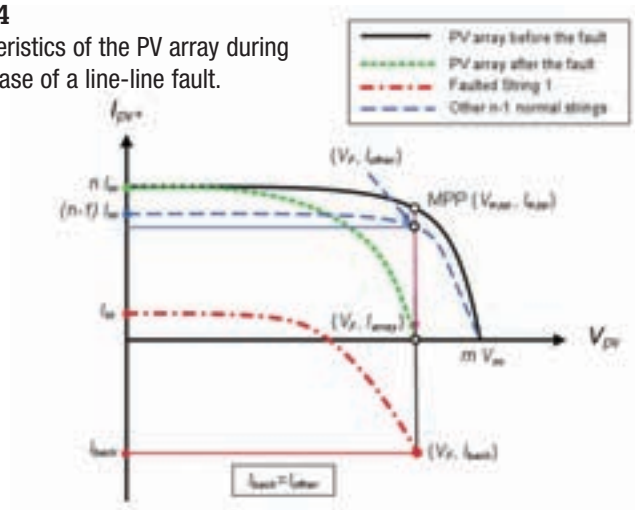


FIGURE 5
Schematic diagram of the PV system after the line-line fault is cleared.

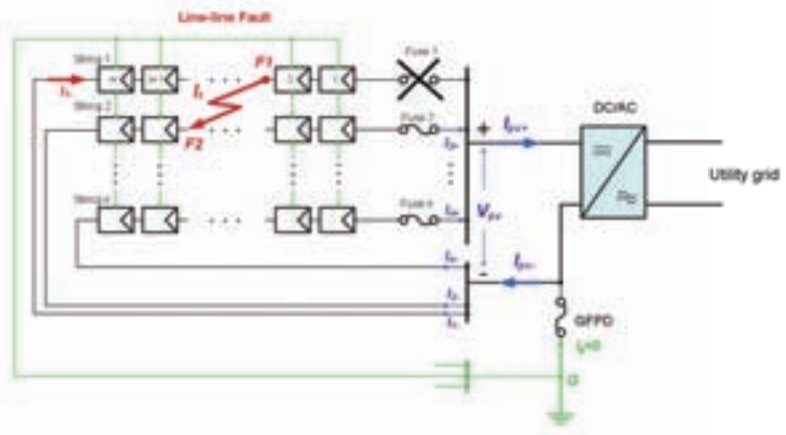
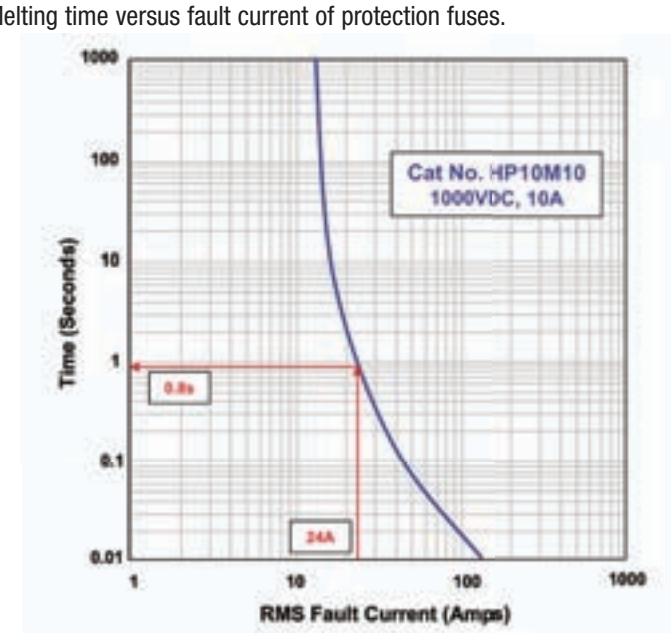


FIGURE 6
Melting time versus fault current of protection fuses.



there is no overcurrent or overvoltage from any utility inverter, battery, lightning strikes or external sources. The reason is that most PV inverters are transformer-based that can provide galvanic isolation between the PV array and the utility grid. Also, the fault impedance is assumed to be zero.

Fault current flows

After the line-line fault, the configuration of the PV array in Figure 2 has been accordingly changed. Specifically, the *(m-2)* modules below *F1* at String 1 (from Module 3 to Module *m*) become parallel with the 2 modules below *F1* at String 2 (Module *m-1* and Module *m*). Yet modules above *F1* and *F2* at String 1 and String 2, respectively, are in parallel. It would be easier to understand if you imagine that *(m-2)* modules below *F1* at String 1 are sharing the same voltage as 2 modules below *F2* at String 2. As a result, the voltage of *m-2* modules at String 1 is pulled down to around the 2X the open-circuit voltage of PV modules (V_{oc}).

Therefore, String 1 is significantly mismatched with other strings and the PV array's voltage might be even larger than the open-circuit voltage of faulted String 1. Instead of supplying power, String 1 may be forced to work as a load at the 4th quadrant in its I-V characteristics (see Figure 3). Note the I_{back}.

I-V characteristics analysis of line-line faults

The I-V characteristics in Figure 3 can be used for current flow analysis, where V_{oc} is the open-circuit voltage of one PV module. Before the fault, the whole PV array is working at MPP (V_{mpp}, I_{mpp}). After the fault, the array's operating point drops vertically to (V_F, I_{array}), where VF could be still equal to V_{mpp}. The other *n-1* normal strings will work at (V_F, I_{other}). The faulted String 1 will work at (V_F, I_{back}) in its 4th quadrant of I-V characteristics as a load.

According to KCL, the current relationships of the line-line fault in PV array are summarized as:

At the positive busbar
$I_{pv+} = -I_{back} + I_{2+} + \ldots + I_{n+}$

At the negative busbar
$I_{pv-} = I_{1-} + I_{2-} + \ldots + I_{n-}$

In the PV array
$I_{pv+} = I_{pv-}$

At the line-line fault point F1
$I_f = I_{back} + I_{1-}$

At the line-line fault point F2
$I_{2+} = I_f + I_{2-}$

The worst-case scenario of line-line faults

The worst case for a line-line fault is that the total current of the PV array is zero ($I_{pv+} = 0$) and all the normal strings are backfeeding current into String 1. The backfed current into String 1 can be simply written as $I_{back} = I_{other}$. The fault scenario could be explained with the help of I-V characteristics analysis in Figure 4. At the moment of the fault, the PV array is working at voltage V_F with $I_{pv+} = 0$, which means the array becomes open-circuit and there is no current feeding into the PV inverter. The currents of other strings have no path and backfeed into String 1.

Notice that, in Figure 4, I_{other} is close to, but smaller than, $(n\text{-}1)\ I_{sc}$. As a rule of thumb, people usually approximate I_{back} as $(n\text{-}1)\ I_{sc}$ in the worst case.

Overcurrent protection devices: fuses

Fuses are commonly used as overcurrent protection devices (OCPD) in PV arrays. According to NEC Article 690.8, the fuses are rated no less than $1.56I_{sc}$. In our case, for example, there are 5 parallel strings in the PV array *(n=5)*. The short-circuit current of PV modules is 6A (I_{sc} = 6A). When carrying out the equation (1.56 x 6 = 9), it is determined that a 9A fuse is preferred. NEC Article 240.4(B) states that the next-higher standard overcurrent device rating shall be permitted to be used; therefore, when 9A fuses are not readily available, the series fuses should be rated at 10A. In the worst case of line-line fault, we can simply assume that the backfed current (I_{back}) is approximately 24A.

According to the melting time versus current diagram in Figure 6, the 10A fuse may take less than 0.8 s to clear the maximum line-line fault (24A). Then, the fault path is detected by the fuse and the fault is interrupted.

As show in Figure 5, after Fuse 1 at String 1 is melted, there is no I_{back} any longer. However, the fault path between *F1* and *F2* still exists in the PV array. The rest of String 1 is flowing current I_{1-} into *F1*, where $I_f = I_{1-}$. For that reason, the fault current I_f is not completely cleared, even though I_f is greatly reduced by the fuse.

In summary, the current equations after the fault clearance can be expressed as:

- At the positive busbar
  $I_{pv+} = I_{2+} + \ldots + I_{n+}$
- At the negative busbar
  $I_{pv-} = I_{1-} + I_{2-} + \ldots + I_{n-}$
- At the line-line fault point F1
  $I_f = I_{1-}$
- At the line-line fault point F2
  $I_{2+} = I_f + I_{2-}$

In practice, blown fuse indication can be used in PV arrays to indicate the fault occurrence. Its light indication may tell the maintenance people at which string the fault has occurred. Therefore, the blown fuse indication can further reduce the fire hazards and other safety issues in PV arrays.

Summary

For all applications abiding by the National Electric Code it is required that overcurrent protection be installed in PV source circuits, PV output circuits, inverter output circuits and storage battery conductors.

Improperly detected and interrupted line-line faults can present the risk of fire hazards and/or decreased efficiencies in solar PV arrays. Excess current flow, including reverse current from adjacent strings to faulted strings can overload conductors and/or connectors leading to overheating and risk of fire. Faulted strings can also negatively impact maximum power point tracking, ultimately affecting the efficiency and power output of the PV array. EB

Ye Zhao is an electrical engineer, and Robert Lyons Jr. is a product manager with Mersen. This article is based on the white paper "Line-line Fault Analysis and Protection in PV Arrays". Visit ep-ca.mersen.com.

Standard Products debuts Generation 2 LED reflector lamps

Standard Products has released its Generation 2 LED reflector lamps with "increased luminosity, exceptional colour consistency and crisp light", it says. The dimmable lamps are available in GU10, PAR20, PAR30LN and PAR38 shapes in 6.5W, 7W, 15W and 20W respectively. According to Standard Products, users can expect professional grade optics, and reduced maintenance and energy costs. THe lamps are Energy Star approved and suitable for use in damp locations.
STANDARD PRODUCTS
www.standardpro.com

New Universal Lighting Everline LED drivers for outdoor and high bay applications

The new family of Everline light lumen LED drivers from Universal Lighting Technologies claims to offer users significant energy savings opportunities and advanced control technologies for outdoor and high bay applications. The drivers boast 0-10V dimming capabilities for precise lighting control down to 10% power in any application with standard controls. With universal voltage (120-277V) and 347-480V inputs, the Everline drivers are UL Dry & Damp Location rated for outdoor applications.
UNIVERSAL LIGHTING TECHNOLOGIES
www.unvlt.com

Lithonia Lighting unveils Shiver LED fixture

Acuity Brands has introduced the Shiver LED luminaire from Lithonia Lighting, a refrigeration and display case lighting system for use in environments ranging from -30ºC to 30ºC. Equipped with Acuity's AccuDrive technology, the fixture uses a single-driver system to operate all fixtures in a 2- to 6-door case, claiming to reduce installation and maintenance costs with fewer components to mount or wire. Sensor options include high/low dimming down to 25%, or on/off for a total solid-state solution.
LITHONIA LIGHTING
www.lithonia.com

Hubbell Lighting adds TRPC, RDIC and LMC-30 to wall sconce portfolio

Hubbell Outdoor Lighting has added three new LED products to its wall sconce offering: Trapezoid (TRPC) and Radius (RDIC) shape to the Architectural Sconce Geometric series and the LMC-30 to the Laredo Southwest series. Both the TRPC and RDIC are 23W LED sconces, housed in wet-listed, die-cast aluminum housing. The LMC-30 is suitable for mounting heights of 15' to 18', delivering over 2700 lumens.
HUBBELL LIGHTING
www.hubbelloutdoor.com

New Leviton Renoir II wall box dimmers and fan speed controls

Leviton has expanded its line of architectural wall box dimmers and fan speed controls with the Renoir II family of multi-voltage 120-277 VAC, 60Hz rated box-mounted lighting controls. Designed to support a variety of load types and configurations, Renoir II is suitable for multi-location dimming environments requiring up to five-way control operation. The line's three models include preset slides with either a thin or standard heat sink, or a rotary control with standard heat sink.
LEVITON
www.leviton.com

Halco Lighting develops programmed start T8 ballasts

Halco Lighting Technologies has introduced its ProLume High Performance programmed start T8 ballasts, claiming to help maximize lamp life, facilitate maintenance and decrease energy costs. Designed for use in buildings with occupancy or daylight sensors and in applications with frequent on/off switching, the T8 ballasts operate in parallel mode, so that when one lamp in a fixture fails, the remaining lamps continue operating. Low ballast factor models EP232PS/L/MV/HE and EP432PS/L/MV/HE can provide an additional 13-15% energy savings, says Halco. The ballasts are NEMA Premium designated and CEE listed.
HALCO LIGHTING TECHNOLOGIES
www.halcolighting.com

Cree introduces CS series LED linear luminaries

Cree has released its CS series LED linear luminaries for low bay lighting applications, claiming to use 40%-50% less energy than comparable linear fluorescents and deliver an unmatched performance combination of up to 120 lumens per watt, 90 CRI and 75,000 hour lifetime. The CS series comes standard with 0-10V dimming control to 5%. The luminaire design integrates an upward-facing LED light strip with Cree TrueWhite Technology and an upper reflector, featuring all-new Cree MicroMixing Optics for optic control.
CREE
www.cree.com

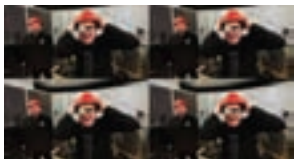
Lind Equipment publishes 2012-13 catalogue

Lind Equipment's new 2012-13 catalogue boasts dozen of new SKUs and growth in the depth of historical lines. It is now available for download from the Lind Equipment site or in paper format. This latest edition features several new Lind products, including the LE970LED 50W LED portable floodlight, and Lind's cord reel offering now with heavy-duty and weatherproof cord reels with up to 12 conductors and 80' of cord.
LIND EQUIPMENT
www.lindequipment.net

Fluke CNX Wireless System 3000-series

Fluke has introduced the CNX Wireless System, the set of test tools claiming to simplify troubleshooting by enabling up to 10 simultaneous electrical and temperature wireless measurements. At the core of the system is a CAT III 1000V /CAT IV 600V multimeter with a screen that displays its readings along with live readings from up to three other measurement modules. The modules can log up to 65,000 sets of data, which can be saved to a computer in .csv format.
FLUKE
www.flukecanada.ca

Southwire and Devo encourage electrical contractors to "Rip It"



Southwire Company and Devo, a 1980s punk/new wave band, are encouraging electrical contractors to "Rip It" with their remake of the classic hit song, "Whip It". The collaboration promotes Southwire's SimPull Rip Chip disc, a system claiming to save time, while eliminating the need to use a knife to remove the stretch wrap placed around wire reels to keep them clean, dry and secure during shipping. The company lined up original Devo band members Mark Mothersbaugh and Gerald Casale to record the video in Los Angeles earlier this year, while a number of electrical contractors have starring roles. Watch the video here: http://bit.ly/T6bsbF.
SOUTHWIRE
www.southwire.com

Eaton debuts bi-directional solar disconnect switches

Eaton has introduced its new bi-directional disconnect switches, claiming to provide control and protection for normal and reverse current faults. The new disconnect switches boast of enhancing operator safety, extending equipment life and reducing installation costs in both grounded and ungrounded systems. The UL-certified switches are available at 30A, 60A and 100A and have either 600V DC or 1000V DC configurations.
EATON
www.eaton.com

GE Evolution switchboards with I-ZSI and RELT

GE says its Evolution Series switchboard, officially unveiled at NECA 2012, accommodates "the latest technology for people and property protection", such as Instantaneous Zone Selective Interlocking (I-ZSI) and Reduced Energy Let Through (RELT). I-ZSI simultaneously provides arc fault protection and instantaneous selectivity, which GE claims is an industry first. Meantime, RELT Instantaneous trip allows a circuit breaker to be temporarily set to a more sensitive pickup to provide better protection during installation and maintenance, promising an added margin of safety for personnel. The design of the front neutral space in the series provides the clearance to accommodate additional breakers in a more efficient footprint, says the company, adding that the Evolution Series provides expanded coverage for nearly every switchboard application: 6000A rating, 667A/si. bus density, and 4000A 100% rated stationary.
GE
www.geindustrial.com

Wheatland Tube debuts FasTrak Plus with Plus ID coating

EBMag was there when Wheatland Tube, a division of JMC Steel Group, debuted its FasTrak Plus—electrical metallic tubing (EMT) with a new interior diameter (ID) coating at NECA 2012. The new Plus ID coating claims to deliver excellent slip properties, while making wire pulling on small size EMT (1/2"–1") up to 20% faster and pushing conductor easier. The coating comes standard on all Wheatland EMT from ½"–4", including Color Check and 20' EMT.
WHEATLAND TUBE
www.wheatland.com

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Kris Paszkowiak, P.Eng.

EV charging systems and the code

The old reliable internal combustion engine is being supplemented (and may even be supplanted) by electric drive motors that provide the driving force in electric vehicles (EVs). There are many different models of electric vehicles, such as fuel-cell-powered or plug-in hybrid, etc. The move to EVs is driven by the ever-increasing cost of gasoline and the associated negative impacts on the environment of car engine emissions.

But before the EV is driven off the dealer's lot, consideration needs to be given as to how the vehicle will be maintained in operating condition. One concept includes an onboard rechargeable electricity storage system using batteries. This system requires a connection to a receptacle for the purpose of charging the batteries at regular intervals. These EVs need to be plug in to charge the batteries whether at home or on the road. The Canadian Electrical Code (CEC) Section 86 contains rules for the installation of electrical conductors and equipment (EVSE) that connect an electric vehicle to a source of electric current by conductive or inductive means to accomplish the necessary charging.

The electric vehicle batteries are charged through an electric vehicle inlet connector. Rule 86-100 defines the special terminology used, such as the definitions for electric vehicle, charging equipment (EVSE), EV connector and inlet. Rule 86-104 limits the alternating current system voltage used to supply charging equipment to 750 volts maximum.

Rule 86-306 requires each receptacle used for the purpose of EV charging to be labelled in a permanent manner identifying it as an EV charging receptacle. Also, the receptacle must be a single receptacle of CSA configuration 5-20R supplied from a 125V branch circuit rated not less than 20A and be protected with a ground fault circuit interrupter (GFCI) of the Class A type when the receptacle is installed outdoors and within 2.5 metres of finished grade. This voltage and amperage level is generally available in residential homes and commercial buildings.

Rule 86-300 requires EVSE to be supplied by a separate branch circuit that supplies no other loads. The only exception to the rule is that the circuit can be used to connect the ventilation equipment intended for use with EVSE.

Rule 86-302 requires the total connected load of a branch circuit supplying EVSE and the ventilation equipment to be considered continuous for the purposes of Rule 8-104. Therefore, the maximum continuous load on this circuit cannot exceed 16 amperes.

Rule 86-306(1)(b) presents another acceptable option of using a receptacle of the appropriate CSA configuration in accordance with Diagram 1 or 2 when supplied from a branch circuit rated at more than 125V or more than 20A: for example, a non-locking type receptacle of CSA configuration 6-30R or a locking type receptacle L6-30R. These receptacles would allow for higher voltages and currents that would be beneficial because they provide much faster battery charge restoration and, thus, quicker vehicle availability.

Rule 86-400 (2) requires adequate ventilation to be provided in each indoor charging site as specified in Rule 26-546. The EVSE must be electrically interlocked with the ventilation equipment so that the latter operates with the EVSE and, should the supply to the ventilation equipment be interrupted, then the EVSE must also be made inoperable. EB

Kris Paszkowiak is principal of CodeSafety Associates, a consulting firm serving the needs of the electrical industry. He holds a Master Electrician licence and has served numerous organizations over the years, including the Canadian Advisory Council on Electrical Safety, Committee on CE Code Part I and UL Electrical Council. E-mail CodeSafety Associates at kris.paszkowiak@codesafety.ca.

Questions and answers compiled by the Electrical Safety Authority | VISIT WWW.ESASAFE.COM

Tackle The Code Conundrum... if you dare!

Answers to this month's questions in December'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

Type FCC systems shall not be used for branch circuits exceeding:

a) 20A **c)** 30A
b) 25A **d)** 40A

Question 2

Unless the ground fault circuit interrupter is an integral part of an approved factory-built hydromassage bathtub, or located behind a barrier, it shall be installed not closer than:

a) 0.5m **c)** 1.5m
b) 1.0m **d)** 3.0m

Question 3

Connections to portable motors shall be permitted with flexible cord of a serviceability not less than that of Type S cord.

a) True
b) False

Answers: EBMag October 2012

Q-1: Areas where adequate ventilation is provided and paint finishes are regularly applied by spraying, the interior of spray booths and their exhaust ducts are considered:

a) Class I, zone 1. Ref. Rule 20-402(1).

Q-2: Receptacles required for maintenance of rooftop HVAC equipment shall be supplied by a branch circuit that does not supply any other outlets or equipment:

a) True. Ref. Rule 26-704.

Q-3: What is the maximum continuous load permitted on a service switch if marked for continuous operation at 100% and is supplied by multi-conductor cable?

a) 100%. Ref. Rule 8-104(4).

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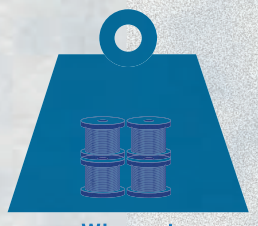

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