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What electricity-saving failure have you seen?

These days, everyone is under pressure to reduce electricity consumption, buy and install energy-efficient products and systems, monitor and measure those solutions, make adjustments to save even more electricity, etc., and while current technology is certainly up to the challenge, can we say the same for the people it is supposed to benefit?

A few years ago, researchers compared the energy-saving promises of LED lighting against what was happening in the real world. What they discovered was that, with the significant energy savings delivered by LED lighting, end users were turning on more lights than necessary (more than they did with their previous lighting scheme), and keeping those lights on longer.

In short, any energy efficiency benefit that could have been realized with the LED lighting was quickly murdered by human misbehaviour.

Here's a story I heard at a conference several years ago that may be true, may be urban legend: an elderly woman complained to her utility and the inspection authority about her exorbitant electricity bill. She was convinced there was something wrong with the grid, or that maybe her power was being stolen. It was impossible, she argued, for her to rack up a bill that high!

After numerous investigations and site visits, the guy telling the story noticed something in the elderly

woman's home that no one else had noticed up to that point. The woman was leaving her fridge door open. When he pointed this out to the woman, she explained she did not have air-conditioning, and leaving the fridge wide open helped her stay cool during the summer.

And I'll bet her fridge was Energy Star-rated. BC Hydro recently ran a "Distaste for waste" tournament, asking people to vote on what they considered to be a ridiculously wasteful act. Contestants included things like leaving on the television for pets, leaving on the lights in an unused room, etc.

And so, inspired by these accounts, I ask you to share with us your own story/stories of the dumbest, most wasteful electrical-related situations you have seen... either during the course of your work, or on the home front. It's your choice to remain anonymous or not. If we get enough stories, we'll publish them together as a special article (and the most interesting submissions may even earn you some swag). But keep them manageable... just a couple hundred words, tops.

(And just to mix things up a bit, feel free to share your account of an electricity-saving measure that is actually used properly by its end users more often than not, and delivers on its energy-saving promise.) **EB**

Anthony Caplan

I ask you to share with us your own story of the dumbest, most wasteful electrical-related situations you have seen

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16 Maintaining battery systems for backup power reliability

Standby battery backup systems play a critical role in keeping essential operations functional in the event of a utility outage, and most employ an uninterruptible power supply and a string of batteries. And while most batteries used in today's UPS systems are 'maintenance-free', they are nonetheless susceptible to deterioration from corrosion, internal shorts, sulphation, dry-out and seal failure.



20 Swanky interior lighting solutions from all angles

In the latest instalment in our ongoing series "House of Unlimited Budget", we continue to explore electrical technologies, products and systems for the discerning homeowner... where cost is not an issue! This month, we hope you're dazzled with the latest in interior lighting, including modern chandeliers, nostalgic bulbs, classy LEDs and sleek, hidden recessed options.



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STOCK PHOTO

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Strategies for a safe, cost-effective protective apparel program

You have a duty to keep your employees safe and to ensure any personal protective equipment—including flame-resistant clothing—is maintained properly. But the multiple types of FR garments available—not to mention the different brands and sourcing programs—can leave you feeling overwhelmed and exhausted.



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PowerStream signs with Korean utility for smart grid projects



PHOTO COURTESY POWERSTREAM.

PowerStream (www.powerstream.ca) and Korea Electric Power Corp. (KEPCO, cyber.kepco.co.kr) have signed a Memorandum of Agreement (MOA) that outlines four project initiatives the two energy companies will undertake over the next three to five years. These projects will further the development of smart distribution and micro grid networks in the North American marketplace, according to PowerStream.

The agreement was developed nearly a year after the organizations had established an initial MOU to work collaboratively in the areas of micro grid and smart grid technologies, Powerstream noted. The goal is to develop a large-scale application that would serve as a model for further advancement of these technologies in world-wide electricity distribution systems, the company added.

Canaplus merger leads to AD Canada Plumbing & Heating



Where market leaders grow

Affiliated Distributors (AD, www.adhq.com)—a \$31-billion contractor and industrial products wholesale buying/marketing group—announced the establishment of AD Canada Plumbing & Heating through a merger with Canaplus Limited Partnership (www.canaplus.com), a buying group in Canada for independent Canadian wholesale distributors of plumbing and heating supplies, and related products.

(Just a few years ago, AD merged with the Canadian electrical buying group Independent Electrical Distributors [IED] Limited Partnership II.)

Beginning January 1, 2016, the 23 current members of Canaplus will become the founding members of AD's newest division: AD Canada Plumbing & Heating. These members operate more than 250 branches across Canada.

Pan-Canadian Task Force to reduce diesel use in remote communities

The governments of Manitoba, Quebec, Newfoundland and Labrador, the Northwest Territories, Yukon, and Ontario are establishing a Pan-Canadian Task Force to reduce the use of diesel fuel to generate electricity in remote communities.

This agreement comes on the heels of the Council of the Federation's announcement of the Canadian Energy Strategy, which identified energy in off-grid communities as a priority.

Reducing or eliminating diesel use in these areas would reduce harmful emissions, strengthen local economies, and create well-paying jobs, the strategy noted.

A joint report will be prepared that outlines approaches currently being used or considered for eliminating the use of diesel, including grid connection or alternative energy solutions. It will also look at opportunities for collaboration between jurisdictions.

TTC garage doors and scissor lift create lethal cocktail

Matheson Constructors Ltd. and two supervisors have pleaded guilty and have been fined a total of \$133,000 after a fall at a Toronto Transit Commission (TTC) garage in which one worker died and another suffered broken bones.

(While no one was engaged in electrical work, this incident could just have easily involved an electrical crew.)

Matheson Constructors was engaged by the TTC to perform work at the company's Malvern Garage, which includes an automatic bus wash.

In August 2013, two Matheson site superintendents—Phil Lindsay and Karl Jedan—were on the jobsite and supervising.

Two workers (first day on the job for both) received an orientation from Lindsay at the site. Working on a scissor lift, they began insulating the overhead pipes.

An overhead door in the garage was in the Open position. The door was later lowered halfway by a TTC employee (not the designated TTC inspector) at the request of the workers. That employee did not lock out the controls to the door.

Upon lowering the door, the scissor lift was moved into a position behind the door. A few minutes later, a mechanic pushed a cart through the open doorway, triggering an electric eye mechanism on the door and causing it to open. The scissor lift was knocked over, with both workers falling to the concrete floor about 20 ft below.

One of the workers suffered blunt head trauma injuries and died several days later. The other worker suffered broken bones.

The court found that Matheson Constructors failed, as a constructor, to ensure that the safety of workers was protected, contrary to Section 23(1)(c) of the Occupational Health & Safety Act, and fined the company \$125,000.

The court also found superintendents Lindsay and Jedan guilty of failing as supervisors to take every precaution reasonable in the circumstances for the protection of a worker, contrary to Section 27(2)(c) of the act; specifically, failing to take the reasonable precaution of ensuring that an overhead garage door could not contact an elevated work platform upon which two workers were working. They were each fined \$4000.

Electrical Business

September 2015 • Volume 51 • Issue 9

ELECTRICAL BUSINESS is the magazine of the Canadian electrical community. It reports on the news and publishes articles in a manner that is informative and constructive.

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Published by Annex Publishing & Printing Inc.
222 Edward Street, Aurora, Ontario L4G 1W6
Tel. 905-727-0077 • Fax 905-727-0017

Publication mail Agreement #40065710
Return Undeliverable Canadian Addresses to Circulation Department
P.O. Box 530, Simcoe, ON N3Y 4N5
e-mail: kthomson@annexweb.com

United States Second Class Postage paid at Lewiston, NY
(USPS-741-470) US POSTMASTER:
Send address changes to
ELECTRICAL BUSINESS,
P.O. Box 8145, Lewiston, NY 14092

Printed in Canada
ISSN 0013-4244

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SUBSCRIPTION RATES:

Canada: Single issue \$7.00
12 issues: \$35.00 (includes tax)
USA: \$59.00 (US)
International: \$75.00 (US) per year

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CEA applauds EPA recognition of Canadian electricity exports

The Canadian Electricity Association (CEA, www.electricity.ca) says it is “pleased to see electricity exports from Canada included among the many greenhouse gas [GHG] reduction options made available to U.S. states under the final version of the Clean Power Plan”, which was issued by the U.S. Environmental Protection Agency (EPA).

Under the new regulation, EPA has assigned each U.S. state a specific target for reducing GHG emissions from existing fossil fuel-fired power plants. The rule identifies a menu of solutions states can apply to meet their respective targets, and affirms that the use of non-emitting resources from outside the U.S. is an acceptable strategy (so long as imported energy meets the same compliance conditions as non-emitting energy produced in the States).

Citing “abundant hydropower resources, a sizeable nuclear fleet and expanding renewable production”, CEA insists Canada boasts one of the cleanest supply mixes in the world, with about 80% non-GHG-emitting generation. The majority of electricity exports to the States involve the sale of surplus output from hydro-producing provinces, such as British Columbia, Manitoba and Quebec, and from nuclear and hydro supplies in Ontario, notes CEA. Cross-border trade is expected to continue growing through development of new clean energy sources in Canada, CEA added, such as the Lower Churchill hydropower projects in Labrador.

Change+Opportunity at APPrO 2015

“At APPrO 2015 you will encounter the industry’s most widely respected and knowledgeable speakers in sessions that are guaranteed to spark your interest and participation,” says Stephen Somerville, chair of the 27th Annual Canadian Power Conference & Networking Centre (a.k.a. APPrO)... and Electrical Business Magazine will be there as a supporting media sponsor.

APPrO 2015 will host amongst its delegates, sponsors and exhibitors, an array of power generation professionals from across the spectrum of power technologies. The C-Suite participants stem from every aspect of industry, including major to small generators, government representatives from all levels, as well as regulatory bodies, local distribution companies, consultants, legal experts and

more from across Canada, the U.S. and overseas.

The event is being held November 17-18 at the Metro Toronto Convention Centre, South Building. Visit www.appro2015.com for the most up-to-date conference information.

Dick Roney sells rep agency to Brent Norrey

In a letter addressed to customers, Dick Roney writes: “After a 43-year career in the electrical business, it is time for a younger team to take control and

drive the business”. He is selling his agency, Roney Marketing (www.roneymk.com), to Brent Norrey.

“Brent brings youth, a financial background, and has grown up around the electrical industry,” writes Roney, who will stay on as a consultant to ensure a smooth transition.

“Roney Marketing will continue to represent our manufacturers to the electrical distribution industry with a service and knowledge level that all have come to expect from the agency,” Roney concludes.

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Vancouver Island First Nations receive funds to analyze hydro projects

Two British Columbia First Nations on Vancouver Island are making plans for future hydro projects thanks to boosts from the First Nations Clean Energy Business Fund (tinyurl.com/qgyzw9r).

The Quatsino First Nation, near Coal Harbour, will receive \$30,000 to examine the feasibility of a 5MW run-of-river hydro project, located within the First Nation's traditional territory. The study will determine the technical viability of the project and assess environmental factors such as impacts on fish habitat and potential species at risk.

Additionally, the Ka:'yu:'k't'h'/Che:k'tles7et'h' First Nation (pron: kai-you-cut / sheh-kluh-szet), near Kyuquot, will receive \$40,000 to support a feasibility study of a proposed 1MW run-of-river hydro project. The study will include an examination of water flows, as well as an assessment of commercial, physical, and biological feasibility.

Southwire acquiring cable manufacturing plant from ABB

"We are committed to growing in the global wire and cable market. Today, we take another step toward that goal [...]" said Southwire Co. president & CEO Stu Thorn of the company's move to purchase a high-voltage and extra high-voltage (HV & EHV) underground transmission cable manufacturing plant from ABB Inc. (www.abb.com), thereby adding EHV cable products to Southwire's (www.southwire.ca) portfolio.

Located in Huntersville, N.C., the 240,000-sf plant is capable of producing cables ranging from 230kV to 400kV. Positioned on a 20-acre site in Commerce Station Business Park, the Huntersville plant "fits nicely with Southwire's family of manufacturing facilities and customer service centres", says the company. **EB**

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Scott Hoy

It is with great sadness that we announce the passing of our teammate and good friend, **Scott Hoy**. He was 51.

Scott joined *Electrical Business Magazine* as account manager in May 2007. On August 6, 2015, he succumbed to a very aggressive cancer. He died peacefully surrounded by family, friends and colleagues.

He was a regular fixture at electrical industry conferences and tradeshow (too numerous to mention!) all across Canada (and a few in the States, too), and is known to many in our industry. Our thoughts and prayers are with him and those he leaves behind. Visit tinyurl.com/ng47uzf.



Christina Pape

Christina Pape has joined the team at **E.B. Horsman & Son** (ebhorsman.com) as the business developer for process instrumentation.

Pape comes from SNC Lavalin Inc. in Montreal where she worked as an electrical engineer in addition to providing instrumentation & controls engineering for SNC Lavalin Inc. in Edmonton, Alta.



Heather Jackson

Ideal Industries (Canada) Corp. has promoted **Heather Jackson** to key account manager.

Jackson will be responsible for the sales, sales planning, marketing, and relationship management of a number of distributors, the company says. Jackson was previously assistant product manager at Ideal (www.idealindustries.ca) for three and-a-half years.



Heather Kleb

Heather Kleb is the new president of **Women in Nuclear-Canada (WiN)**, (www.wincanada.org). Prior to taking over her current role as a senior program manager at **Bruce Power**,

Kleb's experience in both the nuclear and mining industries included roles such as interim president & CEO for the **Canadian Nuclear Association**, as well as positions with **Atomic Energy of Canada Ltd.** (recently renamed Canadian Nuclear Laboratories).



Jeffrey Lyash

Ontario Power Generation (www.opg.com) has named **Jeffrey Lyash** its new president and CEO. Lyash joins OPG from CB&I Power (www.cbi.com) where he was responsible for engineering,

procurement and construction of major electrical generation projects in both domestic and international markets, according to OPG. Lyash currently serves on the board of directors for the Nuclear Energy Institute and on the board advisory committees for the Electric Power Research Institute and Drexel University.

NB Power (www.nbpower.com) is welcoming four new members to its board of directors. They include **Alain Bossé**,

Andrew MacGillivray, Paul McCoy, and Vicki Wallace-Godbout. Bossé is the president and COO of Groupe Savoie Inc. McCoy is a principal with the Atlantic Wind Connection Project. Wallace-Godbout is a First Nations lawyer and small business owner, and MacGillivray is the retired president and CEO of Gay Lea Foods.



Stuart Lee

Stuart Lee—currently the senior vice-president, Corporate Development and Commercial Services, at **Capital Power Corp.**—has been named president & CEO of **EPCOR** (corp.epcor.com). The utility says

Lee possesses more than two decades of experience as a financial and commercial executive, the majority of which has been in the energy and power sectors.



PHOTO COURTESY HORIZON UTILITIES.

Left to right: Sal Sorrento, St. Catharines city councillor; Kathy Lerette, vice-president of operations, Horizon Utilities; and Alan Caslin, regional chair of Niagara Region.

Horizon Utilities was presented with the 2015 Green Business award from the **Niagara Regional Council**. The company (www.horizonutilities.com) won its award for its 12 Mile Creek vegetation project. The initiative was developed to find an ecologically friendly way of maintaining the vegetation under and around the power lines in the area with more sustainable species. **EB**



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Mike Doherty

Electrically safe work condition regs and standards

recently discussed, in general terms, the concepts of Test Before Touch and Live-Dead-Live—two very basic techniques for helping you establish an electrically safe work condition. Getting detailed information for your particular situation may depend on the sector in which the work is being done, and maybe even its geographical area.

Regulations always require that establishing an electrically safe work condition be done in an organized, comprehensive and documented fashion. Crews need to be competent and trained. The regs are sometimes very detailed but, quite often, they are general and non-specific.

The United States, for example, boasts a somewhat more uniform system, as OSHA regulations contain different sections on lockout/tagout (LOTO) depending on the scope of work in areas such as those addressed in specific standards for general industry, marine terminals and the construction industry. Of course, these regs delve into more than just electrical hazards but any hazard that may require equipment to be put into a safe condition for work.

The National Electrical Safety Code (NESC a.k.a. ANSI IEEE C2) is the U.S. standard for the safe installation, operation and maintenance of electrical and communication utility systems (overhead and underground), and substations. It offers significant information and guidance on the isolation of electrical equipment for safe electrical work zones. This should be used as required to back the OSHA regulations for that sector.

In Canada, the basic sector equivalent of the IEEE C2 document is CAN/ULC S801 “Standard on Electric Utility Workplace Electrical Safety for Generation, Transmission and Distribution”. This Canadian national standard applies to the construction, operation,

maintenance and replacement of electric utility systems used to generate, transform, transmit, distribute and deliver electrical power to various customers. Depending on the scope of work, it is an outstanding document to use when considering the requirements for a comprehensive electrically safe work condition (Clause 10).

Both ULC S-801 and IEEE C2 are referenced as required for individual companies developing comprehensive documented procedures for electrically safe work conditions that align with legislated conditions from the authority having jurisdiction. While not identical, these two standards sport many common threads.

In Ontario, for example, many in the electrical utility sector use the Utility Work Protection Code (UWPC) to execute their isolations and safe work practices. Originally developed by the legacy Ontario Hydro, the comprehensive and detailed UWPC is still being used in the province. Granted, UWPC is an Ontario-based code, but most provinces have similar practices as developed by their own electrical utilities over the years.

In the U.S., NFPA 70E uses Article 120 “Establishing an Electrically Safe Work Condition”, where as in Canada we use CSA Z462 Clause 4.2 “Establishing an Electrically Safe Work Condition”.

CSA Z460-13 “Control of hazardous energy: Lockout and other methods” (CSA doesn’t use the word ‘tagout’) is a very detailed standard that should be referenced within the appropriate sector and scope of work. This standard is very focused on the topic, and goes into greater detail than CSA Z462.

The bottom line is that regulations all over North America have similar requirements for

the establishment of an electrically safe work condition when job planning and risk assessment procedural techniques have made that determination. Regardless of the scope of the electrical task, there are many similarities between the sectors, regulations, standards and guidelines.

The basics involve putting into place a comprehensive and rigorous procedure. Everyone concerned needs to be trained and competent. Field audits need to be carried out to ensure that a high level of compliance is in place.

In cases where a direct contact and/or arc flash incident occurred, and LOTO and/or some protection was being used then, quite often, the safety measures were likely executed incorrectly. Regular audits of the procedures in this area, as well as attention to detail in the completion of the documentation, can be a significant leading indicator of potential problems rather than the lagging indicators found afterward during serious incident investigations.

Your business needs to have an outstanding isolation procedure in place that can be justified; using the standards for your sector as your template just makes sense. Whether you’re a massive utility or a mom-and-pop organization, your responsibility for establishing an electrically safe work condition remains the same. **EB**

A subject-matter expert on electrical safety, Mike Doherty is the director of learning & continual improvement at Shermco Industries Canada Inc. He is a licensed electrician and an IEEE senior member, and has served as the Technical Committee chair for CSA Z462 since its inception. His specialties include electrical safety and health & safety management, maintenance, consulting, training, auditing and electrical incident investigations. Mike can be reached at mdoherty@shermco.com.

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Will they launder their FR garments **correctly**?



STOCK PHOTO

Strategies for a safe, cost-effective protective apparel program

You're responsible for the safety of 50 maintenance electricians and it's time to update your company's flame-resistant (FR) clothing program. Under federal and provincial health & safety regulations, you have a duty to keep your employees safe and to ensure any personal protective equipment (PPE) is maintained properly.

In fact, the many standards associated with the selection, use, care and maintenance of FR clothing collectively place several responsibilities on the company. In short, the garments must:

- properly fit the wearer
- be inspected prior to each use
- be laundered to manufacturer's specifications or industry standards
- be repaired with flame resistant (FR) materials
- be systematically retired and removed from service

So you know the rules, but now what? From the multiple types of garments available to the different brands and sourcing programs, the options can be overwhelming and exhausting, even to the most seasoned safety professional. Before jumping into a program, ask yourself the following questions:

- How dirty do my employees get? Can they effectively remove the soils at home?
- How rough are the employees on their garments?
- Including retirements, how much employee turnover did we experience last year?
- How many employees gained or lost weight requiring new size garments?

It is critical to note there is no one-size-fits-all approach to PPE program management. What might work best for a company in the oil & gas industry might not be the best solution for a company in a manufacturing environment.

So how do you develop a program that works best for your business? First you need to understand the options available and how those options impact the total cost of ownership (TCO) of your program. In this article, we'll walk you through a few basic questions to help you develop a safer and more cost-effective PPE program.

A little bit now means a lot later

In developing your PPE program, you should not lose sight of the principle objectives: to design the safest program most cost-effectively. By considering the program's TCO, you can improve safety and save money in the long term.

The TCO of your garment is largely determined by its cost and its wear life. In a typical FR program, for example, workers are provided one set that includes a shirt and pants for each working day, with the addition of seasonal outerwear. Depending upon your specific work environment, you might estimate the average wear life of everyday clothing like shirts, pants and coveralls to be around one year. Because seasonal outerwear is worn less frequently, you might estimate the wear

Room for improvement in your FR garment program?

Take the following quiz to find out if you have room for improvement in managing your FR program.

1. Do all garments properly fit the wearer?
2. Are all FR garments inspected prior to each use?
3. At what temperature are FR garments laundered?
4. Are chlorine bleach, oxidizers, fabric softeners or dryer sheets used during the laundry process?
5. Are rips or tears mended using regular thread?
6. Do you have a plan in place for reviewing and systematically retiring and removing garments from service?

ANSWERS

- | | | | |
|--|--------|--------------------------|-------|
| 1. Yes | 2. Yes | 3. Typically 50C to 70C. | 4. No |
| 5. No, FR garments should be repaired using flame-resistant materials. | 6. Yes | | |

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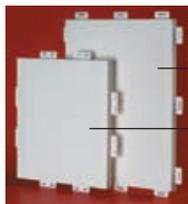
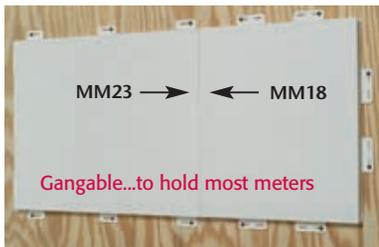
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PVC1040 NEW!	1-1/4, 1-1/2	Combo style, w/ adapter sleeves and bushings for EMT and Rigid
PVC105	2	
PVC106	2-1/2	
PVC109	3, 3-1/2, 4	Combo style, w/ adapter sleeves for 3" and 3-1/2"

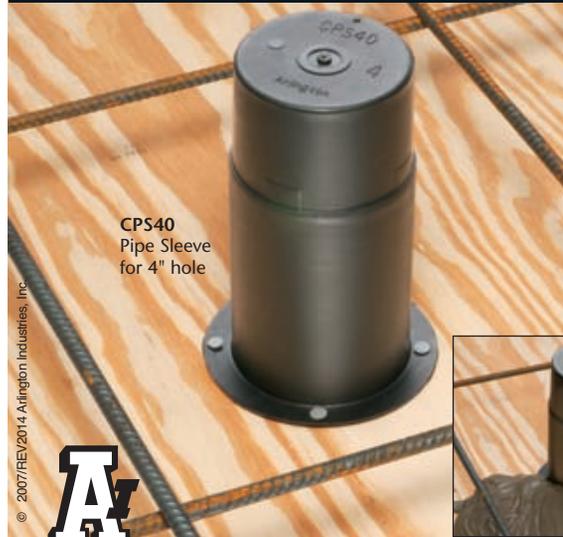
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life to be as much as three years. Items that will impact a garment's wear life include soil conditions, wear and tear, employee turnover and size changes—all considerations specific to your working environment.

Imagine this scenario: let's say you purchase all of your 50 employees FR clothing, which includes five shirts and five pants. The cost for each shirt or pants is about \$55 or about a \$1 per week.

Throughout the year, you are required to purchase replacement garments due to staining from heavy soils, and damage due to rips and tears. Many companies have found this to increase the overall cost of their program by as much as 30%. Following a weight loss challenge, two of the workers drop about 20 pounds, requiring them to go down in clothing sizes. This forces you to retire their inventory of garments halfway through the year. This doubles the TCO of the products, as you will need to replace the garments after only half of their estimated wear life.

The same holds true for the purchase of new inventory when you replace employees due to retirement or turnover. Conversely, had you used a managed rental program, you would have had better control over your expenditures, as the costs of laundering, repairs and replacements due to employee turnover and size changes are often included.

While this scenario demonstrates the benefit of renting your everyday work clothing, there may be some other situations where purchasing garments (e.g. seasonal outerwear) is the better solution for you. Ultimately, you want to keep costs low, but not at the expense of worker safety. Many companies have found that a hybrid program—encompassing both purchase and rental options—creates a safer program while providing the best economic solution.

Defining the total cost of ownership

To accurately compare the cost of FR garment purchase versus a managed FR program, you need to look at all the costs you will incur throughout the wearable life of the garments. Based on this number, you can calculate your daily or per use cost for the garment, giving you

a baseline number to compare against the cost of a managed program.

To help identify the factors that will contribute to the TCO of your program, ask yourself the following three questions:

#1 - What's the soil load?

Industries with particularly heavy soil loads are frequently exposed to high levels of flammable materials, such as fuel, grease and oil. These contaminants make employee uniforms difficult to clean, and using the incorrect cleaning compounds could damage the material. The standards for laundering flame-resistant clothing require, naturally, that flammable contaminants be removed from the garments.

Employees who launder their FR clothing at home are unlikely able to remove heavier soils. As a result, many of them might throw away those garments (believing them to be permanently soiled) or worse, continue to wear garments contaminated with flammable soils.

This is also a common situation for many companies that use a local cleaner or laundry facility to clean garments, ultimately driving up the costs of your program.

#2 - How much wear and tear will the garments experience?

Are workers regularly moving in and out of areas where tears or rips are likely? Do they work around heavy machinery or tight spaces that could lead to potential snags? Ontario's Occupational Health & Safety Act, for example, requires employers to ensure "the equipment, materials and protective devices provided by the employer are maintained in good condition", and this includes repairing garments with flame-resistant thread or repairing holes with the proper FR materials.

Assuming employees doesn't have access to FR thread, they increase their risk of injury because the use of untreated thread could cause the garment to fail. To eliminate this risk, you replace the garment. Depending on the nature of the industry, the replacement costs can increase the overall cost of the program by as much as 20%.

#3 - What's the average turnover for employees who need to wear FR garments?

Even if you're in a high-demand industry, you can count on some degree of worker turnover. Whether employees are forced to relocate due to family responsibilities, or they retire or have found another opportunity elsewhere, you can expect an average turnover of 15% to 22%.

Because turnover is unavoidable, it is something you need to take into consideration when reviewing the TCO of your program. It's not unlike the scenario of workers gaining or losing weight—where they need to go up or down a size—because turnover forces you to retire an entire set of garments.

As you can see, you will have to consider a number of factors impacting the TCO should you purchase your FR garments. The soil conditions, wear and tear, weight loss/gain, and turnover all increase the overall cost of your program by as much as 15% to 20% on average.

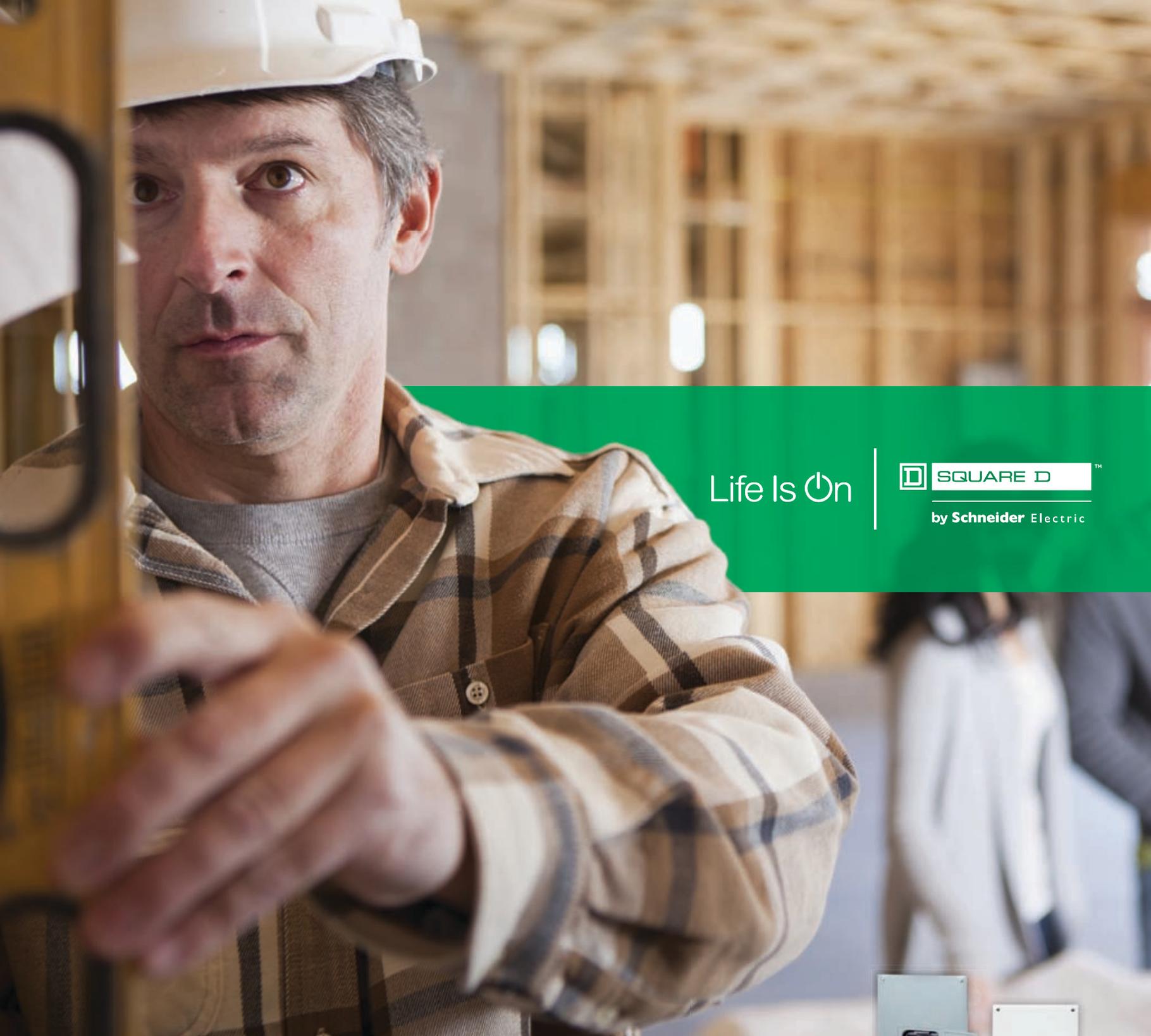
Weighing the responsibilities: self-managed versus managed

Once you've completed an assessment that identifies the TCO of your program, the next thing to decide is how FR garments will be laundered. There are a few options:

1. Employees will launder and manage their own FR apparel
2. Send FR garments to a local cleaner for laundering.
3. Engage a uniform service provider to maintain and manage your FR garments.

Some businesses require employees to launder their own garments. While it is an option, many organizations are moving away from this practice due to industry standards that establish best practices for FR garment laundering and repair so as to maintain their integrity. For example, ASTM F2757 "Home laundering care and maintenance of flame, thermal and arc resistant clothing" outlines the proper home laundering methods, which include turning FR garments inside out, washing them separately and using no fabric softeners or chlorine bleach.

However, even were FR garment users to diligently follow the steps above and launder FR garments according to the instructions in ASTM F2757, some contaminants simply cannot be removed via home laundering. Most FR clothing users don't have at-home water



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temperatures high enough, nor detergents strong enough, to remove petroleum-based substances that can sometimes stay on clothing.

When FR garments are outsourced to a local cleaner that doesn't specialize in PPE laundering, one has to question whether the integrity of the flame resistance is maintained. (Few cleaners provide confirmation of how garments are laundered.)

With a managed FR garment program, you are able to combine the best of both worlds—laundry service combined with garment repair and replacement. This assures you the proper water temperatures, water softness and cleaning agents are employed. Under a managed FR garment program, weekly route services are used to collect garments; the clothing is hand-inspected, laundered according to industry standards, repaired or replaced when deemed damaged or defective, and returned.

Developing a safer, more cost-effective FR garment program

Now that you understand the different factors that contribute to the TCO of your FR garment program, let's go back to our original scenario where you are responsible for outfitting a team of 50 employees in flame-resistant clothing. Based on an estimated cost of \$550 per year to outfit an employee in five FR shirts and five FR pants, you will spend about \$27,500 a year for garments.

As a next step, consider the variables listed above and include them in the TCO estimate. For example:

Replacements due to size change	6.00%
Replacements due to non-repairable garments	10.00%
Turnover	4.00%

These factors result in an increase of 20% to the initial garment cost or \$5500 for the year. Now consider the costs to clean the garments:

FR shirt	\$0.50 (per shirt)
FR pants	\$0.50 (per pants)

The estimated cost to clean these items would be about \$260 per year per employee, or \$13,000 for 50 employees.

When you look at a managed program with the same scenario, each employee is provided five clean shirts and pants each week at an average cost of \$11.00 per week per employee. The total cost of the program is about \$28,600 a year as compared to \$46,000 for a purchase and clean program. You no longer have the concern of soil loads, tears, maintenance or turnover. The result is a safer program at a cost savings of 38%.

In addition to the cost savings, a managed program helps give you peace of mind. You don't have the headaches of making sure John, for example, isn't wearing soiled garments from last week because, with the managed program, a uniform service provider picks up soiled garments on a weekly basis to inspect them for tears or damage, and launders the uniforms according to industry standards. Clean garments are delivered directly to your business.

When you look at costs for infrequently used items, such as outerwear, the evaluation plays more favourably toward purchasing garments due to the longer wear life.

Rent or buy? That is the question

As regulations continue to put the responsibility on employers to implement and maintain PPE programs that limit risk to workers, more businesses and safety professionals increasingly debate the best way to acquire and maintain their employees' FR garments.

As mentioned, there's no one-size-fits-all solution, but by looking at some of the different factors that contribute to the TCO of the FR clothing program—along with your options for laundering and maintaining FR garments—you will have a more



PHOTO COURTESY CINTAS

accurate assessment of the best option for your business.

Whether you decide to use a purchase, rental or hybrid FR garment program, it's your responsibility as an employer to make sure it's not only cost-effective but limits the risk to the worker and improves the overall safety of your workplace. **EB**

This article is based on the white paper "Should I rent or purchase flame-resistant clothing? Strategies for building a safer and more cost-effective protective apparel program" by Cintas Canada Ltd. (www.cintas.com).

References

- ASTM 1449 "Industrial laundering of flame, thermal, and arc-resistant clothing".
- ASTM F2757 "Home laundering care and maintenance of flame, thermal and arc-resistant clothing".
- CSA Z462 "Workplace electrical safety".
- NFPA 70E "Electrical safety in the workplace".
- NFPA 2112 "Flame-resistant garments for protection of industrial personnel against flash fire".
- NFPA 2113 "Selection, care, use, and maintenance of flame-resistant garments for protection of industrial personnel against flash fire".

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Maintaining battery systems for backup power reliability



PHOTO COURTESY FLUKE

Duane Smith

Standby battery backup systems play a critical role in keeping essential operations functional in the event of a utility outage. Most backup power systems employ an uninterruptible power supply (UPS) and a string of batteries. The UPS backs up the digital control system (DCS) to keep control of plant operations until systems can be safely shut down or the auxiliary generator kicks in.

Although most batteries used in modern day UPS systems are ‘maintenance-free’, they are nonetheless susceptible to deterioration from corrosion, internal shorts, sulphation, dry-out and seal failure. This article outlines best practices for keeping these ‘battery banks’ at optimum performance so that, should an outage occur, the backup is ready.

Top 2 indicators of battery health

#1 - Internal battery resistance

Internal resistance is a life-span test, not a capacity test. Battery resistance stays relatively flat up until the end of life draws near. At that point, internal resistance increases and battery

“Best practice requires measuring ohmic values over months and years, each time comparing them to previous values on record to create a base line.

capacity decreases. Measuring and tracking this value helps identify when a battery needs replacing.

Only use a specialized battery tester designed to measure battery resistance while the battery is in service. Read the voltage drop on the load current (conductance) or the AC impedance. Both results will be in ohmic values.

A single ohmic measurement is of little value without context. Best practice requires measuring ohmic values over months and years, each time comparing them to previous values on record to create a base line.

#2 - Discharge testing

Discharge testing is the ultimate way to uncover the true available capacity of a battery, but can be complicated to perform. In discharge testing, a battery is connected to a load and discharged over a specified period. During this test period, current is regulated and a constant known current is drawn while voltage is measured periodically.

Details of the discharge current (the specified time period for discharge testing, and the capacity of the battery in ampere hours) can be calculated and compared to the manufacturers’ specification. For example, a 12V 100 amp-hour battery may require a discharge current of 12 amps for an 8-hour period. A 12V battery would be considered discharged when the terminal voltage is 10.5V.

Batteries cannot support critical loads during and immediately after a discharge test. You must transfer critical loads to a different battery bank until well after the test is complete, then reconnect a temporary, comparably-sized load to the batteries under test. In addition, prepare a cooling system to compensate for a rise in

TABLE 1 Inspections recommended by IEEE 1188 “Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications”

Items	Voltage and current			Temperature		Ohmic		Ripple
	Overall float voltage measured at the battery terminals	Charger output current and voltage	DC float current (per string)	Ambient temperature	Temperature of the negative terminal of each cell	Cell/unit internal ohmic values	Cell-to-cell and terminal connection detail resistance of entire battery	AC ripple current and/or voltage imposed on the battery
Monthly	●	●	●	●				
Quarterly	●	●	●	●	●	●		
Yearly and Initial	●	●	●	●	●	●	●	●

ambient temperature before conducting the test. When large batteries discharge, they release a significant amount of energy as heat.

Top 5 causes of battery failure

1. Loose terminals and inter-cell connections
2. Aging
3. Over-charging and over-discharging
4. Thermal runaway (The main cause of battery failure is heat. For every 8C (15F) increase in average temperature, battery life is cut in half.)
5. Ripple

When one battery in a string fails, the entire string will either go offline or have its lifespan reduced (a single bad battery raises the charge voltage of adjacent batteries, due to charger settings, affecting the usable life of the entire string). In a worst case scenario, a battery with a high level of impedance can overheat and ignite or explode during discharge. Voltage measurements alone will not flag this danger.

Recommended battery tests and schedule

IEEE is the primary source of standard practices for battery maintenance, recommending a combination of tests on a periodic basis over the life of the battery. The organization also recommends the following schedule for discharge testing:

- An acceptance test made at the manufacturer's factory or upon initial installation.
- Periodic discharge testing: at an interval not greater than 25% of the expected service life, or two years, whichever is less.
- Annual discharge testing: when any battery has reached 85% of the expected service life or dropped >10% from capacity.

Since scheduling full-scale discharge testing can be difficult, quality regular maintenance is extremely important. By operating the battery according to manufacturer charging requirements and following the IEEE recommendations for battery testing, it should be possible to maximize the life of the battery system.

Key indicators of battery failure

Healthy batteries should maintain a capacity above 90% of the manufacturer's rating; most manufacturers recommend replacing the battery when it falls below 80%. When conducting battery tests, look for these indicators of failure:

- Drop in capacity of more than 10% compared to the baseline or previous measurement.

- 20% or more increase in resistance compared to baseline or previous.
- Sustained high temperatures compared to baseline and manufacturer specs.
- Degradation in plate condition.

Conducting standard battery tests

It is important to ensure you are wearing the proper personal protective equipment (PPE) before conducting the following tests.



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This is why it is so important to implement and follow a regimen of battery testing, and meticulously record the resulting measurements.

COMMON BATTERY TERMS

Capacity test

A discharge of a battery at a constant current or constant power to a specified voltage.

Float voltage

The voltage at which the battery is held by the charging system to compensate for the natural discharge of the connected batteries.

Float current

The current that flows while the battery is held at the float voltage.

Internal Ohmic values

The internal resistance of the battery (a characteristic of every battery).

Discharge testing

The battery is connected to a load until the battery voltage falls below a defined preset limit.

AC ripple current

Residual AC on the rectified voltage in DC charging and inverter circuits.



PHOTO COURTESY FLUKE

Float voltage

1. Measure the individual cell voltage or string using a digital multimeter or battery analyzer on a monthly basis.

Charger output

1. Measure the charger output voltage at the charger output terminals using a digital multimeter or battery analyzer on a monthly basis.
2. Observe the output current shown on the charger current meter or use an appropriate DC current clamp meter. Measure monthly.

DC float current

1. Refer to manufacturer's specs for approximate values for expected float currents.
2. Use an appropriate DC current clamp meter to measure expected float current on a monthly basis.

Internal ohmic values

1. Use a battery analyzer to measure the individual battery ohmic values on a quarterly basis.

2. Establish reference values and maintain in the battery database.

Monitor for the long haul

Facilities like data centres, hospitals, airports, utilities, oil & gas facilities, and railways cannot operate without 100% backup power reliability. Even standard commercial and manufacturing facilities have backup power systems for their emergency systems, alarms and controls, emergency lighting, steam and fire control systems.

This is why it is so important to implement and follow a regimen of battery testing, and meticulously record the resulting measurements. Over time, those numbers will tip you off to any problems with the backup battery system, enabling you to schedule any required maintenance before an emergency hits. **EB**

Duane Smith is a senior sales support engineer for Fluke's digital multimeter team, and has more than 40 years of experience with the use and application of Fluke DMMs.



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IN CASE YOU MISSED IT...

VIDEO • Saskatoon, Sask. hosted the 21st Skills Canada National Competition, where “the best and brightest students and apprentices in skilled trades and technologies were tried, tested and judged”, and EBMag correspondent Mike Edwards was there to take in the action. Visit tinyurl.com/o23bude.



PHOTOS • EBMag recently returned from Mebane, N.C., where GE cut the ribbon to officially open its new Customer Experience Centre. Here, customers can touch and feel what they're buying. More at tinyurl.com/q7savxo.



VIDEO • Congratulations to Dustin Tessier of Tesco Automation for winning a trip to the 6th Annual International Electrotechnical Commission (IEC) Young Professionals workshop in Minsk, Belarus from Standards Council of Canada (SCC). See his winning entry here: tinyurl.com/qdw6f32.

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Visit epec2015.ieee.ca

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We continue to explore electrical technologies, products and systems for the discerning homeowner... where cost is not an issue! This month we hope to dazzle you with the latest in interior lighting, including modern chandeliers, nostalgic bulbs, classy LEDs, and sleek, hidden recessed options.



The Merge system outlines a square in the ceiling for a modern recessed look.

PHOTO COURTESY TECH LIGHTING.

Layer up!

Swanky interior lighting solutions from all angles

Renée Francoeur

PHOTO COURTESY LUX.



The Florence bulbs in amber and clear are ideal for fancy fixtures.

If you're used to popping in a series of potlights and a pendant here or there, you could be missing out on an opportunity to take your residential project to the next level through interior lighting.

"A big thing in lighting and creating environments is trying to layer light... creating contrast between light and dark, accenting colours, and that kind of stuff," says Tom Sargeant of Tech Lighting.

"When you layer lighting in a space, it adds to that upscale appeal," continues Shelley Wald, president of WAC Lighting. "Different technologies now allow us to fold the lighting right into the architecture so it makes it more accessible... and indirect lighting gives a different feel than direct."

One product, four layers

At Meyda Lighting, incorporating all lighting layers (task, decorative, accent and ambient) in a single design is a win-win for customers desiring a one-stop-shop solution.

Meyda's Chandel-Air family showcases all four layers plus has the ability to move air with its ceiling fan. Uplights surround the fan as well as inner lights, which illuminate an optional diffuser made of fabric, acrylic, art glass, amber or silver mica. Cool-temperature LED spotlights stud the diffuser's exterior for accent lighting, and downlights—ideal for reading and other tasks—make up the final option.

For Max Cohen, director of hospitality at Meyda Lighting and 2nd Ave. Lighting, the Chandel-Air does it all. He recently installed a two-tier Chandel-Air for an upscale project in the Adirondacks featuring a 35-ft ceiling.

"That single fixture can do a bunch of things:

uplighting for the beams on the ceiling, creating a glow. And that's controlled by one separate switch. Another switch lights up the candlesticks around the piece," he says. "There's a traumatic effect created from the spotlights—just 2W with a super-blue colour—that light up the moose [displayed in the room], showing its shadows on the walls, and that really creates some interesting lighting."

Like Chandel-Air, Tech Lighting's new Merge recessed linear system (part of the Element line) offers light layering in a single system.

"It builds on the theme of recessed but it's adding a new twist with a general illumination portion," says Sargeant, Tech's vice-president of product development. "So it's really filling the space with light in a simple, clean manner that leaves ceilings uninterrupted. That look seems to be what people are going for."

Merge is a long linear system featuring a 3-in. channel of indirect LED illumination—"a narrow seam of light in the ceiling," Sargeant explains. The light source is aimed upward into a reflective dome, then pushed down, doing away with shadow and glare trouble, he adds.

The system is able to make 90-degree turns and transition from the ceiling down a wall. This means the tracks can create a square or any geometric shape on the ceiling. The edges of the channel are also bevelled, casting a slight angle upward so "it looks like an extra architectural element in the home".

In addition to the general illumination, Merge has a low-voltage busbar (essentially a track system) running on the inside that allows users to twist-and-lock LED adjustable spot heads and/or pendants anywhere along the track for another layer. The

Merge Gimbal Spot, as an example of one option, does not break the ceiling plane, providing for a smooth overall appearance.

Each layer of the system has its own dimming ability, and spots and pendants can be moved at any time to a different area along the track. The system will run you about \$120 US/ft.

Layering aside, Wald notes a hot trend today is lighting that ‘muds’ into the ceiling and almost disappears, such as WAC’s Aether with its low-profile housing (retailing for between \$478 US to \$561 US).

“Another thing we’ve noticed is a trend now in the square aperture for recessed. It’s hot,” Wald says. “It adds a more linear feeling to a space when it’s used in conjunction with cove lighting and, when it’s mudded right in, it’s just supremely clean.”

Fit for royalty

Nothing says opulence quite like a big, shiny chandelier. WAC’s Line chandelier “screams technology”, says Wald. The Line, retailing for about \$1499 US, features a thin, edge-lit LED panel that provides ambient light. It offers a “direct-indirect light distribution, which delivers ample light to work surfaces while also illuminating the ceiling and upper portion of walls”.

The Cyclone chandelier from 2nd Ave. Lighting (acquired by Meyda) is also an attention-grabber.

“It’s like a tornado, but goes about it in an elegant way. These are incredibly popular, and we’re always making one for a customer, every other week or so,” Cohen says. “We’ve done a lot of the Barrel Stave ones where we used recycled wine barrels. We’ve also done whiskey barrels... that rustic contemporary look is really trending right now.”

LEDs go ritzy

At Wilshire Manufacturing, LEDs just didn’t fit the bill for extravagant chandeliers and sconces dripping with ornaments.

“With LEDs, it’s a new world. But not all LEDs are created equal,” says Steven Kaufman, Wilshire’s CEO. “A lot of the existing LED systems for decorative lighting were very bluish and just didn’t have the colour, brightness or the dimming that you come to expect in high-end decorative lighting... the light and the electronics need to match.”

The company, therefore, decided to redesign an advanced LED system geared to decorative lighting. It took years of optical engineering work and analysis, Kaufman says; finally, “we cracked the code”, and the PrisMatrix LED system made its debut.

PrisMatrix features dual optics and “special LED chips that are full-colour” and have a brightness and full dimming capability similar to incandescent bulbs, Kaufman says.

“A lot of retrofit bulbs have a big white heat sink right on them, so the aesthetics look garish. Our design was able to separate the electronics, optics and thermal management, and put it all into the fixture itself.”

Additionally, because PrisMatrix doesn’t use traditional bulbs, there are a variety of interchangeable glass and crystal envelopes to choose from. Bulbs can last over a decade, Kaufman adds.

“The fixtures of the future high-end home are going to combine really innovative, modern designs and aesthetics with technology, and that’s what we do; we marry those two,” Kaufman says.

Old school cool

Los Angeles artist Carolina Fontoura Alzaga creates what she says are “luxurious, cascading, and seemingly traditional chandeliers” from used bike parts, and she has started using Lux Technology Group’s new LED filaments in her works.

“Our client [Alzaga] is selling these chandeliers to celebrities,” says Candice Long-Lerno, director of business management at Lux. “The filaments are the way to go. They look really high-end and are the only UL-rated filaments on the market right now.”

Lux’s filaments come in an array of shapes and sizes that all evoke a classic Edison bulb vibe, including the Tuscany flame-tip candle, Milan blunt-tip, Florence extended flame-tip candle, Hope G25 globe and the Axiom A19, among others. Many are available in both clear and amber coatings.

“The candle bulbs are great for chandeliers because they have such a pointed tip and look like real candles for an authentic feel,” Long-Lerno says. The bulbs come with interchangeable bases and can act as direct replacements for incandescent.



PHOTO COURTESY 2ND AVE. LIGHTING.

The Cyclone chandelier is a popular choice among 2nd Ave. Lighting clients.



PHOTO COURTESY WAC LIGHTING.

WAC’s Line chandelier “screams technology”.

“I think the biggest hurdle for the LED market is the look of the LED... that metal casing on the bottom. So that makes it an easy sell with the filaments; these look beautiful,” Long-Lerno says. “Plus, when you’re talking 15 bulbs per chandelier, if you can cut the electricity costs by 80-90%, that adds up pretty quickly.”

Not to be overlooked

When it comes to contemplating interior lighting solutions, Wald reminds contractors that they don’t need a lighting designer to make a room sizzle.

“You can pick really nice flush-mounts, sconces, pendants and go over the options with your clients. Even in traditional spaces, you’d be surprised at LEDs that can work. Take a look around.”

All the professionals agree on one thing: lighting makes the home.

“Lighting is so customizable; from choosing warmer to cooler temperatures, and putting thought into that and investing some money into that shouldn’t be overlooked,” says Long-Lerno. “Lighting and how it affects all the other elements is such a big part of the look and feel of a home.” **EB**



Change Orders, Part 2: Schedule and site changes

My last column introduced the subject of Change Orders (COs), exploring how *changes in scope* can lead to a CO. Here I will look at COs resulting from changes in

schedule or changes to site conditions.

Changes in schedule

Schedule changes usually manifest as delays, extensions, compression

and out-of-sequence work.

Most subcontracts contain specific language about delays and preclude a subcontractor from recovering costs due to schedule delays. Instead, the subs are

afforded a schedule extension equal to the amount of time they have been delayed. These clauses usually contain very specific terms and conditions for notification requirements and limitations for compensation. It is important to read and understand these terms, as they vary between projects, contractors and subcontracts.

Should the General Contractor (GC) or Owner extend the duration of the project past the contractual completion date or timeframe for reasons outside of the subcontractor's control, the sub is typically entitled to a contract modification to provide compensation for the Extended General Conditions (EGCs) required by the extension. Typical EGCs would include costs for salaried positions (e.g. project managers, superintendents, administrative personnel), jobsite office and rental equipment, small tools and consumables, and any other direct project costs that are incurred as a result of the extended schedule.

Schedule compression is becoming more prevalent in the construction industry, typically to combat schedule extensions. There are a myriad of reasons for this, which I won't explore here, but they mostly boil down to financing and construction loan terms. Project schedules are built with little *float* or extra time, and are very sensitive to unforeseen delays. Any delays must be overcome to keep the project on schedule without using up all the float, so activities are compressed and trades are stacked.

What might this look like? Let's say that, due to a delay (e.g. weather, failure to perform by another sub, unforeseen conditions, etc.), an activity or area that has been allocated on the master schedule as a 10-day activity must now be performed in 5 days, and multiple trades must work in the same area simultaneously rather than one after the other. The result is that more workers are required to perform the same scope of work in a shorter period, overtime costs are incurred, and the workers' efficiency is reduced due to the congested work area. These conditions all have a direct and measureable impact on cost, and are compensable.

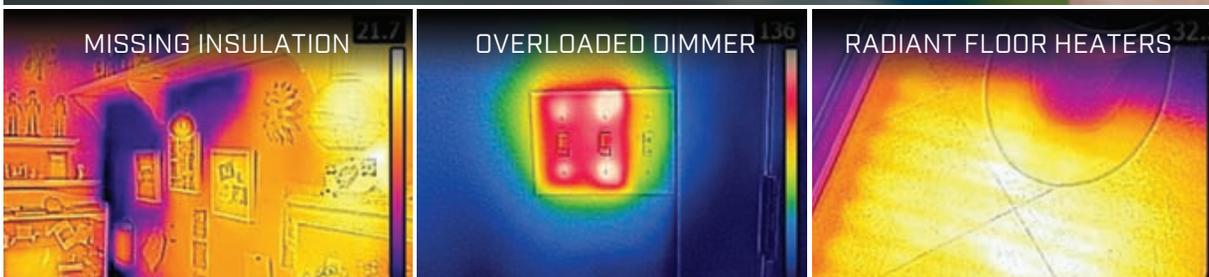
Out-of-sequence work may also constitute an opportunity for compensation. Much like delays, most subcontracts contain language that

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“Schedule compression is becoming more prevalent in the construction industry, typically to combat schedule extensions [...] Project schedules are built with little float or extra time, and are very sensitive to unforeseen delays.”

allows a GC to redirect a subcontractor’s workforce or alter the construction sequence as needed, often with as little as 24 hours notice. This allows the GC to avoid cost impacts from subs due to unforeseen obstacles that may arise during construction.

For example, let’s say you’re scheduled to begin work in Area A on Wednesday. On Monday, the GC discovers they have a problem in Area A that must be corrected before any work can start. The GC can direct you to work in an alternate area—without incurring a cost impact for the redirection—while the situation in Area A is corrected.

While there are typically no limits on this ability written in the contract, it is understood that you must be given the originally schedule duration to complete your scope in Area A. If not, then the redirection may result in schedule compression when you are finally cleared to work in Area A, which is compensable.

Changes in site conditions

The final group of cost impacts consists of unforeseen conditions, weather and Acts of God, and safety. Unforeseen conditions are most common in subgrade activities (e.g. excavation, rock removal, de-watering) and in renovation and rehabilitation work (e.g. asbestos, unknown structural interferences). These usually result in time and material impacts, and may also carry a schedule impact, all of which are compensable.

Weather impact and Acts of God are almost always addressed in the subcontract with specific legal language and should be evaluated on a project-by-project basis. Normally, no compensation is available for schedule delays resulting from

these occurrences, but time extensions are granted. When the occurrence results in damage or rework, these costs would be compensable to the subcontractor.

Safety is a more complicated subject, making it more difficult to substantiate and recover costs. A safety incident that shuts down a jobsite for an extended period (days or weeks) would carry a compensable cost impact, but

only when your company is not the reason for the shutdown. Costs may include demobilization and remobilization, schedule extension, extended general conditions (EGCs), additional safety training and travel-related costs (when the project is outside of your local territory).

All of these may be submitted for compensation to the GC or Owner, depending on the nature

of the safety incident that closed the jobsite. **EB**

Adam Cooper has over 20 years of electrical construction and contracting experience, and has worked for several of the largest electrical contractors in the U.S. He started Ascent Consulting (www.ascentconsult.net) to offer his knowledge and experience to organizations looking for ways to grow and improve.

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Subrules 64-060(12) and 64-210(5) for solar PV

As we continue our look at solar PV installation requirements in the new CE Code (2015), let's examine new Subrules 64-060(12) requiring disconnecting means for combiner boxes and 64-210(5) for protection of conductors against rodents.

Subrule 64-060(12)

A large fire recently occurred in a building housing 500kW inverters, and personnel were forced to disconnect the power by opening the individual PV source circuit fuse holders (which are not approved to be opened under load). To isolate the power to the building, more than 400 individual fuse holders needed to be opened under load, as the combiner boxes did not have a PV output (outgoing) circuit disconnect.

A disconnecting means for the PV output circuit at the combiner box allows you to safely open the fuse holder within. A disconnect at the combiner box will increase the likelihood of disconnecting the load prior to opening the attachment plugs, which are also not approved to be opened under load.

Subrule 64-060(12) states that a disconnecting means for the combiner box is required for the PV output circuit and shall be rated to interrupt the load, integral with the combiner box or installed within 2 m of the PV combiner. Additionally, when the combiner box is equipped with fuses, the Subrule requires that a disconnecting



PV conductors damaged by rodents pose a risk of fire.

means be interlocked with the door.

(While not yet published, the public review draft of CSA C22.2 No. 290 "Photovoltaic combiner boxes" provides requirements for disconnecting means that are integral with a combiner box or, if not, then appropriate marking [Clause 4.2]). Combiner boxes with integral disconnecting means are currently available, which facilitates compliance.)

Subrule 64-210(5)

PV conductors that have been damaged (broken) by rodents pose a high risk of series arcing faults, parallel arcing faults caused by shortening PV positive to negative conductors, or ground faults—all of which may result in a fire, which is of particular concern with systems installed on buildings.

Subrule 64-210(5) states that where the

DC arc fault protection is not located at the module, PV source circuit conductors and cables on or above a building shall be provided with mechanical protection in the form of an enclosed raceway or other acceptable material to protect against damage from rodents. (An Appendix B note provides examples of "other acceptable material", such as expanded metal, solid metal and screening.)

When DC arc fault protection is located at the module (as required by Rule 64-216), the probability of fire is greatly reduced, so the requirement for mechanical protection is omitted. **EB**

Nansy Hanna is the director for Engineering & Program Development at Electrical Safety Authority (ESA) where, among other things, she is responsible for product safety, code development, improving harmonization and alternative compliance, worker safety, and aging infrastructure programs. She is a LEED-Accredited Professional and a member of CSA CE Code-Part I, Sections 24, 32, 46, 50 and 64. Nansy can be reached at nansy.hanna@electricalsafety.on.ca.

ALWAYS consult the electrical inspection authority in your province/territory for more specific interpretations.

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Tackle The Code Conundrum... if you dare!

Answers to this month's questions in October'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

Does the CE Code allow you to have two supply services of the same voltage from the same system of any supply authority enter a building when only one will be used for supplying a fire pump?

a) True b) False

Question 2

What is the maximum mounting height for the overcurrent device handle of a panelboard in a dwelling unit?

a) 1.5 m b) 1.6 m c) 1.7 m d) 1.8 m

Question 3

For a mobile home, the minimum permitted size conductor for the power supply cord is:

a) #10 AWG c) #6 AWG
b) #8 AWG d) #4 AWG

Answers:
EBMag August 2015

Q-1: Electrical equipment approved for Class I (where the atmosphere contains butadiene), Group D equipment shall be permitted to be used if such equipment is isolated properly in accordance with the code requirements by sealing all conduit 16 trade size or larger.

a) True. Ref. Rule 18-050(4)(a).

Q-2: Rigid main contact conductors for an electrical hoist shall be supported so that there is an air space of not less than ___ mm between conductors.

c) 25 mm. Ref. Rule 40-012(2).

Q-3: The ampacity of the feeder supplying a total of 60kW of heating equipment in an apartment building from a 208V, 3-phase switchboard is:

a) 132 amp. Ref. Rule 62-116(2).

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