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Photo courtesy REM.

Cover: A rendering of the new REM automated LRT project in Montreal, breaking ground this year it's slated to open in 2021.
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Getty

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features

departments

Next issue:
Net Zero and beyond, pedestrian bridges, smart grids and more.

on topic

Dream Big

Among the many excellent sessions I attended during the ACEC National Leadership Conference in Ottawa last October, it was an energetic and passionate panel discussion on the concept of a Northern Corridor across Canada that left the greatest impression on me.

If you're not familiar, the proposal involves the development of a 7,000 km east-west right-of-way through our mineral-rich north—a route that would accommodate transportation and energy networks. It's a national infrastructure project with economic implications from coast-to-coast-to-coast.

In this issue's ACEC Review, chair Todd Smith shares the ACEC's endorsement of the idea, and encourages consulting engineers across the country to support the project for the opportunities it presents to this industry and also for the legacy it will leave behind.

A strong champion of the proposal is Senator David Tkachuk from Saskatchewan. Tkachuk, a member of that panel, called the proposal a modern day equivalent of Sir John A. Macdonald's national railway. By creating such a bold government-approved footprint across a somewhat neglected region, it would remove barriers and promote further business development.

The most impassioned panellist was John van Nostrand, an architect and founding principal of SvN in Toronto. He called the proposal a "game changer in re-establishing how we develop as a country."

He placed emphasis on including indigenous communities from the outset. More than a government-led infrastructure project across Crown land, the northern corridor would fall into the new era of reconciliation with First Nations, and it would involve partnerships and consent from the beginning.

Panellist Corrina Leween, Chief, Chesletta Carrier Nation, added that partnerships are what First Nations communities are looking for.

Also on the panel was Andrei Sulzenko, co-author of a 2016 report outlining the northern corridor concept. Published by the University of Calgary's school of public policy, Sulzenko said pursuing the corridor issue was in response to an apparent erosion of our trade access with the U.S.

"We can no longer rely on our neighbours to the south," he said, adding that we need to work harder on agreements with Europe and Asia/Pacific.

He outlined benefits including: opening up new areas to development; improving quality of life in those regions; minimizing the environmental footprint through coordinated efforts; and also reinforcing our arctic sovereignty.

The report estimates the corridor would cost $100 billion, laying the groundwork for greater private sector investment.

This nation-building concept is not new, as there was a similar proposal developed some 50 years ago, but it was never pursued.

In 2016 our current federal government announced its Investing in Canada plan, spending $180 billion over 12 years focusing on transit, green infrastructure, social infrastructure, trade and transportation routes, and Canada's rural and northern communities.

This one massive project ticks all of those boxes and deserves to be on the docket. As van Nostrand pleaded at the conference: "Dare to dream big."

Doug Picklyk

FOR PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE

CANADIAN CONSULTING engineer

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Photo: REM

Rendering of a station interior for Montreal's new Réseau express métropolitain project.

TRANSPORTATION

Teams selected for Montreal's $6.3B REM project

SNC-Lavalin and AECOM will lead the engineering design for the Groupe NouvLR consortium, the team selected by pension-fund manager Caisse de dépôt et placement du Québec (CDPQ Infra Inc.) as the preferred proponent for the engineering, procurement and construction of the electric-powered light-rail system, the Réseau express métropolitain (REM).

The NouvLR General Partnership includes SNC-Lavalin Major Projects, Dragados Canada, Aecon Québec, Pomerleau and EBC Inc.

"Thanks to the great cooperation of the partners and teamwork shown by SNC-Lavalin's Infrastructure group, we will be able to participate in this innovative and significant project," said Ian Edwards, president, Infrastructure with SNC-Lavalin, in a company release. "We are proud to have been chosen—all the more so since it is based in Montreal, the city of SNC-Lavalin's founding over 100 years ago."

The design elements will include tunnels, bridges, stations, railway infrastructure (tracks, power and traction systems, etc.), road improvements, intermodal equipment and other structures as well as work on obtaining environmental permits, environmental monitoring and urban integration.

"We are delighted to contribute AECOM's global design expertise and local talent toward the success of this landmark project," said Michael S. Burke, AECOM's chairman and CEO in a media release. "Through interconnection with bus networks, commuter trains and the Montréal metro, the REM will help ease traffic congestion and reduce GHG emissions, accelerating Québec's transition to a low-carbon economy."

Once built, the 67-km network will be the fourth largest automated transportation network in the world after Singapore, Dubai and Vancouver.

Parsons selected as Owners Engineer for Gordie Howe Bridge project

Windsor-Detroit Bridge Authority (WDBA) has selected Parsons for the role of Owner's Engineer for the Gordie Howe International Bridge project.

Back in January 2015, Parsons was named WDBA's General Engineering Consultant to provide a range of professional engineering services during the preparatory activities and procurement stages of the project. This new $61 million contract—the first contract WDBA has awarded for services related to the design-build phase of the project—is the result of WDBA exercising an option for the original contract to be amended to select Parsons as Owner's Engineer.

COMPANIES

New CEO for Consulting Engineers of Ontario

Bruce Matthews

Bruce Matthews, P.Eng., the new CEO of CEO, brings 16 years of management experience in the not-for-profit sector, including prior roles at Professional Engineers Ontario, the Real Estate Council of Ontario and the Ontario College of Trades.

MGAC opens in Toronto

Paul Stapley

MGAC, a U.S.-based construction project management firm, has opened an office in the Toronto area led by Paul Stapley. MGAC has worked across Canada for over two decades on projects including Queen's University's Isabel Bader Centre for the Arts, Memorial University's Core Science facility, Toronto Pearson Airport Marriott, and the design and construction of a $200M 12 MW data centre for a top five Canadian bank.

RJC's new appointments

RJC Engineers announced the appointment of four new principals and seven new associates to its leadership teams across the country.

The new principals include: Dennis Gam, P.Eng., with the Vancouver building science & restoration

team; Jamie Murphy and Enzo Vercillo of Edmonton's building science and restoration team; and Damien Stoneham, P.Eng., in Vancouver.

The new associates include: Meredith Anderson, P.Eng., in Vancouver; Ryan Coles, P.Eng., Calgary; Bob Korneluk, P.Eng., and Scott Laing, P.Eng., in Edmonton; Dominic Mattman, P.Eng., and Craig Wadsworth, P.Eng., in Toronto; and Clint Plett, P.Eng., in Victoria.

GOLDER

Golder's new look

Golder refreshed its brand, the engineering firm's first major brand update in over half a century.

"Golder has enjoyed a long and successful journey, responding to incredible challenges with a powerful resilient spirit, driven by our employee owners and their commitment to our company," says Golder CEO Dr. Hisham Mahmoud. "Updating our brand isn't just about our logo, it's about sharing our success story more broadly with the world."

According to the company it is much more than a new logo; it is a milestone marker in the company's history, a momentum builder for the future, and a representation of Golder's commitment to its clients and communities.

In its new role, which begins in April, Parsons will support WDBA (the owner) through design review, providing technical advice and monitoring and overseeing the construction activities of the private-sector partner through inspections, compliance reviews and audits. This does not involve the actual design of the bridge, that service will be performed by the private sector team awarded the design, build, finance, operate and maintain contract.

WDBA is concluding its public-private partnership (P3) procurement process, and construction on the new bridge will begin this year.

BUILDINGS

EllisDon team begins $411M Toronto hospital project

A fixed-price contract valued at $411M was awarded to the EllisDon Infrastructure MGH Inc. team to design, build and finance a major redevelopment of the Michael Garron Hospital (formerly Toronto East General Hospital).

EllisDon is the developer, design-builder and financial advisor. B+H Architects and Diamond Schmitt are the design team, while the engineering teams on the project include: Mulvey & Banani International, Crossey Engineering, Stephenson Engineering and WalterFedy.

The project involves renovations within the existing hospital and new construction of an eight-story patient care tower with a three-story podium connecting to the existing hospital.

The scope of work includes approximately 550,000 sq. ft. of new space and 100,000 sq. ft. of renovations.

The expected substantial completion date is September 2023.

AWARDS

Alberta's 22nd Showcase Awards

The Consulting Engineers of Alberta held its 22nd annual Showcase Awards Gala on February 23rd. This year there were 52 projects submitted and 15 Awards of Excellence were handed out along with 11 Awards of Merit.

The Awards of Excellence went to: Arrow Engineering Inc. (Building Engineering – Commercial); DIALOG (Building Engineering – Institutional); RJC Engineers (Building Engineering – Recreational) (Community Development); Hatch (Community Outreach & In-House Initiatives); Stantec Consulting (Environmental) (Sustainable Design) (Transportation Infrastructure – Bridges); Morrison Hershfield (International); Amec Foster Wheeler Environment & Infrastructure (Natural Resources, Mining & Industry); Associated Engineering (Project Management) (Studies, Software & Special Services); SMA Consulting (Small Firm – Big Impact); and ISL Engineering and Land Services (Transportation Infrastructure

Source: Infrastructure Ontario

Rendering of the new Michael Garron Hospital.

DIALOG won a Showcase Award for the Singhmar Centre for Learning, NorQuest College.

– Roads, Interchanges, Airports, Mass Transit & Ports) (Water Resources & Energy Production).

The 2018 Lieutenant Governor's Award went to Ken Pilip, P.Eng., CEO & Registrar, Consulting Engineers of Alberta, and the Harold L. Morrison Rising Young Professional Award was handed to Jordan Brandenburg, P. Eng., a civil engineer with Klohn Crippen Berger.

UBC's Brock Commons – Tallwood House big winner at Wood WORKS! BC Awards

The Brock Commons – Tallwood House located at UBC in Vancouver was the most celebrated project of the 14th annual Wood Design Awards in BC, held February 26th at the Vancouver Convention Centre.

The 18-storey project won in three categories, the Engineer Award, the Architect Award and Wood Innovation Award.

Sharing the 2018 Engineer Award were structural engineering firm Fast + Epp and fire engineering/building code consultants GHL Consultants, both of Vancouver.

In total there were 100 nominations in 14 categories this year.

For complete award results visit wood-works.ca/bc.

S + A adds Associates

Smith + Andersen has appointed four new senior associates and six new associates across its offices in Toronto, Ottawa and Vancouver.

The senior associates include: Rafael Correa, B.Arch., lighting team in Toronto; Elaine Guenette, P.Eng., mechanical engineering in Toronto; Josephine Jordan, C.Tech., electrical team in Ottawa; and Chris McPherson, P.Eng., Toronto's electrical team.

The new associates include: Hani Fadali, P.Eng., Toronto's electrical team; Maria Gallo, P.Eng., Kevin Key, P.Eng., and Bertha Lai, P.Eng., all with the mechanical team in Toronto; James Manson, on the electrical team in Vancouver; and Mike Mitani, P.Eng., a team leader with the Ottawa electrical team.

Nordmin Group adds construction services business

The Nordmin Group, based in Thunder Bay, Ont., has announced the creation of Nordmin Constructors, a company focused on providing full engineering, procurement and construction (EPC) solutions to the mining and industrial sectors across North America and around the world.

The new Constructors business joins Nordmin Engineering, founded in 2005 by Chris Dougherty, and operates as a sister company rather than a division of Nordmin Engineering.

The Nordmin Group has offices in Sudbury, Ont., Kamloops, B.C. and Salt Lake City, Utah.

CHAIR'S MESSAGE

Our Role in nation building projects

The ingenuity and expertise offered by consulting engineers played a key role in past nation building projects, such as the trans-continental railways and the TransCanada highway. Today, our industry has the opportunity help drive Canada's next major nation building idea.

In 1976, a northern national corridor connecting all regions of Canada was proposed by General Richard Rohmer. The concept was to create a pre-established route dedicated to accommodating multiple infrastructure assets; including roads, rail, power, pipeline and communication networks. Such a corridor would make connecting northern and remote communities to vital economic and quality of life enhancing infrastructure economically and environmentally viable. It would eliminate the need for multiple reviews of major projects, allow better consultation with the First Nations and local stakeholders, and require a significantly smaller geographical and environmental footprint than the current fragmented approach. This corridor would also allow for a more efficient and environmentally sustainable way of extracting natural resources, helping to grow Canada's economy.

General Rohmer's idea laid dormant until May 2016, when the University of Calgary School of Public Policy released a paper promoting further study of the corridor idea. The Senate Committee on Banking, Trade and Commerce, interested in the study, released its own report recommending the federal government support additional research and establish a task force to determine how such a corridor could be developed.

ACEC's Board of Directors, recognizing the impact of a northern corridor and the role consulting engineers could play in shepherding this infrastructure project to reality, issued a position statement supporting the development of a corridor. ACEC-Canada has endorsed the Senate Committee's report and continues to promote the idea of a corridor to the government. We hosted a panel discussion on the topic at our recent national conference, co-authored an

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MESSAGE DU PRÉSIDENT DU CONSEIL

Projets d'édification du pays : Le rôle des firmes de génie-conseil

L'ingénuité et l'expertise des ingénieurs-conseils ont largement contribué à la réalisation de projets d'édification du pays. Il suffit de penser au chemin de fer transcontinental ou à l'autoroute transcanadienne. Maintenant, notre industrie a l'occasion de participer à un autre chapitre de l'édification de notre pays.

En 1976, le général Richard Rohmer a proposé de relier toutes les régions du Canada par un corridor national dans le Nord. Son idée consistait à créer un couloir réservé à différents actifs d'infrastructure - par exemple des réseaux routiers, des voies ferrées, des lignes électriques, des pipelines et des lignes de communication. Un tel corridor avait pour ambition de relier les collectivités reculées et du Nord à des infrastructures vitales à la croissance économique et à la qualité de vie, et viables sur le plan économique et environnemental. Cette solution était avantageuse dans la mesure où elle éliminait les multiples examens de projets d'envergure, améliorait les consultations avec les Premières Nations et les intervenants locaux, et laissait une empreinte écologique sur un territoire plus étroit que l'approche fragmentée actuelle. Elle permettait également d'extraire les ressources naturelles de manière plus efficace et plus écologique, ce qui aurait stimulé la croissance économique du Canada.

Mais l'idée du général Rohmer est restée lettre morte jusqu'en mai 2016, lorsque l'école des politiques publiques de l'Université de Calgary a publié un document recommandant de se pencher plus attentivement sur ce concept de corridor. Le Comité sénatorial permanent des banques et du commerce s'est intéressé à cette étude et a publié un rapport recommandant au gouvernement fédéral d'appuyer la recherche sur cette question et d'établir un groupe de travail chargé de déterminer s'il serait possible de créer un tel corridor.

Le conseil d'administration de l'Association des firmes de génie-conseil (AFGC) a pour sa part publié un énoncé de position soutenant la création d'un corridor. L'AFGC estime en effet qu'il serait bénéfique de créer un corridor du Nord et que les ingénieurs-conseils pourraient chapeauter ce projet d'infrastructure pour le concrétiser. AFGC-Canada a endossé le rapport du Comité sénatorial et continue de promouvoir cette idée auprès du gouvernement. Nous avons d'ailleurs organisé une discussion

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ACEC and RAIC collaboration brings QBS closer to reality

Qualifications-Based Selection (QBS) encourages a strong alignment of the objectives of design consultants and their clients – resulting in more innovation, higher quality and significant life-cycle savings on projects.

By Don Ardiel, Royal Architectural Institute of Canada

ACEC and the Royal Architectural Institute of Canada (RAIC), through close collaboration, have been effective advocates of QBS to the federal government. RAIC's Director of Practice Support Don Ardiel summarizes some exciting developments in the promotion of QBS resulting from the ACEC-RAIC partnership.

The Royal Architectural Institute of Canada (RAIC), the Association of Consulting Engineering Companies – Canada (ACEC) and the Interiors Designers of Canada (IDC) are moving ahead on negotiations with the federal government and have begun the consultation process for its long-awaited plans for the Qualifications-Based Selection pilot project. The Standing Committee on Government Operations and Estimates was treated to an impassioned presentation from ACEC's President and CEO John Gamble in support of Qualifications-Based Selection.

QBS PILOT BY PSPC

Years of relationship building resulted in a successful Qualifications-Based Selection (QBS) workshop on September 18, 2017. Hosted by Public Services and Procurement Canada (PSPC) Assistant Deputy Minister Arianne Reza, Toon Dreesen of RAIC led the discussion with ACEC President and CEO John Gamble, Cal Harrison of QBS Canada, and Mark Steiner of the American Council of Engineering Companies. These industry leaders told the audience of federal officials that best value in delivering successful projects is achieved through selecting architecture and engineering consultants based on their qualifications, not the lowest fee.

The ongoing advocacy efforts by RAIC and ACEC for QBS are paying off. On February 6, 2017, PSPC issued a request for information to consult with the public on how best to approach Qualifications-Based Selection for federal projects.

THE STANDING COMMITTEE ON GOVERNMENT OPERATIONS

"We're trying to do timely delivery. We're trying to do fiscally responsible delivery, and we're trying to encourage quality and innovation. And at the centre of this is, of course, the public interest and the taxpayers' dollars."

This is how John Gamble, ACEC President and CEO, began his testimony to the House of Commons Standing Committee on Government Operations and Estimating in Ottawa on February 6, 2017.

Mr. Gamble presented a strong, articulate, and passionate argument for the adoption of Qualifications-Based Selection (QBS) in hiring architects and engineers.

"I would suggest to you that the engineering fees and the architectural fees that you pay at the beginning of a project should not be viewed as an expense to be minimized but as an investment to be leveraged."

The ability to optimize capital investment, design with new materials, and implement state-of-the-art processes is best achieved when the procurement processes used to hire architects and engineers seek to reward rather than discourage innovation, he said.

"What we find is that when the lowest price is assumed to be the best price, proponents will minimally interpret the scope of work in order to be competitive. That means they're not looking at alternatives. They're not looking at the value adds."

Mr. Gamble provided parliamentarians with a clear Qualifications-Based Selection (QBS) roadmap to achieve superior outcomes in federal capital investment and improved business opportunities for Small and Medium Enterprises (SME) and large architecture and engineering firms.

"At the end of the day you want to make sure you have the right team for

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the right job, and they have adequate resources to deliver on what you have committed to the Canadian taxpayer. I would suggest that the lowest price is not the best price; the right price is the best price."

The RAIC, ACEC, municipalities, and public agencies across Canada support QBS for its ability to leverage the best results from creative design professionals, said Mr. Gamble. The ability of design professionals to innovate has never been more in demand than now with federal government mandates to drastically improve the energy and functional performance of their capital assets while at the same time supporting social procurement and small and medium-sized enterprises.

"In summary, you get the right outcomes, the right team, realistic schedules and budgets, fewer change orders and disputes, a better business relationship, and at the ends of the day, better service, better quality, and better value for taxpayers."

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op-ed with the Chair of the Senate Committee, and endorsed a funding application by the University of Calgary to continue its development of a feasibility study for a corridor.

Federal Transport Minister Marc Garneau said the government "agrees with the committee's finding that improving national transportation and communication networks will encourage economic growth and facilitate exports." This is a positive first step toward making a northern corridor a reality.

A northern national corridor would be a game changer for Canada, strengthening and uniting our nation. Our industry can and should play a leadership role in making General Rohmer's idea a reality. I encourage you to learn more about this nation building opportunity and how you can support ACEC's efforts in moving this idea to reality.

TODD G. SMITH, P.ENG.
CHAIR, BOARD OF DIRECTORS, ACEC-CANADA

suite de la page 9

d'experts sur la question lors de notre dernier congrès national. Nous avons également publié une lettre d'opinion signée par le président du Comité sénatorial et par le président et chef de la direction de l'AFGC. En outre, nous avons appuyé une demande de financement soumise par l'Université de Calgary pour réaliser une étude de faisabilité sur la mise en place d'un corridor.

Le ministre des Transports, Marc Garneau, a déclaré que le gouvernement « souscrit aux conclusions du Comité sénatorial relativement au bien-fondé d'un réseau national de transport et de communication, qui favoriserait la croissance économique et faciliterait les exportations ». Il s'agit d'un premier pas constructif vers la concrétisation du projet de corridor national dans le Nord.

Un corridor national dans le Nord changerait la donne au Canada en consolidant et en unissant davantage notre nation. Notre industrie pourrait et devrait jouer un rôle de premier plan pour concrétiser l'idée du général Rohmer. Je vous invite à prendre connaissance des tenants et aboutissants de ce projet d'édification du pays et à découvrir comment vous pouvez participer aux efforts déployés par l'AFGC en vue de concrétiser cette idée.

TODD G. SMITH, P.ENG.
PRÉSIDENT, CONSEIL D'ADMINISTRATION, AFGC-CANADA

Vancouver's SkyTrain on the Canada Line, Marine Drive Station.

Getty

PLANNING FOR MORE DRIVERLESS TRAINS

While the vision of autonomous, or self-driving, automobiles navigating our roads remains a glimpse into the future, the reality of automated "driverless" trains shuttling commuters on public transportation services around the world is a growing trend today.

Automatic Train Operation (ATO) technology allows transit systems to ultimately improve the capacity, speed and the regularity of trains, while also reducing operating costs.

According to the International Association of Public Transport (UITP), by 2025 some 2,300km of driverless metro lines will be in operation globally, compared with around 800km today. Vancouver's SkyTrain is currently the longest ATO in North America (79.7km), and the recently-announced Réseau express métropolitain (REM) line in Montreal, breaking ground this year with operation slated for 2021, will run 67km making it the fourth longest worldwide after Singapore, Vancouver and Dubai.

The REM light rail transit (LRT) line with be electrified with an overhead catenary system, while Vancouver's uses a third rail electrification system.

To gain some insights into the design considerations and trends in electric rail transportation systems today, we posed questions to the experts at SNC-Lavalin's Rail & Transit Engineering team.

Responses were provided by Richard Catlow, I Eng., director, power supply & distribution Canada Central, and Adam Christian, vice president, Western Canada.

Can you discuss major design differences between third rail and catenary electrification with respect to design benefits for each.

Both third rail and catenary systems have their own benefits that factor into the decision on which to use in a particular application.

For LRT systems that operate at grade or in street settings, the choice to adopt a catenary system is usually based on the need to avoid people or objects coming into contact with the electrified infrastructure and hence raising the conductor makes sense, although it does not eliminate the danger entirely.

Some traction power equipment manufacturers have reduced this danger for third rail systems by developing a novel segmented design that only supplies the section of conductor rail that is occupied by the train, although it is expensive and requires more maintenance than a catenary or power rail.

On networks that use segregated guideways third rail can be used, as the risk of objects or people coming into the contact with the conductor is limited by the design of the infrastructure, although again, the danger is not eliminated entirely, particularly at stations.

Modern variants of power rail typically adopt an inverted contact face at the bottom of the rail and shroud the side and upper faces with insulating material to improve safety. Power rail systems may also operate in small tunnels - particularly older systems - and therefore there simply isn't the

space available to install overhead catenary.

Power rail systems are also avoided where climatic conditions are expected to produce regular icing or snow, because heating the power rail to de-ice it requires a lot of energy due to its specific heat capacity and (for some systems) complicated electrical isolation between the heating element and the power rail itself.

Catenary, with its smaller conductors, is much easier to de-ice through circulating currents and due to the smaller cross section area which leads to smaller ice accretions.

Overhead catenary generally requires the envelope of the railway to be larger than for a power rail to accommodate the overhead lines and supporting structures and to maintain electrical safety clearances within prescribed limits. This can increase the height of overbridges and tunnel dimensions.

Increasing use of a "conductor beam" which is a rigid aluminum extrusion into which a standard copper contact wire is let, can considerably reduce the required dimensions, but the beam requires supports typically at 5m centres, as opposed to 50 or 60m centres for conventional wiring.

Power rail systems generally require less design effort and are quicker to construct than catenary systems, but as has been noted, they are only suitable for a small selection of potential projects.

Third rail systems conduct a DC power supply whereas overhead catenary systems can conduct DC and AC. AC systems use higher voltages and because of the correspondingly lower currents than a DC system for a given power output, incurring significantly fewer I2R [energy] losses in the overhead conductors.

AC systems allow higher train powers and greater substation spacing than a comparable DC system, and the substations are less complex because AC to DC converters (usually rectifiers) are not needed.

AC systems are usually arranged to connect to transmission level voltages because they take a single phase load that causes unbalance on the network (which must be limited to avoid damage), although newer technology now allows increasingly economic phase balancing and facilitates connection to lower voltage levels that are more economical to connect to.

There are benefits and constraints with both systems that are usually evaluated on a "whole system basis" including the trains and signaling systems at early stages of a project where the cost and technical implications of the electrification system choice are evaluated across the other relevant equipment and systems.

In general, modern application of DC systems is in metros, underground railways and light rail, and AC electrification for commuter rail, heavy haul freight and higher speed networks. There is a blurring of these lines in many cases and some metros have adopted 25kV and some new commuter rail has adopted 1500V or 3000V DC.

Many legacy systems around the world with heavy loads continue to operate and expand DC systems, because the cost of wholesale conversion to AC is very expensive and disruptive to the network.

What makes automated train operation (ATO) systems unique from an electrical engineering planning perspective?

ATO systems are typically more consistent in terms of power demand as the variability of driver behavior is removed. Of course, when an ATO system is attempting to make up for a delay then it may recover time by driving more intensely until the service returns to normal.

However, in normal operation the system will drive similarly according to the timetable and time of day, which will affect passenger loading, dwell times and possibly headways.

The power demand requirements are largely dictated by the design and quantity of rolling stock, signaling headways and how it is operated (as well as external factors such as climate).

Some operators who have converted from manual driving to ATO operation have reported noticeable increases in energy use and higher peak currents once ATO operation was implemented. This is due to the ability to drive the vehicle more accurately than human drivers, allowing the trains to be driven "harder".

A rendering of the Panama Rive-Sud station for the proposed REM automated LRT project in Montreal.
(Image courtesy REM)

Early ATO systems generally used a single driving mode (usually focused on obtaining maximum performance). Later generation ATO systems flex the driving mode to recover time, to maintain the timetable, or to minimize energy consumption.

ATO systems were traditionally deployed to allow shorter headways between trains than could be achieved with manual driving. Systems with three-minute headways are charac-

terized by higher mean to peak current ratios and higher RMS [root mean squared] currents, when compared with parts of a network which may only have 15 or 20 minute headways. With DC systems, this generally leads to a reduced substation spacing and increased equipment ratings for the intensive parts of a network to avoid violating a number of safety and operational criteria.

How is station design different for automated "driverless" trains?

For typical urban LRT and metro systems, the primary considerations for the functional elements of station design are: a) safety, b) capacity, and c) minimizing dwell times. For driverless systems, achieving these objectives relies more heavily on the wayside and vehicle systems as well the station facilities, including platforms, walkways, escalators etc.

The absence of a driver means that the installed systems must be capable of detecting unsafe situations and reacting in a safe manner to avoid consequential incidents. For example, if a person falls from a station platform into the guideway, the systems must be able to detect the incident and prevent trains from entering the station until it's safe.

Typically, a Guideway Intrusion Detection System (GIDS) will be installed that detects the presence of a person or object in the guideway and, through communication with the Automatic Train Control (ATC) system, will prevent trains from entering the affected zone. The GIDS effectively acts as the driver's eyes in terms of "seeing" that an intrusion has occurred, but it does not require the train to be within sight of where the incident has occurred to be effective, as would be the case in a driver-only system (with no GIDS).

Some systems have gone a step further and installed platform screen doors, which provide a barrier between the platform and the guideway when no trains are present in the station and automatically open when the train arrives and is stationary to allow access and egress of passengers.

In addition to GIDS and platform screen doors, driverless systems rely upon CCTV systems to provide the control centre with real-time images of stations, passenger movements and incidents. The combination of the detection systems and CCTV provide the control centre staff with a more complete picture of any situation and can be used to permit the return to normal operations, once it is confirmed that an unsafe situation has been rectified.

Are there examples of existing transit systems being converted to Automated Train Operations?

Converting existing systems to ATO or ATC has occurred on networks such as London Underground. To do so requires an upgrade of the train control system and the installation of equipment onboard the trains.

The benefits of ATO on high capacity/high frequency networks are clear in terms of service performance and reliability, so the opportunity to convert existing transit systems is there if the infrastructure is suitable for driverless operation, i.e. consists of entirely segregated guideway (elevated, below ground or protected at grade).

Current technology does not yet permit driverless trains to operate safely in urban or densely populated areas where interactions with objects or people entering the guideway at places other than stations may occur, e.g. level crossings or along unprotected sections of the guideway.

However, in Western Australia the mining companies and the railroads have successfully implemented driverless freight trains that operate in relatively remote locations on dedicated tracks, so the technology is always evolving. **CCE**

Fire Safety Challenges in Data Centres: UNINTERRUPTIBLE POWER SUPPLY BATTERIES

As new battery technologies are introduced, issues like thermal runaway need to be understood and addressed.

By Cel Chow, P. Eng.

The fire protection of data centres has become more and more challenging with the introduction of the uninterruptible power supply (UPS) batteries using the most advanced energy storage technology.

Traditionally, lead-acid batteries paired with uninterruptible power systems were often used. Over the years, the introduction of alkaline and nickel-based batteries provided impressive progress to improve the battery performance.

Recently, the newly developed lithium-ion batteries offer more power, smaller battery space, longer run time and shorter charging time. However, despite these advantages, the rechargeable lithium-based cells require special care in their electrical and mechanical design, and arrangement, to avoid a potential overheating problem during the charging and discharging process because of thermal runaway.

Danger with Thermal Runaway

Thermal runaway is an energy release process accelerated by the increasing temperature of cells during use or overcharging.

The elevated cell temperature draws more charging current, causing additional heat buildup within the cells. This phenomenon is generally caused by an internal short circuit in an individual cell or when the cells are exposed to intense heat and cascades into a self-sustaining reaction.

Smoke is usually observed emanating from the cells, however it is generally not accompanied by a flame. However, if the cells are arranged and installed in a compact manner, this behavior may be completely different and explosions can sometimes occur.

Code and Design Standards Requirements and Guidelines

Both the National Building Code of Canada and the National Fire Code of Canada do not have any fire protection requirements for energy storage systems.

A new National Fire Protection Association (NFPA) Standard, 855, Standard for the Installation of Energy Storage System, is in development. In the meantime, NFPA 1, Fire Code, Chapter 52 Energy Storage Systems, introduces the following new requirements for energy storage system:

1. More than 100 gallons (US) electrolyte capacity in a sprinklered

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building for lead-acid and nickel-cadmium batteries

2. The maximum allowable quantities of 600 KWh for lithium, sodium and flow batteries, and 200 KWh for other battery technologies in a fire rated compartment.

NFPA 1 also requires hazard mitigation analysis. A Failure Mode and Effects analysis (FME) must be provided to the Authority Having Jurisdiction when any of the following conditions are present:

Battery technologies are not identified in NFPA 1, Chapter 52 or the quantity of the specified battery exceeds the specific threshold in NFPA 1 Chapter 52.

More than one storage battery technology is provided within the compartment.

The analysis shall evaluate the consequences of the following failure conditions:

1. Thermal runaway
2. Failure of a battery management system
3. Failure of a required ventilation system
4. Voltage surges on the primary electric supply
5. Short circuits on the load side of the stationary battery storage system
6. Failure of smoke detection, fire suppression, or gas detection system.

Measures to Prevent Thermal Runaway

Thermal runaway can be prevented by providing favourable working conditions for the batteries and regular preventive maintenance.

A higher battery room temperature will shorten the service life of the batteries. It is advised to maintain the battery room ventilated with a temperature not exceeding 25 degrees C.

A scheduled battery replacement program shall be in place for the aged or failing batteries according to the battery manufacturer's maintenance recommendations and related industry standards.

The last, but not least, measure is to establish a preventative maintenance program on the UPS and batteries to test impedance, resistance and voltage.

Additional Fire Prevention Measures for Critical Data Centres

If a data centre with an unoccupied battery storage room is classified in the Level 3 category, which contains essential or irreplaceable equipment where its loss would cause a critical delay in resuming operations, an oxygen reduction fire prevention system could be installed in the centre.

Oxygen reduction fire prevention systems create an environment that prevents the formation of fire and smoke. In general, the air in the room supporting a fire will likely contain at least 17% of oxygen in volume. This type of fire prevention system continuously reduces the oxygen concentra-

tion throughout the room to 15% to prevent ignition of most combustibles, including plastic materials, by introducing nitrogen into the room from a nitrogen generator.

This system was originally developed for preventing fires in nuclear power plants' electrical appliance rooms.

In Sweden, Lund University has conducted fire tests proving that most plastic materials will not burn in an atmosphere with oxygen concentration of 15% or lower, however, lithium and lithium-ion batteries were not tested.

Some studies demonstrate that a decrease of oxygen concentration led to an increased ignition time for most combustible materials. It is also apparent that the reduction of the oxygen concentration in an environment will inhibit or delay the start of the electrical equipment and the batteries but fast fire growth, flame spread and explosions will not likely occur.

In Europe, these systems are commonly used in data centres as well as in warehouses for frozen goods, cellulose products, lithium battery storage and hazardous materials.

This system is presently approved by European Approval Agencies such as Vds (Germany), POJTES (Russia) etc. and case by case (project) approvals in UK, Sweden, France and others.

There is currently no North American approval or NFPA standard developed for these fire prevention systems. In fact, systems that result in the oxygen content being less than 19.5% are not permitted for occupied spaces without providing employees supplemental respirators by federal regulation (OSHA) in the United States.

In conclusion, if a facility is not normally occupied by employees, and is very critical to the facility operation, such as remotely-controlled military, weather or communication stations, provision of an oxygen reduction fire prevention system is a good option for fire prevention.

With the marked increase in the deployment of batteries using the most recently developed technologies in data centres, a thorough assessment on the fire prevention of the energy storage systems is critical to the fire protection professionals providing a safe environment to the high-tech industry. CCE

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Lithium Ion Batteries: THE EVOLUTION of UPS

By David O'Reilly

An uninterruptible power supply for emergency back-up is essential when designing and implementing a data centre.

An outage to a business' data centre can have a critical impact on operations, resulting in loss of vital data, security, or revenue. To avoid such a situation, an uninterruptible power supply (UPS) for emergency back-up, such as a battery, is essential when designing and implementing your data centre.

Choosing the correct UPS solution requires careful thought and consideration to a client's unique server room or data centre needs. There are several options on the market, from wet cell battery solutions to valve-regulated lead-acid (VRLA) batteries. However, a recent addition to the market may revolutionize the way data centres are powered from now on: the Lithium-Ion (Li-ion).

The Li-ion battery solution brings a number of advantages over the traditional VRLA:

- 40 to 60% less footprint
- 60 to 70% less weight
- Faster recharge time
- Up to three times the expected life
- Ten times the number of cycles
- 30 to 50% savings in Total Cost of Ownership due to reduced maintenance requirements

Looking at these statistics, choosing Li-ion would seem to be the most sensible choice for new UPS seekers. But what about UPS owners that already have a battery system in place? Is converting existing batteries to Li-ion a good idea? Does it make sense?

Racks of VRLA batteries require space and weight considerations.

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To determine if a Li-ion battery conversion is a fit, consider these key factors.

Reduced footprint and weight

If a business looks at data centre space (most likely whitespace) as a precious commodity — whether a business enabler, or revenue centre — then it is possible reduced space equates to increased revenue generation or production. But what about reduced weight; how does that benefit a UPS owner? Reduced weight is important for those owners who are located above the ground floor. Have you ever had to constrain your battery or equipment floor loading due to weight restrictions? If so, you may benefit from Li-ion. In fact, Li-ion can also serve as an efficient way to solve that old generator problem too.

Longer life expectancy

Li-ion batteries are expected to last more than 10 years, reducing the burden and cost of battery replacements.

Reduced cooling capacity

Li-ion batteries are more tolerant to higher temperatures. How does this benefit a UPS owner? Simply put, if your data centre or battery room design is calculating cooling needs for batteries, then Li-ion may help save utility costs due to cooling batteries.

Integrated battery monitoring system

Li-ion batteries for UPS systems come standard with an integrated Battery Monitoring System (BMS) that provides a clear picture of battery runtime and health. Other battery solutions do not come standard with BMS and require a fair amount of on-site labour to install.

First in Canada

As a relatively new technology in the UPS space, some may be a bit hesitant to try it out while Li-ion is still in the initial phase. Results, however, show the technology is finding great success globally among early adopters.

In Canada, Edmonton-based F12.Net is among the first to use Li-ion in the country. F12 offers comprehensive managed IT programs — including IT strategy, cloud services, disaster recovery planning, simplified employee onboarding, and cybersecurity — to enhance its customers' productivity.

Last year, F12 decided to complement its existing data centre in Edmonton with a new, fully-hosted facility in Toronto. Top of mind for the new facility was energy reliability — to deliver clean, reliable power to its IT infrastructure so that customer data is accessible 24/7 without any unexpected downtime.

Schneider Electric worked with F12 on the deployment, which included EcoStruxure-ready Galaxy VM power protection, StruxureWare for Data Centres software, and the Li-ion. The original plan was to use a standard VRLA battery like in its Edmonton facility, but when F12 learned about all the advantages of the Li-ion, it left a lasting impression and convinced the company to go with the new solution.

To date, F12 is seeing great results with the new Li-ion UPS solution and is looking to be among the first of many companies in Canada to embrace the technology. CCE

David O'Reilly is Vice President & General Manager of the Schneider Electric IT Solutions Division in Canada.

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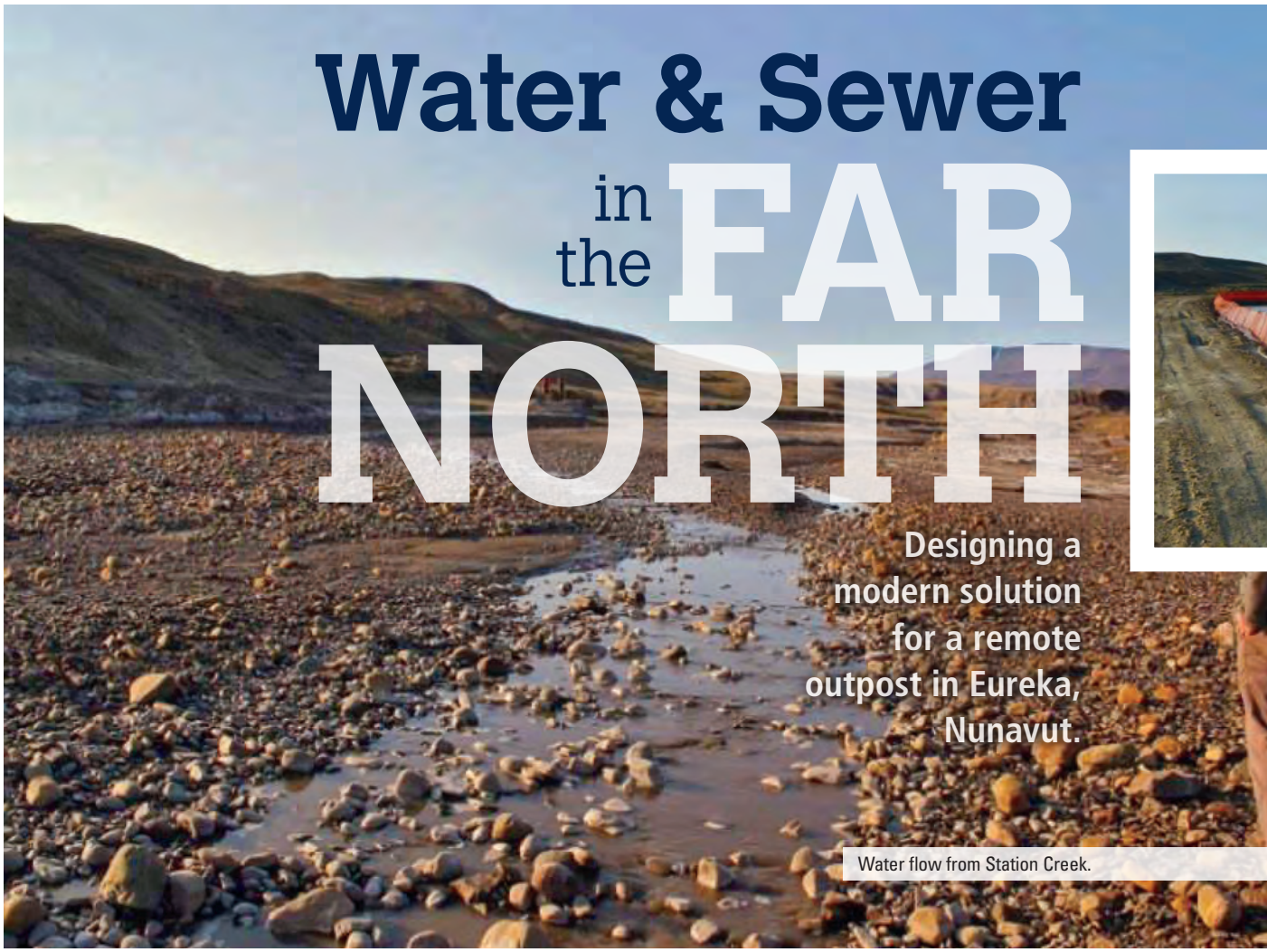
Water & Sewer in the FAR NORTH

Designing a modern solution for a remote outpost in Eureka, Nunavut.



Water flow from Station Creek.

By AECOM

Eureka, Nunavut was founded in 1947 as a small research base, designed to be part of a network of Arctic weather stations. Located on Slidre Fjord in the Qikaqtaaluk Region midway up Ellesmere Island, the outpost is about 1,110km from the North Pole where average temperatures in February are -37°C.

Isolated and remote, the site is the second-most northerly permanently inhabited site on Earth—Alert, Nunavut is number one, only 817km from the North Pole. The facilities in Eureka include the main High Arctic Weather Station, the Polar Environment Atmospheric Research Laboratory located 10km west of the Station, and Fort Eureka located adjacent to an airstrip approximately 1km east of the Station.

The Weather Station, which houses a rotating population, has an existing raw water reservoir and treatment package plant and a lagoon for treating its wastewater. AECOM's Canada business was retained to provide a more reliable water supply for the Station and to modernize the wastewater system to satisfy more stringent effluent discharge requirements.

Water supply

The design for the water supply involved decommissioning the existing reservoir which was leaking and located in the vicinity of contaminated soils. A new raw water reservoir, lined with multiple geotextile layers, was designed to provide watertight storage and protection from underlying site conditions.

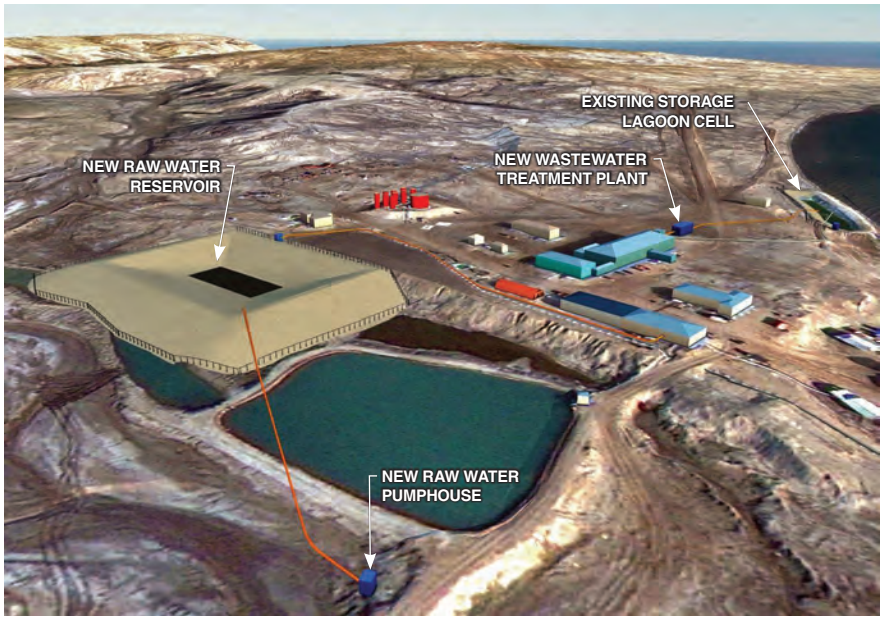
Water flow in the area comes from the run off of melted snow between late June to late August. The stream follows a well-worn creek bed which empties into the Arctic Ocean.

To capture water for the new reservoir a pump house will be installed near the discharge point of creek into the ocean, and a temporary 75 mm suction pipe will be extended into the creek's water flow to transfer water to the reservoir.

At the reservoir a well pump will be located within an inclined shaft along with a water supply line to draw water directly to tanks within an existing insulated raw water tank room.

The Station's water treatment plant uses ion exchange softening to remove hardness for utility water, and that's paired with reverse osmosis (RO) filtration for drinking

Below: The existing raw water reservoir. Right: The existing wastewater lagoon in summer. Bottom: The proposed reservoir location and site plan.



water. AECOM assessed the existing condition and recommended that the process not be altered; however there will be a new prechlorination system.

Wastewater treatment

Nunavut's wastewater effluent limits relative to the Wastewater Systems Effluent Regulation (WSER) do not directly apply to Eureka as they are for systems delivering greater than 100 m^3/day, and the Eureka Station only averages 5 m^3/d. However, a new system was designed to meet future WSER effluent requirements.

Eureka's existing wastewater lagoon, used for both treatment and storage, consists of a single facultative cell providing treatment with a seasonal discharge during two months of the year when the lagoon is not frozen.

During the winter, biological activity is extremely slow and the treatment process is reduced primarily to the settlement of solids. The effluent quality will not approach WSER limits for most of the key parameters.

The recommended solution is the installation of a Moving Bed Biofilm Reactor (MBBR) treatment process, a more compact and less complex technology when compared with other mechanical treatment systems such as membrane bioreactors (MBR) or sequencing batch reactors (SBR).

MBBR is a submerged attached growth process using a conventional aeration tank with a synthetic packing material suspended in the tank.

In Eureka, heating and power is provided by diesel generators, so it was important to minimize the footprint and energy consumption of the treatment unit.

Treated effluent for the proposed wastewater treatment system would be discharged to a retention basin constructed in place of the existing wastewater lagoon. An overflow will be provided so that the retention basin can naturally discharge to the ocean during summer operation.

Containerized convenience

The MBBR treatment process can be preinstalled in an insulated intermodal shipping container, with the sludge dewatering process installed in a similar container. The preassembled system is designed so the majority of the on-site installation would be limited to connections to existing piping and power.

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But you steadied me. As you
always did. Thousands watched...
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as I wish you were here.

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Design of the proposed containerized wastewater treatment plant.

All of the mechanical stations, including the creek pump station (feeding raw water to the reservoir), the raw water reservoir pump station (transferring water to the water treatment plant), the retention basin pump station (discharge retention basin to the ocean) have also been designed to be installed within insulated containers and preassembled as much as possible prior to delivery.

All outdoor piping was designed to be pre-insulated with 75 mm rigid polyurethane foam and covered with a 1 mm factory-applied galvanized lock seam, spiral steel, outer jacket. Galvanized cladding was used over HDPE, as it has a lower coefficient of temperature expansion and it provided protection from inquisitive wildlife.

To ensure protection against freezing, an electric duplex heat tracing system was designed to provide 20 W/m for raw water pipes and 13 W/m heating for wastewater pipes. By installing a duplex system, the backup heat tracing can be used in the event of a failure until the weather or daylight conditions improve with summer.

The project will supply 22 months of raw water storage, with accommodation for up to 2.4 meters of ice and temperatures as low as -55°C, and the new containerized biological wastewater treatment process will meet future WSER guidelines. This project received the 2017 Keystone Award at the ACEC Manitoba Awards of Excellence. CCE

Arctic water and wastewater treatment design, Eureka, Nunavut	
Owner:	Public Services and Procurement Canada
Consulting firm:	AECOM

LIABILITY ISSUES

Avoiding litigation through mediation and arbitration

By Philip Carson, Miller Thomson LLP

Getty

An engineer has several ways to protect itself from liability, including working only within defined areas of practice competence, careful peer review to limit errors, comprehensive insurance, and careful contracting to limit liability exposure.

An engineer is best served by negotiating contractual terms that include a well defined scope of work and defined events that require field review. A contract should include limitations of liability that, among other things, exclude consequential damages and limit liability to the policy limits of the engineer's liability insurance. Last but not least, a contract should include defined dispute resolution procedures.

While there are many steps that can be taken to protect an engineer in the event of a dispute, there is little that an engineer can do to prevent litigation when faced with a determined claimant.

Binding arbitration can be an effective dispute resolution mechanism, as it is generally a faster and less expensive process than court, and is final with little room for appeal. As well, the proceedings and outcome in arbitration are confidential.

The commitment to proceed to arbitration is almost always made at the contracting stage with the inclusion of an arbitration clause in the agreement. As an example, the ACEC Document 31 – Engineering Agreement between Client and Engineer, contains mandatory arbitration wording that refers disputes to arbitration under CCDC40 "Rules for Mediation and Arbitration." Accordingly, all disputes between the owner and engineer will be decided in arbitration.

The difficulty arises when the dispute involves more parties than just the engineer and owner, as arbitration can be compelled only among parties who have all agreed to arbitrate. If even one party to the dispute is not bound by arbitration, a court will be unlikely to require the parties to proceed through arbitration.

In many situations, such as building construction, claims against engineers can come from several directions and several parties. An owner may dispute the fees, or have claims related to the function, operation or cost of the completed project. A general contractor or subcontractor may have a claim against the owner or general contractor for extras or delays, and then the owner blames the engineer and everyone blames the subcontractors.

It is not unusual for claims to involve six or more parties. In those kinds of circumstances it may be nearly impossible to bind all parties to arbitration after the fact.

With careful planning and cooperation between the owner and engineer, binding all parties to arbitration can be achieved at the contracting stage by using an integrated set of contracts that have mutually compatible arbitration provisions. If the prime consultant is involved in developing and issuing tender documents, the prime consultant should have some influence over the contract documents.

As an example, the CCDC forms of agreement provide for arbitration as between the owner and general contractor. The accompanying trade subcontract issued by the Canadian Construction Association ("CCA 1- stipulated price subcontract") mirrors the arbitration provisions in the CCDC forms of agreement, and they all reference CCDC40 "Rules for Mediation and Arbitration" as the guide for dispute resolution.

Most importantly, the subcontractor is bound to arbitration in a dispute that involves the owner and the general contractor. If the contracting is consistent throughout the contracting chain, a multi-party dispute can be arbitrated.

Similar wording can be incorporated in the engineer's contract and in the various contractor and subcontractor documents to ensure that all disputes proceed through arbitration.

Where industry standard contracts are not used, customized contract documents can build in the same kind of wording. It is essential that any customized contracts be reviewed by a lawyer and that they prescribe mutually consistent mechanisms for arbitration.

Mediation is a process by which a mediator facilitates a settlement meeting and tries to bring the parties to a negotiated resolution. Regardless of whether a contract requires mediation, parties often refer their disputes to mediation in an effort to avoid litigation. The best way for multi-party disputes to be effectively resolved is through mediation, as the expense and time required for a trial can be prohibitive.

There is a saying that a good mediated outcome is one where all of the parties are equally disappointed by the agreed result.

Essentially, all parties have to be prepared to concede something in the interest of avoiding risk, expense and time commitments.

Disputes cannot be avoided, but with good planning at the contracting phase an engineer and owner can set the stage for efficient dispute resolution. **CCE**

Philip Carson, is a partner at Miller Thomson LLP, pcarson@millerthomson.com.

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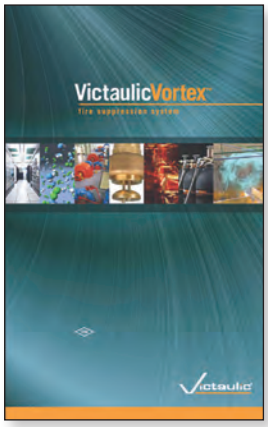

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Carrier has announced that its AquaEdge 19XR water-cooled centrifugal chillers, 23XR water-cooled screw chillers and AquaForce 30XV/XA air-cooled screw chillers are compatible with both R-134a as well as lower global warming potential (GWP) option R-513A refrigerant.
www.carrier.com/commercial

Two new Minicore energy recovery ventilators (ERVs) from Ruskin, the enERVent models MCV500 and MCV1000, exceed 50 to 60% total energy recovery effectiveness with 0.5% cross-contamination. The heat exchanger technology exceeds ASHRAE 90.1 standards. The ERVs are also AHRI 1060-certified.
www.ruskin.com

The Bosch Buderus SSB industrial boilers are designed with a small footprint, minimal clearance requirements and output ranges from 800 to 4,096 MBH. Each boiler has two independent heat exchangers which can be operated individually. The boilers can be cascaded on either side.
www.bosch.ca

WATER TREATMENT

The Qdos 20 pump from Watson-Marlow Fluid Technology Group offers sodium hypochlorite metering in disinfection applications with flow rates to 32 gallons/hr at a maximum of 100 psi—suited for water treatment plants injecting into water lines at higher pressure.
www.watson-marlow.com

Vancouver-based CORE Energy Recovery Solutions, developer and manufacturer of energy recovery ventilation (ERV) components, has been formed from the merging of Canada's dPoint Technologies and Germany's PAUL Wärmerückgewinnung.
core.life

Schneider Electric donates to Ryerson's Smart Building Lab

Caption: (l-r) Adrian Thomas (vp, buildings, Schneider), Tom Duever (Dean, faculty of engineering and architectural science, Ryerson), Jenn McArthur (assistant professor, architectural science, Ryerson), Juan Macias (sr. vp digital energy solutions, Schneider), Dr. Mohamed Lachemi (president, Ryerson), Steven Liss (vp, research and innovation, Ryerson), Ian Mishkel (vp, alumni relations, Ryerson), Alan Fung (associate professor, mechanical and industrial engineering, Ryerson) and Bala Venkatesh (academic director, centre for urban energy, Ryerson).

Schneider Electric Canada is donating $1 million in kind to design and build a new Smart Building Analytics Living Lab at Ryerson University—the first of its kind in Canada. The lab, expected to open late 2019, will be used by students in engineering and architectural science to demonstrate savings in energy consumption and in capital and operating expenses for buildings of all sizes.

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By Bronwen Parsons

Thoughts on Design

A collection of essays by Ron Britton is a rare work — the product of someone who thinks deeply about the issues facing Canadian engineers.

When super-nerdy theoretical physicist Sheldon Cooper on CBS' The Big Bang Theory dismisses Howard Wolowitz for being "just an engineer," it always gets a laugh. But for Professor Ron Britton, P.Eng., the fact that engineers often don't command the same respect as scientists is a serious problem. It not only discredits the profession, he believes, but also stumps innovation and affects Canada's economy.

Science vs. engineering is just one of the themes Britton explores in On Design: A Philosophy of Design and Engineering (2017, Friesen Press, Victoria, B.C.). The book is a 300-page compendium of short columns Britton published over 15 years in the Keystone Professional, the magazine of Engineers Geoscientists Manitoba (formerly APEGM).

The result is a rare beast, the production of a Canadian civil engineer who has thought deeply about professional issues and how students should best be educated and trained. It treats these subjects seriously, but also with humour and readability. It covers wide ground, learning from events like the 2011 Fukushima disaster and the 2010 Toyota car recall, and citing the thoughts of everyone from Plato to Sir Arthur Canon Doyle.

At a time when most engineering professors concentrated on research, Design Chairs in Engineering were established to refocus on teaching practical design.

Britton, a professor (now retired) at the University of Manitoba, was one of the first five Design Chairs in Engineering launched in 2001 by the Natural Science and Engineering Research Council of Canada (NSERC). At a time when most engineering professors concentrated on research, the chairs were established to refocus on teaching practical design. Britton himself had five years of work experience, first as an agricultural engineer designing farm building structures in Manitoba, then as a specialist for the wood industry, including a stint in London. He returned to school, earned a Ph.D at Texas A&M, and took up professorship at the University of Manitoba. According to U of M dean emeritus Douglas Ruth, "... Ron has had perhaps more influence on engineering education in Canada than any other academic."

Much of the time Britton wrestles how to define engineering design and how it should be taught. But for the practising engineer who takes up this book, his personal anecdotes provide some of the most memorable passages.

Early in his career, for example, ("Responsibilities," p. 197), Britton had just been hired by a large timber company when the president sent him to Toronto to sort out a messy situation. Three of the top salesmen there were substituting materials, resulting in inferior buildings. When young Britton fired the salesmen and ordered the affected structures to be upgraded, the irate Toronto manager accosted him and demanded a retraction. But the president of the company stood behind Britton. It was a lesson he never forgot: that the president had relied on him because as a professional engineer he had signed the Code of Ethics and therefore would put things right in a dishonest situation.

Another personal anecdote appears in "Can we be trusted?" (p. 271). In the wake of the Elliot Lake mall collapse and the Lac Megantic train inferno, a journalist from the National Post reached out to Britton. The journalist's e-mail said he was researching for an article on "how we value life—or more to the point, how much we will spend to save one."

Noting that in an emergency room no expense is spared, he wanted Britton's opinion on "how much engineers value safety during the design process of, say, a bridge. I'm wondering if we could always make things safer but draw the line at a certain point for the sake of cost and efficiency."

It's a great question and one that flummoxed Britton somewhat. He spent an hour talking with the journalist, but felt dissatisfied with his own response. He doesn't know if the article was ever written and saw the light of day.

By raising these kinds of discussions, this book provides a treasure trove for anyone who, like Britton, likes to grapple with the underlying ethical and professional forces that are shaping engineering today. CCE

On Design: A Philosophy of Design and Engineering is available in electronic, soft and hard cover, at www.amazon.ca.

Bronwen Parsons was the Editor of Canadian Consulting Engineer from 1997-2016.

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