BUILDING SOLUTIONS FOR AEC PROFESSIONALS

CONSTRUCTION CANADA

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DESIGNING SAFE CURTAIN WALLS

NBC 2020 Changes Explained

A Green Solution to Blue Problems

How PCM Ceilings Save Energy

What is AI-driven Surveillance?

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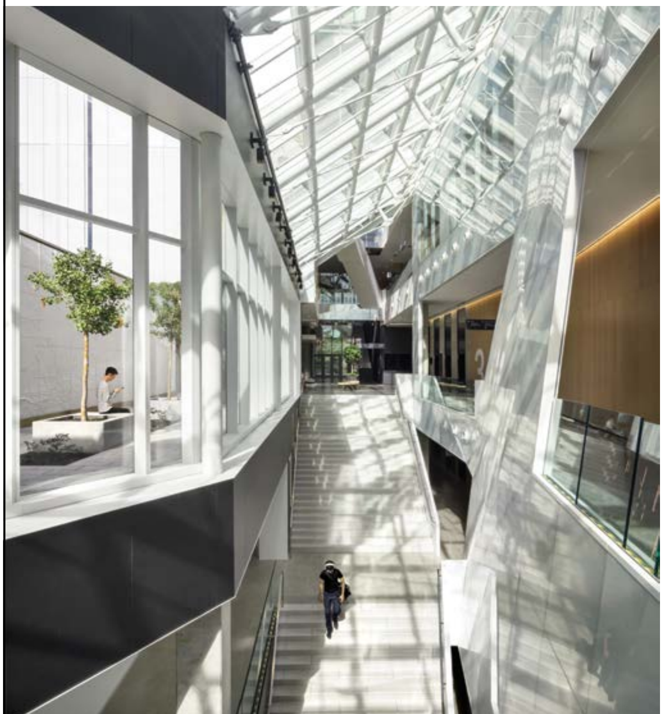

The Hélène Desmarais Building at HEC Montréal features a striking glass curtain wall that merges modernity with heritage. The translucent glass envelope allows natural light to flood the interior. Designed by Provencher_Roy, the high-performance facade not only exceeds thermal expectations but also exemplifies sustainable design in urban architecture.

PHOTO BY EMA PETER/COURTESY V2COM.COM

SEE ARTICLE ON CURTAIN WALL FIRE SAFETY AND *NBC* 2020 FIRESTOP REQUIREMENTS ON PAGE 32.

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Following a devastating fire, Best Builders' Phoenix House is a remarkable rebuild setting a new benchmark for low-carbon renovations while addressing resilience and holistic sustainability in a multi-generational home—it's also Canada's first Zero Carbon certified, BUILT GREEN® Net Zero Energy+ home.

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Canmore (AB)

Spring Creek has transformed from a mobile home park into an impressive multi-phase community largely fueled by geo-exchange, which has prioritized performance, walkability, green space, and local businesses – embracing social, environmental, and economic sustainability: a community certified BUILT GREEN® Platinum.

The Hidden Power of PCM

Ceiling the Deal on Energy Savings

By Jason T. Cavanaugh and Michael "Mick" Dunn

PHOTO COURTESY ARMSTRONG WORLD INDUSTRIES

Today's facility owners and managers face more intense demands than ever, driven by challenges such as tighter budgets, compressed timelines, and the need to create and maintain spaces that attract the right customers while promoting greater employee productivity.

These same demands extend to specifiers tasked with meeting every expectation for new construction or renovation projects. One critical consideration is occupant comfort, which has evolved beyond ensuring a space is neither too hot nor too cold. Today, several dynamic factors play a significant role:

- Climate change: Regions are increasingly experiencing extreme heat, and some climate zones now require air conditioning installations where they previously did not. Harsher winter storms and persistent droughts are also becoming more common.
- Heightened focus on indoor environmental quality (IEQ): Key factors such as room temperature, acoustics, cleanliness, and air quality are now central to supporting occupant health, happiness, and productivity.
- Aging HVAC equipment: Many facilities, particularly K–12 schools, are struggling with outdated equipment that operates inefficiently.
- Tighter budgets: Economic pressures are driving many facility owners and managers to find innovative ways to do more with less.
- The vision of a net-zero carbon world: Businesses and communities are pursuing aggressive goals to achieve a net-zero carbon footprint.
- Stewardship of the planet: There is an increasing emphasis on reducing energy consumption

FIGURE 1

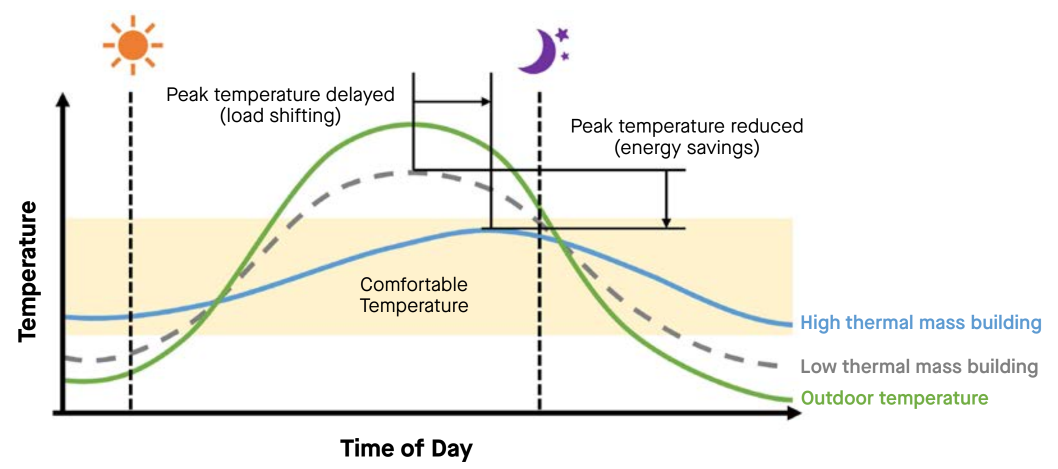


Illustration of temperature variation between thermally massive buildings and light buildings in a climate with warm days and cool nights.

ILLUSTRATIONS COURTESY ARMSTRONG WORLD INDUSTRIES

and minimizing the waste of natural resources, such as water.

The recent innovation of integrating phase change material (PCM), a well-established technology, into ceiling panels has generated significant interest. It is already proving its capability to address many of the challenges identified. Simply put, PCM in a ceiling panel helps maintain a consistent and comfortable temperature of 22 C (72 F) by passively absorbing heat when room temperatures rise and releasing it when the space cools.

Central to conversations about PCM ceilings is their ability to reduce energy consumption significantly by offsetting HVAC demand during peak hours when mechanical heating and cooling are at their least efficient. For example, a ceiling composed of a mineral fibre panel that uses PCM technology can reduce energy costs and decrease consumption by up to 15 per cent (according to measured cooling energy savings in lab tests).[1] While the energy savings potential of PCM ceilings is paramount, the whole story lies in their multifaceted impact, enhancing acoustics through sound blocking and absorption, simplifying installation processes, and contributing to broader environmental sustainability goals.

Thermal mass

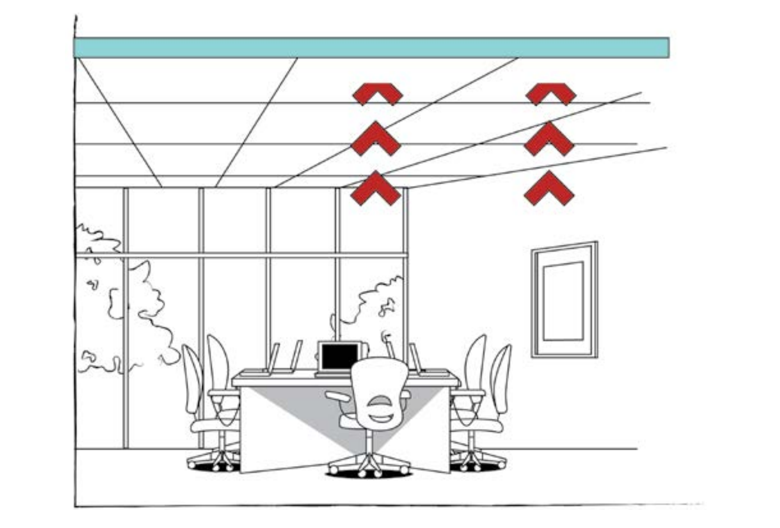
As climate change continues to drive extreme weather events, there is an increasing emphasis on enhancing the resiliency of the built environment. One effective way to achieve this is by using thermal mass, which refers to a material's ability to absorb, store, and release heat energy. By passively moderating indoor temperature fluctuations, thermal mass helps make building structures more resilient to heat waves and power outages. Concrete, brick, and stone have high thermal mass, absorbing and releasing substantial heat. These thermally massive materials function as buffers, smoothing out the daily temperature cycles inside buildings by absorbing heat during the day and releasing it in the evening.

Building thermally massive structures can be accomplished through strategic material selection for both the exterior and interior of a building. For example, stone or tile floors and granite countertops contribute to maintaining interior temperature control. Additionally, lesser-known interior solutions, such as water-filled containers, and emerging technologies, such as PCM, are increasingly being explored to enhance the thermal resilience of buildings further.

Increasing the thermal mass of buildings can play a crucial role in advancing sustainability initiatives by mitigating the carbon emissions that have contributed to global warming and extreme climate events over many decades. Buildings with high thermal mass can passively cool and heat interior spaces, reducing the strain on mechanical HVAC systems and, in turn, decreasing energy consumption (Figure 1). Moreover, thermal mass functions like a battery; it can be "charged" when renewable solar or wind energy is available, and then that energy can be "discharged" during peak hours to lessen the reliance on carbon-intensive power plants.

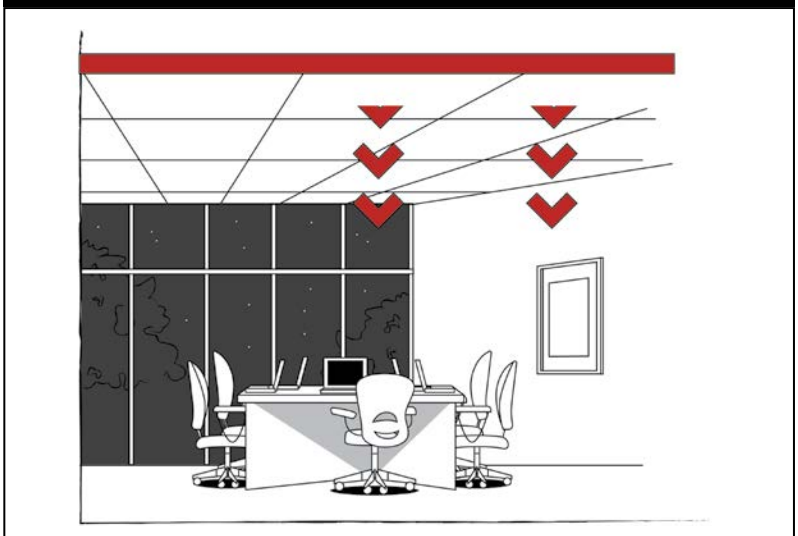
As of 2019, burning coal, natural gas, and oil for electricity and heat was the single-largest source of global greenhouse gas emissions.[2] Increased thermal mass can help lower carbon emissions

FIGURE 2A



The phase change material (PCM) in the ceiling panels "melt" as they absorb heat during the day when occupancy and outdoor air temperatures warm up a space above 22.2 C (72 F).

FIGURE 2B



As the space cools below 22.2 C (72 F) in the evening, phase change material (PCM) re-crystalizes, releasing heat to keep the space warm without use. Both passive processes reduce the demand on mechanical heating/cooling systems.

by decreasing the use of HVAC systems and optimizing their usage time.

While there are initiatives to accelerate the clean energy transition, including thermal storage strategies, some inherent issues in high thermal mass materials make them less attractive. Production of cement, the key component of concrete, emits significant CO2, contributing to approximately seven per cent of global emissions.[3] Moreover, the large weight and volume of conventional materials used for thermal mass make them difficult to transport, slow to build with, expensive, and impractical for retrofitting into existing buildings. The door has been opened for science and technology to increase thermal mass in buildings through better, sustainable solutions that meet modern desires and requirements for building operations and environmental responsibility.

PCM ceilings and thermal mass

Using PCM for thermal control is not a new concept, with ice in a cooler being a familiar example. As ice absorbs energy (*i.e.* heat) inside the container to keep its contents cool, it changes into a liquid state. If that liquid is exposed to an environment of 0 C (32 F) or lower, it will reverse the process, releasing heat and returning to its solid (ice) state.

Hidden discretely in the ceiling panel, PCM acts similarly to ice in a cooler. PCM in the ceiling panels absorbs and releases heat as it changes phase in response to fluctuations in air temperature. As a space warms—typically during the day when it is occupied or receives sunlight—the crystalized PCM gradually dissolves, absorbing heat and cooling the space. The stored heat is released into the space as the room cools at night or during low-occupancy times, and the PCM re-crystalizes. The PCM in ceiling panels is engineered for maximum performance around a comfortable 22 C (72 F) (Figures 2A and 2B).

Introducing PCM ceilings to a building or space presents an easy, efficient way to increase thermal mass, especially considering other options such as brick, concrete, or stone. Compared to these conventional thermal mass materials, PCM ceiling panels have a more concentrated storage capacity, are thinner, and are more thermally conductive—allowing heat storage and release to occur more readily. Moreover, because almost every space needs a ceiling, PCM ceiling panels can increase thermal mass without adding another element to the building or room.

In theory, a building can be made more thermally massive by, for example, building a brick divider in a room; however, this will change the function and design and can be labour-intensive. On the other hand, PCM ceiling panels are easy to install—a single person could replace old panels using little more than a ladder. To illustrate these advantages, consider that the PCM in lightweight mineral fibre ceiling panels can have more than 10 times the energy storage density of brick.[4]

Energy savings

As mentioned, lab tests show that PCM ceilings can improve energy savings by as much as 15 per cent by providing up to 35 BTU per square foot of passive cooling.[4] PCM ceilings also offer several other benefits, many stemming from their primary advantage of being able to regulate thermal comfort naturally. By absorbing and releasing heat, PCM ceilings help maintain stable indoor temperatures and even reduce peak indoor temperatures during extreme events such as heat waves and "cold snaps." In doing so, PCM ceilings help lower the demand for mechanical HVAC equipment. To follow are several categories of PCM ceiling advantages, with key benefits related to each:

Less demand for HVAC systems and lower energy consumption

- Pre-cooling or pre-heating strategies can be developed with PCM ceilings to reduce the burden on HVAC systems during peak hours.
- Passive PCM heating/cooling can continue thermal management during power outages.
- PCM ceilings can maintain comfort in changing climates or environments with daily hot-cold fluctuations without additional energy costs.

Flexibility

- Allow economical "spot managing" thermal comfort in areas—such as attics or older annexes—that experience more drastic temperature swings than other parts of a building.
- Enable room-by-room upgrades as budget allows.
- Offer temperature stabilization and prevention of overheating/overcooling inefficiencies in spaces that often require heating in the morning and cooling in the afternoon.

Budget friendliness

- Offer a budget-friendly option for buildings in climates requiring air conditioning for fewer than 20 days during the year.
- Leverage existing assets through retrofit or new-ceiling investment to improve environmental comfort and energy savings with minimal incremental cost.
- Provide an economical alternative when the budget does not allow HVAC system retrofits or replacement.
- Have a low price of entry. PCM ceilings do not require an increase in a building's physical footprint, structural work/changes, mechanical installations, or electrical engineering.

Labour-saving

- Maintenance-free and reliable, unlike traditional mechanical heating/cooling equipment.
- Non-labour intensive, with a relatively fast installation that a building's maintenance staff can do.

According to measured cooling energy savings in lab tests, ceiling panels with phase change material (PCM) can reduce energy costs and consumption by up to 15 per cent.

PHOTO COURTESY ARMSTRONG WORLD INDUSTRIES

Environmental

- Reduce carbon footprints plus lower energy expenditure and wear-and-tear on equipment.
- Help mitigate challenges—including budgetary and increased strain on HVAC infrastructure—of building electrification.
- Fit into the thermal comfort portion of the WELL Building Standard and can contribute to energy and atmosphere credits for LEED.

In addition, because the PCM in ceiling panels is composed of natural, inorganic materials, including salt and water, they are nonflammable and safe for use in buildings. The raw materials can be sourced domestically and are plentiful, allowing for the scaling of the technology.

Lastly, acoustical benefits top the list of PCM ceiling advantages. PCM ceiling panels support better acoustics in two ways. First, the PCM technology can be blended with acoustic sound absorption and sound-blocking ceiling panel technology. Second, the PCM can improve a ceiling's sound-blocking performance, reducing noise transmission to adjacent areas.

Who can benefit from PCM ceilings?

While almost any building type in a vast array of climate zones can find advantages to installing PCM ceilings, these are five main categories warranting strong consideration of using the technology:

Regions experiencing wide diurnal temperature fluctuations

In dry climates with hot days and cool nights, PCM ceilings, enhanced by strategies such as night ventilation or simply opening windows, can naturally absorb heat during the day and release it at night with little or no energy expense.

Regions with high energy costs

Building operators in jurisdictions that face high peak-demand charges due to thermal loads on energy grids can realize significant financial benefits from PCM ceilings' energy savings. Building owners can also take advantage of time-of-use rate structures with PCM by pre-cooling the building during hours when electricity is less expensive, allowing the building to maintain passive comfort during high-rate hours.

Where comfort, productivity, and resilience during outages are crucial

This includes offices, schools, healthcare facilities, and data centres. PCM ceilings are particularly effective in spaces with direct sunlight, high occupancy, and other intermittent heat sources that cause significant temperature swings.

Older buildings with aging HVAC systems or no air conditioning

Commercial buildings waste part of the energy they consume. This is primarily due to outdated equipment and inefficient use of lighting and HVAC systems. PCM ceilings can boost efficiency and provide a pre-charged "bank" of cooling to help outdated HVAC systems keep up during the hottest hours.

Management systems that night ventilate based on prevailing weather
These systems can optimize operations to leverage the thermal storage capacity of PCM ceilings, enhancing overall performance.

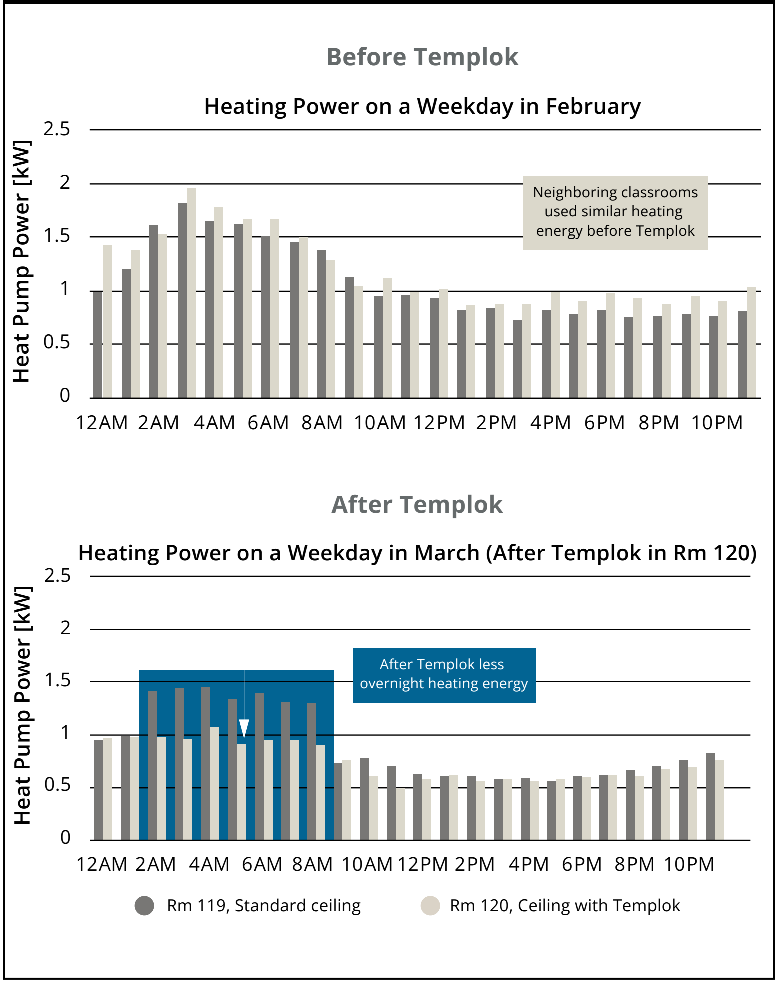
PCM ceilings—at work and commanding attention

Integrating PCM technology into mineral fibre ceilings is drawing the attention of communities and government agencies dedicated to improving building energy efficiency. It is already demonstrating its value in real-life applications.

In a controlled laboratory study, the performance of these ceiling panels with PCM was evaluated to demonstrate their load-shifting and temperature-moderating effects in a room-scale chamber. The study found that after pre-cooling, the 33 PCM ceiling panels absorbed approximately 4,000 BTU of heat generated in the room during the day. This significantly reduced daytime cooling energy, achieving about a 20 per cent reduction in the rate of air temperature change during the day. This was ascertained by comparing scenarios with PCM-enhanced and standard acoustical ceilings, showing that the PCM scenario delayed air conditioning by nearly two hours.[4]

Further, a high school facing high overnight heating costs during the school year installed the same mineral fibre ceiling products with PCM in two classrooms. Baseline heating energy in four classrooms was monitored for several months to assess if the technology would effectively reduce high energy consumption for heating during winter and spring nights. All four classrooms were in the same wing and of similar size and function, and each was primarily heated by an individual split heat pump system inside the room. The PCM ceiling panels were deployed in one upstairs and one downstairs classroom—with the original ceiling panels remaining in the other two rooms for comparison. Across several analysis techniques, during winter nights, the classrooms with the PCM ceilings saw a five to nine per cent decrease in energy use compared to the control rooms (Figures 3A and 3B).[4]

FIGURE 3A & 3B



Results of phase change material (PCM) ceiling installation in a high school show that after installing ceiling panels with PCM, classrooms used less heating energy overnight compared to a neighbouring room without a PCM ceiling. Several months of data analysis estimate a five to nine per cent heating energy savings.

Conclusion

According to the U.S. National Oceanic and Atmospheric Administrati on (NOAA), the 10 warmest years on record all occurred in the past decade, with 2023 being the warmest year on record for North America, South America, and Africa, as well as the second warmest for Europe.[5]

Facilities are facing unprecedented challenges as climate change continues to warm winters and summers and drive extreme weather events. These range from heat-driven closures of schools that historically did not need cooling systems to elevated pressure on businesses to reduce their carbon footprint to remain competitive and compliant.

Although PCM technology has existed for some time, its integration into ceiling panels offers an exciting new solution for increasing the sustainability and resiliency of the built environment. This is due to their ability to

Ceiling panes with phase change material (PCM) technology provided a solution for this complex for aging HVAC systems and maintaining consistent temperatures in spaces with consistent swings in occupancy.

PHOTOS COURTESY ARMSTRONG WORLD INDUSTRIES

Phase change material (PCM) ceiling panels can further enhance indoor environmental quality (IEQ) when acoustical technology is introduced to enhance sound blocking and sound absorption.

increase a building's thermal mass in ways that overcome modern challenges for facility operators, specifiers, architects, designers, and contractors responsible for ensuring that new construction and renovations maximize every opportunity to create beautiful, functional, and sustainable spaces.

By improving energy efficiency and IEQ, mineral fibre ceiling panels with PCM enhance the bottom line and align with today's mandatory sustainability objectives—supporting occupant well-being and productivity while helping to move the world toward a net-zero carbon future.

Notes

[1] Learn more at armstrongceilings.com/content/dam/armstrongceilings/commercial/north-america/technical-guides/templok-technical-guide.pdf

[2] Review the global greenhouse gas (GHG) overview at epa.gov/ghgemissions

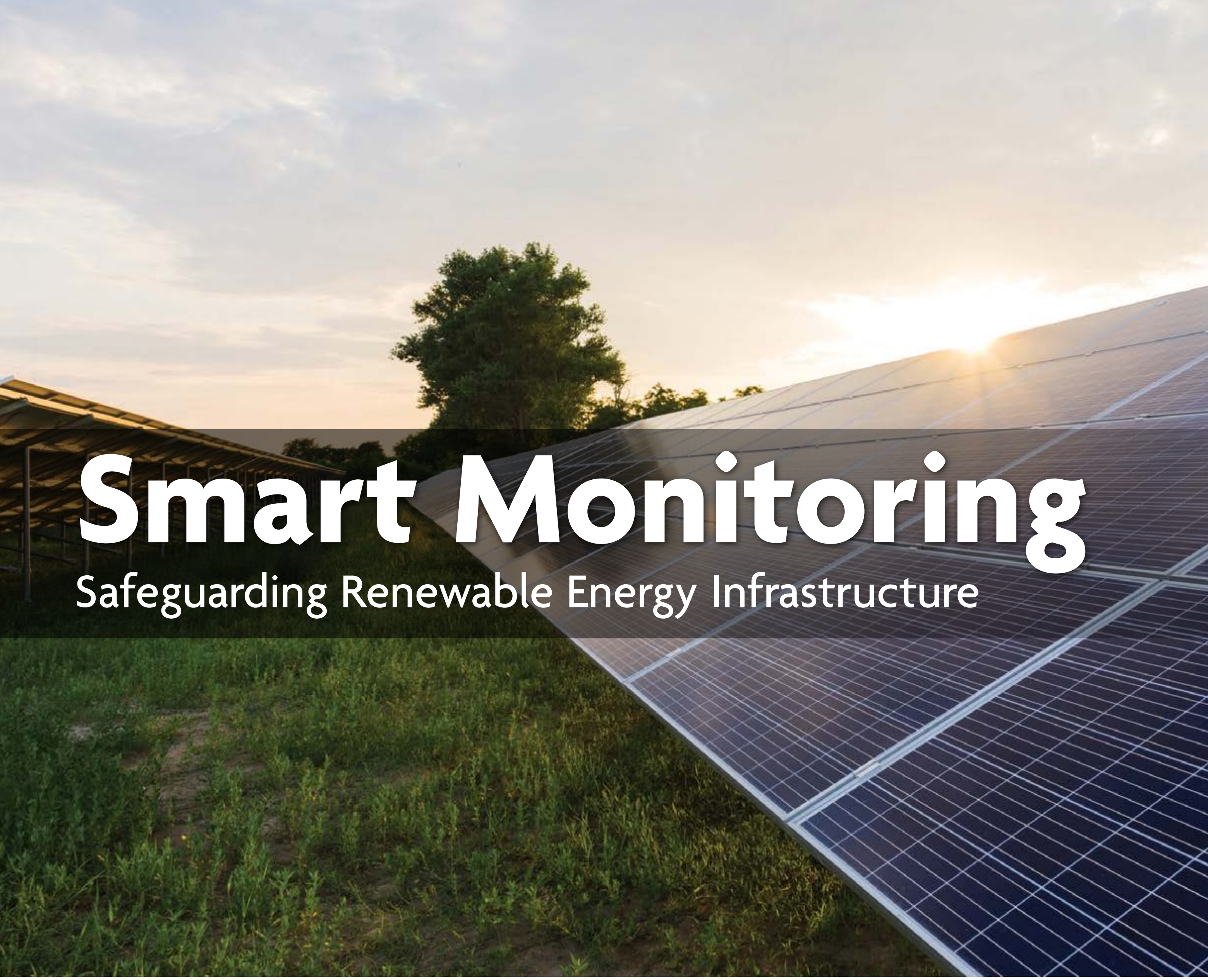
[3] Read "Everything You Need to Know About Embodied Carbon," carboncure.com/concrete-corner/everything-you-need-to-know-about-embodied-carbon/

[4] See note 1.

[5] Refer to climate.gov/news-features/understanding-climate/climate-change-global-temperature#:~:text=Highlights,0.20%C2%B0%20C)%20per%20decade.

Jason T. Cavanaugh is a mechanical engineer at Armstrong World Industries in Lancaster, Pa., specializing in developing energy-efficient building products. Cavanaugh is a member of ASHRAE T.C. 6.9 Thermal Storage and ASTM International. In 2024, he presented a conference paper on an experimental assessment of Phase Change Materials (PCM) ceiling tiles for cooling load management. He can be reached via email at JTCavanaugh@armstrongceilings.com.

Michael "Mick" Dunn, technical sales manager at Armstrong World Industries, is passionate about developing and deploying products and solutions incorporating Phase Change Materials (PCM) in the construction industry. His 20 years of construction management experience include being the founder/owner of the Maine-based Shift Energy, LLC, which specializes in large-scale commercial solar heating systems. In 2015, Dunn co-founded Insolcorp, LLC, and continues to focus on the need and interest for dynamic ways to store thermal heat and improve the sustainability and resiliency of the built environment. He can be reached at MRDunn@armstrongceilings.com.



Smart Monitoring

Safeguarding Renewable Energy Infrastructure

By Sophie Laplante

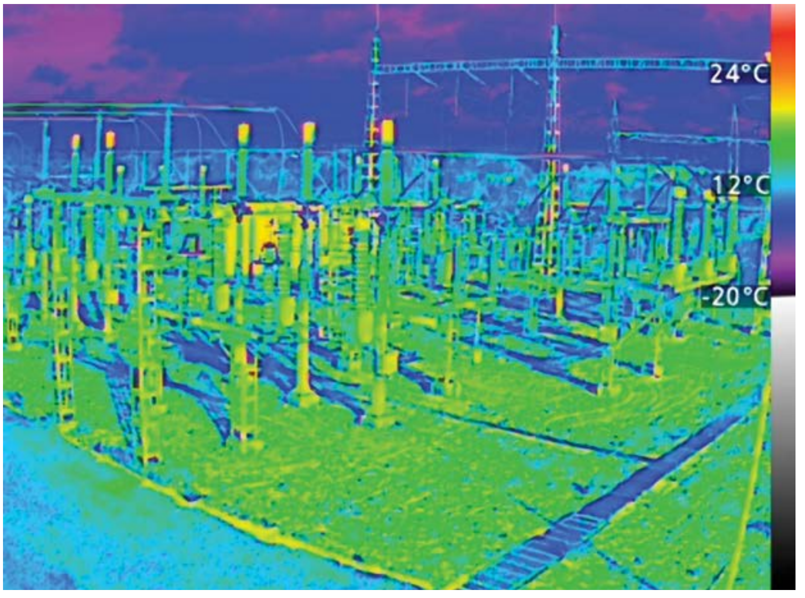
PHOTOS COURTESY AXIS COMMUNICATIONS

As cities prioritize sustainability and environmental responsibility, they reflect their citizens' commitment to reducing their carbon footprint. Across Canada and around the globe, urban planners are increasingly incorporating renewable energy sources alongside green public spaces to support these goals. In this shift, it is equally important to ensure these power sources are seamlessly integrated into urban infrastructure and protected from both external threats and internal structural malfunctions. A secure and well-monitored energy network supports long-term sustainability and resilience and ensures a stable and reliable power flow. Here, surveillance emerges as an ally that city planners can integrate to ensure seamless and uninterrupted operations.

Among renewable energy options, solar power stands out as a top choice because of its versatility, scalability, and cost-effectiveness. Solar generators are space-efficient, requiring minimal infrastructure and can be deployed in underutilized areas such as landfills. They are also highly scalable, as solar power can be generated through compact rooftop setups to expansive community solar farms. Lastly, as the technology matures, development, installation, and maintenance costs continue to decline, making solar an attractive option for city planners looking to integrate sustainable energy solutions.

Solar farms are an essential component of urban renewable energy planning, but their success depends on more than just power generation. Security and surveillance play a vital role in

A solar plant overlooked by a camera.



On-site thermal monitoring.

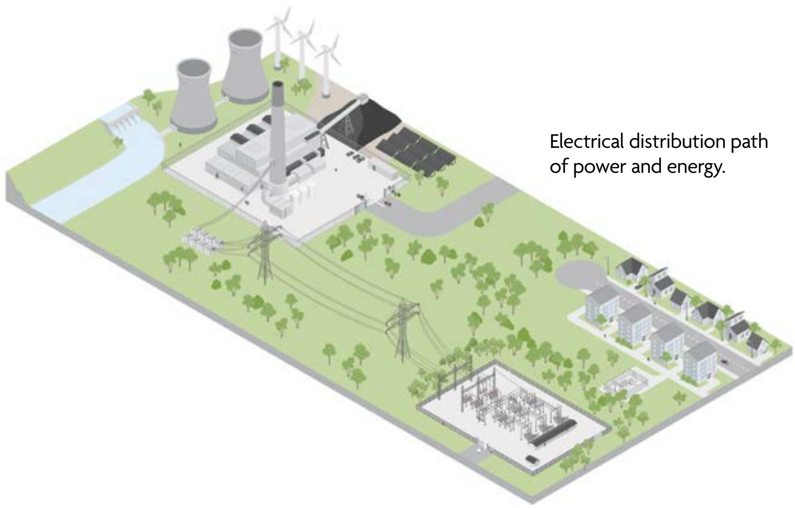
maintaining their efficiency and ensuring they operate as part of a stable, protected energy grid.

Securing solar farms as part of a resilient energy grid

While the unique characteristics of solar farms offer numerous benefits, they also present distinct security challenges. Though these installations are cost-effective to maintain once operational, their initial construction requires substantial investment. Solar farms are structurally efficient and can last upwards of 20 years, but external threats and breaches can hasten their decline and increase expenses. This makes it essential for city planners to implement robust security measures from the outset to protect these assets and minimize the risk of costly repairs and reconstruction.

Remote monitoring can serve as an invaluable ally in mitigating risks. By using this technology, operators can significantly reduce the need for time-consuming on-site checks, primarily since solar farms are often located in far-flung areas. With remote monitoring, operators can effectively oversee the perimeter of solar farms using panoramic cameras, focus on sensitive equipment or areas using bullet or box cameras, and use pan-tilt-zoom (PTZ) cameras in places where movement is anticipated. This allows for greater flexibility and control in surveillance.

In urban areas, the threat of intruders and trespassers is particularly pronounced at night when potential witnesses are scarce. However, in remote locations where solar farms are often situated, threats can arise at any time of the day and at the hands of both humankind and wildlife.



Electrical distribution path of power and energy.

A halogen-free thermal camera and outdoor speaker overlooking site.

As such, urban planners must be prepared for attacks from various sources. Visual cameras are effective for gathering details, and thermal cameras can enhance surveillance by reliably detecting intruders in all lighting conditions. These cameras can operate in complete darkness without emitting light pollution, making them suitable for protecting both solar installations and nearby wildlife.

Surveillance is essential for protection against intruders and for equipment maintenance. In this context, thermal and thermometric cameras provide significant utility. Thermal cameras are effective for general monitoring in various conditions. In contrast, thermometric cameras are particularly beneficial for equipment that requires close temperature control, such as engines or machinery exposed to high heat or humidity. It is advisable to employ a combination of both types of cameras for optimal equipment maintenance. Thermal cameras are cost-effective and sufficient for less critical issues, such as detecting minor leaks or misaligned panels. In contrast, though more expensive, thermometric cameras offer superior accuracy and precision, making them ideal for emergencies such as overheating or potential explosions.

AI and smart technology in solar farm security

Advancements in AI and smart technology have transformed surveillance from a tool for perimeter security into a sophisticated system that enhances operational efficiency, automates access control, and provides predictive maintenance insights. Beyond monitoring, these technologies play a crucial role in streamlining operations and improving overall facility management. By integrating AI-driven surveillance, energy operators can automate various functions, such as managing vehicle access through license plate recognition, classifying visitors as authorized personnel or intruders, and enhancing operational efficiency through predictive maintenance and energy forecasting.

With automation, operators can significantly enhance perimeter security. Rather than just monitoring the facility, AI can be leveraged to detect activity, such as when an unauthorized person or vehicle enters the perimeter. Further, when certain conditions are met, the system can be programmed to trigger alarms and alerts for security personnel or rescue operations. In instances where access control is necessary, AI can assist as well. When integrated with access control systems, AI can safely and independently facilitate entrances and exits in an area.

Through machine learning and AI, surveillance cameras can analyze human and vehicle behaviour patterns. By recognizing these patterns, the cameras can detect and identify activities such as tampering, loitering, trespassing, and other suspicious behaviours. While this heightened sensitivity may increase the likelihood of false alarms, modern and reputable surveillance systems are equipped to discern environmental sounds and movements, such as animal activity or rustling branches. This capability enhances the accuracy and reliability of security notifications.

AI is also helpful in monitoring infrastructure and equipment health. AI-enabled cameras can recognize equipment tampering, such as in panels, transformers, or other critical infrastructure.

They can also detect obstructions, such as view-blocking debris, overgrown vegetation, and other potential barriers that hinder visibility. Moreover, through IoT sensors, these cameras can also sense smoke, indicating fires, overheating, or explosions. Such alerts enable security personnel to be promptly summoned for inspection and intervention.

With automated surveillance systems, city planners and operators can anticipate benefits beyond basic security functions. They can expect reduced budgetary impacts due to decreased reliance on on-site security personnel and manual patrols. Additionally, these systems provide situational awareness and enhance the ability to respond to emergencies faster and more accurately, resulting in quicker response times and minimizing adverse effects.

Building a secure and sustainable energy network

A well-planned surveillance system will deliver the best results. In designing this, city planners need to carefully consider the size, needs, and priorities of the solar farm to select the surveillance devices that will deliver the best outcomes efficiently. By integrating a combination of various types of cameras, AI, and other control systems, solar farms can be effectively kept safe and secure.

Access monitoring and control

A well-protected solar farm employs a comprehensive surveillance system incorporating various cameras and automated capabilities. Thermal cameras and radar perimeter protection systems may be installed to secure the perimeter. These radar systems enhance thermal cameras by detecting and classifying humans and vehicles near restricted areas, allowing for early intervention before a potential breach occurs.

Access control systems are also implemented to log human and vehicle visitors to the facility. Cameras placed by entrances and exits maintain visual records of visitor movement, while access barriers, such as biometrics or ID scanners, capture additional details. This integration allows for the reconciliation of visual and other records. Similarly, for vehicles, license plates can be logged and cross-checked, and access can be granted or denied with the help of AI.

A thermal camera with a high-quality thermal video stream.

Complete situational awareness and specific monitoring

To achieve complete situational awareness within the facility, various types of cameras can be installed based on factors such as size, lighting conditions, and surveillance needs. Box cameras are ideal for entrances and exits due to their conspicuous nature, which can deter potential intruders. Pan-tilt-zoom (PTZ) cameras provide extensive coverage and detailed imagery from a single unit, making them particularly valuable for wide-area monitoring. Meanwhile, as previously discussed, thermal and thermometric cameras enhance security with their quick and sensitive detection capabilities and long-distance coverage.

Certain areas of a solar farm require more stringent surveillance measures. These include high-value targets such as substations and inverters, operations and maintenance buildings that store sensitive facility data, and battery banks, which are essential for energy storage during peak demand. Depending on the size and environmental conditions, a combination of different camera types can be deployed in these critical areas to ensure robust monitoring.

Promoting facility and personnel health

With the assistance of thermal and thermometric cameras and AI, surveillance systems can also effectively monitor the health of equipment within the solar farm. Equipment such as cooling fans and heat exchangers, cabling and junction boxes, and transformers are susceptible to overheating

Solar panels on office roof.

Personal protective equipment (PPE) detection analytic.

because of the high electrical loads they manage. Thermal and thermometric cameras are instrumental in monitoring these components, detecting overheating cables, identifying temperature anomalies, and sensing leaks.

It is imperative for personnel to be protected and well-supported to facilitate the repair of any detected defects and conduct routine maintenance checks. Surveillance systems can support workplace safety compliance by using their control systems to verify personal protective equipment (PPE) use prior to granting access. Additionally, body-worn cameras can enable remote training and assistance for on-site personnel, further supporting their safety and effectiveness.

Strengthening urban energy security

As sustainability and environmental consciousness become top priorities for citizens, solar farms emerge as a feasible solution for balancing the demands of urban power generation with the need to protect natural ecosystems. These facilities, characterized by unique features that make them suitable for urban settings, require city planners to evaluate appropriate surveillance strategies carefully. Modern surveillance systems, enhanced with AI and smart technologies, go beyond basic monitoring. However, there is no one-size-fits-all approach—planners must assess their specific needs to determine which devices and systems provide the best outcomes. When implemented effectively, surveillance solutions can deliver comprehensive monitoring, optimize access control, enhance situational awareness, and support the health and safety of both facilities and personnel.

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Green Roofs

The Sky-high Solution to Stormwater Struggles

By Rick Kile

PHOTOS ©2022 ED MASSERY

As urban areas expand and large-scale storms become increasingly common, stormwater management has become a critical challenge for cities across North America. Aging and undersized infrastructure, climate change, and increasing impervious surfaces have intensified flooding risks and water pollution. Local municipalities are tasked with finding solutions to mitigate the impact on their communities by implementing various resolutions into their building codes.

Amid these pressing issues, vegetated roofs offer a promising solution—mitigating stormwater runoff, promoting sustainability, and enhancing urban resilience. By leveraging their inherent retention qualities and incorporating additional technologies to meet detention requirements, vegetated roofs, also known as green roofs, provide a sustainable approach to managing stormwater.

Although vegetated roofs and amenity spaces are recognized for a number of social, economic, and environmental benefits—including urban

Vegetated roofs offer a long-term return on investment by reducing energy consumption, minimizing stormwater fees, and increasing property value.

beautification and the use of underutilized spaces—stormwater management remains the largest driver of vegetated roofs around the world.

In North America, the effectiveness of vegetated roofs is particularly evident in large urban centres, such as New York City and Chicago. For regions prone to heavy rainfall or flooding, like the Eastern Seaboard, these systems can provide a buffer by retaining significant amounts of water. Leading the charge, municipalities such as Toronto are driving adoption by requiring or subsidizing vegetated roof installation with their *Green Roof Bylaw*. The first North American city to adopt this type of requirement, Toronto aimed to encourage the construction of green roofs both on city- and privately-owned buildings. More recently, New York City has implemented *Local Law 92/94*, which requires new construction and major roof renovations to install green roof or solar, with a primary goal of driving an additional 3.7 million L (1 million gal) of stormwater each year. These programs provide excellent examples of how cities can drive development to manage stormwater, while benefitting from the other benefits provided by vegetated roofing.

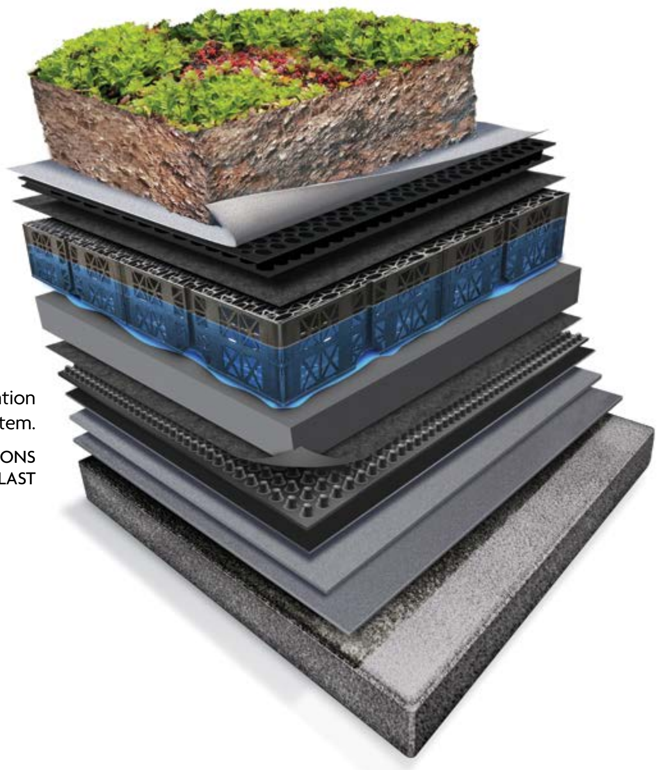
For building professionals, the challenges involve understanding local stormwater management codes and what strategies can be implemented to meet both retention and detention-based requirements. First, it is important to look at how vegetated roofing systems have developed over the years.

History of vegetated roofs

The concept of vegetated roofs dates back centuries, with early examples in Scandinavia, where sod roofs provided insulation for homes. In the 20th century, Germany pioneered modern green roof technology, emphasizing their environmental benefits. These innovations later spread to North America, where cities began exploring vegetated roofs as part of broader sustainability efforts.

Chicago's City Hall is believed to be one of the earliest modern green roof assemblies in the

Visitors can enjoy outdoor spaces with lush greenery, durable finishes, and improved water management systems.



Extensive detention blue roof system.

ILLUSTRATIONS COURTESY SIPLAST

U.S., leading to the city's pioneering of green roof requirements. Before this, the first known green roof in New York City was built on Rockefeller Center in the 1930s. In recent years, New York City has further amplified its efforts with two new *Sustainable Roof Laws* adopted in 2019, requiring all new buildings and major renovations to have available roofing space covered by a vegetated roofing system, solar panels, or wind turbines.

Over the past two decades, materials, design, and installation advancements have made vegetated roofs more accessible and effective. Today, they are a cornerstone of sustainable urban development, recognized for their ability to address environmental and infrastructure challenges, including stormwater management.

Despite their proven benefits, vegetated roofs are sometimes misunderstood at the surface level. Perceived as purely decorative, green roofs are fully functional systems designed to manage stormwater, improve insulation, and have even proven to help extend the lifespan of a building's roof. Although vegetated roofs may have higher upfront costs than traditional roofs, they offer a long-term return on investment (ROI) by reducing energy consumption, minimizing stormwater fees, and increasing property value.

Advancements in materials and design have made vegetated roofs viable in a wide range of climates and building types. Proper plant selection—from sedums and succulents to large, mature trees—and irrigation systems ensure adaptability across commercial buildings for various needs.

Sustainable benefits

Beyond stormwater management, vegetated roofs provide additional sustainable benefits that enhance urban resilience. These systems improve insulation, increasing energy efficiency and reducing heating and cooling costs. They mitigate the urban heat island effect—where urban areas are -16 to -15 C (2 to 5 F) colder than surrounding rural areas—through the cooling effects of evapotranspiration. Biophilic design, or incorporating nature into the built environment, including vegetated roofs and walls, has been proven to improve mental health, expedite healing times, encourage outdoor activity, and contribute to healthier communities. The environmental benefits extend further, as certain plant species improve air quality by filtering pollutants and noxious gases. Depending on the vegetation type, green roofs can boost biodiversity by creating habitats for pollinators and other wildlife essential for healthy ecosystems.

Incorporating green roofs into new developments and retrofits is a practical and impactful way to meet municipal regulations and sustainability targets. For commercial building consultants and architects, these systems represent a vital strategy for managing stormwater while building for a resilient, efficient, and environmentally conscious future.

FIGURE 1

Layered extensive vegetated roof system.

The urban stormwater challenge

Stormwater runoff poses significant environmental and economic concerns for cities. When rain falls on traditional rooftops, streets, and other impermeable surfaces, it flows into storm drains, often carrying pollutants into waterways. During heavy rainfall, these systems can quickly become overwhelmed, leading to flooding, infrastructure damage, and costly repairs.

Traditional extensive vegetated roofs manage stormwater by retaining water within the profile of the growing media and any retention layers, which make the stored water available for plant use. While this aids in managing the stormwater for a project by reducing the overall volume entering the storm system, they do not address detention requirements, which seek to reduce the peak flow from a building. However, by integrating additional components within the vegetated roof profile, design teams can create space to park water while it is slowly released off a roof at a reduced, metered rate. This is usually achieved with a fixed aperture as part of the drain assembly. This helps cities mitigate flood risks and reduce the strain on overburdened stormwater systems, especially during peak rainfall. A notable example of an innovative approach to roofing is a multi-faceted plan that incorporates vegetated roofing, amenity decks, and various waterproofing and roofing solutions.

Perceived as purely decorative, green roofs are full functional systems designed to manage storm water, improve insulation, and have even proven to help extend the lifespan of a building's roof.

What builders should know about vegetated roofing

Vegetated roofs mimic natural landscapes to manage water sustainably. These systems are designed with multiple layers, each serving a specific purpose:

- Membrane—The protective layer responsible for keeping the structure watertight.
- Root barrier—Responsible for resisting root penetration of the membrane layer. A root barrier is not required with all membrane technologies, however, this should be co-ordinated with the membrane manufacturer.

Appropriate waterproofing membrane selection, high-quality drainage and storage components, engineered media, and suitable plant selection ensure long-term functionality and resilience of vegetated roof systems.

Green roofs elevate rooftop terraces into multifunctional, durable spaces.

- Drainage and retention layer—Responsible for providing drainage, retaining water for use by the plant material, and providing aeration to the bottom of the media profile.
- Growing media—A specialized soil layer composed of course aggregates, fine aggregates, and organic components with water and nutrient-holding capacity that provides structure for healthy root systems. Majority of the retention capacity of a vegetated roof is within the profile of the media.
- Vegetation—Plants absorb water and release it back into the atmosphere through evapotranspiration, integrating natural water cycles.

Inverted roof membrane assemblies typically include an additional drainage layer and insulation above the root barrier and below the drainage and retention layer.

A majority of municipalities include detention-based requirements that require water to be captured and held on-site for a duration of time and slowly released to the storm. Compared with at-grade landscapes, vegetated roofs do not possess the ability for stormwater to infiltrate the groundwater. The vegetated roof can retain a finite amount of water before the roof starts to release the water that has migrated through the assembly down the drain and away from the project. By integrating additional layers into the vegetated roof assembly, design teams can create space to temporarily store that detention requirement until it is released from the rooftop, as shown in Figure 1 (page 23).

By combining these components, vegetated roofs reduce runoff volume and delay peak flow, providing an alternative solution to traditional stormwater management methods. In recent years, integrating modern advanced materials and design innovations has significantly enhanced the performance of vegetated roofs.

Once based on esthetics, these systems are engineered to deliver many advantages.

Implementation

Stormwater management is critical for commercial building consultants and architects, particularly as sustainability becomes a central focus in modern construction. Understanding the role of advanced roofing systems in managing stormwater runoff is essential for designing environmentally responsible and efficient buildings.

Incorporating vegetated roofs into new projects effectively addresses stormwater management while enhancing the building's sustainability profile. This process requires early integration into the planning and design stages to ensure compatibility with the roof's structural load, waterproofing, and drainage systems. Collaborating with specialists during these stages can streamline implementation and improve outcomes.

Choosing the right materials is equally crucial. Appropriate waterproofing membrane selection, high-quality drainage and storage components, engineered media, and suitable plant selection ensure long-term functionality and resilience. Architects and consultants should also prioritize compliance with municipal regulations and sustainability benchmarks, optimizing the roof's environmental and operational impact.

Projects well-suited for rooftop stormwater management are typically found in major urban centres, where buildings are constructed with zero lot lines. Sloping sites pose additional challenges, as water naturally seeks its level, often limiting storage to the site's lowest point. High water tables and brownfield sites can complicate excavation efforts, making it difficult to install detention tanks below grade. If the project meets these criteria, using rooftop systems to store stormwater becomes a more financially viable option, as it avoids consuming valuable ground-level space.

Incorporating vegetated roofs into new projects requires thoughtful planning and collaboration. Best practices involve integrating these systems into the design process, ensuring compatibility with structural load, waterproofing, and drainage requirements. By addressing these factors early, consultants and architects can achieve optimal results while simplifying project execution. By leveraging the latest techniques and technologies, such as stormwater retention systems and advanced green roof designs, architects and building consultants can effectively mitigate runoff, promote urban sustainability, and align projects with forward-thinking environmental goals.

Consideration should be given to the additional loading posed on the structure. One cubic foot of water weighs approximately 28.3 kg (62.4 lb). It is critical to work with the civil engineer, structural engineer, and manufacturer to understand the loading a rooftop stormwater management system may impose on a structure. Although most roof systems will only need to manage a couple of inches of water, at 2.36 kg/m^2/mm (5.2 lb/sf/in.) of thickness, it will likely affect the design of the structure.

In the face of heightened environmental and climate challenges, these living architectural features bring natural beauty to urban buildings and pave the way for architectural innovation. By embracing innovative solutions such as vegetated roofs, builders and policymakers can address today's challenges while ensuring a sustainable future for future generations.

Rick Kile, director of green and amenity business at Siplast, brings extensive experience in the construction industry and developed a strong foundation in landscape architecture and planning. His expertise lies in fostering innovative solutions that enhance both environmental sustainability and esthetic appeal. Kile's passion for creating technically sound and functional on-structure landscapes has positioned him as a key player in advancing Siplast's commitment to sustainable construction practices.

Weathering the Storm

The Durability of Metal Roofing

By Rob Haddock

PHOTO COURTESY METAL ROOFING ALLIANCE (MRA)

As extreme weather events like the recent wildfires in California and hurricanes in coastal communities become more frequent, owners and designers increasingly recognize the critical need to reinforce their construction projects against the potential damage severe weather conditions can inflict on homes and commercial properties. Standing seam metal roofing provides a durable and long-life solution.

The roof is the first line of defence when nature unleashes its fury in terms of wind, wildfire, and hail, which raises important questions for the AEC industry. What should professionals keep in mind? What are the areas of concern, and what can be done to combat extreme weather conditions? Let's explore.

Damaging winds

Wind creates powerful "uplift" (suction) forces on a roof. Different areas ("zones") of the roof experience these forces to varying degrees, some higher than others. A standing seam metal roof can be engineered to withstand virtually any uplift force desired or mandated by building code authorities—up to and including Category-5 hurricane forces and even tornadic wind forces.

However, this degree of wind resistance does not magically happen but results from careful design, testing, attachment, and installation specifications. Unlike many other roofing materials, metal's mechanical properties remain stable over time, so it will perform as designed throughout its decades-long service life.

Of course, the more durable the design, the higher the roof's initial cost. Designing to exceed building code requirements may not always be economically feasible, but that is a personal or business decision and certainly an option.

Also, it is important to note that code requirements for wind forces have generally increased in recent decades. A roof designed in 1990 may not comply with today's more stringent standards. Roof durability in a windstorm may also depend upon the building's structural design—if the structure to which it is attached fails, so will the roof.

In post-Hurricane Irma inspections, the Monroe County, Florida's staff summary found that "metal roofs fared far better than those roofs covered by asphalt shingles," prompting county officials, in recent years, to propose an ordinance that requires all new or replacement roofs to be metal. This is a true testament to the sustainability and durability of metal roofing, particularly in high-wind areas.

The exceptional performance of standing seam metal roofing in high-wind conditions is due in part to its structural attachment methods, frequency, and interlocking joint features, which reduce the likelihood of wind detaching the panels. Most importantly, metal is an inert material, unlike membranes or asphaltic materials, ensuring its mechanical properties do not diminish over time and under exposure to UV and other environmental conditions. In other words, it will behave as tested throughout its life of 60 years or more.[1]

Standing seam metal roofing offers a distinct advantage over other roof types, such as membrane and hot-applied asphaltic roofs, because it acts as a "structural" covering and can be engineered to withstand almost any force imposed by wind. When designed as such, some structural standing seam profiles can withstand extremely high wind pressure, making metal the roof of choice in high-wind regions.

By increasing the frequency of attachment, increasing the gauge thickness of the metal,

Decreasing the panel width, using external seam clamps, or any combination of these can double or triple the roof's durability in a windstorm for a modest added cost.

Hail

Different building materials react to hail impact to varying degrees. While hail may cause minor dings in siding, gutters or asphalt shingles, larger and more dense hailstones can cause severe damage and even puncture a roof.

Metal roof material is the most reliable defence against hail damage. The extent of the damage depends on factors such as the size and hardness of the hailstones, the type and thickness of metal, and the substrate to which it is installed. Steel roofs, for example, are much less likely to dent from the hail than a vehicle, which uses softer grades of steel that can be easily moulded into the sleek lines and curves of an automobile.

While most insurance policies distinguish between functional damage (which affects water resistance) and cosmetic damage (which does not), esthetics may still be a concern in high-visibility areas. Some may view hail dents as a flaw, while others appreciate them as part of the roof's character, emphasizing its durability over time. In architectural design,

Hurricane Otis wind damage to a grocery store roof.
PHOTOS COURTESY S-5!

Unlike other roofing materials, metal roofs will not spark and ignite into flames, making them safer during a lightning strike or wildfire.
PHOTOS COURTESY METAL ROOFING ALLIANCE (MRA)

Metal's non-flammable characteristics reduces the risk of external fires spreading to the building.
PHOTO CREDIT GETTY IMAGES/HPW

esthetic considerations can vary widely—some embrace natural weathering effects, while others prioritize pristine appearances. Ultimately, whether esthetic damage is a performance concern depends on the owner's expectations and the roof's intended application.

Generally, a 0.51-mm (24-gauge) thick steel roof will typically remain functionally undamaged by hail up to 24.5 mm (1 in.) diameter. However, copper 453.6-g/m^2 (16-oz./sf) thick is another story because it is softer and may be more vulnerable to cosmetic annoyance. Despite the claims of many "storm-chasers," it is extremely rare for hailstones, even of significant size and velocity, to impact a roof's functionality to necessitate its replacement. Claims suggesting hailstones can significantly affect the function of a metal roof are almost always unfounded and rarely factually supported.

A recent study by the Metal Building Manufacturers Association (MBMA) and subsequent ASTM symposium paper provides solid data to back this up.[2]

Snow and ice

Snow presents unique challenges for any roof type. The migration of snowpack, accumulating

Metal roof material is the most reliable defence against hail damage.

PHOTOS COURTESY S-5!

snow on the roof, can put significant stress on roof flashings and drainage systems. It can also produce significant sliding forces on steep roofs, resulting in the sudden release of snow (and ice), dumping tons of the fallout below the eaves in seconds. This causes hundreds of millions of dollars in property damage, personal injury, and even death each year.

Re-freezing meltwater on a roof can wreak havoc. When the roof warms from the invisible spectrum of the sun's rays or from building heat loss, snowpack begins to melt—the runoff refreezes at the eaves. The eaves are as cold as the (colder) ambient air temperature. So, when it is frigid, ridges of ice (ice dams) can build up, preventing meltwater flow and drainage at the roof edge. Static water pressure above the ice dam may infiltrate the roof panels, potentially causing damage to the exterior walls, insulation attic and building interior, resulting in rot, mould, and watermarks. Left unchecked, this problem will persist each time the same conditions exist. Ice dams as thick as 457 mm (18 in.) or more have been reported.

Pitched metal roofs, manufactured from materials that create a slippery surface, can increase the risk of sliding snow, sudden rooftop avalanches and ice hazards in the discharge areas below the eaves. The most effective way to mitigate these risks is by installing a scientifically tested and engineered snow retention system designed to handle the snow loads expected on the specific roof profile. Ideally, this system should comply with the only recognized consensus standard, *Evaluation Criteria 029-2018 for Standing Seam Metal Roof-Mounted Rail-Type Snow Retention Systems*, developed by the International Association of Plumbing and Mechanical Officials (IAPMO). To ensure compliance, request the "Evaluation Report" issued by IAPMO, a crucial document when vetting or specifying snow guard systems.

Lightning and fire

When it comes to lightning and fire, metal is the clear choice. Unlike other roofing materials, metal roofs will not spark and ignite into flames, making them safer during a

A heavy buildup of snow and ice on this pitched metal roof highlights the risk of sudden rooftop avalanches, emphasizing the importance of installing a properly engineered snow retention system.

lightning strike or wildfire. Additionally, metal's non-flammable characteristic reduces the risk of external fires spreading to the building.

A common misconception is that a metal roof "attracts" lightning. In actuality, lightning finds its way to Earth, based primarily on the building's height relative to its surrounding terrain, structures or trees, so a metal-roofed home is no more likely to be struck than any other roof type.

Most lightning-related damage and fires occur when the lightning charge passes through non-conductive materials such as wood, masonry, or stone on its way to the ground. A steel-framed, metal-roofed building is one of the safest places during a lightning storm, as the structure provides a direct, conductive path for any potential strike to reach the ground.

For metal roofs installed over non-conductive materials, grounding is a widely accepted practice, particularly in Europe, where a simple conductor running from the roof to a grounding rod is commonly used. While the lightning protection industry in some regions requires more complex and costly approved systems, basic grounding can be a practical and inexpensive way to enhance protection. However, in metal-framed structures—such as pre-engineered metal buildings—grounding is generally less critical, as the structure itself serves as an immediate path to ground.

Regardless of the structure type, it is always advisable to maintain a safe distance from walls during a lightning storm, as they can conduct the charge.

Conclusion

Metal is considered the most environmentally friendly and sustainable roofing material available, and it is known for its long-lasting performance and reliability.[3] It offers exceptional durability in extreme weather conditions, is 98 per cent recyclable,[4] and is made from up to 90 per cent recycled material, depending on the type of metal.

A standing seam metal roof can be engineered to withstand virtually any wind uplift force and can be reinforced even post-construction. It is highly resistant to hail damage, can effectively manage snow and ice with an engineered snow retention system, and is non-flammable, so it will not spark and ignite into flames during a wildfire or lightning strike.

Manufacturers must develop products to increase a roof's resilience and address some of the most challenging conditions roofing and exterior projects often encounter.

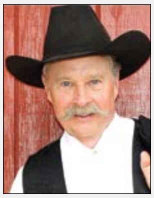
Notes

[1] Metal Construction Association. 2018. "Service Life Assessment of Low-Slope Unpainted 55% Al-Zn Alloy-Coated Steel Standing Seam Metal Roof Systems." October 2018. metalconstruction.org/index.php/online-education/service-life-assessment-of-low-slope-unpainted-55-al-zn-alloy-coated-steel-standing-seam-metal-roof-systems---published-102018

[2] See STP 1650, 2023—available online at astm.org, doi: 10.1520/STP165020220099, astm.org/stp165020220099.html

[3] See note 1.

[4] Modern Steel Construction. 2023. "EAF Statistics." *Modern Steel Construction*, May 2023. modernsteel.com.



Rob Haddock, CEO and founder of S-5!, is a former contractor, award-winning roof-forensics expert, author, lecturer and building envelope scientist who has worked in various aspects of metal roofing for five decades. S-5! recently achieved an Evaluation Report of compliance (ER) to IAPMO EC 029–2018 industry standard for testing and certifying snow retention devices. For more information, visit s-5.com.

NBC 2020 Defines Key Fire Barriers at Edge-of-Slab Joints

By John Valiulis
PHOTOS COURTESY HILTI

Curtain walls, by definition, are exterior walls that "hang" away from the building floor slabs rather than sitting on top of the floor as a window wall would. This inevitably creates a gap between the outside edge of the floor slab and the inner surface of the curtain wall.

In a multi-storey building, any gap in a floor that could allow a path for fire and/or smoke to spread between stories is a significant hazard. Such a spread could result in a fire being established in two or more storeys in a short period before the deployment of fire department personnel and fire-fighting resources to the building's interior. A multi-storey fire could easily result in an out-of-control situation, causing a significant hazard to building occupants and the responding fire personnel.

To prevent fire spread between stories in buildings tall enough or large enough to require fire-resistance-rated floors, the *National Building Code of Canada* (*NBC*) has long had requirements to close all gaps in a fire-resistance-rated floor with materials and systems that would provide "continuity" of the fire resistance of the floor slab. The concept of "continuity" is important enough to appear more than 80 times in the code.

Before examining the latest code requirements, it is useful to step back to see what the edge-of-slab joint fire protection requirements were in previous code editions. Article 3.1.8.3 of *NBC* 2015 stated the requirement as follows:

3.1.8.3 Continuity of Fire Separations
4) The continuity of a fire separation shall be maintained where it abuts another fire separation, a ceiling, a roof, or an exterior wall assembly. (See Note A-3.1.8.3.(4).) A-3.1.8.3.(4) Fire Separation Continuity. The continuity of a fire separation where it abuts against another fire separation, a floor, a ceiling, or an exterior wall assembly is maintained by filling all openings at the juncture of the assemblies with a material that will ensure the integrity of the fire separation at that location.

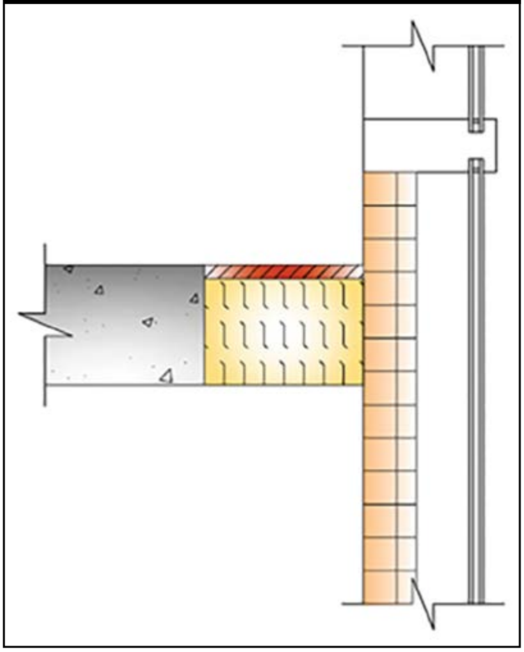
The building code has traditionally taken a performance-based approach, outlining the requirement for floor slab continuity at the intersection of an exterior wall but without specifying deemed-to-comply solutions. Previously, the code did not provide clear guidance on how designers or contractors should achieve fire resistance at the edge-of-slab gap. In contrast, the updated code introduces precise and practical requirements, offering much-needed clarity.

Many knowledgeable Canadian design and construction professionals have been specifying and installing perimeter joint firestopping systems tested and listed for this purpose (discussed further) to comply with this requirement. However, the 2015 *NBC* can be interpreted to mean it would be acceptable to simply extend the fire rating of the floor slab out to the curtain wall across the edge-of-slab gap, using some approved materials within the gap of unquantified performance, and not considering the construction and fire behaviour of the curtain wall itself. This would provide "continuity" of the rating of the floor slab. Therefore, something similar to what is shown in Figure 1 might have been approved in some cases.

Over the past 20-plus years, fire testing has shown that trying to prevent storey-to-storey vertical fire spread by focusing only on the gap at the edge-of-slab would not provide sufficient protection. Typical curtain wall components will bend, expand, melt, and/or break when exposed to the intense heat of a fire in the storey below. To give a trivial example, if a spandrel panel exposed to fire bends and expands/flexes outwards, this could open a gap, even if the gap were filled and sealed pre-fire with mineral wool and a firestop sealant.

Based on fire test results, the clear takeaway has been that all the curtain wall components need to be considered when establishing the correct firestop design solution. The 2020 *NBC* did what other codes around the world have already done, which is to specify the specific fire test method that must be used to evaluate and quantify the adequacy of the perimeter joint firestopping, using a fire test protocol that incorporates the effect of the curtain wall construction details. The chosen fire test method was ASTM E2307, *Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus*. This same test method is referenced in codes in many other countries, including the United States and the *IBC*. The *NBC* 2020 code requirement reads as follows:

FIGURE 1



Mineral wood safing compressed into edge-of-slab gap and sealed with firestop sealant.

3.1.8.3. Continuity of Fire Separations
4) Except as provided in Sentence (5), joints located in a horizontal plane between a floor and an exterior wall shall be sealed by a firestop that, when subjected to the fire test method in ASTM E2307, "Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus," has an F rating not less than the fire-resistance rating of the horizontal fire separation.

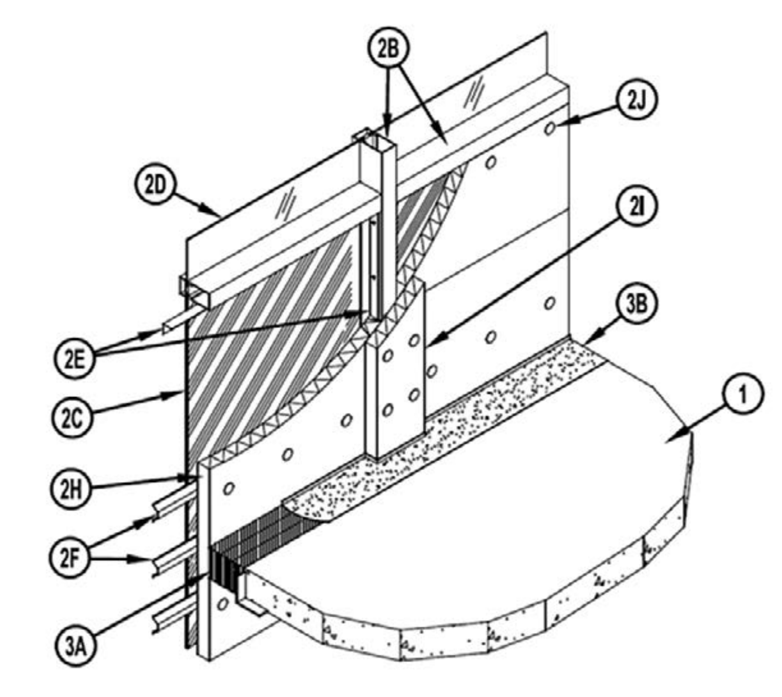
The required fire-resistance rating (F rating) of the perimeter joint system must be equal to the fire-resistance rating of the floor slab. If the building is small enough and/or short enough, as defined by the building code, that the code does not require any rating for the floor slab, then perimeter joint firestopping is not required.

ASTM E2307 is referenced within Canadian test method CAN/ULC-S115 for testing perimeter joint fire stopping without any modifications. Future editions of the *NBC* will likely be revised to reference CAN/ULC-S115 for the perimeter joint firestop requirement instead of E2307. Practically speaking, that would not be a technical change. The required fire test method would be unchanged. It would be referenced differently, indirectly via CAN/ULC-S115.

ASTM E2307 fire test and listings

ASTM E2307 took approximately 10 years to develop and issue as a published standard. The

FIGURE 2



Most curtain wall system listings show a large number of details that must match to deliver the stated fire-resistance rating.

long development time was due to a years-long debate regarding what the pass-fail criteria of the test method should be.

It was acknowledged that curtain walls are built such that they are not fire-resistance-rated assemblies, nor are they required to be fire-resistance-rated per the building code. They are generally not designed or intended to stop fire from moving from inside the building to the outside, nor are they designed to prevent a fire lapping the outside from re-entering the building at some storey above.

All other fire resistance tests dealing with the intersection (joint) between two assemblies always involve both intersecting assemblies being fire resistance rated. When subjected to a fire test, it was not obvious what performance should reasonably be expected of a non-fire-rated assembly (the curtain wall).

The ASTM fire test standards committee finally agreed the curtain wall itself did not have to be fire-resistance rated *per se*. That would be an unjustified requirement, given that building codes do not require it. However, how that curtain wall behaves and reacts under fire exposure is a key variable that must be accounted for in establishing the correct assembly of materials to prevent interior fire spread at an edge-of-slab gap. The pass/fail criterion was thus accepted to be flame penetration only at the perimeter joint protection or its boundaries or the passage of flames or hot gases through the joint protection sufficient to ignite a cotton pad. ASTM E2307 does not mandate any specific behaviour or temperature rise limitation of the curtain wall components. However, as mentioned, the curtain wall details will determine whether any proposed seal of the edge-of-slab gap will prevent vertical fire spread. When exposed to the fire test, the behaviour of the curtain wall framing, spandrel, and other wall components will determine whether a proposed seal of the perimeter gap will achieve the desired fire resistance rating.

The deflections, movement and/or melting of various curtain wall components during fire exposure will be a strong determining factor in whether the materials used to seal the edge-of-slab gap, and the installation methods for those materials, will succeed or not to prevent fire spread from the storey below to the storey above via the edge-of-slab joint.

The E2307 fire test assembly is a two-storey apparatus with a fire exposure room on the lower storey and an observation room on the upper storey. A unique feature of the ASTM E2307 fire test is it exposes the curtain wall spandrel to fire exposure from two sides: from the inside below the floor slab and the outside above the window of the lower floor. This is meant to simulate the highly possible condition of a fire on the lower floor, breaking the windows and emerging out of the building.

ASTM E2307 has now been in use for 20 years. Due to its reference in the building codes of many countries and for many years (since 2006 in the *IBC*), many tested and listed perimeter joint firestop systems are available. As of this publication date, UL Solutions has 232 tested and listed systems using this standard, and Intertek has 314 systems. These are the eight main variables that each of those systems specify in detail to make clear to what specific curtain wall details a given system listing would apply:

1. Framing (*e.g.* steel or aluminum)
2. Spandrel material (*e.g.* concrete, glass, stone)
3. Spandrel insulation—type, density, thickness, attachment method

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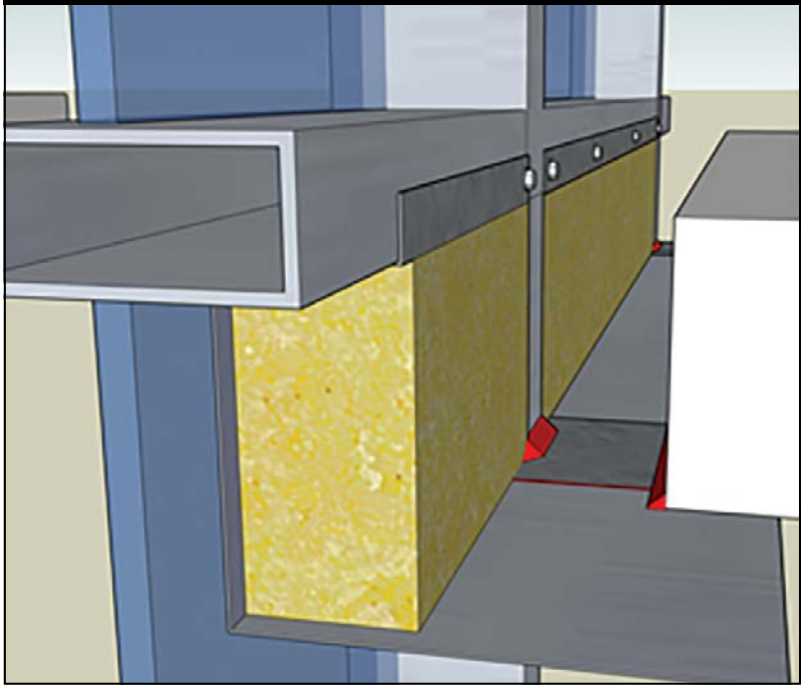
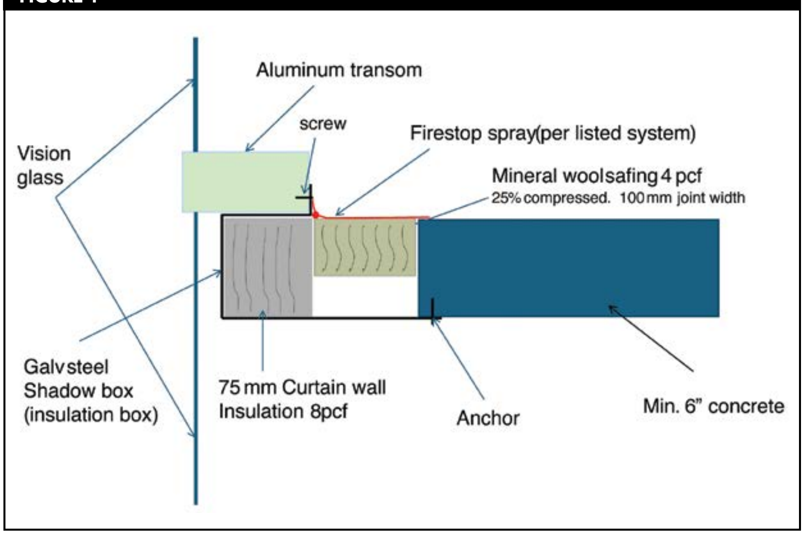
FIGURE 3



Simplified example of insulated steel shadow box installed in a zero-spandrel curtain wall as part of an E2307 listing (safing gap is shown open/unsealed, prior to protection).

FIGURE 4



Example of tested/listed perimeter firestop system for a zero-spandrel wall.

4. Dimensions of spandrel panel (if any), height of spandrel panel above floor line
5. Insulation covers (if) needed over transoms or mullions
6. Size of the edge-of-slab gap
7. Firestopping part 1—type, density, and compression of safing insulation (insulation in edge-of-slab gap)
8. Firestopping part 2—type, thickness, and overlap of sealant needed over the safing insulation

Items six and seven are sometimes combined when a preformed firestop solution is used.

Additional curtain wall components beyond the eight mentioned are often specified in the listings if determined by the listing laboratory to be important to the fire performance of the perimeter gap protection. Figure 2 (page 34) shows an example of a curtain wall firestop system. The large number of details shown in the listing, which the listing laboratory deemed critical, is typical. Such a comprehensive enumeration of the wall and joint details in the listing resulting from an ASTM E2307 fire test will help ensure the designer or contractor will select a suitable match for the wall being built and thus ensure the fire resistance rating indicated in the listing will be achieved.

Curtain wall assemblies that have a floor-to-ceiling glass with a small spandrel extending below the floor line, or curtain walls with all vision glass (often referred to as "zero spandrel" curtain walls), must be constructed and protected in particular ways to prevent fire spread between stories. A perimeter joint firestop system listed with a wall having spandrel panels would not apply to zero spandrel wall assemblies and vice versa. Zero-spandrel curtain wall firestop systems often rely on insulated steel shadow boxes to help create the firestop system which would prevent vertical fire spread. Figure 3 shows a simplified example of a shadow box installed in a zero-spandrel curtain wall, thus providing the foundation for possible firestopping of the remaining safing gap. The shadow box is filled with stone wool (mineral wool) 120 kg/m^3 (nominal 8 lb/ft^3) density, with layers (fibre axis) to be vertical. Figure 4 shows an example of a listed firestop system for a zero-spandrel curtain wall.

Important tip: Verify a proposed system listing, or the system listings referenced within a proposed Engineering Judgment (EJ), are sufficiently similar in all important variables to the needed wall installation.

The most critical items that must match between a proposed field installation and the tested/listed firestop system are:

a) the spandrel type
b) framing type
c) spandrel insulation

If other details do not match, an EJ can often be obtained from a firestop manufacturer with E2307 fire test data. However, any offered EJ should reference tested systems that at least match items a, b, and c.

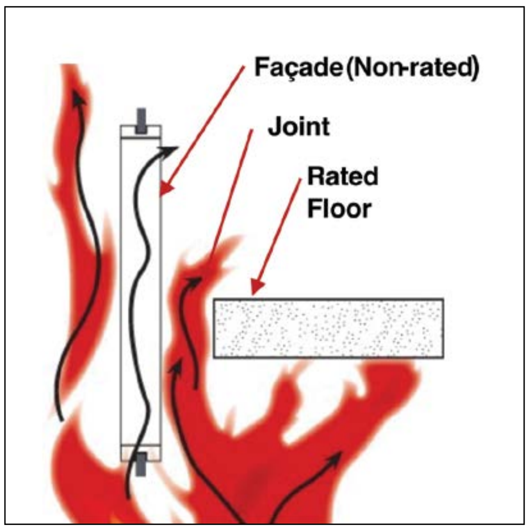
Important tip: Perimeter joint firestop system listings for curtain walls using spandrel panels will not provide a suitable basis for an EJ if the target wall is zero-spandrel or floor-to-ceiling glass.

A firestop manufacturer may be willing to offer an EJ based on one of their tested systems to accommodate some differently constructed curtain walls. The issuance of an EJ does not guarantee that the proposed solution will provide the required fire-resistance rating. Similar to proposed installation details from any vendor, an EJ is a recommendation from the issuer, who has a vested interest in its acceptance and implementation. It is ultimately the responsibility of the recipient to critically assess the EJ's validity.

Manufacturers, naturally motivated to offer solutions to potential customers, may propose options they believe are "close enough," even when a thorough evaluation might reveal that the conditions do not sufficiently align with tested assemblies. To ensure compliance and effectiveness, recipients should carefully scrutinize proposed EJs, verifying that key parameters align with relevant fire test data.

To help the recipient of a proposed EJ assess whether the EJ should be accepted/approved or not, the International Firestop Council (IFC) has published a document entitled "Recommended IFC Guidelines for Evaluating Firestop Engineering Judgments – Perimeter Fire Barrier Systems."[1] An EJ meeting the IFC Guidelines would explicitly list the tested and listed systems being referenced in supporting the conditions of the EJ. The receiver and/or approver of the EJ should verify the referenced listings have details that are reasonably similar to the offered EJ. If not, the issuer of the EJ should be asked to justify on what basis the referenced listings were extrapolated to meet the conditions of the present field condition. Evaluating an EJ, as the IFC Guidelines suggest, is subjective. With the IFC guidance, most people can detect when they are being offered an EJ that does not have a sufficient basis in past testing. An EJ that is too far removed from the presently needed conditions should not be accepted or approved. Inadequate perimeter joint firestopping installed throughout a building, one storey after another, creates a possible danger to occupants and potential liability that should be avoided.

ASTM E2307 fire test after ignition of exterior burner (at five minutes).



Curtain wall spandrel is exposed to fire from the inside and the outside in E2307 fire test.

The one approving (or not) a submitted EJ will depend on the job, and could be the design professional in responsible charge, the installation contractor, or some Authority Having Jurisdiction (AHJ) if there is strong and knowledgeable local code enforcement.

To help encourage a higher degree of reliability and technical soundness of issued firestop EJs, in 2024 UL Solutions launched the "Technical Evaluation Developer Program" (TEDP). UL Solutions uses the term "technical evaluation" as their alternative term for EJ in this program. It is

Gap between curtain wall and edge of slab.

a voluntary program for firestop manufacturers. UL examines the knowledge level of the technical staff developing EJs and evaluates the quality and consistency of the internal process for developing EJs. UL conducts audits to assess a manufacturer's management system (MS), ensure adherence to the MS, and evaluate the MS regarding the program's requirements. UL will select a sampling of the EJs issued within a given year for fire testing to verify if the EJs predict the fire-resistance rating the previously untested engineered designs can achieve sufficiently closely. Those manufacturers' offices meeting the program requirements are accredited and listed by UL within their Category Control Number (CCN) "WYGB." Accredited companies can be found at ul.com/piq by searching for CCN (listing category) WYGB. It might seem that a curtain wall designer needs to browse the 500-plus available perimeter joint firestop listings to find a suitable firestop for any wall design. In fact, in many cases, the proposed curtain wall design details may need to be modified to some extent to make the firestopping possible, either in accordance with a tested/listed system or with a well-justified EJ. As any firestop manufacturer with this kind of fire test experience can say, there are curtain wall conditions that would not pass an E2307 test and, therefore, could not be feasibly provided with an EJ. If no wall design changes are made, a conscientious firestop manufacturer asking for an EJ may offer a design that indicates something labelled as "smoke seal only" without indicating any anticipated F-rating. This expresses honestly that they cannot reasonably assure a quantifiable fire resistance rating equal to the rating of the floor slab.

In the past, when *NBC* 2015 and previous editions required only the "continuity" of the floor fire resistance, EJs were offered and often approved even if the manufacturer offering the EJ did not have any relevant fire test data on the behaviour of the target wall type. Many EJ issuers included caveats/disclaimers similar to these:

- "Curtain wall design by others"
- "Rating of this system is dependent on the performance of surrounding construction"
- "Rating up to X hours, or as long as the assembly remains intact in a fire scenario"

These disclaimers made it plain that the company offering the EJ did not know how the curtain wall construction might affect its proposed firestopping of the perimeter joint.

Seeing such a disclaimer should be considered a red flag now that *NBC* 2020 mandates a perimeter joint firestop tested to ASTM E2307. E2307 is not simply a joint test. It is a test of a complete curtain wall assembly. The construction details of the curtain wall are a larger factor in determining the fire resistance rating of the perimeter joint firestopping than the materials in the safing gap.

Important tip: A proposed perimeter joint firestop EJ with a disclaimer indicating that

Terminology

Joint firestopping designed and tested to prevent vertical fire spread at the gap between a fire-resistance-rated floor slab and a curtain wall is commonly referred to using many different terms. This article will refer to it as "perimeter joint firestopping." This is consistent with the term used in the Canadian fire test method CAN/ULC-S115. Such firestopping is also commonly referred to as:

- Perimeter fire barrier (refer to ASTM E2307)
- Perimeter fire containment (refer to IBC)
- Edge-of-slab firestopping
- Curtain wall firestopping
- Perimeter gap firestopping

All these terms usually refer to systems tested to ASTM E2307.

A failed ASTM E2307 fire test—flame spread through safing gap (having insulation and sealant) due to curtain wall reaction to fire exposure.

precise curtain wall construction details have not been considered is unlikely to meet the intent of *NBC* 2020.

To offer system listings or justified EJs compliant with *NBC* 2020 for many jobs, firestop manufacturers should (if they have not already) invest in and accumulate sufficient E2307 fire test data. Such fire testing will, first and foremost, result in listed designs. Just as importantly, comprehensive E2307 fire test experience can provide relevant fire test data to justify some EJs. The variety of curtain wall variations for which a firestop manufacturer could offer well-supported EJs will be proportional to the extent of their E2307 fire test experience. Some have a large body of listings and some do not.

Suppose an EJ that includes disclaimers similar to "curtain wall design by others" nevertheless indicates an hourly rating (F-rating); it can typically be assumed unless explained otherwise, that this EJ would not achieve the stated rating if tested to ASTM E2307. The developer of the EJ is communicating they have knowledge about the behaviour of the joint sealant materials but that they do not have sufficient understanding of the fire behaviour of the curtain wall itself and how that could impact the joint sealants.

As a best practice, many manufacturers will provide a clear conclusion regarding the expected fire performance within a well-justified EJ, stating something similar to "design represents a firestop system expected to pass ASTM E2307 if tested." However, do not expect to see the opposite conclusion stated as clearly, that the details shown would likely not pass the fire test or that the fire rating cannot be predicted. The latter case is indicated more subtly by one of the disclaimers discussed above or by the statement "smoke seal only."

Conclusion

NBC 2020 now has requirements for firestopping the joint (gap) between the edge-of-slab and a curtain wall that harmonizes with the requirements in many other developed countries. It has done this by requiring perimeter joint firestopping that has been tested to ASTM E2307.

It is up to the specifier, designer, contractor, AHJ, and others in the construction chain to be alert of the possibility that a proposed firestop system listing or proposed EJ might not match the conditions of the curtain wall being constructed closely enough and that alternatives should be sought. Lack of a suitable match from one manufacturer could necessitate contacting other firestop product and system suppliers, who might have testing and listings that provide a closer match to the details of the curtain wall that is to be constructed. One should not assume that the company a contractor typically relies on for firestopping has the solutions for every curtain wall.

It could be the design details of a curtain wall under construction are so far removed from the 500-plus available Intertek and UL listings that no available firestop manufacturer has a system close enough to use as listed or per an EJ with reasonable extrapolation. Some curtain wall construction details cause an ASTM E2307 fire test to fail before achieving a minimal one-hour F-rating. If the proposed construction is thought to be able to pass a fire test, but there is not sufficient fire test data available to develop and justify an EJ, a commissioned fire test to ASTM E2307 could be needed to determine whether a proposed solution will provide the required F-rating. Building designers should be advised that the lead time for large-scale testing is typically many months, costing more than $40,000 per test. If that is the chosen path, one should seek out a firestop manufacturer with extensive fire test experience to guide this design process, or otherwise be ready to do multiple tests if a successful solution is not established on a first attempt. Even manufacturers with decades of perimeter joint firestop fire test experience will fail some tests when they try new conditions significantly different than what they have tested before. Modifying a curtain wall assembly to pass ASTM E2307 for the needed F-rating can sometimes be a trial-and-error process.

John Valiulis is director of codes and standards with Hilti North America. He has 39 years of experience working in multiple countries as a fire protection engineer in research, construction applications, and national codes and standards development. He holds degrees in chemical engineering and fire protection engineering. Valiulis has instructed fire protection engineering seminars in North America, South America, Europe, Asia, the Middle East, and the Caribbean and has written for many U.S. and Canadian publications. He has served on six NFPA technical committees and numerous ASTM committees. He has contributed to developing the *National Building Code of Canada* (*NBC*) and the *International Building Code* (*IBC*). Valiulis can be reached at john.valiulis@hilti.com.

Russell Snow, FCSC, CSP, CTR

Honoured to have served, excited for what's next

As I transition into the "Russ Who?" role of immediate past president, it's hard to believe I stepped into the position of president of CSC just a few months ago. Time has flown by, and as I write my final message in this role, I can't help but reflect on the journey.

First and foremost, I want to express my heartfelt gratitude to all CSC volunteers—past and present. The dedication and hard work I've witnessed throughout my term and over the years have been truly inspiring. Leading such a talented and committed group, whether at the chapter or national level, has been an absolute honour. I am deeply grateful for every moment spent supporting our association's growth.

As my term as president nears its end, it feels like there's still so much to accomplish. Yet, reflecting on the key initiatives we've completed and the exciting ideas still on the horizon, I realize how much progress we've made. Thanks to the dedication of many, we're on track to keep advancing these initiatives under the leadership of Kelly Sawatzky, RSW, CSP, along with the outstanding executive council, board of directors, and members across the country. While we've faced challenges, we've turned them into opportunities for growth, and I'm excited for what lies ahead. Although I haven't seen some of my ideas come to fruition, I remain committed to completing them as I transition into my new role as immediate past president.

Working closely with the executive council has given me great confidence that CSC is in excellent hands moving forward. Kelly, along with our treasurer, Don Shortreed; Abigail MacEachern; Yvon LaChance; Jonathon Greenland; and the incoming fourth vice president, is more than equipped to carry on the work we've started. Our current board of directors is passionate and continues to bring great ideas forward, ensuring our association's continued success.

To Nick and Clafton—words can't express how grateful I am for your unwavering support and guidance this past year. You are the backbone of CSC, and I'm incredibly thankful for everything you've done.

As this chapter closes, I want to express how truly honoured I am to have served as your president. I'm deeply grateful to my friends, colleagues, and family for giving me the opportunity to contribute to CSC. I will always cherish the experiences and accomplishments we've shared. And remember, this isn't goodbye. As we all know, once you're part of CSC, it becomes a part of you—forever in your heart and soul.

I am truly committed to CSC. In fact, I AM CSC.

Honoré d'avoir servi, excité pour la suite

Pendant que je fais la transition vers « Qui est Russ? » en tant que président sortant, il est difficile de croire que j'ai pris le poste de président de DCC il y a quelques mois. Le temps a passé, et alors que j'écris mon dernier message dans ce rôle, je ne peux m'empêcher de réfléchir au voyage.

Tout d'abord, je tiens à exprimer ma profonde gratitude à tous les bénévoles de DCC—passés et présents. Le dévouement et le travail acharné dont j'ai été témoin tout au long de mon mandat et au fil des ans ont été vraiment inspirants. Diriger un groupe aussi talentueux et engagé, que ce soit au niveau des sections ou à l'échelle nationale, a été un honneur absolu.

Alors que mon mandat de président tire à sa fin, j'ai l'impression qu'il y a encore tant à accomplir. Pourtant, en réfléchissant aux initiatives clés que nous avons réalisées et aux idées passionnantes qui sont encore à l'horizon, je me rends compte des progrès que nous avons réalisés. Grâce au dévouement de nombreux intervenants, nous sommes sur la bonne voie pour continuer à faire progresser ces initiatives sous la direction de Kelly Sawatzky, RDA, PCD, ainsi que du remarquable conseil exécutif, conseil d'administration et membres de partout au pays. Même si certaines de mes idées ne se sont pas concrétisées, je reste déterminé à les mener à terme alors que j'assume mon nouveau rôle en tant que président sortant.

Travailler en étroite collaboration avec le conseil exécutif m'a donné une grande confiance que DCC est entre d'excellentes mains à l'avenir. Kelly, ainsi que notre trésorier, Don Shortreed; Abigail MacEachern; Yvon LaChance; Jonathon Greenland; et le quatrième vice-président à venir, est plus que bien équipé pour poursuivre le travail que nous avons commencé. Notre conseil d'administration actuel est passionné et continue de proposer d'excellentes idées, ce qui assure le succès continu de notre association.

À Nick et Clafton—je ne peux exprimer avec des mots combien je suis reconnaissant de votre soutien indéfectible et de vos conseils au cours de la dernière année. Vous êtes l'épine dorsale de DCC, et je suis incroyablement reconnaissant pour tout ce que vous avez fait.

Au moment de clore ce chapitre, je tiens à dire combien j'ai été honoré d'avoir servi en tant que président. Je suis profondément reconnaissant à mes amis, collègues et membres de ma famille de m'avoir donné l'occasion de contribuer à DCC. Et rappelez-vous, ce n'est pas un au revoir. Comme nous le savons tous, une fois que vous faites partie de DCC, cela devient une partie de vous-même—pour toujours dans votre cœur et votre âme.

Je suis vraiment dévouée à DCC. En fait, JE suis DCC.