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How to stop oversizing residential transformers and wiring for aggregated peak loads



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Christa van Dyk, C.E.T.
President, ABEC (North)

Message from the ABEC North president

As I embark on another year as president, I am continually heartened by the dedication and commitment of the board and their trust they have in me to continue as their president.

I've come to see ABECN as a team; together, we created abundant opportunities to teach, learn, mentor, share, advocate, brainstorm, and give back to our community at large.

The steadfast efforts of the board, committee members, authors, speakers, sponsors, and our community have led to expanded opportunities and offerings. We've continued hosting our monthly Casual Night Series events and luncheons, summer and holiday season socials, the summer BBQ, and have also introduced plant tours to our programming.

In the first five months of 2025, the board has overcome obstacles, leading to significant achievements. July marks the debut of our newly redesigned website, featuring a modernized ABECN logo that represents our evolution.

The excitement and the effort the board has put into these two major accomplishments stand as a testament to their exceptional dedication to our society.

At the 2025 Annual General Meeting on February 20, 2025, Jamie Murphy RET, P.L. (Eng), CCCA, LEED® AP, Lindsay Verhelst, and Ryan Asselstine officially resigned their positions on the board. As we say farewell to them, we acknowledge their invaluable contributions, enthusiasm, and commitment to ABECN over the years.

At the same time, we welcomed new faces to ABEC North's board of directors. Please welcome Lisa Henderson, P.Eng., Armin Mueller, RRO, RSE, and Casie Chou, M.Sc., P.Eng. to the team, and their fresh perspectives as we continue to strengthen and grow our community.

I look forward to the rest of 2025, and the year 2026. Thank you for joining us.

Christa van Dyk


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CALENDAR OF EVENTS



ABEC North Schedule of Events

July 8, 2025

*ABECN July Casual Night Summer Patio Social
6:00 p.m. to 9:00 p.m.*

August 13, 2025

*ABEC North BBQ in conjunction with
CSC Edmonton Chapter*

September Casual Nights and Luncheons

Start up again – topics to be determined

ABEC South Schedule of Events

Monthly Luncheons

September 24, 2025

October 22, 2025

November 26, 2026

January 28, 2026

February 25, 2026

March 25, 2026

April 22, 2026

May 27, 2026

Seminar Series:

November 2025 – TBA

June 25, 2025

*Annual Golf Tournament at Springbank Links Golf Club
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October 22 and 23, 2025

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RED DEER JUSTICE CENTRE: AN ALBERTA CATALYST FOR HIGH-PERFORMANCE FAÇADES



By Peter Dushenski

Peter Dushenski is the managing director of Alberta-based GlasCurtain inc. Since 2013, he's led the manufacturer to several industry firsts including the world's highest thermally-performing glazed curtain wall based on Passive House (PHI) certification – rated to 0.60 W/m²K – while growing the company's installer network to over 35 partners across North America. Before this role, he worked for the provincial government in Public Health policy. Today, when he's not knee-deep in fiberglass, Dushenski's passions include design, history, and staying active with his young family.

In a province primed by sub-zero necessity, the new \$200 million Red Deer Justice Centre (RDJC) might look like just another functional, durable government building. But beneath its limestone and glazed façade is a quiet story of local innovation.

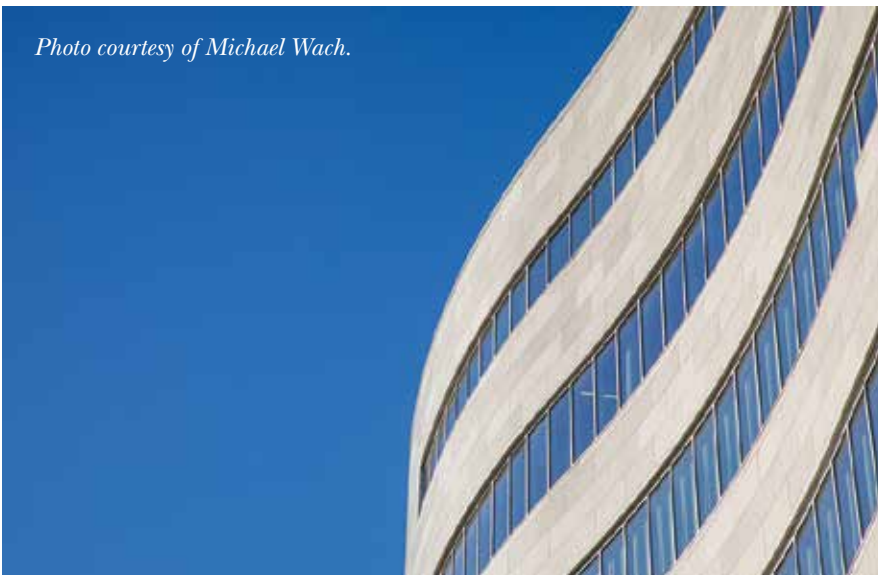
This high-performance project – designed by DLR Group and

Group2 Architecture in conjunction with Alberta Infrastructure – was born of a moment in Alberta when a bold vision emerged for public infrastructure, one that embraced ambitious energy targets and environmental stewardship. This included an unprecedented investment in K–12 schools, as well as several civic buildings, including

this eight-storey Central Alberta courthouse targeting net-zero performance.

Among the first provincial projects to target net-zero, this mandate was the culmination of a groundswell movement for sustainable construction approaches over the last 20 to 30 years. From energy-efficiency optimizations to embodied carbon calculations to occupant wellness scores, we've seen public expectations for building performance continually edge higher and higher. This demand-side pressure has then been mirrored in energy codes and green building standards, such as Passive House, LEED, and net-zero, but also in the National Energy Code for Buildings (NECB), as well as local adaptations like BC Energy Step Code. As the Red Deer Justice Centre demonstrates, the role of government is not just regulatory, it's also catalytic. Public projects such

Photo courtesy of Michael Wach.

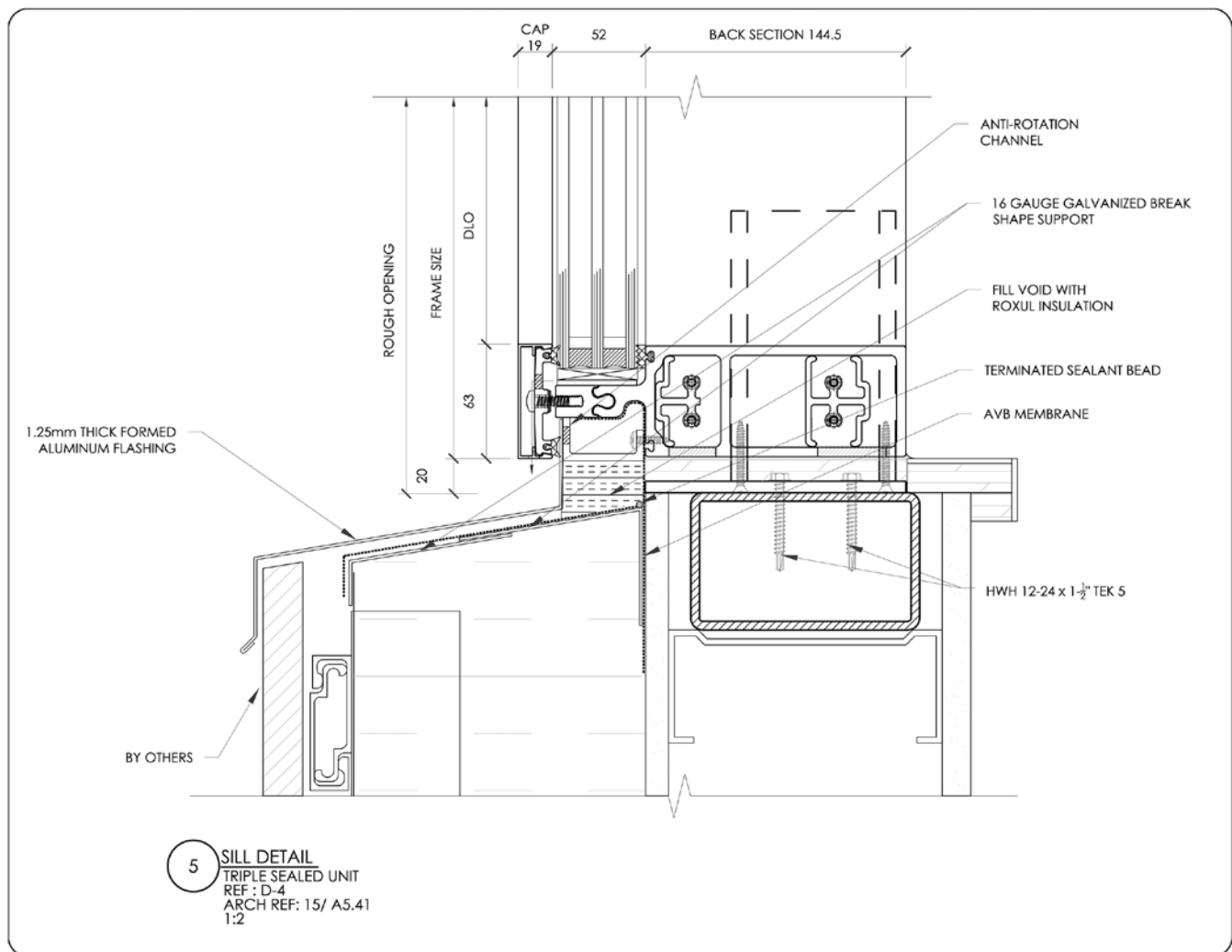




as large-scale public buildings play a critical role in signaling demand to market players by reducing the risk of newer technologies, validating emerging innovative materials, and offering reference points the private sector can trust.

In this sense, policy on the demand-side does much more than enforce standards – it moves industries forward – and there are countless historical examples to support this. From US DARPA working with MIT and Intel to kickstart the

microelectronics revolution, to Canadian governments working with General Electric to spur innovation in hydroelectric turbines for large-scale dams across the country, and beyond. Government has long played a key role in technological





innovation via market-making.

Of course, as important as the government's role is, it can't do everything. It can offer "carrots" (grants, loans, etc.) and "sticks" (regulations, fines, etc.), but it still needs industry partners to execute and build. The best-laid plans of mice and men, and all that... So, when it came time to design the new high-performance Red Deer Justice Centre, surely the government at the time seized this opportunity to support and encourage local champions, right? Right??

Well, yes and no. You see, for decades Canadians have been only too comfortable increasingly outsourcing the production of advanced building materials, opting instead to import technologies, systems, and components from Europe, Asia, and the United States, often without asking whether they're suited to our climate, culture, or carbon goals, and whether they help or hurt our local industries. The results have unfortunately been somewhat predictable: a diminished domestic manufacturing base, more

limited architectural flexibility, and a shrinking sense of Canadian (much less Albertan) identity in our built forms.

Indeed, what's been missing from the national discourse, and certainly from our written policies in recent decades, is a robust framework for domestic production, particularly for building materials. While demand-side regulatory incentives have improved and show no signs of abatement in spite of the increasingly uncertain geopolitical landscape, supply-side policies such as preferential procurement for low-carbon and locally-made materials are still developing.

Thankfully, at RDJC, some key design decisions stuck through to project completion. Among the success stories was the specification of an Alberta-made triple-glazed, fibreglass-framed curtain wall system: GlasCurtain's Thermaframe 7.

This fibreglass-framed façade upgrade added just 0.5 per cent of the total project cost, in exchange for nearly doubling the thermal performance of the system compared

to "business-as-usual" aluminum-framed alternatives, saving 286 tonnes of embodied carbon today and another 310 tonnes in operating emissions over the next 50 years for a total of 596 tonnes CO₂e savings, or the same impact as preserving 6,200 mature boreal trees. The local economy benefited as well to the tune of 15 full-time paycheques, not to mention the economic multiplier of these wages that boosted local GDP by 1.3-times that amount. In fact, when you crunch the numbers, the fibreglass-framed costs were more than fully matched by new domestic revenue in year zero and will continue to pay back a second time through payroll taxes and induced spending. That's all before we factor in the qualitative increases in domestic resilience and local know-how that could've easily ended up overseas or south of the border, as well as the productivity benefits from the higher-performance façade for building occupants. That's a really good news story; it's one we should be rightly proud of!

All in all, the Red Deer Justice Centre demonstrates that high-performance procurement can be local and arguably should be local. With an Alberta-made fibreglass-framed curtain wall, the province rightly seized the opportunity to make its new courthouse lower-carbon and more energy-efficient.

So what lessons can we draw from the Red Deer Justice Centre?

1. Local jobs matter. Every tonne

of CO2e avoided came with a paycheque attached, which is a message that should resonate in every Albertan.

2. Carbon and cost aren't enemies.

Relatively modest line-items (less than one per cent) have the capacity to eliminate over hundreds of tonnes of carbon emissions across a building's life-cycle

3. Procurement is policy. A

reasonable price preference for domestic low-carbon materials could lock-in all these benefits by default.

Of course, skilled manufacturing capacity doesn't just fall from the sky, which is why government also has an

important role to play in bolstering construction-related education, facilitating apprenticeships, and funding hands-on training, all of which Alberta is doing at the moment. In fact, Alberta Innovates was a key player in supporting the CAN/ULC-S134 flame-spread testing for Thermaframe, making the system code-compliant for use in mid-rise institutional buildings such as the newly opened RDJC.

Looking ahead, the RDJC offers a broader model of success, one to be learned from and built upon, even if there's more work to do (and there's always more work to do...) because when we work together using locally-made materials, we don't just cut shipping emissions and shorten

lead times, we create jobs, circulate capital within our own communities, attract investment and foster pride in place. We make buildings that belong, not just technically, but culturally and climatically.

As jurisdictions across Canada look to build greener, smarter, and more responsibly projects, like the RDJC, it will serve as a powerful reference point. Alberta has a growing opportunity to position itself as a sustainability leader. Given our cold climate know-how and ever-increasing manufacturing capacity, projects like Red Deer Justice Centre show that we're moving in the right direction, one innovative façade at a time. ■



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HOW TO STOP OVERSIZING RESIDENTIAL TRANSFORMERS AND WIRING FOR AGGREGATED PEAK LOADS



By Alexander Jordan and Yuxiang Chen



Alexander Jordan is a recent University of Alberta graduate who completed his graduate studies in building science, and is also a registered APEGA E.I.T. His main field of interests are reducing energy consumption and GHG emissions in the building sector and using novel statistical processes for estimating aggregated residential peak load behaviour for buildings and communities.

Dr. Yuxiang Chen is an associate professor of building engineering and a licensed professional engineer under APEGA. He is an expert in the design, construction, and performance assessment of high-performance buildings, with a focus on thermal energy storage, daylighting, intelligent operation, utilization of renewable energy, and their intelligent and integrated design and operation.

What is residential aggregated peak load and why does it matter?

For building design, peak electrical load is interpreted as the expected maximum power the building will need in a single moment throughout the lifespan of the building. Although this load may only occur once or a handful of times, the building equipment and the grid must be sized accordingly to prevent blackouts or blown fuses. In a residential setting, peak loads are driven by two categories: building load and occupant load. The building load is the power used by HVAC devices, including heat pumps for air conditioning and heating, air handling units (AHUs), and electric water heaters. Because building load is primarily driven by space heating and cooling, seasonality and climate impact residential peak load. Historically, building loads have been driven by air conditioning in warmer outdoor temperatures, as space heating has been met using fossil fuel combustion. Building envelope performance and heat pump technologies continue to improve, causing electric heating to become increasingly feasible. However,

increased building loads from electric heating in colder months threaten greater, more frequent peak loads in the winter. This is particularly challenging for cold climates such as Alberta, which rely upon extensive space heating during harsh exterior conditions. Therefore, continued improvement of building envelope performance and heat pump efficiencies are critical to reducing the impact of space heating electrification on building-driven peak loads. Alternatively, occupant load is described by high-intensity, short-duration activities such as cooking, washing, and recreational activities [1,2]. Although occupant loads are caused directly by occupant behaviours, actions such as opening windows and adjusting the thermostat may also impact the building load. As people's behaviour in houses is generally unpredictable (it's not certain when a family will cook or when heating/cooling will be active), there is an inherent randomness associated with the timing and size of peak loads [3]. These factors make predicting peak loads difficult for designers.

When considering residential peak load for multiple households, aggregated peak load describes the summed

power load of more than one household. Therefore, estimating aggregated peak load becomes a statistical problem, where the aggregated peak load depends upon the probability of high loads between households aligning at the same time (e.g., two or more houses cooking simultaneously). The primary application of considering peak load on an aggregated household level is that the electrical equipment responsible for supplying power to homes must be sized according to the estimated aggregated peak load, which is difficult to predict. Examples of electrical equipment include the feeder equipment for a subdivision of homes or the common transformer installed in a multi-unit residential building. Conventional methods and codes for sizing electrical transformers tend to result in oversized transformers, increasing construction costs with no additional benefits. By having an accurate, statistical estimation of aggregated peak load, installed electrical equipment can be sized with known levels of risk, achieving significant reductions in the size of electrical equipment, as observed in the discussed case study.

The remainder of this article discusses a novel method developed for estimating aggregated peak loads using historically collected load data to estimate peak loads for similar buildings. This is the second article produced by students from the Intelligent Design and Operation for Built Environment (IDOBE) lab at the University of Alberta, led by Dr. Yuxiang Chen (Associate Professor, Department of Civil and Environmental Engineering). The IDOBE lab, along with the Cross-Disciplinary (Building Engineering) in Civil program at the University of Alberta, supports the development of local building science experts to support the future of Alberta's building envelope industry.

Estimated aggregated peak load: Distributions and convolution

For estimating aggregated residential peak load, the most straightforward method is to calculate the absolute maximum, which assumes each household within the aggregation is utilizing maximum power. While this does work for establishing a maximum possible baseline, the absolute peak loads between households will not align when considering a sufficiently large number of households [4]. This is more widely referred to as demand

diversity, where aggregated household-level demands become less random as the number of households increases. Therefore, although singular household loads are highly random and unpredictable, demand diversity suggests that at an aggregated level, the random effects of individual household loads diminish. This also implies that individual household peak loads have less effect at the aggregated load level, and the impact is further reduced as the number of households increases. Therefore, demand diversity allows designers to develop alternative methods for calculating peak load that are more accurate to reality.

Before considering the developed method for estimating aggregated peak load, it's necessary to discuss three main concepts from statistics: data distributions, probability distributions, and convolution. Beginning with data distributions, a data distribution is a generalized term for the spread of data within a collected dataset. Distributions are typically visualized through histograms, which assign frequencies to corresponding data bins. Taking daily peak load data for example, the histogram shown below in Figure 1 corresponds to the daily peak load distribution of one of the case study households. The vertical axis indicates the frequency of observations for each load magnitude on the horizontal axis, where, for visual purposes, each bar corresponds to a set of load values ranging from 200 W (otherwise referred to as 200 W bins). Alternatively, histograms can also be used to represent probability distributions, where instead of the vertical axis corresponding to the number of observations, the vertical axis indicates the probability of the observation relative to the rest of the data. While data and probability distributions act as visual representations of datasets, a mathematical way to express the shape of a probability distribution is the probability density function (PDF), which assigns a function that follows the same shape as the histogram. A sample PDF fitted to the data distribution in Figure 1 is provided below in Figure 2. Unlike data distributions, which describe the frequency of each load, probability distributions and PDFs instead define the associated probability of each load occurring. Hence, when summing loads between households to investigate aggregated loads, probability distributions and PDFs are useful for determining the probabilities of different combinations of aligned loads.

The final concept from statistics is convolution, which

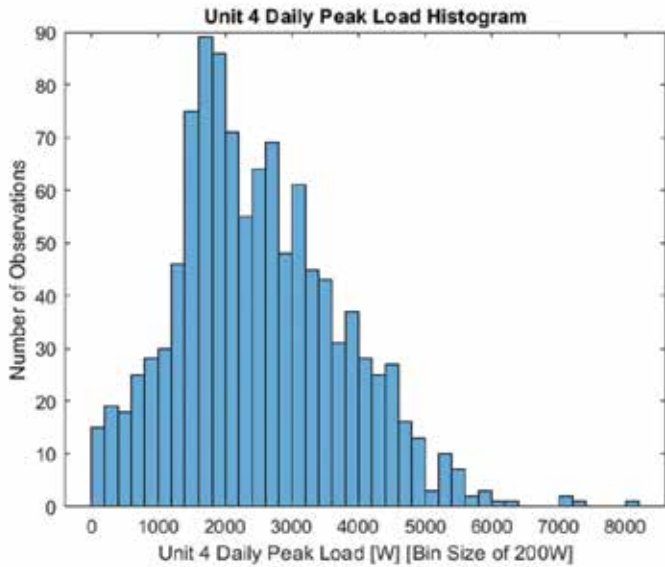


Figure 1. Histogram of Unit 4's daily peak loads [W].

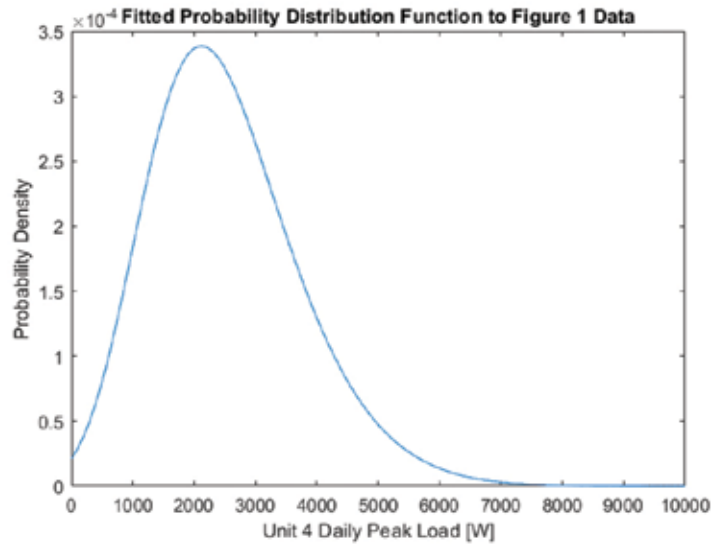


Figure 2. Fitted probability density function for Unit 4's daily peak loads [W].

is the statistical process for combining or summing two probability distributions or PDFs into a single resulting probability distribution/PDF [5]. The main caveat with convolving PDFs is that the functions or distributions cannot be directly added to each other. The reason for this is rooted in probability. In statistics, to determine the outcome probability of two independent events occurring, the product of the probabilities is taken from both events. In other words, using A and B as examples of independent events, the probability of both A and B occurring is the probability of A occurring multiplied by the probability of B occurring. This can be expressed mathematically as $P(A \text{ and } B) = P(A) * P(B)$, where for two-coin flips, A and B would be $P(A \text{ and } B) = 0.5 * 0.5 = 0.25$. Now, instead of discussing coin flips, we replace the coin flips with power loads. Unlike coin flips, which have two outcomes, heads or tails, household load can be any value equal to or greater than 0 W, representing an infinite number of possible outcomes. Therefore, when considering aggregated peak load, the goal is to consider all possible combinations of outcomes from household A and household B using the associated probabilities of each load, which are taken from either the probability distribution or PDF. Convolution achieves this by multiplying the probabilities of all possible combinations between two independent events, which in this case represents the possible loads and their respective probabilities of occurring for two households. Although convolution can only be performed for two households at a time, convolution can be repeated by first combining

household A and B to achieve distribution AB, combining AB with C to form ABC, and repeated to expand to any number of households in the aggregation.

Convolution drives the method for aggregated peak load estimation, as it considers all possible combinations of individual household loads that could combine to form aggregated peak loads. Performing convolutions can be difficult, especially for complex data distributions or PDFs. Fortunately, multiple methods exist for performing convolution. This study used an approximation method that generated independent trial load datasets through sampling. For sampling, minutely resolution load data collected from five households was used as the basis for generating trial load datasets. Each trial represents a new set of load data for a singular household with the order of values shuffled, where the order of the load data corresponds to time. By generating trial datasets and taking random aggregated sums, this achieves an approximation of the convolution as each trial summation represents a random combination of outcomes for the five households. Therefore, considering enough trial summations, the combination of all possible outcomes will be evaluated, resulting in an aggregated load distribution for five households.

This section explores the underlying principles of the developed aggregated peak load estimation method. However, several nuances remained that required additional adjustments to be integrated into to the

method, which are summarized as follows:

- The output of a convolution is another probability distribution of the two summed probability distributions. Since this study is focused solely on peak load, only the maximum load values were taken from each summation (aggregation) of trial datasets. By only taking the maximum load values, the output becomes a probability distribution for the aggregated peak load, rather than the aggregated load.
- Convolution assumes independence between household peak loads, however, factors such as time of day and temperature are known to influence when common peak loads occur between buildings. Therefore, the method had to be adapted to incorporate common factors that increase the likelihood of peak loads aligning between households.
- The above description of the method only considers the total load of each household. Using sub-metered load data, the above method can be divided into peak load estimations for different load subcategories, such as occupant-driven plug load and HVAC load.

Case study data collection and estimate development

As the estimation method requires a large amount of load data to generate the aggregated peak load estimation, previously collected load data was used from an energy monitoring case study in Edmonton, Alta. The case study households consisted of the following features:

- The case study consisted of five townhomes in a single building block with no gaps between units as seen in Figure 3. Four case study households were “middle” units with two attached households on opposing sides, and one unit was an “end” unit with only one side attached to a neighbouring unit.
- Each household was installed with a fuel-switching heating system, with a schematic shown below in Figure 4. Each system consisted of an electric-powered air-source heat pump (ASHP) that could provide both space heating and cooling and a natural gas tankless water heater (TWH) that provided space heating and domestic hot water. As these units had partially electric heating systems, the peak load behaviour is different compared to



Figure 3. Exterior photo taken at end unit of case study building.

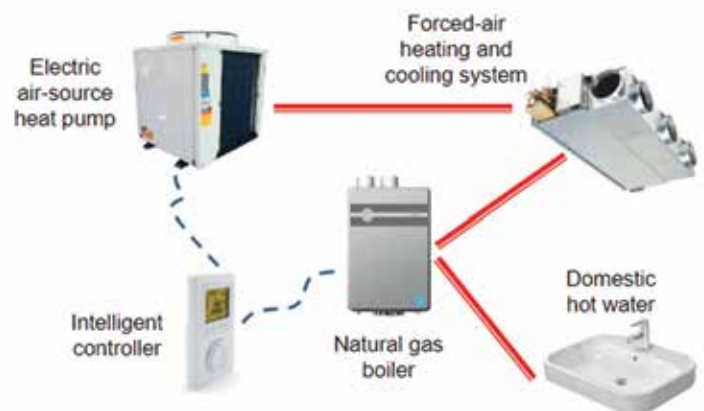


Figure 4. Schematic of fuel-switching space heating system in case study households.

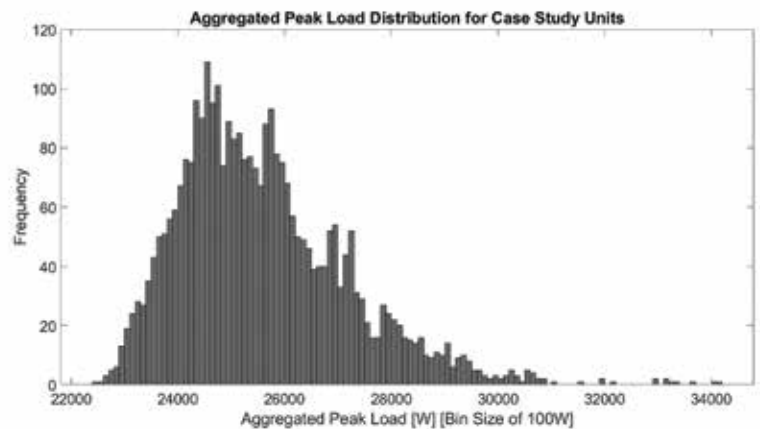


Figure 5. Histogram of convolved (generated) aggregated peak loads for case study units.

- houses with conventional natural-gas furnace systems.
- The households studied were designed to be high-performance buildings, exhibiting well-insulated and air-tight building envelopes. Additionally, heat recovery

Table 1. Aggregated peak load estimate thresholds for various percentiles.

Percentile	Threshold [W]
90%	27720
95%	28540
99%	30284

ventilators (HRVs) were installed in each unit to reduce the required energy from space heating.

- Power data was collected at a minutely interval using a commercial energy monitoring system from March 2020 to February 2023. Sub-metered power channels were available for the ASHP, air handling unit, and mechanical room (which primarily consisted of the HRV).

Performing the developed convolution approximation method resulted in a probability distribution for the aggregated peak load of the five households from the case study. To interpret the resulting distribution, percentiles were used. Percentiles indicate the percentage of values in a dataset below or above a specified threshold. For example, the 99th percentile indicates that 99 per cent of the data is equal to or lower than the specified threshold. Applied to the aggregated peak load estimate, by identifying the 99th percentile, we identify the value that corresponds to 99 per cent certainty that the specified load threshold will be exceeded. Different percentiles can be used to obtain different levels of certainty depending on the needs of the designer. Figure 5 shows the obtained aggregated peak load estimate distribution, and Table 1 below shows the 90 per cent, 95 per cent, and 99 per cent percentiles obtained from the aggregated peak load estimate.

Using the thresholds identified from the 99th percentile, the potential downsizing can be calculated for a corresponding 99 per cent certainty of meeting the building's peak load. For the case study data collection period, the highest observed aggregated peak load was 25,458 W, which fell within the identified peak load thresholds. Each unit in the case study building had a 100 A transformer installed, which corresponds to a building capacity of 60,000 W ($100 \text{ A} * 120 \text{ V} = 60,000 \text{ W}$). The 99th percentile threshold peak load was 30,284 W, which corresponds to a potential downsize of 49.53 per cent.

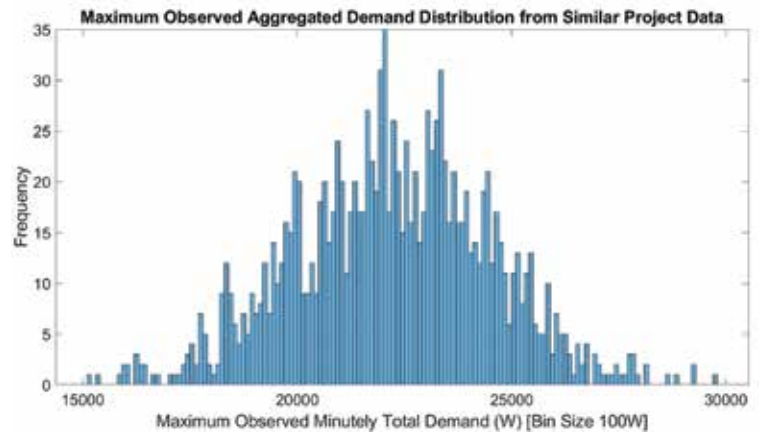


Figure 6. Observed aggregated peak load distribution from similar project

From this estimate, further sizing optimization could be assessed for the block (building) and community level transformers. From a design perspective, one per cent risk is relatively high, however, the transformer in this case study could still be downsized even with an added safety factor or higher percentile. The transformer capacity is used as the main example, but the potential to downsize applies to all electrical equipment that is sized according to peak load. The case study shows the value that historical load data can play in designing future buildings for aggregated peak load.

Although the developed aggregated peak load estimate used load data specifically from the case study households, the estimate method can be expanded to similar households. A similar case study, also situated in Edmonton, Canada, consisted of 13 similar newly constructed townhomes equipped with fuel-switching heating systems. As the aggregated peak load estimate is for five households, different combinations of load data can be taken for five of the 13 households to see different observed peaks. For choosing unique combinations of five households from 13 total households, 1287 unique observed peak loads can be found and are shown below in Figure 6. From the histogram, it is seen that all observed combinations fall within the 99th percentile threshold of 30,284 W established from the case study estimate, showing the potential for applying the estimate between similar households. Although some minor differences exist between the similar project and the case study project, these results showcase the estimate's reliability, which is essential for downsizing electrical equipment without issue.

Conclusions and recommendations

As seen from the discussed case study, the electrical equipment installed in the building was sized to almost twice the required peak load estimated and observed. By installing common transformers and taking advantage of how demand diversity simplifies the behaviour of residential demand, designers can achieve significant savings by downsizing the installed electrical equipment. Building designers are also responsible for developing well-insulated, high-performance building envelopes to reduce building load's contribution to peak loads. It's noted that in some regions, building and electrical codes may dictate the necessary equipment size to be installed. For these regions, policymakers must ensure that electrical equipment installed in buildings is not consistently oversized. In conclusion, it's recommended that policymakers and designers continue to work together to stop oversizing electrical equipment for residential peak load.

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THE GLASS ROOF: SLOPED GLAZING NEED NOT LEAK

By Chris B. Makepeace in 1995, Intro by Kevin McCunn

*Chris Makepeace retired from from Alberta Infrastructure and Transportation in 2005
and now consults part-time with Building Science Engineering Ltd.*

Kevin McCunn is a building envelope engineer retired from Alberta Infrastructure and is on the board of ABEC North.

Sometime around the turn of the century, and shortly after I completed the engineering, fabrication drawings, and installation details for a second large skylight project, my boss dropped an article on my desk, asked if I had seen it, then turned and walked away. It was a paper, a thorough study of sloped glazing function and water management detailing from the 1995 Florida conference Thermal Performance of the Exterior Envelopes of Buildings VI.

By that point in my career, I understood physics and construction practice well enough to believe that NO, we can NOT build a glass roof that does not leak. We have enough trouble building leak-free windows with vertical glazing and building leak-free roofs using roofing materials. Sloped glazing relies on little gaskets and gobs of sealant to block way too many joints and gaps between aluminum and glass. I wondered then why any reasonable person would propose they might not leak.

About five years later, I met the author of the paper, Chris Makepeace, and found he was most interested in getting things built right, and in sharing his knowledge of how. Chris had been part of a small team of building science types at Alberta Public Works (now Alberta Infrastructure) responsible for setting standards for new construction of government buildings, for reviewing design and construction, and for investigating building problems.

It was due to the problems with existing sloped glazing and the difficulty in procuring new installations that the department had been (and still is) steadily eliminating skylights. Many are renovated to clerestory structures with vertical glazing, some are roofed over, and on only a very few, deemed 'too significant' to the architecture,

is sloped glazing used in the reconstruction. Guidelines created then are still in place, the current Technical Design Requirements for Alberta Infrastructure Facilities.

So, the expert author of "The glass roof: Sloped glazing need not leak" still recommends against using sloped glazing. Please enjoy the article as it is as relevant as ever. Ignore the concepts and your skylight leaks immediately. Ignore the details and it will leak soon. Consider every little issue and maybe, maybe... Well, good luck.

Kevin McCunn

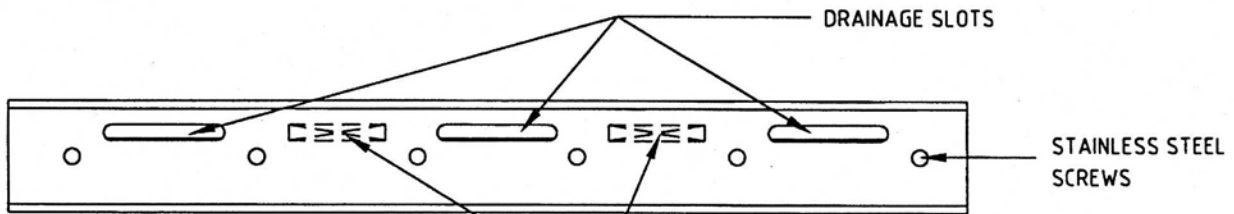
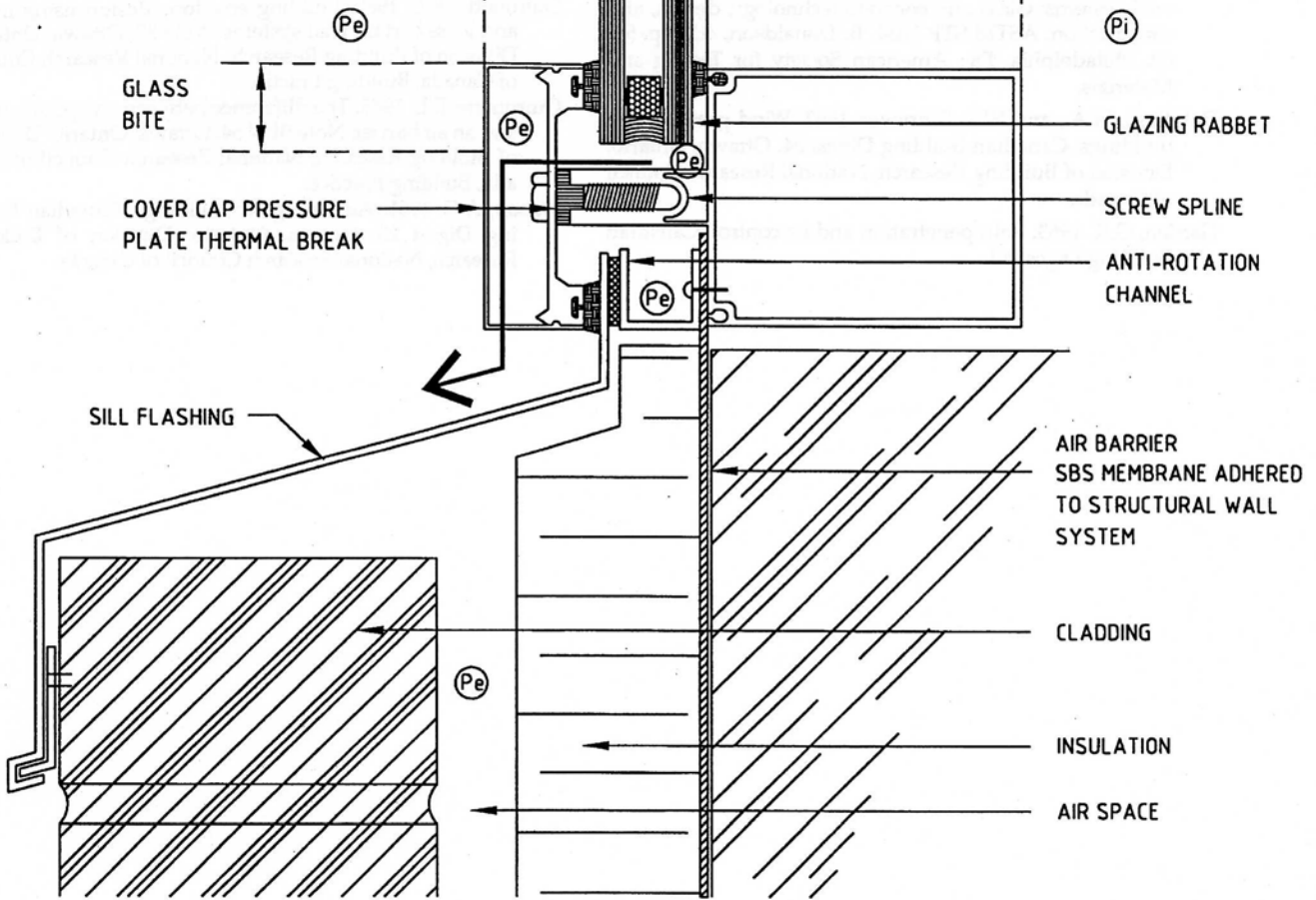
Abstract

The observations presented in this paper are based on the investigation of more than 100 leaking sloped aluminum and glass roof installations. The principles presented have been developed through discussions with testing agencies, researchers, designers, aluminum framing manufacturers, installers, maintenance personnel, and other building science specialists for the past 20 years.

For the purposes of this paper, the details are conceptual so as not to represent any manufacturer's system, although some similarities may be discernible. The description of the details and the performance observations are based on actual installations of several manufactured aluminum profiles that have been modified to follow the principles described in this paper. These installations have provided a sloped glass roof that does not leak.

There is no such thing as a standard design for a sloped, glazed roofing system of more than one lite. Each design becomes a custom system to some degree, depending on the manufacturer's aluminum framework profiles and

DRY GASKET, EXTERIOR GLAZED, PRESSURE
EQUALIZED, RAIN SCREEN CURTAINWALL



NOTE: - ALL HORIZONTAL PRESSURE PLATES TO HAVE 3 DRAINAGE SLOTS PER HORIZONTAL SECTION (NO HOLES OR DRAINAGE SLOTS ARE PERMITTED IN VERTICAL PRESSURE PLATES).

- THERMAL BREAK OF SCREW SPLINE SHOULD BE JUST VISIBLE IN ORDER THAT SLOTS ARE LOW ENOUGH TO DRAIN GLAZING RABBET.

SETTING BLOCKS @ 1/4 POINTS OR AS RECOMMENDED FOR SIZE OF GLAZING MUST NOT BLOCK DRAINAGE SLOTS.

(Pi) = PRESSURE INTERIOR

(Pe) = PRESSURE EXTERIOR

title

**EXTERIOR GLAZED PRESSURE
EQUALIZED RAINSCREEN
CURTAINWALL**

approved

DRAFT

date

MAY 1995

scale

N.T.S.

plan no.

drawing no.

1

the design loads that must be accommodated. The basic materials of aluminum and glazing units do not leak. The leaks occur where these components join each other or where the system joins the building envelope system of the remainder of the building.

Designs that are based on sole reliance of the exterior seals to provide a single line of defense to water entry have repeatedly proved to be a flawed approach. Designs where the water tightness seals are placed in a protected location, with minimal contact with water and where water is controlled and redirected to the exterior through the design of the framing, have provided watertight installations. This alternative concept may sound simple, but the details of how this can be accomplished are complicated by the limitations and compromises imposed by the design and by available systems. If the owner is willing to pay for a waterproof glass roof, the others in the team can construct it.

Introduction

At least one of the magazines produced each month for the architectural, engineering, building owners, building operators, or real estate communities will have an article on the variety of benefits of the use of glass in the building envelope. Sloped glazing often is a major part of such articles. Skylights and atriums with sloped glazing are expressed as the great design tools used by architects to give building exteriors a signature and presence, while within the interiors of buildings they provide an exterior view orientation, comfort, and warmth. Also, they enhance the occupant's perception of the interior space. The positive effects on productivity, stress, and wellness of humans because of natural light has been well documented. The problems resulting from marginal design by some architects and manufacturers, the poor attention to details by them and the installers, and the incorrect maintenance by building operators rarely are mentioned in detail in such publications. Yes, sloped glazing can be of great benefit to the architectural design, but it can be a building owner's worst nightmare.

Sloped glazing is a roof, a glass roof, and, like any other roof, people expect it not to leak. Unfortunately, that is not always the case. When it leaks, it can speed up the degradation of the components that make up the sloped glazing system, increasing the leakage problem and/or requiring replacement of failed components within the system. Water leaking through sloped glazing systems can degrade the construction at its perimeter, resulting in

roof damage; corrosion of steel elements within the roof, ceilings, and walls; and stain and/or break down drywall, interior finishes, and carpet. Water leaking through sloped glazing can follow structural elements to finally appear in remote parts of the building. When sloped glass roofs leak onto floors or stairs, they not only damage carpet and stain tiles but the leakage can turn into a serious safety hazard for the public.

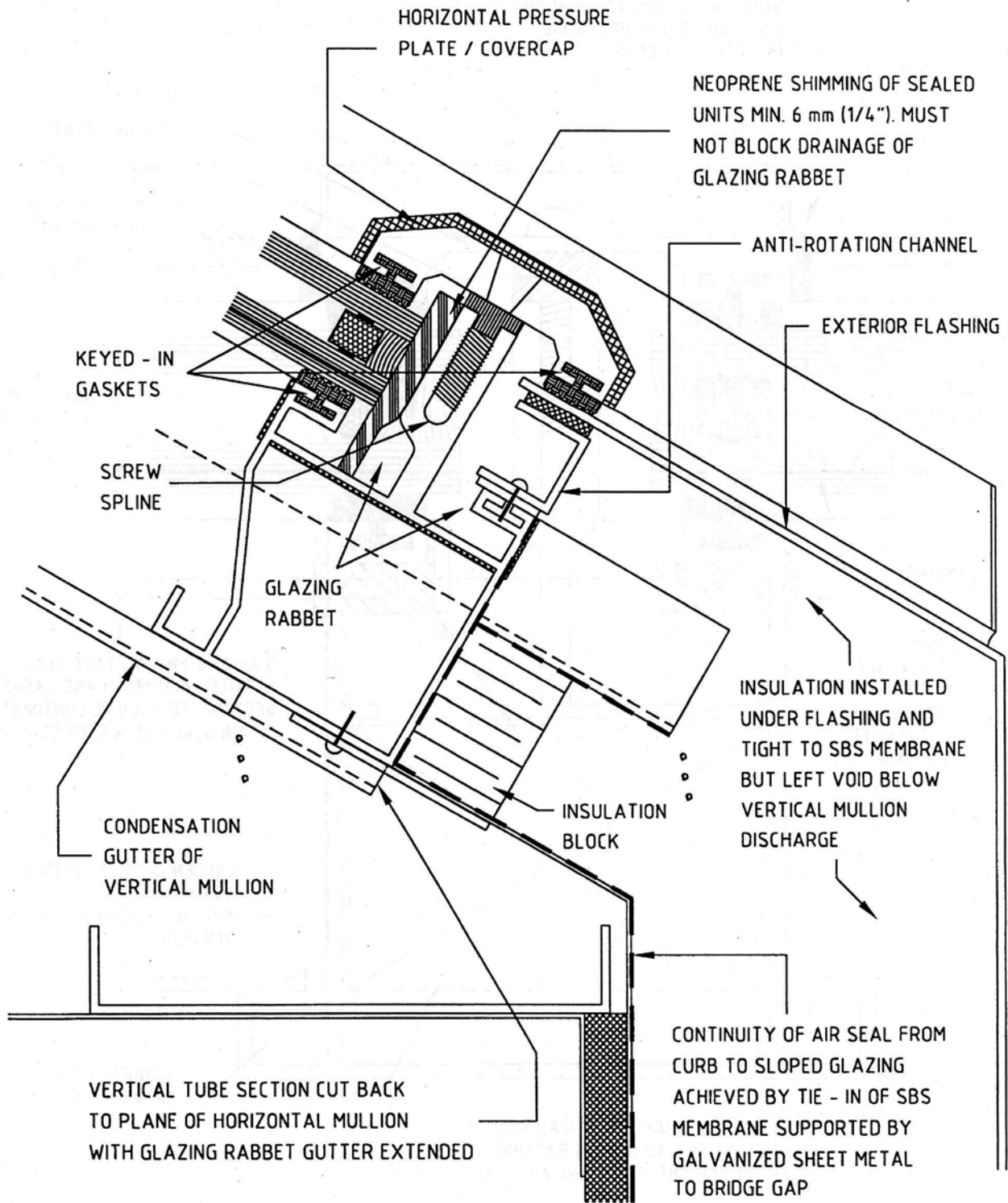
In one public mall in Edmonton, the maintenance staff placed 200 buckets to collect water leaking through an aluminum and plastic system. The cost to repair the system was more than the original cost, so the owners held off on replacement until one day when a panel broke and fell, narrowly missing a pedestrian. Had the panel hit her and resulted in any injury, the litigation and its cost could have been well beyond the cost of replacement.

Design principles

Little information is available to architects in the way of design information. Most architects rely on the manufacturers to provide the details for their system. Manufacturers develop their design in response to the demands of the marketplace and slant toward their component that makes up the system. The aluminum manufacturers produce designs that deal with the advantages of aluminum but sometimes fall short when it comes to considerations of the glass or seals. Panelized glazing and acrylic manufacturers often neglect the effect of the frame on performance. There is a great difference of opinion on how to accomplish all the details necessary for a well-functioning system. Compromises within all designs created by the industry may jeopardize the overall performance, both short and long term. The design must adequately address the basic principles of sloped glazing systems.

There are mainly two approaches taken by manufacturers. The first and most prevalent is to rely on the exterior seals between the components to keep water from entering the glazing framing. These systems may provide some sort of interior seal, especially between the frame and glazing. However, no real emphasis is placed on providing a water seal at these interior junctions of components.

The problems with such an approach include exposure of the exterior seal and/or sealants to ultraviolet radiation, thermal stresses, reaction to pollutants, and workmanship. Installers must clean, prime, place, and tool sealants in various weather conditions with the hopeful result of



	<p>title</p> <p>SKYLIGHT HORIZONTAL MULLION SECTION SILL</p>	<p>approved DRAFT</p> <hr/> <p>date MAY 1995</p> <hr/> <p>scale N.T.S.</p> <hr/> <p>plan no.</p> <hr/> <p>drawing no. 2</p>
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providing a 100 per cent perfect, long-lasting finished product. Millions of dollars are spent every year in recaulking the exteriors of buildings that rely on this approach. All too often when a sloped glazing system leaks, the maintenance staff calls for the next layer of sealant on all the joints.

The second approach is based on realizing that the exterior seals will not be completely watertight. The watertight seals are designed on the interior of the system to minimize their contact with water and to drain what water is in the system back to the exterior. Some manufacturers have realized the folly of the first approach and have started to make changes over the last years to change their designs. It has been difficult in today's marketplace, however, to make a watertight system and remain competitive.

Modern vertical aluminum and glass systems used in high-rise construction are based on this second approach (Figure 1). Using pressure equalization and draining of the glazing rabbet in what is commonly referred to as a rain screen design (Garden 1963; Brown et al. 1991). Air pressure differences across the exterior surface of a wetted wall can drive water through the imperfections present in the exterior seals. Equalizing the pressure across the cladding components and exterior seals that act as a screen to the inner wall can eliminate these forces, hence the name pressure-equalized rain screen. To accomplish this equalization of pressure, the presence of other features is necessary in the framing system: an effective air barrier, a compartmentalized glazing rabbet, and a large, protected venting area through the cladding relative to the leakage area of the air barrier.

The air barrier is created by the inner lite of glass of the unit, the seal between this inner lite of glass and the frame, the frame tube face of the glazing rabbet, and the sealed joints of the framing sections. Compartmentalization is achieved by a continuation of this barrier out through the screw spline, thermal break, and pressure plate to form a pocket of air between the sealed unit edge and frame. This pocket is called the glazing rabbet.

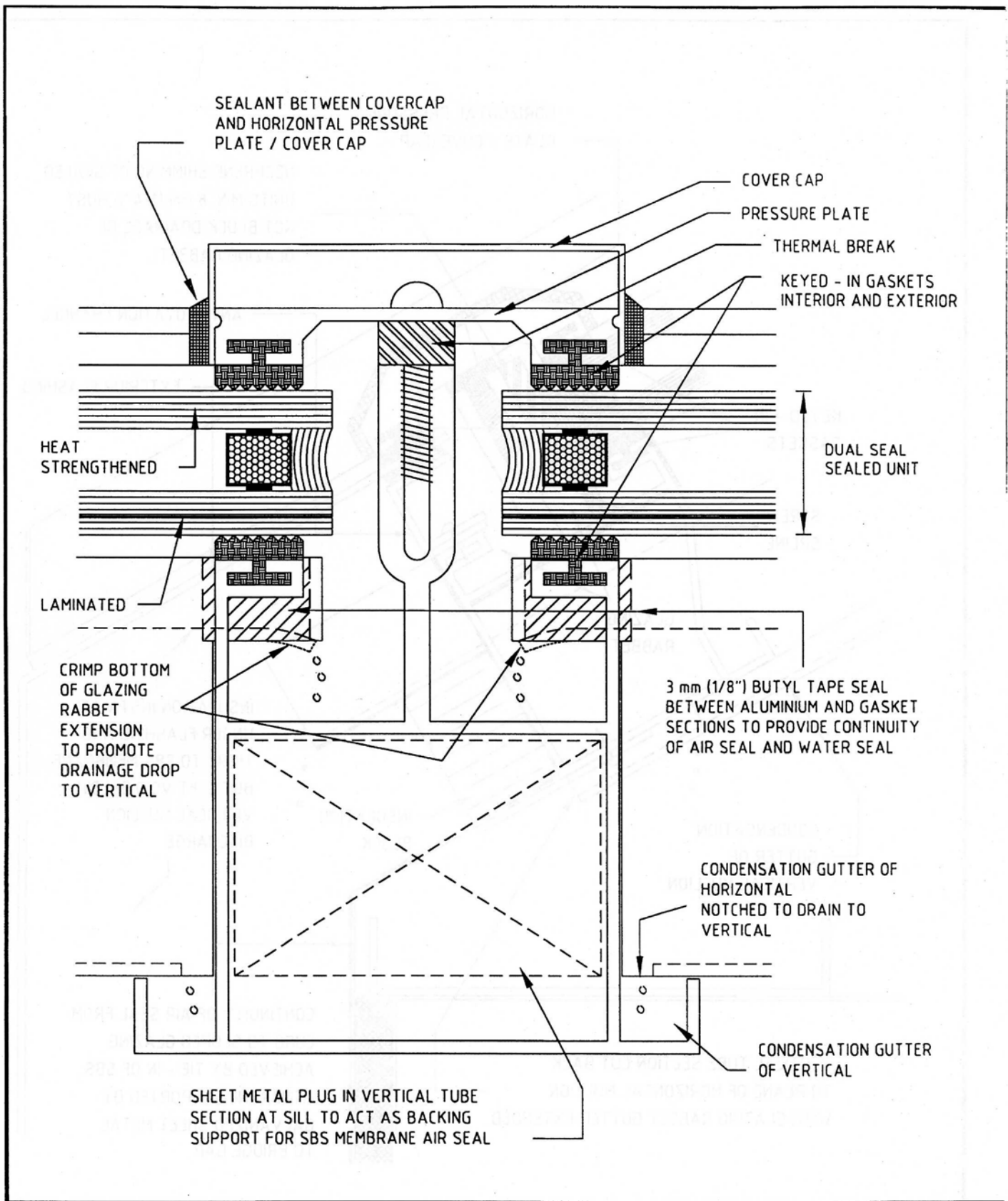
Compartmentalization is not complete unless the small gap at the comers created by the lack of an extension of the screw spline is filled with a comer plug. Venting is provided through slots in the pressure plate, which also can act as drains should any water enter the glazing rabbet. Interior seals between aluminum and glass of butyl tapes, sealants, plugs, and gaskets are protected on the interior of such a design from water, so their performance is not affected by water.

Failure of vertical glazed walls, used in sloped glazing applications, is frequent because the water is not drained through the exterior face of pressure plates and cover caps but is held at a variety of interior butt joints of the systems, where it either finds a hole or degrades the sealant materials until a hole is created. Leaving out the comer plugs in an effort to drain water down the verticals eliminates compartmentalization of individual units, thus reducing the effectiveness of the pressure-equalized design. Additional water entry floods the glazing rabbet, while pumping of the system during windy conditions can drive water through the interior seals that are now exposed to water. Sealants used in joints between frame sections or between frame and glass prematurely break down. Sealed units positioned in a nondraining glazing rabbet will lose their seals prematurely, resulting in fogging of the unit.

The components and methods used to install both vertical and sloped glazing systems have a great deal in common, but differences in the design to control the water that bypasses the exterior deterrent seal sets them apart. How the water is drained back to the exterior will determine the performance of the systems and set the two systems apart.

As the designs of buildings and the construction of those designs are different, so are the designs and construction of each sloped glazing installation. Some simple concepts, however, if followed, can be the difference between success and failure.

1. Maximize the effectiveness of the outside sealant or gasket system, but do not rely on it to provide total waterproofing for the system.
2. Minimize or eliminate the ponding of water at these exterior seal locations. This will prolong the effectiveness of the seal and reduce the buildup of dirt and other contaminants that may be allowed to enter the system if an imperfection exists. Water ponding at the exterior seals can be pumped into the system through imperfections by the movement of glazing materials under high wind conditions.
3. When water does get into the glazing rabbet it be contained, controlled, and redirected back to the exterior. The glazing rabbet provides a gutter that should provide adequate separation between water and the interior seals of the system (Figure 2). The gutter is created by the screw spline, tube face, and glazing leg of the rabbet. The glazing leg is elevated to ensure that the glazing does not sit in water, where its components and seals can be degraded by water.



	<p>title</p> <p>VERTICAL MULLION</p>	<p>approved DRAFT</p> <p>date MAY 1995</p> <p>scale N.T.S.</p> <p>plan no.</p> <p>drawing no. 3</p>
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4. Pressure equalization of the glazing rabbet will not perform to the same extent as it does in a vertical wall system due in part to the lack of compartmentalization of the interconnected glazing rabbets of the individual glazing. It is still extremely important, however, to provide an effective “air barrier” plane within the system. Without this separation between the inner and outer environments, the building envelope is incomplete and can provide a pathway for both air and water to be transported through the envelope (Handegord 1979; Quirouette 1982, 1985; Wilson 1961; Dalgliesh and Schriever 1962).

Infiltration of cold winter air can cool interior construction surfaces to a temperature at which they can reach the dew point of the interior air, resulting in condensation forming on these surfaces. Freezing of interior pipes, discomfort, and the transport of outside contaminants may occur because of uncontrolled air leakage into the building.

Exfiltration of moist interior air through the air barrier can result in condensation occurring within the glazing rabbet on colder surfaces. This additional water would have to be contended with and drained.

The air barrier location becomes complicated by the variety of planes that are providing this function. Sealants, gaskets, or other materials susceptible to water degradation should be located where they will only have limited contact or be accessible for periodic replacement.

5. A means of containing, collecting, and disposing of condensation should be developed within the framing profiles to contain condensate water that might accumulate on inner aluminum and glass surfaces. Where moderate humidity levels are maintained and not exceeded, where adequate heat is provided, and where some air movement exists over the surfaces to break up the insulating air film, condensation should not be a problem. The use of add-on systems usually is aesthetically poor and leads to joints that may have to be sealed. The incorporation of condensate gutters is not a safeguard against water leakage, as one manufacturer often states. The drainage of a condensate collection system must not be back to the exterior, through the air barrier system, but should be from an evaporation trough at the sill or by mechanical drainage if a large amount of condensation is expected.

Details

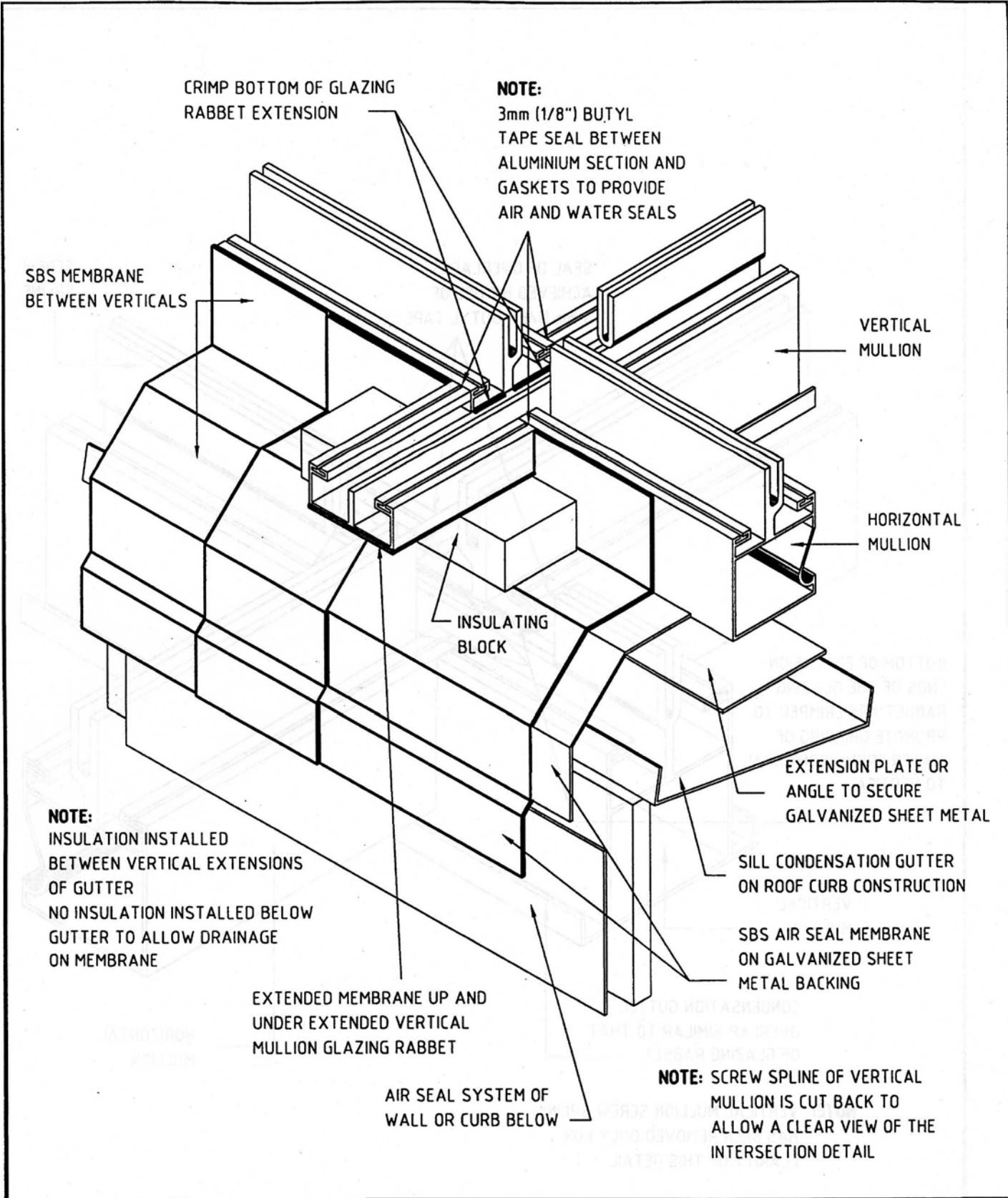
The details presented do not represent any specific manufacturer's sloped aluminum and glass system. While conceptual for the purpose of this paper, the details are based on actual installations of modified manufacturers' systems available in the Alberta market. The details and text are based on a simple sloped glazed design where the head ties into a rain screen clad wall above, at the sill to a protected membrane roof and at the endwalls to a vertical curtainwall.

General profiles

All of the details are based on two basic aluminum profiles—horizontal mullions (Figure 2) and vertical mullions (Figure 3). They are similar in design in that the main tube section provides the structure to support the live and dead loads of the system. It may be economical to provide a miscellaneous metal frame under the aluminum framing to provide support when loads increase beyond the maximum allowable loading of the aluminum profile. Steel can be introduced within some aluminum profiles as well, but aesthetics and cost usually will govern which approach is taken.

The sealed units are installed from the exterior so that a minimum gap of 1/4-in. (6 mm) exists between the unit edge and the face of the screw spline. They are positioned by resting the sill edge of the unit on 80-durometer-hardness neoprene setting blocks positioned at quarter points of the length of the sill screw spline. The aluminum profile raises the edge support of the unit from the plane of the main tube face of the frame on a raised glazing leg. The raised leg of the gutter (glazing rabbet) has a keyed-in gasket to separate the glass unit from the frame. This glazing method allows the unit to be moved during placement to properly achieve the correct bite for the edge of the unit. The height of the raised leg of the glazing rabbet and gasket should be sufficient to elevate the joints between the aluminum and gasket and the edge of the sealed unit to prevent these points from ever sitting in water. A raised leg of 3/8-in. to 1/2-in. (10 mm to 13 mm) is of sufficient height as a rule of thumb for a horizontal member no greater through 6 ft, 0-in. (1.8 m) in length where the angle of slope of the system is 30 degrees or greater.

Water at the gasket could leak through the end joints of the gasket or between the gasket and glass to the interior. Water in contact with the edge of a sealed unit can cause some sealants used to manufacture the unit to swell or lose



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adhesion to the glass surface, resulting in seal failure. The polyvinyl butyral (PVB) plastic inner layer between the plys (layers of glass) of the inner lite of the sealed unit, when in contact with water, can discolour and affect the optical quality of the lite.

The units are held in place by an exterior applied pressure plate. This pressure plate should be thermally separated from the screw spline. This can be achieved by a polyvinyl chloride (PVC) or ethylene propylene diene monomer (EPDM) keyed-in profile that is secured to the screw spline and penetrated by the screw fasteners of the pressure plate.

The vertical pressure plate may or may not have a cover cap like that of a standard curtainwall. If it does have a cover cap, it should be designed to accept the fact that, from time to time, glaziers, window washers, and the maintenance staff may be walking on it. When they do, they may damage the profile and the clamping ability of the profile to the pressure plate. Such loss of contact can result in caps being caught by the wind and ripped from the system.

For the horizontal pressure plates, a low profile with no cover cap should be used to minimize the amount of water that is retained at the outside seal. The degree of slope of the glazing and the height of the gasketed pressure plate will affect how much water and dust are retained at the horizontals. This is visible on barrel vault systems, where the top glazing is dirty and the lower lites are cleaner. Retention of water and dirt on the upper lites also may result in streaking of lower lites, where water eventually drains.

Some manufacturers promote the use of a silicone or semicapless design for the horizontals. While this design approach does have some merit in minimizing the amount of water and dirt that is retained, it is not without a cost. The performance of silicones can be affected greatly or be a factor in the degradation of other elements used in the glazing system. Compatibility testing of the silicone with all contacting surface materials must be undertaken before and during construction and by maintenance staff in the future if work is to be undertaken. Preparation of component surfaces for priming, proper placement of the silicone, and tooling of the joint is essential to ensure acceptable long-term performance of this sealant. This exterior sealant weatherseal design may have to be installed in less through favourable weather conditions, whereas with a dry glazing and pressure plate system, the limitations imposed by weather are not as critical. Only when the slope of the glazing system is nearly flat does the silicone weatherseal design seem to have a small benefit.

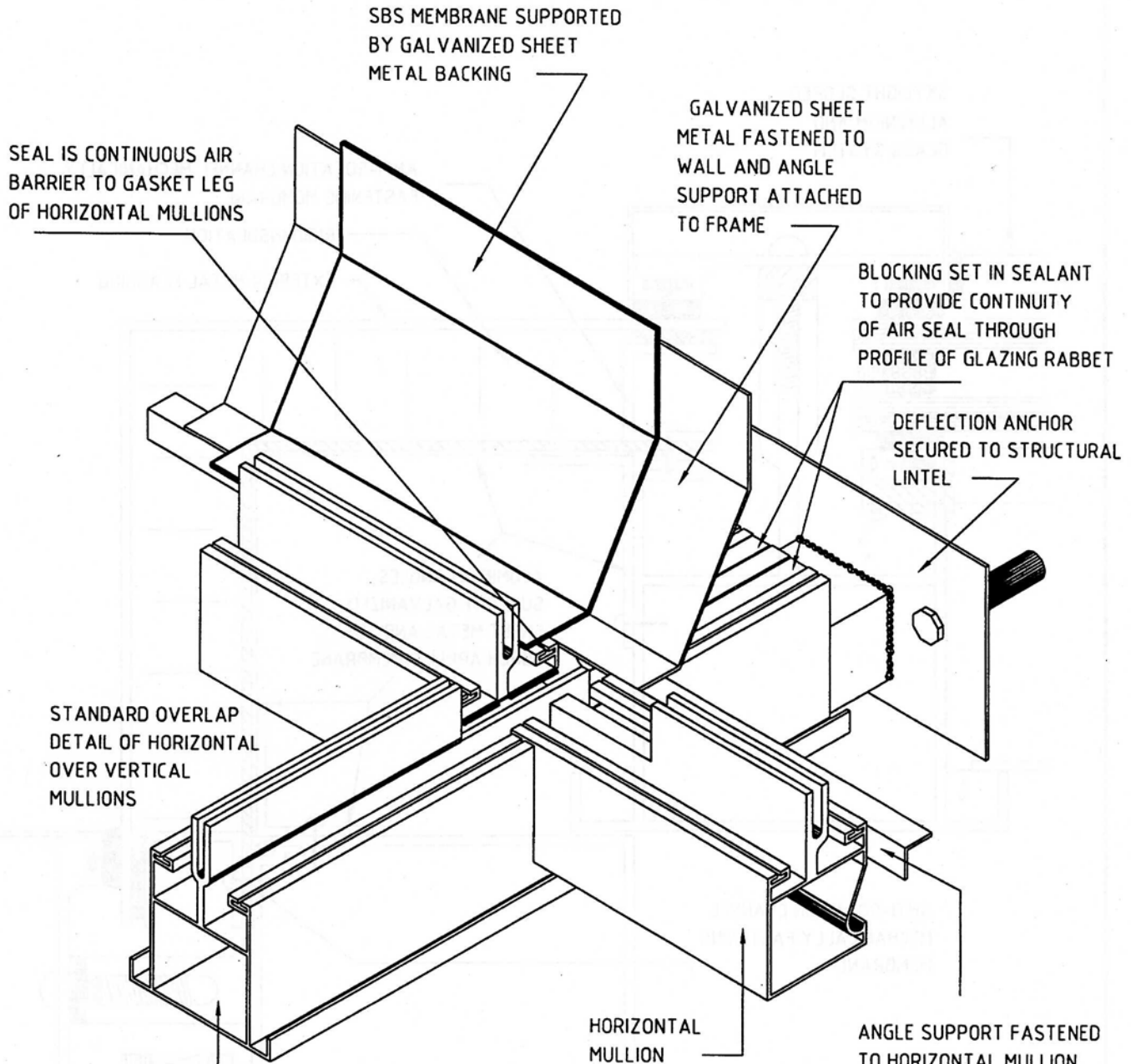
The dry gasket and pressure-plate approach prevents the units from being uplifted from the system, while at the same time providing an acceptable degree of water tightness. The drained design approach of the system acknowledges that whichever exterior seal approach is used it does not have to be 100 per cent watertight for the life of the installation.

The main difference between the horizontal and vertical mullions profiles is in the design height of the raised leg of the glazing rabbet. Obviously, if the vertical mullion is to collect all the water draining from the horizontal mullions, it must be of sufficient height to provide that function. It also must be of sufficient height to protect the seals designed at the junction of the horizontal to vertical mullion from coming into contact with water, which could degrade them.

Horizontal to vertical mullion intersection

The water that is collected and contained in the glazing rabbet must be directed back to the exterior, otherwise the water level would rise sufficiently to wet the interior seals and possibly enter through them to the interior. The horizontal mullion, therefore, drains into the vertical glazing rabbet (Figure 4), where it can be drained at the sill of the sloped glazing system to the exterior. If the two aluminum sections were to butt together, as in a standard curtainwall, the seal joint would constantly be in contact with water. If the horizontal glazing rabbet overlapped onto the tube face of the vertical glazing rabbet directly, the seal would still be exposed, and the drainage of the vertical glazing rabbet would be restricted. The jointing of the horizontal to vertical mullions must therefore be overlapped and elevated.

As stated previously, the vertical glazing rabbet is greater in depth to ensure that it is not blocked by the overlapping extension of the horizontal glazing rabbet and at the same time to prevent water from coming into contact with the seals necessary between the aluminum sections to ensure a continuity to the air barrier. Water flowing down the vertical glazing rabbet, if of sufficient quantity, will form a series of waves like those seen on sloped sidewalks or roads. If these waves are slowed or interrupted, the resulting turbulence of the water can raise the water level in the gutter. Excessive caulking of the junction joint, debris within the system, and water dripping from the horizontals into the verticals can be disruptive to this wave pattern in the vertical glazing rabbet. To accommodate such situations, the overlap height should be at least 3/8-in. (10 mm). This depth may seem excessive to some manufacturers; in fact, most are not as deep. When



NOTE: - SCREW SPLINES OF HORIZONTAL AND VERTICAL MULLIONS HAVE BEEN CUT BACK FOR A CLEAR VIEW OF INTERSECTION DETAIL.
 - VERTICAL SCREW SPLINE IS REMOVED TO PLANE OF HORIZONTAL SCREW SPLINE TO ALLOW FOR TIE - IN OF AIR SEAL

	<p>title</p> <p>HEAD JUNCTION</p>	<p>approved DRAFT</p> <p>date MAY 1995</p> <p>scale N.T.S.</p> <p>plan no.</p> <p>drawing no. 6</p>
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investigating leakage at these joints, one often finds bits of construction debris, a fine dust powder, bits of vegetation, and insect bodies. If the system can self-clean, then the problems may never occur.

The extension overlap of the horizontal glazing rabbet should promote the dripping of water draining from the horizontal into the vertical. This can be accomplished by either cutting or crimping the lip edge of the overlap. When there is only a small amount of water draining from the horizontal glazing rabbet, the surface tension of the water will cause the water to cling to the surfaces of the aluminum on either the underside of the horizontal glazing rabbet extension or on the upstand surfaces of the downslope screw spline and raised leg of the profile. This causes the water to flow on these surfaces and over the seal junction between the horizontal and vertical sections. If the surface tension can be broken by a drip at the termination of the horizontal, this contact with the critical air barrier and seal joint can be prevented and the potential for water entry can be eliminated (Figure 4).

The air barrier and water seal between the aluminum sections at this overlap often are a bead of sealant as recommended by the manufacturers. The authors' experience is that such an approach often is not acceptable. The glazier rarely prepares the surfaces and uses too much sealant, which can block the vertical glazing rabbet. The joint is anything but a "design joint", and should there be any movement of the aluminum sections after the sealant has set, the sealant probably will shear, leaving an open joint for water and air to pass through. If the sealing joint requires several applications of sealants between frame, gaskets, and glazing, other joint problems are introduced. For the available systems, the authors prefer the use of 1/8 in. (3 mm) thick by 1/2 in. (12 mm) wide butyl tape. In sloped glazing applications the authors have opened after 15 years, the butyl tape is still pliable. This tape may have some self-sealing ability when it gets hot in the summer. One continuous strip of tape is used to seal from the top of the gasket on one side of the section to the top of the gasket on the underside of the section. It would be preferable to provide some design joint for the joints, but for now the tape approach is more forgiving. From investigations of problem sloped glazing projects, the most common failure at this junction is the reliance of the design on a sealant.

Sill junction

A conflict between the designers, manufacturers, and installers of sloped glazed systems often is regarding the

sill junction. Designers want a minimal visual element. Manufacturers are reluctant to extend their systems beyond the perimeter plane of their exterior horizontal mullion sections into the gray area of trade responsibility between roofer, general contractor, and themselves. The result all too often is a lack of room, and a variety of materials detailed, which forces the glazier to make an attempt at sealing this joint with caulking. The sill detail and the horizontal to vertical junction should be no different in how water is drained from one plane to another. The design should minimize the possibility of any water contact at the joint between aluminum sections and the joint between these sections and the air barrier and water seal of the curb of the roof.

To do this, the vertical gutter of the glazing rabbet only is extended beyond the plane of the outer face of the horizontal tube mullion (Figures 2, 3, 5). The remainder of the vertical tube is cut back to the exterior plane of the horizontal tube so that the tube face can be used as the plane of air seal and waterproofing.

The air barrier and waterproofing seal of the protected membrane roof would be extended up the exterior vertical face of the roofing curb. From the curb to an extension angle or plate (depending on the manufacturer's horizontal profile), a 20-gauge (1.0-mm) galvanized sheet metal backing is used to provide structural support for a torch-applied reinforced SBS (styrene, butylene, styrene) membrane. The void created at the end of the vertical tube also must be plugged (Figure 3). The sheet metal is not overlapped at joints to minimize the buildup of elements. The metal surfaces are then primed with the membrane manufacturer's recommended primer and allowed to flash off.

Care must be taken when using a small detail torch to install the membranes. A pool of liquid SBS should be created before the roll of membrane and the membrane is rolled into the liquid, adhering the membrane to the surfaces. First, at the verticals, a width of membrane measuring 6 in. to 8 in. (150 mm to 200 mm) is extended up the surface from the curb to the sheet metal, to the plane of the horizontal, and to the underside of the glazing rabbet gutter extension, where it is cut to the width of the gutter extension and adhered to the underside of the gutter. The remainder is extended up the side of the raised legs of the gutter. It is critical that these cuts be accurate, otherwise air leakage will occur in the corner junctions. The remainder

of the space between verticals is membraned from the curb to the plane of the horizontal with at least a 2-in. (50-mm) overlap of membrane joints.

A peel-and-stick membrane could be used. However, it is less workable in these tight confines, and, in hot conditions, the membrane may tend to flow. The membrane top termination should be mechanically fastened to prevent such slippage. This detail protects the critical joints of the aluminum sections from having water on their surface, while at the same time extending a flexible system of materials from the roof curb to the aluminum sections, which is designed for water contact.

Rigid polystyrene, type IV, is used to provide the continuation of the thermal barrier from the roof up the exterior of the membrane to the face of the aluminum sections. A void of insulation is created at each vertical at the membrane plane so as not to restrict drainage on the membrane plane and, during colder weather, to allow sufficient heat to maintain water flow to the roof. At the underside of the glazing rabbet extension, a block of insulation is used to wedge the membrane against the underside of the extension to provide some resistance to slippage or sag of the membrane. Flashings are installed over the insulation to protect the insulation and provide an aesthetic appearance.

Head junction

The air barrier and waterproofing functions are achieved by galvanized sheet metal and reinforced SBS membrane, sealing from the exterior glazing gasket key of the slope glazing system to the air seal of the rain screen wall above (Figures 2, 6). Here the vertical mullion tubes are extended for anchorage and to provide for the sealing of the vertical glazing rabbets. A plug is needed for the vertical glazing rabbet profile, made from aluminum or neoprene, and laid into a bed of compatible butyl sealant. The plugs should be held back from the edge of the metal backer and membrane that overlaps it so that a drip can be created. This prevents the butyl seal from getting wet should water be entering the system from the above construction.

Water that enters through exterior joints or seals is contained on the membrane plane and drained to the glazing rabbet of the horizontal mullions and then from there into the vertical mullions. Insulation is installed on the exterior of the membrane. Flashings on the exterior are again designed to shed water but are not relied upon to be completely watertight. The flashings can be installed

over the pressure plate and cover cap system, but this means that they must be removed should glazing replacement be necessary. To install them under the pressure plates provides the mechanical fastening necessary and a finished look similar to that of the glazing itself. The only joint that would be necessary to seal would be the joint created between the pressure plate gaskets at the verticals. A plug or sealant can be used to minimize water entry and would have to be maintained.

Jamb junction

The jamb detail (Figure 7) is similar in concept to that of the other two details in that all joints that could have water on their surfaces are shrugged. The vertical endwall would be designed as on exterior glazed and pressure-equalized curtainwall framing system. From this system, galvanized sheet metal is installed so that the exterior face of the sheet metal is flush with the tube face of the glazing rabbet and is brought flush to the top surface of the glazing gasket key of the raised leg. This can easily be accomplished by using aluminum angles fastened to the typical tube profiles of both systems, but special profiles also could be introduced. Fastening of these angles must not be made through into the glazing rabbet gutter of the sloped glazing system. The surface of the galvanized backer and the aluminum surfaces to which a membrane is to adhere are primed and a reinforced SBS membrane is installed in a shingle fashion from the tube face of curtainwall glazing rabbet to the top face of the key profile raised leg of the sloped glazing framework. The membrane with the galvanized sheet metal backing now provides both the function of an air barrier and the plane of waterproofing. Water entering through any joint in the exterior cladding or seals is either drained into the glazing rabbet of either aluminum frame system or directed on the slope of the membrane back to the exterior at the sill. Anti-rotation channels are installed to provide support for the pressure plates and to mechanically retain the membrane.

Polystyrene type IV is installed on the exterior of the membrane and then covered with finished metal. All joints from the top of the sloped glazing are shingled and drained in a fashion where the vulnerable sealing products used to join the aluminum profiles and glazing to aluminum are not subjected to wetting.

Conclusion

If these fundamental philosophies are followed in the variety of geometric designs for sloped glazing that are

created in the minds of designers, one can see that the more complicated the design, the more complicated the details become. The standard sections available from most manufacturers have their limitations. If the project is exceptionally large, the cost of the variety of profiles necessary to achieve these details may be within budget. To reduce costs, it may be easier to simplify the design of the sloped glazing. The costs, however, do not start and end with the manufacturers of the aluminum extrusions. The costs start with the need for proper detailing by a knowledgeable consultant and must continue through the shop drawing review, construction, and then maintenance of the system. Owners who feel they can reduce the importance and costs associated with each of these stages may be paying substantially more to fix the leakage problems later, especially if a lawyer becomes involved.

Ask any owner of a building what the main function of a roof is and he will state that it must be waterproof. The glass roof is no different. It should not leak. There is a great debate among contractors and designers as to how this can be achieved, but the owner of the building is the person forced to live with or pay for the problems should the approach taken be unsuccessful.

Sole reliance of an exterior-exposed seal as the only line of defense against water infiltration remains a fundamentally flawed concept. The continuous 100 per cent perfect seal in construction does not exist. The alternative is to design a water deterrent at the joints of the exterior components that minimizes the retention of water at the joints and the possibility of water entry through the joints.

Within the interior profiles of the glazing rabbet of the aluminum extrusion, a gutter system is created that raises the glazing from a location where it could be sitting in water. The gutter system should contain and direct any water that passes through the inevitable imperfections of the exterior screen, from horizontal to vertical member in a raised and shingled design. The design of the overlap should prevent water from flowing over the joint air and water seal of the aluminum sections. The vertical glazing rabbet gutter must be designed to collect all the potential water entering it and direct it in a similar raised and overlapped design at the sill. The use and reliance on caulked, nondesigned joints that are subjected to water flowing over them leads to a limited performance life.

Total pressure equalization of this sloped glazed system may not occur in large or complex designs. Unlike vertical glazed walls, where individual units are compartmentalized,

the drainage system necessary within sloped glazed systems interconnects these individual compartments through the glazing rabbet. The interior air seal of the system must still be continuous and may, depending on the detail, act as a water seal as well.

Control of water that infiltrates past the exterior seals is perhaps the most important attribute of a sloped glazing system, but the other functional requirements cannot be overlooked. The interweaving of air and water seals, overlapped and elevated aluminum profiled sections, and sealants and membranes is a tangled web, all of which must be designed, installed, inspected, and maintained to provide the function it was intended to perform—a roof of glass that does not leak.

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ADVANCING ANCHOR INSTALLATION AND QUALITY ASSURANCE: KEY UPDATES IN CSA A23.3 (ANNEX D) FROM 2019 TO 2024



By Ali Ahrabi

Ali Ahrabi graduated with a bachelor's in civil engineering in 2006 and obtained his Master of Science in Civil Engineering from Concordia University in 2012. He has been a professional engineer in the province of Quebec (Ing.) since 2013 with experience in a variety of engineering settings. Ahrabi currently serves as the manager of codes and approvals at Hilti Canada. Ahrabi contributes to the development of fastening-related provisions within NBC and CSA with heavy emphasis on anchors, including contributions to CSA technical committees A23.3, S6, S16, and S304. He can be reached at Ali.ahrabi@hilti.com.

Post-installed concrete anchors are commonly used to attach curtain wall and window wall systems to concrete slabs, particularly in mid- to high-rise buildings. While it is less common, these anchors are also used in some cases to secure cladding systems to concrete walls. In all such applications, anchors serve a critical role in transferring loads from the building envelope to the structure. It's essential that their design and installation follow current standards and include appropriate inspection. The following article outlines key updates to anchor installation requirements in CSA A23.3 that are relevant to both structural and building envelope professionals.

The design of concrete buildings in Canada is governed by the CSA A23.3 standard, which is referenced by both the National Building Code (NBC) and provincial or territorial building codes. NBC 2020 refers to the 2019 edition of CSA A23.3 (CSA A23.3-19) for designing concrete structures.

Annex D of CSA A23.3 is dedicated to the design, installation, and quality assurance requirements for cast-in and post-installed mechanical and adhesive anchors in concrete. This annex became “normative” (mandatory) in the 2019 version of CSA A23.3, whereas it was “informative” (nonmandatory) in the 2014 version. As a result, the requirements outlined in Annex D should now be

considered enforceable under NBC 2020 and any provincial or territorial codes that have adopted CSA A23.3-19.

This article will focus on the installation and quality assurance requirements of anchors as detailed in Clause D.10 of Annex D. It will explore the provisions outlined in the 2019 version of CSA A23.3 and discuss the updates introduced in the newly published 2024 version, then highlight key changes between the two versions.

Clause D.10 in CSA A23.3-19

The 2019 version of CSA A23.3, Clause D.10 is dedicated to the installation and inspection of anchors. It requires that all anchors be installed by qualified personnel (Clause D.10.1) following the manufacturer's printed installation instructions (MPII). For adhesive anchors, this requirement further specified that only personnel trained in adhesive anchor installation could perform this work (Clause D.10.1).

The required level of inspection for both mechanical and adhesive anchors vary depending on the anchor category specified in the manufacturer's evaluation report. Adhesive anchors are subject to specific inspection requirements, as outlined in Clauses D.10.2.2 to D.10.2.4, which call for periodic or continuous special inspections. In certain cases, such as adhesive anchors installed horizontally or

upwardly inclined to support sustained tension loads, continuous special inspection by a special inspector was mandatory. D.10.2.4 requires that a special inspector provide a report confirming that continuous inspections have been conducted during the installation of adhesive anchors in these orientations. Such reports verify that all work complied with the approved contract documents and the manufacturer's printed installation instructions (MPII), ensuring proper installation.

Personnel installing adhesive anchors horizontally or upwardly inclined to support sustained tension loads are required to hold a certification from recognized programs, such as the ACI/CRSI Adhesive Anchor Installer Certification program or an equivalent certification (Clause D.10.2.3).

The 2019 version of CSA A23.3 references ACI 355.4 for proof loading requirements where specified by contract documents (Clause D.10.2.2), without providing further clarity for how to accomplish this.

Updates in Clause D.10 of CSA A23.3-24

The 2024 update to CSA A23.3 introduces several important changes in Clause D.10, broadening its scope and enhancing provisions on quality assurance. The title has been revised to include post-installed reinforcing bars, expanding the range of installations that require inspection.

A significant update is the introduction of D.10.2 Quality Assurance, which provides a structured framework for special inspection requirements. Table D.3 (as shown below), a new addition, outlines the minimum levels of special inspection for both anchors (adhesive and mechanical) and post-installed reinforcing bars.

The definitions of "special inspection" and its different levels (periodic vs. continuous) have been added to Clause D.2. Adhesive anchors and post-installed reinforcing bars now have more defined inspection requirements, including clear stipulations for continuous special inspection in cases where they are installed horizontally or upwardly inclined to resist sustained tensile loads. Additionally, continuous special inspection and proof loading are mandated when the manufacturer's data specifies these conditions.

Another key update is the inclusion of detailed requirements for proof load testing, as outlined in D.10.2.2.2. This section specifies the threshold loads to be

applied during proof load testing for adhesive anchors and post-installed reinforcing bars. The load, held for at least 10 seconds, must be the lesser of two values: 67 per cent of the published characteristic bond stress capacity (for uncracked concrete, with adjustments for edge distance and concrete strength) or 80 per cent of the minimum specified steel yield strength of the anchor.

The 2024 version also introduces ASTM E3121 as the standard for conducting confined proof load tests in situ. A footnote in this section emphasizes that proof load testing is not a substitute for special inspection. These updates clarify the process for performing proof loads, ensuring that anchors are installed properly and consistently.

Additionally, the 2024 version introduces the term "third-party" inspectors, emphasizing their role in independent inspection of anchors. According to the newly added definition of "third-party inspector" in Clause D.2, these inspectors must be hired by the owner or the owner's representative and are required to furnish detailed reports to the licensed design professional and building officials.

Comparison between 2019 and 2024 versions

The 2024 version of Clause D.10 presents a more comprehensive and clearly defined set of requirements compared to its 2019 counterpart. The expansion of the clause to include post-installed reinforcing bars demonstrates a broader recognition of the types of applications that require quality assurance. Furthermore, the introduction of specific standards, such as those based on ASTM E3121, reflects the need for greater clarity in conducting anchor testing.

While the 2019 version focused heavily on the proper installation and inspection of adhesive anchors, the 2024 version goes a step further by providing more details on third-party inspection, continuous special inspection, and the required load level for proof loads.

Conclusion

Whether installing mechanical anchors, adhesive anchors, or post-installed reinforcing bars, the 2024 updates clarify the need for thorough inspections and third-party verification to ensure installations meet safety and performance standards. ■

THE REVAY CORNER:

The resilience of the construction industry comes from our ability to adapt



By Suzanne Checkryn, P.Eng., PMP, MBA –
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Suzanne Checkryn is a professional engineer with more than 25 years of experience working in engineering, construction and consulting. Throughout her career, Checkryn has worked with major firms to complete projects on schedule and to overcome significant engineering and construction challenges. She has been involved in a variety of projects, including multibillion-dollar projects with complex engineering, supply chain, construction, project controls, risk management and change management requirements. Checkryn has extensive field experience working with owners, engineers, consultants, general contractors, subcontractors and suppliers.

At Revay, Checkryn is responsible for the firm's Calgary office which services Alberta, Saskatchewan and Manitoba. She has been retained as expert for referee, mediation, arbitration and litigation. Checkryn also delivers training focused on claims avoidance and claims management to clients and industry associations across Canada and at the University of Calgary.

THESE ARE UNCERTAIN TIMES

It's hard to believe over five years have passed since the global pandemic was declared in March 2020. This period brought uncertainty for everyone, including the construction industry. Project owners, contractors, subcontractors, suppliers, designers, consultants, and all other project players were trying to manage the changing situation and understand the impacts to their projects – some of which would take time to unfold.

The years that followed March 2020 brought not only various unforeseeable knock-on effects such as supply chain disruptions and material price escalation, but also challenges such as inflation, labour shortages, and geopolitical events across the globe. Based on what has unfolded in 2025 so far, including the implementation of some tariffs, the threat of more tariffs, and changing governments and policies, in many ways we are back to square one.

Considering the issues described above, most of which persist today and present future uncertainties, it is crucial for the construction industry to remember past solutions and continue collaborating, problem-solving, and sharing knowledge.

The industry is navigating the road ahead; a road that will require people to think differently. This article discusses the road ahead for construction and good practices that can aid with this navigation.

Think differently and don't forget the basics

In times of certainty, and in situations where projects are well-defined with respect to scope, schedule, and budget, fewer issues are likely to arise. Under these conditions, the contracting parties (e.g., the owner and the general contractor) can often work through scope changes or impacts such as delays or disruptions amicably.

In the current landscape, there is increased uncertainty, leading to greater risks, issues, and impacts. When projects encounter significant challenges, these problems often become intertwined, making it difficult for parties to resolve them amicably. Additionally, some of the issues today's projects may face are arguably unforeseeable by anyone (i.e., owner; designer; general contractor; etc.).

When it comes to managing risks, issues, and impacts on projects, there are many practices that can, and should,

be implemented. For example, two essential practices for projects, especially in times of uncertainty, are:

- Investing more time and money in earlier project phases; and
- Being proactive with respect to documentation during construction.

Investing more time and money in earlier project phases

For any project, when looking at the total cost, the design phase represents a small percentage of the cost compared to the construction phase. Additionally, the ability to influence project outcomes is much higher at the design phase, and the cost of changes is much lower. Conversely, by the time a project is in construction, the ability to influence project outcomes is low, and the cost of changes is high.

While it is in an owner's interest to have accurate and complete designs, we have seen projects trending towards a compressed design phase. In these situations, the design is often incomplete which results in a higher likelihood of changes, delays, and cost overruns. Additionally, there remains a continued reliance on traditional contracting models that shift risk to a party instead of promoting collaboration to mitigate risks and resolve issues.

Executing projects today involves more uncertainty than projects before 2020, in addition to common construction problems such as incomplete designs and changed site or soil conditions. Therefore, project teams likely need to think differently. This may include studying and considering different options, and investing more time and money in the earlier phases of projects for the following, among other activities:

- Identifying risks;
- Selecting contracting models and commercial/cost strategies;
- Advancing designs; and
- Developing complete and reliable scopes, schedules, and budgets.

As the level of uncertainty on current and future projects may be higher than pre-2020 times, owners may consider different contracting models that provide a greater emphasis on collaboration; in particular, when it comes to planning and scheduling, budget development, constructability, material selection, procurement, and change management.

Given the likelihood of external, unforeseeable, factors, it may also be pragmatic for owners to consider different commercial/cost strategies for scopes that cannot be accurately estimated, or that may be subject to change or substitution, such as material. This will furnish parties with more flexibility when problems arise and result in owners paying for actual costs instead of paying for added risk that may not happen.

Proactive documentation during construction

At Revay, we have always encouraged project stakeholders to take time to prepare accurate baseline documents (i.e., budgets; schedules that include all activities; execution plans) and to proactively maintain contemporaneous records, including (but not limited to): meeting minutes; update schedules; progress reports; daily reports; change orders; transmittal, request for information ("RFI"), and change order logs; and formal/informal correspondence.

In early 2020, more unforeseen events began occurring on projects. At that time, some parties could not analyze the impacts of issues, or determine paths forward, due to:



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- The absence of agreed processes; and/or
- The absence of sufficient documentation.

While we have seen some improvements since 2020, we remind the construction community that it is crucial for parties to agree upon a process for managing projects issues, including required documentation. We further add that documenting changes, issues, lost time, and additional costs individually can help resolve disputes more easily during or after projects.

As we articulated in 2020, we reiterate that effective project management, contract administration, and documentation practices are more important than ever before. Establishing agreed-upon practices at the beginning of projects, and proactively maintaining documentation, allows parties to be more agile when issues arise and efficient in demonstrating impacts such as delay, disruption, or additional costs.

Conclusion

Amid the challenging and uncertain times that started in 2020 and continue today, the construction industry has consistently come together to develop solutions. Best practices have been reinforced, and new practices have been developed. In other words, this has also been a time of collaborating, problem solving, and communicating.

Currently, Canada is in a situation where we are rethinking our trade partners, which will greatly impact our country including the material supply for construction projects. Add to this known labour shortages and productivity issues, and a growing population. Therefore, construction leaders not only in local areas, but across provinces and the country, must continue to come together as a community to support each other, share ideas, and overcome project challenges that may otherwise be insurmountable.

In closing, one undeniable thing remains the same – we’re all in this together, and the solutions to these challenges will come from working together. ■



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THERE IS NO SUCH THING AS A FREE THERMODYNAMIC LUNCH

By Joseph W. Lstiburek, Ph.D., P.Eng., Fellow ASHRAE

At the most basic level, a building is an environmental separator – it keeps the outside out and the inside in. Why? Well, sometimes the outside sucks and we want to keep it from getting into the inside or into the thing that separates the inside from the outside. Sometimes the inside sucks and we want to keep it from getting into the thing that separates the inside from the outside. It can be cold and miserable outside. It can be hot and humid and miserable outside. Inside is also often an issue. There is a big difference between a warehouse and an indoor swimming pool or humidified pressurized hospital or art gallery.

Design objectives

In order to function as an environmental separator, the elements, components, assemblies, and sub-systems that comprise a building must meet the following objectives (Hutcheon):

- Control heat flow
- Control airflow
- Control water vapour flow
- Control rain
- Control ground water
- Control light and solar radiation
- Control noise and vibrations
- Control contaminants, environmental hazards, and odours
- Control insects, rodents and vermin
- Control fire
- Provide strength and rigidity
- Be durable



Photo 1: Moisture sensitive materials – The newer materials are by and large more sensitive to water damage than the older traditional materials. Oriented Strand Board (OSB) is significantly more moisture sensitive than plywood.

- Be aesthetically pleasing
- Be economical

Not all are equal. The things that will kill you are more important than the things that irritate you. The things that kill you quickly are more important than the things that kill you slowly. The things that irritate you quickly are more important than things that irritate you slowly.

Clean water and sewage are a big deal. Separating sewage from drinking water is the basis of all civilization. Hate to admit it, but the plumbing code is more important than the fire code, structural code, and energy code. In a natural disaster, we send clean water not bags of insulation. Plumbing codes came first. Then



Photo 2: Thermal insulation – Significant increases in thermal insulation added to wall assemblies, roof assemblies, and foundation assemblies.

fire codes. Rome burned, London burned, Chicago burned, and we got the fire codes. Guess what? Fire codes are more important than structural codes. We got fire codes before we got structural codes. Now we also have structural codes. Guess what came last? The energy codes. Not much happens with plumbing any more, and not much happens with plumbing codes. Same with fire and same with structure. Buildings don't burn and they don't fall down. Yes, of course, we have fires, and we do have structural failures, but they are not rampant. What I am trying to say is that plumbing, fire, and structural practice is mature and well established. Not so energy. We are screwing things up and it is going to get worse before it



Far left – Photo 3: Ductwork – Buildings now have ducted and fan-driven heating, cooling, and ventilation systems – and are significantly more airtight – so moving large quantities of air within them can lead to unacceptably high negative and positive air pressure differences.

Left – Photo 4: Kitchen range hoods – Exhaust systems, such as kitchen range hoods, can lead to significant negative pressures.

gets better. As we change the energy flow across buildings things get very different, especially when we start looking at degradation mechanisms – damage functions.

Water is one of the three principal damage functions affecting building materials and assemblies. The other two are heat and ultra-violet radiation. Arguably, water is the most significant.

If the goal is for buildings to last a long time, we must build them dry, keep them dry, and let them dry if they get wet. Not complicated in principle. It shouldn't be complicated in practice but often is. It didn't used to be. What changed?

What has changed

Three big things have changed in our lifetime:

- We don't build out of rocks and hundred-year-old trees anymore;
- We have very little energy exchange from the inside to outside and vice versa; and
- We have heating, cooling, and ventilation systems that condition the inside almost year-round.

First, the materials that buildings are constructed from have changed dramatically. The newer materials are by and large more sensitive to water damage than the older traditional materials (Photograph 1). I am

beginning to view engineered wood as an insult to wood and to engineers. We used to go to forests and take big trees down, cut them into boards, build boats out of them, and sail them around the world. Try doing that with oriented strand board (OSB). We have paper-faced gypsum in place of plaster and lath. We are lining the buildings with paper; we are building paper buildings. Even the dumbest of the Three Little Pigs didn't build his house out of paper. So, are we going to go back to rocks and 100-year-old trees? Nope. We must change the way we build to accommodate the new realities.

Second, thermal insulation was added to wall assemblies, roof assemblies, and foundation assemblies. The function was to keep the heat inside during the heating season and keep the heat outside during the cooling season. We added more and more and more. We have reached the point where very little energy exchange happens across building assemblies. This is both good and bad. The good is that buildings are very comfortable and consume very little energy. The bad is that the ability of building assemblies to dry – should they start out wet or get wet during service – has been reduced. Drying is an energy exchange process. Less movement of energy yields less drying.

When we had poorly insulated buildings the energy exchange was

great, and we were not very concerned about “incidental water.” For example, windows have always leaked. Not a lot, but a little. When they leaked into wall assemblies that were uninsulated or poorly insulated, they were able to dry due to the exchange of energy across the wall assembly. We called this water leakage “incidental water” and didn't worry much about it as it did not lead to damage. Today, we can't ignore “incidental water” as energy is not available to promote drying. This “no longer incidental water” has led to fundamental changes in how we install windows and doors, how we flash service penetrations and how we install claddings.

Third, heating has been around for a long time. Cooling is a more recent development. Today, except in very limited circumstances, buildings are heated and cooled year-round. Buildings are also now mechanically ventilated. Buildings no longer rely on operable windows for an exchange of air between the interior and exterior. These changes are also both good and bad. Again, the good news is that buildings are very comfortable and consume very little energy. With controlled mechanical ventilation we can control the quality and the quantity of the air buildings exchange with the exterior. The bad news is that during cooling periods interior surfaces are colder and relative



Photo 5: Back-drafting fireplace – Negative pressures due to air exhausting systems backdraft combustion systems such as fireplaces.



Photo 6: Mould – When we caulked and sealed old buildings, we reduced air change and increased interior mould.

humidity adjacent interior surfaces is higher, which can lead to moisture problems. The bad gets worse if we do not bring in sufficient exterior air. We can create indoor environmental issues. The opposite is also bad. If we bring in too much exterior air, we can create indoor environmental issues such as excessive interior surface wetting in hot-humid and mixed-humid climates or excessive interior dryness in cold climates leading to discomfort and material damage to hygroscopic interior trim and finishing materials.

It gets even more complicated with ducted and fan-driven heating, cooling, and ventilation systems (Photograph 3). Buildings are significantly more airtight, so moving large quantities of air within them can lead to unacceptably high negative and positive air pressure differences. And we are not done yet. Exhaust systems, such as kitchen range hoods, can lead to significant negative pressures (Photograph 4) and backdraft combustion systems such as fireplaces (Photograph 5). Because of the huge improvements in efficiency, typical air conditioning systems no longer run long enough to sufficiently dehumidify the interior of buildings. On top of that, modern high efficiency air conditioning systems provide less dehumidification than old, inefficient units.

Over time, the moisture sensitivity of assemblies has gone up as well as the “dwell time” for water in these building

assemblies. Building assemblies are staying wetter longer and the modern materials are unable to tolerate the moisture stress. This is coupled with heating, cooling, and ventilation systems that must address air change, air pressure, and interior humidity control. Things are much more complicated than they used to be.

The new reality

Because there has been a big change in energy flow, materials, and conditioning, we must change the way we build.

When we insulated old buildings, the paint fell off them and attics rotted. When we caulked and sealed old buildings, we reduced air change, increased pressure differences, messed up combustion air and chimney performance, spilled and back-drafted furnaces and water heaters, collected radon and other soil gasses, increased part load humidity, and increased mould (Photograph 6), increased part load humidity, and increased mould again. We should have learned. Actually, we did... but we seemed to have forgotten today*.

Building assemblies need to be protected from wetting via rainwater, groundwater, air transport, and from vapour diffusion. The typical strategies use water control layers, air control layers, vapour control layers, thermal control layers (“insulation”), air pressure control, and control of interior moisture levels through ventilation, dehumidification, and source control. Climate location,

season, and interior loads determine the strategies.

The reduction in energy flow is going to get even greater. The change in materials is going to get even greater. Wait for the fun that is coming when we add carbon and carbon sequestration and embodied energy to the mix. This is complicated enough with new buildings where we start with a clean sheet of paper. Wait till we do all of this in existing buildings. Retrofits are going to be way more fun. There is no such thing as a free thermodynamic lunch. I bet that the ghost of Rudolph Clausius** has a big grin.

* I never get a call saying, “Joe, things are going great – let’s have a beer.”

** I think Rudolph Clausius is the big dog of thermodynamics... entropy baby... entropy...

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PROTECTING FIRST-YEAR WORKERS: SAFER JOBSITES, STRONGER BUSINESSES



**Alberta Construction
Safety Association**

By the Alberta Construction Safety Association (ACSA)

First-year workers at a construction company, regardless of age – from another company, industry, or country – are more likely to get injured on the job than their co-workers. From 2019 to 2023, they accounted for 55 per cent of Alberta Workers' Compensation Board (WCB) claims. Preventing injuries and maintaining strong health and safety programs lower WCB premiums. Achieving this requires a shared commitment to safety at every level, from office to field.

The Alberta Construction Safety Association (ACSA) partners with over 56,000 member companies and 240,000 workers by offering training, certifications, designations, and resources to help reduce workplace risks and pursue safety and business excellence.

Leadership sets the tone

When the ACSA spoke with new workers to understand contributing factors to their higher injury risk, a key theme emerged: time and capacity pressures led to less supervision and coaching. While it's easy to focus on frontline supervisors, they also face pressure from leadership. Getting new workers the necessary time and oversight is a responsibility shared across all leadership levels.

"Workers and their supervisors take cues from leadership. When leaders provide adequate time and resources for onboarding and welcome feedback from the frontline, it

builds a culture where safety is part of daily practice," said Mark Hoosein, ACSA's chief executive officer.

Experienced workers also play a crucial role guiding first-year workers, sharing safe practices, and fostering a supportive team environment.

"For first-year workers, adapting to new worksites takes time, as well as training and support through onboarding," Hoosein added.

How can your company reduce first-year worker injuries?

Effective onboarding is key. A thorough process helps new workers understand safety protocols, expectations, and job site hazards. Supervisors and experienced workers must reinforce these to build competence and confidence.

"Combining this with mentorship and ongoing support, workers develop safe practices from day one," Hoosein said.

Many first-year workers noted a disconnect between formal safety training and job conditions. One worker said nothing could fully prepare him, stressing the need for site-specific training, active supervision, and continuous feedback.

The most common first-year worker injuries include being struck by objects and back or spinal injuries. Falls from heights are the costliest, often due to longer recovery times.

What support does ACSA offer?

The ACSA partners with industry, government, educational institutions, and associations.

The ACSA offers industry-recognized virtual and in-person training tailored to business needs. Courses like the Construction Safety Training System (CSTS) and Leadership in Safety Excellence (LSE) help workers, supervisors, and managers understand their safety responsibilities.

Leaders and workers can pursue designations like the National Health & Safety Administrator (NHSA) and National Construction Safety Officer (NCSCO) to enhance safety leadership. Companies can further show their commitment by achieving COR certification, which supports continuous improvement of safety management systems.

Recognize safety leaders

Ahead of the 2025 conference in Calgary this November, the ACSA invites nominations to honour individuals and organizations demonstrating business excellence through safety leadership. Submit nominations at www.youracsa.ca/awards.

Learn and connect

The ACSA will host regional events in March in Medicine Hat and Lloydminster. These sessions will provide resources, answer questions, and connect you with other businesses.

The injury prevention campaign kick-off will be in May in Edmonton, Red Deer, and Calgary. Visit www.firstyear.youracsa.ca to subscribe for updates.

Whether you're a first-year worker, supervisor, or company leader, safety starts with collective accountability. The ACSA is your partner in building a safer, stronger future for Alberta's construction industry.

Learn more at www.youracsa.ca or contact info@youracsa.ca. ■

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PROMPT PAYMENT TIMELINES: WHEN TO PAY OR ADJUDICATE?

By Josh Tyrbuch, Sean Manery, Pat Clark, and Kirk Mason



Josh Tyrbuch, student-at-law.



Sean Manery, partner.



Pat Clark, partner.



Kirk Mason, partner.

The construction law team at HMC Lawyers has over 130 years of cumulative litigation experience. We have been acting for construction industry clients for decades, and our practice continues to grow. We have handled almost everything pertaining to construction, ranging from straightforward lien matters, to complex, multi-party litigation. Our experience includes extensive work on behalf of all construction industry participants, including owners, developers, contractors, subcontractors, design professionals, architects, and consultants. To get in touch with the HMC Lawyers construction law team, contact our office at 403-269-7220.

As many in the Alberta construction industry are now aware, sweeping changes were made to the province's construction legislation in the summer of 2022. Two of the major changes were the introduction of prompt payment deadlines for all members of the construction chain, as well as the availability of an adjudication system to settle payment disputes.

The basis of the prompt payment amendments in Alberta was the

introduction of the "proper" invoice, and payment timelines related to this. Proper invoices must be issued by any general contractor to the owner every 31 days while on site. Once a proper invoice is issued, this triggers payment deadlines to the general contractor. These deadlines subsequently trigger further payment deadlines for any subcontractors or sub-subcontractors. A summary of these payment timelines and deadlines can be found in the attached figure, titled "Proper Invoice Payment Timelines."

As can be seen from that figure, the owner has either 14 days to issue a notice of dispute to their contractor if they do not agree with the work invoiced for, or 28 days to make full payment. There are then further payment timelines for general contractors to follow for paying their subcontractors, and payment timelines subcontractors must follow for paying their sub-subcontractors.

The second major change coming from the 2022 amendments to Alberta's construction legislation was the introduction of an adjudication process for disputes over invoice and payment amounts. If any company or individual in the construction chain

disputes a proper invoice, they may refer the matter to an "adjudication."

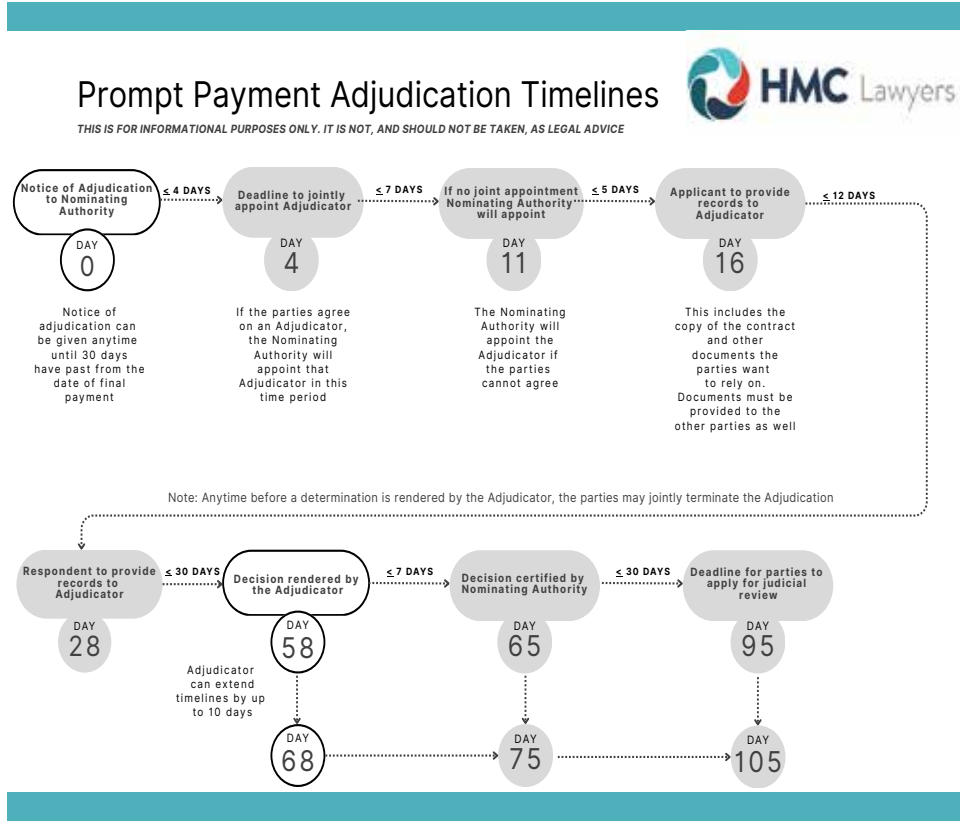
The adjudication process is meant to be a quicker and more cost-effective solution for companies, rather than dealing with the sometimes long and arduous litigation process. The timelines for the adjudication are seen in the attached diagram, titled "Prompt Payment Adjudication Timelines." The adjudication process is designed such that it can often be completed within 100 days (or less).

Further changes were made in 2025 to Alberta's construction legislation. They make it easier for parties to access the adjudication process. Previously, if final payment had been made by an owner or if a court action had been started by one party, none of the other parties in the construction chain could access the adjudication process. The new changes now allow for a party to refer a matter to adjudication while a court process is ongoing. They further allow any party to refer a matter to adjudication if it is done within 30 days after final payment has been made.

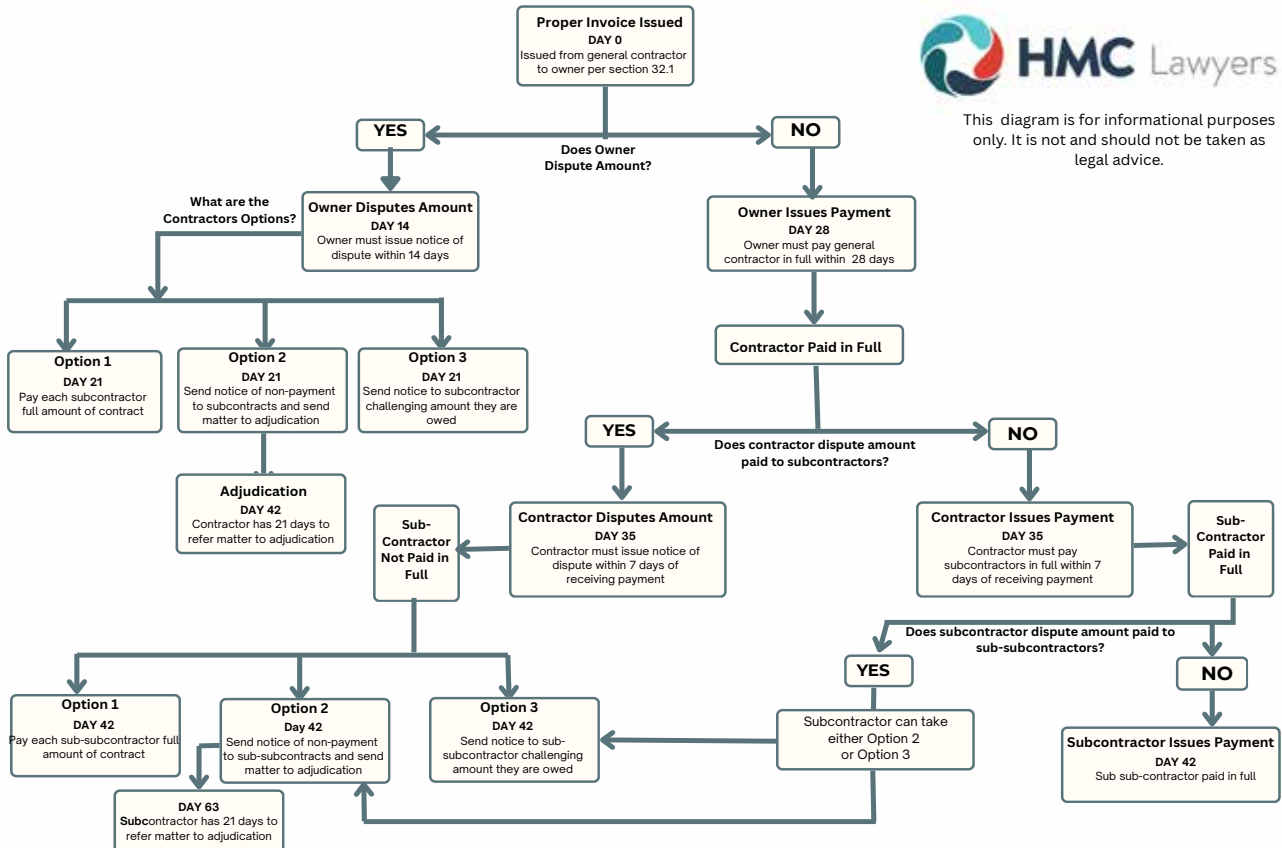
These changes prevent a party from commencing a court action to slow down the adjudication process. It

also allows parties to still refer matters to adjudication when the contract has been completed, but final payment has not been made. It ultimately makes the adjudication process, designed to bring quicker resolution to construction claims, more easily accessible for more parties.

This post is written on behalf of the construction law team at HMC Lawyers. It should not be taken as legal advice. If you have further questions or think you may be able to pursue an adjudication or court matter because of failure to pay an invoice for a construction process, please contact the construction law team at HMC Lawyers to further discuss your matter at 403-269-7220. ■



PROPER INVOICE PAYMENT TIMELINE



This diagram is for informational purposes only. It is not and should not be taken as legal advice.

INSULATED GLAZING UNIT (IGU) FROST/DEW POINT TESTING: HOW TO BETTER PREDICT REMAINING SERVICE LIFE



By Bruce Fournier, P.Eng., Michael Zinoviev, M.A.Sc., P.Eng.

Left: Bruce Fournier, P.Eng., is a building enclosure specialist at Sense Engineering in Ottawa. He provides building enclosure engineering and consulting services for new and existing buildings.

Right: Michael Zinoviev, M.A.Sc., P.Eng., is a consultant in building restoration at Sense Engineering in Ottawa, specializing in the repair and renewal of existing structures.



Owners and operators of existing buildings can be challenged with accurately predicting when and at what rate your IGUs may fail and need replacement. However, a test method is available to provide more accurate service life predictions and capital expenditure forecasting.

What is an IGU?

An insulated glazing unit (IGU) consists of two or more panes of glass separated by spacers. The space between the glass is usually filled with air or a low-conductivity inert gas like argon. These units provide significantly improved insulating value and reduced noise transmission compared to older single-pane windows. IGUs were first introduced into the marketplace in the 1950s and became more common in 1970s.

What do we mean by “IGU failure”?

An IGU failure typically refers to when

condensation forms between the glass panes, commonly referred to as fogging. This occurs when the IGU’s perimeter seal between the glass panes has been breached, and the desiccant has no further capacity to absorb moisture that has infiltrated the glazing cavity. The fogging obstructs visual acuity through the IGU, and the lost seal can reduce the thermal performance.

There are many factors that impact when and at what rate failure/fogging occurs, including:

- Temperature
- Environment
- Exposure
- Desiccant Quantity
- Sealant Material
- Fabrication Quality
- Protection from Moisture

Common service life assumptions

A common assumption for IGU

service life within industry is approximately 25 to 35 years. However, building IGU fogging/failures do not all happen at once, and can start occurring well before the average service life. They often follow a normal distribution or “bell curve” when accounting for failures over the life of the windows. A good historical database (or list) of your building’s IGU failures/replacements can help predict the future failure rate.

This method of prediction and budgeting may suffice for some building owners or operators. However, what if...

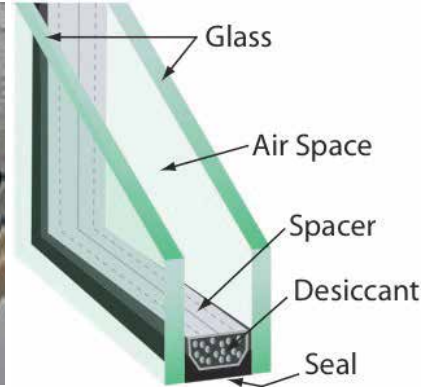
- You are comparing comprehensive fenestration repair or replacement strategies, and your IGUs have exceeded a typical service life? Should you proceed with a large rehabilitation if most of your IGUs are likely to fail well before the service life of the rehabilitation is realized?



An example of a double glazed IGU construction (Hopson Glass).



Examples of failed IGU (note: condensation between glass panes).



Frost/dew point test apparatus.

- You are planning for a wholesale building renewal project and are unsure whether IGU replacement should be completed as part of that work while the building is vacant or in conjunction with other work to take advantage of access and/or economies of scale, or
- You simply want to predict IGU replacement budgets more accurately to better avoid unforeseen costs?

... you can consider conducting IGU Frost/Dew Point Testing. This may be important if the cost associated with IGU replacement is high, either from the vantage point of material replacement, and/or cost of mobilization and access.

IGU Frost/Dew Point Testing (ASTM E576)

IGU service life can be predicted through frost/dew point testing, and this method is more reliable than using historical failure data. This testing involves rapidly cooling the glass to low temperatures using a standardized testing apparatus to induce condensation within the IGU cavity, referred to as the frost/dew point.

The apparatus includes an insulated container, and uses dry ice to chill a plate on the apparatus, which is then used to cool the IGU test surface down to -50°C . If condensation forms

at a temperature closer to the IGU's normal service conditions, such as -5°C for example, then the IGU is closer to the end of service.

Results gathered in combination with the IGUs' service conditions (which includes frame construction, exposure to moisture and temperature loading, and IGU components), allow for more accurate service life predictions. Predictions can be further improved if testing can be repeated over successive years, allowing performance trends to be established.

The larger impact of glazing renewal is also best evaluated with comprehensive energy modelling correlated to historical energy usage. ■



Condensation/frost forming on the IGU being tested.

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