FACILITIES STANDARDS MANUAL

REAL ESTATE, ENVIRONMENT AND FACILITIES MANAGEMENT

FACILITY PLANNING AND DEVELOPMENT

December 2024

"REFM buildings should be sustainable, accessible, attractive & efficient in operation"

INDEX

APPENDICES

Figure 1: Firehall No. 17

A INTRODUCTION

The City of Vancouver (CoV) Real Estate, Environment and Facilities Management (REFM) team provide this document as a tool for design teams and developers to draw upon lessons learned in the operation of existing REFM buildings, and to provide guidelines on expectations, standards, and targets that future projects should meet. This knowledge is also provided to facilitate communication and understanding between CoV Maintenance and Operational teams and the design team.

OBJECTIVE

The objective is not to state a prescriptive performance requirement, but rather, to provide background information to designers, developers, and others that are not involved in City projects so they can address project specific requirements with an understanding of CoV's guidance and alignment of intent.

INTENT

This document will not address every situation and every requirement set out by the City of Vancouver. It is intended to document accepted REFM practice and provide a starting point for further informed consultation during the design and construction processes.

- Objectives and criteria that are listed in sections within the body of the guideline identify the intent of that section and what is required by the project to achieve.

- Guidance may be provided to identify possible solutions or acceptable practices, but it is expected that alternative solutions will be found to achieve intent.

- Not all sections of the FSM will have a Master Specification. Only sections that have items with specific concerns to the CoV as a building owner and operator.

This guide is not meant to eliminate innovation and design thought, but to clearly define City of Vancouver expectations on project outcomes. Deviations from required objectives and criteria are expected to occur in rare circumstances and shall be requested, in writing, by the design team as early in the design process as possible. Written approval from City Staff is required, otherwise it is expected that the deviation has not been approved.

New construction and renovation projects are covered within the scope of this document, and unless otherwise stated, guidance should be considered applicable to both forms of project.

The design team should assure themselves that they are referencing the latest version of documents, where relevant.

REFERENCES

This document sits as part of a suite of existing City of Vancouver Design Guideline documents and policies. It should be read in conjunction with complementary typology specific guidance and City of Vancouver policies. In the event that a conflict or duplication exists between other guidelines and policies or if guidelines are not publicly available please bring this to the attention of the City of Vancouver Project Manager. Current publications include:

- Bike Mobility Amenity Guidelines
- Bird Friendly Design Guidelines
- Childcare Design Guidelines
- Climate Emergency Response Plan
- CoV Office Accommodation Guidelines (internal use only)
- CoV Urban Farming Design Guidelines
- Direct Digital Control (DDC) Technical Guidelines
- Electronic Security Systems Specification
- Energy Modelling Guidelines
- Green Operations Plan 2.0
- Housing Design and Technical Guidelines
- Neighbourhood Energy Guidelines
- Outdoor Lighting Strategy
- Rain City Strategy (and associated bulletins)
- Reducing Barriers for Trans and Gender Variant Community Members
- Seniors Housing, Community Care Facility and Group Residence Guidelines
- Street and Public Realm Lighting design Guidelines
- Streetscape Design Guidelines
- Vancouver Parks Board: Park Development Guidelines
- Waterwise landscape Design Guidelines
- Zero Emission Building Policy

(The following documents are in preparation, please confirm their availability)

- City-affiliated Kitchen Facility Guidelines

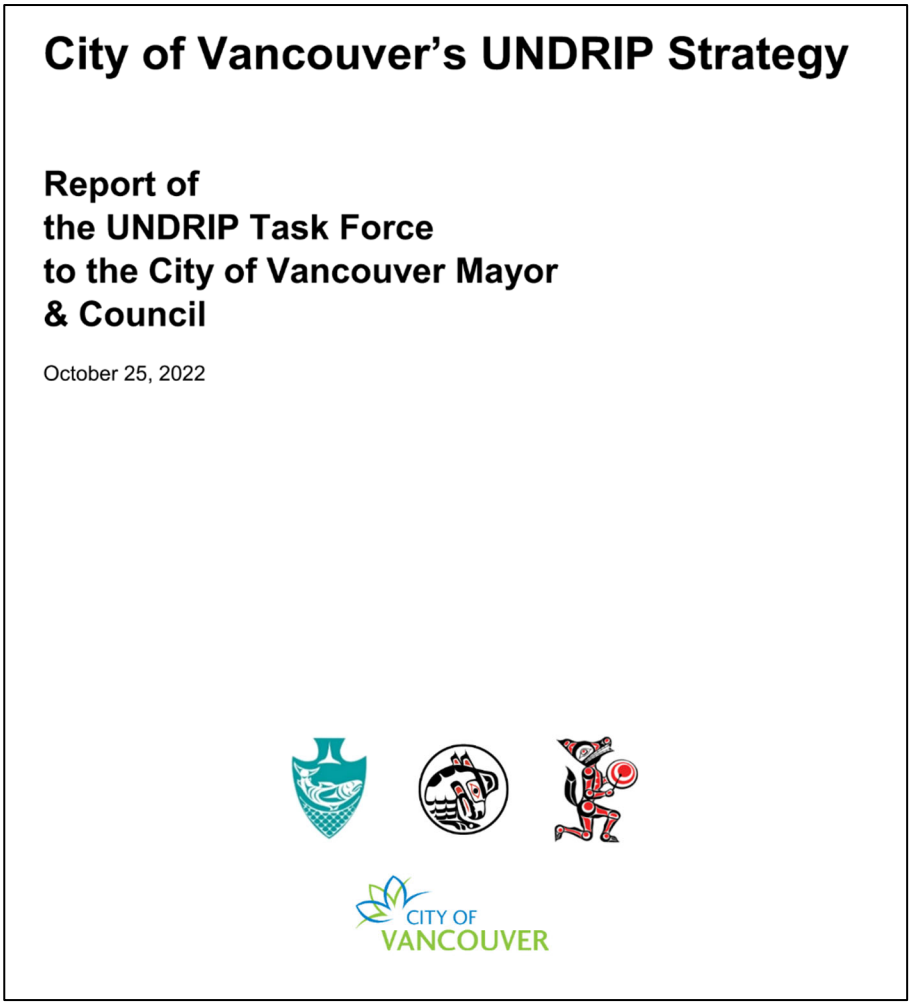
The design team should assure themselves that they are referencing the latest version of the above documents, where relevant.

B GENERAL CONSIDERATIONS

UNDRIP Strategies & Commitments

The City of Vancouver created a task force to develop, provide recommendations and create strategies that would develop and strengthen relationships with xʷməθkʷəy̓əm (Musqueam Indian Band), Sḵwx̱wú7mesh (Squamish Nation), and səlilwətaɬ (Tsleil-Waututh Nation). A final report was developed and brought forth to City council (https://council.vancouver.ca/20221025/documents/p1.pdf).

As of 2023, the task force is continuing its efforts to develop and put forth a 5-year action plan that will implement the 79 recommendations outlined in the final report to council.



Protecting Vancouver's Heritage

City-led construction project requiring ground-altering activities need to comply with the provisions of the BC Heritage Conservation Act (HCA). The purpose of the HCA is to facilitate the protection and conservation of heritage sites in British Columbia, including archaeological sites within the City of Vancouver.

This policy applies to all city-led engineering work sites where ground-altering activities are proposed. Should the design team be unaware of the requirements of the BC Heritage Conservation Act, it is incumbent upon the team to confirm with the City of Vancouver Staff if any actions are required prior to the start of work.

Archaeology permits are required through the BC Archaeology Branch, as well as the xʷməθkʷəy̓əm (Musqueam Indian Band), Sḵwx̱wú7mesh (Squamish Nation), and səlilwətaɬ (Tsleil-Waututh Nation).

Figure 2: Heritage Hall – Scott Construction

OBJECTIVES

.1 The City of Vancouver declared a Climate Emergency in 2019 that followed on from a policy target of becoming the world's greenest city by 2020. High performance and sustainable buildings demonstrate the City's commitment to these objectives and reduction on carbon emissions as part of the Renewable City Strategy.

CRITERIA

.1 Per the Zero Emissions Building Plan, new City of Vancouver buildings or Major Renovations should achieve Passive House Certification (EnerPHit for major renovations) and use no fossil fuels or achieve Zero Emissions through other approaches, unless the standard and/or intent is not applicable or feasible. LEED® Gold certification is required for new construction projects over 500m^2. Refer to the most current LEED® Canada New Construction (NC) standard for stand-alone buildings, and LEED® for Commercial Interiors (CI) for City owned airspace parcels.

.2 Target 40% reduction in embodied carbon for new buildings. Refer to VBBL for latest information.

.3 Use low embodied carbon materials where possible for new and renovation projects.

.4 In terms of energy supply, attempt to electrify by all means possible, with consideration to infrastructure and mechanical systems.

.5 All City capital funded building projects must contribute to the City's Rain City Strategy and Integrated Rainwater Management Plan's target of capturing and treating 90% of annual rainfall on public and private property. This requires that projects capture (infiltration, evapotranspiration and/or reuse) and clean (treat) rainwater from a minimum of the first 48mm of rainfall per day.

.6 Facilities received from other sources, including those constructed for the city using Community Amenity Contribution (CAC) funding, and those with long term leases to the City for the life of the building, should be constructed to the same standard as City capital funded facilities. Where the city funded facility it is a small air space parcel in a larger building funded by others, and it is not viable to achieve Passive House certification for the whole building, then at a minimum the city owned portion of the building must be designed and shown to achieve a minimum of 35% reduction in energy consumption compared to the current City of Vancouver Building By-Law, and reduce Greenhouse Gas Emissions through the use of only low carbon fuel sources.

GUIDANCE

.1 Zero emission, high performance buildings represent a step change in the approach to designing and constructing buildings. The knowledge required to do so is readily available from organizations such as ZEIC, B2E, CLF, ZEBx, the Vancouver Zero Emissions Building Exchange. Design teams should consider including team members who are trained as Certified Passive House Designers/Consultants/ Trades persons alongside LEED® accredited professionals when required.

.2 Recent focus has addressed building operational energy and carbon emissions, however, recognition that embodied carbon also has role to play in addressing climate change needs to be investigated to achieve the new building requirements and should be strongly considered when selecting materials for major and minor renovations.

Accessibility Strategy

The Accessibility Strategy (https://vancouver.ca/people-programs/accessibility-strategy.aspx) demonstrates the City of Vancouver's dedication to enabling full participation for individuals with disabilities through inclusive services, programs, and infrastructure, and the removal of barriers. It emphasizes the recognition of the rights, dignity, and independence of people with disabilities, contributing to the promotion of a culture of equity and inclusion for all community members.

As a part of the Accessibility Strategy, the city has included that all new City-owned facilities, such as the Marpole Community Centre, and retrofitted buildings, such as West Point Grey Library branch, will now be designed and built to meet the Rick Hansen Foundation Accessibility Certification (RHFAC) Gold. Please read more at the links below:

OBJECTIVES

.1 The City of Vancouver carefully selects and assembles design teams and look to them to lead the design and construction administration process. The extent of consultation and communication with the city will vary by project however regular communication and review through the REFM Project Manager is needed. The objective being clear understanding by all project participant of deliverables and outcomes and the timeframe in which to do so.

.2 It is highlighted that renovation projects inherently require additional resources and reporting to address the existing building conditions and occupants.

.3 The FSM is to be read in conjunction with the directions from the UNDRIP Strategy and MMIWG2S Response Report. Confirm requirements for each project with the CoV Project Manager.

CRITERIA

.1 Design Teams should report and seek formal review and comment from REFM at the following points:

- Kickstart Meeting and Strategic Objectives,
- End of Schematic Design,
- End of Design Development,
- 50% Construction Documents,
- 75% Construction Documents,
- 90% Construction Documents.

GUIDANCE

.1 For renovation projects, an existing building survey, comprising written description and photographic records, should be completed as part of the schematic design phase activities to document existing conditions and defects.

.2 Delegated design of detailed design elements such as guardrails, glazing systems and seismic restraint is recognized as part of design practice, however design teams should always confirm and check coordination of delegated design items and completion of Field Reviews.

.3 Record drawings should be promptly provided by the design team following receipt of Contractor mark ups. Accuracy and completeness of documentation are critical.

.4 New Facility/Building – Digital Building Information Transfer

- Architecture/Engineering consulting services for new facilities/buildings shall include the required service/effort to allow for digital transfer of all building components/equipment's information to CoV as a part of close out.
- Following are examples of data (not limited to) that should be included:
    - Manufacturer
    - Model #
    - Serial Number
    - Location
    - Electrical Information
- As the start of the project the Consultant team shall confirm requirements and format with the CoV project manager.

OBJECTIVES

.1 The City of Vancouver maintains a wide portfolio of buildings. An enhanced focus on durability during the design phase greatly facilitates their operation and extends their lifespan. As part of the design process, the City of Vancouver will look to optimize system and material selection through a comprehensive understanding of the expected lifespan and maintenance requirements of the proposed design.

CRITERIA

.1 Target a long building design life of 100-years with corresponding expectations for materials and systems.

GUIDANCE

.1 Design reports should include a section discussing the durability considerations of the proposed design which should be addressed by all design team members.

.2 Consider adopting and reporting on durability in a manner described by the methodology and approach set out in CSA S478 Standard for Durability in Buildings.

.3 External use of wood products should be carefully assessed, and protection provided.

OBJECTIVES

.1 Maintenance of the city portfolio is a key aspect of REFM - from handover through to renewal. Warranties are requested to address latent defects that are not apparent during construction and the 12-month period immediately following Substantial Performance. The level of warranty will be determined on a project specific basis with reference to the capital cost to do so.

CRITERIA

.1 Provide industry standard warranties for all products incorporated into the building.

.2 Confirm with the City of Vancouver Project Manager, no later than the end of the Design Development, if any enhancement to the standard warranty scope and period is required.

.3 As a minimum, enhanced warranties for heat pump technologies shall be required for all projects. This shall as a minimum require a 5-year parts and labour warranty for all parts.

GUIDANCE

.1 Warranties are typically requested for: roofing, flooring, painting and millwork. Independent, industry warranties are preferred over manufacturer warranties where available.

.2 If cost prohibitive, consider requesting enhanced third-party inspection services instead.

.3 The form of warranty should be provided as a submittal in the manufacturer's standard, unamended form. Completed warranty documentation should be provided in the Operation and Maintenance Manual for the benefit of the City of Vancouver.

EXPECTATIONS OF ENGINEERS

.1 Professional Engineers are bound by the code of conduct and professional practice guidelines that are laid out by the Engineers and Geoscientists of British Columbia (EGBC). As the regulating body, it is expected that every engineer in BC abides by the guidelines and expectations of Good Engineering Practice.

.2 To ensure that the expectations are clearly laid out, the EGBC has written a number of Professional Practice Guidelines to be followed for various disciplines. These are accessible here: https://www.egbc.ca/Practice-Resources/Professional-Practice-Guidelines

.3 No work required to meet these guidelines may be omitted from a response to a Request for Proposal to the City.

NOTE

Every engineer working for the City of Vancouver shall follow these guidelines and is expected to be familiar with their professional obligations.

QUALITY ASSURANCE

.1 All projects completed for the City of Vancouver must follow the EGBC Guidelines for utilizing the Engineers stamp. This includes the Engineer of Record signing and sealing all final reports and drawings for projects ranging from small feasibility studies, to tenant improvements and large new builds, including the firms license to practice number.

.2 Engineers are required to allow for sufficient site reviews during the construction process of work. No additional service fees will be expected by the City for any site reviews which require an Engineer to sign off on their letters of assurance, unless there is a change to the contract that could not have been foreseen by the design team.

.3 The EGBC identifies sufficient field reviews to be a single site review for each month of active construction. Site reviews must be accompanied by field review reports clearly outlining what was reviewed and any notable comments from the Engineer. Depending on the work being done, a photo or video site review may be a considered reasonable approach to meet these expectations.

.4 Consultants must demonstrate compliance with EGBC Professional Practice Management Plan requirements to undertake a documented risk assessment process for the professional activities or work for each project. The consultant's risk assessment document for the professional activities on the work must be submitted to the City, detailing identifies risks along with proposed mitigation strategies. For projects with any High-Risk Professional Activities or Work (HRPAW) identified, the consultant must provide documentation of the Independent Reviews completed for any HRPAW undertaken for the project.

NOTE

The expectations of working with the City of Vancouver is to follow the standards set out by The Association to ensure proper oversite, and to limit low bidding on construction administration.

C ARCHITECTURAL

OBJECTIVES

.1 Spatial layouts of buildings respond to programme, site and by-law requirements. As operators of many of their buildings, a consistent approach to the operational layout, access to spaces and thermal comfort provides for safety and efficient maintenance.

CRITERIA

.1 All CoV owned buildings/spaces shall be built with universal design incorporated. Beyond the requirements of the VBBL, include universal design principles in the design. Refer to the BC Housing guidelines for universal design principles.

.2 Building designers should address, demonstrate and document their design and access approaches to the building envelope, garbage & recycling and service rooms.

.3 Physical barriers are mandated for all areas requiring fall protection. Alternate approaches may be accepted on an exceptional basis with the written approval of the REFM Director.

.4 All fire department connections must have unobstructed clear access, signs indicated areas covered and protective caps in place.

.5 Mailbox to be accessible from the interior of the building at the main entrance (confirm requirements for each facility).

.6 For new facilities, all public-facing facilities, including but not limited to community centres and libraries, childcare, fire halls, and office spaces, and public-facing meeting spaces are to have cooling, with designated public-facing cooling centres.

.7 New libraries, community centres and childcare facilities should be provided with both the requirements of a cooling centre, as well as the requirements for a cleaner air space. The project team is to confirm for each facility before proceeding with design.

.8 All other facility types should be confirmed with CoV staff and partners in advance of the design phase. This should be documented as part of the schematic design phase.

.9 A warming centre has a primary response to provide short-term emergency shelter when outdoor air temperatures reach -4°C (25°F) or below (or feels like -5°C [23°F] or below). Typically, these warming centres are activated in community centres, public gathering spaces, and churches. Refer to Mechanical – HVAC section for technical details on warming centre space requirements.

.10 A cooling centre has a primary response to provide temporary support and relief during a heat wave. Typically, these cooling centres are activated in community centres, and libraries. Refer to Mechanical – HVAC section for technical details on cooling centre space requirements.

.11 A Cleaner Air Space has a primary response to provide relief from wildfire smoke events. These spaces are intended to provide accessible indoor spaces with improved air quality. Refer to Mechanical – HVAC section for technical details on the Cleaner Air space requirements.

.12 Designated publicly accessible Cooling Centres and Cleaner Air Spaces, located within new facilities and/or applied to existing buildings, are to be confirmed for each facility before proceeding with design, and must incorporate the enhanced cooling and clean air requirements as defined below.

GUIDANCE

.13 Generally access in and around buildings should be straight forward and not prescriptive. Circulation routes should be functional to facilitate ease of access with minimal gates and barriers.

.14 Unless a specific programme requirement, for reasons of safety and fall protection, limit roof and elevated deck access.

.15 Provide safe and protected access to building facades, roofs, and services spaces via:

- Physical barriers: guardrails, parapet walls, fixed and protected access ladders etc.). As noted above, this is considered to be the minimum requirement.
- Alternate approaches require approval, in advance of construction documentation commencing by the REFM Director. This may be the case for heritage or renovation projects and due consideration should be made early in the design process.

.16 Ease of access for serving in and removal by users and service vehicles; preference for ground floor without having to maneuver bins up and down stairs or through an elevating device to waste removal area; compactor consideration where required, properly sloped drains and hose bib in room for cleaning bins and garbage room; overheat, width and other clearance consideration for waste removal vehicles access and loading.

.17 Successful and efficient projects will identify a strategy for the above spaces during schematic design and continue to develop and document their proposals throughout the design process. A drawing (plan, elevation and three-dimensional representation) or specification section to demonstrate the project specific approach should be provided by the end of the construction document phase with confirmation that this has been coordinated across all design disciplines.

.18 Review specific guidance for service rooms in the mechanical and electrical sections of this document.

OBJECTIVES

.1 The public nature of City of Vancouver buildings dictates that building security is a key concern. REFM liaises internally with their own consultants to assess security needs and requirement.

.2 City of Vancouver buildings should be secure to maintain the safety of occupants within.

CRITERIA

.1 Request that REFM undertake a threat risk assessment following completion of schematic design. Undertake CEPTED assessment if requested by City of Vancouver security, as part of the threat risk assessment.

.2 Early operator input, no later than the end of design development, is required if the building will not be operated by the city.

.3 Implement the recommendation of that assessment in consultation with the CoV's project manager.

.4 Follow requirements of the City of Vancouver Electronic Security Systems Specification.

.5 Power outage should result in 'fail closed' operation but with means to egress.

GUIDANCE

.1 Use an architectural hardware consultant to develop project specifications for hardware.

.2 Include a written 'sequence of operation' for all doors to facilitate understanding of operational requirements.

.3 Existing door hardware suppliers are Schlage or Corbin, including a 10-year service contract.

.4 Basis of design can be considered to have performance equivalent to Schlage Commercial D grade hardware. Pre-approved alternates will be considered.

.5 Interchangeable cores are preferred for ease of replacement.

OBJECTIVES

.1 This section is to provide guidance for architectural millwork, refer to other technical guidelines for specific requirements to other city owned/operated facilities.

CRITERIA

.1 Construction Quality:

- To be in accordance with “custom grade” as defined in the latest edition of the “Quality Standards for Architectural Woodwork” as published by AWMAC (Architectural Woodwork Manufacturers Association of Canada), except as noted below.
- AWMAC Guarantee to be provided.
- Inspection to be provided by an appointed inspector, approved by AWMABC (BC Chapter of AWMAC).
- All materials to be formaldehyde free.
- Use wood certified in accordance with the Forest Stewardship Council’s Principles and Criteria if it is competitively priced with non-certified wood.
- Use adhesives and sealants that have low VOC levels per the LEED® requirements listed under credit 4.1 “Low-Emitting Materials, Adhesives and Sealants”.

.2 Casework:

- Cabinets: 19mm (3/4”) natural hardwood ply interiors with 12mm (1/2”) natural hardwood ply backs. Good quality melamine interiors are acceptable except at wet areas such as art sinks, kitchen sinks and around dishwashers – these must be water resistant plywood core with plastic laminate to resist wet or stainless steel.
- Drawers: 12mm (1/2”) hardwood ply drawer sides, 6mm (1/4”) hardwood ply bottoms, or preapproved drawer systems.
- Finish (clear finish on wood): 1 coat of clear sealer, 2 coats of catalyzed clear lacquer finish - lacquer to be water and bleach (mild solution) resistant.
- Finish (plastic laminate). There may be a preference for plastic laminate finish on lower doors as some cleaning contractors have scarred door faces with cleaning buckets – confirm requirements for each facility.
- Base: toe kick height of all cabinets shall be consistent with rubber base used in the facility; rubber base over 19mm (3/4”) plywood. Toe kick depth to be minimum 100mm (4”).

.3 Countertops:

- 19mm (3/4”) high density particle board post-formed with backer under unsupported spans over 900mm (3ft.), except, all counters with sinks shall be water-resistant plywood core.
- Acceptable materials: plastic laminate (post-formed edges), or other (confirm requirements for each facility).
- Wood is not preferred for countertop edges. If wood is used, it is not to be exposed on the horizontal surface of the countertop.

.4 Backsplashes:

- All counters with sinks shall have minimum 100mm (4”) backsplashes and side splashes; additionally provide water impervious surface on wall above sinks and min. 600mm (2ft.) high or to underside of cabinets above.
- Gypsum board with paint finish or vinyl wall covering not acceptable.
- Acceptable materials: plastic laminate (post-formed), ceramic tile, glass or other, confirm requirements for each facility.

.5 Hardware:

- All hardware to be commercial grade.
- Hinges:
  - 125mm (5”) minimum, Blum or Mepla, or pre-approved equal.
  - System screw mounting plates required at all hinges.
- Drawers:
  - Up to 150mm (6") deep - Blum or Mepla 3/4 extension slide or pre-approved equal.
  - Over 150mm (6") - KV or Accuride full extension slides or pre-approved equal.
- Pulls: Richelieu 33205 Brushed D or similar easy to grab handle that is a pre-approved equal, confirm requirements for each facility.
- Standards: to be steel, adjustable on 12mm (1/2”) centres, flush with cabinet side wall face.
- Door stops to be wall mounted where possible complete with backing provided in the wall.
- Shelf clips: to be compatible with the standards, and to allow for shelves to be mechanically fastened to support bracket.
- Locks: Corbin 0737 & 0738 with #75 Strike or pre-approved alternate
  - Locks on all lockable millwork to have a common key.
  - Different individual lock on staff cabinets / lockers with master key.
  - Confirm any requirements for locked millwork beyond this minimum for each cacility.

- Keyboard trays at counters in offices, review requirements for each facility.

.6 Seismic:

- Shelves, cupboards, cabinets, etc. to be made earthquake safe.
- Adjustable shelves to be mechanically fastened to support bracket.

GUIDANCE

.1 The above are general requirements for architectural millwork. Any deviations/alternatives from the above, must be reviewed and approved by REFM and city staff partners.

OBJECTIVES

.1 The public nature of City of Vancouver buildings requires landscaping to be built to create a natural environment while maintaining public safety.

CRITERIA

.1 Incorporate native trees and shrubs as well as increase vertical vegetation structure in landscaping to enhance biodiversity.

.2 Fences:

- All steel fencing to be hot dipped galvanized, then primed and painted.
- To be un-climbable; no gaps in fence to be larger than 100mm (4”), chain link openings to be no more than 38mm (1.5”).
- All gates to be self-closing.
- Minimum fence height is 1.5m (5 ft) in height.

.3 Landscaped Areas/Playgrounds (general):

- Outdoor areas should be designed and built to create a natural environment utilizing a variety of textures and natural materials.
- Do not use dark colours for impervious and play surfaces to reduce heat island effects.
- Very light and reflective materials are not acceptable as they cause glare problems.
- All play and walking surfaces shall be non-slip.
- The use of grass in areas should be considered carefully; it cannot sustain the traffic in small areas.
- Plants must be of sufficient size to withstand the use of the area. Plant species must not only be non-toxic but vigorous and easy maintenance.
- At grade, use pervious surfaces wherever possible to minimize storm water run-off.
- Although natural plantings are preferred, artificial turf may be considered for small areas of roof-top play areas providing that sand (rather than rubber chips) is used as the medium to hold it in place.
- All growing media to be mushroom free.
- Provide 405mm (1'-4") wide mowing strips adjacent to buildings, fences, etc.

.4 Drainage and Grading:

- Grades to provide positive drainage of all lawns, paved areas and others. Ponding is not acceptable.
- Allow no drainage of surface water towards buildings, across sidewalks or onto neighbouring properties. Drainage must be away from building entrances.
- All drains must be lower than interior floors.
- All drains near engineered wood chip or sand play areas to have the capability to trap sediment with an easily removable and cleanable sediment trap.
    - If there is not sufficient head room in the space below for a sediment trap, then at minimum provide a wye 45° elbow complete with clean-out access. Review with the City of Vancouver for each building.
- Drainage from above-grade landscaped areas:
    - Drains to be bi-level, to drain both surface and roof waterproofing membrane
    - Both surface and waterproofing membrane must be sloped to drains
    - All roofs to have scuppers at a lower elevation than the interior floor elevation.
    - Drainage shall be designed so that if any roof drain should block the ponded water shall be able to flow to another exterior drain so that no water shall enter the interior.
    - Slope lawns from 1.5% to 6%.

.5 Irrigation:

- All rooftop landscaped areas shall be irrigated.
- If irrigation is provided, use high-efficiency irrigation technology.
- If irrigation is provided, include irrigation controller as part of DDC system. A stand-alone irrigation system may be acceptable but must be approved by City of Vancouver Operations.
- If irrigation is not provided, hose bibs are to be installed at minimum 15.25m (50ft.) apart.

GUIDANCE

.1 Use landscape consultant to develop project specifications for landscaped areas, playgrounds and irrigation systems.

OBJECTIVES

.1 The purpose of this section is to identify a cohesive outline and the City of Vancouver preferences for elevating devices.

CRITERIA

.1 Consult a qualified elevator consultant during the design phase.

.2 All new equipment must meet the current TSBC-code requirement (B44-16) and or any governing bodies that may have jurisdiction.

.3 All new equipment must be non-proprietary or/if proprietary, full serviceable access and training will be given to current City of Vancouver elevator maintenance contractor.

.4 If the Facility has a dedicated elevator, the elevator controllers shall be non-proprietary allowing 3rd party maintenance to adjust or troubleshoot fault codes and be designed so that it can be included in the City of Vancouver elevator maintenance program.

.5 The suitability of the proposed controller products will be determined based on the proprietary nature of the equipment, degree of site programmability, track record on previous installations and the experience of local personnel with the product proposed.

.6 Pre-approved controller products (subject to change):

- Motion Control Engineering (MCE) Model PTC-AC.
- Or pre-approved alternate.

.7 Elevator requirements are:

- Cab size and layout to be confirmed for each Facility.
- Minimum cab size:
  - Minimum clear door opening of 1,300mm (4.25ft.) wide by 2,400mm (8ft.) high.
  - Clear inside cab dimension of 1,800mm (6ft.) wide by 2,500m (8.25ft.) deep by 2,900mm (9.75ft.) high.
- Minimum weight capacity: 2,268kg (5,000lbs).
- Cab finish must be durable and accommodate the use of protective padding.

.8 Provide lunar keyholes installed at each elevator door level to help expedite the rescue.

.9 Heating, cooling and ventilation requirements for the proposed elevator, are to be identified and brought forth to the mechanical consultant for design of the system. This information should be specific to the elevating devices being proposed for the project, and not general catalogue material.

GUIDANCE

.1 The guidance of an elevator consultant during the design phase, brings forth their experience and expertise to a project, that streamlines the design process as well as enabling the use of the latest technologies and bringing forth their lessons learned from previous City of Vancouver projects.

.2 The mechanical consultant should provide their heating, cooling, and ventilation calculations along with their building design calculations. Refer to the HVAC section for further details.

OBJECTIVES

.1 The purpose of this section is to identify a clear basis for garbage, recycling and janitorial in the City of Vancouver owned/operated facilities. Specific requirements for city owned and operated facilities will be found in their dedicated technical guidelines.

CRITERIA

.1 As a part of the City's Greenest City Strategy, the City of Vancouver requires all buildings to provide adequate storage for garbage and recycling. These storage areas must meet all building code regulations, and all zoning and development by-laws.

.2 Review for each Development acceptable garbage strategies: location, water, drainage, container size, type and schedule. Dedicated garbage and recycling that is appropriate to the facility use is required.

.3 Recycling, as part of the City's Green Initiative Strategy, is a requirement for all city facilities, both in individual units and for common collection. As a guideline, the suggested interior space per LEED® under Prerequisite 1, "Materials and Resources" for a commercial building of up to 465m^2 (5,000ft^2) in size is 7.6m^2 (82ft^2).

.4 Confirm expected recycling volume for each facility with city and/or operator.

.5 Include accommodation of oversize items (as required).

.6 Ensure that waste facilities align with both the recycling and organic collection programs (https://vancouver.ca/home-property-development/food-scraps.aspx).

.7 Plan for safe/suitable storage of any specialized or toxic/hazardous materials being disposed of in the garbage room prior to collection and comply with the applicable disposal requirements of the current fire by-law.

.8 The Garbage and Recycling Storage Facility Design Supplement is a tool for developers on the proper design of garbage and recycling storage facilities for both new and retrofit buildings. Refer to the City of Vancouver Developer guide to designing garbage and recycling storage facilities (https://vancouver.ca/files/cov/Garbage_and_Recycling_Storage_Facility_Supplement.pdf).

GUIDANCE

.1 Review and planning of garbage, recycling and compost is crucial for operations to assure sufficient size and location of facilities and meeting the City of Vancouver's strategic goals.

.2 Janitorial requirements will vary by project and early consultation with REFM Project Managers to determine operator requirements is required. A recommended minimum approach would be:

.3 A single janitorial space per floor of the building.

.4 At least 2.5m2 (27ft2) in area with 900mm (3ft.) clear width adjacent to mop sink for access and cart storage.

.5 Mop sink, including stainless steel surround with mop hooks located over the sink.

.6 Resilient wall and floor finishes with continuous coved junction at wall/floor interface.

.7 Electrical receptacle for floor equipment charging.

.8 Suitable storage for the size of the facility to keep and store consumables and cleaning supplies. Backflows for janitorial sinks and chemical mixing stations.

D BUILDING ENCLOSURE

BUILDING ENCLOSURE - GENERAL

.1 Building enclosure systems have changed significantly over the last few decades and are still constantly evolving. While the industry has made great strides in the performance of the building enclosure system as relates to weather control and durability, the goal in the present and the future is to continue these performance improvements, while seeking greater energy efficiency and reducing the carbon footprint of building assemblies.

.2 The intent of this guide is to construct buildings with a 100-year service life, using durable materials and solid design principles based on proven building science knowledge. However, different components of building assemblies are subject to shorter replacement cycles. This should be considered in the design so that these components to be easily replaced without disturbing the rest of the building assembly, whenever possible.

.3 This guide recognizes four categories of project types:

- Minor Renovations.
- Major Renovations.
- Minor New Builds – small areas below 500m^2 (5,380ft^2).
- Major New Builds – areas greater than 500m^2 (5,380ft^2).

.4 To align with the City of Vancouver's Sustainability Objectives all projects require Building Enclosure Commissioning in compliance with NIBS Guideline 3. In addition to commissioning, major renovations, minor and major new builds are expected to:

- Meet the Passive House energy performance standard, or an approved alternative zero emission building standard, and use no fossil fuels, in order to minimize energy consumption and GHG emissions.
- Meet a minimum of LEED® Gold Certification. Refer to the most current LEED® Canada NC, CI, or other appropriate LEED® standard.
- Calculate the life-cycle equivalent embodied carbon emissions through a whole-building life-cycle assessment (LCA) study, and identify opportunities to reduce embodied carbon emissions by 40% compared to the baseline.

- This section will be broken down into the four general components of the building enclosure system: roof, walls, fenestration, and below grade. The general design principle of the building enclosure adopted will involve adequate control of water, air, moisture and heat. This means all building enclosures must be designed with four major control layers to control corresponding elements. Maintaining continuity between the systems is paramount, while meeting criteria on each of the assemblies, as the whole building is considered a system in itself.
- Due to the involvement of detailing with many other disciplines (I.e. penetrations from other disciplines like mechanical, plumbing, electrical etc), a building enclosure professional (BEP) must be involved in the design from an early stage.
- This guide uses ASHRAE 90.1 prescriptive targets as a baseline for energy efficiency design; many projects will end up pursuing performance-based energy compliance pathways. Discuss with the prime consultant and CoV project manager to understand the energy pathway on a project by project basis. City of Vancouver is classified within climate zone 4.
- Use screens to secure enclosed spaces to avoid bird entrapment (i.e. ducts, pipes, intake and exhaust vents etc.). Ensure ventilation grates and drains have openings no larger than 20mm x 20mm (3/4” x 3/4") or 10mm x 40mm (1/2” x 1.5”), and cap ends of all open pipes.

QUALITY ASSURANCE:

.1 All projects completed for the City of Vancouver must follow the EGBC Guidelines for utilizing the Engineers stamp. This includes the BEP signing and sealing all final reports and drawings for projects ranging from small feasibility studies, tenant improvements to large new builds.

.2 Engineers must also allow for sufficient site reviews during the construction process of the building enclosure work. No additional service fees are expected by the city for any site reviews that are required by an engineer to sign off on their letters of assurance. Enhanced field reviews for building enclosure engineers are generally considered to include 1-2 site reviews per week of active exterior shell construction. Site reviews shall be accompanied by field review reports clearly outlining what was reviewed and any notable comments from the engineer.

CITY OF VANCOUVER DRAWING REVIEWS:

.1 This item applies to all projects but will have more reviews needed for larger projects. We will break this up into the following categories:

- Minor Renovations.
- Major Renovations.
- Minor New Builds – small areas below 500m^2 (5,380ft^2).

- Major New Builds – areas greater than 500m^2 (5,380ft^2).

.2 Based on those categories the following drawing reviews shall be expected by the REFM staff :

- Minor Renovations – One (1) total drawing review at 30-50% construction drawings completion.
- Major Renovations – Two (2) total drawing reviews at 50% DD phase and 75% construction drawings completion.
- Minor New Builds – Two (2) total drawing reviews at 100% SD phase and 75% construction drawings completion.
- Major New Builds – Three (3) total drawing reviews at 100% SD phase, 30-50% construction drawings and 75% construction drawings.

.3 The reviews noted above are meant to be completed by the REFM staff associated with Divisions 04 through 09 as they pertain to the building enclosure components which are over and above the project managers that conduct regular drawing reviews. The design teams are expected to take any comments provided to them by the city staff and submit clear responses to each, identifying the action taken and/or reason for the design.

OBJECTIVE:

Roofs are one of the most important components of the building enclosure due to their proximity to the natural elements. The roof will likely have the shortest lifespan of these components due to the same reasons. Therefore, it is important for the roof assembly to be constructed of durable materials. It is also the location where the most heat gain occurs, so adequate insulation is required.

This section includes guidance on low-sloped roofs as well as steep sloped roofs of different materials, with two main types of low-sloped roofs: protected membrane roof assembly, conventionally insulated roofing system, green roofs and steep sloped roofs.

.1 Protected Membrane Roof Assembly:

- This type of roof assembly is constructed with the waterproofing membrane applied directly to the supporting deck structure and is protected from the elements with insulation and overburden.
- The benefit of this type of assembly is that the most vulnerable and important component, the waterproofing membrane, is protected. Secondly, the membrane in this assembly acts as multiple control layers: weather, air and vapour. Therefore, making this an efficient and durable system and preferred where durability in the roof system is desired.

.2 Conventionally Insulated Systems:

- This type of roof assembly is constructed with the waterproofing membrane exposed to the weather and there is potential for mechanical damage. This is a common type of roofing system used in Canada due to simplicity and cost reductions. Where a Conventionally Insulated System is less durable compared to the inverted system, it provides cost savings as well as ease of construction, maintenance, and repair, as the primary waterproofing is visible.

.3 Green Roofs:

- Designers are expected to encounter the integration of energy-efficient methods and environmentally sensitive architectural innovations such as green roofs as an option in new construction to promote quality architecture and consolidate the built environment in harmony with the surrounding.
- Use green roofs where possible for new and renovation projects.

.4 Steep Sloped Roofs:

- Steep sloped roofs (greater than 100mm [4”] of rise for every 300mm [12”] of run), which make up the vast majority of Vancouver rooflines.

CRITERIA

.1 Low-sloped roofs (less than 75mm [3”] of rise for every 300mm [12”] of run), are good candidates for green roofs. Low sloped roofs shall be designed to have adequate sloping towards at the drainage plane with a minimum of 2% slope to prevent water ponding. Membranes shall be lapped positively according to slope.

.2 Low-sloped roofs shall be designed to have adequate sloping towards at the drainage plane with a minimum of 2% slope to prevent water ponding. Membranes shall be lapped positively according to slope. Per Passive House design principles, field drains in a roof area act as thermal bridges and should be avoided where possible. Consider the use of scupper drains at the perimeter of the roof areas to avoid these unnecessary thermal bridges.

.3 Low-sloped roofs shall be designed with parapets for the purpose of reducing wind pressures on the roofing members. Parapets are recommended to have a height of 1,050mm (3’6”) and are insulated or thermally broken from the building.

.4 Roofs are to be designed to achieve the project’s energy requirements and with enough insulating properties to offset the expected radiative heat gain. On restoration projects that do not require a whole building energy model, a minimum of R-30 is required. Otherwise, refer to the energy model requirements when the project is pursuing a performance-based energy compliance pathway.

.5 Roofs must be designed for wind uplift forces according to CSA 123.21. Confirm requirements with the BEP.

.6 Rooftop equipment should be installed on elevated sleepers if no penetration of the waterproofing is required. If penetrations are required, install rooftop equipment on waterproofed curbs with minimum height of 200mm (8”) above the finished roof surface.

.7 Rigid insulation used must be produced with a low Global Warming Potential (GWP) blowing agent to meet the requirements of the new Canada Environmental Protection Act. Specifically, as of January 1st, 2021, the newly implemented “Ozone-depleting Substances and Halocarbon Alternatives Regulations” (SOR/2016-137) restricts the use of products using hydrofluorocarbon (HFC) blowing agents.

.8 All roofs must be accessible from the interior of the building. Roofs with rooftop equipment requiring regular maintenance require stairway access. Roofs with rooftop equipment requiring occasional maintenance or no rooftop equipment require at minimum a ladder and a roof hatch.

.9 Roofs must be designed to restrict access by the public from the exterior. In the case of rooftops which are accessible by the general public, protection for roof-mounted assets and safe roof access are required.

.10 Membranes must be fully bonded. Preference to be by torch applying the membrane to the surface of the concrete or substrate material to help isolate potential leaks. In the case of a wood framed substrate or any other situations

where a torch applied method is not ideal nor possible, an equivalent adhesive applied system may be used.

.11 Insulation must be adhered with two-part urethane adhesive unless it will be used in a protected membrane roof assembly. In the case of a conventional roof assembly over wood frame decking, screw fasten the first layer and adhere the upper layers, thus reducing thermal bridging and eliminating washer heads at fasteners from showing through the roofing membrane.

.12 Roofing assemblies are designed to meet Guarantee Standards of the Roofing Contractors Association of British Columbia (RCABC) Guarantee Corp. (RoofStar Guarantee) as published in the "RGC Roofing Practices Manual" ("RPM") and require a minimum five (5) year RoofStar guarantee with the option to increase to ten (10) years.

.13 Provide roof edge safety barriers, roof anchors, and fall protection in accordance with the VBBL and with Worksafe BC requirements.

- Specifically, for fall protection, each project should be assessed for where and how often parts of the roof may be accessed. If all or most servicing of roof areas can occur 4m (13ft.) from the edge (control zone plus buffer zone distance) there is less need for roof edge safety barriers. If areas needing servicing are located near roof edges, then we need to consider what method of fall protection is required in consultation with City of Vancouver OHS, environmental, and maintenance staff.

.14 For the moderate to steep sloped roofs, asphalt shingles are appropriate. For all other roof designs, discuss with the City of Vancouver project manager.

.15 Where an extensive green roof is provided it must:

- Be easily removable (i.e. modular) to assist with maintenance access to the roof membrane and assembly below.
- Be minimal maintenance for weeding, fertilizing and plant replacement.
- Not require irrigation. Temporary irrigation may be set up for the first year only (but a permanent hose bib is required at the roof).
- Be self-sustaining.

.16 Roof leak detection systems are required in some project specific locations. Project teams should work with REFM project manager, to review project plans to ensure that roof leak detection plans are operationally feasible to accommodate the system, considering every new roof assembly and/or request for variance from RCABC. RCABC (Waterproofing Systems: Leak Detection & Monitoring Systems) is recommended to be used as a reference. If flood testing is required to water test waterproofing membranes, testing shall be conducted prior to installation of insulation and overburdens and be performed to ASTM D5957 - 98. Roof detection systems must:

- Be reviewed with the City of Vancouver staff. All specifications and details of the proposed system are to be provided for review and approval prior to proceeding.
- Have a non-proprietary monitoring system.
- Be compatible with, and actively connected to the city's controls systems to allow remoted monitoring of any alarms. Refer to the DDC Technical Guidelines for additional information.

GUIDANCE

.1 Materials:

- Roof Material
  - Asphalt shingles are appropriate for moderate to steep sloped roofs. Look for longer (at least 30-year) warranties on asphalt shingle roofing. Avoid products containing built-in mass inhibitors as many contain zinc, copper and other toxins that harm aquatic life, and may render water unusable for landscape or other rainwater harvest applications. Elect for manufacturers that offer up to 25% recycled content. Select light-coloured mineral top layer; dark asphalt roofs create additional unwanted heat gain during summer months, and shingles subjected to wide temperature swings do not last as long. For all other roof designs, discuss with the City of Vancouver project manager.
- Insulation:
  - The below outline is an example of a preferred product, equals or alternatives to the below are welcomed and encouraged.
  - Conventional Roof Assemblies - Horizontal application: Polyisocyanurate Insulation. Thicknesses must be as indicated on Assembly Schedule. To CAN/ULC S704-11 Type 2 and ASTM C1289-03 manufactured using HCFC-free blowing agents and integrally laminated to heavy, non-asphaltic, fiber reinforced, non-organic glass fibre facers. Maximum panel dimension shall be 1,200mm (48"). Install in two layers minimum, with joints staggered 300mm (12") between layers. Thermal Resistance Value to be minimum RSI 1.00/ 25mm (1"). Sopra-Iso by Soprema, Siplast, IKOTherm III by IKO Industries Ltd. or Energy 3 CGF by Johns Manville. Install asphalt impregnated mineral wool insulation as top layer over the polyisocyanurate to mitigate decreased cold weather performance of polyisocyanurate.
  - Protected Membrane Roof Assemblies - Horizontal Application: Extruded Polystyrene Foam Insulation. Thicknesses must be as indicated on Assembly Schedule. To CAN/ULC S701 Type 4: Thermal Resistance Value to be minimum RSI 0.87/ 25mm. Styrofoam Roofmate by Dow Chemical Canada Inc., Foamular 350 by Owens Corning. XPS to be manufactured using HCFC-free blowing agents.

- Conventional 2 Ply SBS Modified Bitumen Roof Membrane:
    - The below outline is an example of a preferred product, equals or alternatives to the below are welcomed and encouraged.
    - Preferred manufacturer: Soprema or Siplast. Alternate systems to be requested and reviewed by comparison of membrane properties, subject to approval by Consultants and Owners. Approved Siplast system: Base sheet - Paradiene 20 TG; Cap sheet - Parafor 30 TG. Approved Soprema system: Base sheet – Sopraply Base Plus P/P 3.0; Cap sheet – Sopraply Traffic Cap Plus G/P 4.0.
    - Deck Sheathing: Dens Deck Prime.
    - Air/vapour barrier: Self Adhered vapour barrier Paradiene 20 SA or Sopralene Flamstick 180.
    - Protection board: As recommended by manufacturer.
    - Drains with clamping rings (RD-100 roof drain by Watts Series)
    - Liquid Flashing: Liquid flashing is composed of a polyester fleece reinforcement encapsulated with a polymethyl methacrylate (PMMA) resin. Accepted product Parapo by Siplast. Install at dowels, bolts and all other membrane penetrations.
    - Filter fabric: as recommended by roof system manufacturer.
    - If required by REFM Staff (to be reviewed on a project by project basis): Waterproofing plies to be checked for penetrations after installation by Detec or SMT Membrane Integrity Scan.
- Conventional Single Ply Roof Assemblies:
    - Refer to RCABC guidelines for best practices. REFM to review and approve products on a project by project basis, as recommended by the BEP on the project.
- Protected 2 Ply SBS Modified Bitumen Roof Membrane:
    - Same preferred manufacturers as conventional system above. Top of cap sheet to be sanded instead of granulated. Drainage system to include drainage plane on top of membranes (either via grooved insulation or drain mat) and on top of insulation (via drain mat).
    - Insulation: Rigid XPS Insulation with HCFC-free blowing agents.
- Sheet metal flashing and trim:
    - The below outline is an example of a preferred product, equals or alternatives, such as PVDF and pre-finished aluminum, to the below are welcomed and encouraged.
    - Carbon Steel to Z275: Thickness 24 gauge or better. Finish must be prefinished steel with factory applied silicone modified polyester on primer; both paint and primer must back cured. Include paint system coating to reverse side of coil stock to prevent corrosion of backside surfaces and ensure uniform colour. Performance Level: “CSSBI S8-2008. Coating thickness must not less than 25

micrometres +/- 3 micrometres (1.0 mils +/- 0.1 mils). Product: Perspectra Plus Series.

- Fabrication: Fabricate metal flashings and other sheet metal work in accordance with applicable RCABC and SMACNA details and specifications. Metal flashings must be formed to maximum 2,400mm (8 ft.) lengths using one piece for each flashing section. Make allowances for expansion at joints. Use flat-lock folded seams for all joints and splices of thru-cavity flashings. S-lock joints may be used if all flashing surfaces are sloped greater than 3:1. Use standing seams for all joints and splices for cap flashings. Use flat-lock seams where cap flashings are accessible to occupants.

OBJECTIVE:

.1 The exterior wall system recommended by modern building science principles are exterior insulated rainscreen systems. This type of cladding system separates the water shedding layer from the weather control layer and introduces a cavity between the two layers. The exterior insulation helps to minimize the effects of thermal bridging by insulating the structure. The cavity facilitates drying when moisture penetrates the water shedding layer, providing a redundancy in the control of water penetration into the back-up wall cavity, increasing the lifespan of the wall system significantly compared to conventional face sealed systems. Additionally, the rainscreen system also allows for easy repairs and maintenance of the system.

.2 Vapour barriers are required in the City of Vancouver owned buildings and are to be located on the warm side of insulation. Do not install more than one vapour barrier or component acting as a vapour barrier within an exterior wall assembly. Continuous, fully supported air barriers are also required within all exterior wall assemblies. Air leakage through the envelope should be controlled as part of an energy efficient building enclosure design. The project sustainability targets are to be considered and followed for air leakage requirements.

.3 Air barrier components to have the following properties:

- Material air tightness: 0.02 l/s·m^2 @75Pa.
- System air tightness: 0.2 l/s·m^2 @75Pa.
- Building air tightness: 2.0 l/s·m^2 @75Pa.

.4 Except when mechanical system requirements override this requirement, the air barrier system is to have a comprehensive air tightness of 0.2 l/s·m^2.

.5 On projects pursuing Passive House standards and/or certification, review that standard for specific Passive House airtightness targets.

.6 Coordinate design with BEP.

.7 Identify air / vapour / moisture barrier system locations and all materials on drawings. Provide details showing the continuity of the air / vapour / moisture barrier systems at all joints and junctions between enclosure assemblies (windows, doors, walls, roofs, penetrations, foundations, etc.) at the building. Coordinate details of drainage, venting, insulation, and cladding of enclosure assemblies.

CRITERIA

.1 All heated occupied buildings must have an air barrier system. The air barrier must be located thermally protected in the wall assembly and must be continuous across all parts of the building. This should be illustrated by red line in the permit application package.

.2 The air barrier is to be structurally supported to resist maximum wind loads, 30-year return. This is particularly important at movement joints where wearing caused by excessive movement cycles of an unsupported membrane may fail.

.3 The air barrier shall resist cyclic deformations caused by structural or other movement at all joints.

.4 Production of a durable air barrier requires selection of durable materials and location of the air barrier within the building enclosure where it will not be rapidly deteriorated by the elements.

.5 Air barrier system shall be tested and rated in advance of construction and/or by testing in the field during construction and commissioning to check compliance with air tightness requirements.

.6 The air barrier is to be integrated with all components of the building enclosure such as walls, windows and door frames, roof, foundation, and service penetrations.

.7 The air barrier shall have a service life equal to cladding or be maintainable from inside the building.

.8 The air and vapour barriers are to be located close together in the assembly, or be of one material, if possible. Where separate air and vapour barriers are used, the air barrier on the exterior sheathing is to be vapour permeable. Any materials located between separate air and vapour barriers must be immune to moisture damage (100% inorganic).

.9 The vapour barrier is to be located on the warm side of insulation.

.10 The moisture barrier must be continuous and flashed to the exterior to prevent entry of water into the stud wall cavity.

.11 Quality Management:

- Submittals: Certification for air barrier assembly (CCMC or equivalent)
- Quality Assurance: Construct mock-up of assemblies to check contractor's procedures and test mock-ups to verify air tightness and resistance to structural loading.
- Quality Control: Test random portions of the assembly to verify air tightness.
- Whole Building Air Tightness Testing: Carry out fan depressurization testing with smoke to verify air tightness of completed building. Air tightness testing to also include positive and negative thermographic scans of building. For new construction and major renovation classification projects, whole-building pressurization testing shall be conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air leakage rate of the building envelope shall not exceed 0.40CFM/ft^2 under a pressure differential of 0.3in of water, with

this air leakage rate normalized by the sum of the above-grade and below-grade building envelope areas of the conditioned space and semi-heated space. For repair and voluntary renovation classification projects, pre-construction and post-construction tests using ASTM E779 or ASTM E1287 are required to demonstrate that the building airtightness is equal to or better than the pre-construction state.

- Cladding shall be designed to be weather tight under sustained conditions of combined wetting and 50Pa wind pressure.
- Cladding shall be designed to resist lateral and vertical deformations of the primary structure without loss of attachment to the building.
- At minimum, the overall effective R-value of exterior wall systems shall be designed to R-18 (which takes into account the thermal bridges interfacing with the opaque wall areas). Refer to energy modelling results for projects pursuing performance-based energy compliance pathways. The energy modelling requirements govern over the minimum R-value stated above when they are different.
- Cavities built behind the cladding shall be drained and ventilated to the exterior. Vent the rain screen systems with min. 19mm (3/4") capillary breaks and cross cavity flashings at every second floor minimum.
- For buildings with greater than 5-storeys, cavities behind the cladding shall be compartmentalized by adding blocking at every other floor level, beneath the parapet and at the outside corners of the building, in ways which does not compromise drainage and ventilation.
- Penetrations by structural elements, electrical, mechanical services through the building enclosure, and interfaces at windows and doors are the most common sources of service life and performance related problems with air, vapour and moisture barrier systems. Take care during design and construction to detail these interfaces in a durable fashion.

GUIDANCE (Applies to Minor Renovations Only):

.1 Air Barrier: Identify all air seal materials that form the air barrier assembly. Building Enclosure Consultant to meet with Contractor to confirm air barrier line is understood prior to start of construction. Contractor to clearly identify location and continuity of air, vapour, and moisture barrier on the drawings to the BEP during this meeting.

.2 Cladding material and their approximate corresponding service life are as follows (specify appropriate cladding materials for each project's specific service life requirements during design):

- 60-80 service year - concrete/masonry blocks, brick veneer.
- 30-40 service year - stainless steel, aluminum, Hardie composite boards, stucco

.3 Fasteners (attachment of cladding, sub-girts, flashings, etc.) located in the exterior wall cavities or exterior of the air barrier shall be of stainless steel, hot dipped

galvanized or PFVD coated with a minimum of 2,000-hours salt spray rating in accordance with ASTM B117.

.4 Vinyl siding, EIFS, and wood siding should not be considered on REFM buildings as these are not highly durable materials for these types of buildings aiming to achieve longer lifespans.

.5 Semi rigid mineral wool insulation shall be used in exterior wall cavities, and fiberglass batt or mineral wool batt insulation is acceptable for use in stud cavities.

.6 Air/Vapour Barrier Requirements (to be designed and coordinated by a BEP):

- Interior insulated rainscreen walls: install a warm side fully sealed vapor retarder.
- Exterior insulated rainscreen walls: install a min. 1mm thick self-adhered SBS modified asphalt sheet acting as both air and vapour barriers on the warm side of the insulation. Air vapour barrier to be a continuous membrane applied over exterior sheathing. Membrane to be manufactured by Soprema, Siplast, Bakor, or IKO. High quality liquid applied air barriers (vapour impermeable) are acceptable.
- Split insulated (insulation inside and outside of stud wall) rainscreen walls: Install a self-adhered sheet membrane or liquid applied vapour permeable air barrier on the exterior sheathing and a vapour retarder on the interior of the stud cavity.

OBJECTIVE:

.1 Fenestration systems design involves the following two major principles:

- The selection of the adequate fenestration components such as windows and doors, which are designed to be robust and durable systems from of the manufacturer and,
- Maintaining the integrity of the control layers at the transitions to the rest of the building envelope (installation on site).

.2 The latter mentioned above presents a unique challenge to the building envelope in the form of detailing with other building envelope components. This makes the interface between openings and the rest of the building envelope especially vulnerable and will require careful planning and integration by the design professional early in the design phase.

.3 One effective way to mitigate the risks of water leaks at fenestrations is to locate openings at recesses, or by the use of overhangs above the openings to reduce exposure. This will greatly affect the potential for water penetration at the openings. Additionally, storefront window systems are more vulnerable to water penetration and should similarly have overhangs installed above. This is defined by applying the overhead ratio per the criteria explained below.

.4 Overhead ratio is defined as the length of the overhang (distance from jamb outwards and to the side) to the height of the overhang above threshold of the door. The extent of the overhang recommended to be installed above doors and storefront windows depends on the fenestration type.

.5 If the doors and storefront windows meet the required water ingress rating (using the Canadian supplement to NAFS or based on the recommendations of the enclosure consultant for the project), the overhead ratio = 1:4.

.6 If the door and storefront window system does not meet the required water ingress rating but exceeds 100Pa and is an outswing door, then the overhead ratio = 1:2.

.7 If the doors and storefront windows cannot pass a water ingress test at 100Pa or is an inswing door, then the overhead ratio = 1:1.

.8 All city-owned buildings are required to meet the Bird Friendly Design Guidelines (https://guidelines.vancouver.ca/guidelines-bird-friendly-design.pdf). Project teams should work with REFM's Environmentatl Services team to review project design and ensure that bird friendly strategies are feasible at the early design stage and are included in alternative design options.

CRITERIA

.1 Select window frame systems utilizing exterior rain screen principles, interior air seal barriers, and cavities pressure-equalized to the exterior to minimize water infiltration into the internal areas of the system, assembled and installed to provide control and drainage to the exterior of any water which enters the pressure equalized cavities.

.2 Window systems shall use compressed gaskets as seals between frame and glazing, with the exception of structural silicone glazed curtain wall systems (SSG).

.3 Except for curtainwall systems, window frames are to be glazed with internal removable stops or using tamper proof fasteners where security is required.

.4 Air infiltration/exfiltration level: the BEP on the project shall calculate these values per NAFS and the Canadian supplement.

.5 For buildings following a performance-based energy compliance pathway, refer to the energy modelling results for maximum U-values. For buildings designed to ASHRAE 90.1: provide overall U-values and SHGC that are lower than prescriptive values for Zone 4 buildings. Maximum U-values:

- Non-metal framing US I≤ 1.76 W/m^2·K.
- Metal curtainwall/window wall USI ≤ 2.16.
- Metal windows, operable for fixed, and non-entrance doors: USI ≤ 2.61.
- Overall SHGC ≤ 0.36.

.6 Design to meet CAN/CSA-A440.4 "Window and Door Installation".

.7 All city-owned buildings are required to meet the Bird Friendly Design Guidelines (https://guidelines.vancouver.ca/guidelines-bird-friendly-design.pdf). Project teams should work with REFM's Environmentatl Services team to review project design and ensure that bird friendly strategies are feasible at the early design stage and are included in alternative design options.

GUIDANCE

.1 Sealed insulated glazing units to have a 10-Year warranty, minimum.

.2 Frame materials to be selected for a minimum 40-year service life with a minimum 10-year warranty.

.3 Acceptable frame materials include:

- Thermally broken aluminum.
- Fiberglass where permitted by code may be specified provided it meets a minimum performance class and grade of CW 45 in accordance with NAFS.

- PVC windows, certified to AAMA 303 may be considered for buildings of less than 6-storeys in height, and where permitted by building code, provided they meet a minimum performance class and grade of CW 45 in accordance with NAFS.

.4 Frame coatings: Aluminum AAMA 2603 for interior coatings, AAMA 2604 for exterior coatings in high traffic areas for greater abrasion resistance, AAMA 2605 for exterior exposed coated surfaces.

.5 Anodized finishes to conform to AAMA 611 or AAMA 612 (clear coated anodized finish).

.6 All materials should be shop fabricated and finished with no field cutting of materials allowed.

.7 All windows to be installed over a waterproofed sub sill pan that covers the entire underside of the window up to the air seal line.

.8 Sills at service doors to be a minimum 100mm (4”) above finished grade surfaces and be serviced by ramps to grade if required to be accessible.

.9 Sills at main public access doors and at exit doors must be located flush with exterior walkways. Provide drainage and full waterproofing of the sill of the door. Provide adequate drainage on site to prevent ponding of water adjacent to doors.

OBJECTIVE

.1 While the building is hidden below grade and out of sight, it is critical to incorporate the same control layers at this location. At below grade, the building is in close contact with soils - which can be wet and cold, making the building vulnerable heat loss via conduction, as well as potential water penetration through hydrostatic pressures built up in the soil.

.2 The intent is to deal with this by designing a good waterproofing, and drainage and thermal barrier system to be installed on the building face which comes in contact with soils. With an adequate drainage layer, we can minimize hydrostatic pressure which will greatly reduce the building's exposure to water. The BEP should seek to understand the hydrostatic pressure that will act on below grade walls of a building and design the below grade waterproofing system accordingly.

.3 Designing to minimize thermal bridging is also critical below grade. A major portion of heat loss can occur below grade because of potential heat loss due to conduction. Ensuring a continuity wherever possible below grade will be paramount in the thermal performance of the building.

.4 Coordinate design with BEP.

CRITERIA

.1 Testing of permeability, bond strength, and material thickness will be carried out by the owner at his expense. Applicator to provide material submittal and drawings showing any deviation from RCABC waterproofing standards.

.2 Quality Control:

- Contractor to test moisture content of concrete substrate to verify that substrate moisture content does not exceed manufacturer's specifications.
- Submit results to consultant prior to application of membrane.
- EFVM scans are to be performed prior to installation of overburden.

.3 Warranties and Guarantees:

- First two years - Guarantee, secured by performance bond, commencing on the final holdback release due date.
- Third year to fifth year - Extended guarantee, unsecured by Bond, commencing on the expiration of the performance bond. Joint and sealant guarantee by coating applicator and manufacturer.
- Horizontal waterproofing: 5-year RCABC waterproofing warranty and detailing with the option to increase to ten (10) years; 10-years manufacturer material warranty. These warranties only apply to horizontal applications or projects with hydrostatic conditions, RCABC does not cover vertical waterproofing of foundation walls. In the case that a 5-year RCABC

waterproofing warranty is provided the performance bond and extended guarantee are not required.

- Submit the RCABC RoofStar “Roofing Assignment and Guarantee Request” sheet with all roof guarantee certificates.
- Submit signed certificates to consultant.
- On projects with higher hydrostatic pressure: a 5- to 10-year manufacturer’s guarantee is required. Discuss with CoV project manager.

GUIDANCE

.1 For buildings designed to ASHRAE 90.1: Provide overall U-values that are lower than prescriptive values for climate zone 4 buildings.

.2 For buildings following a performance-based pathway: refer to energy modelling report for U-value requirements of assemblies.

.3 Vertical below-grade waterproofing:

- Cast-in-place Concrete wall: 1-ply 3mm thick minimum thermofuse SBS sheet plus drainage board.
- Blind-side Form Wall: 1-ply self-adhesive 3mm thick minimum thermofuse SBS sheet plus drainage board.
- High risk occupancy: 2-ply 3mm thick minimum SBS sheet membrane plus drainage board. The City of Vancouver’s preference for sites with high hydrostatic conditions is cast in place concrete foundation walls instead of shotcrete. Architect to review this with the project’s structural engineer of record.

.4 Horizontal below-grade waterproofing:

- Low slope application under landscaping: minimum 2-ply thermofusible SBS sheet membrane plus drainage board.
- Low slope application under hard landscaping including concrete topping: 3-ply thermofusible plus drainage board.
- Root barrier to be provided at all landscaped areas in accordance with system manufacturer’s recommended root barrier.

.5 Drain bodies require clamping ring to receive membrane.

.6 Membranes under landscaping require access for maintenance and replacement. Membranes are not to be buried under cast-in-place concrete except as absolutely necessary at sidewalks and driveways. Pavers or other material that can be removed and re-used for hard landscaping is preferable.

.7 For soft landscaping (plants etc.) over membranes use materials that can be removed with light excavation equipment and be disposed of. More valuable plants can be placed in movable planters.

.8 Membranes should be fully bonded to the surface substrate to help isolate leak locations.

.9 The system must be able to withstand active cyclical crack movement to a maximum of 1.5mm and remain waterproof.

OBJECTIVE:

.1 The following specification sections are intended to guide the discussion within design teams when they are defining the products to be included in the basis of design. The products listed below are widely used on City of Vancouver buildings and have historically been widely available when the city's facility operators and maintenance teams need to source them. Alternative products are acceptable, especially as new products are developed and manufactured more locally. Design teams should discuss the basis of design products with the City of Vancouver's project manager during early stages of design to provide an excellent specification package for each and every project.

SECTION 06 10 00: ROUGH CARPENTRY

.1 Wall sheathing: Douglas fir plywood to CSA O121 with applicable grade stamp. 19.0mm thick, standard construction. Vendor must be FSC Chain of Custody certified. Product must carry an FSC Claim (FSC MIX, FSC Recycled, FSC 100%).

.2 Metal wall cladding sheathing: Exterior grade douglas fir plywood to CSA O121 with applicable grade stamp. Borate preservative treated in accordance with CAN/CSA 080 using "Advance Guard" borate-pressure treatment.

.3 Exterior wood battens: Douglas fir species. Standard grade to NLGA, Paragraph 122c. ACQ-C or CCA preservative treated in accordance with CAN/CSA 080. Materials to be kiln-dried after treatment.

.4 Fasteners: Fasteners must be stainless steel or double hot-dipped galvanized to meet ASTM A-153.

SECTION 07 17 00: BELOW GRADE DAMPPROOFING

.1 Below Grade Dampproofing – E.Proformance Wall by epro, E.Protect+ by epro, Henry Bakor 700-01, or Insulmastic -7102 reinforced at cracks.

SECTION 07 13 00: BELOW GRADE SHEET MEMBRANE WATERPROOFING

.1 Waterproofing – Colphene Flam 180 or Colphene BSW (V or H) Plus by Soprema, depending on foundation wall construction, or approved alternate.

.2 Drainage mat: Sopradrain by Soprema, Delta-Drain 6000 HI-X by Consella Dorken or approved alternate.

SECTION 07 21 13: BOARD INSULATION

.1 Below grade vertical application: Extruded Polystyrene Foam Insulation. Thicknesses as indicated on assembly schedule. To CAN/ULC S701 Type 4: Thermal Resistance Value to be minimum RSI 0.87/25mm (1”). Styrofoam SM by Dow Chemical Canada Inc., Celfort 300 by Owens Corning. XPS to be manufactured with HCFC-free blowing agents.

.2 Below grade horizontal application (high load vehicle area compressive strength min 690kPa – Project specific compressive strength to be confirmed by the project’s structural engineer): Extruded polystyrene foam insulation. Thicknesses as indicated on assembly schedule. To CAN/ULC S701 Type 4: Thermal Resistance Value to be minimum RSI 0.87/25mm (1”). Styrofoam HI-100 by Dow Chemical Canada Inc., Foamular 1000 by Owens Corning. XPS to be manufactured with HCFC-free blowing agents.

.3 Interior horizontal application (compressive strength min 275 kPa – Project specific compressive strength to be confirmed by the project’s structural engineer: Extruded Polystyrene Foam Insulation. Thicknesses as indicated on assembly schedule. To CAN/ULC S701 Type 4: Thermal Resistance Value to be minimum RSI 0.87/25mm (1”). Styrofoam HI-40 by Dow Chemical Canada Inc., Foamular 400 by Owens Corning. XPS to be manufactured with HCFC-free blowing agents.

.4 Above grade vertical application Extruded Polystyrene Foam Insulation. Thicknesses as indicated on assembly schedule. To CAN/ULC S701 Type 3: Thermal Resistance Value to be minimum RSI 0.87/25mm (1”). Styrofoam CavityMate by Dow Chemical Canada Inc., Celfort 200 by Owens Corning. Shiplap edges. XPS to be manufactured with HCFC-free blowing agents.

.5 Above grade vertical wall application: Rigid mineral wool board insulation. Thicknesses as indicated on assembly schedule. To CAN/ULC S702 Type 1: Thermal Resistance Value to be minimum RSI 0.70/25mm (1”). Comfortboard 110 Insulation by Roxul Inc. or approved alternate.

.6 Horizontal application: Polyisocyanurate Insulation. Thicknesses as indicated on Assembly Schedule. To CAN/ULC S704-11 Type 2 and ASTM C1289-03 manufactured using HCFC-free blowing agents and integrally laminated to heavy, non-asphaltic, fiber reinforced, non-organic glass fibre facers. Maximum panel dimension shall be 1219mm (48”). Install in two layers minimum, with joints staggered 300mm (12”) between layers. Thermal Resistance Value to be minimum RSI 1.00/25mm (1”). Sopra-Iso by Soprema, Paratherm Polyiso Boards by Siplast, IKOTherm III by IKO Industries Ltd. or Energy 3 CGF by Johns Manville.

.7 Exterior horizontal application: Extruded Polystyrene Foam Insulation. Thicknesses as indicated on assembly schedule. To CAN/ULC S701 Type 4: Thermal Resistance Value to be minimum RSI 0.87/25mm (1”). Styrofoam Roofmate by Dow Chemical Canada Inc., Foamular 350 by Owens Corning.

SECTION 07 21 29: SPRAY URETHANE FOAM INSULATION

.1 EW4 CIP concrete with internal insulation: Spray-Applied Polyurethane Foam Insulation: ULC certified sprayed/frothed rigid closed cell foam to CAN/ULC S705.1 with properties indicated below and meeting National Research Council (NRC) requirements for a type III air barrier. Heatlok 0240 insulation by Demilec Inc., Walltite Eco v.3 by BASF Canada, JM Corbond III by Johns Manville.

.2 Thermal Resistance (aged) must be minimum RSI 1.0 per 25mm and the total spray resistance value must be as shown on Drawings.

.3 Work of this section must be covered by the third-party warranty provided under the manufacturer's quality assurance program.

SECTION 07 27 13: MODIFIED BITUMINOUS SHEET AIR-VAPOUR BARRIER

.1 The air vapour barrier must be a continuous membrane applied over exterior sheathing. 1mm thick self-adhesive membrane: Manufactured by Soprema, Bakor, IKO or approved alternate manufacturer. Fluid applied air vapour barrier membrane: Bakor Airbloc 32 or 33 or approved alternate.

.2 The transition membrane to perimeter tie-ins: Protectowrap Jiffyseal 140/60, or Soprema Flamstick 180, or for foil faced membrane applications: Protectowrap PS45 Aluminum self-adhered foil faced sheet membrane.

SECTION 07 52 11: SBS MODIFIED BITUMEN ROOF MEMBRANE - CONVENTIONAL

.1 Roofing membranes to be 2 Ply SBS modified bitumen for low slope roofs. Preferred manufacturers: Siplast or Soprema.

.2 Deck Sheathing: Dens deck prime.

.3 Air/vapour barrier: As recommended by manufacturer.

.4 Protection board: As recommended by manufacturer.

.5 Drains with clamping rings: RD-100 roof drain by Watts series, sized for the roof area.

.6 Liquid Flashing: Liquid flashing is composed of a polyester fleece reinforcement encapsulated with a polymethyl methacrylate (PMMA) resin. Accepted product: Parapo by Siplast. Install at dowels, bolts and all other membrane penetrations.

.7 Filter fabric. As recommended by manufacturer.

SECTION 07 62 00: SHEET METAL FLASHING AND TRIM

.1 Carbon Steel to Z275 must be a thickness of 24 gauge or better. Finish must be prefinished steel with factory applied silicone modified polyester on primer, both paint and primer back cured. Include paint system coating to reverse side of coil stock to prevent corrosion of backside surfaces and uniform colour. Performance Level: "CSSBI S8-2008. Coating thickness not less than 25 micrometres +/- 3 micrometres (1.0 mils +/- 0.1 mils). Product: Perspectra Plus Series.

.2 Fabrication: Fabricate metal flashings and other sheet metal work in accordance with applicable RCABC and SMACNA details and specifications. Form to maximum 2,400mm (8ft.) lengths using one piece for each flashing section. Make allowance for expansion at joints. Use flat-lock folded seams for all joints and splices of thru-cavity flashings. S-lock joints may be used if all flashing surfaces are sloped greater than 3:1. Use standing seams for all joints and splices for cap flashings. Use flat-lock seams where cap flashings are accessible to occupants.

SECTION 07 92 00: JOINT SEALING

.1 Joint sealants: 2 component urethane with primer, typical product Sonneborn 'NP2', Sikaflex2. Architect to select colour based on wet and dry finish colour.

.2 St Structural sealant: DOW 795 or 983 silicone sealant, Tremco Spectrum 2. To be specified by the structural engineer on the project.

SECTION 08 44 13: ALUMINUM CURTAIN WALL

.1 Curtain wall aluminum framing and aluminum cladding shall incorporate a pressure equalized rain screen system with complete air and weather seals, allowing any water entering the framing to drain to the exterior and allow air into the pressuring chamber to provide nearly instantaneous pressure equalization.

.2 Anchorage shall be designed to accommodate all thermal, seismic and building movements without any harmful effect to the curtain wall including glass and glazing and sealant applications.

.3 Design Criteria:

- Air Tightness: in accordance with ASTM standard E283 at a pressure differential of minimum 300Pa.
- Water Tightness: in accordance with ASTM standard E331 at a pressure differential of minimum 700Pa.
- U Value (Frame and Glass): < 2.0W/m^2K. To be confirmed by energy compliance pathway requirements.
- U Value (Glass): < 0.300 w/m^2K. To be confirmed by energy compliance pathway requirements.

- Shading Coefficient: 0.62 – 0.68. To be confirmed by energy compliance pathway requirements.
- Visual Light Transmission: 0.72 – 0.76. To be confirmed by energy compliance pathway requirements.
- Low E on surface #2 for double glazed IGUs.
- All units: Argon filled.
- Approved Manufacturers: RAICO, Kawneer, Alumicor, OldCastle.
- Accessories: PVC anti-rotation blocking. XPS insulation not permitted.
- Aluminum Doors: Kawneer Style 240 Series or approved alternative.

SECTION 09 22 00: FURRING AND LATHING

.1 Backer board: Three ply laminated sheet constructed of a corrugated asphalt kraft building paper centre faced each side with building paper, nominal thickness of 3mm (nom). Hal-Tex Rainboard by Hal Industries Inc. or High Density polyiso coverboard 6mm thick, ASTM1282 Type II Class 4.

.2 Stucco stops: 0.62mm (24 gauge) galvanized plaster stop complete with pre-drilled weep holes. Acceptable Products: “J” Moulding – No. JPM-75 by Fry Reglet Corporation.

.3 Square nose plaster stop by Bailey Metal Products Ltd.

.4 Vertical expansion joints: Back-to-back stucco stops spaced 6mm (1/4”) apart, complete with backer rod and caulking.

.5 Horizontal expansion joints: 0.45mm (26 gauge) galvanized expansion joint with perforated legs. Acceptable Product: No. 90 solid wing expansion joint by Bailey Metal Products Ltd.

.6 Tie wire: 1.22mm (18 gauge) diameter zinc coated annealed steel wire.

.7 Metal Lath Vertical surfaces: self-furring galvanized welded wire mesh, 1.62mm x 50mm x 50mm (16 gauge x 2”x2”).

.8 Metal Lath Horizontal surfaces (soffits): expanded sheet steel, galvanized high ribbed lath, sized to suit support spacing.

.9 Reinforcement mesh: expanded sheet steel, 150mm (6”) strip galvanized diamond mesh. Outside corners: 0.45mm (26 gauge), galvanized expanded wing corner beads with 65mm (2½”) minimum perforated legs. Acceptable Products: Corner Key - No. PCM-75-75 by Fry Reglet Corporation, Expanded Wing Corner Bead by Bailey Metal Products Ltd. Inside corners: 0.45mm (26 gauge) galvanized diamond mesh with 75mm (3”) minimum perforated legs. Acceptable Product: Safety Edge Cornerite by Bailey Metal Products Ltd.

.10 Fasteners for stucco backer board, lath and trim: Staples: 1.62mm (16 gauge) hot-dipped galvanized or stainless steel, sufficient length to penetrate 25.4mm (1") minimum into wood stud framing. Fasteners: #12- 14 x 12.5mm (1/2") long stainless steel 300 series screws. Acceptable product: I.C.H. Traxx self-drilling, self-tapping metal screws. Or Leland DT2000 coated fasteners.

.11 Insect screens at base of walls at grade: perforated vinyl and black nylon or fibreglass insect screen mesh.

.12 Soffit fire dampers: Acceptable Product: Series 8 steel egg-crate grilles by E.H. Price with "Ruskin UL classified ceiling fire dampers", Model No. CFD2 with fusible links for 3/4 hour FRR.

.13 Soffit vents: 65mm (2½") minimum perforated vinyl vents. Acceptable Products: Soffit Vent – No. PCS-75-V-250 by Fry Reglet Corporation.

.14 Zinc-rich paint: Zinga. Two coats for severe environments. Overcoat with urethane topcoat.

.15 Locate expansion joints at points where building movement is anticipated and as defined by the consultant.

SECTION 09 24 00: STUCCO

.1 Mix stucco in accordance with AWCC standard specification.

.2 Stucco Base Coat: Acceptable Products: Base Coat Stucco – Pump Grade (Reinforced) by Quikcrete, Fibre Base Coat by SpecMix. Proportioning: to Manufacturer's requirements.

.3 Acrylic Finish Coat Primer: factory premixed proprietary product delivered in liquid form in factory sealed containers, requiring liquid colorant as only site additive. Acceptable Products: Colour Prime by Dryvit Systems Canada, Imascoprime by Imasco Minerals Inc.

.4 Acrylic Finish Coat Materials: factory premixed proprietary product comprised of silicone enhanced acrylic polymer or mix of acrylic modified polymers delivered in liquid form in factory sealed containers, requiring liquid colorant as only site additive. Acceptable Products: DPR Acrylic Finish by Dryvit Systems Canada, Flexcoat Acrylic Finish by Imasco Minerals Inc.

.5 Liquid Bonding Agent: vinyl polymerization types capable of bonding cementitious material immediately after application and drying. Completely free from any tendency to harden or craze-crack. Unaffected in temperatures ranging from –30°C to 140°C (85°F - 284°F). Non-toxic and incombustible. Minimum tensile strength of 600 psi (depending upon nature of materials bonded together). Minimum sheer strength of 175 psi when properly cured.

.6 Apply stucco coats to achieve thickness stated in AWCC Standard with the following minimum values. Scratch coat: 9.5mm (3/8”) minimum. Brown coat: 9.5mm (3/8”) minimum. Acrylic coat: 9.5mm (1/8”) minimum.

.7 Cure times to meet or exceed the following: Scratch coat: 7-days minimum. Brown coat (Sto Primer): 28-days minimum. Brown coat (HotPrime): 10-days minimum.

WHOLE BUILDING AIRTIGHTNESS PERFORMANCE VERIFICATION TESTING

.1 Whole building airtightness testing must be conducted in accordance with the EN13829 standard by an independent testing provider designated by the owner. Testing must achieve a maximum of 0.6 air changes per hour at 50Pa pressure (ACH50) in both pressurized and depressurized states.

.2 All coordination with the testing provider is the responsibility of the contractor. The contractor must ensure adequate notice is provided to all parties prior to scheduling testing.

.3 The testing provider must distribute written results of all tests within three days of testing completion.

.4 Testing:

- Testing Stage 1: In-Situ Performance Testing:
  - Throughout the progress of the project and at the discretion of the Owner, airtightness testing may be completed.
  - In-situ testing shall be completed to verify compliance with airtightness performance requirements.
- Testing Stage 2: In-Situ Final Performance Testing
  - At final completion, project airtightness testing must be completed.
  - In-situ testing shall be completed to verify compliance with airtightness performance requirements.
- Re-Testing Requirements
  - All re-testing shall be completed by the testing provider selected by the owner.
  - Should testing reveal a failure with the building performance or poor installation, re-testing and passing of the verification testing shall be completed at the cost of the contractor. The contractor shall provide written clarification of the cause of the failure and propose a recommendation to ensure performance requirements are met for all re-work and future works. Further testing will not be scheduled until written confirmation is received by all parties. Any proposed modifications must be reviewed and accepted by the consultant and the owner.

E MECHANICAL

E MECHANICAL

INTRODUCTION

.1 The mechanical divisions are some of the most critical sections related to energy consumption within new and existing buildings, as well as maintenance issues that arise due to design decisions made by the design team. The following is intended to be used to guide the design team through common decisions and issues and ensure that the REFM team at the city has proper input at the correct times.

.2 The following sections are general in nature and apply to the mechanical discipline as a whole. They are meant to apply to any project size or project type being undertaken with the City of Vancouver.

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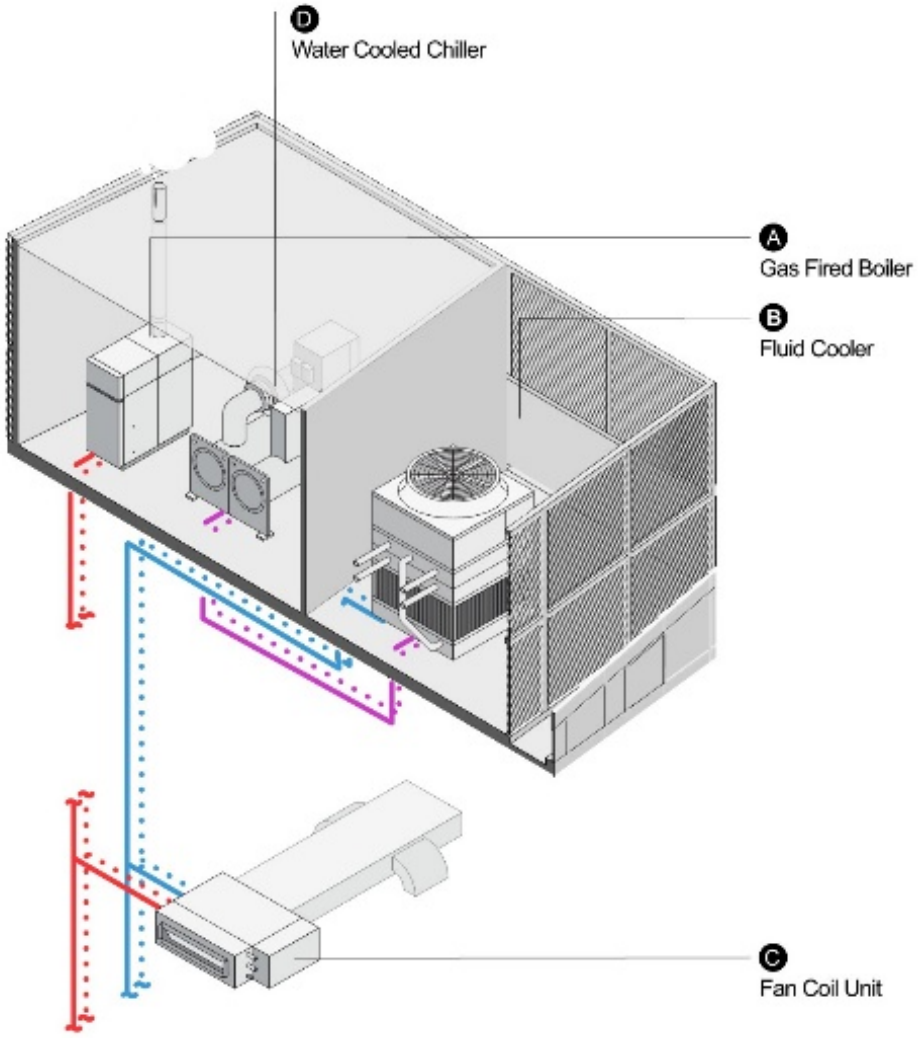


Photo credit: AME Group - Mechanical System Schematic Design

PROJECT COORDINATION

.3 It is expected that coordination with all disciplines continues throughout the design of any project, large or small, or throughout the writing of any study. The following must be considered throughout design related to this coordination but is in no way an exhaustive list of coordination expectations. These items are meant to help limit obvious issues noted by the city staff:

- 277V or 460/480V power may not be used for any mechanical equipment unless written approval is provided by the REFM staff.
- The mechanical consultant is expected to provide a clear motorlist on their drawings that clearly shows the electrical elements and coordination required by Division 26.
- Major structural elements must be shown on mechanical plans and are to be clearly labelled.
- All louvers required for active mechanical ventilation must be shown on mechanical plans with the required size. Notes clearly identifying whether they provided by the mechanical trade or are part of the cladding systems must be provided.
- Mechanical drawings must be completed with layout plans that show equipment removal pathways or access intent. It must be clear that the design has considered replacing major mechanical equipment and how it is meant to be done.
- For any project completed using Revit, the mechanical consultant is responsible for showing clash detection reports done in-house prior to the completion of the design, with no major clashes with other disciplines.
- Mechanical drawings must be completed with layout plans that show the locations of access panels/doors that are required for service access. The location of access panels/doors must be coordinated with the architect.
- For new construction: Mechanical rooms shall be located on the ground level/floor with double door access to the exterior of the building for ease of maintenance and equipment replacement. Written permission by the CoV mechanical engineer is required for mechanical rooms that will not be located at the ground level/floor.
- Integrated testing of mechanical systems interconnected with fire alarm systems must be performed to CAN/ULC S1001. Provide integrated testing worksheets and results, for future use. Systems must be commissioned by Integrated Testing Authority separate and independent and not contracted by the Fire Alarm verification contractor. Owner's representative shall be invited to witness the 1-year testing and subsequent testing required by the standard.

NOTE

This list may change over iterations of this standard and designers are expected to clearly review the version applicable to their project for the latest expectations.

The noted items are common items that affect future operations and maintenance of REFM facilities.

CITY OF VANCOUVER DRAWING REVIEWS

NOTE

The reviews noted are meant to help staff understand maintenance at City Operated facilities, push designs to be more manageable, and ensure that the design teams are accountable to the comments that they receive.

.1 This applies to all projects, but more reviews will be necessary for larger projects. Should the CoV not provide any feedback to the consultants in a reasonable time, it is assumed that there are no comments of consequence, and the consultants should not wait to continue with the design. Should the city staff provide comments after a reasonable time, the consultants must respond to the comments in writing.

.2 This section will be broken up into the following categories:

- Minor Renovations.
- Major Renovations.
- Minor New Builds – small areas below 500m^2 (5,380ft^2).
- Major New Builds – areas greater than 500m^2 (5,380ft^2).

.3 Based on those categories REFM staff expect the following drawing reviews:

- Minor Renovations – One (1) total drawing review at 30-50% construction drawings completion.
- Major Renovations – Two (2) total drawing reviews at 50% DD phase and 75% construction drawings completion.
- Minor New Builds – Two (2) total drawing reviews at 100% SD phase, 75% and 95% construction drawings completion.
- Major New Builds – Three (3) total drawing reviews at 100% SD phase, 30-50% construction drawings, 75% and 95% construction drawings.

.4 The following must be provided at the 75% drawing review:

- Equipment schedules,
- Complete system schematics,
- Pipe/ductwork sizing clearly shown,
- Sections shown through busy areas and corridors,
- Equipment clearance and servicing shown,
- Specifications and controls sequences.

.5 The reviews noted above are meant to be completed by the REFM staff associated with Divisions 21 through 25. The design teams are expected to take any comments provided to them by the city staff and submit clear responses to each, identifying the action taken and/or clarifying the reason for the design as it exists.

NOTE

The intent of this is to reduce wait times for replacement of failed parts, reduce costs for delivery and will allow the city to stock parts and equipment that require regular replacement or servicing.

It also allows the city to depend on local vendors, service and parts companies for expertise and service calls.

LOCAL WHERE POSSIBLE

.1 Any equipment that requires regular maintenance or servicing over the life of a building, including monthly, yearly, or failure end of life replacement parts must be locally sourced, where possible.

.2 For existing facilities, where existing stock or equipment is locally serviceable or sourced, equipment should match the base building in order to limit requirements for storage or replacement parts on site or at city works yards.

RECORD DRAWINGS

.1 The mechanical consultant is responsible for providing complete Final Design Drawings and Record drawings to the city upon completion of the project, as well as a complete set of PDF and CAD files/Revit model files of the record drawings.

.2 The consultant has the option to require the mechanical contractor to help complete record drawings for the project, but it is the responsibility of the consultant to ensure that the work is completed and provided to the city as a complete set of drawings.

.3 The above clarifies the responsibilities for any project.

.4 For definition of Final Design Drawings and Record Drawings, refer to EGBC.

OPERATION AND MAINTENANCE (O&M) MANUAL

.1 The Operation and Maintenance (O&M) manual should contain the following information:

- Table of content,
- Project address,
- Date of substantial completion,
- Contact info of all contractors,
- Contact info of all suppliers,
- Letters of assurance (including all Supporting Professionals),
- Operating permits (e.g. Electrical, elevating devices, boilers and pressure vessels, refrigeration plants, etc...),
- Licensing sign-offs (e.g. childcare, kitchen, etc...),
- Final inspection reports by authority having jurisdiction,
- Warranty letters and certificates (including all sub-contractors and manufacturers),
- Extended equipment warranties,
- Description of systems,

- Operating instructions of systems and components,
- Maintenance, lubrication and troubleshooting instructions, including all preventative maintenance and lubrication requirements and schedules,
- Approved shop drawings,
- Equipment start-up reports,
- 3rd party commissioning reports,
- Spare part lists,
- Integrated fire and life safety testing worksheets (S1001),
- Records drawings,
- Final design drawings
- Mechanical - Room-by-room calculated heating and cooling load in a table format,
- Mechanical - Room-by-room outdoor air ventilation calculations in table format,
- Mechanical - testing, adjusting and balancing (TAB) reports,
- Mechanical - pressure test reports,
- Mechanical - backflow inspection report,
- Mechanical - domestic water chlorination report,
- Mechanical - heat trace megger test report,
- Mechanical - final equipment schedule (as-built),
- Mechanical - valve tagging list, including service and location,
- Mechanical - duct cleaning letter,
- Mechanical - chemical treatment letter (Hydronic Piping),
- Mechanical - itemised fire damper drop test report,
- Mechanical - filter list and schedule,
- Fire Protection - fire safety plan,
- Fire Protection - firestopping installation letter,
- Fire Protection - fire pump startup report,
- Fire Protection - above ground material test reports,
- Fire Protection - below ground material test reports,
- Fire Protection - hydraulic calculations,
- Fire Protection - backflow inspection report,
- Fire Protection - heat trace megger test report,
- Fire Protection - heat tracing insulation letter (FPER),
- Fire Protection - NFPA 25 (spk maint.) copy.

.2 Refer to an O&M checklist sample in **Appendix G**.

ENERGY GRANT APPLICATIONS

.1 The consultant team is expected to advise the CoV staff of any funding opportunity through energy efficiency grants or similar, at the outset of any design project. These can include grants for replacing gas-fired rooftop units (RTUs) with electric only heat pump RTUs, up to new building electrification incentive programs through BC Hydro or FortisBC.

.2 Consultants are not expected to complete all the work associated with funding opportunities without additional compensation. This will be worked out between the city and the consultant team based on available programs, or unless it was noted within the RFP to the consultants for the project in question.

.3 As funding programs change, the city looks to its consultant teams to help them navigate these complexities and advise when design decisions could help drive funding availability.

NOTE

To meet the City's Climate Emergency Response and Green Operations Plans, these two items are critical to achieving those goals and both can have significant impacts to the GHG emissions over the life of a facility.

GENERAL SUSTAINABILITY GOALS BEYOND CERTIFICATIONS

.1 Refrigerant Management:

- To meet the City of Vancouver's Green Building Policies, select low global warming potential (GWP) refrigerants for all equipment. Consultants must consider the options available and utilize systems that have a proven track record and limited GWP during the implementation of any refrigeration equipment.
- Systems using CO_2 for heating or domestic hot water production are preferred options compared with those containing HCFCs.
- Costs and local support for equipment must be considered when finalizing selections to limit the need for over-seas parts and long lead times for critical repairs.

.2 Zero Emissions Heating and Domestic Hot Water:

- In alignment with the City of Vancouver's Climate Emergency Response Plan and the Green Operations Plan, all new buildings associated with the City of Vancouver must utilize zero emissions system solutions for the primary building heating systems and domestic hot water (DHW) heating systems. Where possible, technology used must have locally sourced parts for repairs and be product that has been used in the Lower Mainland on previous projects. This includes facilities such as low-income housing, libraries, pools and community centres, civic centres etc. Deviating from this requires approval from the City of Vancouver.
- In addition to the above, and where possible, zero emissions heating and DHW systems must be used to replace aging infrastructure in primary plant replacement projects. If not possible, the design team must show why it cannot utilize a zero emissions system for such replacements prior to moving forward into design. This may be due to limited electrical infrastructure, or space constraints that cannot support such systems.

OBJECTIVE

.1 The intent of this section is to outline the requirements of the mechanical consultant to complete and advise the City of Vancouver REFM staff on their thermal comfort analysis, and to provide guidance on thermal zoning to the design team. This must be done for both new build and major renovation projects.

.2 For minor renovations, zoning diagrams are required to identify the control zones, but thermal comfort calculations as identified below are not required.

CRITERIA

.1 A thermal zoning diagram showing thermal zones must be created for any project. This should be completed during the preliminary design stage and provided to the City of Vancouver for distribution to REFM for their comment.

.2 For renovations projects:

- Worst case thermal comfort calculations must be performed in accordance with the ASHRAE 55 standard (as referenced in the VBBL), for a number of worst case zones around the perimeter for both summer and winter months. These must be provided to the City of Vancouver for their records and should the city request additional spaces to be modelled, this must be completed by the engineer.

.3 For any building type:

- The mechanical consultants must complete a full building thermal comfort model that shows compliance with ASHRAE 55, using the latest 2050 weather files approved by the City of Vancouver.
- Cooling must be provided for all occupiable spaces.

.4 HVAC outdoor design condition (new and renovation projects) should be based on the VBBL 2019 Table C-2:

- Winter Design Temperature: 'Vancouver General' – January 1% : -8°C (17.5°F).
- Summer Design Temperature: Vancouver 2050s: 32°C DB/24°C WB (90°F DB/75°F WB).

.5 For occupiable spaces, the heating system must be able to maintain a minimum room temperature of 19°C (66°F) when the outdoor temperature is -15°C (5°F).

.6 Summary of heating and cooling load calculations (room by room level breakdown) shall be provided to the City of Vancouver for review and record-keeping purposes.

.7 Specific indoor design temperature requirement:

- Gym: Cooling indoor set point at summer outdoor design temperature: 19°C (66°F).

- Weight training room: Cooling Indoor Set Point at Summer Outdoor Design Temperature: 19°C (66°F).
- Multi-Purpose Room: Cooling Indoor Set Point at Summer Outdoor Design Temperature: 22°C (72°F).

.8 When a facility is designated as a warming centre (new or existing building), the HVAC should be designed to meet the following:

- Outdoor temperature: -15°C DB (5°F). The coldest temperature the city has recorded in 54 years is -15.3°C on December 27, 2021.
- Indoor temperature is to be maintained at 21°C DB/14.5°C WB (70°F DB/58°F WB) at 50% RH.
- Ventilation system shall be designed for the maximum occupancy capacity.
- If an air source heat pump systems is used as the primary heating source, a backup heating source (such as electric boiler) shall be provided.

.9 When a facility is designated as a cooling centre (new construction), the HVAC shall be designed to meet the cooling demand at the following condition:

- Maximum occupancy capacity.
- Outdoor temperature: 35°C DB/25.6°C WB (95°F DB/78°F WB).
- Indoor Temperature to be maintained at 24°C DB/16.8°C WB (75°F DB/62°F WB).
- Ventilation system should be designed to maintain indoor CO_2 concentration to not exceed 700ppm above outdoor CO_2 level at max occupancy capacity.

.10 When a facility is designated as a cooling centre (existing building retrofit), the HVAC shall be designed to meet the cooling demand at the following condition:

- Maximum occupancy capacity
- Consultant should evaluate equipment sizing based on the following outdoor air conditions:
  - Outdoor temperature: 35°C DB/25.6°C WB (95°F DB/78°F WB).
  - Outdoor temperature: 32°C DB/24°C WB (90°F DB/75°F WB).
- Indoor Temperature to be maintained at 24°C DB/ 16.8°C WB (75°F DB/62°F WB).
- Ventilation system should be designed to maintain indoor CO_2 concentration to not exceed 700ppm above outdoor CO_2 level at max occupancy capacity.

.11 Cleaner Air Space:

- Temperature should be kept below 26°C (79°F) preferably between 21°C (70°F) and 24°C (75°F).
- Relative humidity should be kept between 35 and 50%.

- PM2.5 should be kept as low as possible. Indoor levels should be lower than outdoor levels.
- Carbon monoxide (CO) should be kept below 10 ppm.
- Carbon dioxide (CO_2) should be kept below 1000 ppm.
- Other pollutants such as nitrogen oxides (NO_x), polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs), should also be kept as low as possible.
- When a facility is designated as a cleaner air space, the HVAC system shall be designed to meet the following conditions:
    - Outdoor temperature: -8°C DB (17.5°F) in winter conditions, and 32°C DB/24°C WB (90°F DB/75°F WB) in summer conditions – CoV facilities standards requirements.
    - Indoor temperature is to be maintained between 21°C (70°F) and 24°C (75°F) at 50% RH.
- Ventilation system shall be:
    - Designed for the maximum occupancy capacity.
    - Equipped with a minimum MERV-13 rating filters.
    - 2-stage filtration system preferred, such as a MERV 8 prefilter and MERV 13 final filter.
    - Allowance for a future carbon filter installation.

GUIDANCE

.1 All designers must follow ASHRAE 55 to meet the intent of the VBBL.

.2 When considering zoning of thermal zones, do not group too many offices together. They must be limited to 3-4 smaller offices or 1 to 2 larger offices. Perimeter zones must not be grouped together with interior zones, or zones which have multiple building exposures to be on their own control. Meeting rooms should be on their own thermal zone. Do not mix high density with low density rooms unless approved by the city staff.

.3 Weather files must be used as directed by the BC Housing Guidelines and/or City of Vancouver for future weather files.

.4 When the project scope includes heating and cooling load calculations, the engineer must submit a summary of the calculations to the City of Vancouver during the design development and final design stages, to be incorporated into the final O&M manuals. The summary should, at a minimum, include the following information:

- Heating and cooling block loads,
- Room by room heating and cooling load, separated into:
    - Ventilation heating load,
    - Perimeter heating load (inc. air leakage load),

- Ventilation cooling load,
- Perimeter cooling load (inc. air leakage load),
- Solar heat gain,
- Internal heat gain.

OBJECTIVE

.1 The intent of this section is to clearly document the project's ventilation calculations and limit issues with submissions for LEED® and/or Passive House Certifications.

CRITERIA

.1 VBBL guidelines for ventilation standards must be followed on new and existing projects unless a certification standard requires a higher ventilation rate overall for the project.

.2 Always use the highest ventilation rate required between two standards. As an example, generally Passive House ventilation rates can be lower for small residential suites than the ASHRAE 62.1 standard. In this case, ensure that the higher rate of the two is used.

GUIDANCE

.1 For LEED® projects, compare the two ASHRAE 62.1 standards referenced at the time of the design for the VBBL and the relevant version of LEED® being pursued. The more stringent of the two must be used. As an example, currently the VBBL references ASHRAE 62.1 – 2001 prior to Addendum N, and LEED® v4.1 references ASHRAE 62.1 – 2016. The mechanical consultant is responsible for confirming references at the time of the project.

.2 Where Passive House projects are pursued, the VBBL and Passive House ventilation requirements must be compared, and the highest requirement must be used.

.3 City staff may request these calculations to show compliance with that specific project.

.4 Even if not required by the VBBL guidelines for building permit, the mechanical consultant must identify on the front drawing sheet of each project (renovations and new construction), what comparisons were completed, if any, and what standard defines the project.

.5 For demand control ventilation systems, each space must have a defined minimum outdoor airflow rate based on either ASRHAE 62.1 or Passive House standards. The system must increase outdoor air rates as required, based on the CO_2 levels of the space, to the design outdoor airflow rates.

.6 No room can have its minimum outdoor air setpoint equal to zero for any part of the normal operating times of the facility (i.e. outdoor air can be shut off during unoccupied times only).

.7 Verification of outdoor air volumes during the balancing phase of the project must be completed throughout the range of operation of the ventilation system. These values must not exceed a 10% discrepancy from the original design intent.

OBJECTIVE

.1 For all projects, the emphasis for HVAC equipment and systems will be on simple, yet high-efficient and zero carbon emissions options. All heating systems for new projects must be zero emissions utilizing electrification solutions.

.2 With retrofits and renovations, zero emissions systems must replace any fuel fired heating plants unless it can be shown that it is not feasible based on size, electrical capacity, or other constraints.

.3 For all new buildings, the REFM is committed to follow the City of Vancouver's Zero Emissions Building Plan (https://vancouver.ca/green-vancouver/zero-emissions-buildings.aspx) and the Climate Emergency Response Plan. The design team shall act in accordance with the targets outlined within those documents to achieve zero emissions in all new buildings. Using the latest version of the City of Vancouver Zero Emissions Building Plan will identify thermal energy demand intensity (TEDI) and greenhouse gas intensity (GHGi) targets with increased targets for city owned and developed projects outlined within the Climate Emergency Response Plan.

.4 Systems must maintain simplicity with regards to their design, future maintenance, and operational aspects.

.5 The below guidance must be read and used in conjunction with all associated city-owned design guidelines for specific building types.

CRITERIA

.1 As noted above, zero emissions systems must be implemented in all new buildings and all renovations unless it can be shown to be not feasible for an existing building.

.2 High temperature heating hot water systems must **not** be used. The maximum water temperature for water-based systems is 45°C (113°F), and where possible distribution water must be designed in such a way that the temperature delta is greater than 10°C (20°F) to reduce the overall pump head pressure.

.3 REFM's preference is that all mechanical equipment is consolidated in an indoor mechanical space. Where not possible, the mechanical consultant must minimize the amount of equipment installed outdoors and exposed to the elements.

.4 The mechanical consultants must provide a mechanical room plan noting all required equipment clearance and a clearly defined path for maintenance for REFM to review.

.5 Where heat is required for non-regularly occupied or transient spaces, electric baseboard or force-flow heating must be used in lieu of water based or gas-fired heaters.

.6 A hydronic system is the preferred system type over a Variable Refrigerant Flow (VRF) system. Request discussion with REFM team prior to any design work for a VRF system.

.7 Mechanical consultants must ensure manufacturer recommendations on straight length of pipe leading into circulation pumps are achieved, or design with the use of a suction diffuser.

.8 Pressure and temperature plugs for measuring conditions at heat exchangers, coils, pumps, and other major mechanical equipment must be provided.

.9 All air handling systems conveying outdoor air into buildings must be equipped with a minimum prefilter with a MERV 8 rating, a minimum final filter MERV 13 rating, and allowance for a future carbon filter.

.10 For wet service rooms, such as water entry rooms, fire sprinkler rooms, janitor rooms, and washrooms, use space heating equipment (i.e. radiant heaters, unit heaters etc.) that can be mounted at high levels on the wall or hung from the ceiling.

.11 All heating systems shall be capable of operating and provide space heating down to an outdoor temperature of -20°C (-4°F). If the system is unable to operate in those conditions, provide suitable back-up heat source of the system.

.12 CoV's preference is to decouple the heating/cooling system from the ventilation system.

.13 When specifying equipment, the consultant should ensure that all required accessories (from manufacturer or a third party) are clearly identified in either the equipment schedule or project specifications.

.14 Pump(s) shall not be selected base on the maximum operating point (flowrate and pressure), they should also consider the average and lowest operating point/range, in order to achieve high energy efficiency.

.15 Pumps specified shall either be electrically commutated motors (ECM) or complete with variable frequency drive (VFD) for all applications, including constant speed applications.

.16 Pumps should be selected in such a manner that the duty point meets the following criteria:

- Duty point is located between 80-90% of the pump speed curve.
- The median operation point of the pump to be as close as possible to the peak efficiency curve.

.17 When a smaller pump is selected to address low-flow conditions, a sequence of operation is to be provided, identifying that the smaller pump will be used in a lead operation. Control sequences must be verified and accepted by the Commissioning Provider during commissioning.

.18 Ceiling exhaust fans installed within spaces to have a noise generation of 1.5 sone or less.

.19 All HVAC ducting to be acoustically lined on either side of fans and equipment to prevent equipment sound transfer to occupied spaces.

GUIDANCE

.1 The use of low temperature systems and higher temperature deltas is more likely to reduce overall energy consumption of the piping distribution system and allows the heat pump technology to operate at a greater efficiency. Systems operating at these temperatures will also accommodate future potential for connections to a City District Energy System.

.2 Installing equipment in a central, indoor mechanical room will allow for a more streamlined maintenance program and ensures a longer life expectancy, over rooftop installed equipment for REFM. As equipment will be located inside, within a locked mechanical space, it will be protected from vandalization and wear from outdoor elements. The design team must review other City of Vancouver design guidelines and standards for specific building requirements.

.3 Equipment clearances and removal paths are critical to the maintenance of mechanical systems. At minimum all equipment must be able to be fully removed, with an associated path for removing the equipment. For large equipment, that would require large machinery (i.e. crane) or major disruptions (i.e. removal of mechanical room wall etc.) to remove all mechanical components of the equipment must have at least a removal path/service access. During the design, the final location of large equipment should factor in the potential for a full removal of the equipment, along with other considerations (i.e. aesthetics, performance etc.).

.4 The use of electric baseboards in these types of spaces limits the complexity of the systems and will reduce the overall heating system energy consumption. This will also reduce additional maintenance on these high traffic locations that typically see greater wear.

.5 The use of VRF systems provide many challenges with the REFM's operations and maintenance of buildings. These challenges include DDC integrations for monitoring and control, the ongoing maintenance of the system by a serviced by a certified manufacturer's representative, challenges with replacement of the system at the end of service life (i.e. removal of existing refrigerant piping throughout building) and the potential for leaks over the life of the system, and the inability to easily locate the source. These challenges restrict the viability of VRF systems in buildings owned and operated by the City of Vancouver.

.6 Should VRF system be considered, consultant must provide a memo or report comparing various aspects of VRF systems and conventional hydronic-based system to City of Vancouver for review and approval. Consultant shall evaluate the advantages and disadvantages of each system, including but not limited to,

- Refrigerant charge and safety,
- Capital cost,
- Controls integration,
- Energy metering,
- System footprint,
- Maintenance and operational aspects and,

- Lifecycle replacement considerations.

.7 Poor entry conditions of the water system into the suction side of the pump will result in reduced pump performance and may damage the pump that could lead to increasing required maintenance or premature failures.

.8 The provisions for the pressure and temperature plugs allows on-site troubleshooting of the equipment during commissioning and throughout the life of the building.

.9 MERV 13 filtration has been shown to benefit indoor air quality and the allowance for carbon filtration will improve the building's ability to deal with changing outdoor air conditions, wildfire smoke, vehicle fumes etc.

.10 The mechanical consultant shall design the ventilation system completely independent from zone heating and cooling system and incorporate the following:

- Dedicated duct, diffuser for ventilation air.
- The ventilation system should be able to ventilate the space without turning on the zone heating/cooling unit fan.

OBJECTIVE

.1 Equipment serviceability and removability is critical to building maintenance and ongoing energy performance. Serviceability is a key design consideration and demonstrates a successful collaborative project.

.2 The following is meant to limit issues with future maintenance, which in turn will optimize building performance. This section is not meant to identify in detail all mechanical elements that require maintenance access and exactly how/where to provide the access. The equipment manufacturer's instructions are to be followed for proper access and good engineering practice.

CRITERIA

.1 The clearance requirements for regular maintenance of all major equipment must be clearly shown on a layout drawing.

.2 The equipment removal intent must be clearly shown on a layout drawing, and/or referenced architectural or structural plan, if it is not standard through doors.

.3 All mechanical equipment (FCU's, VAV boxes, motorized dampers, valves, filters, etc.) shall be installed, at the lowest level, within 0.5m (1.6ft.) above the finished ceiling height.

.4 Locating equipment above a parking stall must be avoided in all cases unless approval is provided by CoV for circumstance that cannot be avoided.

GUIDANCE

.1 To limit the need to guess the intent for major equipment removal, the equipment removal strategy must be identified within notes on the associated drawing layout. Include items such as coil pull areas, chiller removal or knock-out panels, the heat pump replacement path, etc.

.2 Typical equipment maintenance and replacement methods must be verified with equipment suppliers or manufacturers (i.e. for air handling systems, that may only see replacement parts over the life of the building, the largest piece of that unit will need to be considered for removal). This should be noted on the drawings where applicable.

.3 Knock-out panels, removeable structure and the intent for these items must be coordinated and documented (i.e. do not note "knock-out panel", clarify "knock-out panel for fan removal").

.4 Locating equipment above a parking stall must be avoided in all cases unless approval is provided by the City of Vancouver for circumstances that cannot be avoided.

.5 The following is a sample of standard equipment access considerations. Note that it is not comprehensive:

- Access to hydronic coils must be provided on both upstream and downstream sides.
- Access to filter sections must allow for easy pull of the largest filter section being used and ensures that no other equipment is required to pull filters (i.e. it must be easy to pull the filters without tools).
- Valves, dampers, and sensors must be easily accessible from the ground or a ladder unless provided with approval from the City of Vancouver for access with a lift or other means.
- Access to motors, pumps, and fans must be provided with a clear working platform at the access point that meets Worksafe BC requirements. Access to these items from a lift or scaffolding is not an acceptable solution unless directed by the City of Vancouver. Consider the replacement of large motors or components that cannot be carried and allowances for fixed lifting apparatus near the equipment for ease of removal.
- Cleanouts for plumbing systems must be easily accessed by hand or ladder access. Where there is difficulty in achieving easy access, pipe cleanouts to walls or floors as needed to eliminate the requirement for lifts.
- Grease and oil interceptors must be easily accessible for cleanout. Access requiring a lift is not acceptable. The cleanout must also not require the service company to run equipment or hoses through public spaces unless agreed upon by the City of Vancouver.
- Minimize confined space access to equipment. Equipment needs to be safely and easily accessible for service and replacement.

OBJECTIVE

.1 The intention of this section is to outline the basic requirements for rooms dedicated for smudging ceremonies and to be clear regarding expectations at the outset of a project.

.2 Smudging is an important cultural ceremony which may take place in every building that is owned and operated by the City of Vancouver, and it is expected that every building will have specific spaces with smudging controls which will mitigate the circulation of smudging smoke from that space to adjacent spaces in the building.

CRITERIA

.1 Smudging must be accommodated in a minimum of 1 to 2 spaces within each new building.

.2 In each dedicated smudging room or space, smells and smoke must not be transferred to adjacent rooms or spaces.

.3 Allow for a localized control for smudging exhaust systems with timer.

.4 For areas with smoke detectors that may be triggered by smudging, include a local smoke detector bypass feature.

.5 Provide clear signage in all applicable areas where smudging has been designed for.

.6 The mechanical consultant must also help to outline to the City of Vancouver staff at the outset of the project the potential effects of smudging occurring throughout the building. This includes, but not limited to:

- The possibility of smoke recirculation between adjacent spaces,
- Possible concerns related to smoke exhaust systems for special alternate solutions,
- Other interactions of the smoke with the mechanical and fire systems.

.7 For all new construction, smudging should be accommodated within the follow areas (where applicable):

- Arts and Culture Studios.
- Multipurpose Rooms.
- Meeting Rooms.
- Offices.
- Amenity Rooms (housing projects).
- Housing Units.
- Lobby/Centralized Entrance Areas of public-facing buildings.

GUIDANCE

.1 The mechanical consultant for each project must be engaged early to understand the dedicated rooms required to have localized exhaust systems and to be able to speak to effects of smudging throughout the building.

.2 Provide a dedicated smudging system in the form of an exhaust fan and make-up air unit complete with duct heater. As an alternative option a counterflow style heat recovery ventilator (HRV) can be used to meet energy performance requirements (i.e. Net Zero, Passive House etc.). The HRV shall be sized to the larger of either 3 air-changes per hour (ACH), or the minimum outdoor air requirements. The HRV unit shall come complete with an activated carbon filter to protect the core on each side of the airstream (return and supply).

.3 Limit the use of fancoils that supply multiple rooms where smudging is expected to occur or ensure that the controls shut off recirculation of the air in the room where the ceremonies are meant to occur.

.4 Exhaust systems and all controls should be locally hard wired to operate. Equipment with an adjustable time clock is preferred. The systems may be monitored through the DDC for status only. Provide proper signage at the local control switch that has City of Vancouver staff approved verbiage.

.5 For areas with smoke detectors that may be triggered by smudging, include a local smoke detector bypass initiated by the same mechanism as the localized smudging exhaust control. Coordinate with City of Vancouver Fire Department requirements. Key switch operation is recommended to limit the operation of smoke detector bypass functions to staff trained to address the fire & life safety implications of bypassing fire detection systems in accordance with the fire safety plan for the site.

.6 Include smudging exhaust systems with smoke detector bypass features in the coordinated life safety systems commissioning for the site to verify correct operation and absence of nuisance alarms.

.7 Ensure that proper training for city staff is done at the completion of each project.

.8 Use non-porous, impermeable materials for HVAC systems and adjacent finishes to prevent deterioration cause by smudging materials.

OBJECTIVE

.1 This section should be referred to when a VRF system is considered for a CoV facility (new or retrofit).

.2 A VRF system has unique challenges in design, operation, maintenance, and controls.

.3 The following is meant to limit VRF system issues with operation, maintenance, and control system.

.4 The equipment manufacturer's instructions are to be followed for proper design and installation.

CRITERIA

.1 Shutdown/failure of one indoor unit shall not prevent the operation of the rest of the VRF system.

.2 When a VRF system is used for space heating and cooling, the ventilation system should operate independently from the VRF system.

.3 Provide BACnet control connection to DDC.

.4 Refrigerant charge of a VRF system shall not exceed the limit defined by ASHRAE 34 and CSA B52 (latest version). Provide refrigerant limit calculation for CoV review during design.

.5 When multiple enclosed offices are supplied by one indoor ducted unit, specify a zoning kit from the same manufacturer to allow independent temperature control for each enclosed office.

.6 The manufacturer limit on refrigerant pipe length and elevation difference limit (between condenser, branch boxes and indoor units) shall not be exceeded.

.7 All manufacturer installation guides shall be followed, including service clearances, piping, and refrigerant joint requirement.

.8 The bottom of the condenser shall be installed above the local maximum snow level height.

.9 Include all accessories needed for cold climate installation (if system is used for heating).

.10 Every indoor unit shall come with a wired wall-mounted remote.

.11 All indoor unit installation locations should allow easy filter replacement access and include all serviceable access requirements for all future maintenance.

.12 All VRF systems should come (at minimum) with 10-year compressor warranty and 5-years part warranty.

GUIDANCE

.1 Do not duct ventilation air to the inlet (return) of the indoor units. Provide a separate diffuser for ventilation air to serve the space.

.2 When the building is equipped with DDC system, specify BACnet interface for VRF system.

.3 Condenser unit should be elevated off the ground/roof surface using a condenser stand. The minimum height of the condenser stand shall be 600mm (2ft.).

.4 Do not route refrigerant piping through a small, enclosed space (if possible). If this is unavoidable, the mechanical consultant shall review CSA B52 and ensure that all safety requirements are provided.

.5 Consider using a hybrid VRF (HVRF) system to reduce overall refrigerant charge and minimize refrigerant conveying piping throughout the building. Hybrid VRF is a heat recovery VRF System that replaces refrigerant with water between the branch circuit controller and the indoor units.

OBJECTIVE

.1 VRF air handling units (AHU) integration kits are becoming a common method to provide heating and cooling for AHUs in fully electrified buildings. The following is meant to limit system issues with operation, maintenance, and control systems.

.2 The equipment manufacturer’s application guide is to be followed for proper design and installation.

CRITERIA

.1 VRF AHU integration kit should be controlled by DDC using a hardwired 0-10V signal.

.2 In cooling mode, the entering air temperature (EAT) of the DX coil shall be maintained inside the manufacturer's recommended temperature range for cooling.

.3 In heating mode, the EAT of the DX coil shall be maintained inside the manufacturer's recommended temperature range for heating.

.4 When VRF AHU integration kit is providing heating or cooling, the airflow through the DX coil shall be maintained at the manufacturer’s recommended airflow range.

GUIDANCE

.1 VRF AHU integration kit typically has an operation range limit on the DX coil EAT temperature. For heating, if it is found that EAT of the DX coil will be lower than the manufacturer’s recommended operating range, provide an electric pre-heating coil upstream of the DX coil.

.2 Typical airflow turn-down ratio for VRF AHU integration kit is 70%. If a higher airflow turn-down ratio is needed, split the DX coil into 2 or 3 coils. Each coil should come with its own motorized damper.

OBJECTIVE

.1 The operation and maintenance aspects of air distribution system sometimes are overlooked during the design process. This section lists good air distribution system design that promotes ease of operation and maintenance and previous project lessons.

CRITERIA

.1 For constant volume HVAC application (e.g. washroom exhaust) use one of the following:

- For application where low pressure drop is required, or airflow is higher than 100L/s (200CFM), the mechanical consultant should consider the use of a variable air volume (VAV) box and balancing damper (e.g. longest duct run and low fan static application).
- For application where the flowrate is 100L/s (200CFM) or lower and static pressure of 63Pa is available, the mechanical consultant should consider the used of an automatic balancing damper/constant airflow regulator in combination with register/plenum box.

.2 For balancing damper installation above drywall, use cable operated remote balancing damper instead of regular balancing damper and access panel.

.3 Do not combine two different air class exhaust into the same duct. In the case of HRV/ERV system, only interconnect the different exhaust systems (e.g. washroom exhaust & general return air) at the exhaust inlet. Always provide a backdraft damper at the interconnection point for each branch.

.4 When the return air of an ERV/HRV is a combination of the constant exhaust (e.g. washroom exhaust), and variable flow return/exhaust air (e.g. general exhaust), provide either VAV boxes or motorized damper for the variable the flow on the return/exhaust air branch. The motorized damper should be accompanied by a duct pressure sensor installed at 2/3 length of exhaust air (EA) duct.

.5 Provide motorized damper on all outdoor air intakes.

.6 Provide a motorized damper or a backdraft damper on all exhaust air prior to penetration to the building exterior.

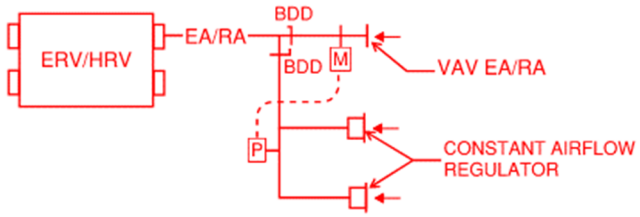
.7 Variable Air Volume system should be designed for dynamic air balancing.

GUIDANCE

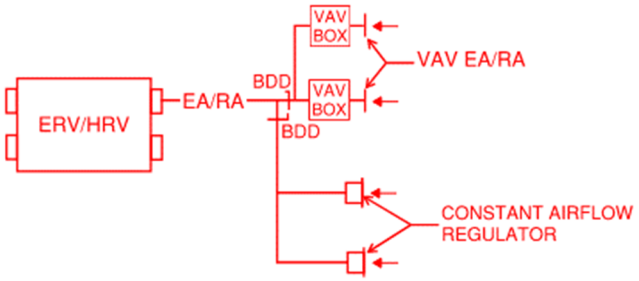
.1 Usage of automatic balancing damper/constant airflow regulator eliminates the need of a balancing damper and access panel since the automatic balancing damper can be accessed by removing the grille/diffuser.

.2 An automatic balancing damper is calibrated to automatically adjust to changing pressures, which beneficial in a system that combines VAV and constant volume inlet/outlet (dynamic balancing).

.3 Below are two (2) schematic examples of an air system for criteria items #3 and #4.



VAV ERV/HRV with Motorized Damper VAV intake and Constant Airflow Regulators



VAV ERV/HRV with VAV Boxes and Constant Airflow Regulators

OBJECTIVE

.1 A hydronic systems operation and maintenance aspects are sometimes overlooked during the design process. This section identifies good engineering for hydronic systems that promote ease of operation and maintenance and incorporated previous project lessons learned by CoV staff and partners.

CRITERIA

.1 Variable flow hydronic loop should be designed for dynamic water balancing.

.2 Design hydronic system for the following water temperature:

- Heating water supply/return (HWS/HWR) – 45°C/35°C (113°F/95°C)
- Chilled water supply/return (CHWS/CHWR) – 7°C/12°C (45°F/54°F)

.3 Any hydronic systems should be provided with:

- Air and dirt separator (combined or separate)
- Side-stream filter and chemical pot feeder assembly
- Expansion tank(s)
- Air vent(s) located at the highest point of the system.

.4 Only use VFD or ECM pumps, including in constant flow system applications. When a VFD is utilized, it should be installed as close as possible to the pump it serves and no more than 900mm (3ft.) away.

.5 The use of a balancing valve to reduce a pump flowrate is not acceptable.

.6 The use of a triple duty valve is not acceptable, unless approved by the CoV.

.7 The use of a 6-way pressure-independent control valve should be used when serving a change-over coil (heating/cooling).

.8 Terminal unit piping connections should be provided with the following (as a minimum):

- Isolation valve on the supply and return pipes,
- Air vent (at high-point of piping),
- Drain hose connection, complete with a screw cap,
- Braided stainless steel flexible pipe connection.

.9 Expansion tanks should be sized based on the largest fluid temperature differential and total system volume, including fluid volume inside the equipment and piping.

.10 Any hydronic-based equipment subjected to an outdoor condition (i.e. freezing environment) should have a glycol solution as a means of freeze protection unless otherwise reviewed and accepted by CoV engineers.

GUIDANCE

.1 Dynamic water balancing requires the following components:

- Pressure-independent control valve for variable flow branches. Examples of pressure-independent control valves are Belimo PIQCV, Belimo EPIV or other equivalent valves.
- Automatic flow limiting valve/auto flowrate regulators for constant flow branches. Examples of automatic flow limiting valves are Griswold Controls automatic flow limiting valve, Xylem pressure independent flow limiting valves or other equivalent valves.

OBJECTIVE

.1 The operation and maintenance aspects are sometimes overlooked during the design process. This section identifies good engineering for chiller systems that promote ease of operation and maintenance and incorporated previous project lessons learned by CoV staff and partners.

CRITERIA

.1 Chilled water system should be designed with primary and secondary loop. Primary loop (chiller loop); Secondary loop (distribution loop).

.2 Chilled water system should come with a low loss header separating the primary loop and secondary loop.

.3 Chilled water system should be designed to maintain either the chiller's minimum runtime (typically 2 minutes) or the manufacturer's recommendation, whichever is the highest of the two.

.4 Each chiller should come with a dedicated chiller pump, except for modular chillers.

.5 Two (2) or more chillers configuration is preferred when possible. Select the number of chillers to prevent chiller short cycling.

.6 For freeze prevention, use 30% propylene glycol fluid mixture.

.7 Provide a temperature probe for each of low loss header's inlets and outlets.

.8 Provide temperature probe at the middle of low loss header tank.

GUIDANCE

.1 Multipurpose tanks can be used to combine functions of a low loss header, air and dirt separator, and buffer tank. When using a multipurpose tank, specify manufacturer installed insulation.

.2 To meet the minimum chiller runtime, determine the required minimum system volume. Use a buffer tank to add system volume, as required.

.3 Buffer tanks should come with insulation to minimize any standby losses. The insulation type and thickness should be based on usage and energy code requirements.

OBJECTIVE

.1 The operation and maintenance aspects of an air source heat pump (ASHP) sometimes is being overlooked during the design process. This section lists good engineering for ASHP that promotes ease of operation and maintenance and previous project lessons.

CRITERIA

.1 For Chilled Water Side: See Mechanical - Chillers section.

.2 Heating water system should be designed with primary and secondary loops. Primary loop (ASHP loop); Secondary loop (distribution loop).

.3 Heating water system should be provided with a low loss header separating the primary loop and secondary loop.

.4 Heating water system should be designed to maintain either the ASHP's minimum runtime (typically 2 minutes) or the manufacturer's recommendation, whichever is the highest of the two

.5 Each ASHP should come with a dedicated pump, except for modular ASHPs.

.6 Two (2) or more ASHP configuration is preferred when possible. Select number of ASHP to prevent from short cycling and providing sufficient redundancy as the project requires.

.7 Use 30% propylene glycol fluid mixture as a means for freeze protection.

.8 Provide a temperature probe for each of the low loss header's inlets and outlets.

.9 Provide a temperature probe in the middle of the low loss header.

GUIDANCE

.1 Multipurpose tanks can be used to combine functions of a low loss header, air and dirt separator, and buffer tank. When using a multipurpose tank, specify manufacturer installed insulation.

.2 To meet the minimum ASHP runtimes, determine the required minimum system volume. Use a buffer tank to add system volume, as required.

.3 Buffer tank should come with insulation to minimize any standby losses. The insulation type and thickness should be based on usage and energy code requirements.

.4 Not all ASHPs are capable of supporting a temperature delta (ΔT) of 10°C (18°F) on the HWS/R side. The design of hydronic system should take into account this limitation.

OBJECTIVE

.1 The operation and maintenance aspects of ERV/HRV sometimes is being overlooked during the design process. This section lists good engineering for ERV/HRV that promotes ease of operation and maintenance and previous project lessons.

CRITERIA

.1 A counterflow plate heat exchanger core for ERV/HRV is preferable to a thermal wheel core.

.2 Specify HRV for rooms with high humidity concerns such as drying room, car wash, and water entry room. For other applications mechanical consultant to specify and ERV.

.3 Always include the following specification with ERV/HRV equipment schedule.

- Supply air flow and external static.
- Exhaust airflow and external static.
- Winter condition (at winter design condition):
    - Winter outdoor air (OA) temperature (DB/WB),
    - Core OA EAT (DB/WB) (if ERV/HRV come with pre-heater),
    - Core return air temperature (DB/WB),
    - Core supply air temperature (DB/WB).
- Summer condition (at summer design condition):
    - Summer OA temperature (DB/WB),
    - Core OA EAT (DB/WB) (if ERV/HRV come with pre-heater),
    - Core return air temperature (DB/WB),
    - Core supply air temperature (DB/WB).
- For occupied space application, when the leaving SA temperature of the core expected to be lower than 18°C (64°F) at winter design condition, provide electric duct heater downstream of ERV/HRV.
- When specifying ERV/HRV for a building with DDC control, specify ERV/HRV without manufacturer controller, but include signals for:
    - 0-10V fan speed control and,
    - 0-10V for thermal wheel speed control.
- When specifying commercial grade variable flow ERV/HRV for a building with DDC control, specify airflow measurement station for supply air and exhaust air.

GUIDANCE

.1 For on-demand ERV/HRV applications, the supply fan will be controlled to maintain certain supply air (SA) duct pressure. The SA airflow sensor will provide air SA flowrate to DDC, and the DDC system will modulate the exhaust air (EA) fan to produce EA flowrate proportional to SA flowrate.

OBJECTIVE

.1 The intent of this section is to provide general guidance to mechanical consultants regarding the REFM preferences (i.e. previous experiences, maintenance etc.), and should be considered within the project's context. The general intent of this section is to provide quality assurance, future ease of maintenance, accessibility, and good practice.

CRITERIA

.1 Working fluid for a dry cooler and a close loop of cooling tower shall be 30% propylene glycol, for freeze prevention purposes. Constant minimal flow or draining fluid cooler and cooling tower for winter is not an acceptable method.

.2 Traditional cooling towers, both open and closed loops, are no longer acceptable by REFM. Use either a hybrid cooling tower or a dry cooler.

.3 Install a water meter on each cooling tower makeup water line.

.4 Exterior makeup water lines serving the cooling tower shall be insulated and heat traced.

GUIDANCE

.1 Constant minimal flow for freeze prevention is not acceptable because it consumes a lot of thermal energy and electricity for condensing pumps. It is also an unreliable method as could potentially be subject to failure of piping, control hardware/software etc.

.2 Draining close loop fluid in the cooling tower, adiabatic cooler and dry coolers in the winter is not recommended due to corrosion for the heat exchanger, and draining the cooling tower, adiabatic cooler and dry cooler is allowed in case of emergency only.

OBJECTIVE

.1 The intent of this section is to provide general guidance to mechanical consultants regarding the REFM preferences (i.e. previous experiences, maintenance etc.), and should be considered within the project's context. The general intent of this section is to provide quality assurance, future ease of maintenance, accessibility, and good practice.

CRITERIA

.1 Server room cooling shall be designed to have redundant dedicated cooling units to provide continuous cooling.

.2 Server room to have a dedicated second source of cooling if the building has a chiller and chilled water as the primary cooling method.

.3 CoV preference for IT room cooling system is hot aisle containment, cool aisle is an acceptable alternative design approach.

GUIDANCE

.1 When a building has a chiller and server room served with two (2) chilled water-cooling devices/equipment (e.g. Chilled water CRAC or fan coils), a split unit air conditioner (air source) should be provided for an alternate source of cooling in case of unavailability of chilled water supply.

OBJECTIVE

.1 The intent of this section is to provide general guidance to mechanical consultants regarding the REFM preferences (i.e. previous experiences, maintenance etc.), and should be considered within the project's context. The general intent of this section is to provide quality assurance, future ease of maintenance, accessibility, and good practice.

CRITERIA

.1 When the building is equipped with DDC:

- Specify basic 0 to 10V control when specifying AHU. Each part of the AHU should be controlled directly by DDC, including fan speed, dampers, ERV wheel rotation speed, coil control valves, coil pumps, DX heat pump capacity, etc.
- AHU sensors should be connected directly to DDC as a control input.
- Mechanical consultant shall provide detailed control sequences and control point list for each AHU.

.2 Specify single power connection for AHU.

.3 Specify VFD or ECM direct drive fan. Do not use a belt-driven fan.

.4 Specify MERV 8 pre-filter and MERV 13 final filter.

.5 Specify dirty filter sensors across both pre- and final filters.

GUIDANCE

.1 Criteria note #1 does not apply to packaged heat pump RTU and heat pump MUA.

OBJECTIVE

.1 The intent of this section is to provide general guidance to mechanical consultants regarding the REFM preferences (i.e. previous experiences, maintenance etc.), and should be considered for all projects. The general intent of this section is to provide quality assurance, future ease of maintenance, accessibility, and good practice.

CRITERIA

.1 All new projects must follow the British Columbia Insulation Contractors Association (BCICA) Quality Assurance Certificate Program (QACP).

.2 All insulation tradespersons shall have a Red Seal or TQ designation in the Heat and Frost trade, and/or registered apprentices/helpers supervised by qualified journey-persons.

.3 Workmanship must conform to the latest QAC Standards as published in the BCICA Quality Standards for Mechanical Insulation Commercial and Institutional Buildings Manual (QSMIM).

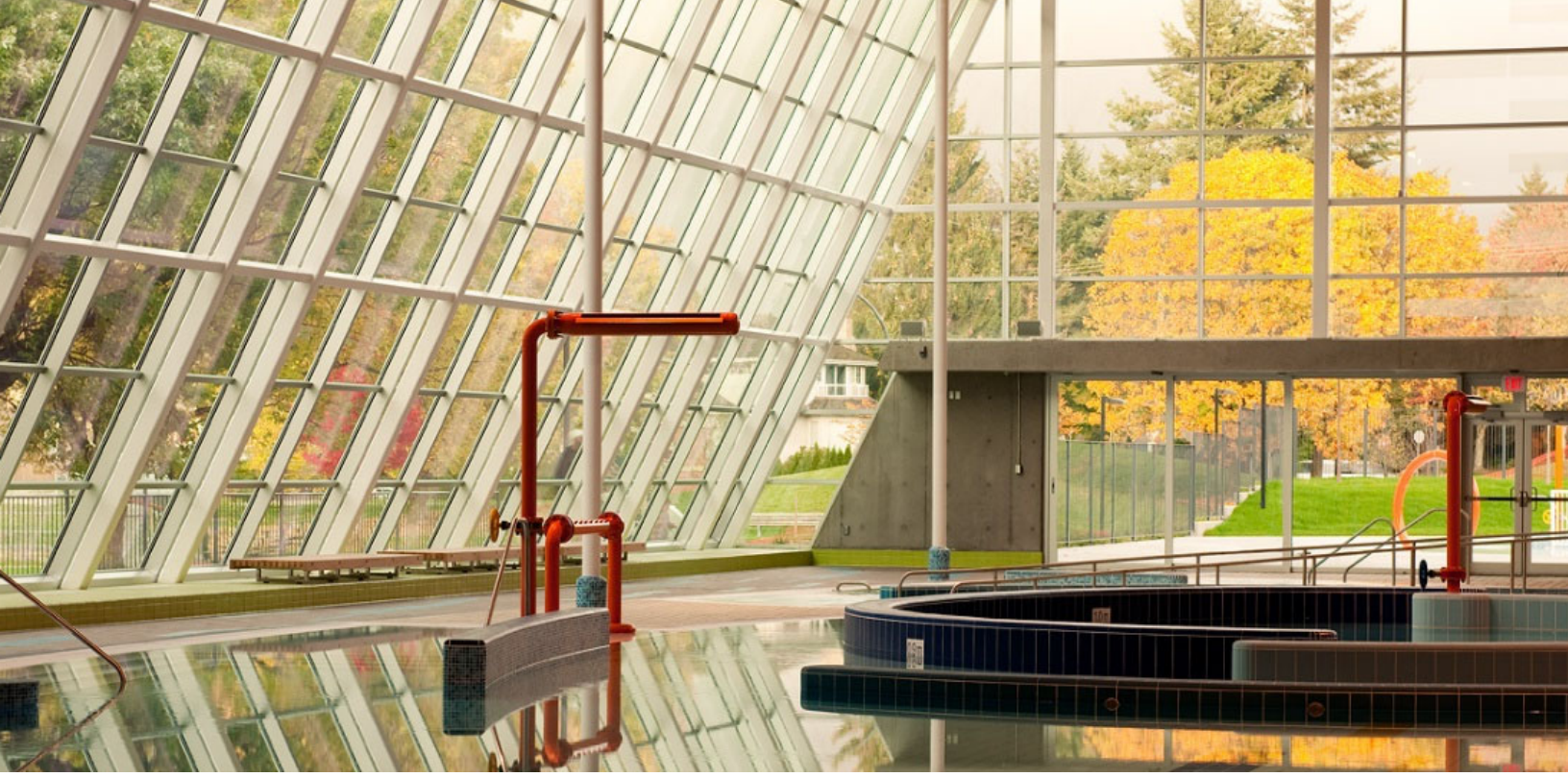
.4 Duct insulation R-Value shall meet or exceed duct insulation R-Value prescribed by ASHRAE 90.1 (latest edition).

.5 Exterior duct shall come with 50mm (2”) internal rigid duct liner with line sheet metal walls and tops.

GUIDANCE

.1 Quality assurance is a high priority to REFM. Following the BCICA QACP ensures qualified journeypersons will undergo technical reviews to ensure compliance with specifications. This program also provides a level of confidence in the installation due to the on-site review reports and the final certification from a BCICA representative.

.2 The usage of an internal ridged duct liner for the exterior ductwork ensures the protection of the insulation from physical and weather-related damages. Internal line sheet metal ensures smooth airflow inside the duct.



F PLUMBING

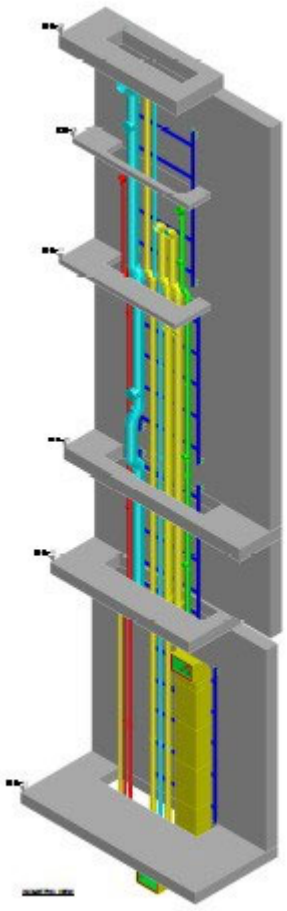
OBJECTIVE

.1 The intent of this section is to provide general guidance to mechanical consultants regarding the REFM preferences for ongoing maintenance of the plumbing systems within their facilities. These guidelines note general principles; the consultant must review any additional design guidelines for specific building types for additional information and details.

CRITERIA

.1 Isolation Valves:

- As a part of the REFM design reviews, the mechanical consultant must provide a plumbing isolation plan based on the following considerations and other project requirements. The below items identify some general requirements, but the consultant must review additional design guidelines where applicable for additional details.
- In residential projects, isolation must be provided in such a way that each suite, and each vertical riser can be isolated independently.
- In commercial buildings, isolation must at least be provided on a floor-by-floor basis. Further isolation to be designed as required in this document or as seen fit by the mechanical consultant.
- In community centres, isolation must be provided in such a way that an entire washroom group, or changeroom can be isolated, so as not to interrupt the operation of adjacent washrooms or changerooms.



.2 Pipe Sloping:

- As a part of the construction administration and field review services provided by the mechanical consultant, piping support (i.e. hanger spacing etc.) and spot checks on drainage piping sloping must be reviewed on site and documented in the consultant's field review reports.

.3 Vertical Pipe Risers:

- Mechanical consultants must strive to design plumbing risers to be located and accessible in common areas or accessible piping chases as much as possible.
- Piping risers (i.e. domestic, drainage etc.) must be clearly identified on site, or as a part of the final record drawings.

.4 Pipe Penetration Through Stud:

- Any pipe penetration through a stud, shall be provided with a cable protector steel plate.

.5 Plumbing Drawings:

- Pipe tags for storm water line (STW) and sanitary (SAN) lines must show pipe size, fixture unit (FU), and pipe slope.

- Show pipe invert on STW and SAN lines at the following locations:
  - Upstream and downstream of vertical offset.
  - Pipe drop from above.
  - Pipe connection to a pipe riser.
- Project where plumbing fixture is added or removed:
  - Plumbing drawing to show all the plumbing lines that are affected by the addition or removal of plumbing fixture, from the added/removed fixture to the city connection.
  - Show new fixture units (FU) on each plumbing line from new/removed plumbing fixture to the city connection.

GUIDANCE

.1 Isolation Valves:

- The general concept for the isolation requirements is for future maintenance and minimizing disruptions to adjacent fixtures or suites.

.2 Pipe Sloping:

- The review of piping supports, and drainage pipe sloping is not to provide a detailed and comprehensive review of the entire drainage system. However, the spot checks and documentation provide REFM with some level of confidence that the plumbing systems are being installed with good workmanship and in accordance with the VBBL.

.3 Vertical Pipe Risers:

- Riser access and identification is crucial for ongoing building maintenance in buildings such as social and low-income housing projects. Identification requirements will be more important in the event that the plumbing risers are not accessible (i.e. within a plumbing service wall).

OBJECTIVE

.1 The intent of this section is to provide guidance to mechanical consultants regarding the REFM preferences (i.e. previous experiences, maintenance etc.), and should be considered within the project's context. These guidelines note general principles; the consultant must review any additional City of Vancouver design guidelines for specific building types for additional information and details.

CRITERIA

.1 All projects must utilize commercial grade plumbing fixtures.

.2 All plumbing fixtures used must have parts and/or replacements available through local suppliers and wholesalers.

.3 The use of a dual check backflow device is not permitted.

.4 Each plumbing fixture shall have its own shut-off valve.

GUIDANCE

.1 The use of commercial grade plumbing fixtures in all of REFM's facilities is intended to maintain a level of quality and ensures that robust equipment is being used across all their assets.

.2 Plumbing fixtures that are not locally sourced create potential downtime to the facility or increased costs for obtaining and storing extra parts and fixtures. The design consultant should take this into consideration when specifying equipment. Locally sourced, non-proprietary fixtures and equipment are preferred by REFM.

.3 The designers refer to the code requirements regarding backflow devices. However, in the event that a dual check backflow device is permitted, it is required that the designer provides a double check valve assembly in lieu.

.4 The designer must refer to additional City of Vancouver design guidelines and standards for building specific fixture requirements that remain beyond the scope of this standards manual.

.5 Refer to the City of Vancouver's Parks Board washroom strategy https://vancouver.ca/files/cov/parks-washroom-strategy.pdf.

OBJECTIVE

.1 The intent of this section is to provide guidance to mechanical consultants regarding specific plumbing fixtures further to the general requirements outlined above. REFM has elected to improve their environmental impact and reduce water consumption across their portfolio of projects and facilities. It is essential that the ability to use a safe, clean, and accessible washroom is extended to everyone. Access to a washroom is a basic human right, as outlined by the BC Human Rights Code.

CRITERIA

.1 Water Closets:

- Manually operated flush valves are preferred for all projects. Water closets must be high-efficient (HET), WaterSense labelled, have a MaP test rating of 1,000 of better and have a maximum flow rate of 4.8lpf (1.28gpf).

.2 Urinals:

- Manually or electronically operated (battery-type only) flush valves are acceptable for all projects. Urinals must be high-efficient (HET), WaterSense labelled, and have a maximum flow rate of 1.9lpf (0.5gpf).

.3 Lavatories:

- CoV staff washrooms only: Manual palm-operated metering faucets meeting accessible requirements. Faucets must be low-flow type, WaterSense labelled, and have a maximum flow rate of 1.9lpm (0.5gpm). Standard of acceptance: Delta 86T1153.
- Public washrooms: Touchless infrared faucets (hard-wired) meeting accessible requirements. Faucet must be low-flow type, WaterSense labelled, and have a maximum flow rate of 1.9lpm (0.5gpm). Standard of acceptance: Sloan EFX-200-4-BOX-BDT-CP-0.5GPM-MLM-IR-FCT.
- All CoV lavatory faucets should come equipped with point of use thermostatic mixing valve to eliminate the change of scalding. Standard of acceptance: Lawler TMM-1070.

.4 Showers:

- Manually operated showers are acceptable for most projects. Showers in community centres, and social or low-income housing type projects must be provided with metering style faucets (push button) with the ability to adjust the run time. Showers must be low-flow type, WaterSense labelled, and have a maximum flow rate of 7.6lpm (2.0gpm).
- Specified shower valve shall meet the Vancouver Plumbing By-Law 2019-2.2.10.7.3 or the most current VBBL requirements.

.5 Drinking Fountains:

- Drinking fountains must be non-filtered, non-refrigerated models and be provided with bottle filling stations. Drinking fountains must be located in close proximity to regularly used plumbing fixtures to avoid a long dead-leg of domestic cold water.

.6 Floor Drains:

- For social and low-incoming housing projects, designers must ensure that floor drains are located in all washrooms, laundry rooms, and kitchen areas.

.7 Hose Bibs:

- Hose bibs should be provided at the following areas:
  - In each outdoor area.
  - In a dedicated garbage/recycling room, also include floor drain.
  - At any location with a condensing unit installed.
  - At any green roof.
- Hose bibs shall be:
  - Frost-free with a vacuum breaker.
  - Vandal proof when they occur at grade or at any location that is accessible to the public.
  - Recessed if wall-mounted in outdoor play areas.
  - Keyed and tamper-proof in outdoor play areas
- Exterior hose bibs shall be frost-free complete with vacuum breaker.
- Hose bibs shall be recessed if they occur at outdoor play areas.

.8 Janitor Sinks:

- Provide a floor-mounted mop sink in each Janitor room, complete with approved backflow preventer valve.
- Backflow preventers shall be included and provided for connection to automated cleaning product dispensers.

GUIDANCE

.1 Urinals

- Hardwired flush valves require multiple trades in order to diagnose and troubleshoot any potential issues. Therefore, battery-type flush valves are the only type which will be allowed in REFM facilities.

.2 Drinking Fountains

- The request for non-filtered and non-refrigerated drinking fountains is due to ongoing maintenance and requirements for additional backflow protection.

.3 Showers

- The metering valve use in community centres, and social and low-income housing projects is intended to provide a more robust product to occupancies in which damage and misuse is more commonly seen.
- If a centralized thermostatic mixing valve is not provided at the outlet of the domestic hot water heater, provide one of the two options:
  - Thermostatic shower valve.
  - Point-of-use thermostatic mixing valve, upstream of the shower on the domestic hot water side.

.4 Floor Drains

- Suite and plumbing fixtures are vulnerable to general abuse and misuse. Therefore, the requirement for additional floor drains is to assure the mitigation of additional property damage due to floods and leaks caused by the mistreatment of fixtures.

OBJECTIVE

.1 The intent of this section is to provide guidance to mechancial consultants regarding the REFM preferences arising from previous experiences, failures, maintenance knowledge, and understanding of the piping systems. This section is not intended to be all inclusive and any deviations must be discussed with REFM prior to the issuance of tender documents.

CRITERIA

PEX Piping for A/LL Domestic Water Supplies

.1 Domestic water supplies (up to 50mm [2”] diameter) must be cross-linked polyethylene (PEX), or stainless steel.

.2 Domestic water supplies (65mm [2.5”] and greater) must be ductile iron or stainless steel.

.3 The use of PVC, CPVC and Aquatherm are not acceptable piping materials for domestic water use.

.4 Storm piping must consist of cast iron piping, and must be insulated throughout the building, from the drain body to utility connection.

.5 Cleanouts on drainage piping must consist of a wye-fitting and a cap. Manufactured cleanout caps must not be used unless approved otherwise by REFM.

.6 The use of PEX piping for domestic hot water recirculation is **not permitted**, use stainless steel piping.

GUIDANCE

WYE Fitting for Cleanouts

.1 The use of PEX should be limited to residential, tenant improvement/renovations, and field house type projects, and shall be at the discretion of the REFM.

.2 PVC and CPVC piping may only be used in recreational projects for use in pools. Aquatherm has been found to have premature failures arising from the installation of the piping and fittings, and being combined with copper piping.

.3 Manufactured cleanouts have been found more difficult to use for maintenance purposes. Consultants should be aware that the wye-fittings require more space within walls.

GENERAL (EXAMPLE)

.1 The following pertains to following Mechanical specification sections:

- 22 11 16 – Domestic Water Piping.
- 22 13 00 – Facility Sanitary Sewerage.
- 22 14 00 – Facility Storm Sewerage.

.2 References:

- CSA B137.5 – Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications.
- ASME B36.19M – Stainless Steel Pipe.

PRODUCTS

.1 Ductile Iron Water Pipe Inside the Building:

- Special Class, ductile iron pipe, cement mortar lined, ULC Listed, conforming to:
  - Minimum thickness class 54.
  - AWWA C150 - Thickness Design of Ductile-Iron Pipe.
  - AWWA C151/A21 - Ductile-Iron Pipe, Centrifugally Cast.
  - AWWA C104-13 Cement Mortar Lining for Ductile Iron Pipe.
  - Interior: Asphalt seal coating on the inside cement mortar lining. For use in potable water systems.
  - Exterior: Alkyd phenolic primer and protective enamel finish.

.2 Stainless Steel Piping Systems:

- Pipe:
  - Only 304/304L or 316/316L stainless steel pipe must be used.
- Stainless steel pipe must conform to:
  - ASTM A312 / A312M and ASME B36.19M, Type 304/304L or 316/316L, Schedule 10, or 40. Roll grooved as appropriate to the pipe material, wall thickness, pressure, size and method of joining. Use roll sets specifically designed for grooving the applicable stainless steel pipe.
  - Pipe ends must be roll grooved in accordance with AWWA C606 and must be free from indentations, projections, burrs, roll marks, etc. where the gaskets are seated. Roll grooves must be well defined with fully formed vertical flanks.

- Stainless steel pipe sizes:
  - 50mm (2”) and smaller: Schedule 10 suitable for use with press type fittings.
  - 65mm (2-1/2”) to 150mm (6”): Roll grooved schedule 10 suitable for use with galvanized rigid style mechanical couplings.
  - 200mm (8”) to 300mm (12”): Roll grooved schedule 10 suitable for use with galvanized rigid style mechanical couplings.

EXECUTION

.1 Crosslinked Polyethylene (PEX) Pipe:

- Installers must be trained and certified by the manufacturer to install pipe and fittings according to the manufacturer’s guidelines.
- All expansion tools used with cold expansion fittings must be as recommended by the fitting manufacturer.
- Installers must comply with the manufacturer’s technical guidelines including but not limited to technical manuals installation guides, technical bulletins, and product submittals.
- The minimum bend radius for cold bending of the pipe must be not less than six (6) times the outside diameter. Bends with a radius of less than this requires a bending template as supplied by the pipe manufacturer.
- Where fittings are encased in concrete or buried underground, they must be wrapped as per the manufacturer’s recommendations to protect the material.
- Piping that passes through expansion joints or walls must be covered in protective polyethylene convoluted sleeving (flexible conduit) extending 400mm (16”) on each side of the joint. Secure sleeving on pipe to prevent movement during installation.
- Provide a protective conduit around the pipe when entering walls. Extend 150mm (6”) on either side of the entry. For penetrations at manifolds, use rigid PVC bend guides.
- PEX tubing passing through metal studs must be used with grommets or sleeves at the penetration.
- Manufacturer’s wall penetration brackets must be used at all wall membrane penetrations.
- Hangers and support spacing must follow the recommendations of the pipe manufacturer and the applicable building/plumbing code.

.2 Stainless Steel Pipe:

- Preparation:
  - Stainless steel must be cut with a wheeled pipe cutter or approved stainless steel pipe cutting tool. The pipe must be cut square to permit proper joining of the fittings.

- Remove scale, slag, dirt and debris from inside and outside of pipe and fittings before assembly.
- The pipe end must be wiped clean and dry. The burrs on the pipe must be reamed with a deburring or reaming tool.

.3 Installation:

- Stainless steel press connections must be made in accordance with the manufacturer's installation instructions.
- Provide protection against abrasion where stainless steel pipe is in contact with other building members by wrapping with an approved tape, pipe insulation or otherwise suitable method of isolation.
- Provide allowance for thermal expansion and contraction of stainless steel pipe passing through a wall, floor, ceiling or partition.
- Vertical stainless steel pipe must be supported at each floor or at 3m (10ft.) intervals.
- Where a hanger or support for stainless steel pipe or tube is of a material other than stainless steel, it must be suitably separated and electrically insulated from the pipe or tube.

.4 Hangers and Supports:

- Spacing of hangers and supports for stainless steel pipe:
  - Size smaller than 25mm (1"): Maximum spacing of 2.5m (8.2ft.).
  - Size 25mm (1") and larger: Maximum spacing of 3m (10ft.).
- Spacing of hangers and supports for stainless steel tube:
  - Size smaller than 25mm (1"): Maximum spacing of 2.5m (8.2ft.).
  - Size 25mm (1") and larger: Maximum spacing of 3m (10ft.).

OBJECTIVE

.1 The intent of this section is to provide general guidance to mechanical consultants regarding the REFM preferences (i.e. previous experiences, maintenance etc.), and should be considered within the project's context. The general intent of this section is to provide quality assurance, future ease of maintenance, accessibility, and good practice.

CRITERIA

.1 All new projects must follow the British Columbia Insulation Contractors Association (BCICA) Quality Assurance Certificate Program (QACP).

.2 All mechanical fittings must be supplied with removable insulation and jacketing (where applicable).

.3 Insulation Finishing:

- Interior (Exposed) – Canvas, PVC or aluminum/stainless steel jacketing.
- Exterior – Aluminum/stainless steel jacketing with watertight seal (refrigerant piping to also follow these requirements).

.4 All rainwater leaders (including drain body) must be insulated throughout the building, from the drain body to utility connection.

.5 Flexible elastomeric (closed-cell) insulation is acceptable.

.6 All insulation tradespersons shall have a Red Seal or TQ designation in the Heat and Frost trade, and / or registered apprentices / helpers supervised by qualified journey-persons.

.7 Workmanship must conform to the latest QAC Standards as published in the BCICA Quality Standards for Mechanical Insulation (Commercial and Institutional Buildings) Manual (QSMIM).

.8 Pipe insulation R-Value shall meet or exceed pipe insulation R-Value prescribed by ASHRAE 90.1 (latest edition).

GUIDANCE

.1 Quality assurance is a high priority to REFM. Following the BCICA QACP ensures qualified journeypersons will undergo technical reviews to ensure compliance with specifications. This program also provides a level of confidence in the installation due the on-site review reports and the final certification from a BCICA representative.

.2 It has been found that cutting of insulation disrupts continuous vapour barriers and in general the insulation continuity at points in which regular maintenance is typically required. The allowance of removable insulation will provide ease of maintenance and assurance that the piping insulation is maintained throughout the life of the building.

.3 The insulation finishes ensure a level of protection is provided and maintained across all of REFM's buildings. These have been used and have been found to provide adequate protection from everyday wear and tear from occupants or the elements.

.4 The insulation of the storm water system is to avoid the potential for condensing on cast iron piping within the building.

.5 Flexible elastomeric (closed-cell) insulation is an approved alternative that has been used previously and has been found to be easily installed and easily maintained during renovations or repairs.

GENERAL (EXAMPLE)

.1 The following pertains to following Mechanical specification sections:

- 22 07 19 – Plumbing Piping Insulation.

.2 References:

- British Columbia Insulation Contractors Association (BCICA) – Quality Standard for Mechanical Insulation Manual.

PRODUCTS

.1 Preformed Pipe Covering

- Piping Thermal Insulation:
  - Preformed insulation formed glass mineral wool pipe insulation with all service jacket vapour retarder (ASJ). ASJ must be re-enforced with glass fibre, factory applied with pressure sensitive lap closure.
- Piping service temperature 0°C to 315°C (32°F to 599°F).
- ASJ vapour transmission rate 0.02 perms maximum.
- "K" value at 24°C (75°F) = 0.033 W/m.°C (0.23 Btu.in/hr.ft^2°F).
  - Flexible elastomeric (Closed-Cell) insulation complying with ASTM C534, Grade 1, Type 1 for tubular materials. Self-adhering tape specifically engineered to cover joints of self-adhering elastomeric tube material.
- Piping service temperature -183°C to 105°C (-297°F to 220°F).
- Water Vapour Permeability transmission rate 0.05 perms maximum.
- "K" value at 24°C (75°F) = 0.035 W/m.°C (0.25 Btu.in/hr.ft^2°F)

.2 Finish Jackets

- Jackets:
  - Thermocanvas Jacket: fire rated, 170g (6oz) fire retardant canvas jacket for covering mechanical insulation indoors, 25/50 fire class, plain wave cotton, no dyes.
  - All Service Jacket: high puncture and tear resistance with 0.03mm minimum thick foil. Water vapour permeance of 0.02 perms maximum. Self-adhesive material, flame spread/smoke development rating not to exceed 25/50.
  - PVC Finishing Jacket: white, UV resistant, for indoor or outdoor applications, 25/50 fire class, minimum 0.50mm thick.

- Aluminum Jacket: 0.51mm (22ga.) thick stucco or smooth aluminum jacketing with longitudinal slip joints and 50mm end laps with factory applied protective liner on interior surface.

- Preformed Fitting Covers:
  - PVC Fitting Covers pre-moulded one-piece covers, white, UV resistant, for indoor or outdoor applications, 25/50 fire class, minimum 0.50mm thick.
  - Aluminum Fitting Covers: Die shaped components with factory applied protective liner on interior surface, 0.51mm (22ga.) thick.

EXECUTION

.1 Cold Water Application

- Screwed or welded fittings:
  - Insulate fittings with a section of the pipe insulation mitered to fit tightly. All seams must be sealed using vapor retarder tape.
  - Ensure insulation and fitting covers (where applicable) are removable.
- Flanged and grooved fittings:
  - Insulate with oversized pipe insulation or mitered blocks to the thickness of the adjacent pipe insulation, then seal all seams of vapor retarder jacket with vapor retarder tape.
  - Ensure insulation and fitting covers (where applicable) are removable.

.2 Hot Water Application

- Screwed or welded fittings:
  - Insulate fittings with sections of the pipe insulation mitered to fit tightly, or with tightly placed flexible insulation covered with reinforcing membrane stapled in place. Alternately, insulate fittings with tightly placed flexible insulation and apply PVC fitting covers.
  - Ensure insulation and fitting covers (where applicable) are removable.
- Flanged and grooved fittings:
  - Insulate with oversized pipe covering or mitered blocks to the thickness of the adjacent pipe covering. Alternately, insulate with tightly placed flexible insulation and apply PVC fitting covers.
  - Ensure insulation and fitting covers (where applicable) are removable.

.3 Finishes

- Exposed Piping Indoor (Canvas) CPF/1:
  - The factory applied integral all service jacket must be neatly applied to receive the fabric jacket. Apply a jacket with a fire resistive lagging coating. Apply a finishing coat of fire resistive lagging coating.
- Exposed Piping Indoor (PVC Jacket) CPF/4:
  - Apply PVC jacketing using necessary fastenings on approximately 300mm centers, or bond using an adhesive recommended by the manufacturer to provide a continuous seal. Overlap each section by a minimum of 75mm. Cover longitudinal and circumferential joints with finishing tape neatly applied. On hot piping, tacks may be used to secure jacket laps. Tacks are to be applied on 100mm (4”) centers.
  - Apply PVC jacket or preformed PVC fitting covers over insulated fittings, valve bodies, valve bonnets, strainers, and flanges to provide a complete jacket system. Secure with appropriate fastenings and jacket finishing tape.
- Exposed Piping Outdoor (Metal Jacket) CPF/3:
  - On fiberglass style insulation, apply a coat (minimum 1 litre per 1.5m) of weather coating over the insulated surfaces. While still wet, embed a layer of reinforcing membrane and finish with a final coat (minimum 1 liter per 1.5m) of weather coating.
  - On elastomeric style insulation, provide two (2) coats of Armaflex WB finish or equivalent weather resistant coating. Coverage must be as per manufacturers recommendations.
  - Apply metal jacketing with a 60mm overlap at 3 o’clock using necessary fastenings on approximately 150mm (6”) centers.
  - Over insulated fittings, valve bodies, valve bonnets, strainers and flanges apply metal jacket or preformed metal fitting covers to provide a complete jacket system. Secure with necessary fastenings.

OBJECTIVE

.1 The purpose of this section is to provide guidance to mechancial consultants regarding REFM's standpoint on domestic hot water systems and the willingness and interest in looking at decarbonizing their buildings, both new and existing. As this technology is developing quickly, each project will need to be considered on its own to determine which system is suitable.

CRITERIA

.1 Domestic hot water systems must meet the goals of zero emissions domestic hot water systems and have buildings equipped with zero emissions hot water heating systems.

.2 For tenant improvements and minor renovations, the design consultants must remove fuel fired equipment and replace them with zero emissions electrified systems unless not proven to be feasible due to a lack of electrical power, space, or other constraints.

.3 The solution for each building may depend on various constraints but the following are some known solutions, this is not meant to be a comprehensive list, but to provide guidance:

- High-efficient heat pump style systems:
  - Refrigerant based (i.e. R-134a, R410a, CO_2); Nyles, Mitsubishi, Water Drop, Lync, Colmac or Sanden.
- Electric resistance style systems:
  - These options are more suitable to small tenant improvements or buildings with small hot water demands and usage which can also eliminate or limit the need for recirculation on very small systems.

.4 DHW supply temperature for laundry rooms shall be 60°C (140°F) at point of use (inlet of laundry machine), which can be achieved by:

- Electric booster water heater.
- Laundry machine with internal heater.
- DHW system that maintains 60°C (140°F) at point of use.

.5 All domestic hot water tanks to be:

- Seismically secured
- Provided with drain pan installed and piped to drain
- To be set at 60°C (140°F) minimum.

GUIDANCE

.1 REFM is looking to advocate sustainable designs and reduce carbon emissions and in doing so will follow the City of Vancouver's Zero Emissions Building Plan (https://vancouver.ca/green-vancouver/zero-emissions-buildings.aspx).

.2 As REFM begins to implement and install new high-efficient electrified domestic hot water systems, the next step will be upgrading aging domestic hot water systems during renovations. The intent is to replace all fuel fired systems with zero emissions domestic hot water plants. The mechanical consultants must show due diligence and sufficient cause to not implement zero emissions systems. This will require coordination with the electrical and architectural consultants.

GENERAL

.1 The following pertains to mechanical specification sections and is intended only to be used as an example of a system that has currently shown as a good high efficiency zero emissions domestic hot water heating system:

- 22 33 00 – Domestic Water Heaters.

PRODUCTS

Air-to-Water Heat Pump Hot Water System (EXAMPLE):

.1 Heat Pump Unit:

- Heat pump water heater must be packaged air source equipment, factory assembled, charged, and tested. The heat pump must be suitable for heating potable water with published heating capacity and COP based on project specifications.
- Heat Pump units must consist of compressor, condenser, evaporator coil, direct drive axial fan or a centrifugal blower, hot water circulating pump, piping, and controls; they must be factory assembled, charged, and tested.
- All components, including assemblies, sub-assemblies and the materials that go into constructing the heat pump water heater's potable water system must be certified for coming in direct contact with potable water, including but not limited to: piping, brazing, soldering or welding materials, circulator pumps, flow sensors, temperature sensors, thread sealants, flow control valves, and flat plate heat exchangers.
- The entire heat pump must be UL1995-Standard for Heating and Cooling Equipment.
- Electrical: Unit control panels must be UL1995-Standard for Heating and Cooling Equipment and UL508A-Standard for Heating and Cooling Equipment listed.

.2 Cabinet:

- The cabinet must be either corrosion resistant epoxy coated 12-gauge aluminum, 304L stainless steel, or 316L stainless steel. Supports, channels and beams must also be constructed of the like.
- Compartments must have large access doors for servicing.
- Refrigerant components must be in a separate compartment from fan for in-operation servicing.
- Unit must have stainless steel drip pan for condensate.
- Cabinet must be designed for outdoor operation.
- Cabinet must be insulated to prevent condensation from forming on exterior surfaces.

.3 Compressor:

- Hermetic scroll type or reciprocating piston type suitable for high temperature operation with R-134a refrigerant. Compressor must be furnished with service valves for suction and discharge connections.

.4 Compressor controls/accessories must include the following:

- High pressure safety monitoring.
- Low pressure safety monitoring.
- Multi-function phase failure relay (scroll types).
- Active compressor mounted protection with advanced algorithms, fault history, and LED indicators. (scroll types).

.5 Condenser:

- The condenser must be a 316L Stainless steel copper brazed plate vented double wall type, standard on all units. Single wall condenser construction is not allowed. The UL Listed, NSF 61 OR 372 compliant, and suitable for up to 232°C (450°F) high temperature operation with potable water.
- The condenser unit must be operational pressure rated to no less than 435 PSI (30 Bar), with built in temperature ports for performance monitoring.
- The refrigerant must be R-134a.
- Refrigerant Accessories:
    - Filter-drier: Sweat connection type.
    - Site Glass: Moisture indicating type.
    - Liquid Line Service Valves: Bronze quarter turn type.
    - Discharge Check Valve: Copper magnetic in-line type.
    - Liquid Line Solenoid Valve: Electrically actuated.
    - Compressor Crankcase Heater: Belly band type for scroll compressors.
    - Suction Accumulator.
    - Liquid Receiver.

.6 Fan:

- The fan arrangement must be draw-through design, 600mm (24”) direct-drive axial fan with high-performance axial impeller with integrated control electronics. Corrosion-resistant galvanized sheet steel, coated with black plastic, aerodynamically optimized guard grille.

.7 Evaporator Coil:

- The evaporator coil must be copper tube with aluminum fins with E-Coating for corrosion protection.
- Condensation must be captured and drained to a single point connection with standard pipe threads.

- Expansion Valve.
- Thermal expansion valve must be specifically designed for heat pump use with field adjustable superheat feature.

.8 Anti-Short Cycle Control

- Anti-Short Cycle Control: Units must be factory wired to allow a maximum of twelve compressor starts per hour to prevent compressor short cycling and allow time for suction and discharge pressures to equalize, permitting the compressor to start in an unloaded condition.

Water-to-Water Heat Pump Hot Water System (EXAMPLE)

.1 Heat Pump Unit:

- Heat pump water heater must be packaged water source equipment, factory assembled, charged, and tested. The heat pump must be suitable for heating potable water with published heating capacity and COP based on project specifications.
- Heat pump units must consist of compressor, condenser, evaporator, hot water circulating pump, piping, and controls, all factory assembled, charged, and tested.
- All components, including assemblies, sub-assemblies, and the materials that go into constructing the heat pump water heater's potable water system must be certified for coming in direct contact with potable water, including but not limited to: piping, brazing, soldering or welding materials, circulator pumps, flow sensors, temperature sensors, thread sealants, flow control valves and flat plate heat exchangers.
- Entire heat pump must be UL1995-Standard for Heating and Cooling Equipment.
- Electrical: Unit control panel must be UL1995-Standard for Heating and Cooling Equipment and UL508A-Standard for Heating and Cooling Equipment listed.

.2 Cabinet

- The cabinet must be either corrosion resistant epoxy coated 12-gauge aluminum, 304L stainless steel or 316L stainless steel. Supports, channels and beams must also be constructed of the like.
- Compartments must have large access doors for servicing.
- Cabinets must be designed for outdoor operation.
- Cabinets must be insulated to prevent condensation from forming on exterior surfaces.

.3 Compressor

- The compressor must be a hermetic scroll type or reciprocating piston type suitable for high temperature operation with R-134a refrigerant. The compressor must be furnished with service valves for suction and discharge connections.

- Compressor controls/accessories must include the following:
  - High Pressure Safety monitoring.
  - Low Pressure Safety monitoring.
  - Multi-function Phase Failure Relay (scroll types).
  - Active compressor mounted protection with advanced algorithms, fault history, and LED indicators. (scroll types).

.4 Condenser

- The condenser must be 316L Stainless steel copper brazed plate vented double wall type, standard on all units. Single wall condenser construction is not permitted. UL Listed, NSF 61 OR 372 compliant, and suitable for up to 232°C (450°F) high temperature operation with potable water.
- The condenser unit must be operational pressure rated to no less than 435 PSI (30 Bar), with built in temperature ports for performance monitoring.
- The refrigerant must be R-134a.
- Refrigerant Accessories:
  - Filter-Drier: Sweat connection type.
  - Site Glass: Moisture indicating type.
  - Liquid Line Service Valves: Bronze quarter turn type.
  - Discharge Check Valve: Copper magnetic in-line type.
  - Liquid Line Solenoid Valve: Electrically actuated.
  - Compressor Crankcase Heater: Belly band type for scroll compressors.
  - Suction Accumulator.
  - Liquid Receiver.

.5 Evaporator

- The Evaporator must be a 316L Stainless steel copper brazed plate single wall type, standard on all units. Unit must be operational pressure rated to no less than 435 PSI (30 Bar), with built in temperature ports for performance monitoring.
- The refrigerant must be R-134a.
- The evaporator must be a copper tube with aluminum fins with E-Coating for corrosion protection.
- Condensation must be captured and drained to a single point connection with standard pipe threads.

.6 Expansion Valve

- The thermal expansion valve must be specifically designed for heat pump use with field adjustable superheat feature.

.7 Anti-Short Cycle Control

- Units must be factory wired to allow a maximum of twelve (12) compressor starts per hour to prevent compressor short cycling and allow time for suction and discharge pressures to equalize permitting the compressor to start in an unloaded condition.

EXECUTION

.1 Installation

- Water heaters must be installed level and plumb in accordance with manufacturers written instructions and referenced standards. Materials shall conform to all manufacturer's recommendations including electrical connections and wiring.
- Water heater must be installed with individually isolating shut-off valves for servicing and maintenance.
- All electrical requirements must be coordinated with Division 26.

.2 Start-Up

- Start-up on the unit must be performed by factory trained and authorized personnel. A copy of the start-up report must be provided to the owner and factory.

OBJECTIVE

.1 The intent of this section is to provide general guidance to mechanical consultants regarding the REFM preferences (i.e. previous experiences, maintenance etc.), and should be considered within the project's context. The general intent of this section is to provide quality assurance, future ease of maintenance, accessibility, and good practice.

CRITERIA

.1 Use stainless steel pipe for DHWR lines. Copper tubing and PEX pipe is not acceptable as a DHWR piping material.

.2 Design DWHR system using combination of variable flow pump (pressure control) and thermosetter thermal balancing valves.

.3 DHWR system should be designed to reduce hot water wait time to 30 seconds or less.

GUIDANCE

.1 Specify thermosetter thermal balancing valve for use as domestic hot water return (DHWR) balancing valves. The valve will modulate the DHWR flowrate to maintain DHW temperature at the branch pipe which brings several advantages:

- Reduces DHWR flowrate which equates to a reduction in pipe erosion.
- Thermosetter valve will ensure the DHW temperature at the pipe branch does not drop below set point.
- Eliminates requirement for DHWR balancing.
- Allow for modulation of the DHWR pump based on a pressure setpoint when paired with a VFD pump.

.2 Specify VFD pump that can be controlled based on the pressure set point for DHWR pump to fully take advantage of the thermosetter thermal balancing valve.

OBJECTIVE

.1 The intent of this section is to provide general guidance to mechanical consultants regarding the REFM preferences (i.e. previous experiences, maintenance etc.), and should be considered within the project's context. The general intent of this section is to provide quality assurance, future ease of maintenance, accessibility, and good practice.

CRITERIA

.1 To prevent possible crossovers between cold and hot water provide external spring-loaded check valves on each cold and hot water supply upstream of the fixture.

.2 Selection of backflow preventer devices shall follow City of Vancouver Water Work By-Law no. 4848.

.3 Backflow preventer devices shall installed to meet CSA B64.10-17 (R2021) - Installation of Backflow Preventers and Vacuum Breakers.

GUIDANCE

.1 Install external check valves on each cold and hot water supply upstream of faucet where crossover between DCW and DHW can occur if discharge outlet is closed. Example of plumbing fixture where cross over can happen are (but not limited to):

- Mop Sink/Service Sink Faucet.
- Hands Free Faucet.
- Eye Wash.
- Emergency Shower.
- Pre-Rinse Unit.

.2 Follow CSA B64.10-17 (R2021) installation requirement for backflow preventer, especially for clearances and connection to drain.

G ELECTRICAL

OBJECTIVE

.1 The intent of this section is to provide general guidance to the electrical consultants on the REFM preferences for ongoing maintenance of the electrical systems in their facilities. These criteria are meant to enhance electrical systems maintainability, reliability, and flexibility / ease of future renovations.

CRITERIA

.1 Design & Review Process:

- The electrical consultant is required to submit design documents for review by REFM team at the following design staged, with enough time to incorporate any feedback:
  - 100% Schematic Design (SD).
  - 100% Design Development (DD).
  - 50%, 75% and 90% Construction Documents (CD).
- Design documents submitted for REFM review must include (where applicable), starting at the 100% Schematic Design submission:
  - Design brief / basis of design.
  - Owner project requirements (developed by Commisisoning Provider).
  - Single line diagrams showing existing equipment, proposed modifications and new components.
  - Electrical load calculation to determine existing and future demand load.
  - Equipment list including electrical data for existing and proposed new equipment.
  - Electrical room locations and equipment layouts, including existing electrical room layouts with proposed modifications.
  - Floor plan showing the existing equipment in scope.
  - Conceptual plans addressing specific functions.
  - Lists of approved systems/vendors (complete specifications not required).
  - Capacity provisions included for future electrification (for facilities where heating/cooking initially uses gas).

- Design documents submitted for REFM review must include, starting at the 100% Design Development submission:
    - Design brief / casis of design.
    - Service rooms layout - final version.
    - Main service distribution layout and elevation showing dimensions.
    - Floor plans and layouts for all systems.
    - Riser diagrams.
    - Control schematics and sequence of operation.
    - Cable routing and penetration details.
    - Grounding and bonding details.
    - Equipment schedules including luminaire schedule with mounting/service access details.
    - Panel schedules - type, bus rating, size, etc.
    - Complete single line diagram.
    - Final load calculation.
    - Fault current rating of the electrical equipment.
    - Fault current calculation at the main distribution.
    - Specifications.
- Design documents submitted for REFM review must include, by the 90% Construction Drawings submission:
    - Final version of detailed drawings.
    - Final version of the specifications.
    - Final equipment circuiting.
    - Final panel schedules showing connected and demand load.
    - Schematic details.
    - Demonstrated load study for all existing equipment intended to serve added loads (complete by 50% construction documents review, performed by a P.Eng. registered in BC).
- An Issued for Construction document set must be issued including all addendums issued during Tender process.

.2 Equipment Selection:

- All electrical systems and manufacturers used shall have parts, replacements, and service available through local suppliers and wholesalers.

.3 Electrical Rooms & Equipment Locations:

- Electrical rooms shall be built with access from common spaces or other service rooms (i.e. not through washrooms or tenant spaces) and constructed with enough empty space to add/modify equipment in the future.
- Provide space in new electrical rooms to increase the initial footprint of equipment in the room by at least 10%, with sufficient space for at least two 42-circuit panels.
- Electrical equipment shall be located in electrical rooms, except for panel boards, which may be located in corridors, other service rooms or occupied spaces, and MCCs or motor starters, which may be located in mechanical rooms.
- Panel boards shall not be located in lobbies, social housing corridors, washrooms, wet locations, chemical storage areas, or outdoors (unless installed in a weatherproof kiosk).
- Electrical equipment shall be installed above mandated flood construction levels (FCL), except where the equipment only serves areas below the FCL (e.g. panel boards serving below-ground parkades)
- Unsprinklered electrical rooms with fire ratings of 2-hours or higher are preferred to sprinklered electrical rooms, to prevent damage from sprinkler leakage or discharge.
- Concrete housekeeping pads (89mm [3.5”] minimum depth) shall be provided for all floor-mounted electrical equipment.
- Structural/seismic restraint and anchorage details, roof supports and bracing details for electrical components shall be provided with a letter of assurance by a professional structural engineer registered in BC.
- Surface mounted (wall mounted) electrical equipment and junction boxes are preferred to be mounted to shallow stut (unistrut/cantruss) support, not directly to wall.
- Provide drip hoods on surface mounted panels in service rooms.

.4 Spare Capacity & Spare Parts:

- Electrical system components (switchgear, switchboards, CDPs, panelboards, MCCs, transformers, feeders, and cable tray) shall be provided with 20% spare capacity (i.e. 20% of the initial peak demand) and 20% of the breaker slots left empty to allow future expansion or renovations.
- 20% of the number of each type of ballast, driver, lamp, and replaceable light module shall be provided as spares, with a minimum of 2 spares and a maximum of 20 spares per fixture type. Alternately, spare luminaires can be provided instead of components.
- 3 fuses of each type & size shall be provided as spare, or 10% (whichever is larger).

- Provide one (1) spare 100mm (4”) secondary feeder conduit from exterior pad-mount transformers to the main electrical room inside the facility, capped off.

.5 Labelling & Identification:

- All power distribution equipment shall be labelled with permanent black lamicoids (red for emergency power) with white lettering, indicating both the equipment name and the name of the upstream source equipment feeding it.
- Normal power receptacles shall be ivory coloured, with red for emergency and orange for UPS receptacles.
- Indoor power distribution equipment enclosures shall be ANSI 61 Gray and outdoor power distribution equipment enclosures Munsell Green 7GY 3.29/1.5.

.6 A consistent naming/numbering convention shall be used for all equipment as follows, with renovation projects using identical naming conventions as the base building, without repeating names:

- One to three letter code for equipment type:
  - Panel = P
  - Centralized distribution panel board = CDP
  - MCC = MCC
  - Transformer = T
- One digit code for voltage level (2 = 208Y/120V or 240/120V, 4 = 480V, 6 = 600V).
- One letter code for power type (N = normal power, E = emergency, U = UPS).
- One to two digit code for floor number.
- One letter code for panel identifier (in alphabetical order, without repeating letters on the same floor).
- For example, a 600Y/347V panel on emergency power on the first floor below ground level could be named P6E-B1A.

.7 Source equipment ID and circuit numbers shall be marked at all boxes, outlets, and conduit stub-up/stub down locations. Markings shall include:

- Adhesive labels on outlet cover plates,
- Permanent marker labelling inside all junction and outlet boxes, visible after wiring has been installed,
- Adhesive labels or permanent marker labelling on conduit stub-up/down locations.

.8 Commissioning:

- Commissioning of Electrical Systems to Include:
  - Breaker, fuse, relay settings and CT / VT ratios documented after implementation of protective device coordination study.
  - Comprehensive documentation for high voltage ground grid installation – including final as-built grid layout, grounding connection schematic, earth resistivity test results, fall-of-potential (electrode resistance) test results, and step and touch potential calculation results.
  - Bonding commissioning report for metallic structures in pool areas.
  - Switchgear and transformer commissioning reports – including final transformer tap settings and any high voltage transformer insulation resistance and polarization index results.
  - Third party lighting controls commissioning including daylighting and occupancy sensor calibration, adjustment of multi-level dimming setpoints, and interface setup for operators.
  - Lighting illuminance testing and reports.
  - Heat tracing systems, including verification of proper heating and temperature control operation, GFCI operation, and supervisory monitoring where applicable.
  - EV charger commissioning including communications, authorization and payment, and load management functions.
  - Submeter commissioning including revenue certifications, communications, data aggregation, and interface setup for operators.
  - Power quality commissioning report documenting power quality (harmonics, fast transients, voltage surges & sags) at central distribution panels on each power branch with facility in full operation.
  - Smart thermostats and other IoT devices, including communications connectivity, schedules and setpoints, and interface setup for operators.
  - Witness tests/demonstrations of all systems with the specialty engineer of record present.
- Any proprietary commissioning tools (e.g. handheld wireless programming tools for lighting controls) shall be provided to REFM maintenance to allow future re-programming/recommissioning without service calls to the vendor.
- Complete information for the final as-built system configuration shall be provided as part of the O&M manuals, with copies of the program/configuration files if available. This includes VFDs, lighting controls, etc.

.9 Record Documentation:

- The contractor shall provide the following documentation for each system as part of the Operation and Maintenance (O&M) manual:
    - Complete list of replaceable parts with part numbers and contact info for ordering replacements and service.
    - Project record drawings, provided as electronic files (file format: .DWG/.RVT and .PDF or equivalent) showing location of all equipment, devices, circuiting, controls, demark connections, schematics, riser diagrams, conduit and box locations. An electronic set of CAD files and BIM models along with associated library, XREFs and linked files shall be included.
    - Lighting control and fire alarm zones shall be clearly identified on the record drawings.
    - Typewritten panel board schedules shall be provided in each panel, with copies in the O&M manual.
    - Testing and commissioning reports and checklists.
    - A training attendance sign-off sheet. This sheet shall identify the site, time and date as well as a listing of all those in attendance, and electronic and/or paper copies of any available training materials.
- As-built drawings (red lined) are prepared by the contractor and passed on to the consultants to incorporate them into the record drawings. Project record drawings shall include, but not limited to:
    - Dimensioned in-slab conduit and box locations.

.10 Power Studies:

- For new facilities as well as modifications, additions, changes of use or occupancy types in CoV owned and operated facilities with three-phase power services, specification shall call for short circuit study, coordination study and arc flash analysis based on IEEE 1584-2018 for all new distribution equipment at the facilities, and any existing equipment with coordination or arc flash levels affected by renovations.
- Changes to panel boards or distribution transformers in tenant improvement (TI) projects do not require arc flash analysis if the equipment only serves the TI space and live work is not expected to be needed. This should be confirmed by the TI engineer of record.
- Scope and deliverable requirements of arc flash studies shall conform to IEEE 1584.1-2022.
- Shock and arc flash warning labels shall be installed on all electrical power distribution equipment rated over 30V in all types of facilities. Arc flash warning labels in small facilities with single-phase power may be general warning labels without incident energy information.

- Power study shall be done by power distribution equipment manufacturers or a third-party specialist firm, using SKM or ETAP software, with arc flash labels applied onsite by the firm performing the study.
- All electronic files for the power study computer models, including library files, must be handed over to CoV for future power study updates.
- All distribution transformers, disconnect switches, mechanical package units and anything that may require infrared scans or clamp-on CTs attached while the equipment is energized should be included in the arc flash analysis.

GUIDANCE

.1 Design & Review Process:

- Having a design review at schematic design phase allows for timely feedback on the basic design concepts and parameters, so that changes can be made with minimum rework and interdisciplinary coordination needed. The pre-tender review allows for design details such as access and maintainability to be reviewed while still allowing changes to be made cost-effectively (i.e. without change order pricing).
- Luminaire details, equipment layouts, manufacturers, and overall system functions are most important to review as these elements have the most impact on electrical systems' serviceability and reliability.

.2 Equipment Selection:

- Electrical system vendors without sufficient local representation or parts availability may lead to downtime at the facility if there are delays in obtaining parts or service and could increase maintenance costs from having to obtain and store extra parts and fixtures.

.3 Electrical Rooms & Equipment Locations:

- Electrical rooms and locations of equipment should be designed to prevent water damage, including overland floods, corrosion due to moisture, sprinkler operation or piping leaks. Equipment should also be located to minimize vandalism and damage from the public or building occupants, and to allow maintenance with minimum disruption to the occupants. The room designs should include sufficient space to perform maintenance and make changes in future renovations.

.4 Spare Capacity & Spare Parts:

- A small quantity of spare parts stocked onsite will allow replacement of failed components with minimal downtime. A larger quantity of spares is needed for LED drivers due to fast development cycles and obsolescence. Spare capacity in equipment will minimize the cost of small renovations in the future and allow for moderate load increases without having to make major equipment upgrades. Priority should be given to selecting equipment models that are likely to have spare parts after completion of construction.

.5 Labelling & Identification:

- Consistent, clear labeling allows circuits to be easily traced and power sources to be identified, improving the ability for maintenance staff to troubleshoot and restore power outages and modify wiring when needed. Standard colours for equipment allow a minimal number of paint types to be needed for paint touch-ups.

.6 Commissioning:

- The commissioning process should be methodical and thorough, with independent verification of proper installation and operation for the key areas listed (at a minimum). Documentation and tools that can facilitate recommissioning, troubleshooting, and preventative maintenance should be provided to REFM to assist them in these activities.

.7 Record Documentation:

- Comprehensive, accurate record drawings, schedules, and system details make ongoing system troubleshooting and maintenance much easier. The same information is also very useful for designing and implementing future renovations of the spaces.
- Contractor to provide single line electrical drawings, including identified and labelled emergency power circuits.

.8 Power Studies:

- Detailed arc flash assessments and labelling of equipment allows REFM and future facilities contractors to implement robust arc flash safety protocols. Providing the electronic system models allows these studies to be kept up to date at a reasonable cost, without duplicating previous efforts. Protective device coordination is important for improving electrical reliability and minimizing outage, while ground grid information is useful when implementing future high voltage equipment upgrades.

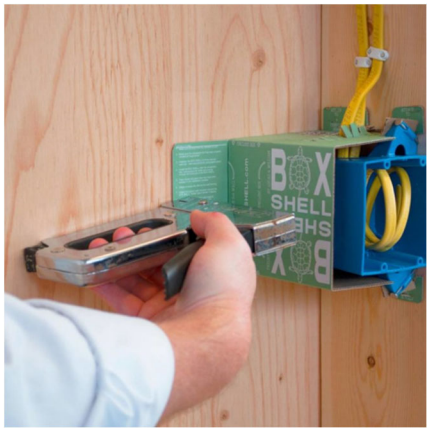
OBJECTIVE

.1 The intent of this section is to ensure that high-quality wiring methods are used, which minimize corrosion, failure of wiring supports, transmission of vibration, voltage drop, conduit damage, and make wiring easier to reconfigure and replace during maintenance or renovations.

CRITERIA

.1 General Wiring Methods:

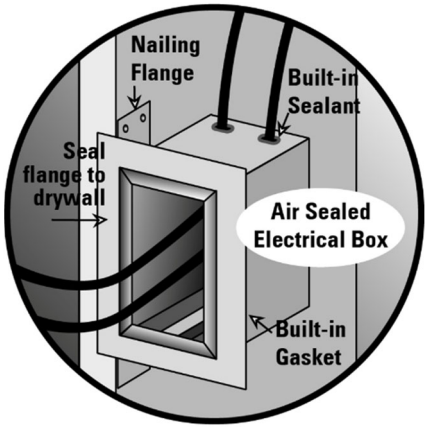
- Aluminum wiring is not permitted.
- Power distribution wiring and conduit shall be secured by metal straps only; plastic straps or cable ties may not be used.
- All wiring shall be concealed, except in parkades, mechanical, electrical or service rooms where it may be installed in surface-mounted raceways or cables. In all public areas, bonding and grounding wires shall be concealed and access limited to prevent wire theft.
- Site distribution wiring shall be underground (overhead services, connections to outbuildings, lights, etc. are not permitted).
- Rigid PVC conduit shall be used for underground wiring unless otherwise noted.
- DB2 conduit may be used for underground wiring where concrete encased.
- RGS conduit shall be used for BC Hydro service wiring in accordance with BC Hydro standards.
- Flexible metal conduit (FMC or LFMC) shall be used for final connections to vibrating equipment such as transformers or motors (3m maximum length).
- Aluminum EMT or RGS conduit shall be used in exterior or wet areas unless otherwise noted.
- AC90 (BX) or Teck cable may be used for final drops to luminaires (3m maximum length).
- Teck cable may be used for feeder wiring within service rooms only where both the source and the load are within the same room.
- ENT (Coreline) is not permitted anywhere.
- Wiring requiring circuit integrity ratings (fire rated circuits) may use any wiring method accepted for this purpose under the VBBL.
- Size feeders for a maximum 2% voltage drop from main distribution to branch circuit panel boards under rated full loads.
- An insulated bonding wire shall be included in each circuit; using conduit as a means of bonding is not permitted.



- Grounding/bonding system details to be provided on design drawings, including ground bus risers, ground bus connection details, and bonding details for connections to any non-electrical components.

.2 Pools, Rinks, and Pumping Facilities:

- Rigid PVC conduit shall be used in all pool areas and pumping facilities unless otherwise noted. Stainless steel 316 alloy conduits shall be used in high corrosion areas.
- Stainless steel conduit and boxes and tin-plated buses shall be used in rooms with chemical storage or processing.
- Full details of grounding and bonding of all devices in pool areas shall be provided on design drawings. Unused bonding points shall be initially installed in the surge tank to allow convenient bonding points for additional equipment added in the future.
- Ensure that duct sealing, firestopping, and air barriers are continuous and airtight in areas using ammonia.
- Use watertight conduit fittings in areas where mechanical piping is routed above the conduit and may be subject to leaks.
- Part 9 Buildings (e.g. field houses, small combustible residential or commercial, etc.):
    - NMD90 copper wiring may be used, secured with plastic or metal staples and framing penetrations. Cable ties may not be used for wiring support.



.3 Air Leakage and Moisture Ingress:

- Coordinate box installations and wiring penetrations with architectural plans to ensure required air barriers remain continuous and so that moist air does not travel through or condense in electrical pathways. Specify airtight boxes, duct seal, box wraps, putty pads, membranes, sealing tape, etc. as necessary to maintain the building's airtightness and compartmentalization.
- Provide water sealing for conduit penetrations and floor boxes so that leaks or flooding cannot travel through raceways and boxes to the level below.
- Use waterproof sealing methods for all vertical non-fire-rated penetrations
- Include penetration, air and water sealing details (in section view) in design drawings for all envelope, roof and floor penetration types. Where these details are specified by architects or other consultants, refer to the relevant details in the electrical drawings and/or specifications.

.4 Firestopping:

- Use waterproof fire stopping methods for all vertical fire-rated penetrations
- Submit shop drawings complete with installation details for each firestopping method used on the project. Include system details in O&M manuals.

- Firestop systems shall be coloured red and labelled at each penetration.
- Ensure that floor boxes are selected and installed so that required horizontal fire separations are maintained.

GUIDANCE

.1 General Wiring Methods:

- The wiring methods specified are intended to guarantee a minimum level of reliability for the building wiring, ensuring that wiring and raceways are well-secured, protected from damage, sized to prevent voltage drop issues, and suitable for the environment in which they are installed.
- Aluminum wiring is not permitted.

.2 Pools, Rinks, and Pumping Facilities:

- Due to the wet and corrosive environments in these types of facilities, corrosion-resistant raceways, boxes, and enclosures are needed, with additional water and air sealing methods in some locations. Robust bonding and grounding systems must be installed for pool areas where occupants are more vulnerable to shocks.

.3 Part 9 Buildings:

- As combustible construction permits combustible wiring insulation or jackets to be exposed, less costly non-metallic sheathed wiring can be used instead of wire in conduit or armoured cable.

.4 Air Leakage and Moisture Ingress:

- High-performance airtight building envelopes are a key element of building thermal energy performance in new buildings, to meet the targets of the City's Zero Emissions Buildings Plan. Electrical penetrations may compromise the envelope airtightness, particularly during retrofit applications where airtightness testing and verification may be less rigorous. Similarly, lack of air and duct sealing can lead to movement of moist air, condensation or water that can degrade and potentially short-circuit electrical equipment and damage the building envelope or lead to poor air quality. Continuous air barriers and duct sealing are critical to preventing these issues. Water sealing at vertical penetrations is also important to limit the damage caused by leaks or flooding within the building.

.5 Firestopping:

- Labelling penetrations of fire-rated partitions with firestop system information and providing detailed record documents makes it easier for building officials, designers and maintenance staff to review or repair firestopping.

OBJECTIVE

.1 The intent of this section is to specify aspects of power distribution equipment that make its operation and maintenance safer, easier, less costly, and to make the equipment less vulnerable to damage.

CRITERIA

.1 Distribution Equipment:

- All low voltage power distribution equipment for a new construction project shall be from a single manufacturer.
- Provide all panel boards with locking/hinged trim and doors, keyed to a common key set for the entire facility, except for individual tenant panels which may have their own key set. Keys for new panels in renovation projects shall match existing where feasible.
- All equipment, including transformers, shall be constructed to permit regular infrared thermal scans of terminations, with viewing ports for scanning installed on all low voltage switchgear rated 1,200A or greater and all high voltage equipment, and enclosure covers that can safely be removed while equipment is energized on all other equipment.
- All power distribution equipment shall have copper busbars and windings.
- Panel boards shall have a minimum 100A bus ampacity, with three-phase panel boards used for all systems where three-phase power is available (i.e. no single-phase, 3-wire 120/208V panels).
- Panel boards shall be flush mounted in all finished spaces.
- Outdoor kiosks and boxes shall use pad-lockable covers where feasible, and tamper-resistant hardware where pad-lockable covers cannot be used.
- Field modifications to electrical equipment shall only be in accordance with design drawings sealed by a professional engineer registered in BC, and modified equipment must be approved by special inspection to CSA SPE-1000 and marked with a label by a certification organization recognized by the Electrical Inspections Branch.
- Control transformers shall be CSA approved. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with Canadian Electrical Code requirements. Limit connected loads to 80% of rated capacity.

.2 Protective Devices:

- Use circuit breakers for circuit overcurrent protection unless otherwise noted. Fuses are only permitted for protection, control, or metering circuits and as components of end-use equipment.
- Moulded case circuit breakers shall be bolt-on type, plug-in breakers will not be accepted.

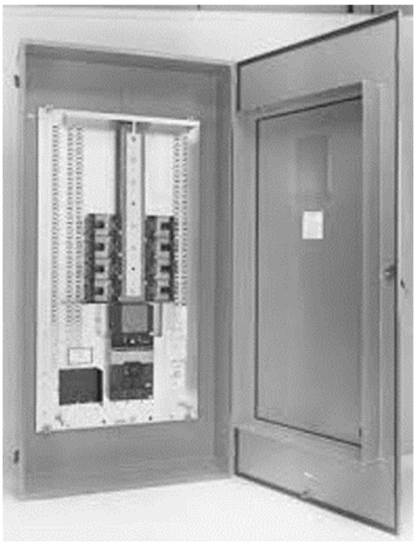
- Use AFCI protection on branch circuit breakers in facilities with culturally significant or valuable items.
- Zone-selective interlocking shall not be used to achieve selective coordination.
- Series-rated breaker combinations shall not be used to achieve breaker interrupting ratings; breakers shall be fully rated for the maximum available system fault current.
- Protective devices fed from generator/emergency power shall be selectively coordinated, with selective coordination confirmed in the system coordination study.

.3 Outlets:

- Provide general-use/housekeeping 5-20R duplex outlets in corridors, lobbies, and indoor public spaces at a spacing no greater than 15m (50ft.).
- Use specification grade receptacles (or higher) or in all locations.
- All receptacles to be tamper resistant type.
- Provide controlled exterior receptacles for seasonal lighting displays, with the ability to be controlled by the exterior lighting controls system.

.4 Mechanical Controls (General):

- Provide motor control centers (MCCs) only where more than two three-phase motor starters (not VFDs) for motors over 5HP are required.
- Motors with VFDs to be fed directly from branch panel boards or upstream switchgear as appropriate; VFDs to be stand-alone units (not integrated into MCCs or package units).
- Motors 5HP and smaller requiring starters shall use loose starters instead of MCCs.
- Do not use fuses for individual motor overcurrent protection.
- Provide single-phasing protection for all three-phase motors.
- Provide all motor starters with relays for automated control (i.e. manual starters not permitted).
- VFDs shall be provided with bypasses, and all VFD options selected shall be clearly specified in the design documents.
- Provide smart thermostats with wireless communications for all electric baseboard or fan-forced heaters with line voltage control. Thermostats shall allow setpoints to be controlled, scheduled, and automated via a web interface and provide energy consumption monitoring tools. Include wireless gateways as required.



.5 For Loads Requiring Safety E-stops:

- The E-stop will shunt trip the upstream branch circuit breaker to ensure isolation if the starter contractor welds closed.
- For loads with VFD control, the E-stop will put the VFD in bypass to ensure full stop and isolation of the load from the VFD.

- Boiler rooms require boiler E-stops at each entrance.

.6 Mechanical Controls (Refrigeration Plants):

- For refrigeration plants at recreation facilities (i.e. ice rinks), the measures in this section shall be implemented.
- Exhaust fans that are required for safety purposes shall:
  - Have emergency generator power backup.
  - Have 'not-in-auto' status monitored by the DDC system and issuing an alert to the building operator.
  - Have a means for detection and automatic shut-off of ignition sources on fan failure.
- UPS power shall be provided for:
  - Ammonia or other hazardous gas detection systems.
  - DDC control power.
- Control power sources for MCCs shall be located external to the MCCs, outside of the MCC arc flash boundary, with individual protective devices to allow MCC control power to be shut off for servicing without affecting other loads.
- Separate as-built control power distribution schematics (excluding control logic for individual loads) shall be provided with the project record drawings, with a full-sized laminated copy posted in the mechanical room.
- Ammonia or other hazardous gas detection systems shall have ULC-certified third-party remote monitoring, independent from the fire & security systems remote monitoring.
- Cable sleeves shall be installed on all power and control wire terminations, indicating wire source and destination.
- Connectorized electrical connections shall be used on all drywell heaters to allow local disconnection for servicing.
- Hard-wired controls to be used for life safety systems (DDC/PLC control not permitted unless hard-wired controls automatically bypass these systems upon controller failure).

.7 Disconnecting Means:

- Local disconnecting means (switches or wire connectors) shall be installed at all hardwired end-use equipment unless otherwise noted (including power door operators, kitchen equipment, water heaters, and EV chargers as well as mechanical equipment). Local disconnecting means are not required for heat tracing, 120V lighting, and electric baseboard or unit heaters.
- Redundant fuses shall not be installed in equipment disconnecting means where upstream circuit protection is adequate.
- Disconnect switches shall not be installed between VFDs and motors where possible, or if this is impracticable, they shall be interlocked with VFDs and/or labelled to prevent operation under load.

.8 Quality Assurance:

- Provide infrared thermography scans of all protective devices and wiring terminations within power distribution equipment 1-year after completion. Document as-found condition in a report and provide repair action recommendations.

GUIDANCE

.1 Distribution Equipment:

- Having a single manufacturer for distribution equipment allows for efficient allocation of spares, ease of equipment procurement and troubleshooting, and makes selective combinations of breakers possible. Features such as hinged trim and scanning ports are intended to minimize exposure to live parts and reduce arc flash risk. Other requirements are to ensure that panels have a minimum capacity so that replacement is not needed for minor renovations, while the panel finish and enclosure requirements are intended to reduce the risk of damage to the equipment.

.2 Protective Devices:

- Zone-selective interlocking and series-rated combinations are undesirable due to the challenges they cause for maintenance (often requiring engineering assistance for simple maintenance tasks). Zone-selective interlocking may be specified where necessary to achieve selective coordination in the instantaneous trip range. Circuit breakers are preferred over fuses as they reduce the spare part requirements, prevent single phasing and enable faster restoration of power. AFCIs provide additional protection against fires due to arcing in critical areas.

.3 Outlets:

- Enough outlets need to be provided for general use and for seasonal lighting to reduce the likelihood that building users will have to use extension cords. High-quality, tamper resistant receptacles reduce the risk that they are damaged from frequent use.

.4 Mechanical Controls:

- As MCC starters are harder to maintain and replace than individual starters or branch circuit breakers, the number of loads fed from MCCs should be minimized. VFD bypasses and single-phasing protection are to facilitate resilient mechanical systems operation. Smart thermostats can greatly reduce electrical energy consumption, make operation and monitoring simpler, and are a cost-effective means for measurement, verification, and optimization of these loads.

.5 Mechanical Controls (Refrigeration Plants):

- Due to hazards associated with ammonia and similar refrigerants, additional safety measures are needed for these plants. The measures included in this section are primarily for redundancy, reliability, and

serviceability, to ensure that failures of safety system components do not create unsafe conditions for building occupants or staff.

.6 Disconnecting Means:

- Local disconnecting means allow for safe disconnection of equipment for servicing while minimizing the other loads on the same circuit that may be affected if disconnection is done at the branch circuit breaker.

OBJECTIVE

.1 The intent of this section is to provide robust generator, battery, and UPS backup systems with features that facilitate testing, fuel and battery monitoring, and restoration of power outages while minimizing their and impact to the facility.

CRITERIA

.1 Generators:

- Provide dedicated indoor, climate-controlled, fire-rated room for emergency generators. Generators for standby power (i.e., mission critical but not life-safety) may be exterior package units. Locate generator room away from noise sensitive areas and preferably at grade level but above the flood construction level. Ensure auxiliary pumps, fuel control systems, filling port, etc. are located above the flood construction level as well. Do not locate room below grade or where access for the removal of equipment is impeded.
- Generator fuel storage/design run time shall meet the requirements of the technical guidelines for the facility type.
- Ensure that fuel filling access locations are accessible by fuel delivery trucks – show locations and truck footprint on site plans.
- Locate automatic transfer switches and main emergency distribution in close proximity to (but not within) emergency generator room.
- Provide closed-transition automatic transfer switches with double-sided bypass for critical facilities and those in operation 24-hours a day.
- Include a dedicated circuit breaker and outdoor connection provisions to make safe and efficient connections to a portable load bank for annual full load testing. Ensure load bank connection point does not require long runs of temporary cables to the load bank location. Integral load banks are not permitted.
- Design load bank connection provisions so that they can alternately be used for connection of a temporary generator.
- Provide electronic fuel level gauges for all fuel tanks and visible fill level indicator where fuel filling stations are located.
- Provide fuel polishing systems for all sites with diesel storage volumes of 10,000L (2,640gal.) or greater.
- In fire halls, provide a dedicated fuel tank for the emergency generator which is not shared with fuel supplies for engines or other apparatus.
- In buildings with generators, provide emergency power for freeze protection systems and exhaust fans.

- Wiring connections to generator sets shall be flexible to accommodate vibrations, DLO type conductors preferred. DLO conductors must be terminated using compression lugs explicitly rated for fine-stranded conductors.
- Generator exhausts to be located away from air intakes, play areas, patios, etc. for fumes and noise considerations.
- Visible fill level indicator where fuel filling stations are located.
- Generator exhaust to be located away from air intakes, play areas, patios etc. for fumes and noise considerations.

.2 Uninterruptible Power Supplies (UPS):

- UPS systems shall be equipped with a minimum of 5 minutes runtime at full rated load when backed up by a generator connected via automatic transfer switch, with additional runtime where required by other technical guidelines and In-Building Fibre and Telecommunication Standards.
- UPS battery systems shall be lithium-ion type with a minimum 10-year expected lifetime and battery management system. Lead-acid batteries with shorter lifespans are not permitted unless approved by REFM.
- UPS systems shall be monitored by the BMS system for battery issues and loss of power.
- If supplied from a generator, the UPS shall be rated to withstand power fluctuations during monthly generator testing.
- For large facilities with a significant amount of UPS load, centralized UPS systems are preferred to individual distributed UPS systems.
- BMS system controllers and workstations shall be connected to UPS power where available.

.3 Emergency Unit Lighting (Battery Packs):

- Provide emergency unit lighting in main electrical and generator rooms and local electrical rooms that supply power to emergency lighting circuits.
- Where emergency unit lighting is used (or battery-backed exit signs), it shall have self-testing capability.
- Emergency unit lighting shall be equipped with a cord-and-plug connection to an outlet on the same circuit as the normal lighting in the area (or the generator-backed emergency lighting circuit for the area if it exists).
- Central battery systems shall not be used for emergency lighting.

GUIDANCE

.1 Generators:

- Due to the critical nature of emergency generators, reliable installation conditions and auxiliary systems are needed, with protection against fire and flooding. Ease of access for fuel filling, regular testing and maintenance are important as well. Fuel polishing systems are needed for sites with large quantities of fuel to avoid fuel waste and tank fouling.

.2 Uninterruptible Power Supplies (UPS):

- Ongoing maintenance and battery replacement can be a significant cost for UPS systems. The main intent of using lithium-ion systems without excessive runtimes is to limit the operational and life cycle costs of these systems and ensure that battery monitoring and BMS alarms are provided for early warnings of potential failures.

.3 Emergency Unit Lighting (Battery Packs):

- Unit lighting is needed in critical areas where troubleshooting may be needed if emergency lighting system components fail, as these areas may be completely dark without it. Self-testing reduces the overhead needed to do required testing for these systems, and cord-and-plug connections allow for quick testing or replacement of these units.

OBJECTIVE

.1 The intent of this section is to ensure that electrical submeters installed meet Measurement Canada requirements for revenue metering and are compatible with the City of Vancouver's monitoring systems.

CRITERIA

.1 Submetering (Revenue):

- Separate electrical sub-services with BC Hydro revenue metering are to be provided for each occupancy/commercial tenant space wherever possible. Submetering to separate electrical billing is only acceptable where occupancies/tenants cannot be individually metered by BC Hydro.
- The installation of submeters used for revenue billing shall be overseen and commissioned by a contractor specializing in revenue-approved submeter installations. Electrum Charging Solutions is an example of an acceptable contractor.
- Submeters shall be:
  - Triacta Powerhawk 6000 series
  - Initially verified and sealed by an accredited meter verifier prior to use.
  - Sealed for consumption and demand.
  - In compliance with Measurement Canada Specification S-E-04.
  - Networked and connected to the City of Vancouver triacta meter manager website by the installation contractor.
- A meter inspection certificate must be provided for each meter, which includes:
  - The type designation, serial number, rating, billing parameters, and multiplier assigned by the manufacturer,
  - The inspection number assigned by the contractor,
  - The date of the meter's initial verification or purchase,
  - The meter's current installation address,
  - The date of the meter's installation at its present location.
- A record of meter installation must be provided for each meter, that includes commissioning and S-E-04 inspection details.
- Provide panel-mounted digital metering displays for all services 400A and higher.
- Meters to display true RMS values for phase voltage (line-line and line-neutral), phase currents, kVA, kVar, kW, power factor, frequency, KWh, kW (peak demand) and kVA (peak demand).

- Metering to be field programmable via front key pad and RS232/RS485 port.

.2 Submetering (Measurement & Verification):

- A meter capable of power quality measurements including individual harmonics shall be installed as close as possible to the utility service point of interconnection, and at points serving a large quantity of VFDs.
- The installation of submeters used for power quality monitoring and energy measurement & verification purposes shall be overseen and commissioned by a qualified contractor.
- Commissioning to include confirmation of proper circuit measurements (CT polarity, multipliers, etc.), communications functionality, data aggregation and storage, measurement point identification and load category grouping, software licence and monitoring dashboard setup as applicable.

GUIDANCE

.1 Submetering (revenue):

- These revenue submetering requirements are to ensure that tenant electricity billing is in accordance with Measurement Canada requirements, meters are commissioned correctly, and that the meter data output is comprehensive compatible with the information gathering and billing systems already in place.

.2 Submetering (Measurement & Verification):

- The commissioning requirements of this section are to ensure that the intended measurement points are all fully functional, with accurate information being archived and available to the building operator for real-time monitoring.

OBJECTIVE

.1 The intent of this section is to require measures for electromagnetic compatibility (EMC) of power systems and end-use equipment and reduce problems related to electromagnetic interference (EMI), including surges, sags, harmonic frequency interference, radio frequency interference, common mode noise, and poor power factor.

CRITERIA

.1 EMI/EMC:

- Locate transformers, revenue meters and other electrical equipment that produce external magnetic fields or radio frequency transmissions away from sensitive equipment and sleeping rooms, including on levels directly above or below.

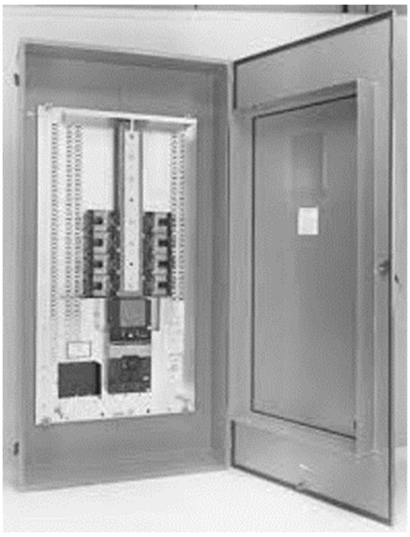
.2 Harmonic Mitigation:

- Provide harmonic filtration, either integral with the equipment or separately, or specialized motor drives to limit total current harmonic distortion from the line side of from each piece of equipment to less than 15%. Limit the harmonic distortions total demand distortion (TDD) at the point of common coupling (PCC) to comply meet the recommendations of with the current edition of IEEE 519 (current edition) and BC Hydro requirements.
- Where a full harmonic analysis is not being performed and harmonic mitigation measure are not being provided at a system level, provide minimum prescriptive mitigation measures as follows:
  - 3% AC line reactors for VFDs up to 7.5HP.
  - Tuned passive harmonic filters for VFDs above 7.5HP up to 100HP.
  - 12-pulse drives or active front end drives for VFDs 100HP or above.
  - K-7 rated or harmonic mitigating transformers where over 60% of the transformer's kW load is electronic equipment (i.e. UPS, motor drives, servers, or network equipment, etc.).
- Include a harmonic analysis in facility commissioning scope, recording harmonic levels at key points in the facility when systems are operating at full load.

.3 Power Factor:

- Correct power factor to at least 95% where normal loading yields a power factor of less than 90%. Provide automatic switching features on capacitor banks and harmonic filters as needed to prevent leading power factors.

.4 Surge Suppression Protective Devices (SPDs):



- Power line filtering. Provide internal or external surge suppression protective devices in the following manners:
    - Install a surge suppression protective device on utility incoming mains at the service box or, where separate, the first set of feeder or branch protective devices downstream of the service box.
    - For areas containing a large group of electronically sensitive loads or loads that are sources of surges, provide surge protection SPDs on panel boards serving those load area.
    - Provide SPDs at intermediate locations between power sources and sensitive loads as needed for protection of the connected equipment. Coordinate surge protection devices within the same power distribution system.
- Install SPDs as close to its connected distribution equipment as possible (maximum 300mm [12”] wiring distance), with straight wiring runs to the equipment bus, and disconnecting means to allow safe SPD replacement without power outages.

.5 Lightning Protection:

- Calculate the lightning risk index for new facilities in accordance with CSA B72, Installation Code for Lightning Protection Systems, and provide a lightning protection system to CSA B72 requirements where the annual threat occurrence of a lightning strike is greater than the tolerable lightning frequency calculated in accordance with CSA B72 Annex C.

GUIDANCE

.1 EMI/EMC:

- The intent of locating this electrical equipment away from sensitive equipment such as servers, lab or medical equipment is to avoid potential interference issues caused by magnetic fields. It should be located away from sleeping areas as much as possible to alleviate residents’ potential concerns about electromagnetic fields in areas where they spend a significant amount of time, as well as to mitigate noise disturbances from transformer hum.

.2 Harmonic Mitigation:

- As harmonic frequency currents can cause significant disruptions in power systems, equipment and harmonic mitigation measures need to be selected in accordance with good industry practices to prevent equipment interference, component failures, and possible utility penalties.

.3 Power Factor:

- Low power factor will incur additional utility costs and reduce the usable capacity of building power systems. Leading power factor can also cause issues with emergency generator operation. Power factor correction should be applied as needed to maximize system capacity and minimize costs, while mitigating issues related to leading power factor.

.4 Surge Protective Devices (SPDs):

- SPDs become much less effective with greater distances from the loads that they protect from voltage surges, so locating them close to sensitive loads and sources of surges and minimizing wiring distances is critical for providing effective equipment protection.

.5 Lightning Protection:

- The intent of these requirements is to require facilities to have lightning protection installed where they are considered to be at moderate or severe risk of lightning damage by the relevant standards, as installation of lightning protection is not a mandatory requirement of the building or electrical codes.

OBJECTIVE

.1 The intent of this section is to provide guidance for design consultants in specifying transformer installations that have high energy efficiency, high reliability, and low maintenance or capacity upgrade costs, while minimizing acoustic-related disruption to building users.

CRITERIA

.1 General:

- Provide flexible conduit for connections to the transformer.
- Provide vibration isolation pads for transformer mounting.
- Ensure transformers are located in electrical rooms or outdoors, away from areas such as dwelling units and offices, and suitable acoustic mitigation measures are taken to prevent transformer noise from disturbing building occupants.
- Provide transformer temperature monitoring devices with peak temperature recording capability for all transformers 300kVA and larger.

.2 Dry-type:

- All dry-type transformers shall meet the minimum NRCan 2019/DoE 2016 efficiency requirements.
- Select low temperature rise transformers, using high temperature insulating materials. Provide three phase transformers with delta-wye connection and accessible voltage taps.
- Rate transformers to accommodate the harmonic currents and voltages present for the loads being supplied. Transformers may be K- factor rated or may be of the phase shifting type designed to mitigate harmonics.
- Make provisions for fan cooling on dry type transformers in excess of 750 kVA. Size transformers for calculated capacity without fan-cooling.
- Cast coil main transformers are preferred.
- Copper windings shall be used unless explicit written approval from REFM is obtained to allow aluminum windings.

.3 Liquid-filled:

- For outdoor pad-mount transformers, insulating liquid type shall be FR3.
- Provide vibration isolation and acoustic mitigation measures for transformers located near occupied spaces.

GUIDANCE

.1 General:

- Flexible anchorage and conduit connections are important to reducing transmission of transformer vibrations and noise through the building structure.
- Transformer temperature metering provides an indication of how close transformers may be to full loading and how transformer heating may affect their expected lifespan.

.2 Dry-type:

- High efficiency transformers reduce the total cost of ownership of transformers. Harmonic mitigation considerations are important to prevent transformer overheating and are most effective if they block or treat harmonics from different parts of the power systems. Fan cooling provisions are an inexpensive way to reduce the cost of future capacity expansions, and cast-coil transformers provide extra protection against moisture and corrosion as well as being higher efficiency.

.3 Liquid-filled:

- FR3 insulating liquid is preferred for reduced fire/explosion risk and toxicity. Acoustic issues for outdoor transformers need to be considered when located close enough to a building to disturb the occupants.

OBJECTIVE

.1 The electric vehicle (EV) charging infrastructure provided needs to meet current CoV EV charging policies, ensure that upstream infrastructure is not overloaded, and that any communications links that their functionality depends on are robust and fully functional.

CRITERIA

.1 Electric Vehicle Supply Equipment (EVSE):

- Electric vehicle charging provisions shall meet the associated requirements of CoV Bulletin 2019-006-BU/EL, VBBL and Parking By-law, with all chargers capable of delivering a 12kWh charge over an 8-hour overnight period.
- Level 2 EVSE to be provided during building construction for new facilities (energized outlets alone will not be permitted).
- Provide EVSE payment and communications features as required by CoV policies and where needed for public charging stations.
- EVSE shall be connected using hard-wired power connections unless otherwise noted.
- EVSE shall be connected using plug-and-receptacle power connections in social housing facilities, with tamper-resistant fasteners for the EVSE and a lockable in-use type receptacle cover.

.2 Electric Vehicle Energy Management Systems (EVEMS):

- Hard-wired communications methods for EVEMS are preferred to wireless methods where available.
- Where available, communications using local wireless mesh networks with a single dedicated cellular modem are preferred to EVSE with individual cellular network connections.
- All licence and ongoing service contract terms required for EVEMS functionality shall be disclosed to the CoV project manager and design engineer at or prior to EVEMS shop drawing review.

.3 E-bike Charging:

- Size circuits/panels based on 500W minimum continuous load per single outlet (1,000W per duplex) in areas where e-bike charging is likely to occur (i.e. in bike storage rooms and near bike racks).

.4 Commissioning:

- Commissioning for EVSE and EVEMS to be complete and fully documented, including:
  - Validating charging, communications, load management and payment functions for each charger and EVEMS load group as applicable
  - For EVEMS-managed circuits, indicate circuit, transformer, and distribution equipment connected load and managed load limits on record drawings and at on permanent labels at the equipment/circuit protective devices.

GUIDANCE

.1 Electric Vehicle Supply Equipment (EVSE):

- The intent of this section is to have EV charging infrastructure installed that can charge vehicles without needing additional components, can be easily serviced, and meets objectives for public vehicle charging where applicable.

.2 Electric Vehicle Energy Management Systems (EVEMS):

- These requirements are intended to allow facility electrical capacity to be maximized while providing sufficient charging capacity and preventing circuit or equipment overloads. As these systems can be highly dependent on their communications links, robust communications links are needed. Ongoing service/licencing requirements are common on these systems, so it is important that the owner is made aware of these costs before system selection is finalized.

.3 E-bike Charging:

- Due to the high wattage of e-bike chargers, sizing circuits and equipment to match charger capacity is needed to prevent overloads and nuisance trips when occupants plug in their chargers at bike parking locations.

.4 Commissioning:

- Proper commissioning is critical to ensure that EVEMS systems work properly, have reliable communications connections and do not overload their associated circuits. Labelling and record keeping is particularly important for these systems, to prevent loads from being added during future renovations that would exceed system capacity.

OBJECTIVE

.1 The intent of this section is to ensure that lighting fixtures and controls are installed in such a way that they can be easily serviced or replaced, that lighting illuminance patterns, and colour characteristics are appropriate for the application, and that control systems operate in their intended manner. Robust, damage-resistant fixtures are also a key concern in particular areas where they are often subject to abuse or corrosion.

CRITERIA

.1 Luminaire Selection Review:

- Luminaire selection is a key item where REFM review is needed. Ensure fixture selections are reviewed with REFM at the earliest opportunity.
- If alternate lighting packages are submitted after the REFM review, REFM staff must be given a chance to review proposed alternates before acceptance, with sufficient mounting and service access methods detailed in the review package.
- All landscape and exterior lighting luminaire types shall be included in the review.

.2 General Lighting Requirements:

- Lighting design shall consider energy efficiency as a high priority and conform with ASHRAE 90.1-2016, NECB 2015, and/or rezoning policy/step code energy use targets as applicable to the project.
- Lighting design shall conform to the recommendations and requirements of the City of Vancouver Outdoor Lighting Strategy and IES Recommended Practices Guideline for the specific application. Where dimming functionality is specified, designed illuminance level may exceed the recommended practices by up to 20% as long as ASHRAE 90.1/VBBL lighting power density requirements are met. Refer to Outdoor Lighting Strategy (https://vancouver.ca/files/cov/outdoor-lighting-design-tips.pdf).
- ENERGY STAR certified lighting is preferred. Non-ENERGY STAR lighting may be used where this criteria would limit fixture selection and increase total cost of ownership.
- Non-proprietary City standardized lighting controls.
- Luminaires and control devices to be suitable for their location such as explosion proof, marine environment, chemical rooms, vandal-resistant, etc.
- Provide a lighting design report and floor plans, including the following information:
  - Luminaire schedule (details below),
  - Lighting control narrative and sequence of operation,

- Zone schedule/functionality by space matrix,
- Lighting control diagrams,
- Calculated lighting level (provide photometric study for review, details below),
- Power density in W/m^2.

- Luminaire schedules shall include the following information:
  - Luminaire tag,
  - Picture/photo of luminaire ,
  - Description,
  - Location,
  - Housing/Trim finish,
  - Distribution/beam,
  - Manufacturer and catalogue number,
  - Light source, CCT and CRI,
  - Initial lumens,
  - Lamp life in hours and ratings (i.e. 100,000 hours L70),
  - Driver/power supply,
  - Voltage ,
  - Watts per luminaire,
  - Mounting type and height,
  - Accessories required.

.3 Photometric Study shall include the following information:

- <u>Floor Plan</u>
  - Calculated surface label/name must include and match the room name and number shown on architectural and electrical drawings. Where there are multiple calculated surfaces within the same space /room, tag them appropriately (preferably directional north, east, etc);
  - The layout in the calculation must include calculated surface outlined (colour coded for distinguishing) and labelled, luminaire type and mounting height labels;
  - Calculation points and values;
  - Luminaire type and mounting height.
- <u>Statistics</u>:
  - Power Density - total power, area, and power density values;
  - Surface/room schedule – area and reflectance (floor, walls, and ceiling);

- Calculated surface/work plane height and calculated point spacing (if available);
- Luminaire schedule – Symbol, Qty, Label, Arrangement, Description, Tag, LLF, Luminaire Lumens, Luminaire Watts.

.4 LED lighting to be used throughout. Use of incandescent or fluorescent sources is not permitted except where approved during REFM review.

.5 All new lighting to be designed to operate at standard voltage 120V (no lighting to be fed from 277V or 347V circuits).

.6 All ballasts/drivers shall be replaceable, with easy access for service.

.7 Luminaires shall not be used as a pull box, junction box or wireway for through wiring.

.8 Luminaires shall be connected to a standard octagonal outlet box, installed with screw-type fasteners, and be interchangeable with luminaires from no less than three (3) other manufacturers without requiring changes to outlet boxes, supports, or architectural finishes.

.9 Ensure that strip lights and accent lighting can be easily mechanically separated from architectural features for service or replacement.

.10 Ceiling-mount luminaires shall be commonly available form factors, such as:

- Troffer style 300mm x 1,200mm (1’x4’), 600mm x 600mm (2’x2’), or 600mm x 1,200mm (2’x4’).
- Surface Mount with standard back boxes/mounting hardware that allows replacement with a different luminaire model.
- Suspended with standard back boxes/mounting hardware that allows replacement with a different luminaire model.

.11 Use diffusers with minimum 3.3mm (0.125”) thickness in metal frame.

.12 Only use acrylic, polycarbonate or glass as a material for diffusers.

.13 Colour temperature and CRI shall be selected by the lighting designer to suit the space and function where it is installed.

.14 Full third- party commissioning services shall be performed for lighting control systems. Refer to the commissioning section of this document for details.

.15 Addressable lighting control circuits and power circuits shall only serve a single tenant or occupancy.

.16 Wireless control devices with batteries shall not be used.

.17 Photocell control of exterior lighting (with time clocks where early shut-off is required) is preferred over digital astronomical controls for outdoor lighting.

.18 Ensure approval by field inspection under SPE-1000 is obtained for field-assembled fixtures.

.19 Interior Lighting:

- Access for service/replacement without requiring scaffolding shall be detailed for all high-bay fixtures (and sensors).
- Designing lighting systems with premium, long-life products that can be serviced without closing the facility is particularly important for areas over pools. Consider using at least two different fixture types in these areas for redundancy in case of concurrent failures for one fixture type. Design of lighting suspended over pools shall include details of suspension hardware (corrosion-resistant materials required, epoxy-coated hot dip galvanized hardware preferred).
- Underwater lighting in pools shall be for decorative use only and not relied upon for general pool area lighting. Colour-changing decorative lights are preferred for this application.
- Direct/indirect systems are recommended for office, conference, and training area lighting where ceiling heights and finishes permit. These systems should have at least a 30% direct component.

.20 Exterior Lighting:

- Use tamper-resistant fixtures in parks and public areas. Wiring access points shall use pad-lockable covers where feasible, and tamper-resistant hardware where pad-lockable covers cannot be used.
- Use warm (2700K) colour temperature luminaires in residential areas and in or adjacent to parks or natural areas with bird habitat. Colour temperatures up to 4000K may be used where cooler colour temperatures are likely to enhance safety, such as at pathway intersections to prevent collisions.
- Reduce light pollution and light trespass as much as possible. Lighting for residential areas or those parts of a building facing a lane, and other areas where practicable, shall be provided with appropriate shielding:
  - Utilize full cut-off optics or full shielding for luminaires that emit over 600 lumens, or any luminaire installed along a side or back yard.
  - Utilize at least partial shielding and a diffusing cover for luminaires that emit 600 lumens or less.
  - Mount light sources no higher than 4m (13ft.) above grade or the balcony surface it illuminates along the side yard, back yard, and similar outward facing courtyards or setbacks of the building.
- Assess and take into consideration surrounding sources of light, such as streetlights, and the reflectivity of surrounding surfaces, such as walls and pavement, in lighting designs to avoid over-lighting.
- Minimize lighting of adjacent exterior properties and properties across a street, lane, or public way.

- Lighting levels should meet or exceed with no more than 20% the IES-RP series recommendations and/or the most stringent lighting level requirements.
- For areas with specific security concerns, IES G-1 (Security Lighting) should be used as a guideline. In areas where visibility of pedestrians and other users would improve perception of security, vertical illuminance levels should be given special consideration.
- For areas and facilities frequented by seniors, higher levels of lighting can be considered as per IES RP-28-20.
- For Childcare Community Care Facilities refer to the CoV Childcare Technical Guidelines.
- Provide luminaires with dimmer, photocell and timer controls. Turn off non-essential lighting between the hours of 11PM and 7AM, as required by the Sign By-Law, and dim during off-peak hours where feasible.
- Motion/occupancy sensors may be utilized along infrequently used paths and parking lots to allow for safe passage when needed. In some applications, light levels should be raised from a lower, "default" setting (50%) to a higher "activity" setting during off-peak hours to avoid startling people walking in the sensor range.

.21 Exit Signs:

- Upgrade red exit signs to green running man type during renovations as per CoV electrical bulletin (2015-006-BU) requirements.
- Photoluminescent exit signs shall not be used in lieu of internally illuminated exit signs.

GUIDANCE

.1 Luminaire Selection Review:

- REFM reviews of luminaire selections are critical to ensuring that fixtures and finishes are compatible, and that luminaires will be easily serviceable and replaceable. Addressing any potential issues early in the design can greatly reduce ongoing maintenance issues during building operation.

.2 General Lighting Requirements:

- Design documentation needs to include enough information to confirm that energy efficiency and lighting levels are being met and allow corrective actions to be taken in a timely manner if needed.
- LED lighting is the base requirement for ease of maintenance and efficiency.
- Wiring, mounting, and drivers need to be designed to allow for easy replacement and fixture reconfiguration.
- Fixtures need to use robust, damage-resistant materials.

- Standard colour temperatures are specified to maximize consistency and compatibility with replacement fixtures.
- Wired controls are preferred over wireless devices with batteries, due to additional maintenance needed for battery replacements.
- Photocells are preferred to digital astronomical controls due to the higher failure rates experienced for astronomical controls.

.3 Interior Lighting:

- Access to luminaires for service and replacement is a key issue for ease of ongoing maintenance. Pool lighting fixtures can be particularly challenging to maintain, so redundancy for fixtures is critical to allow the pool to remain well-lit until service can be done.

.4 Exterior Lighting:

- Specification of vandal-resistant exterior lighting is important to reduce maintenance and theft issues. The requirements are intended to optimize energy use, reliability, security, and public comfort, while minimizing light pollution and aligning with the City's policies for lighting public spaces.

.5 Exit Signs:

- In renovated buildings, the extent of older-style red exit signs that need to be replaced will vary depending on the extent of the work. Photoluminescent signs are not permitted due to potential issues with visibility and reliability during fire emergencies.

H COMMISSIONING

1 GENERAL MECHANICAL

2 SPECIFICATION

OBJECTIVE

.1 Commissioning plays a vital role in quality assurance (during both design and construction), building systems integration, and performance verification. These items are imperative to ensure the efficiency and longevity of the REFM's buildings, fully functional building systems and a smooth and detailed hand-over to the maintenance group.

.2 The Commissioning Provider is intended to take the role of a third-party review throughout the design process and throughout the installation of the building systems. This hands-on approach provides assistance and guidance throughout the development of the project up to the final hand-over to the REFM.

CRITERIA

.1 Major renovations, and new projects must retain a Commissioning Provider during the design phase to provide design guidance to the consultant team.

- At minimum, project size specific, the Commissioning Provider must provide reviews at the 50% and 90% construction document milestones.
- During the design phase, in addition to the design review, the Commissioning Provider must provide a commissioning plan, for use through the construction of the project.

.2 For minor renovations and small tenant improvements, a Commissioning Provider is not required during the design phase unless specifically requested by REFM. Although no Commissioning Provider is required for the design phase, an agent is required during the construction phase to provide a third-party commissioning scope.

.3 During construction phase, the Commissioning Provider must at least provide the following:

- Commissioning meetings, which must be held prior to and during the commissioning period of the project and provide meeting minutes;
- Verification of systems (i.e. system flushed, review of preliminary air and water balancing reports, seasonal testing, functional checks etc.);
- Commissioning (i.e. system activation, testing and adjustments etc.);
- Performance Verification (i.e. functional testing, review of final balancing report, verification with consultants etc.);
- Demonstration of acceptance (i.e. demonstration to owner, completion of documentation etc.).

.4 After the construction administration phase, for large projects, the Commissioning Provider must return to site at least four (4) times throughout the warranty period. During these returns to site, the Commissioning Provider must interview facility staff, identify deficiencies that may be under warranty from the original construction contract, and during the last site review, the agent must provide a detailed evaluation of the status of any outstanding warranty or operational issues.

GUIDANCE

.1 The requirement to have a Commissioning Provider on the design team from the early stages and throughout construction is intended to provide a third-party review of the design, and to identify potential complications which may arise from the design during the final commissioning of the building and the building systems.

.2 The requirement to have a Commissioning Provider during design phases is likely to be cost and schedule prohibitive for smaller projects, unless these are of a complex nature. Requiring a third party Commissioning Provider during construction ensures a satisfactory start-up and hand-over to building maintenance groups.

.3 The Commissioning Provider duties identified above are meant to show the minimum requirement that the REFM expects for all projects during construction, and will provide the quality assurance and hands-on effort required for a smooth transition and hand-over. These duties and the details surrounding them will vary from project to project and will also be based on the complexity of the project. The verification of systems is intended to be a hands-on approach. The Commissioning Provider simply handing over check sheets for verification/start-up by the contractor is not acceptable. This process should be well coordinated review and verification between the contractor and Commissioning Provider.

.4 The post construction phase is essential for continuing “real world” troubleshooting and fine-tuning of the systems through the warranty phase. This phase is also beneficial to REFM in that a quarterly in-depth review is being done on the systems, and can quickly identify any construction warranty issues that may not be noticed until the outset of the warranty period.

GENERAL (EXAMPLE)

.1 The following pertains to following specification sections:

- 01 91 00 – Commissioning.
- 01 91 19.43 – Exterior Enclosure Commissioning.
- 21 05 01 – Common Work Results for Mechanical.
- 22 08 00 – Commissioning of Plumbing Systems
- 23 08 00 – Commissioning of HVAC Systems
- 25 08 00 – Commissioning of Integrated Automation.
- 26 08 00 – Commissioning of Electrical.

.2 References (latest versions):

- ASHRAE Guideline 0 – Commissioning Stakeholders' Guide.
- ASHRAE Guideline 0.2 – Commissioning Process for Existing Systems and Assemblies.
- ASHRAE Guideline 1.1 – HVAC&R Technical Requirements for the Commissioning Process.
- ASHRAE Guideline 1.5 – The Commissioning Process for Smoke Control Systems.
- ASHRAE Standard 202 – Commissioning Process for Buildings and Systems.
- CAN/CSA Z320 – Building Commissioning.
- CAN/ULC-S1001 – Integrated Systems Testing of Fire Projection and Life Safety Systems.
- IESLP-8 – The Commissioning Process Applied to Lighting and Control Systems.
- NIBS Guideline 3 – Exterior Enclosure Technical Requirements for the Commissioning Process.
- Building Cx Association – New Construction Building Commissioning Best Practices.

J SPECIALTY DESIGN CONSIDERATIONS

1 AQUATICS AND ICE RINKS

2 SYSTEMS & SPECIFICATIONS

OBJECTIVE

.1 The purpose of this section is to provide guidance to the design team regarding REFM's standpoint on systems and equipment specific to recreation facilities (new and existing).

CRITERIA

.1 Systems and equipment installed in recreation facilities, which include arena's and/or natatoriums, must be designed in order to promote good ice, water, and air quality. Equipment must be provided that is suitable for the environment that it is serving, (ie. corrosive natatorium air), and systems must be provided that meets capacity, redundancy, and serviceability requirements of the REFM.

GENERAL

.1 The following pertains to following mechanical specification sections:

- All pool sections, air handlers, dehumidifiers, plumbing fixtures, piping, refrigeration plant, hangers and supports

PRODUCTS - GENERAL

.1 Equipment:

- There is a desire to move towards electrification of facilities in order to reduce greenhouse gas emissions. This should be considered in the design of systems, whereby systems are designed to be fully electric or designed such that future conversion to electric systems is not prohibitive due to cost and feasibility.
- Equipment and supporting components must be designed for appropriate vibration isolation.

PRODUCTS - ARENA FACILITIES

.1 Ventilation Systems

- Arena Dehumidification:
  - Gas-fired desiccant dehumidification should be phased out.
  - Heat pump desiccant dehumidification is preferred on new projects.
- Ammonia Plant Room Exhaust:
  - Detection and exhaust must be provided consistent with current Technical Safety BC (TSBC) guidelines for ammonia plant rooms.
  - A plume study of full refrigerant charge release is required on all new projects.
  - Two (2) fans, one for ventilation and one for ammonia purge, is preferred.
  - Emergency purge exhaust fan must be on emergency power and fail in the ON position.
  - Should a VFD be provided on a common exhaust system serving both ventilation and emergency purge, a by-pass on the VFD must be provided, complete with an emergency button to initiate manual by-pass.
  - The purge fan must to be exterior to the room, upblast type, and explosion proof.

- Emergency relief vent stack sensors must be provided to monitor any weepage of relief valves.
- Ammonia detectors must be provided with batter backup, so that they function in a power outage.
- Ammonia sensors must be accurate to 2% at 15,000ppm limit.
- Ammonia detection system must be provided with a multiple light indicator system. Light indicators must be standardized to:
    - Green = 0ppm;
    - Amber = 25ppm;
    - Blue = 100ppm;
    - Red = explosion limit of refrigerant used.
- The ammonia detector must have independent power supply.
- The exhaust system must have a secondary safety protocol on power failure:
    - Should the explosion limit threshold be reached and purge fan not functioning, emergency stop must be initiated on all ignition devices.
- In case of a power failure, purge outdoor air damper must fail open 100% so that the fire department can connect a portable fan to the intake and force a purge.
- Purge fan HOA starter must be displayed on the BMS interface.
- Fans are to be controlled as follows:
    - The ventilation fan must be operated on occupancy and temperature;
    - The purge fan must be operated based on ammonia detection limits;
    - The purge fan must have a manual override;
    - Manual reset of fan to be located inside plant room;
    - Sail switches are to be provided on inlet damper and exhaust fan.
- CO_2 Plant Room Exhaust:
    - Consider a low-level passive ventilation scheme.

.2 Ice Generating Systems (Ammonia)

- General:
    - Cimco is the preferred vendor for ice plants.
    - The City of Vancouver refrigeration strategy document must be referenced and adhered to in any refrigeration plant design.
    - A refrigeration plant system schematic must be provided on Arch D size laminated paper, located just outside of ice plant room.

- Low charge ammonia plants with maximum 136kg (300lb) fluid coolers are preferred.
- CO_2 plants must be considered for new facilities.
- Common high refrigerant discharge pressure cutout must be provided where secondary shuts down all compressors.

- Chillers:
  - U-turn chillers are preferred.
- Compressors:
  - Mycom M series compressors are preferred.
- Heat Exchangers:
  - Only plate and frame heat exchangers may be provided.
  - Insulation blankets must be provided.
  - Oil pots must be provided on the refrigeration side of all heat exchangers.
- Secondary Side (Brine):
  - Brine is preferred, but glycol may be considered.
  - Brine pH sensor must be provided to monitor brine integrity and detect the presence of ammonia.
  - High level and overflow sensors must be provided in expansion tanks.
  - Upon refrigeration leak, brine pump operation must be maintained.
  - One size up must be provided on brine filters in order to maintain clarity for longer.
- Heat Reclaim:
  - At a minimum, heat reclaim from ice plant must be utilized for domestic hot water generation and underslab heating.
  - High level and overflow sensors must be provided in expansion tanks.
  - In case of an ammonia leak, brine pump operation must be maintained.

PRODUCTS - AQUATIC FACILITIES

.1 Ventilation Systems

- Natatorium Air Handling Systems:
  - Mechanical dehumidification is preferred over fresh air dehumidification.

- Heat recovery from mechanical dehumidification system must be considered.
- Air handlers serving natatoriums must be specified so that corrosion due to contact with natatorium air is prevented.
- Building air systems must be design and balanced so that a negative pressure is maintained in the natatorium when compared to changerooms and lobbies.

- Natatorium Trichloramine Exhaust:
  - Deck level trichloramine exhaust system should be considered for new facilities or where feasible to retrofit in existing facilities.
  - Surge tanks must have trichloramine exhaust.
- Chemical Storage Room Exhaust:
  - Chlorine and acid rooms must be exhausted independently of one another in order to prevent mixing of the two air streams.
  - Exhaust rates must be consistent with Worksafe BC guidelines for the chemicals being stored.

.2 Filtration Systems

- General:
  - Redundancy should be considered in filtration plant design.
  - Each pool must have a minimum of two (2) filters.
- Filters:
  - Filter selection, location, and configuration must be considerate of proper access to serviceable components of the filter.

.3 Chemical Treatment Systems

- General:
  - Chemical systems are to be designed for bulk delivery and minimized feed lengths to tanks.
- Primary Disinfectant:
  - Liquid chlorine (sodium hypochlorite) is preferred as a primary disinfectant.
  - Solid chlorine (calcium hypochlorite) will be considered as a primary disinfectant.
- Secondary Disinfectant:
  - UV is preferred as a secondary disinfectant.
  - Clear Comfort oxidation will be considered as a secondary disinfectant.
- pH Balance:
  - Hydrochloric acid is preferred for pH balance.

- CO_2 will be considered for pH balance.

- Chemical Storage:
  - Chlorine and acid storage room must be separated.
  - Where liquid chemicals are stored, dual wall containment tanks in addition to physical curb containment are required.
- Chemical Injection:
  - Injection pumps must be provided complete with emergency stop button.
  - Injection pumps must be peristaltic type.
- Chemical Controllers:
  - Pentair AK 600 is the preferred chemical controller.
  - Interlocks must be present to prevent injection of chlorine and acid at the same time.
  - Chemical controllers must be integrated with the BMS system, allowing monitoring of chemical levels, injection rates, and adjustment of controller setpoints.

.4 Plumbing Systems

- Individual water meters, monitored by the BMS, must be provided on each body of water so that operators can monitor water usage on each pool.
- Consider providing pool makeup water from the domestic hot water systems in order to fill hot pools with hot water. This will allow more efficient chemical balance after a pool fill.
- Connection points must be provided at the water entry station, but also at branch line ends throughout the facility in order to aid in system flushing after a shut down.

.5 Aquatic Pumps

- General:
  - Aquatic pumps must be specified with corrosion resistant components suitable for use with chlorinated water.
- Filter Pumps:
  - All filter pumps must be provided with variable frequency drives.

.6 Heat Exchangers

- Building Heat Exchangers:
  - Heating water heat exchangers must be oversized when low temperature heating loops are present.
- Pool Heat Exchangers:
  - Titanium is the only acceptable material for pool hall heat exchangers.

.7 Hangers and Supports

- Natatorium:
  - Epoxy coated hot dipped galvanized hangers are to be used in natatoriums.
- Pool Mechanical Room:
  - 316L stainless steel or epoxy coated hot dipped galvanized equipment and pipe supports are required.

.8 Variable Frequency Drives

- Drives located in pool mechanical rooms must have a minimum NEMA 4 enclosure rating.
- Line and load reactors are recommended for all facility VFD's.

.9 Instrumentation

- Aquatic Systems:
  - Digital flow meters must be provided on all filtration systems, complete with digital read outs and integration with the BMS for control of filtration pump VFD's.

EXECUTION

.1 Installation

- Mechanical equipment must be positioned such that removal of equipment from the building is feasible without removal of other equipment or systems
- There must be feasible equipment removal pathways from equipment location to building exterior. Equipment removal pathways must be reviewed with facility staff for approval.
- Mechanical equipment must be positioned such that manufacturer specified service clearances are maintained.
- Device tags on equipment must list fastener installation torque
- Isolation valves must be provided on either side of all serviceable equipment and components.
- Clamp on flow and pressure sensors should be avoided. Thermowells and insertion flow sensors must be provided where possible.
- Dielectric materials must be avoided on pipe hangers and supports. Hanger plates must be provided with rubber between saddles and supported component.
- Removable insulation must be provided on all serviceable components, such that it can be placed back on equipment after servicing, without any loss of aesthetic or insulation value.

- Natatoriums:
    - Control sensors must be provided in quantity and location to ensure accurate reading of all locations within the natatorium.
- Pool Filtration Plant:
    - Flow meters must be provided on backwash lines to monitor sanitary discharge rates.
    - Pool filtration pumps must be operated on flow meter feedback to maintain turnover rates.
- Chemical Systems:
    - Storage of dry chemicals where possible should be on the main building level to avoid transport within the facility.
    - Chemical injection pumps must be mounted such that they are accessible for service and not mounted directly over storage tanks.
    - Pool water must be brought to chemical storage rooms and chemicals injected there. This ensures that leaks at injection points are contained within the room.
- Arenas:
    - Rink slab brine headers must be installed such that they are accessible.
    - All pipe penetrations must be sealed off in refrigeration plant room walls complete with outer wall for pipe inspection.
    - CO/NO sensors must be provided in arena proper to monitor due to gas zamboni use.

.2 Start-Up

- Start-up equipment must be performed by factory trained and authorized personnel. A copy of the start-up report must be provided to the owner and factory.
- Commissioning of aquatic systems must be performed by an individual or provider having experience commissioning aquatic systems.
- Ammonia rooms require a smoke test to show full purge exhaust air sweep of entire room.