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TECHNICAL REFERENCE FOR OFFICE BUILDING DESIGN

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Revisions

Version	Date	Description
1.0	May 27, 2016	Original issuance.
1.1	March 6, 2017	Issuance of draft version to Federal / Industry Real Property Advisory Council (FIRPAC) for consultation. The document is renamed to the Technical Reference for Office Building Design, and has a re-written general section, and various edits to the technical content.
2.0	April 3, 2017	Issuance for use under the RPB Policy Framework. Contains edits to technical content of the electrical section, additional requirements for accessible washrooms, improved translations of the French version and minor edits to the scope.
2.1	July 20, 2017	ISBN and catalogue numbers added for publication.

Table of Contents

1 General

1.1 How to Use This Document

This document describes both the general approach to the design of Public Service and Procurement Canada (PSPC) custodial office buildings, and the technical aspects that apply to each major discipline involved in the design. These objectives must always be balanced against all other government objectives including, but not limited to, security, accessibility, sustainability, heritage conservation and end user requirements.

When using this technical reference, apply common sense and ensure best value to Canadians. The application of this document must always be interpreted and considered, both at the scoping stage and throughout design development, by a project team following an integrated design approach to question the validity of each of its components against the problem at hand.

This technical reference is a generic document, while appropriate project-specific requirements can be found in the request for proposal (RFP).The technical reference should be applied to new buildings in their entirety and to renovations of existing buildings, given their constraints, to the greatest extent possible. In its application to renovations of existing buildings, the document is not intended to be applied retroactively. As such, the opportunity to incorporate changes to meet these objectives should be considered as part of the scope of all renovation projects that involve related aspects of planned work. The requirements in this document should not be considered as justification to initiate a project but as minimum requirements.

1.2 Effective Date

April 3, 2017

1.3 Cancellation

This document supersedes *National Performance Standards (NPS)*, and draft Real Property Branch (RPB) *Federal Office Building Standard* (FOBS).

1.4 Authority

This document is issued under the authority of the Director General (DG) Technical Services, Real Property Branch (RPB), Public Services and Procurement Canada (PSPC).

1.5 Context

This document is issued pursuant to the *Department of Public Works and Government Services Act* which states that the roles, duties and functions of the department’s minister include:

- the construction, maintenance and repair of public works, federal real property and federal immovable;
- the provision of accommodation and other facilities for departments; and
- the provision to departments of advice on or services related to architectural or engineering matters affecting any public work, federal real property or federal immovable.

The document also supports the PSPC *Sustainable Buildings Policy* and complements *Government of Canada Workplace 2.0 Fit-up Standards*.

1.6 Scope

This technical reference applies to construction projects undertaken by PSPC or by the private sector on behalf of PSPC on crown owned buildings for which PSPC is custodian and for which the predominant use is office accommodations. This includes buildings predominantly used to offer office space categories such as general administrative, secure administrative, quasi-judicial office space, and call/contact centres.Variances from this technical reference must be justified in writing and submitted for acceptance to the regional PSPC office for Architecture and Engineering Services (AES).

The requirements of this document are not retroactive to existing buildings but do apply to renovation projects to the extent practical given existing conditions.

1.7 Purpose

The purpose of this document is to establish baseline building design and technical requirements for office buildings in order to ensure:

- office buildings are built to a high level of quality that meet operational needs;
- office building requirements are clearly defined and applied consistently by private sector service providers and PSPC staff;
- the design and construction of office buildings contributes to meeting Government and PSPC sustainability targets;
- design excellence;
- sound stewardship of our federal identify; and
- the design and construction of office buildings presents best value to the crown.

1.8 Enquiries

Enquiries about this document should be directed to the Director of Architecture and Engineering Services, Technical Services, Real Property Branch, Public Services and Procurement Canada at: TPSGC.dgbisag-rpbaes.PWGSC@tpsgc-pwgsc.gc.ca.

2 General Design Objectives

Most of the interactions between the federal government and Canadians occur in buildings delivered by PSPC. The quality of these buildings must project a consistent and positive image of the Government of Canada to the public. Design solutions must:

- meet the standards prescribed in this document, and where standards cannot be met, alternative solutions must be provided;
- satisfy the immediate occupancy needs outlined in the functional program and strive to anticipate future building uses; and
- make building systems adaptable to future uses and changing priorities.

The general design objectives noted below must be incorporated and applied to all design solutions for office buildings:

- functional suitability
- health, safety, universal accessibility, and security
- sustainable and enduring development
- creativity, innovation, and technical competence
- inspiring and attractive
- financial performance based on life-cycle costing
- heritage conservation
- environmentally responsible

2.1 Functional Suitability

Ensure design solutions are appropriate to their use and consider the performance of the asset over its entire life.

Design solutions must:

- respond effectively and efficiently to the operational requirements of the project;
- respond effectively to site-specific context and conditions considering urban design and landscape architecture;
- meet local urban design and planning guidelines; and
- be flexible and adaptable.

2.1.1 Code and Standard Versions

The design solutions must comply with all applicable federal laws, regulations and the codes referenced therein. This document references many codes and standards in a dynamic manner, meaning that for all codes and standards referenced, refer to the latest version published. For a full listing of codes and standards referenced in this document, refer to section 13.This is not an exhaustive list of all applicable codes and standards.

2.1.2 Provincial Requirements

When provincially mandated inspections are required in order to facilitate a utility connection or ensure safety of a system through a provincial inspection, the provincially adopted version of a code or standard may be applied to the project.

2.2 Sustainable and Enduring Development

PSPC is committed to the principles of sustainable development in all of its operations. The principles of sustainability must be incorporated in all phases of project delivery, especially in the initial stages when most of the key decisions are made. The building's design for energy use must be optimized through an integrated design approach with all disciplines. It must also meet the performance requirements outlined below as well as those listed throughout this document.

Ensure design solutions maximize a sustainable approach aimed at:

- improving the social value to support more livable communities;
- creating economic efficiencies; and
- reducing our environmental footprint by reducing, recycling, and reusing.

Design solutions must:

- meet the Leadership in Energy and Environmental Design (LEED) Gold for new buildings, alternately Level 4 Green Globes, and meet the *National Energy Code of Canada for Buildings*;
- meet the LEED Silver for renovations, alternately Level 3 Green Globes, and meet the *National Energy Code of Canada for Buildings*;
- utilize passive solar design to maximize the energy performance potential of the building and occupant comfort;
- be tailored to the local climate to ensure the durability and high performance of building systems;
- have an effective choice of building materials and systems to ensure durability and meet pre-determined durability targets set out for each project;
- be consistent with the Federal Sustainable Development Strategy (FSDS); and
- Comply with CSA-S478-95 Guidelines on Durability in Buildings.

2.3 Creativity, Innovation, and Technical Competence

Ensure design solutions demonstrate creativity, innovation, and technical competence in their approach to the functional program and context. However, only proven solutions are acceptable.

Design solutions must:

- maximize project potential as it relates to program requirements for the building and site;
- be innovative and creative in the problem-solving response to program and site constraints;
- demonstrate technical competence in the integration of design, building science, and engineering disciplines; and
- provide best value to the Crown over the life cycle of an asset.

2.4 Inspiring and Attractive

Ensure design solutions take into consideration the physical expression of the asset and contribute positively to the local context.

Design solutions must:

- enhance the immediate environment, both for direct users and the broader community;
- be recognizable as a federal office building, reflecting a positive image of the Crown and its core value of long-term sustainability;
- integrate visually within the unique context of the area; and
- provide clarity and consistency of architectural form and detailing.

2.5 Financial Performance Based on Life-Cycle Costing

Ensure design solutions demonstrate the balance between capital construction costs, operational costs, and sustainability.

Design solutions must:

- demonstrate best value to the Crown from the use of a life-cycle approach to the financial performance of the asset from construction to demolition; and
- be evaluated using life-cycle cost analysis according to industry best practice.

2.6 Heritage Conservation

The requirements of this document are not retroactive, however, major rehabilitation projects of federal heritage buildings should seek to address as many of the principles outlined within this document as possible while still respecting the *Standards and Guidelines for the Conservation of Historic Places in Canada*.

2.7 Environmentally Responsible

PSPC must meet applicable environmental legislation and policies. PSPC is committed to sustainable development, applying it across all business practices, in compliance with environmental laws and regulations, in using environmentally beneficial products and services, and in using resources in a sustainable manner.

The essential principles of environmentally responsible design and construction include:

- Site - Optimize site potential
- Energy - Minimize non-renewable energy consumption
- Materials - Use efficiently environmentally preferable products
- Water - Protect and conserve water
- Indoor Environmental Quality - Enhance indoor environmental quality
- Operations and Maintenance - Optimize operational and maintenance practices over the full life cycle of the facility

These principles serve as the basis for planning, programming, budgeting, construction, commissioning, operation, maintenance, decommissioning of all new PSPC facilities, and for major renovation and alteration of existing buildings and facilities.

2.7.1 Prohibited Materials

The use of the following materials is prohibited on all PSPC projects:

- products containing asbestos;
- products containing pure formaldehyde;
- products containing polychlorinated biphenyls;
- products containing chlorinated fluorocarbons;
- solder or flux containing more than 0.2 percent lead and domestic water pipe or pipe fittings containing more that 8 percent lead; and
- Surface coatings with a concentration of lead in excess of 0.009 percent by weight, as per the *Hazardous Products Act's* Surface *Coating Materials Regulations*.

2.7.2 Demolition/Remediation

Paint must be tested for lead content when alteration or demolition requires sanding, burning, welding or scraping painted surfaces. Do not abate lead-based paint when a painted surface is intact and in good condition, unless required for alteration or demolition. In child care centers, test all painted surfaces for lead and abate surfaces containing lead-based paint.

2.7.3 Removal of Asbestos-Containing Materials

Asbestos abatement is under the jurisdiction of provincial governments and PSPC applies processes and procedures that are consistent with the relevant requirements and regulations. Ensure that the asbestos management plan meets all applicable requirements.

Prior to design in a facility to be renovated, a building evaluation should be performed by a qualified inspector including a review of previous inspection reports and a site inspection. If asbestos damage or the possibility of asbestos disturbance during construction activity is discovered, an asbestos management plan shall be proposed and implemented. (Ref. DP 057, Asbestos Management).

All design drawings and specifications for asbestos abatement shall be produced by a qualified specialist. In general, projects should be designed to avoid or minimize asbestos disturbance. The environmental standards vary in each provincial / territorial jurisdiction and should be supplied by PSPC.

All PSPC construction work that disturbs asbestos shall be performed using appropriate controls for the safety of workers and the public.

2.7.4 Fuel Storage Systems

Storage tank systems must comply with applicable *Canadian Environmental Protection Act* (CEPA). The owner of the storage tank system must identify and register the storage tank system with Environment Canada. Under the Regulations, both the owner and the operators of storage tank systems must comply with the Regulations. The owners and operators both share the responsibility to prevent leaks and spills, report spills, implement emergency response and exercise due diligence in everyday actions.

Storage tank systems are also regulated under one or more of the following federal regulations: the *Canadian Council of Ministers of the Environment (CCME) Code of Practice*, the *National Fire Code of Canada* and the Installation for oil-burning equipment, CSA B-139-09.

If a leak is detected / discovered, the owner or operator (i.e. the property manager or his representative) shall notify Environment Canada and the provincial authority and provide all information requested.

2.7.5 Compliance with the Canadian Environmental Assessment Act (CEAA)

The *Canadian Environmental Assessment Act* (CEAA) assesses the impacts of a project on the surrounding environment which includes the natural environment, health, socio-economic conditions, and the physical and cultural heritage. Its purpose is to promote sustainable development to ensure that environmental impacts of projects are minimized and that the process is open and participatory.

An Environmental Assessment (EA) is a planning and decision making tool which is used to predict and identify environmental effects before they occur, plan mitigation to be incorporated into project design and determine whether a project should proceed. Ensure that EA checklist requirement is completed.

3 Site

The site provides the first impressions to Canadians of a federal office building. The Real Property Branch (RPB) is a custodian of real property assets and a provider of general-purpose office accommodations to federal departments. RPB's goals include:

- meeting the custodial requirements of accommodation as per Treasury Board standards;
- ensuring that provincial and municipal official plans, zoning bylaws, urban design guidelines, and other priorities are considered for the site development in the delivery of the real property program;
- meeting applicable environmental legislation and policies to ensure protection and preservation of ecological zones and habitats; and
- meeting the various site-development requirements of Leadership in Energy and Environmental Design (LEED) or Green Globes pre-established for the project.

3.1 Site-Specific Analysis

A site-specific analysis report must be prepared for each project illustrating that the above goals have been reviewed and evaluated as part of developing an integrated strategy. The site analysis must demonstrate a clear understanding of the existing site conditions.

3.2 Urban Design

The federal government is committed to working closely and collaboratively with Canada's communities in support of local planning priorities while meeting sustainable objectives. The federal government's intent is to support the quality of life of communities with appropriate, sensitive urban design.

3.2.1 Design Objectives

Urban design is important to ensure an appropriate "fit" of the facility within the urban environment. The building's form and adjacent open space areas must be integrated to ensure a cohesive, sensitive solution. Urban design objectives include:

- demonstrating compatibility with the physical characteristics of the area and the environment surrounding it, including neighbouring land uses;
- enhancing the quality of life of the community by:
    - linking, where possible, with the public transit system and including bicycle and pedestrian pathways to reduce stress on the existing transportation system; and
    - preserving and protecting the ecological features and the heritage and cultural values of the community;
- supporting the livable qualities of the neighbourhood and community by:
    - building massing that includes adequate setbacks proportional to the existing neighbourhood, supporting the integration of the building into the local context;
    - providing appropriate pedestrian sidewalk widths to include and support trees, rest areas with benches, and other site features to generate a lively pedestrian culture to ensure accessibility for all users; and
    - illustrating a respect for human scale and use at the street level;
- integrating into the existing streetscape by:
    - orienting the front of the building to the main thoroughfare and providing an open space in front of the façade where the main entrance is located;

- creating an animated and transparent ground-floor level along commercial street frontages such as maximizing the use of clear glazing at public entrance areas and lobbies;
- incorporating elements to aid in the reduction of wind tunnel and wind shearing effects at grade levels around the building;
- integrating site furniture (benches, waste receptacles, light standards), plantings, and bus shelters with the building's design to assist in improving the functionality of the streetscape and neighbourhood;
- locating service entrances away from active public streetscapes, and if space is limited, designing service entrances so they are screened from the street in order to preserve the sense of place and aesthetic appeal of the streetscape, while ensuring that there is no manoeuvring or backing in from the street; and
- the use of crime prevention principles through environmental design for the planning of the site, including taking advantage of opportunities for passive surveillance and territorial control.

3.2.2 Master Planning

Master planning is fundamental for the appropriate organization and development of sites. For federal precincts, campuses, office complexes, and office buildings, a master planning exercise must be undertaken for the project site area. At a minimum the following elements must be studied:

- the site's capacity to accommodate the building or building complex's functional, operational, and experiential components;
- the natural and built environment, including topography and climatic conditions;
- the surrounding context of the site in relation to:
  - rural, suburban, and urban core contexts;
  - neighbourhood and streetscape typologies;
  - heritage designations;
  - servicing;
  - emergency access; and
  - public transit opportunities;
- the projected growth and development of the surrounding area;
- the on-site circulation of employees, business operations, functional requirements, public transit links, and general public use;
- all applicable legislation and standards as well as local municipal official plans, technical standards, and bylaws for the site and adjacent land areas and urban fabric; and
- project-specific costs, risks and other issues associated with the site's development.

Furthermore, master planning for a multiple-building complex or campus must incorporate open areas, which can be either adjacent to the building or at another location as determined by the site master plan. In addition, security elements must be integrated with the site design and building design.

3.3 Landscape Architecture

The intent of landscape architecture design for federal office buildings is to provide integrated design and technical solutions to create liveable and sustainable environments. At varying scales of planning, design, and management, design strategies must encompass innovative and creative built-site infrastructure utilizing natural landscape elements to support and enhance federal office buildings.

3.3.1 Design Objectives

The objective of this section is to establish sound landscape architectural design requirements for federal office buildings. Sites for federal office buildings range in scale from single buildings in urban and rural settings to large campuses, precincts, and districts. Landscape architecture design objectives are to:

- create a well-developed site that will support and enhance the building's function and operation;
- enhance the user's outside experience;
- enhance the linkages and connections with the adjacent streetscapes and neighbourhoods;
- support and enhance sustainable best practices to strengthen the inter-relationship of the landscape and building with the environment through the use of green infrastructure; the reducing, recycling, and reusing of materials; and other sustainable practices and strategies;
- support and enhance the social values by applying universal accessibility best practices for all main access and exit points to buildings and sites, parking, and other amenities; and
- ensure low-maintenance solutions to create operational efficiencies.

3.3.2 Site Design

Site design strategies must utilize the local climate and environment to reduce operational costs and support an effective functional program for employees and the public by:

- demonstrating how sun radii, wind, topography, and vegetation are used to create microclimates to enhance the experience of the site and building for the occupants and visitors;
- illustrating how scale and massing of the building and its infrastructure, such as parking structures and circulation systems, will not negatively impact adjacent open spaces or streetscapes or critical view lines to and from the site;
- demonstrating how the design of the exterior circulation systems and site amenities supports the building's functionality, such as selecting appropriate locations for principal building entrances and key destination points that are easily identifiable when approaching the building; and
- demonstrating how wayfinding and orientation systems are efficient and effective and assist in preserving the cultural and aesthetic values of the landscape surrounding the building.

3.3.3 Technical Requirements

3.3.3.1 Site Areas

Site areas around buildings must encourage interaction with the environment and social interaction of the occupants as well as support recreation activities. The outdoor space must be:

- designed with natural landscaping materials selected to reduce impervious "hardscape" elements;
- designed using native plants to limit maintenance requirements and promote biodiversity;
- integrated with vegetative elements to create a dynamic landscape throughout the year that takes in consideration the four seasons;
- focused on eliminating the use of potable water for irrigation and using where required grey water irrigation systems and plantings, which require little to no irrigation;
- planned with trees placed to provide shaded rest areas and assist in achieving reductions in heat and glare on hard surfaces, as well as to contribute to the general enhancement of pedestrian health and comfort; and

- planned with the intent of integrating planting in and around the building and parking area in order to promote visual surveillance for safety and security.

3.3.3.2 Circulation

Convenience and clarity of the exterior circulation system is a priority. Exterior circulation must be planned to achieve the following objectives:

- demonstration of a clear design strategy for pedestrian, bicycle, vehicular, service delivery, construction, emergency, security, and exterior material-handling circulation routes; intersections; staging areas; vehicular laybys; drop-off areas for building occupants; parking areas; as well as waste and snow storage areas;
- provision of space for drop-off zones and waiting areas for pedestrians and vehicles;
- integration with existing walkways, paths, and vehicular circulation networks; and
- demonstration of parking areas and circulation routes that maximize sustainable best practices to reduce impacts on the natural environment for stormwater and heat absorption.

3.3.3.3 Vegetation

Vegetation strategies must include:

- conservation and enhancement of existing natural areas and restoration of damaged areas to provide habitat and promote biodiversity;
- reinstatement of trees removed from the site on a ratio of two new trees for every tree removed; and
- integrated pest management using, where possible, natural predators to control infestations and monitoring programs where infestations have occurred.

3.3.3.4 Site Grading

Grading strategies must demonstrate an integrated approach to the site and building and adjacent land areas. There must be no negative impacts to riparian zones, ecologically sensitive landscapes, existing trees and shrubs that will be remaining, and adjacent land areas not owned by the federal government.

Site grading must:

- reuse materials, where possible, through efficient excavation;
- minimize the transport and placing of excavated materials to limit compaction;
- avoid the potential for settlement resulting from compression of the underlying soils;
- minimize the need for retaining walls;
- minimize the need for constructing cut slopes; and
- minimize the need for removal of topsoil or other organic soils including fill materials.

3.3.3.5 Site Drainage

The site drainage planning must include the development of a strategy to minimize the volume of stormwater and snowmelt runoff going to municipal systems, and to improve water quality. The approach should if possible be based on the historical conditions of ecosystems in the region.

In all cases, the design of site drainage must minimize the negative impacts of site grading strategies to municipal infrastructure, adjacent landscapes, surface water bodies, and below-ground water tables through:

- the use of above- and below-ground, sustainable green infrastructure stormwater control systems and site design such as the elimination of concrete curbs;
- incorporation of an integrated stormwater retention and detention system for the roof in order to reduce stormwater runoff and, where applicable, to provide irrigation;
    - for example, implementing a green roof or rainwater harvesting strategy should be considered, the viability and effectiveness of which must be clearly demonstrated;
- the provision of grey water irrigation to assist on-site vegetation growth if irrigation is required; and
- the provision of proper drainage to eliminate standing water that is at risk of harbouring mosquitoes or other disease-carrying insects.

For all projects, the following criteria must be respected:

- all surface stormwater runoff must be addressed on-site;
- a major drainage system must be designed to address a 1:100 year storm event;
- where a minor drainage system is required, it must be designed to address a 1:5 year storm event; and
- storm drainage systems must rely on gravity flow wherever possible.

3.3.3.6 Soil Erosion

Site planning and design must include strategies to control and minimize soil erosion, waterway sedimentation, and airborne dust. The site plan and sedimentation control plan for all land-related construction activities must:

- conform to the erosion and sediment control requirements of the provinces and municipalities; and
- mitigate risk of erosion of the embankments and sloped areas, especially those that could impact riparian zones, waterways, and stormwater retention ponds.

3.3.3.7 Site Furniture

The design and provision of site furnishings and shaded rest stops are an important aspect of site planning. The requirements of the functional program must be met and the selection of furnishings must:

- fit with the design concept for the building and surrounding site;
- be made of durable long-lasting materials; and
- require little or no maintenance.

3.3.3.7.1 Bicycle Storage

Secured bicycle storage for 5% or more of the regular building occupants should be provided within 60 m of the building. Bicycle racks should be placed in a location that is convenient to riders, such as a parking garage, parking lot or near a building entry. Bicycle racks should be located to avoid potential conflicts between cyclist and pedestrian traffic and also ensure that users do not cut across turf or planting areas. This location should be highly visible by building occupants, security personnel, security monitoring systems or by general traffic or in a secure (locked) area for use only by employees. Racks should have provisions for locking bicycles to them. Bicycle racks should be compatible with other site furnishings and with the architectural and landscape design. Bicycle storage requirements should also be reviewed in conjunction with local regulations.

Materials for outdoor bicycle racks should be very durable and resistant to vandalism. Movable racks can be an important component in effective outdoor spaces. However operational considerations must be given as to the risk of theft and their storage. Metals that require repainting should not be permitted.

3.3.3.8 Site Lighting

Site lighting designs must achieve necessary light pollution reduction. Refer to section 8, Electrical Engineering, for additional requirements. Designs must:

- support the reduction of light fixture glare;
- support the reduction of light trespass to adjacent sites;
- support a balance between providing good visibility and meeting security concerns while respecting the character of a site, streetscape, and neighbourhood; and
- respect light hierarchies as per master planning and urban design requirements.

3.4 Civil Engineering

3.4.1 Design Objectives

The civil engineering design objectives associated with site development for both new construction and existing buildings include:

- aligning with provincial and municipal requirements found in official plans, zoning bylaws, technical standards, and other design and technical guidelines for the development of sites;
- integrating the project requirements of the utility and services authorities having jurisdiction, including those related to equipment installation, access, maintenance, and replacement;
- locating piping for all systems under dedicated service corridors or vehicular circulation routes to ensure year-round accessibility for maintenance;
- addressing trenching to minimize differential frost settlement of the cuts, reduce the settlement effects of trenches and pipes, as well as ensure frost protection of the pipes;
- controlling stormwater and sanitary sewage to meet the discharge standards of the authority having jurisdiction over the receiving outlet;
- sizing sanitary systems to accommodate “peak waste flow,” including long-term development forecasts as well as allowances for infiltration following municipal guidelines; and
- providing sanitary systems separate from stormwater systems.

3.4.2 Water Supply Services

The planning and design of water supply services for a campus must include the requirements to use a loop system fed from more than one source and to configure the entire distribution network to ensure redundancy of supply. Buildings must also have two feeds to ensure redundancy.

Service connections for individual site and building water supply must meet following design and technical requirements:

- the system design must confirm the available flow rates from the surrounding system;
    - flow rate testing and hydraulic analysis must be completed as part of the design to confirm capacities and pipe sizing;

- flow and pressure requirements for site fire protection demands must be met, including the requirements of:
  - the National Building Code of Canada;
  - the National Fire Protection Association NFPA 24: *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*; and
- domestic water demands (peak and average) must be met;
- service lines to buildings are to be grounded as required by the *Canadian Electrical Code,* specifically the use of 3.0 m minimum metallic, continuous ductile iron or copper piping outside the building footprint is the preferred method of grounding;
- modular wall seals must be provided at water service entries to buildings; and
- cathodic protection of water mains and associated appurtenances must be provided based on soil and groundwater conditions and municipal standards.

3.4.3 Stormwater Management Services

Stormwater management services must be integrated with landscape architectural requirements for surface water flows. Refer to section 3.3.3.5, Site Drainage, for specific requirements. The gravity-based system must have as a minimum:

- pipe flow velocity within a range of 0.6 m/s to 3 m/s under full flow conditions;
- optimization of on-site water detention; and
- stormwater system components that meet the following requirements:
  - catch basin leads must be a minimum of 200 mm in diameter;
  - maintenance holes must be a minimum of 1200 mm in diameter;
  - sumps must be provided in maintenance holes and catch basins; and
  - safety platforms must be provided in maintenance holes that are more than 5.0 m deep.

3.4.4 Site Grading

Site grading must be integrated with landscape architectural design requirements. Refer to municipal requirements and to section 3.3.3.4, Site Grading, for detailed requirements.

3.4.5 Sanitary Services

On campuses, the sanitary sewer system design for individual buildings must be integrated with landscape architectural design requirements.

In rural areas, follow the requirements of the provincial and municipal authorities having jurisdiction for septic systems for on-site sewage treatment. Cesspools are not permitted.

The sanitary system of individual sites and buildings must be sized to accommodate "peak waste flow" as well as the long-term needs of the site. The system must meet the following design and technical requirements:

- cleanouts are to be located in the interior of the building, and maintenance holes must be provided where exterior access is required;
- municipal requirements as well as local guidelines of leakage allowances must be followed, and these design values for extraneous flow rates must be included in calculating peak sanitary flows; and

- pipe velocity flow rates must be confirmed after construction and data must be submitted as part of the commissioning process;
- sanitary system components must meet the following requirements:
  - sanitary sewers must be a minimum of 200 mm in diameter;
  - maintenance holes must be a minimum of 1200 mm in diameter;
  - maintenance holes must be benched;
  - external drop pipes must be provided for maintenance holes where the inlet elevation exceeds 600 mm or in accordance with the local authority having jurisdiction; and
  - safety platforms must be provided in maintenance holes that are more than 5.0 m deep.

4 Architecture and Interior Design

4.1 Design Objectives

The site, setting, and appearance of a federal building contribute to the image of the Government of Canada. In this context, the base building design of a federal building and its interior public spaces must contribute to the overall architectural value of the building. The main building signage and flagpoles must also be integrated into the design of the building.

Federal buildings must have a load factor ranging from 1.1 to 1.3 based on the 2010 American National Standards Institute / Building Owners and Managers Association ANSI/BOMA Z65.1-2010: *Office Buildings: Standard Methods of Measurement* using Method B. Buildings must also meet the following technical performance standards with reference to other detailed requirements in sections 6, Mechanical Engineering, and 8, Electrical Engineering:

- the building must meet a maximum air leakage rate of 0.20 air changes of building volume per hour at the standard building pressure of 50 N/m2, and all buildings must undergo air leakage testing to confirm that this target level of airtightness is met;
- the building must be designed to minimize stack effect, and solutions to achieve these objectives must be identified; and
- the building design service life is to be a minimum of 50 years according to CSA S478: *Guideline on Durability in Buildings*.

4.2 Building Common and Service Areas

4.2.1 Entrances

The building must be designed to direct the visitor to a principal entrance, which must be conveniently located, have a grade-level approach based on existing site conditions, as well as be clearly articulated on the exterior of the building. Secondary and tertiary entrances must also be clearly articulated on the exterior of the building.

Building entrances must meet the following design and technical requirements:

- have a canopy for weather protection, sized for sheltering and for emphasizing the main entrance;
- have weather protection for secondary and tertiary entrances;
- provide conventional swing doors and a vestibule at the principal and secondary entrances, revolving or sliding doors may;
- provide a personnel door for exterior overhead door locations;
- incorporate building and wayfinding signage in compliance with the applicable treasury board federal identity policies, including standard federal signage mounted on a prominent facade and a flagpole mounted on a facade or the rooftop;
- deploy solutions to inhibit the buildup of dirt and moisture in the lobby;
- deploy solutions to maintain the integrity of the security of the lobby; and
- incorporate appropriate decorative or accent lighting to support the design concepts.

4.2.2 Lobbies

The main building lobby must provide a welcoming impression to Canadians visiting the office building and reflect a positive identity for the federal government. Lobbies must meet the following design and technical requirements:

- be clearly visible from the exterior of the building both in the daytime and at night;
- have the elevator lobby and main building lobby located such that they are visible from the building entrance vestibules;
- be laid out to allow a continuous flow of pedestrian traffic with space large enough to accommodate all employee traffic during peak hours;
- provide interlink ground floor entrance areas from the street and the parking lot areas;
- accommodate circulation requirements that include additional floor area for a visitor and a security desk approximately 24 m^2 in size as well as surrounding area for security screening;
- accommodate the placement of reception and security control functions to provide visual supervision and physical control of the lobbies, including elevator lobbies and escalator lobbies;
- be designed to adhere to security requirements (see section 10, Security);
- utilize durable interior finishes for all areas and high-impact-resistant finishes for areas with heavy pedestrian traffic, using finishes that can be easily cleaned and maintained (painted gypsum wallboard [GWB] is not considered durable);
- have appropriate decorative or accent lighting to support the design concepts; and
- at least one accessible washroom must be provided in close proximity to areas where public events may be held.

4.2.3 Building Core and Support Spaces

The core is the central area of the floor plate, which includes elevators, exit stairs, washrooms, mechanical and service shafts, as well as electrical rooms. The elevator lobby and the main building lobby must be designed as an interconnected reception area.

Planning for building cores must establish distances to perimeter glazing following Leadership in Energy and Environmental Design (LEED) requirements, with the workstations located no more than 12 m from the window wall.

Planning of office floor plates must be flexible to allow the subdivision of typical floors into a minimum of two separate tenant areas while not compromising life safety for occupants.

There must be an acoustic separation of sound transmission class (STC) 52 between the building core and occupant areas.

Requirements for building support areas and inter-relationships determined by the functional program must be achieved in the design.

4.2.3.1 Elevators

All occupied areas of a federal multi-story building must be served by at least one passenger elevator. Elevator cab sizes, class, and service capacity are to be determined through an elevator traffic capacity, wait times, and system analysis. Elevators must meet the following design and technical requirement:

- passenger elevators, if more than one, must be grouped in banks of at least two for efficiency;
- travel distances from a given office or workstation to an elevator must not exceed 60 m;
- the location of stairs and their design within buildings must be inviting and encourage their use rather than elevators, to the fullest extent feasible;
- if no separate freight or service elevator is provided, one passenger elevator must be designated as a service elevator;
- a freight elevator must be provided for midrise and higher office buildings;

- a minimum ceiling height of 2.7 m is required in service elevator cabs, and freight elevators must have a ceiling height of no less than 3.7 m;
- elevator wait times must be no more than 24 to 27 seconds during the morning peak time and no more than 31 to 35 seconds during the noon peak time;
- the number of passenger elevators must be determined by the elevator traffic and system analysis;
- provide shuttle elevator(s) from the ground floor lobby to below grade parking with fully automatic operation with selective-collective operation. Capacity must be based on anticipated traffic flow and system analysis; and
- where equipment penthouses are provided, service elevators must provide access to that level.

A non-proprietary elevator control system must be used, and the PSPC project manager must define the extent of control. Destination control systems must be used. Security controls must be installed with override systems as required by the functional program.

Passenger elevator finishes must be focal points for the interior design of the building. Finishes for all surfaces must be durable, easily replaced, and low-maintenance. Door surfaces must be durable, scratch-resistant, and easily replaced. Inside and outside finishes must be coordinated with adjacent wall surfaces.

All finishes for service elevators must meet the service-level requirements for durability, and walls and ceilings must be metal. Flooring must durable, non-slip, easily maintainable, and replaceable.

In passenger elevators, recessed downlights or indirect fixtures must be used. Freight elevators must have recessed ceiling light fixtures.

All elevators must meet the requirements for firefighters emergency operation, with the service elevator designated as the dedicated firefighters elevator for the building.

4.2.3.2 Stairways (Open for Convenience)

Open stairways that connect lobby and atrium spaces must use a similar materials palette as the lobby space. Open risers are not to be provided.

4.2.3.3 Mechanical and Electrical Rooms

Mechanical and electrical equipment rooms must be designed with adequate aisle space and clearances around equipment to accommodate maintenance and equipment replacement. These rooms must meet the following criteria:

- mechanical rooms must be located to minimize heat and sound transmission to other parts of the building;
- mechanical spaces must be large enough to allow for a safe working environment and provide adequate area for maintenance service requirements and for future expansion;
- equipment rooms must have hoists, rails, and fasteners for chains to facilitate installation or removal of heavy equipment;
- easy access must be provided to roof-mounted equipment by an elevator cab stop or a large stairway to facilitate maintenance, and temporary ladders, steep stairwells, and ship's ladders must not be used;
- main mechanical and electrical equipment rooms (such as mechanical penthouses or basement rooms) must not be less than 3.6 m clear in height from the underside of the structure;

- doorways and corridors to the building exterior must be of adequate size to permit the replacement of equipment; and the path may include knock-out panels, hoists, and provisions for cranes but must allow equipment replacement;
- mechanical and electrical rooms must be accessible from non-occupied spaces such as corridors;
- primary substations (electrical vaults) or rooms containing the main secondary switchgear must not be located below garage ramps, washrooms, or janitor closets or be at an elevation that requires sump pumps for drainage;
- transformer vault rooms and emergency generator rooms must be located following the requirements of the local authority having jurisdiction;
- floor-mounted electrical and mechanical equipment such as switchgears, main building transformers, motor control centres and generators, chillers, boilers, pumps, air-handling units, electric motors, motor starters, and tanks must be set on concrete housekeeping pads, curbs, or saddles at least 100 mm thick and at least 100 mm wider on all sides than the equipment they support; and
- fuel tanks or storage tanks must have a housekeeping pad that incorporates a raised barrier of adequate volume for spill containment.

4.2.3.4 Vertical Shafts

Vertical shafts for running pipes, ducts, and flues must be located adjacent to other building core elements. In addition:

- shafts must be straight vertical runs for services;
- shafts must be sized 20% larger in area to accommodate planned expansion of the systems; and
- bus ducts require a raised containment curb edge at floor slab penetrations, and sleeves are to continue to 75 mm above the floor slab.

4.2.3.5 Washrooms

Washrooms must be located adjacent to vertical shafts at the building core. At least one washroom on each floor must be accessible, meeting the requirements of CSA B 651 *Accessible Design for the Built Environment*.

They must be designed with water-resistant, easily maintainable, durable finishes on all walls and floors. A mirror must be provided above each sink, or a continuous mirror provided across the entire sink area.

All washroom partitions must use durable, easily maintainable materials and must be ceiling- or wall-hung. Separation partitions between urinals must be provided. Each washroom must have two recessed waste receptacles, in stainless steel, one for paper towels and one for garbage. Washroom plumbing fixtures must be of a low-flow specification in all areas except basement areas.

4.2.3.6 Change Rooms, Showers, Locker Rooms

Change rooms with lockers must be located as part of washroom areas associated with relevant LEED credit. If provided, the planning of the change rooms must include lockers and benches. The showers must be separate showers and visually separated from the locker areas. All finishes must be water-resistant, easily cleanable, and maintainable.

4.2.3.7 Custodial Spaces

Custodial spaces must be provided to support the operation and maintenance of the building and include building maintenance storage rooms, stockrooms, and maintenance workrooms. Provide a minimum area of 20 m^2 in the basement, on the ground floor adjacent to loading docks, and in the rooftop penthouse. Coordinate requirements with the functional program.

4.2.3.8 Janitor Closets

Janitor closets must be directly accessible from the office floor corridor and discretely located near the washroom facilities.

4.2.3.9 Recycling Centres

Corridor areas must be provided with multi-material waste and recycling recesses. A minimum of three containers is typical: one each for recyclables, mixed recyclables, and compostables. However, the requirements must be confirmed with building management. A minimum of one station per floor or one station per 1000 m^2 must be provided.

4.2.3.10 Waste Management Rooms

Waste management rooms and equipment must be secured and adjacent to loading docks or service entrances and meet the following requirements:

- be sized to accommodate the required functions of central collection, separation, and storage of garbage, recycling, and compostable materials;
- have areas sufficient for the storage of anticipated waste material volumes generated during a three-day building occupancy period;
- have refrigerated areas for compostable materials;
- accommodate all governmental requirements pertaining to waste reduction and waste audit programs; and
- facilities that use waste containers picked up by vendors must have at least one internal loading berth for the waste containers.

4.2.4 Building Management Spaces

Property management, building systems technicians, and building cleaning operations teams must have offices next to the security control centre. Approximately 15 m^2 must be allocated for this standard office space. Refer to the requirements of the building-specific functional program.

4.2.4.1 Security Control Centre

The security control centre must be located adjacent to the main lobby. Approximately 20 m^2 must be allocated for this room, which will require rough-in of specialized conduit in the floor slab and ceiling areas for the workstations. Rough-ins are also required for the building automation system (BAS), the emergency power system, as well as the fire alarm annunciator panel.

Planning for a security command centre and inspection station must be considered if it is not required at the time of building design. The security control centre design criteria outlined above must be used in conjunction with the Royal Canadian Mounted Police (RCMP) physical security guide G1-013: *Security Control Centre Space Requirements*.

4.2.4.2 Loading Docks, Shipping, and Receiving

The loading docks and shipping and receiving areas are to be available to PSPC at all times. These areas must be convenient to service or freight elevators so that service traffic is segregated from the main passenger elevator lobbies and public corridors. They must be fully inside the building and include staging areas. Other requirements include the following:

- loading docks must be located for easy access by service vehicles and be separate from the main public entrances to the building;
- trucks and trailers that remain outside the building must have expandable environmental seals provided to separate interior unloading areas from the exterior;
- dock levellers and one scissor lift must be provided to accommodate the variety of bed heights of service vehicles;
- the edges of loading docks must be protected with edge guards and bumpers; and
- spot lighting must be provided to illuminate the inside of trailers for the loading and unloading activities.

4.2.5 Structured Parking

Parking is to be exterior on-grade parking, interior below-grade parking, or standalone structured parking. The general management criteria are contained in the Real Property Branch *Custodial Parking Policy* and *Custodial Parking Procedure*. Design and technical requirements include the following:

- structures and parking spaces must be laid out for maximum efficiency;
- parking stalls must be full-sized, and compact vehicle-sized parking stalls are not to be provided;
- two-way aisles must have a minimum width of 6.7 m, one-way aisles a minimum width of 3.6 m, and parking spaces must be a minimum of 2.6 m wide and 5.2 m long;
- preferential parking spaces are to be provided for accessible parking and for electric vehicles with charging stations;
- accessible parking spaces must be adjacent to access aisles that are part of an accessible route to the building or facility entrance;
- access aisles and entrance platforms to elevator lobbies are to use bollards and guardrails to safeguard routes;
- entrances and enclosures of elevator lobbies must be located so that they are visible from the interior of the parking facility, and must have a glazed wall area that is a minimum 50% of the total wall area;
- structural elements must not intrude upon the required stall dimensions, columns must not be located within 610 mm of the required aisle (except where the aisle has no stalls perpendicular to it), and each stall must have direct access to an aisle;
- the entire length of the entrance and exit ramps must be protected from snow and ice, and snow and ice must not accumulate on the ramps;
- all vehicular entrances to structured parking are to be secured with overhead doors or grilles that must be electric-powered, on an emergency power circuit, and operated by card-readers or other means of remote control;
- garage openings must have a minimum width of 3.6 m and a minimum height of 2.4 m, and must be monitored by video camera;

- the clear height throughout the vehicular accessible areas of a parking structure must not generally be lower than 2.25 m; and
- a headache bar, with signage indicating the clear height, must be provided in front of each garage opening and mounted slightly lower than the clear height of the parking garage.

Pedestrian walkways must link the exterior structured parking or outdoor parking area with the building entrance. Passive landscape techniques must be used to prevent vehicles from encroaching upon pedestrian walkways. In addition, pedestrian crossings of vehicular circulation lanes must be identified.

4.3 Building Envelope

The objective is to have a building envelope that provides an effective separation between the interior and exterior environments to ensure the comfort of occupants and meet passive solar and energy consumption goals. The exterior enclosure must have a high level of refinement in the aesthetic expressed by the proportions, scale, and relief as well as the materials and colours used.

4.3.1 Exterior Wall Assemblies and Components

The exterior building envelope must be designed in accordance with the “rainscreen” principle. Face-sealed envelope systems must not be used. The envelope must meet or exceed the requirements established in the CSA S478: *Guideline on Durability in Buildings*. Design and technical requirements include the following:

- walls must have a minimum 50-year full service life and at least 30 years of service life prior to a major rehabilitation;
- windows must have a minimum 25-year full service life and at least 15 years of service life prior to a major rehabilitation of gasket and seal replacements;
- roofs must have a minimum 20-year full service life;
- the exterior wall design must provide complete control of the migration of heat, air, and moisture through the building enclosure, and minimizing risk of moisture-related failures must be prioritized in the design of exterior walls;
- the cladding design must have the means to evacuate moisture from the wall assembly and must comply with the American Society of Heating, Refrigerating and Air-Conditioning Engineers ASHRAE 160: *Criteria for Moisture-Control Design Analysis in Buildings;*
- the percentage of vision glazing and the energy performance characteristics of glazing selected for facades must reflect passive solar design best practices, and vision glazing is not to exceed a maximum of 40% of the envelope areas;
- curtain walls must be a pressure-equalized rainscreen design;
- curtain walls and windows must use high thermal performance thermally broken, metal frames with high-performance glazing units;
- metal and glass cladding systems must meet the requirements of the American Architectural Manufacturers Association and CSA Group’s AAMA/CSA 101-A440 *North American Fenestration Standard / Specification for Windows, Doors, and Skylights* in terms of maximum air leakage, as well as meet the performance class AW40;
- opaque wall assemblies must be a pressure-equalized rainscreen design and must reduce thermal bridging to a minimum, to less than 5% maximum of the wall area;
- window wall assemblies are not permitted for multi-storey buildings; and

- a thermal analysis of the window systems must be provided based on the National Fenestration Rating Council's NFRC 500: *Procedure for Determining Fenestration Product Condensation Resistance Values*.

Soffits are totally exposed to weather and must therefore be designed to be resistant to the migration of heat, air, and moisture from the exterior to the interior environments. They must be designed to:

- resist displacement due to wind uplift;
- allow for access to operable equipment; and
- be airtight and insulated to limit condensation on the enclosure materials.

In addition, equipment or distribution systems that may be affected by weather must not be located inside soffits.

4.3.2 Exterior Sun Control

Passive solar principles and techniques must be used with facade and glazing designs to maximize responsiveness to climatic conditions. The base building envelope should be designed and constructed to passively manage solar heat gain, daylight, and glare with the use of passive sun-shading devices. Architectural features in the form of a projection from the face of the building must not cause ice accumulations that could represent a risk to the public.

Provision for repair, maintenance, and window cleaning, must be part of the exterior sun-control system design.

4.3.3 Glazing

The choice and thickness of double- or triple-glazed glass windows and the selection of glazing coatings and type of insulating gas in the air spaces must be based on climate, energy conservation, and security requirements.

Minimize the use of highly reflective glass that produces mirror images to avoid creating glare that would impact the surrounding streets and buildings.

Comply with legislation that aims to reduce danger to migratory birds.

The design of the building must include provisions for cleaning the interior and exterior surfaces of all windows, as per the CAN/CSA Z91-M90: *Safety Code for Window Cleaning Operations*, as amended from time to time.

4.3.4 Interior Sun Control

All windows on general office floors must have manually operated fabric roller shades to control the amount of daylight and heat gain in the office space. The type of shade, fabric, and neutral colour must be consistent throughout the building. The light filtering capacity must range from 0% to a maximum 14% openness factor. Openness factors must be selected and located on facades to achieve optimum effectiveness based on building orientation and exposure.

The interior fabric must be resistant to degradation by temperature variations and colourfast when in direct sunlight. The fabric must be stain- and mould-resistant and dimensionally stable. All fabric and hardware must be heavy-duty commercial grade, with a minimum warranty of 5 years.

Provide remote-operation controls for coverings on clerestory and atria windows. Ensure that systems and techniques are proposed for servicing for cleaning, maintenance, repair, and replacement.

4.3.5 Exterior Doors

Entrance doors must be constructed of heavy-duty materials that can withstand continuous high traffic. The exterior side of one leaf of a double-door entrance must have a lock guard or astragal to prevent tampering or break-in.

Doors used for egress only must not have any operable exterior hardware.

4.3.6 Bird Control Devices

Building design strategies must include techniques to manage bird control and reduce opportunities for nesting.

Design facades to meet the best practices contained in the *Bird-Friendly Development Guidelines* and the *Bird-Friendly Development Rating System* published by the City of Toronto (*www.toronto.ca/lightsout/pdf/development_guidelines.pdf*).

4.3.7 Window Washing Equipment

Building design must include suitably engineered systems for window washing equipment. The design applies to buildings of three stories or 12 m and higher, and must conform to the technical requirements found in the CAN/CSA Z91-02: *Health and Safety Code for Suspended Equipment Operations.*

4.3.8 Roofing Systems

Roofing systems and below-grade waterproofing systems require assemblies that are highly resistive to physical damage, including impact and water-entrapment resistance. Single-ply systems can only be used where the system is fully adhered to a solid structural surface. General principles that must be met include the following:

- roofing design, including metal flashing and trim, must follow the recommendations of the Canadian Roofing Contractors' Association (CRCA) and provincial roof associations;
- roof membranes are to be 2-ply, fully adhered membranes, and loose-laid and single-ply roof membranes must not be used;
- all inverted roof assemblies including green roofs must incorporate suitable wiring systems to facilitate the use of the electric field vector mapping (EFVM) non-destructive testing method to test for leaks in the waterproof membrane;
- roofing is to be sloped to drains and to avoid ponding on the surface of a membrane;
- the exterior surface of parapet walls and penthouses must be consistent and integrated with the envelope assembly materials;
- roof insulation must be installed in a minimum of two layers to maximize thermal breaks;
- permanent access via stairs to all roof levels must be provided to facilitate recurring inspection and maintenance, and the use of ship's ladders is not permitted;
- there must be continuity of the roof waterproof membrane and the wall air barrier;
- noise-emitting roof-mounted equipment must be screened with noise-abating panels;
- roof-mounted equipment must be housed in penthouses or screened by walls;
- roof-mounted equipment must be set back from the roof edge to minimize visibility and allow access for maintenance and repairs;
- critical roof-mounted equipment must be installed to permit roof system replacement or maintenance without disruption of equipment performance;
- pitch pocket details are not acceptable;

- no building element may be supported by the roofing system except walkways;
- exposed waterproof membranes on roofing assemblies must be protected by walkways along routes to and around rooftop equipment and all public/building user activity;
- roof-mounted devices, such as antennae, lightning rods, flagpoles, and roof anchors, must be integrated into the building structure and roof design; and
- all podiums and rooftop areas providing access to building occupants and the public must have protected waterproof membranes and insulation, as well as structural assemblies that will withstand the structural loading of planned activities and parapet heights that will address occupancy requirements.

4.3.9 Skylights and Sloped Glazing/Atria

These public area architectural features at the entrance and lobby spaces pose particular challenges for operations and maintenance. They must meet the following requirements:

- skylight design must follow the requirements of the American Architectural Manufacturers Association (AAMA) / Window and Door Manufacturers Association (WDMA) standard AAMA/WDMA 1600/I.S.7-00: *Skylights and Space Enclosures*;
- skylight placement must be calculated to prevent glare or overheating in the building interior;
- skylight and sloping glazing design must also incorporate the pressure-equalized rainscreen (PER) principle, which is based on the principle of pressure equilibrium;
- condensation gutters and a path for the condensation away from the framing must be incorporated; and
- design strategies must be provided for the cleaning of all sloped glazing and skylights, including access and equipment required for both exterior and interior faces.

4.3.10 Thermographic and Air Pressure Testing

The design intent for the exterior building envelope must be verified with thermal and air performance testing. Building enclosure commissioning must be undertaken by testing and reporting on airtightness based on the following standards and guidelines published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE); the National Institute of Building Sciences (NIBS); and ASTM International:

- ANSI/ASHRAE 90.1: *Energy Standard for Buildings Except Low-Rise Residential Buildings*;
- ASHRAE Guideline 0: *The Commissioning Process*;
- NIBS Guideline 3: *Building Enclosure Commissioning Process*; and
- ASTM E2813: *Standard Practice for Building Enclosure Commissioning*.

Thermographic inspections must be performed at pressurized and depressurized environmental conditions on the finished construction and before occupancy. Other applicable testing methodologies must be followed to verify that the actual construction and specified requirements have been met for the integrity of the air, vapour barrier, and waterproof membrane assemblies within the building enclosure.

Enclosure airtightness testing on all five faces of the building must be undertaken to confirm airtightness achievements. All five faces must meet the airtightness maximum air leakage of 1.27 L/s·m^2 at 50 mPa, following ASTM E779: *Standard Test Method for Determining Air Leakage Rate by Fan Pressurization* and ASTM E1827: *Standard Test Methods for Determining Airtightness of Buildings Using an Orifice*

Blower Door, as noted in ANSI/ASHRAE 189.1: Standard for the Design of High-Performance Green Buildings.

4.4 Architectural Components

4.4.1 Partitions

Partition assemblies have construction and acoustic requirements that must be met as identified by the following requirements in addition to those of the functional program:

- tolerances for deflection and long-term creep must be designed at the top of structures abutting partition walls;
- partition finishes used at the perimeter of a humid space, such as a bathroom, basement, or limited air control area, must be resistant to moisture, mould, and mildew;
- shower areas must use water-durable and mould-resistant partition materials as the substrate; and
- physical security control area walls must include full-height 18 gauge expanded metal mesh as part of the assembly.

4.4.2 Interior Doors

Interior doors must meet the durability requirements, functional program requirements, and the following additional standards, including those published by the Steel Door Institute (SDI), Window and Door Manufacturers Association (WDMA), and Door and Hardware Institute (DHI):

- heavy-duty doors and frames must be used that meet the Level 2 rating per ANSI/SDI 250.4: *Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors*, and all doors and frames should be certified with the Underwriters Laboratories of Canada (ULC) label, factory-primed, and prepared for hardware installation;
- door hardware must meet the Best Grade requirements of the Canadian General Standards Board (CGSB);
- wood doors must be constructed to ANSI/WDMA I.S. 1A: *Interior Architectural Wood Flush Doors* and ANSI/DHI A115-W: *Wood Door Hardware Standards, Hardware Preparation*; and
- doors leading to high-traffic areas must be 70% glazed.

4.4.3 Acoustic Treatment

Acoustic performance must meet project requirements as well as the following:

- the sound transmission class (STC) rating must include careful and extensive sealing of all joints and apertures between components around and passing through the separation, both above and below the partitions; and doors and other openings must use sound attenuation techniques appropriate to the STC;
- ceiling tiles must have a minimum noise reduction coefficient (NRC) or sound absorption average (SAA) coefficient of 0.75 and a minimum ceiling articulation class (CAC) rating of 180;
- reverberation time control in the main lobby areas must not be higher than 0.7 seconds at 500 Hz; and
- performance must comply with the “Maximum Ambient Noise Levels” table and evaluation standards found in the PSPC standard [MD 15000: *Mechanical Environmental Standard for Federal Office Buildings*].

4.4.4 Graphics and Signage

Graphics and signage must meet the requirements set by the *Policy on Communications and Federal Identity*.for the application of the Coat of Arms and flag symbol with bilingual titles, and the use of the "Canada" wordmark. For design standards, refer to the *Federal Identity Program Manual* issued by the Treasury Board as well the following requirements:

- signs for washrooms, elevators, stairwells, emergency exits, and doors of main corridors must comply with the tactile signage section of the *Federal Identity Program Manual*;
- for heritage buildings, signage must be compatible with the original signage design, using the materials, finishes, colours, typefaces, size, and scale as a guide for the new signage design; and
- all equipment and piping in maintenance rooms and in mechanical and electrical rooms, must be provided with signage.

4.5 Interior Design Components

PSPC provides finished interior service and occupant areas as part of the base building. Refer to the functional program for detailed requirements.

4.5.1 Carpet Tile

Commercial-grade carpet tiles must be specified for all base building areas that will be used for general-purpose office space and other functional areas as defined in the functional program. Carpet tile products must comply with the following minimum performance standards:

- for optimum performance, products must be of tufted-loop construction, with a multi-colour/textured pattern and a minimum of 4 fibre colours, with colour selection to take into consideration the ability to mask soiling and staining;
- yarn must be 100% solution dyed nylon or a combination of maximum 30 % yarn dyed, with permanent static control, permanent soil-hiding fibre cross-section with a modification ratio no greater than 2.2 and stain resistance that must be permanent and able to resist trafficking and numerous hot-water extractions without losing its effectiveness;
- carpet fibre must be a minimum pile weight of 576 g/m^2 with sufficient density to ensure long-term resistance to matting and crushing;
- water-based releasable adhesives are to be used that are best suited for the project or for environmental or flexibility reasons;
- carpet tile backings must be chosen based on project application and longevity;
- carpet tile must be certified by the Carpet and Rug Institute (CRI) Green Label Plus standard and must contain a minimum of 40% recycled material, use recovered materials, and be recyclable;
- all existing carpet being removed from buildings must be recycled; and
- during carpet removal, dust control procedures must be followed using high-efficiency particulate air (HEPA) filters.

4.5.2 Other Flooring

Primary public entrance areas to the building and lobbies, including elevator lobbies, must be finished with hard surfaces and with high-density and low-porosity materials chosen for their non-slip characteristics, low moisture absorbency, and hydrophobic nature. The high traffic volume of these areas must meet durable building standards to exceed a 50-year life cycle and be easy to maintain.

Secondary and support areas of the building, as well as high-traffic or service areas where acoustics are not a concern and higher-end finishes are not required as defined in the functional program, must be finished with resilient flooring. Products must be chosen for their durability, recyclability, low volatile organic compound (VOC) emission, low embodied energy, and low toxicity.

4.5.3 Wall Finishes

Primary public entrance areas to the building and lobbies, including elevator lobbies, must be finished for the full height of the walls using materials that exceed the 50-year life-cycle standard of durable building standards. Wall finishes must have a high density and low moisture absorbency, and these hard surfaces are to be chosen for their ease of maintenance. Painted gypsum board is not considered a durable finish.

Wall surfaces in heavy-traffic circulation areas must be treated with materials that are chosen for their impact resistance and low-maintenance character.

4.5.4 Material Finishes - Ceilings

A variety of options are possible for ceiling treatments. For general office spaces, at a minimum suspended acoustic tiles must be used and the following requirements must be met:

- standard office spaces within heritage buildings must maintain the heritage character of the spaces, including general volumetrics and the characteristics of finish materials;
- new suspended ceilings in standard office spaces proposed within heritage buildings must maintain full clearance at the existing windows; and
- washrooms must have full-length cove lighting above the counters or a lighting design that delivers a soft and uniform wall wash.

4.5.5 Architectural Woodwork

All wood products must be certified either by Forest Stewardship Council (FSC) Canada, the Sustainability Forestry Initiative (SFI), or to the CSA Group *Sustainable Forest Management System (SFM) standard*. The requirements are as follows:

- built-in furniture and casework provided in the main building lobby must be heavy-duty; and
- those provided in other areas must be designed for normal use.

5 Structural Engineering

The *National Building Code of Canada* (NBC) serves as the basis for the structural design of office buildings.

Furthermore, the *Treasury Board Policy on Management of Real Property* serves as the basis for structural design because it places protection of the heritage character of federal buildings on an equal footing with other considerations related to real property management and it is within this policy that departmental obligations and responsibilities are defined. The Treasury Board policy stipulates that departments must manage the buildings they administer so as to conserve their heritage character throughout their lifecycle.

5.1 Design Objectives

The structural engineering design objective for office buildings is to provide an economical and efficient structure to meet the functional requirements and to fulfill the following additional requirements:

- the limit state design (LSD) method must be used for all structural design following the requirements of the NBC;
- for existing buildings, guidance provided in the Commentary L of ‘Application of NBC Part 4 of Division B for the Structural Evaluation and Upgrading of Existing Buildings’ of the “User’s Guide – NBC 2010 Structural Commentaries” must be considered;
- the design for seismic protection must conform to the *Real Property Services Policy on Seismic Resistance of PWGSC Buildings*;
- alterations to and additions to heritage buildings shall be achieved by providing sustainable solutions while respecting the heritage value of the site in accordance with the *Standards and Guidelines for the Conservation of Historic Places in Canada*;
- design service life must be established per the CSA S478-95: *Guideline on Durability in Buildings*;
- flexibility to accommodate likely future functional requirements must be identified and integrated into the structural design; and
- the use of rainwater detention on building roofs for stormwater management must be minimized.

5.2 Structural Risk Management Statement

A structural risk management (SRM) statement must be prepared and submitted at each stage of the project. Documentation and submission requirements must be in accordance to the PSPC publication *Doing Business with Real Property Branch (RPB).*

The structural vulnerability of the building and critical building elements for the following areas of potential risk must be identified:

- Environmental loads (wind, rain, snow, ice, geotechnical and site such as hydrostatic pressures, temperature effects, corrosive environment)
- Seismic protection (main structure and non-structural elements, i.e. Operational and Functional Components or OFCs)
- Serviceability requirements (vibration, deflection, fire protection, potential lack of proper maintenance)
- Security concerns (blast threat, progressive collapse prevention)
- Sustainability consideration
- Heritage protection concerns

- Other areas of identified structural risk

Each of these risks and their potential impacts must be included in the SRM statement. The SRM must include statements describing how each of these risks will be mitigated and/or minimized.

Scenarios related to a change in structural conditions or actions should be specified in the structural risk management plan in order to identify possible critical situations for the structure. Each scenario is characterized by a predominant process or action and, where appropriates, by one or more accompanying processes or actions. The identification of scenarios represents the basis for the assessment and design of interventions to be taken to ensure structural safety and serviceability.

The SRM statement must also include a summary description of the structural systems and design loads.

5.3 Floor Loads

Office floor loads must be designed for 3.8 kPa live load unless higher values are required for localized loads such as moveable filing systems.

Live-load reductions must not be used for horizontal framing members, transfer girders supporting columns, and columns or walls supporting the top floor or roof.

5.4 Parking Structures

New parking structures must be designed in accordance with the CSA S413*: Parking Structures* standard.

6 Mechanical Engineering

6.1 Design Objectives

Mechanical products and systems must be properly coordinated with architectural, structural, civil, electrical and other building systems based on whole building design concept and life-cycle review.

Mechanical design must be based on proper selection and application of sustainable, high-performance heating, ventilation, and air-conditioning (HVAC), plumbing and drainage systems and technologies to enhance overall building performance.

Meeting the National Energy Code of Canada is a minimum requirement. Based on specific project requirement and desired Green Building rating (LEED, Green Globes etc.), the design team must target for a higher energy performance.

6.2 Mechanical Environmental Requirements

Mechanical environmental requirements must satisfy PSPC's MD 15000: *Mechanical Environmental Standard for Federal Office Buildings*, including but not limited to, the following:

- indoor design temperature;
- relative humidity operating limits;
- operating temperature range;
- outdoor design temperature;
- minimum outdoor air ventilation rate;
- flushing of air for new constructions and major renovations;
- provision of outdoor air to flush out the building on a floor-by-floor basis;
- indoor air contamination control; and
- acceptable acoustical environment.

All HVAC systems shall include devices to measure and control minimum outdoor air flow.

For spaces not listed in MD 15000 section 5.1, Acceptable Acoustical Environment, the maximum noise levels must not exceed the levels specified by the National Joint Council *Occupational Health and Safety Directive,* Part VII, Noise Control (Levels of Sound).

6.2.1 Building Pressurization

Design systems to ensure proper building pressurization. Ensure control of proper space pressure of the building to manage moisture, water vapor, airborne contaminants and potential for mold growth. The building automation system (BAS) must alarm when the building pressurization drops below a predetermined low limit.

A negative pressure must be maintained relative to the surrounding spaces in areas where exhaust systems are used or an indoor air quality contaminant source is located. Design space and building pressurization to ensure that the maximum door opening forces do not exceed *National Building Code of Canada* limits. Ensure that stack effect is controlled during both natural and mechanical ventilation strategies.

6.3 HVAC Systems

6.3.1 General Requirements

At least three distinct HVAC options must be considered at the pre-design or design concept stages complete with life cycle costing including capital costs, maintenance and operations costs, and replacement costs. The options analysis must consider low energy consumption and address advantages and disadvantages of each option. The selected HVAC system will have low maintenance costs and be known to have proven durability and high performance in the industry.

The energy consumption for each HVAC option shall be obtained by using industry recognized energy simulation software. Submit proposed energy simulation software at early stages of design for approval.

The general requirements of the HVAC systems are:

- HVAC products and systems have an integrated whole building design approach based on Life Cycle evaluation.
- The evaluation of high performance and sustainable design strategies must be carried out during the Investigation and Report (I&R) or initial conceptual design stage.
- Energy/Heat recovery systems must be incorporated when required by applicable code or when feasible based on Life Cycle Evaluation.
- High-occupancy and highly variable occupancy areas must be provided with demand-controlled ventilation (DCV) systems with CO_2 sensors.
- HVAC systems must be capable of automatically maintaining space comfort conditions for all building load variations during the heating and cooling seasons.
- HVAC systems shall include devices to measure and control minimum outdoor air flow.
- Building pressurization control dampers are to be located as close to the air-handling unit as possible, and must be motorized and connected to the BAS.
- Noise generating HVAC components such as dampers and coils are located outside private offices to minimize disturbances.

6.3.2 Supply, Return, and Exhaust Fans

All fans must bear the Air Movement and Control Association (AMCA) seal, and performance must be based on tests made in accordance with the ANSI/AMCA 210: *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating* standard. Fans must be selected based on optimum efficiency, required horsepower as well as sound power level ratings at full-load and part-load conditions. Fan motors must not run at overload anywhere on their operating curves; they must be selected for a 1.15 service factor and fan shafts must operate below the first critical speed.

Variable-speed operation of supply and exhaust fans must be accomplished through the use of variable-speed drives and inverter duty-rated motors. For smaller fans, electronically commutated motors (ECMs) may be used for variable-speed operation.

Fans must be provided with proper vibration isolation, thrust resistant supports or devices, grease box or extended grease lines, belt or coupling guard, inlet and outlet safety screen, companion flanges, flow measuring system and any other accessories necessary for particular application. Fans must be statically and dynamically balanced.

6.3.3 Air-Handling & Air-Distribution Systems

Air Handling Units must have double-walled insulated low leakage casing construction.

Other internal features like internal flow measurement and control, integrated mixing box, integrated energy/heat recovery system, internal LED service lights, thermal break, low leakage insulated dampers, factory installed DDC controls, redundant fans or fan arrays, dehumidification control and single point power must be provided based on specific application requirements

The air-handling unit and its internal components must comply with applicable Air-Conditioning, Heating, and Refrigeration Institute (AHRI) standards.

Individually finned tube coils must be certified to the AHRI 410: *Forced-Circulation Air-Cooling and Air-Heating Coils* standard, and the number of rows and fin spacing must be selected to allow effective cleaning. Select dehumidifying coils for no more than negligible water droplet carryover beyond the drain pan at design conditions. They must also be equipped with mist eliminators designed for low static pressure losses.

Selection of heating and cooling coils must consider the following:

- select heating and cooling coils to optimize system performance and energy efficiency;
- select proper coil headers and fin spacing for effective cleaning;
- minimize or eliminate water droplet carryover downstream from the dehumidification coils;
- provide adequate distance to downstream equipment from the dehumidification coils;
- provide mist eliminators where necessary; and
- provide coil slope for drainage;

Air Handling Units must be provided with double insulated stainless steel drain pans complete with indirect connection to waste systems and deep trap seals suitable for the system pressure.

Provide air filters in accordance with MD 15000: *Mechanical Environmental Standard for Federal Office Buildings*.

Low-leakage AMCA-certified volume control dampers must be utilized for outside air mixing boxes where necessary. Use high-efficiency, low-pressure drop air blenders when proper mixing may not be possible within the air-handling unit. The location of air blenders must be selected based on actual site conditions.

Access doors must be provided for all internal sections of an Air Handling Unit to facilitate proper operation, inspection, service and maintenance. Access door construction must be similar to the Air Handling Unit casing construction.

Air – Distribution System must be designed and constructed in accordance with SMACNA and ASHRAE.

VAV terminal units, VAV diffusers, Grilles, Diffusers, Registers and other components must be properly selected for specific application. Air – Distribution systems must be designed for low pressure drop to minimize over all fan energy use without compromising on comfort at full load and part load conditions.

6.4 Humidification and Water Treatment Systems

Design humidification levels must be coordinated with the overall mechanical HVAC and envelope design to prevent condensation on the interior surfaces, control water vapour migration into the exterior wall assembly, and ensure adequate building pressurization. Analysis of local water supply shall be part of the humidification system design to identify the type of water treatment systems required for the humidification equipment.

Humidification systems must also comply with the requirements of PSPC's MD 15161: *Control of Legionella in Mechanical Systems.*

6.4.1 Humidifiers

Humidification systems must comply with the following requirements contained in section 5.12, Humidifiers and Water-Spray Systems, of the American Society of Heating, Refrigerating and Air-Conditioning Engineers standard ANSI/ASHRAE 62.1: *Ventilation for Acceptable Indoor Air Quality*:

- Make-up water for humidification systems must originate directly from a domestic cold-water source. Air-washer systems are not permitted for humidification purposes.
- Direct steam injection type humidifiers must not be used.

Humidifiers must be CSA-approved and be certified by the Underwriters Laboratories of Canada (ULC-listed) where applicable.

A high-level humidity safety switch as well as a flow switch must be integrated with each humidification system and tied into the BAS.

6.4.2 Water Treatment Systems

Systems requiring water treatment include the following:

- open and closed hydronic systems including cooling towers;
- potable water;
- boiler feed water;
- spray washers;
- humidification systems;
- grey water systems; and
- decorative water systems (fountains, ponds).

Design water treatment systems for the control of microbiological activity including *Legionella* control as well as slime production, dissolved solids precipitation, scaling, and corrosion protection in accordance with MD 15161: *Control of Legionella in Mechanical Systems*.

The chemical feed system must have self-contained microprocessor controls capable of communicating with the BAS. The methods used to treat the system's make-up water must follow the guidelines in the ASHRAE *Handbooks*. Manual addition of chemicals is not permitted.

6.5 Hydronic Systems

Closed-loop systems must include an expansion tank and a pressure-relief valve. Hydronic systems that use a common return system for both hot water and chilled water must not be used. Hydronic systems that use a common distribution system to supply both heated and chilled water are acceptable provided that the system is designed to allow a dead band between change-over from one mode to the other of at least 8 °C outdoor air temperature.

Hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection (e.g. cooling towers) and heat addition (e.g. boilers) must have controls that are capable of providing a heat-pump water supply temperature dead band of at least 11 °C between initiation of heat rejection and heat addition by the central devices (e.g. cooling tower, boiler).

Refer to the CAN/CSA B214: *Installation Code for Hydronic Heating Systems* for detailed information on hydronic systems and components.

6.5.1 Expansion Tanks

Use only diaphragm-type expansion tanks in hydronic systems that are pre-charged to reduce the tank size. Consider operational and maintenance constraints when selecting a suitable location for the expansion tank.

6.5.2 Pipes and Valves

Hydronic system designs must be properly sized with two-way control valves for variable-flow to minimize the pressure drops and reduce pump energy in systems with multiple heating/cooling coils. Closed-loop piping system designs must incorporate pressure-balancing controls, pressure independent balancing valves, expansion tanks and required accessories. Isolation valves must be provided on all equipment and devices, including the following:

- main piping branches;

- heat exchangers (including chiller evaporators and condensers);
- heating and cooling coils;
- terminal units; and
- control valves.

The horizontal supply and return pipe network feeding floor perimeter heating systems shall be located at the bottom of the heaters as opposed to being at the top in order to prevent air entrainment inside the coils, prevent noise, provide proper heating and reduce maintenance labor costs related to the purging of the coils.

Provide local strainers for all terminal units, heating and cooling coils, and heat exchangers. Isolation and shut-off valves greater than 65 mm Ø must be high-performance butterfly valves, and those below 65 mm Ø must be ball valves. Isolation valves must also be provided for zones off vertical risers and major horizontal branches.

Provide flexible pipe connectors as required to prevent transmission of noise and vibration through piping systems. The use of grooved pipe connections is not permitted.

6.5.3 Hydronic Pumps

Design the hydronic pumping system to meet the following requirements:

- inverter duty-rated pump motors for variable-flow systems;
- provide best efficiency point (BEP) selection for the most frequently used flow rate (not the maximum flow rate);
- full flow range pumping capability without any overload conditions;
- maximum 1800 r/min for pump drives;
- chillers with corresponding primary chilled-water pumps and condenser-water pumps;
- sufficient pumping capacity for the stand-by pump(s) to maintain building operation in accordance with the requirements of the business continuity plan;
- sufficient space around each pump for the removal of the bearing unit and impeller without interfering with the operation of any other system;
- mechanical seals and labyrinth seals for all pump rotating assemblies;
- fully independent hydronic pumping systems capable of individual isolation without impacting operations;
- automatic bypass valves for variable primary-only chilled water systems, to ensure that the minimum flow through the chiller is always maintained; and
- variable-flow pumping systems in accordance with the requirements of ANSI/ASHRAE 90.1: *Energy Standard for Buildings Except Low-Rise Residential Buildings*.

6.5.4 Vents and Drains

System drainage connections must be provided at all low points in the hydronic system, at each heating and cooling coil, and at each terminal unit.

Automatic air vents must only be used in accessible spaces, such as mechanical rooms where maintenance personnel can observe them.

Use manual air vents at terminal units and other less accessible high points, at all localized high points in the system, and at each heating coil.

Where hydronic systems are exposed, coordinate with architectural finishes to ensure maintainability.

6.6 Heating Systems

6.6.1 Heating Plants

New buildings or existing buildings undergoing major renovations must be designed to use low-temperature hot water heating systems from dedicated Hot Water Boiler System.

In cases where Central heating and cooling plant (CHCP) steam from District Energy Heating System is the only option, buildings must use steam-to-low-temperature-hot-water heat exchangers as part of energy transfer stations (ETSs). The building heating system must be designed for supply water of maximum 60 °C and return water of minimum 35 °C. Central Heating and Cooling Plant (CHCP) steam must not be distributed throughout any building as a heating medium.

For heat exchange systems, provide accessibility to all components without interfering with the operation of other systems and equipment, including the replacement of the tube bundle and/or disassembly of components. Piping networks must include the following:

- isolating and drain valves;
- piping design that account for thermal stresses;
- piping supports with provisions for thermal movement; and
- non-condensable gas elimination.

Double-wall heat exchangers must be used in domestic hot water heating applications. Plate heat exchangers must be used for waterside economizer applications.

6.6.2 Dedicated Boiler Hot Water Heating Systems

Hydronic hot water heating boilers must incorporate lower operating pressure and lower operating temperature for increased operating efficiencies.

Boilers must be located in a dedicated mechanical room with all provisions made for breeching, flue stack, and combustion air complete with an outdoor air intake. For high-rise applications, locate boilers in the rooftop penthouse to reduce static pressure on boilers.

Hot water heating systems must be designed for redundancy. Dedicated backup capacity must comply with requirements for business continuity plans in conformance with PSPC'S *DP 001: Policy for Emergency Preparedness in Public Works and Government Services Canada* and the Treasury Board of Canada Secretariat's *Operational Security Standard - Business Continuity Planning (BCP) Program*.

While designing dedicated hot water heating systems, incorporate the following:

- high efficiency packaged boiler designs;
- factory pre-assembled components and controls;
- modular design (allowing the isolation of any boiler without interfering with the operation of any other boiler);
- separate specifications for control and relief valves to limit pressure and temperature;
- smart boiler and heating system controls integrated with BAS;
- minimum boiler efficiencies as per the *National Energy Code of Canada for Buildings*;
- boiler systems complete with all required auxiliaries, including expansion tanks, heat exchangers, water treatment, and air separators;
- control and piping arrangements that protect the boiler from thermal shock;
- pipe sizing in compliance with the ANSI/ASHRAE 90.1: *Energy Standard for Buildings Except Low-Rise Residential Buildings*;

- primary heating sources for a building that do not include electric resistance heating and/or electric boilers, except when justified by a life-cycle costing analysis or when utilizing renewable energy sources;
- sodium/potassium-free (Na-K-free) gas valve actuators;
- breeching, vents, stacks, and chimneys, in compliance with the National Fire Protection Association standards NFPA 54: *National Fuel Gas Code* and NFPA 211: *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*;
- factory-fabricated, field-assembled breeching, vents, stacks, and chimneys; and material types, ratings, and distance to adjacent building materials that are in compliance with NFPA 54 and NFPA 211; and
- heat transfer fluid that is free of ethylene glycol.

6.7 Cooling Systems

Cooling systems must be designed in compliance with the CAN/CSA B52: *Mechanical Refrigeration Code.*

Refrigeration systems, the choice of refrigerant, and leak mitigation measures must comply with the ANSI/ASHRAE 15: *Safety Standard for Refrigeration Systems* and ANSI/ASHRAE 34: *Designation and Classification of Refrigerants.*

Domestic cold water must not be used for cooling systems. Only acceptable refrigerants are to be used, in accordance with the CAN/CSA B52: *Mechanical Refrigeration Code.*

6.7.1 Chilled Water Systems

Ensure that the cooling plant controls are integrated with the chillers, cooling towers and distribution system for overall maximum integrated efficiency.

Chillers must meet the CAN/CSA C743: *Performance Standard for Rating Packaged Water Chillers* for energy efficiency requirements. Chiller performance must be certified by the Air-Conditioning, Heating, and Refrigeration Institute (AHRI).

Demonstrate that life-cycle costing (LCC) has been used as the basis for the selection or omission of the following:

- variable-frequency drive (VFD) centrifugal, screw, or scroll chillers;
- water cooled or air cooled chillers
- magnetic bearing chillers
- waterside economizer (free cooling) systems
- heat recovery or heat pump chiller if required for specific application
- thermal storage solutions;
- absorption chillers;
- centrifugal chillers with oil-free compressors;
- rotary screw chillers; and
- scroll chillers.

Chilled water system designs must incorporate the following:

- vibration isolation and seismic control measures;
- flexible piping and conduits;

- common header design for chilled water, with provisions to sequence chillers according to load requirements;
- expansion tanks, heat exchangers, water treatment, and air separators for all auxiliaries;
- recirculation/bypass control valves on chiller condenser piping to maintain the manufacturer's minimum incoming condenser water temperature;
- pressure and temperature gauges, flow and energy-use meters, including adequate illumination, along with isolation valves to allow servicing while in operation;
- microprocessor-based controls capable of communicating with the BAS;
- Provisions for the BAS to sequence chillers to match the cooling load;
- chiller operating limit controls;
- chiller safety controls;
- chiller freeze-protection controls;
- chiller flow controls;
- control panels with self-diagnostic capability and integral safety controls;
- control panels with displays that include the following:
    - run time
    - operating parameters including set-points
    - electrical low-voltage alarm
    - phase-protection loss alarm
    - peak demand limiting controls
    - input/output coefficient of performance (COP)
- BAS-connected chiller leak detection and remote alarming;
- BAS-connected freeze protection, including hard-wired, low-limit switches for all freeze-prone coils;
- piping connections that include isolating and drain valves on chilled water and condenser water loops;
- minimum flow alarm through the chiller when the chiller is operating;
- piping designs that incorporate provisions for the thermal movement of piping and the reduction of thermal stresses on the chiller; and
- air-elimination accessories including a purge system that operates without affecting chiller operations.

Dedicated backup capacity must comply with requirements for business continuity plans in conformance with PSPC's DP 001: *Policy for Emergency Preparedness in Public Works and Government Services Canada (001)* and the Treasury Board of Canada Secretariat's *Operational Security Standard - Business Continuity Planning (BCP) Program*.

Chiller units must be connected to a common header that allows for adequate isolation of individual units without interruption of service to the remaining units.

Cooling systems with a capacity less than 175 kW (50 tons) require a life-cycle cost analysis for incorporating or omitting cooling towers or evaporative condensers. The chilled water system design must maximize chilled water temperatures and minimize condenser water temperatures to achieve the greatest heat recovery rates and highest efficiencies.

Each chiller must be designed to permit refrigerant recovery during servicing and repair.

Chlorofluorocarbon (CFC) refrigerants are not permitted. For acceptable non-CFC refrigerants, refer to the Federal Halocarbon Regulations and the Ozone-Depleting Substances Regulations under the *Canadian Environmental Protection Act*.

6.7.2 Cooling Towers

Cooling tower designs must incorporate the following:

- wet bulb design temperatures that meet the parameters specified in the ASHRAE 90.1: *Energy Standard for Buildings Except Low-Rise Residential Buildings*;
- *Legionella* abatement strategies, including microprocessor controls capable of communicating with the BAS;
- performance certified by the Cooling Technology Institute (CTI) under the STD-201: *Certified Cooling Towers* standard;
- cooling tower fan power requirements that comply with ASHRAE 90.1;
- supply piping connected to a manifold to allow for any combination of equipment use;
- equalization piping between cell basins for multiple tower designs complete with isolation valves between cells;
- ladders and platforms for ease of inspection and replacement of components;
- control strategies for the prevention of “dead heading” with variable-speed pumps when the pump is operated in parallel with other pumps;
- clean-outs for sediment removal and flushing from basins;
- de-icing capability for operations in subfreezing climates;
- provisions in subfreezing climates for draining all piping during shut-downs using indoor drain-down basins;
- heat-tracing and thermal insulation for exterior piping subject to freezing;
- manual shut-down capability;
- basin heaters for all-weather waterside economizers;
- heat tracing above and below grade (down to 900 mm) for all condenser water piping operated in subfreezing climates;
- fibreglass, polyvinyl chloride (PVC), or stainless steel construction for condenser piping, cooling tower basins, and housings, free of bolted or riveted connections;
- vibration and sound isolation in accordance with the CTI STD-201 standard for cooling towers located on building structures;
- cooling tower elevations that maintain the required net positive suction head on condenser water pumps;
- 1200 mm minimum clear space beneath the bottom of the lowest structural member, piping, or sump on all rooftop installations (to allow re-roofing under the tower); and
- BAS-connected temperature and pressure sensors for chilled and condenser water pipes connected to the waterside economizer, with automated controls for waterside economizers and sequenced with the operating chillers to match the load requirements.

6.8 Plumbing Systems

Plumbing systems include domestic cold water supply (DCWS), domestic hot water supply (DHWS), and domestic hot water recirculation (DHWR) systems, plumbing fixtures, traps, sanitary waste and vent systems, and stormwater systems. Design the plumbing systems to meet the *National Plumbing Code of Canada*.

When designing plumbing systems, consideration must be given to the reuse of existing systems by confirming the condition of existing piping prior to re-use. To be fit for re-use, piping systems must satisfy the requirements outlined in this document as well as those contained in the applicable codes listed in section 13 in the Mechanical Codes, Standards, and Legislation section.

Hot water heaters, tanks, heat exchangers and pumps are to be located in mechanical rooms. Demonstrate that life-cycle costing (LCC) has been used as the basis for the selection or omission of heat recovery, instantaneous heating systems, high efficiency heating equipment, and renewable heat sources.

6.8.1 Plumbing Fixtures

All plumbing fixtures must be provided with stated water efficiency ratings and must comply with accessibility requirements as specified in the Treasury Board of Canada Secretariat *Accessibility Standard for Real Property*, the CAN/CSA B651: *Accessible Design for the Built Environment* standard, and the PSPC *Real Property Branch Accessibility Procedure*.

6.8.2 DCWS, DHWS, and DHWR Systems

The domestic water system must be designed to prevent the following:

- water hammer,
- cross-contamination,
- surge,
- erosion,
- noise, and
- cavitation.

In addition, the DCWS, DHWS, and DHWR systems must be designed to include the following:

- lead-free materials for all piping and fixtures in accordance with the CSA B125.1: *Plumbing Supply Fittings* standard;
- bacterial and/or chemical treatment of raw water supplies to be used for potable water services, and as an additional precaution, drinking fountains and water-bottle filling stations equipped with in-line filters capable of removing lead, to meet Health Canada's *Guidelines for Canadian Drinking Water Quality*;
- a DHWR system when hot water availability exceeds 15 seconds at the furthest fixture from the heating source;
- a maximum hot water temperature of 40 °C at showerheads; and
- *Legionella* controls in accordance with MD 15161: *Control of Legionella in Mechanical Systems*.

6.8.3 Sanitary Waste and Vent Systems

Provide separate sanitary and storm sewer runs to the property line, even in instances where the municipal sewers combine sanitary and storm sewers. Comply with the waste treatment requirements of the authority having jurisdiction.

Floor drains connected to the municipal sewer system or discharging into the environment must include safeguards to prevent discharges of hazardous materials where the incidence of discharges occurring is likely, such as in mechanical rooms and workshops.

Provide floor drains with materials and accessories adapted to the following specific building areas:

- cast iron drains and nickel-bronze strainers for public washrooms and other public areas;
- cast iron drains, stainless steel sediment buckets, and stainless steel funnel-type strainers for kitchens and dishwashing areas;
- large-diameter cast iron drains with funnel-type strainers in equipment rooms, with the drains located appropriately to eliminate horizontal runs of drain piping;
- large cast iron or concrete basins for parking garages installed in conjunction with heavy-duty cast iron grates to incorporate sand and oil interceptors; and
- trench drains or roadway inlets for ramps exposed to rainfall.

Provide trap seal primers for all floor drains where drainage is not routinely expected from spillage, cleaning, or rainwater. Provide floor drains with adequate cleanouts and plumbing vents in accordance with plumbing codes.

Only use sewage pumps where gravity drainage is not possible. If sewage pumps are required, only the lower floors of the building must be connected to the sewage pump; fixtures on the upper floors must use gravity flow to provide drainage to the public sewer.

Sewage pumps must be non-clog, screenless, grinder-type duplex pumps, with each discharge not less than 100 mm in diameter, complete with alternators and connected to the emergency electrical power grid.

Septic tanks and disposal fields must comply with all requirements of the authority having jurisdiction.

6.8.4 Stormwater Drainage Systems

Roof drains and overflow drains must be cast iron body type with high dome grates designed to provide adequate drainage.

Elevator shaft sumps must be fitted with sump pumps connected to the emergency power grid. Sump pump pits must be independent from elevator pits.

Stormwater lift stations and sump pumps must only be used where gravity drainage to municipal storm sewers is not possible. Stormwater lift stations and clear water sump pumps must be non-clog, screenless duplex pumps, with each discharge complete with alternators and connected to the emergency electrical power grid. Sump pumps must be complete with sealed cover plates, vents, inspection manholes, and access to level controls.

6.9 Advanced Metering System

Data management must focus on key performance indicators to be meaningful and useful for the implementation of the energy management system (EnMS) as described in the CAN/CSA-ISO 50001: *Energy Management Systems* standard.

Advanced metering systems must be installed in all new construction and major renovation projects to collect information on the consumption of electricity, gas, water, and other utilities (e.g. steam, chilled water).

The metering system must include meters, communications networks, and data management capabilities. Data from variable-frequency drives larger than 3.75 kW must be networked to the advanced metering system.

The advanced metering system must be networked to, or form part of, the building automation system (BAS). It must record data at a frequency no less than hourly (similar trigger points are also acceptable) and store the data in a central repository. The system must be able to show daily, monthly, and annual totalled readings and provide for combined readings to show total energy consumed for the period.

The system must include energy tracking for the whole building (and selected subsystems) by displaying the actual energy consumption in comparison to a baseline (either estimated or established). This data must be available on demand on the central operator workstation, and must be available in a form that allows for the ability to generate advisories to management when normal tolerances are not being maintained.

The advanced metering must record at a minimum the following information:

- electrical components:
    - phase voltages, phase currents, and power consumption (kW) readings for the following:
        - all risers;
        - motor control centres;
        - lighting panels;
        - power distribution panels;
        - telecommunication rooms; and
        - emergency loads (on the load side of the transfer switches);
    - line voltages, line currents, and power consumption (kW) readings for all feeders to the following:
        - motor loads over 15 kW;
        - all major mechanical equipment such as chillers, air-handling units, and pumps; and
        - all spaces planned to be leased;
- for mechanical components and subsystems:
    - electrical, gas and other fuels consumption;
    - domestic water consumption;
    - cooling tower water consumption;
    - steam and/or hot water;
    - chilled water (Energy/BTU metering); and
    - individual water flow or energy-measuring devices provided for chilled water lines serving computer rooms.

The water flow and airflow measuring devices must meet the requirements of the ANSI/ASHRAE 90.1: *Energy Standard for Buildings Except Low-Rise Residential Buildings*.

6.9.1 Power Monitoring

In addition to, or as part of, the above listed metering, power monitoring must also form part of the advanced metering system. The power monitoring must be installed in the primary switchgear (if present and Crown-owned) as well as the main secondary switchgear, and must measure, at a minimum, the phase voltage, phase current, power consumption, power factor, and harmonic distortion.

6.10 Building Automation Systems

The building automation system (BAS) must have a non-proprietary design to monitor, control, and report on all mechanical, environmental-control, and energy-consuming systems, and must be based on Ethernet BACnet TCP/IP network, native BACnet controllers and other devices. The BAS must be able to provide an integrated platform for intelligent, smart and high performing building

The BAS must include as a minimum:

- controllers;
- sensors and other field devices (use smart sensors and devices where feasible);
- Networks;
- Computers;
- All necessary software components including energy management;
- engineering;
- new wiring;
- complete graphical package, including dashboards;
- installation;
- programming;
- start-up;
- commissioning;
- as-built and documentation;
- warranty and maintenance; and
- any devices or accessories to make a complete system.

The BAS must comply with ANSI/ASHRAE 135: *A Data Communication Protocol for Building Automation and Control Networks* and ANSI/ASHRAE 135.1: .Method of Test for conformance to BACnet

The system must utilize direct digital control (DDC) technology with networked distributed processing, and be user-programmable in the field for all required automated functions.

The BAS must provide means for direct access to all setpoints, trends, and objects using BACnet protocol (BACnet/IP or native BACnet). The “As-built” documentation must provide the list of all setpoints, trends, and objects with explanation of their function and/or meaning.

In addition, visual and audible identification of BAS alarm signals must be provided in the security control room during unoccupied periods. However, such alarms must not be integrated with the fire and security systems.

Existing proprietary systems can be used in existing buildings only after a detailed life-cycle cost analysis has been done that can justify the continued use of such proprietary systems or non-BACnet systems.

6.10.1 Operator Work Stations

The primary operator work station (OWS) must be capable of displaying information from the BAS as well as the advanced metering system

The main OWS and secondary OWS must be listed by the BACnet Testing Laboratories (BTL) as either a BACnet Advanced Operator Workstation (B-AWS) or a BACnet Operator Workstation (B-OWS).

6.10.2 Controllers

Standalone, microprocessor-based, fully programmable control units must include the following features:

- the use of BTL-listed DDC controllers only;
- microprocessors (CPUs) with memory and hardware sufficient for the installation and for at least a 25% expansion of capability for each controller controlled by the master controller;
- a controller power supply that accepts local power and provides all conditioning necessary for reliable, fail-safe operation;
- a battery-backed real-time clock accurate to ± 5 seconds/year with 72-hour backup;
- battery-backed RAM with 72-hour backup;
- network interface to other controllers;
- network interface allowing access by operators (including access via OWSs); and
- automatic, complete recovery after a power failure.

6.11 Mechanical Systems for Special Spaces

6.11.1 Entrance and Lobbies

Positively pressurize the entrance vestibule relative to atmospheric pressure to minimize infiltration. Ensure that exterior door operations are not adversely affected and remain within acceptable limits, in conformance with the *National Building Code of Canada*.

6.11.2 Elevator Machine Rooms

Maintain space temperature conditions, as required by equipment specifications and in accordance with the American Society of Mechanical Engineers (ASME) / CSA Group (CSA) standard ASME A17.1/CSA B44: *Safety Code for Elevators and Escalators*. Consider the use of secondary chilled water for cooling, and the use of elevator machine room heat exhausting for heating the remaining building. Ensure that the elevator design minimizes the draw of interior air through the stack effect.

6.11.3 Mechanical and Electrical Rooms

All mechanical, electrical, and telecommunication equipment rooms must be maintained with room space conditions, such as ventilation, heating, and cooling, as required by PSPC's MD 15000: *Mechanical Environmental Standard for Federal Office Buildings*.

Install equipment in a manner that the servicing of any equipment will not require shut-down of other equipment. Identify operational requirements and redundancy requirements where applicable at early stages of design.

The location of water lines must comply with the requirements of the *Canadian Electrical Code*.

All telecommunications rooms must be ventilated and cooled in accordance with the requirements of the Telecommunications Industry Association (TIA) / Energy Information Administration (EIA) standard ANSI/TIA 569: *Telecommunications Pathways and Spaces* and its addenda.

6.11.4 Computer Room Cooling and Ventilation

Provide computer room ventilation in accordance with PSPC’s [MD 15000: *Mechanical Environmental Standard for Federal Office Buildings*].

Provide high performance, low energy cooling system. Cooling systems must be evaluated based on specific use and application of computer rooms.

Identify operational requirements and redundancy requirements where applicable at early stages of design. Demonstrate that an evaluation based on life-cycle costing (LCC) has been used as the basis for the selection or omission of the use of heat recovery and or water side economizer (free cooling) systems.

6.11.5 Service Areas

Requirements for mechanical systems in service areas include the following:

- janitor closets must not be used for the location of any equipment;
- air dampers on mechanical ventilation systems serving transformer rooms and emergency generator rooms require limit switches tied into an alarm for the damper position. The damper position must be interlocked with its ventilation fan;
- the construction, ventilation, and equipping of all rooms containing refrigeration units, such as chiller equipment rooms, must comply with the ANSI/ASHRAE 15: *Safety Standard for Refrigeration Systems*, the ANSI/ASHRAE 34: *Designation and Classification of Refrigerants*, as well as the CAN/CSA B52: *Mechanical Refrigeration Code*;
- indoor parking garages must include supply and exhaust systems activated by carbon monoxide detectors, and must use energy recovery systems where justified by a life-cycle costing analysis;
- the design of the HVAC for the indoor parking areas must include a life-cycle costing analysis of energy recovery systems and of variable air flow systems;
- mailrooms must have independent HVAC systems to deal with the potential for chemical/biological contamination;
- uninterruptible power supply (UPS) battery rooms must be ventilated/exhausted directly to the outdoors at a rate that is in compliance with code requirements and the manufacturer’s recommendations, and in addition:
  - the exhaust system must be connected to the emergency power distribution system;
  - fans must be explosion-proof; and
  - ductwork must consist of a dedicated, negative pressure system of corrosion-resistant material; and
- high-occupancy and highly variable occupancy areas must be provided with demand-controlled ventilation (DCV) systems with CO_2 sensors, with enthalpy energy recovery and de-humidification systems provided where justified by a life-cycle costing analysis.

6.12 Fuel Storage Systems

For fuel storage systems refer to section 8.11.1 Emergency Generator System and 2.7.4 Fuel Storage Systems.

6.13 Miscellaneous Requirements

6.13.1 Acoustical Insulation

Provide acoustical insulation where required to satisfy the requirements listed in Table 5-1, Maximum Mechanical Noise, in PSPC's MD 15000: *Mechanical Environmental Standard for Federal Office Buildings*.

Acoustic treatment of fan noise must be incorporated at the air-handling unit by using duct silencers on the supply and return ducts. The treatment must not use fibre insulation on the interior surfaces of the ductwork upstream of the air terminal units.

6.13.2 Identification of Mechanical Systems

All piping and ductwork systems in new constructions or major renovations must be identified in accordance with the Workplace Hazardous Materials Information System (WHMIS) manual issued by Health Canada, which represents Canada's national standard for hazard classification and communication.

6.13.3 Outdoor acoustical treatments

Air intakes, exhausts, mechanical rooms, cooling towers, air-handling units, emergency generators, and waste-handling equipment must have noise attenuation provisions, where required, to achieve compliance with noise restrictions at the property line.

7 Fire Protection Engineering

7.1 Design Objectives

The design objective of life and safety systems is to ensure the health and safety of federal employees in the event of an emergency. Fire protection and suppression systems must comply with the *National Building Code of Canada* and *National Fire Code of Canada*.

All sites on or off municipal services must be evaluated and strategies provided to address issues related to health and safety. Municipal installations must meet the National Fire Protection Association's NFPA 1142: *Standard on Water Supplies for Suburban and Rural Fire Fighting* and other appropriate NFPA standards that stipulate water requirements for supplying fire suppression systems. Issues to be addressed include the following:

- evaluation of pressure and flow rates to determine their adequacy;
- evaluation of pressure and/or flow rates based on 10 years of projected deterioration (or increase in demand due to population growth); and
- evaluation of the use of fire pump(s) and/or booster pump(s) feeding from a private tank or reservoir.

7.2 Specialized Functions for Base Building and Tenants

Office buildings may have tenants who have requirements related to specialized functions in addition to the base building requirements. These functions must be integrated into the base building system. Furthermore, general storage facilities within base buildings must meet the requirements of the NFPA 13: *Standard for the Installation of Sprinkler Systems* and the NFPA 231: *Standard for General Storage.*

Specialized tenant functions identified in the functional program may include one or more of the following:

- the storage arrangements and protection of a rack storage facility, which must meet the requirements of NFPA 13, NFPA 231, and NFPA 231C: *Standard for Rack Storage of Materials*;
- the storage arrangements and protection of an inflammable and combustible liquid storage area, which must meet the requirements of the *National Fire Code of Canada*, the NFPA 30: *Flammable and Combustible Liquids Code*, and the applicable Factory Mutual (FM) Global Property Loss Prevention Data Sheets;
- facilities having high-value or mission-essential electrical equipment, mainframe computers, or network equipment with the potential for high dollar loss and/or business interruption, which must be designed and installed in accordance with NFPA 75: *Standard for the Fire Protection of Information Technology Equipment*;
- Sprinkler systems such as wet, dry, deluge or pre-action as required for the type of occupancy and approved by Departmental Representative; and
- fire protection requirements for cooling towers, which must meet the requirements of NFPA 214: *Standard on Water-Cooling Towers*.

7.3 Sprinkler Systems

Sprinkler systems must meet all of the requirements below, which supersede the design requirements of NFPA 13: *Standard for the Installation of Sprinkler Systems*:

- all sprinklers installed in any new construction or renovation projects must be listed by a nationally recognized testing facility such as Underwriters Laboratories of Canada (ULC);

- all quick-response glass bulb sprinklers must be equipped with a protective device to reduce damage prior to installation, and the protective device must be removed after the sprinkler is installed;
- all sprinkler escutcheons installed in any new construction or renovation projects must be ULC-listed equipment;
- flow control (on-off) sprinklers must not be installed in any new construction or renovation projects;
- all automatic sprinklers installed less than 2 m above the floor must be equipped with sprinkler guards to provide protection against accidental damage;
- black steel piping and/or copper tubing must be used for all wet-pipe sprinkler piping;
- chlorinated polyvinyl chloride (CPVC) sprinkler piping must not be used;
- galvanized (internal and external) sprinkler piping must be used for all dry-pipe sprinkler systems;
- steel pipe sizes 50 mm and smaller must comply with the specifications in Schedule 40 and must be threaded;
- steel pipe sizes larger than 50 mm must at a minimum comply with the specifications in Schedule 10;
- piping less than Schedule 40 must be roll-grooved;
- threadable lightwall pipes must not be used;
- piping having a corrosion-resistant ratio less than one must not be used;
- plain-end fittings must not be used;
- automatic sprinklers must be installed in all new construction projects and in all renovation projects:
    - this includes elevator machine rooms, boiler rooms, mechanical equipment rooms, walk-in freezers and cold rooms, essential electronic facilities, electrical closets, telephone closets, emergency generator rooms, uninterruptible power service and battery rooms, electrical switchgear rooms, transformer vaults*, and telephone exchange (private automatic branch exchange [PABX]) rooms;
        - * note that sprinklers can be omitted in the transformer vault if the vault is provided with a 3-hour fire separation; however, appropriate fire protection devices must be provided in the vault as required by the local utility and authority having jurisdiction; and
    - all electrical equipment must be provided with a sprinkler-proof enclosure;
- all sprinkler systems must be wet-pipe sprinkler systems unless installed in areas subject to freezing or as directed by the project-specific program;
- in areas subject to freezing, dry-pipe sprinkler systems or dry pendent sprinklers must be installed, heat must be provided in the space, and/or sprinkler piping must be rerouted;
    - do not use heat tape on sprinkler piping;
- antifreeze sprinkler systems must not be installed in any new construction or renovation projects;
- damage to motors, switchgear, electronic equipment, direct digital control (DDC) and alarm panels, computers, etc., must be minimized by applying spray fireproofing;
- sprinklers installed in electrical rooms and electrical closets must be equipped with sprinkler guards to provide protection against accidental damage;
- sprinklers in historically significant spaces must be carefully placed to minimize damage to ornamental materials, and in addition:

  - detailed drawings must be developed for architecturally sensitive areas, showing precise sprinkler locations and finishing notes as necessary to ensure proper installation; and
  - sprinklers must be centred and placed symmetrically in relation to ornamental patterns and architectural features that define the space, such as arched openings;
- sprinklers and escutcheons must match the original architectural surfaces or hardware; and
- oxidized brass or bronze heads are recommended for use in deeply coloured (unpainted) woodwork.
  - in elaborately decorated ceilings, heads must be camouflaged by custom coating and by omitting escutcheon plates, and in such cases, low-profile, quick-response sprinklers are preferred.

7.4 Fire Alarm Systems

Fire alarm systems must meet all of the following special requirements, which are in addition to those contained in the above listed codes and standards:

- have a non-proprietary, open protocol for interoperability with other building systems;
- be monitored by the building automation system in a one-way, read-only manner; and
- be standalone systems able to function independently of other building systems.

In addition, fire protection conduits must meet the requirements set out in section 32 of the *Canadian Electrical Code*.

7.5 Fire Pumps and Accessories

7.5.1 Fire Pump Design and Installation

When a fire pump is necessary to supplement water flow and pressure, it must be sized to comply with the appropriate NFPA standards:

- NFPA 13: *Standard for the Installation of Sprinkler Systems*;
- NFPA 14: *Standard for the Installation of Standpipe and Hose Systems*; and/or
- NFPA 20: *Standard for the Installation of Stationary Pumps for Fire Protection*.

Fire pumps must be designed for manual and/or automatic shut-down. Manual shut-down must ensure that the pump does not shut down prematurely before controlling the fire. Automatic shut-down is only permitted when activated by a low water level shut-off device.

7.5.2 Fire Pump Controller

The fire pump controller must be completely assembled, wired, and tested by the manufacturer before shipment from the factory. The status and condition of all fire pump units must be monitored by and signalled at the fire pump controller, and the status of the fire pump must be monitored by the fire alarm system.

7.5.3 Jockey Pump

A jockey pump (or pressure maintenance pump) must be utilized where it is desirable to maintain a uniform or relatively high pressure on the fire protection system. Jockey pumps must be sized to make up the allowable leakage rate within 10 minutes.

8 Electrical Engineering

8.1 Design Objectives

The electrical engineering design objectives are to provide a safe, reliable, and maintainable electric power system for office buildings. The electrical system design must meet the following objectives:

- be sized to meet the anticipated loads of the building;
- be coordinated in terms of interrupting capacity, device and cable ratings, fault levels, and protective relaying;
- allow safe maintenance, minimizing shock and arc flash hazards for maintenance personnel; and
- support power conservation initiatives.

8.2 Design Studies

8.2.1 Electrical Load Analysis

An electrical load study must be performed for new office building construction as well as renovation projects where modifications to the electrical distribution system may result in overload conditions. The report must analyze the building loads, including scenarios for normal use, off-hour use (nighttime and weekends), emergency scenarios, and different seasons.

8.2.2 Short Circuit, Device Evaluation and Coordination Study

A short circuit, device evaluation, and coordination study must be performed for new office building construction as well as renovation projects where modifications to the electrical distribution system may result in protective devices not being coordinated, or in equipment being subjected to short circuit currents greater than their ratings. If series-rated equipment is used, it must be marked in a clear and conspicuous manner to ensure it is replaced with equipment of the same type and rating.

All electrical equipment panels containing interrupting devices must be labelled with the assembly short circuit current rating. Over-current devices (breakers, fuses, relay, etc.) and overload devices must be coordinated and have settings adjusted as per the coordination study.

8.2.3 Arc Flash Study

An arc flash study must be performed for new building construction as well as renovation projects where modifications to the electrical distribution system may result in the need to update existing safety labelling.

The study must be performed in accordance with the CSA Z462: *Workplace Electrical Safety* standard. Safety labels, also in accordance with CSA Z462, must be applied on all panel boards, motor control centres, switchgear, and major electrical equipment. Labels must comply with the *Official Languages Act*, including bilingual labels for regions prescribed under subsection 35(2) of the Act.

8.3 Site Utility

In buildings where low voltage is economically justifiable for the site utility, new building construction projects should have the utility company furnish power at the main utilization voltage (i.e. 600/347 V or 208/120 V).

In the case of larger buildings, or office building campuses where it is impractical or uneconomical to use low voltage, high voltage (over 750 V) may be used.

Redundant services should be requested from the utility if a cost-benefit analysis finds the redundant connection to be warranted. Redundant service should be requested for larger building (over 25,000 m^2 of floor space).

8.3.1 Substation Ownership and Demarcation Points

PSPC prefers that substations be utility-owned. However, the project details along with discussions with the local utility company will dictate the ownership of the substation and the placement of the ownership and operational demarcation points. Projects involving large buildings and campus locations may require PSPC to own substations due to cost benefits, security requirements, operational requirements, or agreement with the local utility.

8.3.2 Electrical Service

An underground service must be used to supply office buildings where conditions allow. The underground service must be installed in a concrete-encased duct bank. Cables must be selected based on all aspects of the cable operation and must comply with the requirements of the local utility.

8.3.3 Underground Cable and Conduit

Direct buried cables must not be used. Instead, buried conduits appropriate to the site conditions must be used to facilitate the modification and repair of electrical distribution.

8.3.4 Concrete-Encased Duct Banks

Concrete-encased duct banks must be used where many circuits follow the same route, for runs under permanent hard pavements, and where service reliability is paramount, such as at service entrances.

The duct bank installation must comply with the *Canadian Electrical Code*. For new building construction, spare ducts for planned future expansion must be provided. In addition, extra ducts equivalent to a minimum of 25% (of the total ducts) must be provided for unknown future expansion.

Ducts must be routed so as to avoid other underground utilities, foundations, and structures. They must have watertight seals where they enter into buildings, and must slope toward manholes.

8.3.5 Electrical Manholes

Manholes must be spaced such that pulling tension on cables will not exceed amounts that may damage the cable integrity. Furthermore, manholes must be provided with the following:

- cable racks;
- sumps;
- hardware for cable pulling (irons, inserts etc.);
- labelling on all cables; and
- grounding.

Manholes must be large enough to have all conductors secured on cable racks and must provide adequate working space around the conductors.

Separate manholes must be provided for:

- low-voltage cables (not exceeding 750 V);
- high-voltage cables (exceeding 750 V); and
- telecommunications cables.

Electrical handholes may be used for low-voltage feeders (below 750 V), branch circuits, and telecommunications pathways.

8.4 Primary Distribution

Primary power distribution systems consist of transformers, cables, switchgear, and associated equipment and operate at high voltage (over 750 V). For projects in which PSPC-owned primary power distribution systems are being installed, i.e. typically large buildings or campuses, the following design requirements must be met:

- use an open-loop or primary selective system architecture for redundancy if the system supplies over 25,000 m^2 of floor space and/or if the building contains mission-critical equipment such as data centres; and
- provide a minimum spare capacity of 25% above the design demand load as determined according to the *Canadian Electrical Code*.

8.4.1 Primary Substation

Primary substations must be located so that radio frequency interference will not interfere with telecommunications frame equipment. Oil-filled transformers located in underground vaults must not be positioned directly adjacent to or beneath an exit way. No building drainage system may pass through the ceiling of the room containing the primary substation.

8.4.1.1 Primary Substation Transformers

PSPC-owned primary transformers must be installed in compliance with the *Canadian Electrical Code* and the *National Building Code of Canada*. The efficiency of the transformers must meet or exceed the following applicable CSA standards:

- CAN/CSA C802.1: *Minimum Efficiency Values for Liquid-Filled Distribution Transformers*;
- CAN/CSA C802.2: *Minimum Efficiency Values for Dry-Type Transformers*; and
- CAN/CSA C802.3: *Minimum Efficiency Values for Power Transformers*.

Ensure that transformer noise levels which will not cause interference in working areas.

8.4.1.2 Primary Substation Switchgear

PSPC-owned primary switchgear should be provided with draw-out type circuit breakers of the air, vacuum, or SF6 type, or with fused-air interrupter switches, and must comply with the following design requirements:

- include energy-reducing maintenance switching or other effective means of reducing arc flash hazard during maintenance activities such as remote operation;
- be built according to the CSA C22.2 NO. 31: *Switchgear Assemblies* standard and meet the requirements of the local utility, including any metering requirement;
- include a mimic bus to show bussing, contacts, overcurrent devices, and instrumentation;
- all bussing must be copper; and
- include power monitors and advanced metering as per section 6.9, Advanced Metering System.

8.5 Secondary Distribution

Secondary power distribution systems consist of transformers, cables, switchgear, switchboards, and associated equipment and operate at 600/347 V, 208/120 V, or for small buildings at single phase 240/120 V.

Either spot networks (when available) or a secondary selective circuit arrangement must be provided if either of the following applies:

- the building is over 10,000 m^2; or
- the building contains mission-critical equipment such as data centres.

8.5.1 Secondary Switchgear

Secondary switchgear must meet the following design requirements:

- comply with the CSA C22.2 NO. 31: *Switchgear Assemblies* standard;
- have a main service disconnect;
- include hardware to lock out all breakers and switches;
- only use draw-out type breakers for breakers 800A and above;
- have an enclosure that is sprinkler-proof in areas protected with sprinklers;
- contain a ground bus throughout;
- have spare space and ampacity of 25% (for new installations);
- contain energy-reducing maintenance switching if arc flash is a risk for maintenance;
- have the state of each breaker (open/closed) monitored by the building automation system; and
- include advanced metering as per section 6.9, Advanced Metering System.

8.5.2 Distribution Switchboards

Distribution switchboards must meet the following design requirements:

- comply with the CSA C22.2 NO. 244-05: *Switchboards* standard;
- have a main service disconnect;
- have spare space and ampacity of 25% for new installations; and
- contain advanced metering for feeders to panel boards measuring current and totalizing watt-hours as per section 6.9, Advanced Metering System.

8.5.3 Secondary Transformers

Secondary transformers must be installed in compliance with the *Canadian Electrical Code* and the *National Energy Code of Canada for Buildings*. The transformers must conform to the following applicable CSA standards:

- CAN/CSA C802.1: *Minimum Efficiency Values for Liquid-Filled Distribution Transformers*; and
- CAN/CSA C802.2: *Minimum Efficiency Values for Dry-Type Transformers*.

Transformer should be selected based on the following requirements:

- secondary transformers supplying large nonlinear loads must be K-rated or oversized in order to prevent overheating due to harmonics;
- Dry type transformers are preferred for primary voltages of 5 KV or lower where insulation, coordination and protection satisfactory to the Power Supply Authority can be obtained;
- Liquid cooled transformers are preferred for voltages above 5 kV and for loads greater than400KVA at 600V/120-208V;
- Transformer noise levels must not cause interference in working areas; and
- Copper windings are preferred for liquid filled transformers.

8.5.4 Motor Control Centres (MCC)

Motor control centres must meet the following design requirements:

- comply with the CSA C22.2 No. 14: *Industrial Control Equipment* standard;
- be provided with metering and power monitoring as per section 6.9, Advanced Metering System;
- have operator controls as per section 8.10, Operator Controls;

- include interlocks to prevent multiple motor loads with high inrush current from starting simultaneously, in order to prevent nuisance tripping of breakers and to avoid placing excessive loads on transformers or the emergency power supply system
- the MCC is elevated off the ground;
- the use of combination starters is preferred; and
- use motor control centres where they provide an economical and practical grouping of controls.

8.5.5 Motor Control

Electric motors control must meet the following criteria:

- The transient voltage drop from motor starting must be kept below utility limits, this can be done via soft starters, VFDs, or other means.
- Motors must be protected with thermal overload protection of the manual reset type. Built –in overloads in the motor are not acceptable.
- Three-phase motors must be provided with a manually operable disconnecting means which can be locked-out.
- The control scheme be coordinated with the mechanical consultant.

8.5.5.1 Variable-Frequency Drives (VFD)

In cases where motor speed is controlled to various set points, variable-frequency drives (VFD) must be used for all motors greater than 3.7 kW (5 hp). Harmonic distortion generated by VFDs must be mitigated as per section 8.5.10, Power Quality. Data from VFDs for motors over 3.7 kW must be networked to the advanced metering system as per section 6.9, Advanced Metering System. VFDs, conductors, and motors must be coordinated in accordance with manufacturer's requirements.

8.5.6 Electrical Motors

Electric motors must meet the following criteria:

- the efficiency must comply with the *National Energy Code of Canada for Buildings*;
- electric motors 746W and over must be three-phase;
- motor windings preferred in copper when efficiency is superior and when smaller size is a factor.

8.5.7 Elevator and Escalator Power

Electrical design standards in elevators and escalators must comply with the following codes and standards:

- *National Building Code of Canada*;
- *Canada Occupational Health and Safety Regulations,* Part IV, Elevating Devices;
- CAN/CSA B44: *Safety Code for Elevators and Escalators*; and
- CAN/CSA B355: *Lifts for Persons with Physical Disabilities*.

Elevators must be powered from a breaker or fused disconnect located in the elevator machine room that is equipped with hardware for lockout.

8.5.8 Panelboards

Panelboards must comply with the CSA C22.2 No. 29: *Panelboards and Enclosed Panelboards* standard. Separate panelboards must be used for regular power supplying:

- lighting;

- general-purpose receptacles and miscellaneous loads;
- telecommunications systems; and
- mechanical loads (heating, ventilation, and air-conditioning).

Panels powered by emergency power may contain mixed loads.

Panelboards must be of the bolt-on, circuit breaker types. Multi-pole breakers must have a single handle. Each circuit must be clearly labelled with a durable typewritten directory within the panel. All panelboards must be fitted with lock-type doors and door-in-door trim.

Panelboards supplying the main telecommunications room, also known as distributor room C, must be provided with a surge protection device (SPD) with a surge rating of no less than 50 kA per phase (25 kA per mode).

All new panelboards must be provided with minimum 25% spare ampacity and 25% spare overcurrent devices. Where practical, recessed panelboards should have additional spare, empty conduits extending to ceiling spaces.

8.5.9 Secondary Distribution Conductors

Either copper or aluminum conductors may be used for the following equipment:

- motor windings; and
- distribution transformer windings.

Only copper conductors must be used for the following equipment:

- bus ducts;
- switchgear bussing;
- switchboard bussing; and
- cables and conductors.

8.5.10 Power Quality

The building's electrical system must comply with the standards set by the local utility for power-line flicker, total harmonic distortion, and power factor, as well as with the requirements outlined in the following sections.

8.5.10.1 Power Factor

The system design must maintain a minimum power factor of 0.9 lagging. Power factor correction equipment should be utilized when required. If utilized, power factor-correcting capacitors must be properly labelled, complete with listed discharge times for servicing.

8.5.10.2 Electromagnetic Interference

Take precautions to minimize extremely low frequency electromagnetic interference by avoiding the use of single conductor armored cables and taking into consideration potential impact of electromagnetic interference when locating transformer equipment.

8.5.10.3 Total Harmonic Distortion

Total harmonic distortion must not exceed limits set by the utility or interfere with electronic equipment in the building. If it exceeds these limits or interferes with electronic equipment, the distortion must be mitigated. Suitable mitigation measures include, but are not limited to, the following:

- varying equipment operating settings;
- selection of equipment that produces lower amounts of harmonics, such as drives with more pulses;

- selection of equipment with built-in mitigation;
- passive filters;
- isolation transformers; and
- active conditioning equipment.

8.6 Branch Circuits

All branch circuit wiring must be copper and no smaller than No. 12 AWG.

8.6.1 Lighting Branch Circuits

Lighting branch circuits must be 120 V, or Power Over Ethernet (POE) for new construction. Existing installation at 347 V may remain but conversion to 120 V or POE should be considered subject to life cycle costing including the cost of the conductors, equipment, maintenance, and operation.

8.6.2 Receptacle Branch Circuits

Standard receptacles must be duplex, CSA 5-15R, commercial grade, unless otherwise required by code. Emergency power receptacles must be red. Isolated grounding receptacles must be orange. The colour of standard receptacles, switches, and faceplates must be coordinated with the architectural colour scheme.

Receptacles for housekeeping must be CSA 5-20R suitable for 15/20 A and must be placed in walls around permanent cores or corridors. The distance between receptacles in corridors must be 15 m or less, and receptacles must be located within 7.5 m from the corridor ends.

Emergency power receptacles must be provided in all electrical closets and in the main mechanical and electrical equipment rooms if an emergency power system is available. Each piece of mechanical equipment located either in the interior or exterior of a building must have access to a receptacle placed no more than 7.5 m away.

Receptacle faceplates must be labelled on the exterior with a typewritten machine-made label indicating the panel and the number of the circuit that feeds the receptacle.

8.7 Grounding and Lightning Protection

8.7.1 Grounding System

The ground source for the electrical power system must have resistance to ground of less than 5 ohms, as confirmed by the fall-of-potential ground testing method outlined in the Institute of Electrical and Electronics Engineers (IEEE) Standard 81: *IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.*

Electrical rooms must be fitted with a bonding bus interconnected with the building’s grounding system with a minimum of 25% spare terminals or holes for future bonding. All low-voltage power distribution systems must be supplemented with a separate bonding conductor. Each stack of electrical and telecom closets will have its own vertical dedicated ground riser conductor.

8.7.2 Lightning Protection

Lightning protection requirements must be determined in accordance with the latest edition of the CAN/CSA B72-M87: *Installation Code for Lightning Protection Systems*.

Lightning arrestors must be installed on the transformer primary terminals of the main electrical service (subject to agreement with the local utility if the substation is utility-owned).

Surge protection devices compliant with Underwriters Laboratories (UL) standard UL 1449: *Standard for Surge Protective Devices* must be installed on the secondary switchgear with a minimum surge current capacity of 240 kA per phase (120 kA per mode), and must be installed on each switchboard with a minimum surge current capacity of 120 kA per phase (60 kA per mode).

8.8 Placement of Electrical Rooms

Electrical rooms must meet the architectural and interior design requirements listed in section 4.2.3.3, Mechanical and Electrical Rooms, and must support the efficient vertical and horizontal distribution of power and control systems.

Electrical closets must be stacked vertically to the greatest extent possible. If an electrical room contains transformers or other heat-generating equipment, adequate cooling and/or ventilation must be provided so that environmental requirements are met as per section 6.2, Mechanical Environmental Requirements.

Electrical rooms in new building construction must have adequate sleeves installed for future modifications. At a minimum, two capped 100 mm spare sleeves through the structural floors must be installed. All floor sleeve penetrations must extend 100 mm above the finished floor.

8.9 General Workmanship

Electrical installations must be of good workmanship, this requires electrical equipment to:

- be securely and permanently fastened and or supported;
- be installed level, and plumb;
- have cable and conduit be installed parallel to and perpendicular to building lines;
- have a neat and finished appearance; and
- have corrosion protection adequate for the environment.

8.9.1 Seismic Design

Electrical equipment must be laterally restrained for seismic load requirements as outlined in section 5, Structural Engineering, and the *National Building Code of Canada*.

8.9.2 Building Raceways

Raceway systems used in buildings must comply with the *Canadian Electrical Code* and local regulations.

8.9.3 Wiring Methods

Risers for regular power and emergency power must be combined with other core elements to form compact groups and to maximize usable floor space. Bus duct risers must have a 100 mm curb around floor penetrations to prevent water from running down the bus duct. New bus ducts should be totally enclosed. Sprinklers must not aim water at ventilated or open bus ducts.

Conceal raceways for horizontal electrical distribution systems within the concrete slab, in the ceiling plenum, or in a raised floor if one is present. Concrete encased tubing and conduit, electrical metallic tubing, rigid conduit, cable tray, or modular wire distribution systems are acceptable. The minimum conduit size for power and lighting circuits shall be 21 mm. Permanent tags should be provided to feeders at pull and junction boxes. For motors and equipment subject to vibrations or movement provide flexible connections.

In office areas, install zone distribution boxes near anticipated loads to service workstations in compliance with the circuit loading requirements outlined in the *Government of Canada Workplace 2.0 Fit-up Standards*.

8.10 Operator Controls

Commanding and signalling devices must comply with the national standard CAN/CSA Z431: *Basic and Safety Principles for Man-Machine Interface, Marking and Identification - Coding Principles for Indicators and Actuators*. This standard applies to both physical operator controls and human-machine interfaces (HMIs) that form part of a building automation system.

All wired operator controls (e.g. push buttons, selector switches, and pilot lights) must be extra low voltage (below 30 V).

8.10.1 Colour Coding

Motor control and HMI colour coding must comply with the CAN/CSA Z431 standard.

The CAN/CSA Z431 standard allows information to be imparted from three different perspectives:

- the condition of the process;
- the state of the equipment; and
- the safety of persons, property, and/or the environment.

Display colours and shapes for HMIs and operator controls must be from the perspective of the condition of the process or the state of the equipment. From these perspectives, green indicates a normal/operational state.

From the perspective of the safety of persons and property, green indicates a safe condition, and indicating devices must only be applied locally to facilitate service or maintenance (e.g. a green light placed near a door to indicate that it is safe to enter). In addition, indicating devices must include clear labelling to ensure correct interpretation.

8.10.2 Operating Controls Labeling and Language Policy

Labelling on operator controls (mechanical indicators) and HMIs must make use of symbols as per CAN/CSA Z431. Any words used on controls or in HMIs must comply with the *Official Languages Act*, including bilingual signage for regions prescribed under subsection 35(2) of the Act.

8.11 Emergency Electrical Power Supply

All facilities must have an emergency electrical power system for life safety if required by the *National Building Code of Canada* and in accordance with the *Canadian Electrical Code*.

Self-contained battery units may be used for emergency light fixtures in buildings where an emergency generator is not required for other systems.

8.11.1 Emergency Generator System

If required, an emergency generator system must consist of a central engine generator with a separate distribution system with one or more automatic transfer switches (ATSs). The emergency generator system must be provided in accordance with the latest version of the CSA C282: *Emergency Electrical Power Supply for Buildings* standard.

In addition to CAN/CSA C282, the fuel system must also meet the requirements of the latest version of the CAN/CSA B139 Series: *Installation Code for Oil-Burning Equipment*. The base building generator fuel day tank must meet the following requirements:

- have a sufficient quantity of fuel to operate the engine for a minimum of 2 hours of running time at full load;
- be within the proximity of the generator in an appropriately fire rated room; and

- be automatically refilled from a main storage tank with sufficient capacity to operate the engine for a minimum of 12 hours' running time at full load.

The purpose of the tank requirements is to facilitate safe evacuation in an emergency and to protect government assets.

The emergency distribution system must be designed so that emergency power sources cannot under any condition back-feed energy into the de-energized normal system. A permanent system must be provided to allow safe and fast connection of a portable load bank to test the generator full load.

The emergency system status and alarms must be transmitted to the building automation and fire alarm systems.

8.11.2 Emergency Power Loads

At a minimum, emergency electrical power supply must be provided for the following loads (other loads may be added as required):

- life-safety load:
  - exit lighting
  - emergency lighting
  - fire alarm system
  - fire control centre
  - smoke control systems
  - fire pumps, and suppression system
  - high-rise stairway pressurization fans
  - elevators
  - generator auxiliaries (fuel pump, control power, etc.)
- essential building load:
  - lighting:
    - security perimeter lighting
    - lighting for main electrical room, electrical closets, security rooms, fire control centre, telecommunications rooms, and generator room
  - mechanical:
    - mechanical control systems
    - sump pumps
    - sewage pumps
    - exhaust fans removing toxic, explosive, or flammable fumes
    - hydronic heating system (if applicable)
  - telecommunications:
    - telecommunications room emergency receptacles
    - telecommunications rooms back-up power system (UPS)
    - building controls:
    - building automation system
    - advanced metering system
    - security systems

    - electrical:
        - emergency power receptacles
- miscellaneous:
    - horizontal sliding doors in public spaces
    - other associated equipment designated by code
        - essential client loads

8.11.3 Automatic Transfer Switch (ATS)

All automatic transfer switches (ATSs) supplied and installed for the base building and/or tenant must be provided in accordance with the CAN/CSA C282: *Emergency Electrical Power Supply for Buildings* standard and must have the following features:

- both automatic and manual operation;
- network connection to the building automation system;
- dedicated ATSs for:
    - life-safety loads;
    - essential buildings loads; and
- manual bypass isolation switch to permit electrical bypass and isolation of the ATS without interrupting the load (to either the normal or emergency power).

8.11.4 Uninterruptible Power Supply System

Uninterruptible power supply (UPS) systems generally do not form part of the base building but are tenant-owned and -operated. Tenant requirements for UPS systems must be considered in the base building design.

UPS installations that may adversely affect the power quality in the building must include forms of mitigation such as filtering, isolation transformers, and active filtering.

Rooms containing UPS batteries must have sufficient ventilation in order to prevent the accumulation of any vented hydrogen from reaching hazardous levels as per section 6.11.5, Service Areas. Hydrogen detection sensors must be installed in areas where hydrogen is most likely to accumulate. They must also be networked to the building automation system.

Base building UPS systems (non-client-owned), if required, must meet the following requirements:

- have an input power factor of above 0.8;
- have an output power factor of above 0.8;
- have an efficiency of above 90%;
- include a maintenance bypass switch; and
- be interconnected to the building automation system for monitoring status, voltages, and currents.

8.12 Lighting

Lighting must be designed to assist in defining the overall building architecture, meet organizational safety and security requirements, as well as meet the multiple task requirements of individuals in different types of spaces within the building.

Anticipated and existing tasks must be determined with input from clients and PSPC. Default lighting levels are listed in Table 1 and Table 2 at the end of this section. The lighting design must also be in accordance with the *Government of Canada Workplace 2.0 Fit-up Standards*.

8.12.1 Lighting Design Requirements

Lighting design must provide appropriate levels of illumination for performing tasks easily and comfortably. Lighting must satisfy both quantity and quality aspects demanded by the work environment, by providing the following:

- visual comfort to promote workers' well-being;
- visual performance to promote high levels of visual task execution; and
- visual safety to permit safe movement within the work environment.

The lighting system should also be energy efficient, complying with the *National Energy Code of Canada for Buildings* (NECB).

The following requirements must be adhered to in terms of illuminance, luminance ratio, and colour rendering:

8.12.1.1 Illuminance and Luminance Ratio

Light levels must comply with the illuminance and luminance ratio requirements outlined in Table 1 and Table 2 at the end of this section. For specific areas not found in these tables, and for applications other than typical office environments, refer to the Canada Occupational Health and Safety Regulations of the *Canada Labour Code*, *the National Building Code of Canada*, and *The Lighting Handbook* published by the Illuminating Engineering Society (IES). When there are discrepancies between the three sources, the *Canada Labour Code* takes precedence.

8.12.1.2 Colour Rendering and Temperature

For all lighting, lamps must be selected with a colour rendering index (CRI) not less than 80 and a correlated colour temperature (CCT) less than or equal to 4100 °K.

8.12.2 Lighting Power Density

Lighting power densities (W/m^2) must comply with the requirements contained in the latest edition of the *National Energy Code of Canada for Buildings* (NECB). This applies to new and existing buildings where the base building lighting system is being physically replaced.

While individual areas may deviate in power loading from the recommended values, the total power budget for lighting for the building or overall space must not be exceeded unless justified by the client's operational requirements. The total power budget for the project must be documented in the investment analysis report (IAR), and a demonstration must be provided showing that implementation of the proposed design will not exceed the budget.

8.12.3 Day Lighting

To reduce energy consumption by the illumination system, day lighting (also called daylight harvesting) must be considered for all new construction and major retrofits. The IAR must identify whether day lighting is to be implemented. If implementation is not feasible, the report must include a justification for not implementing day lighting.

Day lighting systems in work areas must utilize continuous dimming rather than simple on-off operation to minimize distraction to workers.

8.12.4 Flexibility and Servicing Accessibility

The lighting design must allow easy servicing of the luminaries and replacement of lamps, drivers and ballasts. It must also be possible to economically modify the lighting system post occupancy to meet the required lighting levels.

8.12.5 General Luminaires Criteria

Luminaires and associated fittings must be of standard commercial design, the use of LED lighting is recommended. Designers must use components that are proven (capable of demonstrating the required performance in relevant projects), readily available, technologically current, user-friendly, and that provide convenient operation, ease of maintenance, and energy efficiency. Custom-designed fixtures should only be installed to meet heritage requirements.

Ballasts, when used, must have a sound rating of “A” for all areas occupied by personnel, and must conform to the CAN/CSA C654: *Fluorescent Lamp Ballast Efficacy Measurements* standard and local electrical authority requirements. Ensure that all voltage drops are within the manufacturer’s specification for the lamps being controlled. Ballasts must be electronic and energy-efficient with a minimum power factor of 0.95, and have a maximum total harmonic distortion (THD) of 10%.

Exit signs must be of the light-emitting diode (LED) type and meet the requirements of the CAN/CSA C860: *Performance of Internally Lighted Exit Signs* standard. Location and symbols must be in accordance with the *National Building Code of Canada*.

8.12.6 Specific Lighting Applications

Emergency lighting must be installed and meet the performance requirements of the *National Building Code of Canada* and Part VI of the *Canada Occupational Health and Safety Regulations*. In addition to these requirements, emergency battery-powered lighting must also be provided in main mechanical and electrical rooms, generator rooms, and automatic transfer switches rooms.

Equipment room light fixtures must be located so that lighting is not obstructed by tall or suspended pieces of equipment.

Lighting fixtures must be provided at all building entrances and exits. Exterior lighting fixtures must be connected to the emergency lighting circuit.

Luminaires in parking areas must be placed so that they maintain the required vehicle clearance.

8.12.7 Light Pollution Reduction

The exterior lighting design must comply with the light pollution reduction requirements listed in the latest version of the Leadership in Energy and Environmental Design (LEED) building certification program. This requires defining lighting zones as per the Illuminating Engineering Society (IES) and International Dark-Sky Association (IDA) *Model Lighting Ordinance (MLO)*, and selecting luminaires with an appropriate luminance, shielding, and orientation so that backlight, uplight, and glare (BUG) are in compliance with LEED requirements.

8.12.8 Lighting Controls

8.12.8.1 Lighting Controls Requirements

Lighting controls in office spaces must be designed to meet the latest *National Energy Code of Canada for Buildings* (NECB). Lighting control zones must not exceed the maximum requirements of NECB or one 15 A circuit, whichever is smallest.

The selection of manual control, dimmable control, localized automatic control, microprocessor lighting control, networked control, or any combination of the four is a fundamental design choice and is dependent on a number of factors. These include the frequency of use, available day lighting, normal or extended work hours, and the use of open or closed office plans. The designer must provide descriptions and a rationale for the chosen scheme.

A local means of override must be provided in every area to ensure continuing operations when required.

8.12.8.2 Microprocessor and Networked Lighting Controls

Lighting control systems must function on an open protocol to avoid vendor lock-in, and must be able to integrated with the with building automation, and/or security systems.

8.12.8.3 Lighting Controls for Specific Applications

Building entrance lighting and wall-mounted access security lighting must be controlled by an on-off photocell sensor to activate the lights from dusk to dawn.

All exterior lighting not designated to operate from dusk to dawn must be controlled by a photocell and a time switch, or by the networked lighting control system.

Interior garage lighting should be reduced during off building hours when motion sensors do not detect movement, as an energy-saving measure. This energy saving measure should exclude security lighting within garages.

8.12.9 Base Building Light Levels

Base building light levels must meet the more stringent of the minimum levels outlined in the *Canada Occupational Health and Safety Regulations (COHSR)* of the *Canada Labour Code*, the National Building Code *of Canada*, and those provided in the tables at the end of this section. If specific areas are not found in the tables, then refer to the IES publication *The Lighting Handbook*, latest edition.

8.12.9.1 Interior Lighting Calculation Parameters

Typical default parameters to be used in interior lighting calculations are as follows:

- luminaire ambient temperature: 1.0
- voltage to luminaire: 1.0 (electronic ballast)
- ballast factor: 0.9 (manufacturer’s data takes precedence)
- burnouts: 1.0
- lamp lumen depreciation: 0.9 (manufacturer’s data takes precedence)
- luminaire dirt depreciation: 0.9 (for office spaces)
- light reflectance values: 80-50-20 (ceiling, walls, and floor respectively, assuming light colours)

8.12.9.2 Illumination Levels Interior Spaces

Illumination levels for interior spaces are listed in Table 1. It should be noted that COHSR requirements for illumination levels at task positions of 1000 lux for cartography, plan reading or difficult visual tasks and 500 lux for operating business machines, typing, reading or writing should be met during space fit-up, as per the Workplace 2.0 Fit-up Standards via task lighting.

Table 1: Base Building Interior Illumination Levels

Location	Minimum Average Illumination (lx)[a]	Maximum Uniformity Ratio (avg : min)[b]	Maximum Uniformity Ratio (max : min)[c]
General Office Spaces	425	2:1	5:1
Meeting rooms, boardrooms, conference rooms, file storage areas, training rooms, and reception areas	300	2:1	
Library, general lighting	300	2:1	
Common areas (public spaces, lounges, lobbies, atriums, washrooms, and elevator lobbies)	150	2:1	
Food preparation areas	500	1.5:1	
Lunchrooms and cafeterias	150	3:1	
Electrical and mechanical rooms	200	3:1	
Telecommunications rooms	500	3:1	
Frequently used corridors, stairways, and elevators	100	2:1	
Infrequently used corridors and stairways	50	2:1	

Notes:

[a] Illumination levels for interior office spaces are expressed as the minimum acceptable values of average maintained horizontal illuminance level (lx) over the working plane at each workstation or at floor level for support spaces (based on carpeted areas). To ensure a uniform approach and yield consistent results, measurement of lighting levels must be made in accordance with the document *Measurement of Lighting Levels in the Workplace – Canada Occupational Health and Safety Regulations, Part VI, 928-1-IPG-039*.

[b] The uniformity ratio is given at a task plane height over an entire room or space, except for general office spaces, food preparation areas, and meeting rooms where it is over the task area.

[c] Throughout entire work space comprising the task areas.

8.12.9.3 Illumination Levels for Exterior Spaces

Base building exterior light levels must meet the more stringent of the minimum levels outlined in the *Canada Labour Code* and those provided in the exterior lighting level table below.

Lighting levels must also meet security requirements as determined by performing a threat and risk assessment as per *the Policy on Government Security* published by the Treasury Board of Canada Secretariat and RCMP guidelines as outlined in section 10, Security.

Table 2: Exterior Illumination Levels

<table>
<tr><th>Location</th><th>Minimum Average Illumination (lx)[a]</th><th>Maximum Uniformity Ratio (avg : min)</th><th>Maximum Uniformity Ratio (max : min)</th></tr>
<tr><td colspan="3">Grounds</td><td rowspan="21">10:1</td></tr>
<tr><td>Pedestrian walkways</td><td>10</td><td>4:1</td></tr>
<tr><td>Pedestrian walkways and vehicular intersection</td><td>30</td><td>3:1</td></tr>
<tr><td>Vehicular traffic</td><td>10</td><td>4:1</td></tr>
<tr><td>Vehicular intersections</td><td>30</td><td>3:1</td></tr>
<tr><td>Building Entrances and Exits</td><td></td><td></td></tr>
<tr><td>Frequently used building entrances and exits</td><td>100</td><td>2:1</td></tr>
<tr><td>Infrequently used building entrances and exits</td><td>50</td><td>2:1</td></tr>
<tr><td colspan="3">Open Parking</td></tr>
<tr><td>Vehicular traffic</td><td>10</td><td>4:1</td></tr>
<tr><td>Vehicular intersections</td><td>30</td><td>3:1</td></tr>
<tr><td>Vehicular parking</td><td>10</td><td>4:1</td></tr>
<tr><td>Pedestrian walkways</td><td>10</td><td>4:1</td></tr>
<tr><td colspan="3">Covered Parking</td></tr>
<tr><td>General parking and pedestrian areas</td><td>50</td><td>4:1</td></tr>
<tr><td>Ramps and corners during daytime</td><td>100</td><td>4:1</td></tr>
<tr><td>Ramps and corners during nightime</td><td>50</td><td>4:1</td></tr>
<tr><td>Entrance areas[b] during daytime</td><td>500</td><td>4:1</td></tr>
<tr><td>Entrance areas[b] during nighttime</td><td>50</td><td>4:1</td></tr>
</table>

Notes:

[a] Illumination levels for exterior commercial office building spaces are expressed as the minimum acceptable values of average maintained horizontal illuminance levels (lx) over the usable area at pavement level.
To ensure a uniform approach and yield consistent results, measurement of lighting levels must be made in accordance with the document *Measurement of Lighting Levels in the Workplace – Canada Occupational Health and Safety Regulations, part VI, 928-1-IPG-039*.

[b] The entrance area is defined as the portal or physical entrance to the covered portion of the parking structure and 15 m beyond the edge of the covering into the structure.

9 Telecommunications Systems

9.1 Telecommunication Spaces

Telecommunication spaces must meet the following requirements:

- be stacked vertically to the greatest extent possible;
- be serviced from electrical panels supplying only telecommunications systems;
- be located in dry spaces not subject to flooding from natural sources or building water sources such as washrooms or janitor closets; and
- include required architectural features outlined in the Telecommunications Industry Association (TIA) standard TIA 569: Telecommunications Pathways and Spaces, such as backboards, ceiling heights, and door sizes.

9.2 Telecommunication Entrance Facility

The entrance facility must be within a dedicated enclosed room. However, the room may also serve as a service provider space or access provider (PSPC or contractor) space if the access provider equipment is kept secure with a locked barrier such as a wire mesh to prevent unauthorized access.

The entrance facility must be powered by at least two dedicated 20A, 120 V duplex receptacles on emergency power if an emergency power system is available.

9.3 Telecommunications/Distributor Room

Telecommunications rooms, also referred to as distributor rooms, must be dedicated and not contain electrical equipment for power distribution other than panels supplying the room or related equipment. A minimum of one telecommunications room must be provided per building floor, with additional rooms provided in accordance with ANSI/TIA 569.

Each room must contain at least two dedicated 20A, 120 V duplex receptacles on emergency power if an emergency power system is available, and must provide convenience receptacles on the perimeter of the room every 1.8 m.

9.4 Telecommunication Raceway System

Backbone and horizontal telecommunication raceways must meet the requirements of ANSI/TIA 569 and be installed with sufficient separation distance from power raceways to mitigate the effects of electromagnetic interference (EMI) as per ANSI/TIA 569.

9.5 Service Entrance Pathway

Service entrance pathways must meet the requirements of the ANSI/TIA 758: *Customer-Owned Outside Plant Telecommunications Infrastructure Standard*.

9.6 Telecommunication Grounding and Bonding System

Telecommunication equipment must have a dedicated grounding and bonding system as per ANSI/TIA 607: *Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises* (and addenda). The system must be bonded to the building grounding system.

The telecommunications room must be fitted with copper bonding bus connections interconnected with the building's grounding system with a minimum 25% spare capacity for future bonding. Telecommunication grounding and bonding conductors must be copper.

10 Security

10.1 Design Objectives

The security design must protect facilities and be flexible to allow integration of tenant-funded requirements, both baseline and enhanced. The security design must also comply with all applicable policies, standards and guidelines from Public Services Procurement Canada, Treasury Board Secretariat, Royal Canadian Mounted Police, and the Communications Security Establishment.

10.2 Threat and Risk Assessment

In order for a security system to be effective it needs to be developed based on an understanding of the actual threats and risks it is designed to control. Prior to developing the security elements on an office building project, a Threat and Risk Assessment (TRA) must be completed. The threat and risk assessment process is intended to evaluate a building, its assets, the tenants, the threats against the building and the occupants, and the performance of safeguards against these threats.

10.3 Security Site Brief & Security Design Brief

For new office building construction projects, develop a Security Site Brief (SSB). A Security Design Brief (SDB) must also be developed for all new construction projects and renovation projects which materially impact building security. Refer to G1-005: *Guide to the Preparation of Physical Security Briefs* for details on developing these two briefs. The two documents cover detailed security requirements for life safety and emergencies, site, building design, building layout, electronic access control, electronic intrusion detection, closed circuit television / video equipment, security control centre, secure rooms, vaults, sensitive discussion areas, telecom and data links.

Federal tenants may have specialized functional programs that will guide the fit-up of space within the base building. In this case, the specialized functions must be integrated into the base building systems and design.

11 Definitions

Advanced metering system	A system that collects time-stamped data from meters via a communications network, providing useful data for energy use management, procurement, and operations.
Advanced meters	Meters that have the capability of measuring and recording data at least hourly, and can relay the information to an advanced metering system.
BACnet or BACnet standard	A data communications protocol for building automation and control networks that allows devices from different vendors to interoperate, or work together, on the same network. It is an International Organization for Standardization (ISO) global standard developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). BACnet communication requirements are defined by the ANSI/ASHRAE 135 standard and all current addenda and annexes.
Base Building	The building shell including finished floors, structure, exterior envelope, interior core and demising walls, finished ceilings complete with lighting, and other building systems consistent with the designed function and planned general use of the building.
Building automation system	A modern building control system that optimizes the start-up and performance of a building's mechanical systems, including the alarm, lighting, security, energy monitoring, and heating, ventilation, and air-conditioning (HVAC) systems. The building automation system (BAS) greatly increases the interaction between the subsystems of a building and improves occupant comfort, lowers energy use, and allows off-site building control.
Commissioning	A process of ensuring that all systems in a building are installed, functionally tested, and capable of being operated and maintained to perform in conformity with design intent. Control system commissioning requires a point-to-point check and detailed documentation of each parameter. Commissioning includes a complete functional test of the sequence of operation for each piece of equipment.
Duct bank	Two or more conduits (ducts) routed together.
Extra low voltage	Voltage below 30 V.
Fit-up	Alterations and improvements to the base building or base building systems in order to prepare the accommodation for occupancy by a department.

Handhole	A below-grade enclosure that allows personnel to reach in (but not enter) for the purpose of operating, installing, and maintaining electrical cables.
High voltage	Voltage above 750 V.
Low voltage	Voltage between 30 V and 750 V
Major Renovation	A renovation that involves substantial work to several base building elements at the same time or to an individual base building element at any given time.
Manhole	A below-grade enclosure that personnel may enter for the purpose of operating, installing, and maintaining electrical cables.
Office building	Structures predominantly used to offer office space categories such as general administrative, secure administrative, quasi-judicial office space, and call/contact centres.
Primary distribution	A power distribution system that consists of transformers, cables, switchgear, and associated equipment and operates at high voltage (over 750 V), used to distribute power in large buildings or at campus locations.
Project Team	Project Teams are an internal vehicle to PSPC for the communication of pertinent and essential information relative to the development, implementation and ongoing activities of a project. The size and make-up of project teams is determined by the Project Leader and based on the size, complexity and type of real property project. Refer to the roles and responsibilities for project teams in the NPMS for further details.
Secondary distribution	A power distribution system that consists of transformers, cables, switchgear, and associated equipment and operates at 600/347 V, 208/120 V, or for small buildings at single phase 240/120 V.

12 Acronyms and Abbreviations

AABC	Associated Air Balance Council
ADM	Assistant Deputy Minister
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	ASTM International (formerly American Society for Testing and Materials)
ATS	automatic transfer switch
BAS	building automation system
BEP	best efficiency point
BHMA	Builders Hardware Manufacturers Association
BOMA	Building Owners and Managers Association
BUG	backlight, uplight, and glare
CCT	correlated colour temperature
CEC	*Canadian Electrical Code*
COE	centre of expertise
COHSR	Canada Occupational Health and Safety Regulations
CRI	Carpet and Rug Institute
CRI	colour rendering index
CRN	Canadian Registration Number
CSA	CSA Group (formerly Canadian Standards Association)
CTI	Cooling Technology Institute
DALI	digital addressable lighting interface
DCWS	domestic cold water supply
DDC	direct digital control
DHI	Door and Hardware Institute
DHWS	domestic hot water supply
EIA	Electronics Industries Alliance
EnMS	energy management system
FAR	floor-area ratio
FIPP	*Federal Identity Program Policy*

FSDS	Federal Sustainability Development Strategy
HMI	human machine interface
HVAC	heating, ventilation, and air conditioning
IAR	investment analysis report
IAQ	indoor air quality
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society of North America
IESNA	Illuminating Engineering Society of North America
IWCA	International Window Cleaning Association
LCC	life-cycle costing
LED	light emitting diode
NBC	*National Building Code of Canada*
NEBB	National Environmental Balancing Bureau
NECB	*National Energy Code of Canada for Buildings*
NPMS	National Project Management System
NFPA	National Fire Protection Association
NFRC	National Fenestration Rating Council
NIBS	National Institute of Building Sciences
NJC	National Joint Council
OPC	open protocol connectivity
OWS	operator work station
PWGSC	Public Works and Government Services Canada
RCMP	Royal Canadian Mounted Police
RPB	Real Property Branch
SDI	Steel Door Institute
SFI	Sustainability Forestry Initiative
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
STC	sound transmission class
TAB	testing, adjusting balancing
TBS	Treasury Board of Canada Secretariat
THD	total harmonic distortion
TIA	Telecommunications Industry Association
UL	Underwriters Laboratories
ULC	Underwriters Laboratories of Canada

UPS	uninterruptible power supply
VFD	variable-frequency drive
VOC	volatile organic compound
WHMIS	Workplace Hazardous Materials Information System

13 General Codes, Standards, and Legislation

- *Canada Labour Code*
- *Canada Labour Code*, Part II, Canada Occupational Health and Safety Regulations
- *Canadian Environmental Protection Act*
- *Department of Public Works and Government Services Act*
- *Policy on Communications and Federal Identity*
  - *Federal Identity Program Manual*
- *Federal Real Property and Federal Immovables Act*
- *Government of Canada Workplace 2.0 Fit-up Standards*
- Municipal/local utility regulations
- *National Building Code of Canada* and supplements
- *National Energy Code of Canada for Buildings*
- *National Fire Code of Canada*
- *National Plumbing Code of Canada*
- *Official Languages Act*
- PWGSC *Sustainable Buildings Policy*
- Treasury Board *Fire Protection Standard*
- CAN/CSA Z-234.1-*Canadian Metric Practice Guide.*
- CAN/CSA B651: *Accessible Design for the Built Environment* standard;

13.1 Architectural Codes, Standards, and Legislation

- AAMA/CSA 101-A440 *North American Fenestration Standard / Specification for Windows, Doors, and Skylights*
- AAMA/WDMA:1600/I.S.7: Skylights and Space Enclosures
- ANSI/BOMA Z65.1: *Office Buildings: Standard Methods of Measurement*
- ASHRAE 160: *Criteria for Moisture-Control Design Analysis in Buildings*
- CAN/CSA B651: *Accessible Design for the Built Environment*
- City of Toronto *Bird-Friendly Development Guidelines* and *Bird-Friendly Development Rating System*
- CSA S478: *Guideline on Durability in Buildings*
- CSA Z809 *Sustainable Forest Management*
- NFRC 500: *Procedure for Determining Fenestration Product Condensation Resistance Values*
- *Real Property Branch Accessibility Procedure*
- Real Property Branch *Custodial Parking Policy and Custodial Parking Procedure*
- *RPB Policy on the Stewardship of Federal Heritage Buildings*
- *Standards and Guidelines for the Conservation of Historic Places in Canada*
- Treasury Board Secretariat *Accessibility Standard for Real Property*

13.2 Window Washing Standards

- ANSI A39.1: *Safety Requirements for Window Cleaning*
- ANSI/IWCA I-14.1: *Window Cleaning Safety Standard*

- ASME A120.1: *Safety Requirements for Powered Platforms and Traveling Ladders and Gantries for Building Maintenance*
- CAN/CSA Z91-02: *Health and Safety Code for Suspended Equipment Operations* (2002 most recent revision)
- CAN/CSA Z91-M90: *Safety Code for Window Cleaning Operations*

13.3 Structural Codes, Standards, and Legislation

- CAN/CSA S413: *Parking Structures*
- CAN/CSA S832: *Seismic Risk Reduction of Operational and Functional Components (OFCs) of Buildings*
- CSA S478: *Guideline on Durability in Buildings*
- PWGSC *Doing Business with Real Property Branch (RPB)*
- *Real Property Services Policy on Seismic Resistance of PWGSC Buildings*
- *Standards and Guidelines for the Conservation of Historic Places in Canada*

13.4 Civil Codes, Standards, and Legislation

- Site services follow provincial and municipal standards

13.5 Mechanical Codes, Standards, and Legislation

- AABC *National Standards for Total System Balance*
- AHRI 410: *Forced-Circulation Air-Cooling and Air-Heating Coil*
- ANSI/AHRI 880: *Performance Rating of Air Terminals*
- ANSI/AMCA 210: *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating*
- ASHRAE Guideline 0: *The Commissioning Process*
- ASHRAE Guideline 4: *Preparation of Operating and Maintenance Documentation for Building Systems*
- ASHRAE handbooks:
    - *Handbook—HVAC Applications*
    - *Handbook—Fundamentals*
    - *Handbook—Refrigeration*
    - *Handbook—HVAC Systems and Equipment*
- ANSI/ASHRAE/IES 100: *Energy Efficiency in Existing Buildings*
- ANSI/ASHRAE 105: *Standard Methods of Determining, Expressing, and Comparing Building Energy Performance and Greenhouse Gas Emissions*
- ANSI/ASHRAE 111: Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems
- ANSI/ASHRAE 135: *BACnet - A Data Communication Protocol for Building Automation and Control Networks*
- ANSI/ASHRAE 15: *Safety Standard for Refrigeration Systems*
- ANSI/ASHRAE/ACCA 180: *Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems*

- ANSI/ASHRAE 189.1: Standard for the Design of High-Performance Green Buildings
- ANSI/ASHRAE 34: *Designation and Classification of Refrigerants*
- ANSI/ASHRAE 52.2: *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*
- ANSI/ASHRAE 55: *Thermal Environmental Conditions for Human Occupancy*
- ANSI/ASHRAE 62.1: *Ventilation for Acceptable Indoor Air Quality*
- ANSI/ASHRAE/IES 90.1: *Energy Standard for Buildings Except Low-Rise Residential Buildings*
- ANSI/BHMA A156 Series Standards
- ANSI/DHI A115-W: *Wood Door Hardware Standards, Hardware Preparation* the DHI industry association
- ANSI/SDI 250.4: *Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors*
- ANSI/WDMA I.S. 1A: *Interior Architectural Wood Flush Door*
- ASME UPV: *Code for Unfired Pressure Vessels*
- ASME BPVC: *Boiler and Pressure Vessel Code*
- ASTM E1827: *Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door*
- ASTM E2813: *Standard Practice for Building Enclosure Commissioning*
- ASTM E779: *Standard Test Method for Determining Air Leakage Rate by Fan Pressurization*
- *Canadian Environmental Protection Act*, Ozone-Depleting Substances Regulations
- *Canadian Environmental Protection Act*, Federal Halocarbon Regulations
- CAN/CSA B139 Series: *Installation Code for Oil-Burning Equipment*
- CAN/CSA B149.1: *Natural Gas and Propane Installation Code*
- CAN/CSA B149.2: *Propane Storage and Handling Code*
- CAN/CSA B214: *Installation Code for Hydronic Heating Systems*
- CAN/CSA B355: *Lifts for Persons with Physical Disabilities*
- CAN/CSA B44: *Safety Code for Elevators and Escalators*
- CAN/CSA B52: *Mechanical Refrigeration Code*
- CAN/CSA B64: *Backflow Preventers and Vacuum Breakers*
- CAN/CSA C743: *Performance Standard for Rating Packaged Water Chillers*
- CAN/CSA Z204: *Guideline for Managing Indoor Air Quality in Office Buildings*
- CAN/CSA-ISO 50001: *Energy Management Systems*
- CSA standards for commissioning
- CTI STD-201: *Certified Cooling Towers*
- *Federal Halocarbon Regulations*
- MD 15000: *Mechanical Environmental Standard for Federal Office Buildings*
- MD 15161: *Control of Legionella in Mechanical Systems*
- NIBS Guideline 3: *Building Enclosure Commissioning Process*
- NJC *Occupational Health and Safety Directive*
- *PWGSC Commissioning Policy*

- *PWGSC Commissioning Manual* and PWGSC Commissioning Guidelines
- SMACNA HVAC Air Duct Leakage Test Manual

13.6 Fire Protection Engineering

- CAN/ULC S524: *Standard for the Installation of Fire Alarm Systems*
- CAN/ULC S536: *Standard for Inspection and Testing of Fire Alarm Systems*
- CAN/ULC S537: *Standard for Verification of Fire Alarm Systems*
- NFPA 1142: *Standard on Water Supplies for Suburban and Rural Fire Fighting*
- NFPA 13: *Standard for the Installation of Sprinkler Systems*
- NFPA 14: *Standard for the Installation of Standpipe and Hose Systems*
- NFPA 20: *Standard for the Installation of Stationary Pumps for Fire Protection*
- NFPA 211: *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*
- NFPA 214: *Standard on Water-Cooling Towers*
- NFPA 231: *Standard for General Storage*
- NFPA 231C: *Standard for Rack Storage of Materials*
- NFPA 24: *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*
- NFPA 30: *Flammable and Combustible Liquids Code*
- NFPA 54 / ANSI Z223.1: *National Fuel Gas Code*
- NFPA 75: *Standard for the Fire Protection of Information Technology Equipment*
- NFPA 96: *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*

13.7 Electrical Codes, Standards, and Legislation

- CAN/CSA C282: *Emergency Electrical Power Supply for Buildings*
- CAN/CSA C654: *Fluorescent Lamp Ballast Efficacy Measurements*
- CAN/CSA C802.1: *Minimum Efficiency Values for Liquid-Filled Distribution Transformers*
- CAN/CSA C802.2: *Minimum Efficiency Values for Dry-Type Transformers*
- CAN/CSA C802.3: *Minimum Efficiency Values for Power Transformers*
- CAN/CSA B72-M87: *Installation Code for Lightning Protection Systems*
- CAN/CSA C860: *Performance of Internally Lighted Exit Signs*
- CSA C22.1: *Canadian Electrical Code*, Part I
- CSA C22.2: *Canadian Electrical Code*, Part II
- CSA C22.3: *Canadian Electrical Code*, Part III
- CAN/CSA Z431: *Basic and Safety Principles for Man-Machine Interface, Marking and Identification – Coding Principles for Indicators and Actuators*
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- CSA Z462: *Workplace Electrical Safety*
- IEEE Standard 81: *Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System*
- IES: *The Lighting Handbook*
- *Measurement of Lighting Levels in the Workplace – Canada Occupational Health and Safety Regulations, Part VI, 928-1-IPG-039*

- Provincial electrical codes and regulations
- UL 1449: *Standard for Surge Protective Devices*

13.8 Telecommunication Codes, Standards, and Legislation

- ANSI/TIA 568.1: *Commercial Building Telecommunications Infrastructure Standard* (and addenda)
- ANSI/TIA 569: *Telecommunications Pathways and Spaces* (and addenda)
- ANSI/TIA 606: *Administration Standard for Telecommunications Infrastructure* (and addenda)
- ANSI/TIA 607: *Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises* (and addenda)
- ANSI/TIA 758: *Customer-Owned Outside Plant Telecommunications Infrastructure Standard*

13.9 Security Codes Standards, and Legislation

- Public Services Procurement Canada
  - DP 051: *Departmental Security Program Policy*
  - DP 052: *Corporate Security Program Policy*
- Treasury Board of Canada Secretariat:
  - *Operational Security Standard on Physical Security*
  - *Operational Security Standard - Business Continuity Planning (BCP) Program*
  - *Operational Security Standard - Readiness Levels for Federal Government Facilities*
  - *Policy on Government Security*
  - *Security and Contracting Management Standard*
  - *Security Organization and Administration Standard*
  - *Standard for Fire Safety Planning and Fire Emergency Organization*
- Royal Canadian Mounted Police:
  - G1-005: *Guide to the Preparation of Physical Security Briefs*
  - G1-013: *Security Control Centre Space Requirements*
  - G1-028: *Security Use of Mobile Shelving*
  - *Harmonized Threat and Risk Assessment Methodology (hosted by Communications Security Establishment Canada [CSEC])*