Ryerson University

Sustainable Building Guidelines

VERSION 1

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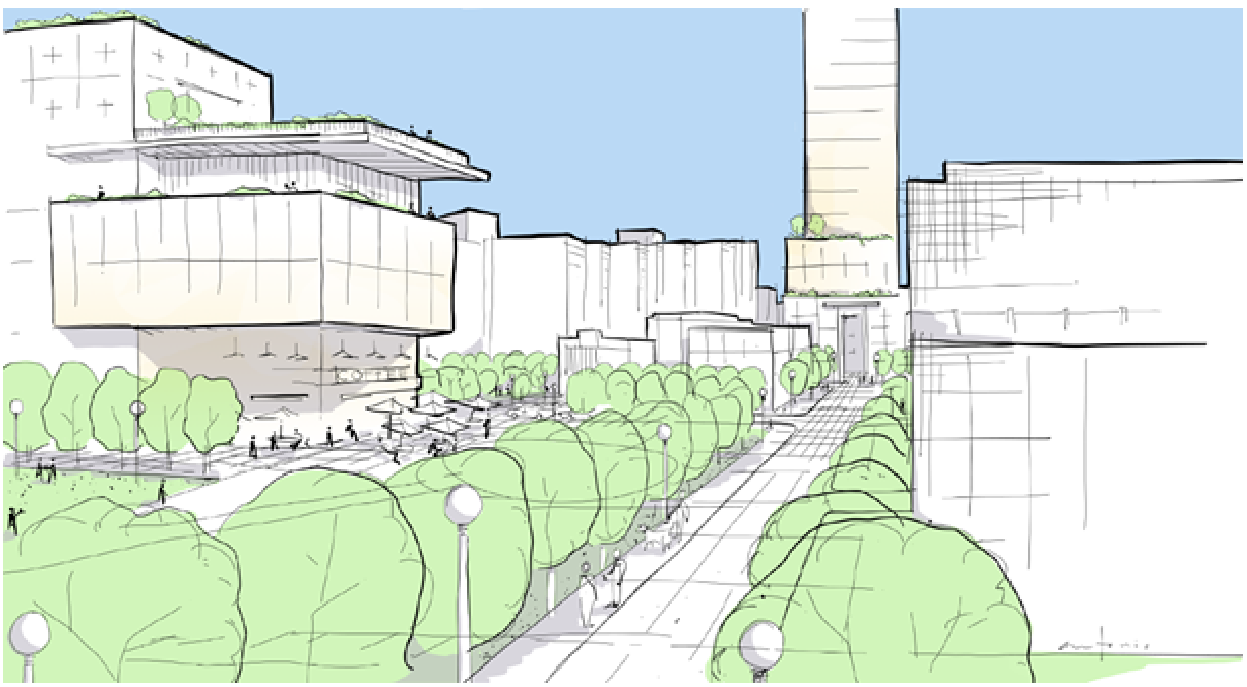

Credit: Ryerson Campus Master Plan 2020, rendering by Hariri Pontarini Architects, Conceptual east-facing view across Gould St.

APPROVALS

Approval Description	Name	Title	Date
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The contents in these guidelines have been approved by all individuals listed in the table above. All project stakeholders are encouraged to perform in accordance with or better than the guidelines presented herein. Approvers acknowledge that the goal of this guideline is to improve the environmental performance of Ryerson’s built infrastructure and minimize its carbon emissions.

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1 ACRONYMS

- AHJ: Authority having Jurisdiction
- ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers
- BAS: Building Automation System
- CD: Construction documents project stage
- COP: Coefficient of Performance
- CRAC: Computer Room Air Conditioners
- CRAH: Computer Room Air Handlers
- CUE: Carbon Usage Effectiveness
- DD: Design development project stage
- DDC: Direct Digital Control
- ECM: Electronically Commutated Motor
- EF: Emissions Factor
- ERF: Energy Reuse Factor
- F&S: Facilities and Services
- GHG: Greenhouse Gas Emissions
- GHGI: Greenhouse Gas Emissions Intensity
- GSM: Gross Square Metres
- GWP: Global Warming Potential
- HVAC: Heating, Ventilation and Air Conditioning
- LEED™ v4: Leadership in Energy and Environmental Design, Version 4 (at Jan 2020)
- LED: Light-Emitting Diode
- LCA: Life cycle assessment
- MFA: Modelled Floor Area
- NASM: Net Assignable Square Meters
- OBC: Ontario Building Code

- PPR: Project Planning Report
- PUE: Power usage effectiveness
- SB-10: Ontario Building Code Supplementary Standard SB-10: Energy Efficiency Requirements
- SD: Schematic design project stage
- TEDI-Heating: Thermal Energy Demand Intensity for Heating
- TEDI-Cooling: Thermal Energy Demand Intensity for Cooling
- TEUI: Total Energy Use Intensity
- TGS: Toronto Green Standards, (Version 3 2019 or as amended)
- UNECFE: United Nations Economic Commission for Europe
- UoT: University of Toronto
- UPS: Uninterruptible Power Supply
- VFD: Variable Frequency Drive

2 DEFINITIONS

Many definitions are taken from or adapted from the Toronto Green Standard (TGS) Version 3.

Building Envelope Restoration Project - Typically done to address building envelope deterioration, replace aging windows, or improve the building envelope performance.

Electrification - Electrification is the process of powering by electricity and, in many contexts, the introduction of such power by changing over from an earlier power source. In buildings, this typically means replacing a fossil fuel source of energy, by electricity either directly, or indirectly.

Energy, Water, and Carbon Reduction Project - Projects that are completed with the specific goals of reducing energy, water, or carbon emissions. These projects aim to use the most energy-efficient technology possible, as prescribed in ASHRAE standards, or other best practices of the industry such as LEED, Living Building Challenge, One Planet, Passive House, or as described in Ryerson guidelines.

Greenhouse Gas Intensity (GHGI) - Total greenhouse gas emissions associated with the use of all energy utilities on-site on a per-area basis, using the most up to date emissions factors (EF) from a reliable source such as the Government of Canada's National Inventory Reports. GHGI shall be reported in kg eCO2/m2/year.

Lease Space: Space that is located in a building that Ryerson does not own or maintain, or that is maintained by a third party hired by Ryerson, but in which Ryerson staff and or students are occupying. Utility invoices are sometimes paid by Ryerson for lease space, or otherwise, the cost of utilities are included in the cost of the lease.

Major Additions - Should be treated as new construction projects in this guideline. Examples of major additions to an existing building at Ryerson include the new Center for Urban Innovation (CUI) and The Chang School of Continuing Education (CED).

Major Renovations - Includes projects anticipated to have a meaningful impact on the utility consumption of an existing building. Projects fitting into this category will be determined on a case-by-case basis by the project team in collaboration with the sustainability team. Examples of major renovations could include revitalization of the building, conversion of a space to a higher energy profile such as an office to lab space, replacement or major upgrades to HVAC systems, building-wide envelope retrofit, and building-wide automation upgrade. Major renovations usually affect a large part of the building.

Minor Renovations - Includes projects that are not anticipated to impact the energy consumption of an existing building meaningfully. Examples of minor renovations could include an office renovation, conversion of space use to a smaller or equivalent energy profile, or any project that affects a smaller portion of the building.

Modeled Floor Area (MFA) – The total enclosed floor area of the building, as reported by the energy simulation software, excluding exterior areas and parking areas. All other spaces, including semi-heated (as defined under SB-10 2017) and unconditioned spaces, are included in the MFA. The MFA must be within 5% of the gross floor area from the architectural drawings unless justification is provided demonstrating where the discrepancy arises and why the MFA should differ from the gross floor area by greater than 5%.

New Construction Project – Include any new buildings or major addition(s) to an existing building.

Power Usage Effectiveness (PUE) - The ratio that describes how efficiently a computer data center uses energy, specifically, how much energy is used by the computing equipment, in contrast to cooling and other overhead that supports the equipment.

Energy Reuse Factor (ERF) - Defined as the ratio of the data center energy that is reused elsewhere in the facility and the total energy brought into the data center (for IT equipment, cooling, power, lighting, etc.). The total energy is essentially the PUE numerator. When heat recovery is used typically the PUE will be higher due to equipment energy use.

Carbon Usage Effectiveness (CUE) - A metric developed by The Green Grid to measure data center sustainability regarding carbon emissions. CUE is the ratio of the total CO2 emissions caused by total data center energy consumption and the energy consumption of IT equipment. The carbon emission factors used should be the same as that used to calculate the GHGI.

Site Energy Use – Includes all energy used onsite including all end-uses, such as heating, cooling, fans, pumps, elevators, parkade lighting and fans, and exterior lighting, etc. It incorporates all site efficiencies, including heat pumps or re-use of waste heat, but does not include energy generated onsite.

Site Renewable Energy Generation – Energy generated on-site from renewable sources, such as solar, wind, solar thermal, and geo-exchange. In cases where a site cannot send energy off-site (e.g., is connected to the electricity grid), only energy consumed (or stored and then consumed) on-site shall be counted as Site Renewable Energy Generation.

Thermal Energy Demand Intensity (TEDI) – The annual heating delivered to the building for space conditioning and conditioning of ventilation air. Measured with modeling software, this is the amount of heating energy delivered to the project outputted from all types of heating equipment, per unit of Modelled Floor Area. Heating equipment includes electric, gas, hot water, or DX heating coils of central air systems (e.g., make-up air units, air handling units, etc.), terminal equipment (e.g., baseboards, fan coils, heat pumps, reheat coils, etc.) or any other equipment used for space conditioning and ventilation. The heating output of any heating equipment whose heat source is not directly provided by a utility (electricity, gas, or district) must still be counted towards the TEDI. For example, hot water or heat pump heating sources derived from a waste heat source or a renewable energy source do not contribute to a reduction in TEDI, as per the above definition. Specific examples of heating energy that are not for space conditioning and ventilation, which would not be included in the TEDI, include: maintaining swimming pool water temperatures, outdoor comfort heating (e.g., patio heaters, exterior fireplaces), gas-fired appliances (stoves, dryers), heat tracing, etc. TEDI shall be reported in kWh/m2/year.

Total Energy Use Intensity (TEUI) – The sum of all energy used on-site (i.e., electricity, natural gas, and district heating and cooling), minus all Site Renewable Energy Generation, and divided by the Modeled Floor Area. TEUI shall be reported in kWh/m2 /year.

3 INTRODUCTION

3.1 Objectives

Ryerson is committed to creating a healthier, sustainable, low-carbon campus. The Sustainable Building Guidelines ("the Guidelines") outlined herein support Ryerson's sustainability priorities to:

- Significantly reduce energy use and GHG emissions from the construction and operation of its facilities to achieve Ryerson's goal of being carbon neutral by 2050.
- Reduce stormwater runoff and potable water consumption while improving the quality of storm water draining to local waterbodies.
- Use sustainable materials, minimize construction and operational waste and divert it from going to landfill sites.
- Protect and enhance ecological functions, integrate landscapes and decrease building-related bird collisions and mortalities.

The Guidelines apply to capital and deferred maintenance projects and should be included in Requests for Proposals and Scopes of Work issued for new projects and referenced in contracts for architects, design consultants, and construction managers.

They identify a minimum level of design and process requirements and recommendations for all new construction, renovation projects, and other projects (as applicable) while providing enough flexibility for individual project teams to meet project goals.

The Guidelines provide project-specific energy, GHG emissions and water efficiency targets in new construction and renovation projects, calculates energy and GHG project budgets, and introduces streamlined modeling, benchmark comparison, documentation submission, and approvals approach.

It aims to align with Ryerson Campus Master Plan and Ryerson Asset Management Plan, along with other Ryerson plans, standards and guidelines. All projects starting after January 2022, must adhere to this guideline.

3.2 Energy and Greenhouse Gas Emissions Performance Targets

Global best practices in energy-efficient and sustainable building design indicate that using a performance-based approach is the most effective way to close the performance gap between design and construction and leads to improved building energy performance (UNECFE, 2015). Through this approach, targets are set for overall building performance rather than its parts.

The University of Toronto (UoT) and the City of Toronto have developed robust sustainable design standards using this approach to dramatically reduce emissions associated with their operations. Much of the content in this set of guidelines has been adopted from UoT's recently published Tri-Campus Energy Modelling & Utility Performance Standard (July 2020) and the City of Toronto's Green Building Standards. The *ASHRAE Standard 189.1* (most recent version) *Standard for the Design of High-Performance Green Buildings, ANSI/ASHRAE/IES Standard 100–(*most recent version*), Energy Efficiency in Existing Buildings* and *Ontario Code SB-10* are also important reference documents. In case of conflict between standards and guidelines, the one having jurisdiction always has priority, or otherwise the most stringent requirements have priority.

The performance-based approach shall be used for all new buildings, major renovations and additions, and minor renovations where appropriate on Ryerson's campuses. The three main performance targets are:

- Total Energy Use Intensity (TEUI)
- Thermal Energy Demand Intensity (TEDI) – Heating and Cooling
- Greenhouse Gas Intensity (GHGI)

The guidelines include the required levels of performance related to energy, emissions and water and have energy modeling requirements that Project Consultants must follow. A complete set of energy performance targets for the most common building archetypes found on Ryerson's campuses is outlined in the following sections.

3.3 Electrification and Decarbonization

3.3.1 Electrification

There are several methods that may be utilized to reduce a building's GHG emissions.. Improving energy efficiency, installing heat recovery systems, and using renewable energy have historically been some of the means by which carbon reduction goals are achieved. In order to meet the ambitious goals of carbon neutrality by 2050, additional measurements must be used to minimize reliance on fossil fuel (natural gas, steam and diesel) in buildings. These additional measures focus on the partial or full electrification of fossil fuel powered heating systems, either by using electricity directly or by using a heat pump.

Ontario's electricity grid has one of the lowest carbon intensities of any electricity grid in North America as a result of a decision by the province to eliminate coal fired electricity generation by 2014. The majority of electricity in Ontario is now produced by nuclear power and hydroelectricity with a smaller portion produced by natural gas and other renewable energy sources such as solar and wind. The low carbon intensity of the electricity grid is also evident when comparing it other common sources of heat and power, as shown in Table 3.1:

Table 3.1 - Carbon Intensity Comparison of Energy Sources

Energy Source	**Carbon Intensity (kg CO2/ekWh)**
Electricity	0.0290
Natural Gas	0.1817 - *6x higher than electricity*
Steam (Enwave)	0.2652 - *9x higher than electricity*

In other provinces such as Quebec, the electricity grid has a lower carbon intensity than Ontario due to the large percentage of hydro-electricity generation. In Alberta, coal is still used for electricity generation and therefore their grid has a much higher carbon intensity relative to Ontario. The purpose of this comparison is to illustrate that electrification is not applicable or appropriate in all provinces seeking to reduce their carbon emissions. However in Ontario, it is the preferred path forward to achieve carbon neutrality. For more info on the Ontario grid, visit: https://www.ieso.ca/.

In many cases, electrification projects do not provide a return on investment and are motivated primarily to meet carbon reduction goals. However this is not always the case. In Canada, the carbon tax imposed on fossil fuels continues to increase on an annual basis and is expected to reach $170 per tonne CO2 emitted by 2030. This helps to make electrification more financially viable, particularly when coupled with Ontario's Global Adjustment and Industrial Conservation Initiative (further discussed in Section 3.3.3), other energy efficiency measures and the use of heat pumps.

3.3.2 Heat Pumps

Heat pumps help improve the overall efficiency of the electrified heating systems, but are often limited in very cold weather. There are two types of heat pump systems applicable to Ryerson - geoexchange heat pump systems (also known as ground source heat pumps) and air source heat pump systems (which take heat from ambient air).

Heat pumps (air source or geo-exchange system) are encouraged in most projects, since they improve the financial viability of the electrification projects by reducing the electricity power and consumption requirement. Air-source heat pumps provide an efficiency of typically 300-500% (COP of 3 to 5), or more in certain climate conditions. The use of air-source heat pumps is limited in extreme cold weather however (including Toronto), so typically, a back up heating system is required. Additionally, using large commercial air-source heat pumps is still considered an innovation in North-American building and limited products are available, although product availability will increase as the market share also increases. For geo-exchange heat pumps, the efficiency is typically better than air-source heat pumps and they are not affected by the weather directly. However, the geo-exchange system requires boreholes, and therefore are more expensive and complex projects.

Finally, some buildings may not have the adequate electrical power capacity available to consider a full electrification of the heating system. This determination would typically be completed by a consulting study completed by an electrical engineer, which is typically completed in most projects where additional electrical requirements are desired. If additional work or a capacity increase is required, the work recommendation should be quantified and communicated with the energy manager. If electrification is not physically possible or cost prohibitive, the energy manager will provide recommendations on an alternative solution that can provide the best carbon reduction compromise.

3.3.3 Global Adjustment and Class A

The electricity grid in Ontario is built to meet the highest demand periods of the year. To reduce demand during peak periods, the Industrial Conservation Initiative (ICI) was launched. One of the goals of the program is to help the province defer the need for investments in new electricity infrastructure. Customers who participate in the ICI, referred to as Class A, pay a surcharge called the Global Adjustment (GA) based on their percentage contribution to the top five peak Ontario demand hours over a 12-month period. Institutions with buildings that have an average peak demand of above 1 MW but less than or equal to 5 MW are eligible to be Class A participants.

In Class A buildings, the cost of electricity consumption in kWh is reduced. This is because in Class A buildings, the cost of electricity is not primarily based on the energy consumption (kWh), but the GA which is a function of the power demand of the building, during the five grid peak hours (kW/kW) and the maximum monthly demand (kW). The more effort put into reducing the GA by creating programs that target reducing demand during the top five peaks, the larger the reduction in the cost of electricity for that particular building. Significant cost savings can often be achieved through participating in this program. For more detail on how Class A is structured, visit:
https://www.ieso.ca/en/Sector-Participants/Settlements/Global-Adjustment-Class-A-Eligibility.

In Class A buildings the cost of electricity is approximately 0.05$/kWh (compared with 0.15$/kWh for a Class B building) which is why it can compete with the lower cost of natural gas and steam, especially with the increasing cost of the carbon tax.

As of 2021, Ryerson's Class A buildings include KH, PIT, RCC, MON, EPH, and SHE. Buildings that are currently in Class B but are eligible for Class A are LIB, POD, JOR, SLC, and RAC clusters (these buildings are on a common electrical meter).

3.4 Applicable Projects

The performance of new and existing buildings should contribute to achieving Ryerson's GHG emissions reduction and sustainability goals. Using a performance-based approach in which multiple pathways can be taken to achieve targets gives project teams the flexibility needed to implement creative and contextually appropriate solutions. The size and type of each project in combination with the building archetype (described in Section 4) will dictate which performance targets should be selected. Project size and type are categorized as follows and are further described in the Definitions section of this guideline (Section 2):

- New Construction
- Major Additions
- Major Renovations
- Minor Renovations
- Building Envelope Restoration
- Projects impacting energy and or water equipment/infrastructure

It is expected that there may be some difference of opinion when it comes to categorizing projects. As such, this will be done on a project by project basis at the discretion of the Project Team in collaboration with the Sustainability Office team.

In this guideline, major additions are treated as new construction projects. Examples of major additions to an existing building at Ryerson include the new CUI building and the CED. In major addition projects, if the existing building space is also renovated, the existing building space should meet the same requirements as the new construction project definition, except for approved heritage features.

4 BUILDING ARCHETYPES

Building archetypes in this guideline have been developed based on their prevalence on Ryerson's campus. The Ryerson project team shall determine the archetype for each building undergoing construction or renovation (or space within a building) during the initial phases of the project. The archetype selection shall then be formalized in the Project Management Office (PMO) project charter. It is recognized that in several cases, buildings will fulfill different archetypical functions, such as mixed residential and academic use. In such cases, blended targets that are weighted on metrics such as gross square metres (GSM) shall be used. The various building archetypes found on Ryerson's campus are as follows:

4.1 Academic

Academic spaces include classrooms, lecture halls, common rooms, multipurpose rooms, and related academic purposes such as study areas not associated with libraries. Characteristics of academic buildings include low-medium intensity plug loads with lighting consistent with desktop reading levels. Occupancy levels fluctuate from low to high during business hours, typically from 8 am to 10 pm on weekdays. Facility operations should consider reduced use on weekends, the possibility of special events, and the likelihood of shutdowns during vacation periods during the summer or annual holidays.

Examples of this archetype: Ted Rogers School of Management (TRS), Podium Building (POD), and the Student Learning Center (SLC).

4.2 Offices

Office spaces for staff, faculty, and student groups are included in this archetype. Characteristics of academic buildings include medium intensity plug loads, with lighting consistent with meeting desktop reading levels. Occupancy can vary from predictable, regular schedules in staff and faculty offices to sporadic occupancy in student office spaces. Staff and faculty offices are expected to have peak occupancy between 8 am and 6 pm on weekdays. Student offices are expected to have lower density and intensity of occupancy but spread out over a longer daily duration beyond 6 pm. Reduced occupancy is expected over weekends and vacation periods. There is a high potential for occupancy sensors and demand control ventilation to modulate lighting and HVAC systems.

Examples of this archetype: Jorgenson Hall (JOR), Rogers Communication Centre (RCC), and South Bond Building (SBB).

4.3 Wet Labs

This type of laboratory is characterized by the practice of handling various types of chemicals and potentially hazardous materials in the lab space. High ventilation requirements are typical due to the presence of fume hoods and high air change requirements. High plug and process loads and high lighting levels that exceed desktop reading levels are typical of these spaces. Occupancy fluctuates throughout the day and year, but peak consumption is still expected to occur between 8 am and 9 pm on weekdays. Air change requirements can be reduced through application-specific demand control ventilation. Energy intensity for this archetype is the highest among archetypes listed and thus provides the best opportunities for innovative energy-saving solutions and GHG emissions reductions.

Examples of this archetype: Center for Urban Innovation (CUI), Science labs in Kerr Hall North (KHN), and Ryerson leased space at Medical and Related Sciences (MaRS).

4.4 Dry Labs

Dry Labs typically consists of laboratories where computational, testing, or mathematical analyses are conducted. The most common occurrence of dry labs on campus is expected to be computer labs. High plug loads, with medium ventilation loads. Year-round cooling will likely be required. Lighting levels generally need to exceed desktop reading levels. Occupancy can be sporadic through the day, week, and year but generally can be expected to peak between 8 am and 8 pm on weekdays. A significant reduction in occupancy can be expected during vacation periods in the summer and annual holidays.

Examples of this archetype: School of Graphic Communications Management, Heidelberg Centre (HEI), George Vari Engineering and Computing Centre (ENG), and Eric Palin Hall (EPH).

4.5 Residential

Included here are living quarters and associated spaces such as cafeterias and lounges. Medium intensity plug loads are typical, with lighting maintained at a desktop reading level and dimmed to be lower as needed. High loads are associated with domestic hot water use and higher water consumption. Occupancy fluctuates throughout the day and may increase over the weekends and evenings, especially during the heating season. Building operation is typically 24/7, 365 days a year.

Examples of this archetype: Pitman Hall (PIT), International Living and Learning Center (ILC), Daphne Cockwell Center (DCC) - residential tower only.

4.6 Retail

Retail areas and common dining spaces, such as public cafeterias, non-industrial scale kitchens. Medium plug loads and lighting levels exceeding desktop reading levels are typical. Occupancy often fluctuates throughout the day, peaking between 9 am and 5 pm, 8 am to 9 pm for the residence cafeteria. Lower occupancy is expected on weekends and vacation periods in the summer and Christmas. For commercial kitchen design, we encourage the designer to review and follow the Green Restaurant Association Standard.

Examples of this archetype: Ryerson Bookstore (BKS), Oakham House Cafeteria(OAK), and Podium Cafeteria (POD), but also leased space such as Balzac's on Gould st and Basil Box on Young st.

4.7 Athletics and Recreation

Athletics and recreation spaces include exercise areas and associated facilities such as gyms, change rooms, locker rooms, spectator stands, and associated lobbies. Medium plug loads with lighting levels generally exceeding desktop reading levels are expected. Occupancy typically fluctuates throughout the day but generally peaks on weekdays between 9 am and 9 pm. Slightly lower occupancy is expected during weekends and vacation periods.

Examples of this archetype: Recreation and Athletics Centre (RAC), Mattamy Athletic Center (MAC), and gymnasiums located in Kerr Hall West (KHW).

4.8 Libraries

Library spaces include stacks, reading rooms, common rooms, and study rooms. Low-intensity plug loads with lighting levels equal to or higher than desktop reading levels are typical. Libraries are expected to have low to medium occupancy throughout the day, especially during weekdays. High occupancy is expected for exam periods throughout the academic year, with significantly reduced occupancy during vacation periods in the summer and annual holidays.

Example of archetype: Library Building (LIB).

4.9 Museum, Galleries and Archives

Museums, galleries and archives are characterized by strict temperature and humidity control requirements, leading to high energy consumption. Low-intensity plug loads with lighting levels equal to or higher than desktop reading levels are typical, except for galleries where lighting level and occupancy can be higher. Decorative lighting is often used, which is typically exempt from ASHRAE 90.1 requirements. The stringent Class of Control, which varies based on collection type, as defined in the ASHRAE Handbook Application, will impact energy consumption. For example, a Class AA collection type will consume more energy than a Class B collection type. More details on Class of Control can be found here.

Examples of this archetype: School of Image Arts (IMA), Ryerson Image Centre (RIC), and Research Center Gallery (GER).

4.10 Data Centre

Data centers typically host a high density of computing equipment requiring a large cooling capacity. A data center in Ryerson's sustainable building design guideline definition needs to have a constant power load of at least 75 kW, as also prescribed in Energy Star Portfolio Manager. Data centers have high electricity demand and are critical infrastructure that typically requires redundancy and high system reliability. They usually use an Uninterruptible Power Supply (UPS) and generators to avoid any possible downtime. Their performance is typically a ratio of how much energy or carbon is used relative to the total IT equipment demand. Power Usage Effectiveness (PUE), the primary benchmark for data center energy efficiency, is the ratio of the total amount of energy used by a computer data center facility to the power delivered to computing equipment.

Examples of this archetype: Main CCS Ryerson Server Room (POD), Secondary CCS Ryerson Server Room (KHSW), and data center owned by George Vari Engineering and Computing Centre (ENG).

Detailed information regarding the performance targets for Data Centres can be found in Appendix A.

4.11 Mixed-use facilities

It is expected that many buildings on campus will have mixed uses. DCC, for example, is a mixed-use building comprising a podium that includes academic space and wet labs, as well as a large residential tower. In such cases, the project team shall calculate weighted performance targets based on a blend of the applicable building archetypes.

Examples of this archetype on campus: DCC (Academic/ Wet lab/ Residential), CUI (Wet lab/Dry Lab/Offices/Academic) and ENG (Academic/Dry Lab/Office/Data Centre).

5 ENERGY PERFORMANCE TARGETS

5.1 New Construction and Major Additions

New construction projects and major additions on Ryerson's campus must meet or exceed the energy performance targets outlined in Table 5.1. New construction will increasingly include buildings that have multiple uses and occupancies, resulting in mixed-use buildings. As indicated in Section 4, the energy performance targets and resulting budgets in these cases will be based on the area-weighted aggregate. When a space archetype is not defined in this guideline, a classification based on a good judgment should be made. For example, a large commercial kitchen would best be categorized as a wet or dry lab depending on the high ventilation loads; a mathematics lab may be more similar to an office space than a lab space as it likely only includes medium plug loads and lighting but not high ventilation.

Ryerson chose to use a single set of stringent TEUI, GHGI, and TEDI values for its performance (as opposed to the tiered approach based on occupancy date used by the City of Toronto and UoT). The performance targets will therefore not change unless the guideline is updated. The energy performance targets are adapted from the University of Toronto Utility Performance Standard and other organizations such as ASHRAE and TGS. Designers are encouraged to surpass these performance targets whenever technically and economically feasible.

Table 5.1 - Minimum Energy Performance Targets for typical building archetypes

Building Archetypes	TEUI ($ekWh/m^2/yr$)	GHGI ($kg\ eCO_2/m^2/yr$)	TEDI – Heating ($ekWh/m^2/yr$)	TEDI – Cooling ($ekWh/m^2/yr$)
Academic	59	4	30	18
Office	59	4	30	18
Wet Labs	316	22	76	76
Dry Labs	156	8	15	83
Retail	78	8	19	19
Residence	59	4	22	15
Athletics	62	4	30	26
Library	57	3	19	15
Museum, Galleries and Archives	156	8	15	83

For new construction projects and major additions with planned occupancy in 2030 or later, TEUI performance targets in Table 5.1 should be lowered by 20% and TEDI targets should be lowered by 50%. GHGI targets should be lowered to 2 kg $eCO_2/m^2/yr$ for all building types, implying that electrification and a high performing building envelope and systems will be critical. Passive House and Canada Green Building Council's Zero Carbon Building are two important standards that can help achieve this goal along with the extensive use of heat pumps and heat recovery.

For more information on the methodology used to calculate the performance targets in Table 5.1, see the energy modeling section (Section 12) of this guideline.

5.2 Major and Minor Renovations

Performance targets must also be established for renovation projects to achieve Ryerson's long-term sustainability and GHG emission reduction goals. Due to the variety of renovation projects that may be undertaken on Ryerson's campus, targets must be a function of the project size and scope. As such, these guidelines outline different requirements for minor and major renovations.

- Major Renovations
- Minor Renovations
- Energy, water, and carbon reduction projects
- Building Restoration Projects

At the outset of each project, the Ryerson sustainability team will determine which category the project fits into.

5.2.1 Major Renovation Projects

Like the requirements for new construction projects, energy and water targets for major renovations follow a performance-based approach in which multiple pathways can be taken to achieve the targets (shown in Table 5.2).

Major renovations typically utilize a request for proposal (RFP) process with a defined scope of work to select external design consultant(s) (architect(s) and/ or professional engineer(s) Project-specific energy and water reduction targets will be developed for each major renovation project based on renovation floor area and building use type and will be included in the project request for proposal or scope of work.

Similar to the approach used for new construction project performance targets, major renovations can occur in buildings of multiple space use types. The area-weighted approach should be used to calculate the performance targets, as explained in Section 4.

In cases where the project will impact multiple building components, categories will be selected based on the most relevant renovation component or the sum of multiple categories. For example, if an existing building is upgrading its interior and envelope systems, it will be required to meet the combined interior and envelope targets. The Ryerson Project Team should select the most appropriate category(ies) on a project-by-project basis. The building type(s) associated with the renovation project should also be selected and should follow the building archetypes used in New Construction targets. For buildings with mixed uses, the targets will be area-weighted to determine a performance target representing the building.

The baseline year energy performance for the building or space should be calculated using actual utility data from the 12 months (minimum) before the project design starts (or the most representative of a typical year). Sub-metering 15 minutes interval data, when available, can be used as well. Ryerson’s Energy Manager can assist in providing utility and or sub-metering data for the building or space. Targets outlined in the table below should be considered a minimum requirement and set relative to this baseline. If utility data is not available, an estimated energy use index can be calculated using a building from the same benchmark category or the TEUI targets associated with new construction projects.

Major renovations can vary in type, size, and scope. All major renovations should use the energy performance targets outlined in Table 5.2 unless they are assigned to one of the following categories. In these cases, refer to the relevant sections below.

5.2.1.1 Heritage Building

When a building receives the designation of a heritage building by the City of Toronto, or some physical features need to be preserved, the project team shall design, at a minimum, within the parameters of *ASHRAE Guideline 34-most recent version - Energy Guideline for Historic Buildings*. Heritage buildings typically have limitations on the possible improvement that can be done on the building envelope, while electrical and mechanical equipment are usually not a limitation. Therefore, a customized approach is required in these types of projects.

Electrification of all heating systems is desired, if the existing electrical infrastructure allows for it, and the use of heat pumps for heating is encouraged. Please also refer to Section 3.3 for more details on electrification and heat pumps. In some cases, a heat pump can be used to meet most heating loads with a natural gas system for peak heating loads.

5.2.1.2 Buildings with Demolition Date

Kerr Hall (KH), Cooperative Education (COP) and GER (Research and Graduate Studies) are buildings planned for demolition, as described in Ryerson's Campus Master Plan. In these buildings, every reasonable effort should be made to meet the energy performance targets outlined in Table 5.2, while considering the remaining anticipated lifespan of the building.

An exception may be made (at the discretion of the Energy Manager) for measures with a simple payback of more than ten years. This exception avoids significant investment in systems that will be demolished in a timeline of less than 15 years and, therefore, will not help Ryerson meet 2030 and 2050 carbon reduction goals. Heat recovery on new ventilation systems is still required and should have an efficiency of at least 50%. If heating systems are replaced, electric systems should be used, if the electric infrastructure is sufficient (see electrification section).

5.2.2 Minor Renovation Projects

Typically, minor renovations (e.g., lighting retrofits, low-flow water fixtures, high-efficiency appliances, classroom furniture, thermostat refit) do not require a whole building energy load calculation. Alterations that include some HVAC modifications can border on major renovations. If an energy load calculation is required, energy targets presented in this guideline shall be included in the project scope. A baseline shall be defined using existing energy use indices when available for target comparison.

5.2.3 Energy Savings Requirements for Renovations

When the project scope has been defined by the project management team, the project consultants shall meet with the sustainability team to categorize the project as major or minor. Energy reduction targets are shown in Table 5.2.

Table 5.2 - Major and Minor Renovation Energy Reduction Targets

Building Archetypes	Interior Renovations: % Reduction	Mechanical Renovations: % Reduction	Envelope Renovations: % Reduction
Academic	8%	38%	25%
Office	3%	38%	25%
Wet Labs	3%	45%	4%
Dry Labs	6%	33%	6%
Retail	14%	33%	3%
Residence	15%	21%	21%
Athletics	11%	34%	20%
Library	8%	30%	20%
Museum, Galleries and Archives	8%	45%	6%

An exception to meeting the energy savings target in Table 5.2 is permitted if a conversion from steam or natural gas to electricity is completed and offers an equivalent percentage carbon emissions savings versus overall energy savings.

For example, if an electric resistance is installed to convert natural gas or steam to electricity (see section 3.3 for more details on electrification), the energy converted is considered to be “saved” under this guideline and can be added to the overall energy savings percentage of the project. So if a building's yearly consumption is 1,000,000 ekWh, with 300,000 ekWh from natural gas, the conversion of natural gas to electricity in this case will create credited savings of 30%.

If, due to the age or condition of a system or a piece of equipment that uses natural gas needs to be replaced, it should be replaced by a fully electric equipment. This includes:

- Natural gas boilers
- Steam boilers
- Humidifiers
- Domestic hot water heaters
- Kitchen equipment
- Lab equipment

This conversion to electricity may, however, not be possible if the power requirements of the electrical equipment cannot be met in the building. Using heat pumps (discussed further in Section 3.3.2) may help to alleviate the need for electric power, to offset a part of the carbon emissions of a new piece of natural gas equipment that would have been installed if the electrical capacity does not allow for full electrification. Additionally, if for example only some equipment can be electrified but not all, the Energy Manager will provide directions to the project team on how to prioritize which equipment should be electrified first. Typically, domestic hot water and lab equipment should be electrified first, followed by humidifiers and kitchen equipment second, and large equipment such as boilers, last.The installation of new equipment that uses steam as a primary energy source makes decarbonisation of the campus very challenging. As such, no new system should use steam as a primary source of energy. This includes:

- Steam heat exchanger
- Ventilation system steam coils
- Humidification system
- Lab equipment
- Terminal reheat coils or radiators

Electrification of equipment using electric resistance or heat pumps should be prioritized. If electrification capacity is limited, using a very efficient natural gas system may be an alternative to electrification, but only if no alternatives are technically feasible, and if approved by the Energy Manager. Another exception is also Kerr Hall where, with the approval of the Energy Manager, steam systems may be used for minor renovations.

5.2.4 Energy, Water and Carbon Reduction Projects

Projects that are completed with the specific goals of reducing energy, water, and or carbon should aim to use the most energy-efficient technology possible, as prescribed in ASHRAE Standards 90.1, latest version, or other best practices of the industry such as LEED, Living Building Challenge, Passive House and as described in this guideline. The BAS sequence of operations shall be at the level of sophistication of *ASHRAE Guideline 36-latest version-High-Performance Sequences of Operation for HVAC Systems.*

5.2.5 Building Envelope Restoration Projects

In building envelope restoration projects, if the building envelope is to be restored, it should be designed to meet the new construction TEDI, but does not necessarily need to meet the new construction other performance metrics. This means, for example, if the facade of a building is restored, the building insulation should be upgraded, and the windows should be replaced. The envelope performance should aim at meeting the requirements of Figure 6.1.

5.3 Leased Space

Ryerson is leasing external spaces to accommodate its growing space requirement. These spaces typically need to be fit out. While it may be challenging for Ryerson to influence the energy efficiency of the central building systems and building envelope of a leased space, Ryerson has influence on the components of the fitout, such as the lighting systems, terminal HVAC systems, local controls, furniture and finishes, and more.

In many ways, the minor renovations guidelines recommendations may apply to leased space fitouts, but may be limited to the central system made available by the landlord. For this reason the fitout should follow this guideline when technically possible. An exception can be made by the Energy Manager.

Preference will be given to leased spaces that align with Ryerson's Sustainable Building Guidelines and or are certified under an existing sustainability standard, such as BOMA Best, LEED, fitwel, WELL, Living Building Challenge, Passive House, One Planet Living, etc.

6 MINIMUM DESIGN REQUIREMENTS

6.1 New Construction and Major Renovations

The minimum design requirements outlined in this section have historically proven to show a good return on investment. They are mandatory for all new construction and major renovations unless an exception is requested and approved by the Energy Manager.

- All new electrical, HVAC and relevant plug load equipment installed shall meet the requirements of ASHRAE 189.1 and ASHRAE 90.1 latest version, when applicable.
- For the existing building, recommendation by ASHRAE 100 - for Energy Efficiency in Existing Buildings, latest version, shall be followed whenever technically feasible.
- All existing pneumatic control systems shall be modernized to DDC controls.
- All pumps and fans shall be installed with speed modulation, such as VFDs or ECM motors.

- All fan coils or other terminal units shall use ECM motors, and the speed of the fan must be modulating according to the load and controlled by the BAS (typically a 0-10V output).
- All hydronic equipment such as heat pumps, fan coils, radiators shall be equipped with a control valve, such that when they are not in operation, the valve closes to allow the flow to bypass the off-line equipment.
- When several ventilation systems are installed and operated in parallel, each fan shall be equipped with an isolation damper that closes when the fan is not in operation, to avoid air from being recirculated or bypassed.
- All equipment shall use 2-way valves. Use of a 3-way valve shall be avoided unless required for mixing.
- All new centrifugal chillers shall be magnetic bearing types.
- All new boilers shall be condensing boiler type.
- All new scroll chillers shall have a turndown ratio of at least 3:1 by using multiple compressors, digital compressors, or variable speed compressors, unless otherwise approved by the Energy Manager.
- All new natural gas heating equipment shall have a turndown ratio of at least 10:1, and even as 20:1 if the option is available in the capacity range of the product specified.
- All new air or water side heat pumps shall be capable of variable refrigerant and airflow. The quietest model available should be selected.
- All dry-coolers or condenser fans shall use ECM motors (typically up to a maximum of 15kW, or more if available) or be direct-drive and equipped with VFDs.
- All large commercial fans shall be direct-drive equipped with variable speed unless no direct-drive models are found for the specific application or if the power capacity cannot be obtained with a direct drive fan (i.e. high desired static pressure).
- All new lighting systems shall be LED and installed with occupancy sensors, scheduling functionality, and dimmable.
- Daylighting technology is encouraged, but if installed, the system shall be thoroughly commissioned and tested to certify that the light level in the space always meets but does not exceed the level recommended by IESNA or the architect's recommendations. The WELL standard requirement can be used to inform the daylighting design as well.
- All new humidifiers shall be electrical.

- All buildings that have substantial simultaneous heating and cooling loads shall use a heat recovery chiller or other means of recovering heat from the cooling system. Careful design shall be used to maximize the utilization of the heat recovery chiller, such as using chilled and heating water temperature reset strategies, and variable flow on primary heating and cooling equipment. Using a low grade heating system also helps increase the heat recovery chiller utilization. Installing heat recovery chillers in series with the larger chiller and boilers helps to maximize the operation of the HRC and ensures that heat recovery equipment will always run in priority. A parallel arrangement in this case is not desired, as it will not maximize the use of heat recovery.

- All newly built and majorly renovated heating systems shall be designed for a maximum temperature of 60°C, but with a reset strategy that allows the hot water setpoint to be as low as possible. Designers are encouraged to use a lower design temperature (low-grade), for example, 49°C maximum temperature. This can typically be achieved by using high-performance heat exchangers and coils in combination with a very high building envelope performance (see figure 6.1) and heat recovery. Radiant floors are also encouraged in lobbies, atriums and other spaces to prompt air stratification. In major renovations that address the heating system, a careful review and re-design of the heating coils and heat exchangers is required to allow the design temperature to be reduced. Exceptions can be provided if a demonstration is shown that carbon savings are not substantial enough to justify the heating system retrofit or if the life cycle cost is not beneficial.

- The use of a balancing valve should be carefully done. Balancing valves should only be installed if required.

- Installing triple-duty valves on pump outlets is not encouraged, as they create an unnecessary flow restriction. Check valves are preferred.

- Demand Control Ventilation (DCV) shall be used in occupied space and labs per the recommendations of ASHRAE 62.1 latest version and CSA Z316.5 latest version - Fume hoods and associated exhaust systems.

- Air-Side Heat-Recovery shall be installed on all new ventilation systems. It shall have a nominal total (sensible + latent) efficiency of at least 70%, except for wet lab systems where a sensible nominal efficiency of at least 50% is required.

- The use of cascade piping and ducting strategies on air or water systems is encouraged to help increase the temperature differential and reuse air in wet labs to reduce wet lab fresh-air requirements.

- Dedicated Outdoor Air Systems (DOAS) are encouraged versus recirculation-type Air Handling Unit (AHU) systems.

- For ventilation systems, control dampers should be controlled individually rather than interlocked, with each individual control output from the controller (typically 3 in total).

- Electrical domestic water heaters shall be used for buildings that are not residence, kitchen, or swimming pools, instead of natural gas or steam heaters.
- As a minimum, building enclosure performance shall have a combined wall-glass R-value in the high-performance enclosures range shown in Figure 6-1 below.

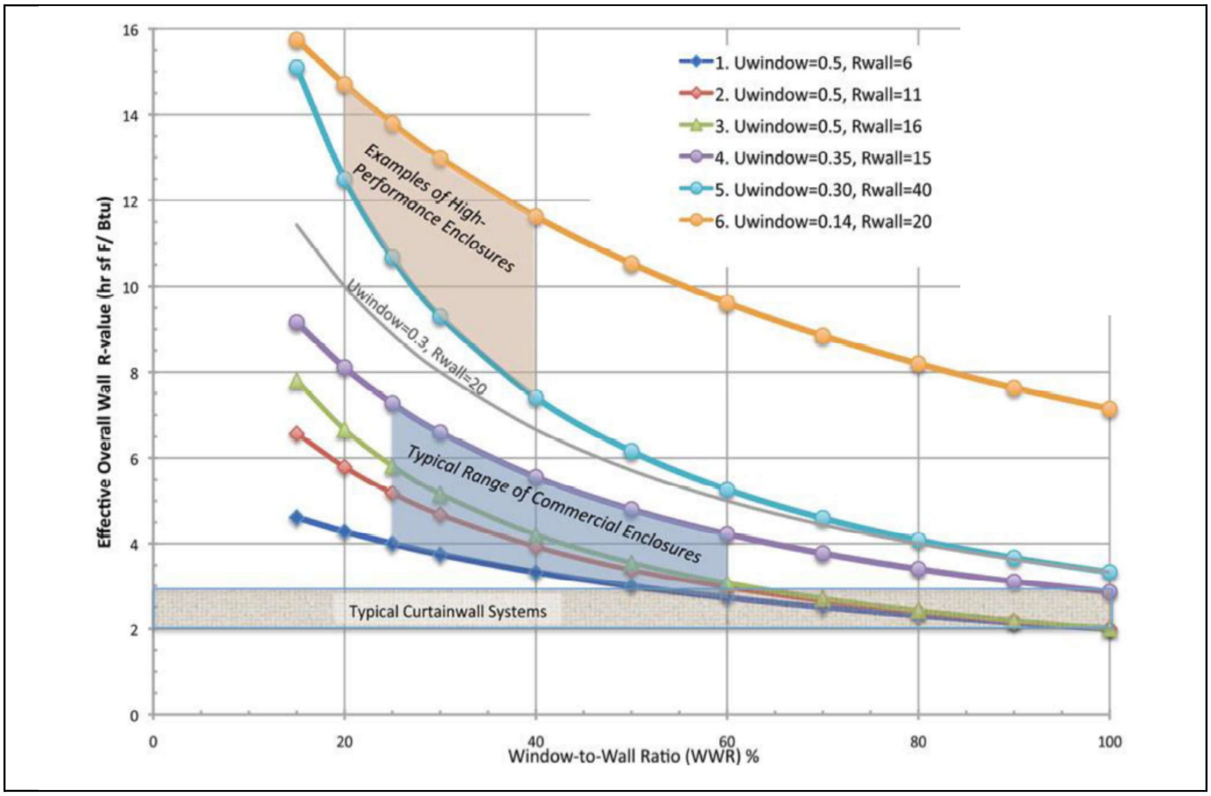


Figure 6.1 - Building Enclosure: Combined Wall-Glass R-value (Straube, 2012)

6.2 Minor Renovations

Where applicable (i.e. where there will be an impact on energy use), all minor renovation projects must meet the mandatory and prescriptive provisions of SB-10 Division 3 Chapter 2 - Additional Requirements to 2013 ANSI/ASHRAE/IES 90.1 for all improvements. In addition, projects must comply with all applicable requirements as follows:

- When applicable all requirements in the new construction Section 6.1 on minimum design and BAS requirements.
- Provide a separate control zone for each solar exposure and interior space. Provide controls capable of sensing space conditions and modulating the HVAC system in response to space demand for all private offices and other enclosed spaces (e.g., conference rooms, classrooms).
- Change all lighting fixtures to LED.

- Install daylight-responsive controls as described in Section 6.1. The sustainability team can allow an exception for this requirement if the installation of daylighting is not practical for a specific smaller renovation project.
- Design exterior lighting to meet Dark Sky criteria, and shall be LED.
- Install occupancy sensors for all spaces except spaces where the lighting is expected to be always ON, such as shared corridors. For this instance, scheduling capabilities are required, and during unoccupied periods, the light should be programmed to be dimmed.
- Lighting dimmable capability for each space.
- Install Energy Star appliances, office equipment, electronics, and commercial food service equipment for 100% of equipment and appliances, unless they are not available on the application market.
- Comply with the requirements of SB-10 Division 3 Chapter 2 for the performance of all exterior building envelope components impacted by the renovation project.
- Comply with the requirements of SB-10 Division 3 Chapter 2 for the performance of all HVAC components impacted by the renovation project.
- When enhanced or improved controls are installed, energy conservation sequences including but not limited to the time of day scheduling, night setback/day setup, and occupancy setpoints shall be included.
- All the newly installed humidification systems or domestic water heaters shall be electric.

7 BAS SEQUENCE OF OPERATIONS

Automation control strategies can be very effective to:

- Reduce energy and water consumption and GHG emissions.
- Improve occupant comfort.
- Resolve operational issues.
- Reduce wear and tear on equipment.
- Reduce operators’ manual tasks.

For these reasons, using an advanced control strategy is required in all designs. The control strategies shall be adequately modeled in the energy simulation, and the savings associated distinctively expressed. The *ASHRAE Guideline 36, High-Performance Sequences of Operation for HVAC Systems, latest version,* is the minimum level of sophistication expected for the sequence of operations. At a minimum, the following sequence shall be used when they apply to the system:

- Trim and Response strategies;
- Chilled water temperature reset;
- Heating water temperature reset;
- Chiller cooling tower temperature reset;
- Supply air temperature reset;
- Static pressure reset on ventilation systems;
- Differential pressure reset on pumping systems;
- Decoupling of dehumidification and cooling algorithms for ventilation systems;
- Demand control ventilation strategies. CO2 setpoint by default should be 800 ppm, or less, recommendation by the WELL standard should be followed;
- General exhaust ventilation should be modulated to maintain a building pressure setpoint (typically slightly negative in winter and slightly positive in the summer), therefore building pressure sensors (at least 3 in new construction,1 minimum in existing building) shall be installed and commissioned with the help of the balancing agent;
- Building systems shall be integrated with the occupancy sensors to shut down in unoccupied periods. Otherwise, the building system should be controlled with an occupancy schedule;
- Air-side economizer mode shall be optimized;
- Using the dewpoint to control the building humidity is preferred against using the relative humidity.
- Cascade control loop is encouraged to improve system stability (i.e. the supply air relative humidity setpoint is reset in cascade to maintain the return air relative humidity.
- Local exhaust systems should be scheduled to match the ventilation system schedule.

The tuning of each PID loop shall be documented to demonstrate stable operations in all ranges of operations and verified between each season change. In most applications, the rate of change shall be slow to avoid erratic operations. The PID tuning shall be completed until deemed satisfactory by the commissioning agent or the client representative.

The Standard 135.1-latest version -- Method of Test for Conformance to BACnet (ANSI Approved) is also a good reference to follow to meet the requirements of this section of the guideline.

8 AIR LEAKAGE

High-performance building envelopes and air barriers are essential to eliminating uncontrolled air infiltration and exfiltration and the associated heat losses and gains. Meeting air leakage targets is influenced strongly by the quality of the design details provided, strict installation procedures on-site, and stringent site verification of the performance and installation.

All new buildings and whole building renovations must undergo air leakage testing following the *U.S. Army Corps of Engineers Air Leakage Test Protocol for Building Envelopes, latest version, or ASTM-3158-18 Standard Test Method for Measuring the Air Leakage Rate of a Large or Multizone Building, latest version*. During the construction, one test must be completed and documented before closing the walls with services and dry-wall to help identify the air leakage deficiencies. The second test shall be conducted before occupancy.

The project team should aim to obtain an air leakage value equal to 0.6 ACH@50Pa as prescribed by the Passive House standard. Until 2030, flexibility is provided if the design cannot meet the Passive House air leakage performance metrics, but it should not exceed 1.2ACH@50Pa. After 2030, all new construction shall strictly comply with the 0.6 ACH@50Pa rate.

The project consultants and the Ryerson sustainability team must be allowed to review the air leakage assumptions used by the energy modeling team before they are used in the model. If a reduced infiltration rate is suggested, the project must commit to achieving the airtightness target and be confirmed by achieving mandatory air tightness testing. The final air leakage testing results and report must be submitted to the Ryerson project team and used in the final occupancy energy model.

A third party should complete the whole building air leakage testing and present the results, and report(s) to the Ryerson project team. The results from any air leakage testing shall be made available to the energy modeling team as soon as possible to refine the air leakage factor inputs to complete the final model report.

A Building Enclosure Commissioning Agent may be engaged during the design development phase to provide input into building enclosure systems related to energy, water, indoor environmental quality, durability, and airtightness throughout the project.

9 WATER

The following water use specifications apply to all new buildings, major renovations, additions, and other projects, as appropriate following the higher levels of performance in LEED™ version 4.1:

- **Indoor Water Use:** Meet, at minimum, the requirements of LEED BD+C: v4.1 - Indoor Water Use Reduction credit (required) and LEED BD+C: v4.1 - Indoor Water Use Reduction credits (optional)

- **Outdoor Water Use**: Meet, at minimum, the requirements of LEED-NCv4.1 Outdoor Water Use Reduction credit (required) or provide no irrigation from potable sources and LEED BD+C: v4.1 - Indoor Water Use Reduction credits (optional)

In addition to the LEED requirements, some additional requirements include:

- All new water fixtures should be touchless with reduced flow.

- All new toilet cabinets shall be low-water type, with both touchless and manual flush options.

- Designers are encouraged to use ventilation system cooling/dehumidification condensate for irrigation, the cooling tower make-up or else.

10 LEED™ REQUIREMENTS

Ryerson is committed to achieving a minimum of LEED Silver certification for all new construction and major building renovations. For some projects, the project scope of work may specify a higher level of certification The project consultant shall prepare a LEED scorecard illustrating that if the project were to pursue certification, it would collect sufficient points to meet LEED Silver (50-59 points). Project consultants should assess the economic potential of obtaining LEED gold and platinum certifications as well.

LEED™ ID+C may be considered for renovation projects (minor and major) and shadow LEED Silver minimum. However, Ryerson University recognizes LEED may not always be applicable for minor renovations and assess on a project-by-project basis and announce it within the issue of any design or project implementation tender documents.

11 ENERGY AND WATER PERFORMANCE REPORTS

The Project Consultant Team must submit an Energy Performance Report for each project. The information included in the report should be based on what is relevant to the project. For example, if the project does not affect the building envelope or lighting systems, these elements do not need to be included in the report. If in doubt, the Project Consultant Team can confirm the applicability of each item and what to include in the report with Ryerson's Energy Manager. In general, the report should include the following information (as applicable):

- Reports are to be submitted at each design milestone;
- Simulation files, detailed simulation results output, and walkaround calculations;
- Summary of key energy model inputs, including any specific operational measures assumed or used that will impact the performance indices;
- Performance results for four key metrics (TEUI, GHGI, TEDI-Heating, and TEDI-Cooling) and other performance metrics.
- Ventilation loads presented as $ekWh/m^2$ to assess the impact on the TEDI budget;
- Building energy use broken down by end-uses and fuel type;
- Calculated whole-enclosure effective thermal performance (i.e., the area-weighted U-value) following the methodology outlined in TGS v3;
- Graph of annual hourly thermal demand with a table to report the peak heating and cooling demand (kW) and annual heating and cooling demand (kWh);
- Narrative and analysis describing the thermal autonomy of the building (i.e., the fraction of time that a building can maintain an acceptable indoor condition, despite the failure of active building systems);
- Description of air leakage control measures, including the modeled air leakage rate and all plans, measures, and protocols being implemented to improve enclosure airtightness;
- Design details and calculations for any on-site renewable energy generation;
- Explanation of any externally calculated energy performance; modeling software limitations;

- Any additional information that is provided as part of the project's submission to the Authority Having Jurisdiction;

If LEED is not being pursued, illustrate how many points would be eligible for LEED Silver in the Energy and Atmosphere category.

The project consultant team must submit a completed LEED v4 indoor water use reduction calculator and an outdoor water use reduction calculator to demonstrate the design fixture flush and flow rates will meet the required indoor and outdoor water use reductions.

The Energy Performance Report should clearly identify any items that do not achieve the Ryerson Sustainable Building Guidelines, with a brief explanation as to the reason(s) or rationale. The Energy Performance Report will be reviewed by the Ryerson Energy Manager, and comments and directions will be provided to the design team. It is expected that these comments and directions will be addressed by the consultant team and reflected in future iterations of the design.

12 ENERGY MODELING

In new buildings, energy modeling should be performed using 8,760-hour (hourly over a year) whole-building computer simulation that meets or is equivalent to *ASHRAE 140 Standard Method for the Evaluation of Building Energy Analysis Computer Programs, latest version*.

Air-side energy recovery and heat recovery chillers shall be modeled according to design even when the modeling software has limited capacity to predict energy performance. If workarounds are required, the project consultant shall describe the procedures used and the effect on energy calculations.

It is known that e-Quest (DOE calculation based) and other energy simulation software cannot model all types of new HVAC systems without using multiple workarounds. In such cases, using more flexible simulation software such as IESVE, Trane Trace 700, Carrier HAP or Energy Plus (and software using Energy Plus) or other approved software is encouraged, if they can adequately simulate the systems chosen in the design. After each design iteration, detailed energy model input and output files shall be provided to Ryerson, including the energy simulation file.

For existing buildings, using energy simulation software to calculate energy consumption is not always required. Regression analysis, standard weather files, hourly calculation, or other methods can be used to evaluate energy consumption. For most metres, Ryerson typically can provide monthly historical building energy and water data for periods of several years and 15-minute interval sub-metering data (available starting in 2020 or 2021 typically). When available and applicable, the most granular energy data must be used to validate or calibrate the energy models.

The Ryerson sustainability team shall review and accept the modeling process, software, input parameters, output format, energy metrics, and results. The modeler will provide the model input and output files at each submission for Ryerson's review, acceptance, and use. Modeling software used for renewable energy systems shall be presented to the Ryerson for approval before being used.

The modeling results to meet this guideline are intended for both regulatory purposes (when required) and to determine whether a project design complies with the targets and budgets established by the Charter. By standardizing the target setting and modeling process, Ryerson will compare performance between buildings and post-occupancy.

Suppose the actual energy performance after 12 months of continuous operation exceeds, or deceeds the predicted performance by more than 15%. In that case, the design team/modelers will be asked to comment and assist Ryerson in determining the possible reasons for the variation.

The model should reflect Ryerson's values for schedules, setpoints, occupancy density, and space loads, so there is consistency between modeling phases. The project consultant team shall ensure the modeling variables required by Ryerson are completely understood and utilized. If there is a reason to believe values for the modeled building will not align with the schedules defined in the Project Charter, the modeler shall bring this to the attention of Ryerson and propose more appropriate values. The project consultant team shall not assume conventional occupancy schedules are always appropriate for Ryerson and shall present them to Ryerson for verification before these are used in the models. The project consultant team must take responsibility for their ultimate approval.

Unless otherwise stated by Ryerson's Energy Manager, the energy model shall use the following hourly weather data, in the form of Canadian Weather Year for Energy Calculation (CWEC latest version) datasets from the Government of Canada, available for free download here.

The use of RETScreen is encouraged to evaluate renewable energy production potential, although other resources may also be used.

The enclosure components must be modeled using effective thermal performance following the guidance in the TGS version 3 Energy Modelling Guidelines "Calculating Envelope Heat Loss".

In creating the energy model, thermal bridging shall be calculated when the overall thermal U-value of wall assemblies is defined. The use of 2D heat transfer software such as THERM to evaluate thermal bridging is encouraged. Otherwise, a conservative approach is to be used when assessing the envelope and window performance. A conservative approach means that the worst-case scenario for heat transfer and air leakage should be considered unless modeled in THERM. If a specific assembly overall U-value is well documented or detailed calculation can be provided to demonstrate performance, it can also be used if approved by the energy manager. This is to ensure that energy consumption and sizing of equipment is not underestimated.

Most Ryerson-owned buildings use district heating and centralized chilled water. The required performance of the building is not differentiated for whether or not district heat is used. An overall efficiency of 0.34 kWElectricity/kWCooling (1.2 kW/Ton) should be used to calculate the centralized chilled water on-site electricity consumption unless otherwise calculated. For example, Ryerson's Ted Rogers School of Management (TRSM) building uses district cooling. For this building an overall efficiency of 0.2 kWElectricity/kWCooling (0.56 kW/Ton) should be used.

Energy simulation software is not always required to calculate energy savings in renovation projects. For example, regression analysis or an hourly weather calculator may be adequate in many project calculations. When existing buildings are simulated, energy data from the invoicing and sub-metering system should be used to calibrate the model. Even simpler calculation methods can calculate savings from lighting retrofits or other simpler equipment replacement projects.

As described above, a conservative approach shall be used to model building envelopes to avoid under-estimating heat loss due to thermal bridges or infiltration.

Performance characteristics shall be reviewed and accepted by the Ryerson's sustainability team before the design proceeds to subsequent design phases.

Modeling the proposed building designs will assist with life cycle costing, estimate greenhouse gas (GHG) emissions, and facilitate future measurement and verification.

For the calculation of the life cycle cost, to reflect current and future legislation on carbon tax, 170$/TonCO2 should be used, which is the expected cost of carbon in 2030.

The cost of energy and carbon intensity of each energy source shall be confirmed with the Ryerson Energy Manager to calculate energy cost savings.

Projects shall use the emissions factors for the Ontario electricity grid listed in the most recent National Inventory Report (NIR) published by the Government of Canada. Table 12.1 below lists other common emissions factors that shall be used. They may be subject to review and adjustment by Ryerson. When renewable energy systems are installed, an annual marginal emissions factor shall also be used to calculate annual emissions avoided and presented along with the emissions results avoided using the factors in the table below.

Table 12.1 - Emissions Factors by Energy Source

Energy Source	**Source TonCO2/invoice energy source**
Natural Gas	0.00189 TonCO2/m3
District Steam	0.0000754 TonCO2/lbs
District Cooling (TRSM)	0.00002230 Ton CO2/Ton HR

During a project's design phases, air infiltration shall be modeled at the target whole building air leakage rate for the project, as recorded in the Project Charter. The Occupancy Submission energy model must be modeled using the actual tested air leakage rate. Note that air leakage test results are often normalized by the total envelope surface area, which is different from the above-ground wall and window areas due to floors and roofs. When converting from an air leakage test to modeled infiltration or vice-versa, the difference in surface areas must be accounted for. Projects proposing reduced infiltration rates will be required to prepare and present documentation to support the use of and means to verify the lower rate. Ryerson is interested in assessing the value of reduced infiltration rates and encourages the modeling team to prepare standard and reduced infiltration models to illustrate the effect on the energy and GHG budgets.

Reduced air leakage rates may be modeled, provided the project team commits a minimum air leakage rate, confirmed by mandatory air tightness testing. Credit will be allowed down to the values required by Passive House, which approximately convert to 0.0001 m3 /s/m2 at 5 Pa. Air leakage testing values determined at 75 Pa can be approximately converted by multiplying the value by 0.112. For example, a tested value of 0.0015 m3 /s/m2 at 75 Pa would equate to 0.000168 m3 /s/m2 at 5 Pa, to be used in the model, instead of the 0.00025 m3 /s/m2 at 5 Pa indicated.

13 EMBODIED CARBON

Embodied carbon makes up a significant portion of a building's greenhouse gas (GHG) emissions and should play an important role in the selection of construction materials.

Life cycle assessment (LCA) should be used as a framework to quantify the potential impacts across the life cycle of the building. An LCA should be completed of the building's structure and enclosure, at minimum. Models of up to 3 structure/enclosure options for Global Warming Potential (GWP) may be requested. The LCA should follow ISO 14044 Standards.

New construction projects and major additions must meet the requirements outlined in LEED BD&C v4.1: Option 1. Building and Material Reuse or Option 2. Whole-Building Life-Cycle Assessment - Path 2, 3 or 4.

14 LIFE CYCLE COSTING

In new constructions and major renovations, Life Cycle Costing (LCC) should be performed to quantify the impacts on GHG, energy costs, maintenance costs, etc. For new construction, the period should typically be 30 years. For major renovations the period should typically be 20 years. The energy modeling results may be used to conduct Life Cycle Cost Analysis (LCCA) and parametric analyses. It may be justified to calculate the LCCA for a longer period, especially in new construction projects, in conjunction with the durability analysis. For each project the consultant should comment on the choice of the period of time used in the calculation.

Models of up to three design options for the energy, GHG, and water systems, including but not limited to HVAC systems, heat recovery systems, dedicated outside air systems, outside air reduction schemes, fenestration, envelope systems, and on-site energy sources may be requested as defined by Ryerson University sustainability team, as specified in the RFP on a case by case basis.

Because of the uncertainty of energy prices and the lifetime of typical components, life cycle cost analysis for energy purposes will typically be done over 20 to 30 years. Ryerson's sustainability team shall define the discount rates and the acceptable Rate of Interest/Return on Investment (ROI) and lifetimes to be used should be reviewed by the Sustainability team prior to calculating the LCC.

15 DURABILITY

When creating life cycle and durability assessments, it is recommended that the CSA S478.19 Durability in Buildings standard (latest version) be used. There are obvious sustainability benefits to ensuring new buildings are built to last as long as possible. With new construction, the team should determine and document the desired useful life of the building and identify the strategies that can be taken to reach that lifespan. This includes, but is not limited to, planning the replacement of building materials and planning for the replacement of HVAC equipment during the life of the building.

16 COMMISSIONING

The projects should meet all the options and path requirements of LEED BD&C v4.1 Fundamental Commissioning and Verification and EA Credit LEED BD&C v4.1 - LEED v4.1 Enhanced Commissioning when applicable, including the commissioning of the envelope.

The following commissioning process (CxP) activities should be completed for mechanical, electrical, plumbing, and renewable energy systems and assemblies following ASHRAE

Guideline (most recent version) and ASHRAE Guideline 1.1 – (or most recent version) for HVAC&R systems, as they relate to energy, water, indoor environmental quality, and durability. The Commissioning Authority (CA) must, at minimum, complete the following:

- Review consultants and contractor submittals, and provide recommendations.
- Verify inclusion of systems manual requirements in construction documents.
- Verify inclusion of operator and occupant training requirements in construction documents.
- Verify systems manual updates and delivery.
- Verify operator and occupant training delivery and effectiveness.
- Verify seasonal testing for at least a summer to winter and winter to summer cycle.
- Review building operations ten months after substantial completion.
- Develop an ongoing commissioning plan.

Develop monitoring-based procedures and identify points to be measured and evaluated to assess the performance of energy- and water-consuming systems.

Include the procedures and measurement points in the commissioning plan.

Verify and document that all PID loops are tuned at occupancy and after the seasonal cycles.

17 BALANCING

Adequate balancing is crucial to obtaining the highest level of building performance.

Systems shall be balanced to AABC or NEBB standards; the certifications of the balancing company and workers shall be provided at the beginning of the project, and throughout if changes of staff occur. The balancing company shall submit its balancing plan before the execution, and the plan will be reviewed by the design team, Ryerson and the Commissioning Authority. The balancing team should be available to participate in commissioning meetings actively.

Reported measurements shall be subject to verification by the Commissioning Authority. Instrumentation and workforce required should be provided to verify results of up to 30% of all reported measurements. The number and location of the verified measurements are at the discretion of the CA. A measured deviation of more than 10% between the verification reading and the design value shall be considered unacceptable.

Design flow rates on VFD systems shall be accomplished with the VFD operating at 55-58 Hz, unless otherwise approved by the Energy Manager.

18 METERING

For new construction, Ryerson's campus-wide metering system shall be used in all new facilities for the whole building consumption sub-metering. The project team shall engage the metering system operator and Energy Manager to review the metering design before the execution of the project to make sure the metering devices are of adequate quality. Water city discharge as required by the city by-law shall also be metered in the campus-wide metering system.

The requirements of both LEED-NCv4 Advanced Energy Metering and LEEDNCv4 Enhanced Commissioning, Option 1, Path 2, Enhanced and Monitoring-Based Commissioning should be met. These credits provide infrastructure for ensuring comprehensive information about the performance of major building systems are available. Record of validation for all metering is required. When appropriate to project scope, separately sub-meter significant use types within the building including. At a minimum (if possible), separately meter:

- Main heating and cooling system.
- Large heating and cooling equipment separately.
- Large kitchens.
- Cooling tower water make-up and discharge.
- Data centers or large data closets.
- Other large energy end-users.

19 INCENTIVES

During the budgeting phase of each project or prior to procuring a feasibility study, the Energy Manager will provide recommendations to the project team on any incentive that may be worth investigating and pursuing during the project. The incentive will typically come from a government entity, such as Natural Resources Canada (NRCAN), Independent Electricity System Operator (IESO) Save on Energy Program and Enbridge.

Based on the Energy Manager's recommendations, the project team must include an allowance for the consulting team to calculate and make recommendations on the available incentives based on the potential energy savings of the project. If the incentive potential is substantial enough (see note below) and the team decides to pursue it, the project team shall ask the consulting team to provide a separate cost to manage, calculate and process the incentive of the project. The consulting team shall do every effort to maximize the potential of the incentive and do all the work required for Ryerson to receive the funds, which may include submitting a calculation, documents, simulation, etc. The project team shall follow up on the incentive progress with the consultant during the execution of the project. . The responsibility of managing the incentive is by the project consultant in coordination with the Energy Manager. The Energy Manager will act as the owner representative but will not perform the calculation and management of the incentive request. The Energy Manager will help share the documentation required to participate in the incentive programs, such as providing energy data. The incentive will be used to offset the cost of the actual project and will be transferred to the cost center once Ryerson receives the funds.

The project consultant should maximize the incentive amounts by using the adequate calculation or M&V plan that can demonstrate all savings from the project.

If the incentive is less than $5,000, once the consulting fees are deducted from the total anticipated amount, the incentive should not be pursued. The Energy Manager also reserves the right to request an incentive not to be pursued if the financial benefits are not substantial enough or if the incentive opportunity arises after project design has progressed resulting in significant redesign to secure the incentive.

20 SUSTAINABLE MATERIALS AND RESOURCE MANAGEMENT

20.1 Construction and Demolition Waste Minimization and Diversion

A well thought out waste management program is an important part of a project's development. It should focus first on eliminating and minimising the amount of waste generated, then reusing materials wherever possible and finally recycling what remains.

For construction, demolition and major renovations (and minor renovations projects, as applicable - depending on type and scale):

- The Project Team must establish waste reduction, reuse and diversion goals. The team should ensure that the project schedule can accommodate the time needed to properly salvage, reuse and recycle materials.

- The contractor must submit a C&D Waste Management Plan that aligns with the established goals. Details on what the plan should include can be found in section 3 of the Whole Building Design Guide (WBDG) - Construction Waste Management resource page.

- WBDG's resource page also outlines other waste reduction practices that should be considered by contractors, subcontractors and suppliers. For example:
    - Reduce extraneous packaging and reuse items such as buckets and containers. Seekout containers and packing materials that are returnable or have buy-back programs.
    - Unused or used but serviceable materials and products can be sold to architectural salvage or used materials retail outlets.
    - Donate leftover materials and products to organizations such Habitat for Humanity (HfH) or ReStore.
- Recycle materials that cannot be eliminated, reduced or reused, as follows:
    - If site separation is possible, teams must divert a minimum of 90% of the construction debris from landfill as calculated under [LEED BD+C: New Construction | v4.1 - Construction and Demolition Waste Management]
    - If site separation is not possible, teams must divert a minimum of 75% of the construction debris from landfill as calculated under[LEED BD+C: New Construction | v4.1 - Construction and Demolition Waste Management]
    - A source separation program must be developed and implemented in accordance with O. Reg. 103/94. Source separation must include (at minimum) 4 streams:
        - Brick and Portland cement concrete
        - Steel and other metals (where possible)
        - Wood (not including painted or treated wood or laminated wood)
        - Drywall (unpainted)
- For additional recyclable material types, see [LEED v4.1 Construction and Demolition Waste Management Calculator]. These additional streams should be considered on a project by project basis, depending on the type and size of the project and materials used. It is expected that for large demolition projects and major renovations, source separation programs will include more than 4 streams.

For the disposal of furniture, products and equipment, every effort should be made to reuse and rehome items that are in good condition. Items that are in good condition but do not have an immediate home should be sent to Ryerson's RUsed Furniture. Otherwise, items that cannot be used but are in good condition should be donated to organizations such as Restore or Goodwill. The Sustainability Office can assist with the process, if necessary. Electronic equipment that is no longer useful must be recycled through the proper Ryerson channels.

20.2 Waste Collection and Storage Infrastructure

When designing new spaces, the collection and storage of landfill waste, recyclables and organics is an important consideration. New construction, additions and major renovation (where applicable) should meet the requirements of LEED BD+C: New Construction | v4.1 - Storage and Collection of Recyclables.

Infrastructure must be provided for dual stream recycling and organics collection, storage and haulage. For interior waste receptacles, Ryerson's waste receptacle standards must be followed. Connect with Ryerson's Sustainability Office to obtain a copy of the waste receptacle standards.

20.3 Sustainable Materials Selection

The choice of building materials are important components of sustainable building design and construction. All new construction, additions and major renovations must meet requirements of the following LEED credits and track using the LEED Building Product Disclosure and Optimization Calculator:

- LEED BD+C: New Construction | v4.1- Environmental Product Declarations: Option 1 - EPD
- LEED BD+C: New Construction | v4.1 - Sourcing of Raw Materials
- LEED BD+C: New Construction | v4.1 - Material Ingredients: Option 1 or 2

New furniture, products and equipment that have an end of life recycling program, are made with recycled materials, and or are made of renewable and sustainably sourced materials that have a third party certification, in that order, are preferred options.

For minor renovations, particularly where finishes, fixtures or furniture are included, the above requirements should be met, if feasible, depending on project type and scale. Exceptions may apply, for instance, if matching existing finishes.

21 BIRD COLLISION DETERRENCE

For all new buildings, major renovations, additions and other projects (as appropriate - e.g. replacing windows in an existing building) meet the requirements of Toronto Green Standard Tier 2-EC 4.4 Bird-Friendly Glazing.

22 SUSTAINABLE TRANSPORTATION

The University recognizes that land use and transportation decisions are linked and can profoundly affect the way campuses function. Sustainable transportation options should be incorporated into sustainable building design to reduce dependence on car travel, the amount of impervious pavement on the site, and the financial, environmental and community costs associated with excessive parking supply. All plans should be designed in coordination and consultation with University Business Services (UBS). For all new buildings and major renovations and additions, where appropriate, strategies that should be implemented to encourage sustainable transportation include:

- Meet the requirements of LEED BD+C: New Construction | v4.1 - Bicycle Storage and Shower Rooms
- All new buildings with parking facilities should install Level 2 and or Level 3 electric vehicle charging stations or must be charging station-ready in terms of the electrical infrastructure. The number of charging stations will be dependent on the number of individuals expected to occupy the building.
- Entranceways and public spaces should be linked to the campus pedestrian network.
- Pathways and pedestrian corridors should be linked to new and existing transit stops, bike parking areas and pedestrian drop-off areas.

23 REFERENCES

Standard 100-2015 -- Energy Efficiency in Existing Buildings (ANSI Approved/IES Co-sponsored)
https://www.ashrae.org/technical-resources/bookstore/standard-100

2018 International Green Construction Code® Powered by Standard 189.1-2017. Online, Available:
https://www.ashrae.org/technical-resources/bookstore/standard-189-1

Guideline 36-2018 -- High-Performance Sequences of Operation for HVAC Systems. Online, Available:
https://www.techstreet.com/ashrae/standards/guideline-36-2018-high-performance-sequences-of-operation-for-hvac-systems?product_id=2016214

LEED™ for New Construction and Major Renovations, Version 4. Online, Available:
https://www.usgbc.org/credits/new-construction/v4

LEED™ for New Construction and Major Renovations Indoor Water Use Calculator. Online, Available: https://www.usgbc.org/resources/indoor-water-use-calculator

LEED™ for New Construction and Major Renovations Outdoor Water Use Calculator. Online, Available:
https://www.usgbc.org/resources/outdoor-water-use-reduction-calculator

Toronto Green Standard, Version 3 (2019). Online, Available: https://www.toronto.ca/city government/planning-development/official-plan-guidelines/toronto-green-standard/toronto-green standard-version-3/

Energy Efficiency Report Submission & Modelling Guidelines for the Toronto Green Standard (TGS) Version 3 (February 2019). Online, Available:
https://www.toronto.ca/wpcontent/uploads/2019/02/93d5-CityPlanning_V3-Energy-Modelling-Guidelines-Feb-2019.pdf

Tri-Campus Energy Modelling & Utility Performance Standard (July 2020). Online, Available:
https://www.fs.utoronto.ca/wp-content/uploads/2021/05/DesignStandards_Part2_May3_2021.pdf

US Army Corps of Engineers Air Leakage Test Protocol for Building Envelopes. Online, Available: http://www.wbdg.org/FFC/ARMYCOE/usace_airleakagetestprotocol.pdf

APPENDIX

Energy Performance Targets For Special-Use Buildings

For the energy-intensive building archetypes below, the TEDI is still used to encourage the installation of high-performance building envelopes; however, the performance metrics used are specific. The appropriate calculation method must be used to evaluate the performance of these systems. Whole building simulation software may not be relevant to calculate the energy consumption from these archetypes. The sustainability team can work with the project team sustainability manager or the energy manager can approve to determine the appropriate different performance targets for these building types on a case-by-case basis if it is demonstrated that meeting the performance targets outlined herein is not possible technologically or is cost-prohibitive.

Data Centre

The metrics used to evaluate performance for new data centers are the Power usage effectiveness (PUE), CUE, ERF, and TEDI.

Heat recovery is mandatory in new data centres if the building has heating loads. In these cases the ERF shall be calculated and documented. The CUE shall be calculated and documented, while no specific target goals are provided at this time.

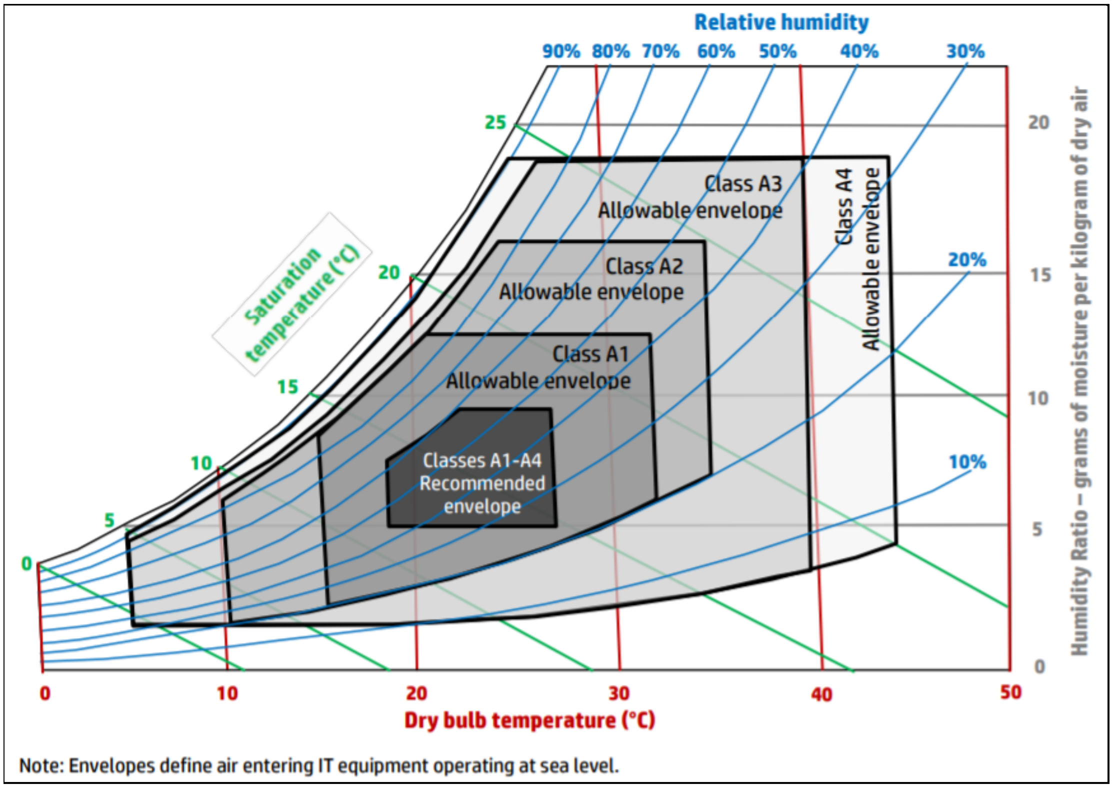
Building Archetypes	PUE (seasonal)	TEDI – Heating (ekWh/m^2/yr)	TEDI – Cooling (ekWh/m^2/yr)
Data Centre	1.22 if heat recovery is not used. 1.5 if heat recovery is used.	30	18

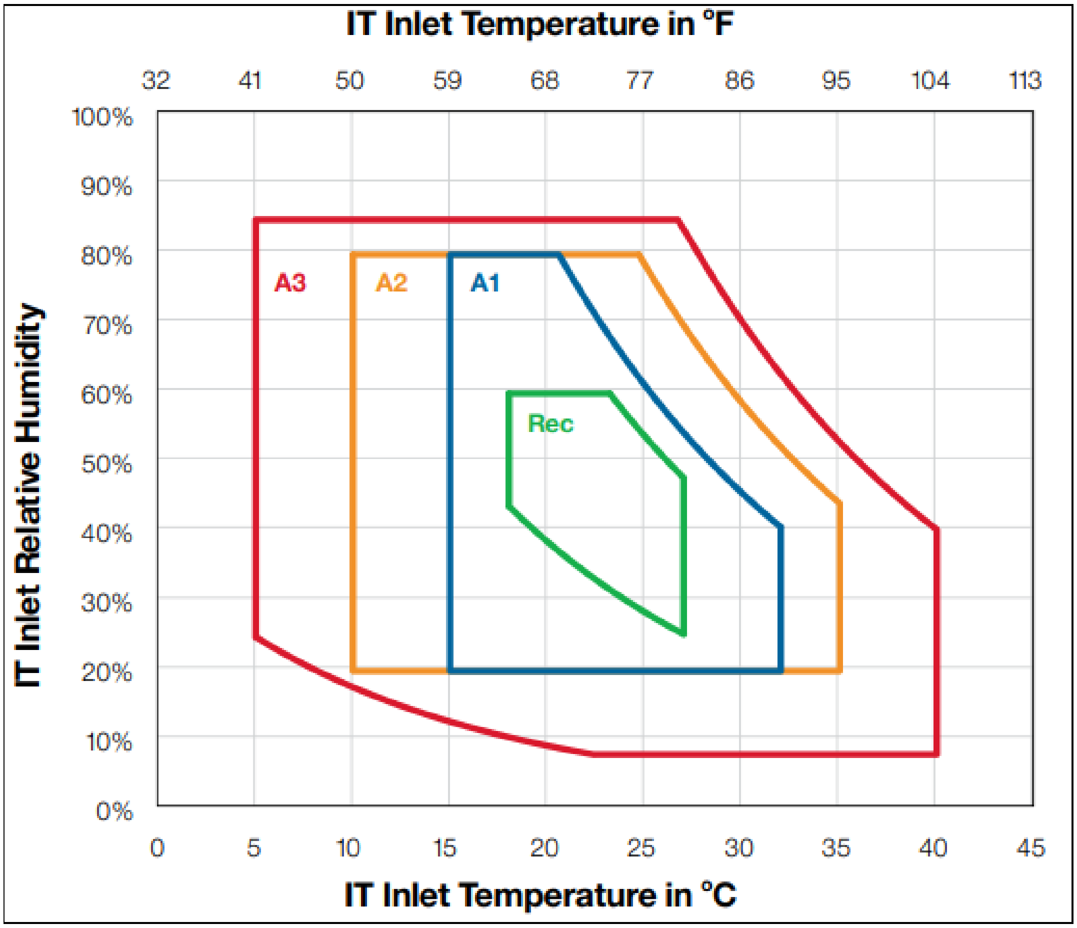
ASHRAE guidelines on *Best Practices for Datacom Facility Energy Efficiency*, (most up-to-date edition) latest Edition, should be used to inform the design of the data centre, series of datacom books authored by ASHRAE Technical Committee 9.9, Mission Critical Facilities, Technology Spaces, and Electronic Equipment, and ASHRAE Standard 90.4-latest version, Energy Standard for Data Centers.

Federal Energy Management Program, Best Practices Guide for Energy-Efficient Data Center Design is also an excellent reference that should be followed.

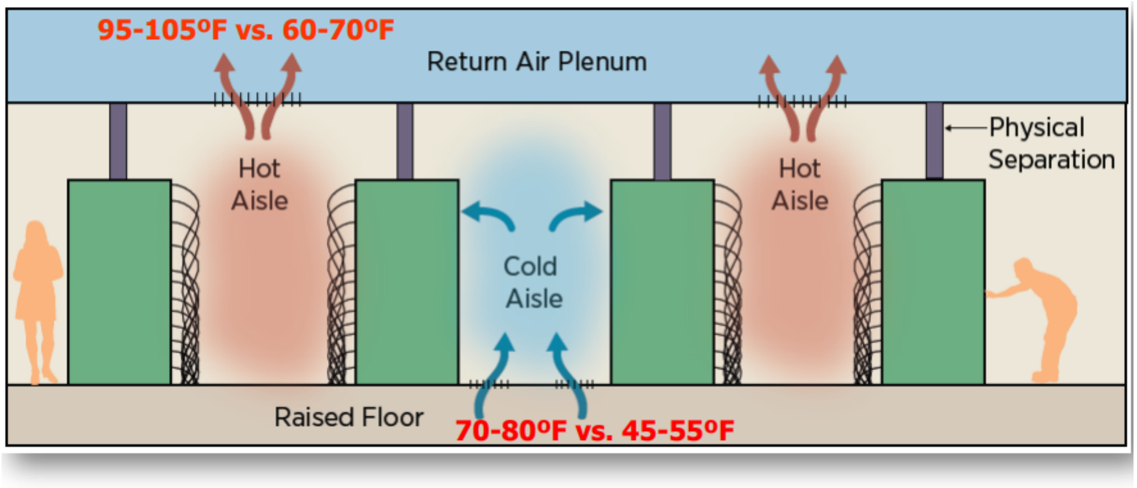
Prefered energy conservation measures desired in new and existing data centres include:

- The range of temperature and humidity used should follow the ASHRAE guidelines as shown below. For each project the design team should provide a justification on which class range was used for the cooling of the computer equipment. See diagrams below.





- CRAC units are not permitted in new construction. CRAH units or other higher-performance solutions are encouraged.
- ASHRAE recommended temperature and humidity ranges are desired, to avoid the "cold" data centre syndrome.
- Air-side or water-side economizers are encouraged, but heat recovery should be prioritized.
- Equipment with modulation capabilities and the use of redundant equipment to improve part-load cooling and ventilation efficiency is recommended.
- Physically contain the cold aisle and hot aisle. Air bypass from the cold and hot aisle should be avoided by using means of containment. Below is an example of containment. Other configurations respecting the intentions of the physical separation design are also acceptable.



Source: http://www1.eere.energy.gov/femp/pdfs/eedatacenterbestpractices.pdf

- Cooling equipment should operate in unison to avoid simultaneous heating and cooling. All equipment shall be monitored on the BAS via BACNet or hardwired.
- The use of adiabatic humidification is encouraged if humidification is required.
- No electric or other means of reheat are allowed.
- ECM fans shall be used for air distribution or otherwise direct-drive fans with VFDs.
- The use of energy-efficient control strategies is desired. The sequence presented in the BAS section of this guideline should be used when possible. The chilled water reset strategy is important.
- Use of heat recovery chillers to reclaim heat and use it in other parts of the building is mandatory if heating loads exist adjacent to the data center.
- Use of pressure differential sensor between cold aisle and hot aisle to modulate ventilation fan speed is encouraged. Other means of modulating the ventilation and cooling capacity based on IT equipment actual load should be pursued.
- When air conditioning is not in use, either because of maintenance or failure, the failed systems should be isolated automatically to avoid air and water bypass.
- Positive pressurization of the data center with dry air to avoid infiltration is recommended when the exterior air dew point is high. This strategy helps eliminate the latent cooling load, allowing a higher supply air temperature of the CRAH unit and avoiding reheat requirements.