GOVERNMENT OF YUKON

2022 Design Requirements and Technical Standards

Yukon

The Government of Yukon is extremely appreciative of everyone who participated in the creation of the Design Requirements and Technical Standards Manual.

This manual has been in development since 2017 and its completion wouldn't have been possible without the dedication of everyone involved. The Government of Yukon would like to thank the Yukon government staff who worked on the manual. We would also like to thank the consultants that provided valuable insight to this project. This project was also made possible thanks to collaboration from the construction industry. Your early responses, feedback, and interest was vital in creating this manual.

Thank you to everyone involved.

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2022 Design Requirements and Technical Standard Revisions Summary

The change summary table that follows describes the revisions and editorial modifications that apply to the Design Requirements and Technical Standard document.

- Editorial Updates are provided for information purposes only.
- Editorial Changes are modifications that improve clarity.

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NOTE: These guidelines and standards are for general information purposes only, and are not a substitute for and should not be relied upon for meeting specific project/contract requirements and applicable laws. Additional or different standards or requirements may apply for specific projects/contracts. Where project-specific standards and requirements exist, further information and verification should be sought from the Government of Yukon or its authorized representative. The Government of Yukon makes no guarantee, warranty or representation in any way (express or implied) with respect to the accuracy, suitability, reliability, usability, or completeness of these guidelines and standards for a specific project/contract. These guidelines and standards may be amended from time to time by the Government of Yukon.

Introduction

1. Introduction

The **Government of Yukon Design Requirements and Technical Standards Manual** provides standards, strategies, and technical requirements for the planning, design and construction of new buildings, additions, renovations, major system upgrades, and maintenance projects for the Government of Yukon. These requirements focus specifically on long-term operational and energy efficiency, occupant health and comfort, environmental impact, system reliability, durability, and consideration of the best value for the Yukon government. The objective of the design requirements and technical standards manual is to set a baseline, over and above the requirements of code minimums, to ensure that all projects incorporate the following features.

1. Designed to be cost-effective, optimize value, spatially efficient, and easy to maintain.
2. Address conditions specific to Yukon, including: local climate, the impacts of climate change, cold climate building design, the impacts of energy use, local construction and maintenance capacity, and limitations on material availability.
3. Incorporate environmental design and construction practices appropriate to Yukon that balance environmental responsibility and the well-being of occupants with the economics of northern construction and life cycle costs.
4. Constructed to be durable and energy efficient, meeting the Yukon government's minimum life expectancy of 60 years for the building structure and consider the service life of all building components from the perspective of life cycle costs.
5. Optimizing project results related to budget, timelines, and stakeholder satisfaction through an integrated design approach that will allow the Yukon government to receive a consistent level of efficiency, quality, and affordability on all capital and maintenance projects.

2. Application and Development of the Manual

The guidelines and standards included in this manual come from an analysis of the typical buildings in Yukon communities, which are typically small-scale and low-rise structures. They are developed from the first edition of the Design Standards for Government Facilities (2000), with additional input from Property Management Division and other stakeholders. As such, the technical content of the manual may not be directly applicable to highly specialized or large buildings. However, it is intended to provide guidelines for all buildings.

The manual is intended to apply to all new construction, additions, renovations, and fit-ups. For existing buildings that are being added to or modified, the requirements and standards of this manual are intended to apply only to the components and systems that are being modified or replaced, and unless specifically identified by the project terms of reference, does not mean upgrading the building to these standards.

3. Organization of the Manual

The Government of Yukon Design Requirements and Technical Standards Manual is organized into nine chapters.

1. **General Project Requirements**: Provides general project planning and design requirements that apply to all disciplines.
2. **Energy and Environmental Design Requirements**: Provides the minimum energy performance requirements, design processes, and guidelines to meet the Yukon government's sustainable goals and policies.
3. **Architectural Design Requirements**
4. **Structural Design Requirements**

5. **Mechanical Design Requirements**
6. **Electrical Design Requirements**
7. **Civil and Site Design Requirements**
8. **Construction General Requirements**: Provides the minimum requirements that must be incorporated into the Division 01 – General Requirements National Master Specifications for all projects.
9. **Appendices**: Includes forms and additional design requirements.

4. Alternatives and Revisions to the Manual

The requirements and standards included in the manual are intended as a reference and baseline from which designs and specifications are developed within the constraints of the construction budget. The purpose is to establish a minimum level of efficiency, quality, and affordability for all Yukon government building projects.

However, the Government of Yukon recognizes that specific projects may require an approach or have requirements that are not adequately addressed by the manual or involve new products or approaches to construction. In these instances, the government will review proposals for alternatives to the standards. Consultant teams should submit all requests for alternatives in writing to the Project Manager for review in consultation with Facilities Management Branch (FM) and Technical Support Unit (TSU). All proposed alternatives require sufficient explanation and supporting material and are required to provide better value and performance than the requirements stated within the manual.

The Yukon government is also open to comments related to the guidelines and standards themselves. These comments and proposals for alternatives will lead to further revisions and additions that will keep the document current. A form has been included in Chapter 10 for submitting comments.

5. Glossary of Terms

Authority having Jurisdiction or **AHJ**: Refers to the organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, and installation, or a procedure.

Category 1, or **Category 2**, or **Category 3**: Refer to the project classification for the application of specific requirements within this manual. Refer to Chapter 1 – Section 1.2.

Client: Refers to the Yukon government department responsible for the management and delivery of the project.

Commissioning: Means the process comprising of the integrated application of a set of engineering techniques and procedures to check, inspect and test every operational component of the project, from individual functions up to complex amalgamations.

Consultant: Refers to the person or entity engaged by the Yukon government to provide architectural or engineering design services, and also includes Design-Builders and/or Contractors contracted using a Design-Build contract.

Design Rationale: Refers to documentation of the reasons behind decisions made when designing a building or system. The design rationale should include the reasons behind the design decision, the justification for it, the other alternatives considered, the tradeoffs evaluated, and the argumentation that led to the decision.

Facilities Management Branch (FM): Is the branch of the Property Management Division that is responsible for the operations and maintenance of most Government of Yukon facilities.

Gross Floor Area: The sum of all building floor areas measured to the outside face of exterior walls for all stories or areas having floor surfaces. Building gross area includes component gross area, general circulation, mechanical and electrical space and exterior walls.

Parti: The primary organizing decision behind a building design, which can be illustrated in the form of a basic diagram or statement.

Property Management Division (PMD): Is a division of Highways and Public Works, and is the primary agent involved in the planning, construction, operation and maintenance of facilities for the Yukon government.

Stakeholders: Project stakeholders may include internal government stakeholders, including: end users, program delivery branches, and building operators. External stakeholders may also be included in some projects.

Sustainable Infrastructure Branch (SIB): Is the branch within the Capital Planning Office, Department of Highways and Public Works. The branch provides guidance on greenhouse gas reduction, renewable energy, energy conservation, climate risk, and other initiatives in Our Clean Future.

Technical Support Unit (TSU): The group within PMD that provides support on all capital development projects, including reviews at various stages of design.

6. Abbreviations

ABS – Acrylonitrile Butadiene Styrene
ACM – Aluminum Composite Metal
ADA – Americans with Disabilities Act
AFUE – Annual Fuel Utilization Efficiency
AHC – Architectural Hardware Consultant
ANSI – American National Standards Institute
ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME – American Society of Mechanical Engineers
ASPE – American Society of Plumbing Engineers
ASTM – American Society for Testing and Materials
AV – Air/Vapour
AWG – American Wire Gauge
AWMAC – Architectural Woodwork Manufacturer's Association of Canada
BAS – Building Automation System
BMS – Building Management System
BNQ – Bureau de normalization du Québec
CAC – Ceiling Attenuation Class
CADD – Computer-Aided Design and Drafting
CCA – Canadian Construction Association
CCME – Canadian Council of Ministers of the Environment
CDP – Central Distribution Panel
CEC – Canadian Electrical Code
CFM – Cubic Feet Per Minute
CLT – Cross-Laminated Timber
CMHC – Canada Mortgage and Housing Corporation
CO_2 – Carbon Dioxide
CPTED – Crime Prevention through Environmental Design
CPU – Central Processing Unit

CRCA – Canadian Roofing Contractors' Association
CRI – Carpet and Rug Institute or Colour Rendering Index
CSA – Canadian Standards Association
Cx – Commissioning
CxA – Commissioning Authority
DCW – Domestic Cold Water
DDC – Direct Digital Controls
DHI – Door and Hardware Institute
DHW – Domestic Hot Water
DLT – Dowel-Laminated Timber
ECM – Energy Conservation Measure
EIFS – Exterior Insulation Finish System
EMT – Electric Metallic Tubing
EPA – Environmental Protection Agency
EPDM – Ethylene Propylene Diene Monomer
ERS – EnerGuide Rating System
ESA – Environmental Site Assessment
EV – Electric Vehicle
FA – Fire Alarm
FACP – Fire Alarm Control Panel
FCSI – Foodservice Consultants Society International
FEMA – Federal Emergency Management Agency
FFE – Furniture, Fittings and Equipment
FM – Facilities Management
FRP – Fiberglass Reinforced Plastic
GFRC – Glass Fibre Reinforced Concrete
GHG – Greenhouse Gas
GUDI – Groundwater under the Direct Influence of Surface Water
GWB – Gypsum Wallboard
HOA – Hand/Off/Auto
HP – Horsepower
HVAC – Heating, Ventilating and Air-Conditioning
IAQ – Interior Air Quality
IDP – Integrated Design Process
IESNA – Illuminating Engineering Society of North America
IEEE – Institute of Electrical and Electronics Engineers
ICF – Insulated Concrete Formwork
IGU – Insulated Glazing Unit
IP – Internet Protocol
ISO – International Organization for Standardization or Polyisocyanurate Insulation
IT – Information Technology
KW – Kilowatt
KWH – Kilowatt hours
KV – Kilovolt

KVA – Kilovolt Ampere
LAN – Local Area Network
LCCA – Life Cycle Costing Analysis
LED – Light Emitting Diode
LPF – Liters Per Flush
LPM – Liters Per Minute
LTTR – Long Term Thermal Resistance
LULA – Limited-Use Limited Application
LVL – Laminated Veneer Lumber
M – Metre(s)
MAP – Maximum Performance Rating
MCP – Motor Circuit Protector
MDF – Medium Density Fiberboard
MM – Millimetre(s)
MPI – Master Painters Institute
MSDS – Material Safety Data Sheet
MWH – Megawatt Hours
NADCA – National Air Duct Cleaners Association
NAFS – North American Fenestration Standard
NBC or NBCC – National Building Code of Canada
NC – Noise Criteria
NECB – National Energy Code for Buildings
NEMA – National Electrical Standards Association
NFC or NFCC – National Fire Code of Canada
NFPA – National Fire Protection Association
NMD – Non-Metallic Dry
NRC – Noise Reduction Coefficient
NRC – National Research Council
NRCA – National Roofing Contractors Association
NSF – National Sanitation Foundation
O&M – Operations and Maintenance
PIA – Privacy Impact Assessment
PDF – Portable Document Format
PEX – Cross-Linked Polyethylene
PG – Performance Grade
PIR – Passive Infrared Sensor
PMD – Property Management Division
POE – Post Occupancy Evaluation
PoE – Power over Ethernet
PQS – Professional Quantity Surveyor
PV – Photovoltaic
PWF – Pressure-Treated Wood Foundation
PVC – Polyvinyl Chloride

R – Thermal Resistance in Imperial System Value
RSI – Thermal Resistance in Metric System Value
SBS – Styrene Butadiene Styrene
SIB – Sustainable Infrastructure Branch
SIP – Structural Insulated Panels
SMACNA – Sheet Metal and Air Conditioning Contractors National Association
SPD – Surge Protection Devices
STC – Sound Transmission Coefficient
TAB – Testing, Adjusting and Balancing
TEDI – Thermal Energy Demand Intensity
TEUI – Total Energy Use Intensity
TIA – Telecommunications Industry Association
TOR – Terms of Reference
TSU – Technical Services Unit
TTMAC – Terrazzo and Tile Manufacturers Association of Canada
UL – Underwriters' Laboratories
ULC – Underwriters' Laboratories of Canada
ULEF – Ultra-Low Emitting Formaldehyde
ULS – Ultimate Limit State
UPS – Uninterruptible Power Supply
VOC – Volatile Organic Compounds
V – Volt
VE – Value Engineering
VFD – Variable Frequency Drive
VPR – Voltage Protection Ratings
VRF – Variable Refrigerant Flow
VWC – Vinyl Wall Coverings
W – Watt
WHMIS – Workplace Hazardous Materials Information System
XLPE – Cross-Linked Polyethylene
YESAB – Yukon Environmental and Socio-Economic Assessment Board
YG – Government of Yukon

1 General Project Requirements

1. General

1.1. OBJECTIVES

1.1.1. The Government of Yukon Design Requirements and Technical Standards Manual provides design, technical, and performance requirements that influence the form, organization, and specifications of buildings. These standards incorporate proven methods and materials, while supporting improved building performance and advances in technology.

1.1.2. The primary objective of the Government of Yukon is to deliver buildings that satisfy the functional needs of the client department and users, while yielding the best value.

1.1.3. Buildings are to be designed specifically for the Yukon climate and physical site parameters, for capital budgets consistent with lowest life cycle costs, and to provide ongoing economic service and high-quality accommodation for program delivery.

1.1.4. Considerations must be given to energy efficiency, occupant health and comfort, environmental impact, reliability, durability, and local materials and workforce.

1.1.5. As a minimum, all projects must comply with the requirements of federal, provincial, city and municipal governments, and all authorities having jurisdiction. Refer to Section 13 – Codes and Regulations.

1.2. PROJECT CLASSIFICATION

This manual applies to the design and construction of: new buildings, building additions, building renovations, major building modernizations, tenant fit-ups, and building system upgrades. Due to the wide variety of project types, the manual's sections specify what category of project they apply to. Where no project type is listed, the section applies to all building projects.

Project types are grouped as follows.

- **Category 1** – Large Buildings.
  - Assembly, care, treatment, or detention major occupancies with a gross floor area more than 300 m^2.
  - Residential, business and personal services, mercantile, or industrial major occupancies with a gross floor area more than 600 m^2.
  - Includes additions to existing buildings larger than the area specified above.
- **Category 2** – Small Buildings.
  - Buildings of occupancies and gross floor areas smaller than those included in Category 1.
  - Agricultural buildings of any area that are not for public use.
  - Relocatable industrial camp buildings of any gross floor area.
  - Includes additions smaller than the areas specified in Category 1.
- **Category 3** – Capital Maintenance Projects and Renovations.
  - Renovations and system upgrades with estimated construction costs > $1 Million.

1.3. LOCAL RESOURCES

1.3.1. LOCAL EXPERTISE

Consider the use of local expertise to guide planning and buildingdesign as they can help inform decisions related to preferred orientations, anticipated use patterns, and examples of proven materials or methods.

The Highways and Public Works – Property Management Division – Facilities Management (FM) Branch is responsible for the operations and maintenance of all Government of Yukon facilities. FM and TSU will provide technical support and review on all projects to ensure that the design addresses the government's long-term maintenance needs.

1.3.2. EQUIPMENT, SUPPLIES AND PRODUCTS

The use of locally available equipment, supplies and products benefits the community and can significantly reduce construction costs. Bringing specialized equipment into most communities is expensive. Building design and construction methods should be tailored for available equipment, and where possible, locally available supplies and products.

1.3.3. YUKON PRODUCTS AND BUSINESSES

The Yukon government's construction contracts are typically eligible for rebates on construction materials or goods manufactured in Yukon and local labour through the Business Incentive Program. Where possible, Yukon-manufactured materials should be specified.

1.4. LOGISTICS AND SCHEDULE

1.4.1. All projects should consider Yukon construction logistics and the short construction season.

1.4.2. Transportation costs can often account for a large portion of a total project budget, particularly in more remote communities. In locations that are only accessible by air, size and weight restrictions will need to also be considered to ensure materials will fit into standard commercial aircraft servicing that community.

1.4.3. A short construction season dictates that structures be erected in a timely manner so that buildings can be clad to weather before the onset of adverse weather conditions. Winter construction can add significant costs to a project budget and should be avoided unless absolutely necessary. Projects should be phased in such a way that they take advantage of the summer construction season.

1.5. APPROPRIATE TECHNOLOGY

To meet the goals and requirements of the Government of Yukon and produce buildings that perform well and keep occupants comfortable, several basic principles are worth noting. These principles can help guide the design of buildings to ensure they are appropriate for Yukon's northern conditions.

1.5.1. SIMPLICITY

The preferred approach to sustainable, cost-effective design solutions supports a "lean" building concept. It is recommended that all Government of Yukon building design solutions strive to:

- minimize enclosed volumes and building perimeter relative to the programmed floor areas;
- provide efficient program delivery by careful planning of related activity areas using uncomplicated floor plan layouts that minimize wasted or wasteful space;
- provide adequate and efficiently planned service spaces and building circulation; and
- plan for future expansion as simply as possible without major disruption to building occupants.

In terms of detailed development, the building design solution is to:

- be kept simple to improve the speed and efficiency of construction and to offer greater opportunity for employment of local tradespersons and labourers;

- provide lines, forms, massing and design elements which are generally rectilinear, appropriate to the intended function, and with a defensible design rationale;
- incorporate materials and methods that will permit quality construction and meet the requirements of the Yukon government under adverse environmental conditions and a limited construction season;
- limit the variety of materials and minimize the number of specialized trades required on a project; and
- ensure procedures needed to operate and maintain the building can be put into practice using readily available labour, maintenance products, and equipment. Where new or innovative procedures are proposed, coordination with FM and TSU will be necessary to regarding acceptable operational, maintenance and training parameters are identified, understood and incorporated in the design.

1.5.2. RELIABILITY

Essential building systems like heating, ventilation, life safety and fire protection must be reliable in the harsh winter conditions of Yukon. Standby or redundant equipment and installations that facilitate quick repairs are an essential characteristic of building systems and must be considered in the design process.

Building components, including interior and exterior finishes, must also be rugged enough to withstand the conditions to which they are exposed without the need for frequent or specialized repairs.

Any materials, equipment or systems that require servicing by specialized trades people, or parts that are difficult to obtain in Yukon are not recommended. In the event that they are determined necessary, the Consultant should work closely with the Property Management Division – Technical Support Unit (TSU) to minimize their maintenance requirements.

1.5.3. STANDARDIZATION

Where possible, this guideline standardizes system elements based on proven performance, ensuring that the final product is cost effective, energy efficient, readily operable and maintainable by facilities maintenance staff. Given the regional variation within Yukon, buildings must respond to differences in:

- community settings;
- climatic zones;
- seismic zones and site classifications;
- transportation systems; and
- site conditions.

Recommendations reflecting local or regional differences and preferences are noted in this document where applicable.

1.5.4. DURABILITY

Prolonged service life of materials and components due to increased durability equates to fewer cycles of replacement, which can be beneficial from an environmental and economic standpoint. This durability is a function of the component, its environment, installation, and maintenance and helps buildings achieve the lowest total service life cost. As stated in CSA S478, Guideline on Durability in Buildings:

> *"Buildings and their components shall be conceived, designed, constructed, operated and maintained in such a way that, under foreseeable environmental conditions, they maintain their required performance during their design service life. The predicted service life*

of buildings and building components and assemblies should meet or exceed their design service life. In the event of renovation, the design service life of the revised structure shall be reconsidered".

Durability requirements apply to building operation and maintenance, in addition to initial construction. Components shall be designed, constructed, and maintained to provide the required performance over the design service life of the building. Components and assemblies that will not last the design service life should be considered in such a way that they can be easily replaced.

It is recommended that Consultants prepare a durability plan in accordance with the requirements of CSA S478.

1.5.5. ALLOWING FOR MAINTENANCE

Size all spaces containing equipment that requires maintenance to ensure that sufficient clearance is provided for building operators. Clearances should consider all other equipment being installed as well as adequate access to the equipment. Refer to Section 9 – Coordination.

Allow space in all service rooms for the storage of all requested mechanical and electrical spare parts. Parts should be safely stored so that they are accessible and organized. Architectural maintenance materials should either be located in the service room, or another dedicated storage room only accessible to maintenance staff. Refer to Sub-Section 11.4 – Maintenance Materials and Spare Parts.

Consultants must demonstrate during schematic design how safe access is being provided for building maintenance staff, and how the design allows for the replacement of equipment which may require replacement during the building's life expectancy.

1.6. DESIGN EXCELLENCE

The Government of Yukon is committed to creating buildings that meet requirements for long-term operational and energy efficiency, occupant health and comfort, reduced environmental impact, system reliability, overall durability, expected best value, and effective use of public funds. It also recognizes that great design inspires and reflects pride in Yukon, its people, and its communities.

1.6.1. PROJECT PLANNING

Projects should incorporate sufficient initial planning and coordination time in their schedules in order to yield a smoother and more efficient completion process, and better overall value.

1.6.2. SITE SELECTION

The selection of the most appropriate site for a project can have a significant impact on the overall success of the project, and has an impact on building form, building orientation, sustainability, functionality and aesthetics due to physical, geotechnical, transportation, climatic, or other factors. Site options should be carefully considered and assessed prior to selection.

1.6.3. CASE STUDIES

Consultants should provide external case studies of other successful and relevant projects. In turn, these examples will help educate the client on the possible direction a project can take.

1.6.4. DESIGN OPTIONS

All projects should investigate a minimum of three distinct and valid design options. Options must consider archetype, form or organizational parti and meet the project requirements. These options should be evaluated through an integrated design process. Refer to Section 4 – Integrated Design Process.

1.6.5. GOVERNMENT OF YUKON IDENTITY

All projects should incorporate the Government of Yukon visual identity. In addition, the public façade should also be developed to clearly convey the building's function and main building entrance.

1.6.6. PROJECT DESIGN REVIEWS

All projects will be reviewed by the project sponsor department, end user representatives, and all PMD branches, including the Technical Services Unit (TSU), for design and technical feedback at several stages of the project in order to provide feedback before changes become difficult and/or costly to implement. Reviews will take place at the following key stages.

a. Conceptual Design.
b. Schematic Design.
c. 30% Construction Documents.
d. 65% Construction Documents.
e. 95% Construction Documents.

All requested changes, comments and questions will be tracked to ensure they are understood and resolved. Consultants are required to respond to all issues raised during reviews.

On projects where Property Management provides design reviews, the Consultant Team will be required to meet with TSU following Schematic Design and 65% Construction Documents.

Refer to YG deliverable requirements for submission requirements at each stage.

1.6.7. EXTERNAL STAKEHOLDERS

Planning, design and execution of projects should be coordinated between different levels of government and affected major stakeholders to ensure buy-in and a successful project. The requirement for stakeholder consultation will be project specific, and the scope of consultation will be defined by the Project Manager in the project terms of reference.

1.6.8. BUILDING PERFORMANCE AND EVALUATION

The Government of Yukon intends to use post-occupancy evaluations and building systems monitoring to assess building performance and identify improvements to be incorporated into future versions of this manual. This will allow for the evaluation of the original design parameters, assumptions, and processes, against final design outcomes by using measured values obtained from commissioning and monitoring.

Refer to Section 12 – Post-Occupancy Evaluations and Chapter 2, Section 2.5 – Energy Metering.

1.6.9. INNOVATION

Design teams should consider new ideas that may add value to the design, construction, efficiency or quality of a project. These ideas should be balanced with the Yukon government's overall goal of constructing buildings that have longer lifespans, are energy efficient, reduce greenhouse gases, increase building quality and maintainability, and offer quantifiable savings in capital and life cycle costs.

2. Site Selection and Assessments

Client departments are normally tasked with selecting sites, although some business case and conceptual design phases may include the selections of sites through a process of site evaluation. In these instances, a weighted site assessment should be completed to determine which site is the best option for a proposed facility.

2.1. LOCATION CONSIDERATIONS

The Consultant will prepare a site assessment to identify opportunities and constraints. The following items should be considered, although it is acknowledged that not all of them will be applicable for all projects.

2.1.1. ACCESS TO SERVICES AND INFRASTRUCTURE

New building sites should be located where existing infrastructure, community services, and public transportation are available to reduce project costs, and to increase access to services for building occupants.

2.1.2. ACOUSTIC CONSIDERATIONS

In areas of significant sources of noise, such as near highways and airports, or where noise may impact occupants, an acoustic consultant should be retained by the Consultant to recommend mitigation measures.

2.1.3. ENVIRONMENTAL DESIGN CONDITIONS

Evaluate the environmental conditions to determine the best location for the building and other outdoor areas on the site. This may include sun path, views, prevailing winds, site erosion, site drainage, flood plains, topography, and trees and vegetation.

2.1.4. HERITAGE DESIGNATIONS

Review the requirements of the heritage authority for all buildings with heritage designation. Ideally this review should be completed during the early project planning stages.

Historic site designations in Yukon are available through the Yukon Register of Historic Places. Territorial sites are designated by the Historic Sites Unit, while municipal sites are designated by either the City of Whitehorse or Dawson City.

Work completed on these buildings must follow the Standards and Guidelines for the Conservation of Historic Places in Canada. All proposed work must be reviewed by the heritage authority.

2.2. SURVEYING

2.2.1. Legal and topographic surveys of the property will be provided by the Government of Yukon.

2.2.2. In addition to the information required on a legal survey, the following features shall be included.

2.2.2.(1) Substantial physical improvements within 6 metres of the property (if possible), including: buildings and structures; roads, sidewalks and paved areas; steps, landings, and curbs; retaining walls, fences, and gates; trees; underground services on and off site; utility poles and overhead lines; catch basins, manholes, and fire hydrants; water boundaries; all individual trees with a minimum caliper of 150 millimetre and the perimeter outlines of thickly wooded areas.

2.2.2.(2) Topographic data based upon a maximum 5 metre grid, and at major features, edges and centerlines of roads and sidewalks, perimeter of buildings, and main floor levels.

2.2.2.(3) Contours should be mapped at 0.5 metre intervals.

2.3. ENVIRONMENTAL ASSESSMENTS

2.3.1. Hazardous conditions affecting the site will be reviewed by the Government of Yukon to assess risks and identify mitigating measures that may be required to manage them. Risks may include contaminated soils and hazardous materials.

2.3.2. The Government of Yukon will undertake a Phase 1 Environmental Site Assessment (ESA) for all projects to identify risks that could impact project viability.

2.3.3. If the Phase 1 ESA recommends further testing or sampling, then a Phase 2 ESA will be performed.

2.3.4. Consider and incorporate — as necessary — all recommendations from the ESA.

2.4. HAZARDOUS MATERIAL ASSESSMENTS

2.4.1. Undertaking repairs, maintenance, renovations or demolition in existing buildings may disturb hazardous materials.

2.4.2. The Government of Yukon will provide a hazardous material assessment. This will identify and inventory locations of hazardous material within the building.

2.4.3. If insufficient samples have been taken, or areas have been missed in the assessment, the Yukon government will consider undertaking additional sampling.

2.4.4. All known hazards must be identified to the contractor carrying out the construction, renovation or demolition as the party responsible for health and safety during the course of the work.

2.4.5. Consultant to prepare National Master Construction Specifications for all hazardous materials that are being removed or disturbed as part of the project. Specifications must address the level of mitigation and other measures recommended by the hazardous material assessment, and must require the Contractor to develop a work plan, and to obtain required reviews and approvals by the authority having jurisdiction.

2.5. BUILDING CONDITION ASSESSMENTS

2.5.1. Prior to undertaking major renovations or additions, existing buildings will need to be reviewed based upon the guidelines and standards included in this manual and relevant codes to determine upgrade requirements. Reviews must include physical site review.

2.5.2. Assessments must be based upon a review of the physical building condition, all available drawings, specifications, records of occupant complaints, maintenance reports and/or interviews with building operators to identify known operational or maintenance issues.

2.5.3. All assessments are to be prepared using the Uniformat II Template provided by the Government of Yukon. This assessment should be appended to a report which summarizes the condition of the various components and identifies concerns and recommendations.

2.5.4. Seismic assessments of buildings are to include an assessment of all building components, including structural and non-structural components (operational and functional) as observed using a non-destructive investigation method. These assessments are to follow the requirements of the currently applicable version of CSA S832, and the recommendations of FEMA E-74. Refer to Chapter 4 – Structural Design Requirements.

2.5.5. When a building is being located adjacent to neighboring buildings not owned by the Yukon government, it is recommended that an independent building condition survey or report be undertaken to determine their condition prior to construction. This reduces the risk to the Owner by allowing for any precautions to be taken during construction and to determine fault in the event of damage to an adjacent structure.

2.6. GEOTECHNICAL ASSESSMENTS

2.6.1. A geotechnical investigation will be provided by the Government of Yukon for all projects involving a new building foundation or foundation remediation to determine the structural capacity, recommended foundation structural alternatives, seismic site

classification, recommended fill materials for effective surface water management, and to identify conditions that might impact building durability such as surface and ground water presence.

2.6.2. For sites with permafrost, the geotechnical investigation must include an assessment of the current ground temperature and expected climate warming during the lifespan of the structure. It should also address the availability of construction materials and schedule, vulnerability of the structure to the potential for differential settlement and surface drainage that may affect the thermal regime of the foundation. Investigations shall follow the recommendations of CAN/BNQ 2501-500.

2.6.3. For new buildings, a full assessment with data from boreholes located on the site will be provided to allow for proper assessment of the site to determine whether there are any conditions that could impact project viability.

2.6.4. For sites requiring wells and septic fields, the geotechnical investigation shall include the required testing.

2.6.5. On smaller projects such as additions, a desktop study using borehole log data from adjacent properties may be determined to be sufficient by the structural engineer.

2.6.6. Existing reports that were prepared for other projects or adjacent properties should not be used without first being reviewed by a geotechnical engineer for suitability.

2.6.7. Geotechnical engineering services will be engaged by the Government of Yukon prior to or early in the design phase to assess the site, during design to review the foundation design, and during construction to provide field and laboratory testing services.

2.6.8. Refer to Chapter 4 – Structural Design Requirements and Chapter 7 – Civil and Site Design Requirements for additional geotechnical requirements.

2.7. MASTER PLANS

2.7.1. It is expected that in the future all parcels that contain more than one Government of Yukon facility will be subject to a master planning process.

2.7.2. Carefully review planning documents prior to commencing work on land parcels to ensure that the master planning requirements are followed.

2.8. ENERGY ASSESSMENTS

2.8.1. Buildings emitting over 30 tons of GHG emissions per year are required to have AHSRAE level 2 energy assessments completed.

3. Functional Program

All functional programs will conform to the Highways and Public Works “Master Space Plan: Space Standards and Allocation Guidelines”, and will either be provided by the Government of Yukon, or will be included in the Consultant’s scope of work. All project-specific functional programming will be developed through careful consideration of the Client service and program delivery requirements, use and occupancy, and physical space needs.

Additionally, options for renewable energy and heating systems should be identified, reviewed, and proposed to the Owner for all functional programs. Please contact Sustainable Infrastructure Branch for guidance on renewable energy systems.

4. Integrated Design Process

In order to achieve the energy performance, sustainability, best value, and other requirements included in this manual, an integrated design process (IDP) is required for all Category 1 projects and should be considered by Consultants for Category 2 projects in addition to design coordination. The Consultant will lead the IDP and will be responsible for developing the project-specific approach to implement it.

IDP is a collaborative whole-building design approach to building design that seeks a higher level of performance on specific energy, durability and environmental goals, while maintaining the project budget and schedule.

4.1. PRINCIPLES OF AN IDP

The principles below are an excerpt from the CMHC document "Integrated Design Process Guide" by Alex Zimmerman, P.Eng.

1. **Goal-driven**, with the primary goal being sustainability, but with explicit subsidiary goals, objectives and targets set as a means to get there.
2. **Facilitated** by someone whose primary role is not to produce the building design or parts of it, but to be accountable for the process of design.
3. **Structured** to deal with issues and decisions in the right order, to avoid locking in bad performance by making irreversible decisions with incomplete input or information.
4. **Inclusive** — everyone, from the owner to the operator, has something critical to contribute to the design and everyone must be heard.
5. **Collaborative** so that the architect is not simply the form-giver, but more the leader of a broader team collaboration with additional active roles earlier in the process.
6. **Holistic** or systemic thinking with the intent of producing something where the whole is greater than the sum of the parts, and which may even be more economic.
7. **Whole-building** budget setting — allows financial trade-offs, so money is spent where it is most beneficial when a holistic solution is found.
8. **Iterative** — to allow for new information to inform or refine previous decisions.
9. **Non-traditional** expertise — on the team, as needed, or brought in at non-traditional times to contribute to the process.

4.2. SUMMARY PHASES OF AN IDP

It is recommended that Consultants follow the "Roadmap for the Integrated Design Process" prepared for the BC Green Building Roundtable, and the following requirements.

4.2.1. PRE-DESIGN

Prior to commencing design, the Consultant Team and the Government of Yukon will set the goals, objectives and overall direction for the project. At this stage the team will also examine site constraints, challenges and opportunities.

Include a visioning workshop between key team members (client, stakeholders, architect, mechanical, structural, electrical, and building operator).

4.2.2. CONCEPTUAL AND SCHEMATIC DESIGN PHASES

Prior to the completion of both the conceptual and schematic design phases, the Consultant Team is to investigate options — include "outside the box" approaches — that will optimize the site design, location, and operational needs. Options should be evaluated in a holistic manner, and through the use of Energy modeling, LCCA and VE.

Include a minimum of two workshops between key team members (client, stakeholders, architect, mechanical, structural, electrical, and building operator), and additional members, including: energy modeler, quantity surveyor/value engineer, and the commissioning agent.

A separate value engineering workshop is also required following the schematic design phase. Refer to Section 5.3 – Value Engineering.

4.2.3. DESIGN DEVELOPMENT

This phase should be used to select and finalize the design choices. A final analysis should be completed using input from the Consultant Team and the Yukon government. This phase should include focused meeting(s) to address specific issues and may involve additional specialist team members from the schematic design phase. Additional value

engineering workshops may need to be scheduled independently of design workshops if additional project cost control is required.

4.2.4. CONSTRUCTION DOCUMENTS

During the construction documents phase, concerns identified during earlier phases need to be addressed in detail. The building operator and commissioning agent should confirm that integration between systems is being maintained.

4.2.5. CONSTRUCTION COMMISSIONING

During this phase, the IDP team expands to include members of the construction team (project manager, contractor, commissioning authority, etc.) and design plans are realized. A green building information session shall be held for contractor and trades near the start of construction. Key outputs from this phase include as-built drawings, commissioning reports, and operation and maintenance manuals.

4.2.6. BUILDING OPERATION (START UP)

During this transition phase, the project team must ensure knowledge of the building is properly transferred to the owner, occupants, and operations staff. This includes the development and distribution of training and education materials, and building documentation (measurement and verification data, commissioning report).

4.2.7. POST OCCUPANCY

The IDP doesn't end when construction is complete. The post construction phase should enable feedback loops which facilitate continuous optimization of the building's performance. Lessons learned during this phase can trigger operational improvements and can be used to inform future projects. Key outputs of this phase shall include updated building documentation, and plans for continuous monitoring, re-commissioning, and environmental management.

5. Project Costing and Long-Term Value

5.1. QUANTITY SURVEYING

5.1.1. All capital projects require cost estimates prepared by the Consultant to accompany each design submission. At minimum, these estimates include:

- Class "D" (Indicative Estimate): Used for budget planning, functional programming, and business case development.
- Class "C" Estimate: Prepared at schematic design.
- Class "B" (Substantive) Estimate: Prepared at design development and 65% construction documents.
- Class "A" (Pre-Tender) Estimate: Prepared at 95% construction drawings.

5.1.2. Category 1 projects require that all estimates must be prepared by a Professional Quantity Surveyor (PQS) except for Class "D" estimates. Category 2 projects do not require a PQS.

5.1.3. For Category 1 projects, the Yukon government will retain an independent Consultant to perform quantity surveying.

5.1.4. For minimum submission requirements, refer to YG deliverable requirements.

5.2. LIFE CYCLE COSTING

5.2.1. Life Cycle Costing Analysis (LCCA) is a method of assessing the total cost of facility ownership. This form of analysis is especially useful when project or component alternatives are being considered that perform the same technical requirements but differ in initial costs and operating costs. As a decision-making tool, it helps to determine if incorporating a higher performing system is a cost-effective investment.

5.2.2. LCCA is to be conducted throughout the project to ensure that operations and maintenance cost projections are established and effective comparative analyses are conducted for targeted building elements and supported with energy modeling and environmental impact assessments.

5.2.3. LCCA will be prepared by the Consultant or the Consultant's PQS.

5.2.4. LCCA is required for all capital projects and is to be included at every design submission, and must follow the requirements listed below.

5.2.4.(1) A full building LCCA is to be completed at the end of the schematic design phase to determine the most cost-effective option. For comparative purposes a 40-year design service life is recommended. This LCCA should verify the cost estimates completed during the Business Case and Conceptual Design phases.

5.2.4.(2) During all phases of design, alternative major components and systems or energy conservation measures (ECMs) are to be analyzed based upon their 20-year impact on energy costs, GHG, maintenance costs, replacement costs, etc. This may include alternative building envelope, HVAC, electrical, or other building systems.

5.2.4.(3) Wherever alternative designs are considered, the alternative with the lowest total service life cost is to be selected unless the Government of Yukon determines that overriding factors should prevail.

5.2.4.(4) All estimated energy use and greenhouse gas emissions (GHGs) are to be determined using energy modeling analysis. Refer to Chapter 2 – Energy and Environmental Design Requirements for energy modelling requirements.

5.2.4.(5) GHG emissions are to be factored into the LCCA using the current carbon tax rate per ton of CO2 emissions.

5.2.4.(6) The Project Manager will provide the Consultant access to the current average energy rates, which are to be used for the preparation of the LCCA.

5.2.4.(7) Include maintenance and repair costs using costs from RS Means for Facilities Maintenance and Repair or equivalent publication. These numbers should be reviewed by the Yukon government.

5.2.4.(8) Include escalation and discount rates determined at the time of preparation of the LCCA.

5.2.5. LCCA will be used in the value engineering process and as part of the Integrated Design Process.

5.3. VALUE ENGINEERING

5.3.1. Value engineering (VE) is a procedure used to obtain optimum value based upon the total cost of facility ownership. Value engineering should use LCCA data to deliver the project requirements at the lowest total cost and should be incorporated as early as possible to reduce impact on schedule or redesign cost.

5.3.2. VE services will be provided by an independent Consultant contracted by the Yukon government.

5.3.3. VE is to be included in all phases of the Integrated Design Process as outlined in Section 4 – Integrated Design Process.

5.3.4. For Category 1 projects a VE workshop will be required after schematic design and will involve the Consultant Team and the Yukon government, including all branches of PMD and the sponsor department. This workshop will review the proposed design options, the cost estimate, and the proposed implementation schedule and approach to implement the best value. This workshop will be a minimum of one day in length but may be longer on a project-specific basis.

6. Inclusive Design

This section defines the high-level goals and requirements related to incorporating inclusive design into Government of Yukon projects. Specific inclusivity provisions will also be addressed in the project-specific functional/spatial programming.

6.1. GENERAL

The Government of Yukon is committed to inclusive buildings. Design projects must create interior and exterior environments that are both universally accessible to persons of all ages and abilities and gender-inclusive. This is to allow all buildings to be easily and comfortably accessed and used by everyone.

The goal of inclusive design is to create buildings that are:

- **Inclusive:** Everyone can use them safely, easily and with dignity.
- **Responsive:** Considering what people say they need and want.
- **Flexible:** Allowing different people to use them in different ways.
- **Convenient:** Everyone can use them without too much effort or special separation.
- **Accommodating:** For all people, regardless of their age, gender, mobility, ethnicity or circumstances.
- **Welcoming:** With no disabling barriers that might exclude some people.
- **Realistic:** Offering more than one solution to help balance everyone's needs and recognizing one solution might not work for all.

6.2. ACCESSIBLE DESIGN

6.2.1. All buildings or parts thereof that are required to be barrier-free under the National Building Code shall be designed in accordance with the design standards of CSA B651, "Accessible Design for the Built Environment". Refer to the NBCC for the applicable CSA B651 provisions.

6.2.2. All floor areas of a building must be provided with a barrier-free path of travel and barrier-free access from the barrier-free entrance unless the storey only contains spaces where a barrier-free path of travel is not required by the NBCC, and where the storey is not served by a passenger elevator, escalator, inclined moving walk, or other platform-equipped passenger-elevating device.

6.2.3. Materials and designs for exterior barrier-free ramps and paths of travel must take into consideration snow and ice buildup, snow-drifting, and snow removal.

6.2.4. Provide accessible parking, and all required pavement markings and signs, as required by municipal regulations and the National Building Code.

6.3. GENDER-INCLUSIVE DESIGN

6.3.1. At a minimum, all buildings are to be provided with one gender-inclusive washroom.

6.3.2. In facilities requiring only two water closets, both should be designated as gender-inclusive.

6.3.3. A separate initiative has been developed regarding gender-inclusive washrooms, change rooms and signage standards. Future updates will coordinate design requirements between the two guidelines/standards. Please refer to the Gender-Inclusive Washroom and Change Room Design Standards.

7. Asset Security Planning

7.1. GENERAL

7.1.1. Security considerations should be determined in the Functional/Spatial Program development stage and fully incorporated during the Schematic and Design Development stages. This allows security measures to be incorporated into all building systems and subsystems early in the design process.

7.1.2. Security measures specified for a building should consider the costs in relation to capital and operating estimates, and any potential limitation on service program delivery or capacity. The combination of security measures and flexibility to determine suitable levels of security, in keeping with program requirements, can be considered the most cost-effective protection.

7.1.3. Security measures may include access control systems, surveillance systems and security alarms, and are to be based on a threat and risk assessment, in accordance with Crime Prevention Through Environmental Design (CPTED) principles (Refer to Sub-Section 7.2). Additional costs must be identified during each project phase.

7.1.4. Surveillance systems will require a privacy impact assessment (PIA), which will be prepared by the Yukon government. Consultants are to assist the Owner in providing the required information, which may include drawings and equipment specifications.

7.2. CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN

Building design, site planning, and landscape design should consider the principles of Crime Prevention through Environmental Design (CPTED) to ensure the safety of users and staff, visitors and the public by deterring criminal activity through design. Designers should consider the following three principles.

- **Natural Surveillance**: Designing to allow for people to easily observe the space around them, and to eliminate hiding places.
- **Territoriality**: Allowing for a clear designation between public, private and semi-private areas to make it easier for people to understand and participate in an area's intended use, to create a sense of ownership, and to discourage criminal activity.
- **Access Control**: Reduce criminal accessibility by limiting the number of entry points to the property and building and by implementing physical and electronic access control hardware.

These principles should be applied to all Yukon government projects through the use of the following design and performance requirements.

7.2.1. ACCESS CONTROL

7.2.1.(1) Discourage entry into non-public areas by restricting public access through the implementation of access control systems.

7.2.1.(2) Avoid providing pathways that allow for unobserved access.

7.2.1.(3) Clearly identify buildings with a street number to assist emergency services.

7.2.1.(4) Use locks, non-removable pin hinges, astragals, and other measures to discourage access.

7.2.1.(5) Refer to Sub-Section 7.3 – Electronic Safety and Security System Requirements.

7.2.2. COMMON SPACES

7.2.2.(1) Locate active interior occupancies adjacent main exterior spaces and main entries to provide natural surveillance.

7.2.2.(2) Design exterior garbage and recycling facilities to screen containers and minimize opportunities to hide.

7.2.2.(3) Exterior sidewalks should be wide enough and landscaped to avoid creating narrow corridors, which could be perceived as threatening.

7.2.3. ENTRANCES

7.2.3.(1) Clearly identify entrances to make them visible to users through design features and signage.

7.2.3.(2) Minimize the number of entry points.

7.2.3.(3) Clearly guide the public to and from entrances through the use of sidewalks, paving, fencing, lighting, signage and landscaping.

7.2.4. FENCING AND LANDSCAPING

7.2.4.(1) Where required, fencing, walls, or landscaping along the front of buildings should be kept low, support surveillance from the street and minimize hiding places.

7.2.4.(2) Avoid landscaping that obstructs views of the building entry from the street.

7.2.4.(3) Use low groundcover, shrubs, or high canopied trees at parking areas and sidewalks.

7.2.4.(4) Avoid placing large landscape features, accessory buildings, or utility structures next to buildings where they could provide a means of access.

7.2.4.(5) Use gates, fences, walls, landscaping and lighting to prevent or discourage unauthorized access to dark or unmonitored areas.

7.2.4.(6) Where appropriate and suited to specific project functional and program requirements use pavement textures, signage, landscape, screening, and fences to define and outline ownership of space.

7.2.5. **LIGHTING**

7.2.5.(1) Provide exterior lighting that enhances natural surveillance.

7.2.5.(2) Ensure adequate visibility in all outdoor areas to allow their use in the dark.

7.2.5.(3) In areas used by pedestrians, provide lighting to avoid possible entrapment areas, and focus lighting on safe routes.

7.2.5.(4) Consider landscaping in the development of the lighting design.

7.2.5.(5) Avoid general lighting of areas not intended for use in the dark, and provide motion activated lights in these areas.

7.2.5.(6) Lighting should be uniform to avoid creating contrast between over and under lit areas, which will enable hiding.

7.2.5.(7) All exterior lights should be controlled using photoelectric sensors in addition to any other lighting controls.

7.2.5.(8) Coordinate the placement of lighting and surveillance cameras.

7.2.6. **NATURAL SURVEILLANCE**

7.2.6.(1) Public and semi-private spaces should be located so that they maintain an unobstructed view from high use areas.

7.2.6.(2) Barriers adjacent exterior sidewalks should not obstruct views.

7.2.7. **SECURITY**

7.2.7.(1) Reduce unauthorized access by incorporating security hardware at entry points.

7.2.7.(2) Hardware types, functions, operating conditions and other requirements are to be determined during Conceptual and Schematic Design phases.

7.2.8. **BUILDING DESIGN**

7.2.8.(1) Orient main building entrances towards the main public street.

7.2.8.(2) Minimize the number of entry points.

7.2.8.(3) Staff entrances, if separate from the main entrance, should be visible from the street or other high-traffic and “generally occupied” areas.

7.2.8.(4) Avoid hidden recesses.

7.2.8.(5) Locate parking areas so they can be observed by nearby occupancies.

7.2.8.(6) Avoid large areas of parking.

7.2.8.(7) Open spaces must be clearly designated and located so they are easily observable.

7.2.8.(8) Avoid creating the potential to climb up buildings to upper levels, roofs, canopies, or ledges. Avoid fencing or other features up against walls,

downspouts, or other surface articulation without some means to deter people from using them.

7.3. ELECTRONIC SAFETY AND SECURITY SYSTEM REQUIREMENTS

7.3.1. GENERAL

7.3.1.(1) Confirm security requirements for all spaces during design.

7.3.2. SECURITY AND SURVEILLANCE SYSTEMS

7.3.2.(1) For the selection and design of security and surveillance systems, refer to Chapter 6, Sub-Section 8.2 – Electronic Surveillance.

7.3.3. ELECTRONIC/KEYPAD ACCESS CONTROL

7.3.3.(1) Provide electric or keypad access control device at all main and staff entrances and all service areas.

7.3.3.(2) If not stated in the functional program, confirm the requirements for after-hours access to spaces. Design the building to allow for access to these spaces while maintaining the security of the rest of the building.

7.3.3.(3) Refer to Chapter 3, Sub-Section 3.1.3 – Door Hardware.

7.3.3.(4) Refer to Chapter 6, Sub-Section 8.1 – Access Control and Intrusion Detection for technical requirements.

8. Seismic Restraint

8.1. COMPONENTS TO BE SEISMICALLY RESTRAINED

8.1.1. On Category 1 projects, provide seismic restraint on the following components in all buildings, even if structural calculations do not require them.

8.1.1.(1) Suspended ceilings.

8.1.1.(2) Heating plants.

8.1.1.(3) Tanks.

8.1.1.(4) Air Handling Units.

8.1.1.(5) Ductwork.

8.1.1.(6) Sprinkler systems.

8.1.1.(7) Suspended lighting.

8.1.1.(8) Generators.

8.1.2. Refer to Chapter 4 – Structural Design Requirements for additional seismic restraint requirements.

8.2. SEISMIC ENGINEERING OF NON-STRUCTURAL COMPONENTS AND EQUIPMENT

8.2.1. Contractor or sub-trades are to retain engineers for the design of seismic connections for all non-primary structural components not designed by the Engineer of Record. The Contractor-retained engineers are required to provide letters of assurance of design and field review to the Authorities Having Jurisdiction.

8.2.2. The requirements for seismic engineering are to be clearly stated in the Contract Documents.

9. Coordination

9.1. MAJOR BUILDING EQUIPMENT LOCATIONS

9.1.1. Locate major mechanical and electrical components and service spaces such as boiler rooms, ventilation fan rooms, generators, and electrical service and distribution equipment in the building for easy and convenient access. Where possible, direct access from outside to service spaces, without intruding on or crossing through public or program areas, is required.

9.1.2. Situate mechanical and electrical service spaces to allow for convenient ground floor access, and near service vehicle parking spaces whenever possible to provide easy access for servicing, routine inspection and major component replacement.

9.1.3. Service rooms on upper stories or on roofs can be more difficult to service; however when approved by the Yukon government, must be provided with proper access to allow for transporting equipment, material and tools.

9.1.4. Refer to Chapter 3, Sub-Section 5.1.4 – Facility Fall Protection for fall protection requirements related to roof-mounted equipment.

9.2. SERVICE ROOM REQUIREMENTS

9.2.1. Provide adequate maintenance access space in all service rooms to meet regulatory and code requirements and provide sufficient clearances around all components.

9.2.2. Plan service rooms early in design process to ensure sufficient space is allocated to accommodate the proposed equipment.

9.2.3. Service rooms that are not located on the ground floor should be accessible by a set of stairs or ships ladder to allow for equipment and tools to be brought into these areas.

9.2.4. Service room access must consider the replacement of the largest pieces of equipment through the provision of large doors, removable wall panels, roof access hatches, etc.

9.2.5. All service rooms require protection against unauthorized access.

9.2.6. Any equipment located on a roof must also meet access requirements. Ladders are not permitted to access service spaces.

9.2.7. Provide adequate lighting and service receptacles to facilitate the maintenance of equipment.

9.3. SERVICE SPACE ACCESS

9.3.1. Provide easy access to controls and equipment to allow for proper control and maintenance of mechanical and electrical systems.

9.3.2. Provide adequate clearances to maintain controls and equipment, including all manufacturer recommended clearances and any horizontal and vertical clearances required by code at a minimum. Maintenance is to be possible in a safe and healthy position for an average person. Excessive reach, twisting, stretching, crawling for maintenance should not be necessary. Maintenance is to be possible to be carried out in a safe way with all other equipment in the area working under normal conditions.

9.3.3. Locate access panels as necessary in ceilings and walls to provide building operators with easy access, control, and to maintain all equipment located within construction assemblies without requiring special tools.

9.3.4. Specify and coordinate access panels to address required types, identification, sizes, and required locations, and to allow for consistency across the project.

9.3.5. Consider servicing and access of maintainable components located more than 3 metres above floor elevation. Include provisions for hoisting, fall restraint, or access catwalks as deemed necessary by the specific component.

9.3.6. Installation of equipment on rooftops shall be avoided. If roof top installations are necessary, access to such equipment shall be designed to be available under adverse environmental conditions without need to clear a path to or around the equipment. Maintenance staff shall be protected against the environment during equipment service and repair. In communities outside of Whitehorse mechanical equipment shall always be located inside (on the warm side of) the building envelope unless the equipment function requires it to be located outside the envelope.

9.4. PHYSICAL SPACE REQUIREMENTS FOR SYSTEMS AND COMPONENTS

9.4.1. Coordinate projects to accommodate all structural, mechanical and electrical systems and components in the building assemblies, while ensuring that the environmental, fire, and acoustic separation functions of the assembly are maintained.

9.4.2. Coordinate the location of components and their servicing points through an integrated design process to avoid system clashes during design, construction and maintenance.

9.4.3. All mechanical and electrical components shall be positioned on the warm side of the building assembly air/vapor barrier to avoid compromising the integrity of the envelope and thermal bridging.

9.5. BUILDING ENVELOPE

9.5.1. In the design of the heating and ventilation systems, consider the heat gain and loss through the construction assemblies, thermal bridging, and integration of all openings through the building envelope.

9.5.2. Consider the impact of summer heat gain due to long solar days, especially in northern communities.

9.5.3. Consider the impact of large temperature swings over short time periods. Variations of 40°C over 6 hours have been observed.

9.5.4. The building configuration must be coordinated with the mechanical design to effectively manage heat gain/loss through the design of massing, orientation, window placement, and solar shading devices.

9.6. DESIGN COORDINATION OF BUILDING COMPONENTS

9.6.1. As part an integrated design process, coordinate the location and placement of all building components that have an impact on the exterior and interior architectural appearance of the building, including light fixtures, devices, vents, louvers, etc.

10. Commissioning and Verification

Building Commissioning (Cx) is a systematic approach to improving system performance, operations and maintenance, indoor air quality and thermal comfort, and energy efficiency. It provides additional benefits such as improving occupant comfort, health, and productivity in new and existing buildings. Commissioning goes beyond testing, adjusting and balancing (TAB) of individual systems and traditional reviews by Consultants. It involves the functional testing of interconnected systems and confirms whether building equipment meets the Yukon government's goals, or whether it needs to be adjusted to improve efficiency and overall performance consistent with the design intent. Typically, the long-term life-cycle benefits have been proven to outweigh the up-front investment required.

A main objective of commissioning is to affect the safe and orderly handover of the facility from the constructor to the owner, confirming its operability in terms of performance, reliability, safety, and information traceability. Additionally, when executed in a planned and effective way, commissioning normally represents an essential factor for the fulfillment of schedule, cost, and quality requirements of the project.

The commissioning process addresses the following five principles.

1. Determine Government of Yukon requirements, and establish measurable project performance parameters.
2. Plan and execute the commissioning process.
3. Verify and document compliance with requirements.
4. Transfer knowledge to the building operations and maintenance team.
5. Undertake post-occupancy monitoring and evaluation of the building, and develop re-commissioning manuals.

10.1. GENERAL REQUIREMENTS

10.1.1. Third party commissioning is required on all Category 1 buildings.

10.1.2. Category 2 and 3 projects require contractor TAB and system design compliance reviews by the Consultant, unless third party commissioning is specified by the Yukon government in the terms of reference.

10.1.3. The commissioning process will be led by the Commissioning Authority (CxA). The CxA will be selected prior to design development to allow Cx to be incorporated into the design and specification development periods, and to enable the CxA to be involved during design.

10.1.4. The commissioning process must follow the guidelines of CSA Z320 (Building Commissioning) and CSA Z5000 (Building commissioning for energy using systems).

10.1.5. FM shall be present at all commissioning meetings during design and construction.

10.2. COMMISSIONING ROLES AND RESPONSIBILITIES

The CxA is responsible for the following.

- Reviewing the Government of Yukon's Project Requirements and Basis of Design.
- Reviewing the design and specifications from a commissioning perspective.
- Preparing the commissioning plan and requirements, with submissions at schematic design (system identification), design development, 65% and 95% construction documents.
- Planning for performance verification, testing, O&M manuals and training requirements.
- Preparing all required schedules and forms.
- Leading all commissioning meetings.
- Performing construction phase reviews and reporting.
- Reviewing all commissioning-related submittals.
- Performing verification checks, diagnostic monitoring, acoustic testing, and functional testing.
- Facilitating maintenance staff training.
- Preparation of a Commissioning Report, summarizing all phases of commissioning.
- Preparing the Building Maintenance Manual and recommissioning plan.
- The development of a maintenance plan indicating maintenance tasks, frequency, components requiring maintenance, and location of component to be serviced.
- Performing seasonal/deferred testing and warranty review with the Consultant Team.

The Design Consultant is responsible for the following.

- Reviewing the Government of Yukon's Project Requirements and Basis of Design.
- Reviewing and coordinating with the commissioning plan and requirements at all stages of design and construction documents.
- Incorporating appropriate changes to design and contract documents to reflect comments made during design reviews.
- Assisting in the planning for performance verification, testing, O&M manuals and training requirements.
- Participating in all commissioning meetings.
- Reviewing reports from construction phase Cx reviews.
- Reviewing documentation from performing verification checks, diagnostic monitoring and functional testing.
- Reviewing Commissioning Report.
- Reviewing Building Maintenance Manual and recommissioning plan.
- Performing seasonal/deferred testing and warranty review with the CxA.

10.3. EQUIPMENT AND SYSTEMS TO BE COMMISSIONED

Newly installed or modified equipment and systems must be commissioned. The Consultant team and YG will be required to develop the requirements for each item, and to identify any other equipment and systems that may require commissioning. The equipment and systems to be commissioned should include, but are not limited to:

- building envelope airtightness using pressurization and depressurization;

- roofing membranes;
- door hardware;
- commercial kitchen equipment;
- elevators, including emergency recall operation and emergency in-car operation;
- all systems and components of the domestic water system, sprinkler system, and HVAC systems;
- refrigeration systems;
- central building automation system;
- energy metering systems;
- electrical systems, including: switchboards, distribution panels, transformers, motor control centres, power and lighting panels; lighting fixtures and controls, surge suppressors, equipment connections, and lighting protection;
- emergency power supply;
- fire alarm system, including egress system, emergency lighting systems, and security/ egress locking interface systems;
- data and communications;
- security system;
- integration of Fire Protection and Life Safety Systems to CAN/ULC-S1001; and
- landscape irrigation systems.

11. Maintenance Requirements

11.1. MAINTENANCE CONSIDERATIONS

Operational efficiency is one of the primary post-construction goals of good building practice. Operational efficiency is measured by time and cost.

Four primary O&M time and cost considerations are:

1. Fuel and Power Consumption

   Consumption is largely dependent on operating practices; however, the shape and layout of a building, choice of energy conservation measures and use of daylight can have a significant effect on fuel and power consumption.

2. Operation and Maintenance of Equipment

   The planning and layout of a building, which provides sufficient storage for tools and spare equipment, with convenient access to mechanical and electrical equipment locations that encourage efficient predictive and preventive maintenance and improved operational efficiency.

3. Low-Maintenance Finishes

   Selected building materials and finishes should be durable and simple to maintain and repair, thereby reducing time and cost, and increasing operational efficiency.

4. Building Custodial Services

   The choice of building finishes and floor plan layout, and the convenient location and adequate sizing of storage for janitorial supplies and cleaning equipment will affect regular caretaking operations and operational efficiency.

11.2. REDUNDANCY

In communities without local Yukon government maintenance staff or in mission critical facilities, redundancy of key building components or systems should be considered during the design phase. This will protect the building asset by allowing specific systems to continue to function in the event of a failure. In the case of mission-critical facilities, this will also protect the building contents and/or allow for continued operation. Redundancy can also include alarm systems that notify maintenance staff of an issue prior to complete failure.

11.3. PREDICTIVE MAINTENANCE

1. Consultants are to identify maintenance requirements of specified equipment components as part of the LCCA.
2. The Consultant is required to allow for the development of a predictive maintenance plan as part of the building operations and maintenance manual to allow for replacement at optimum times.

11.4. MAINTENANCE MATERIALS AND SPARE PARTS

Maintenance materials and spare parts are supplied by the construction contract for use by the building maintenance staff, and are intended to be stored on site for easy access. The Consultant should determine, in consultation with the Yukon government maintenance personnel what maintenance materials and quantities should be supplied under the construction contract in addition to the amounts noted below.

11.4.1. ARCHITECTURAL

Supply the following architectural maintenance materials.

11.4.1.(1) Cladding: Provide minimum 2% of exterior wall area for each type of exterior cladding.

11.4.1.(2) Flooring and Floor/Wall Tile: Provide minimum 2% of gross floor area for each type and colour of flooring/tile used.

11.4.1.(3) Paint and Stain: Provide one 1 litre can of each colour and paint/stain type, and indicate paint number, location, and use.

11.4.1.(4) Ceiling Systems: Provide minimum 2% of gross ceiling area for each type of ceiling system used (other than gypsum board).

11.4.2. MECHANICAL

Supply the following mechanical maintenance materials.

11.4.2.(1) Belts: 1 set of belts for each piece of belt-driven equipment.

11.4.2.(2) Filters: 2 full sets of replacement filters of each type used in the system(s).

11.4.2.(3) Side Stream Cartridge Filters: 12 (if applicable, to match design filtration rating).

11.4.2.(4) Glycol: 1 additional 208 litre (55 gallon) sealed drum of Dowfrost HD, pre-mixed 50/50.

11.4.2.(5) NFPA required spares.

11.4.2.(6) Fusible links for fire dampers: 6 spare fire damper links for each temperature rating.

11.4.2.(7) Specialized Tools and Testing Equipment: e.g. glycol testing kit, water testing kit.

11.4.3. ELECTRICAL

Supply the following electrical maintenance materials.

11.4.3.(1) Breakers: 2 spares for each ampere rating under 20Amps.

11.4.3.(2) Fuses:

a) 1 spare set for each type and size for systems rated up to 240VAC. Including control fuses;

b) 1 set of three, compatible with each type and size for 3-phase systems; and

c) Fuse pullers: One set compatible with each type and size installed.

11.4.3.(3) Generators:

a) 5 spare oil filters;

b) 5 spare fuel filters;

c) 5 spare air filters; and

d) 1 set of fan belts for each type used.

11.4.3.(4) LED Driver and fixtures: Minimum 2% of total quantities installed for each type.

11.4.3.(5) Lighting Lenses and Louvers: Minimum 2% spare for each type and length

11.4.3.(6) Specialized Tools and Testing Equipment: 2 each lighting control and program remotes.

11.4.3.(7) Fire alarm: 1 spare of each initiating and peripheral device, including modules.

11.4.3.(8) Variable Speed Drive: Two spare air filters and replacement control fuses for each type.

11.4.3.(9) Starters: Minimum 10% spare starters of each size 1 spare set of control fuses of each size.

11.4.3.(10) Photovoltaic modules: Minimum 2% spare for each type and size spare photovoltaic modules should be crated and stored on site.

12. Post-Occupancy Evaluations

As part of the commissioning and integrated design processes, the project team, the Government of Yukon, and the Commissioning Agent will participate in post occupancy evaluations (POE) of all projects. This will involve gathering information on lessons learned, including differences between modelled and actualdata as part of performance verification. This phase will involve the following steps.

1. Objective Setting

   The Government of Yukon will establish the POE, budget, timeline. This should be coordinated with a building walk-through.

2. Surveys, Interviews and Planning

   The Yukon government will collect information from the building operators and conduct occupant/operator satisfaction surveys to identify concerns with the building operation, management or maintenance.

3. Data Collection and Analysis

   The Yukon government Project Manager will provide the Design Team with data from the building to allow the Design Team to provide an assessment to benchmark performance, gain insight on occupant perceptions, obtain measurements, and identify low/no cost efficiency improvements. The deliverables from this assessment should include:

   - current energy performance;
   - list of deficiencies related to the POE;
   - newly identified efficiency opportunities relating to program schedules and needs, along with savings and cost estimates;
   - general recommendations for improving performance;
   - benchmarking against similar facilities; and
   - comparison of actual performance to design performance, baselines, or the Yukon government's requirements.

4. Energy Performance Assessment

   - Energy model shall be reviewed and updated with information that accurately reflect actual building use, such as occupancy and operating hours.
   - After 1 year of building operation, the consultant shall prepare a report of current energy performance based on comparison of actual consumption data (gathered from utility bills and sub meters to most updated energy model.
   - With exception of plug loads, equipment categories with actual energy use of more than 130% compared to its anticipated consumption will be investigated by the POE team to ensure related systems are free of technical and operational deficiencies.

5. Information Transfer

   The Yukon government project manager will meet with the Consultant to present the results of the POE, share lessons learned, and identify performance issues and corrective

actions. The project manager will summarize this in a final assessment report which consolidates the data collected and compares it to the established targets and baselines.

13. Codes and Regulations

13.1. AUTHORITY HAVING JURISDICTION

In Yukon, development, building and trade permits in most communities are issued by Government of Yukon Building Safety and Standards Branch. In Whitehorse, development, building and plumbing permits are issued by the City of Whitehorse. In Dawson, development permits are issued by the City of Dawson.

It is required that the Consultant consult with the AHJ following the completion of the schematic design to ensure compliance with all bylaws, codes, regulations, and standards.

13.2. REFERENCED CODES AND REGULATIONS

All references to codes, regulations, standards, or other referenced documents within this manual should be to the latest edition adopted by the Authority Having Jurisdiction, or where not adopted by the AHJ, the latest version of that document. All work must meet or exceed these requirements or the design and performance requirements specified in the manual. In the case of a conflict or discrepancy, the more stringent requirements shall apply.

13.2.1. NATIONAL MODEL CODES

The National Building Code of Canada, the National Fire Code of Canada and the National Plumbing Code of Canada have been adopted without changes in Yukon. The National Energy Code of Canada for Buildings has not been adopted by the Government of Yukon, but is enforced in the City of Whitehorse under the Building and Plumbing Bylaw.

13.2.2. OTHER CODES AND REGULATIONS

The following codes, regulations, standards and guidelines are either referenced within this document, or are included for design reference.

1. Architectural Woodworking Manufacturers Association of Canada (AWMAC)
   - Architectural Woodwork Standards Manual.
2. American Society of Heating, Refrigeration, and .Air-Conditioning Engineers (ASHRAE) Handbooks, Standards and Guidelines.
   - ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   - ASHRAE 55, Thermal Environmental Conditions for Human Occupancy.
   - ASHRAE 62.1, Ventilation for Acceptable Indoor Air Quality.
   - ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
   - ASHRAE Guideline 4, Preparation of Operating and Maintenance Documentation for Building Systems.
   - ASHRAE Handbook.
3. American National Standards Institute (ANSI).
   - ANSI/ISEA Z358.1, Emergency Eyewash and Shower Equipment.
   - ANSI/ASSE Z359, Fall Protection Code.
4. American Society of Plumbing Engineers (ASPE) Data Book.
5. American Society for Testing and Materials (ASTM).
   - F876, Standard Specification for Crosslinked Polyethylene.
6. BC Green Building Roundtable.
   - Roadmap for the Integrated Design Process.
7. Bureau de normalization du Quebec (BNQ).
   - CAN/BNQ 2501-500, Geotechnical Site Investigation for Building Foundations in Permafrost Zones.
8. Canada Mortgage and Housing Corporation (CMHC).

- Integrated Design Process Guide.

9. Canadian Construction Association (CCA).
   - CCA 82, Mould Guidelines for the Canadian Construction Industry.
10. Canadian Council of Ministers of the Environment (CCME).
11. Canadian Standards Association (CSA).
    - CSA 22.1, Canadian Electrical Code, Part 1.
    - CSA A440S1, Canadian Supplement to AAMA/WDMA/CSA 101/I.S.2/A440-11, NAFS - North American Fenestration Standard / Specification for windows, doors, and skylights.
    - CSA-C22.2 No. 141, Emergency Lighting Equipment.
    - CSA-C22.2 No. 214, Communications Cables (Bi-National standard with UL 444).
    - CSA-C22.2 No. 232, Optical Fiber Cables.
    - CSA B44, Safety Code for Elevators and Escalators.
    - CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
    - CSA B72, Code for Lighting Protection Systems.
    - CSA B139 Series 15, Installation Code for Oil Burning Equipment.
    - CSA B149.1, Natural Gas and Propone Installation Code.
    - CSA B149.2, Propane Storage and Handling Code.
    - CSA B214, Installation Code for Hydronic Heating Systems.
    - CSA B651, Accessible Design for the Built Environment.
    - CSA C282, Emergency Electrical Power Supply for Buildings.
    - CSA C448, Design and Installation of Ground Source Heat Pump Systems for Commercial and Residential Buildings.
    - CSA C813.1, Performance Test Method for Uninterruptible Power Supplies.
    - CSA C860, Performance of Internally-Lighted Exit Signs.
    - CSA S406, Specifications of Permanent Wood Foundations for Housing and Small Buildings.
    - CSA S478, Guideline on Durability in Buildings.
    - CSA S500, Thermosyphon Foundations for Buildings in Permafrost Regions.
    - CSA S501, Moderating the Effects of Permafrost Degradation on Existing Building Foundations.
    - CSA S502, Managing Changing Snow Load Risks for Buildings in Canada's North.
    - CSA S503, Community Drainage System Planning, Design, and Maintenance in Northern Communities.
    - CSA S832, Seismic Risk Reduction in Operational and Functional Components (OFCs) of Buildings.
    - CSA Z32, Electrical Safety and Essential Systems in Health Care Facilities.
    - CSA Z317.1, Special Requirements for Plumbing Installations in Health Care Facilities.
    - CSA Z317.2, Special Requirements for Heating, Ventilation, and Air Conditioning (HVAC) Systems in Health Care Facilities.
    - CSA Z317.13 Infection control during construction, renovation, and maintenance of health care facilities.
    - CSA Z320, Building Commissioning.
    - CSA PLUS 4011, Technical Guide: Infrastructure in Permafrost: A Guideline for Climate Change Adaptation.
12. Canadian Electrical installation standard (CEIS)
    - CECA 1-2011 Good workmanship in electrical construction.

13. Energy Star Canada Product Certifications.
14. Federal Emergency Management Agency (FEMA).
    - FEME E74, Reducing the Risks of Nonstructural Earthquake Damage.
15. Illuminating Engineering Society of North America, The Lighting Handbook.
16. International Dark-sky Association (IDA)
17. Institute of Electrical and Electronics Engineers (IEEE).
    - Colour book series.
18. National Air Duct Cleaners Association (NADCA).
    - Standard for Assessment, Cleaning and Restoration of HVAC Systems (ACR).
19. North American Fenestration Standard (NAFS).
    - AAMA/WDMA/CSA 101/I.S.2/A440-11, NAFS - North American fenestration standard/Specification for windows, doors, and skylights.
20. National Fire Protection Association (NFPA).
    - NFPA 10, Standard for Portable Fire Extinguishers.
    - NFPA 13, Standard for the Installation of Sprinkler Systems.
    - NFPA 14, Standard for the Installation of Standpipe and Hose Systems.
    - NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection.
    - NFPA 22, Standard for Water Tanks for Private Fire Protection.
    - NFPA 24, Standard for the Installation of Private Fire Service Mains.
    - NFPA 37, Standard for in the Installation and Use of Stationary Combustible Engines and Gas Turbines.
    - NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
    - NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Equipment.
    - Other NFPA standards where required.
21. National Research Council (NRC).
    - Best Practice Guide on Fire Stops and Fire Blocks and Their Impact on Sound Transmission.
    - National Energy Code of Canada.
22. National Sanitation Foundation (NSF) Product Certifications.
23. Parks Canada.
    - Standards and Guidelines for the Conservation of Historic Places in Canada.
24. Sheet Metal and Air Conditioning National Association (SMACNA) Publications and Guidelines.
    - HVAC Duct Construction Standards.
    - HVAC Systems Design Guide.
    - Seismic restraint guide.
25. Telecommunications Industry Association (TIA).
    - ANSI/TIA-568-C.0-1, Generic Telecommunications Cabling for Customer Premises.
    - TIA/EIA-568-C.1, Commercial Building Telecommunications Cabling Standard.
    - ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard.
    - ANSI/TIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.
    - TIA-570-C – Residential Telecommunications Infrastructure Standard.
    - TIA-598-C, Optical Fiber Cable Colour Coding.
    - TIA/EIA-606-A, Administration Standard for the Commercial Telecommunications Infrastructure.

- TIA-607-C – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

26. Terrazzo and Tile Manufacturers Association of Canada (TTMAC).
    - Specifications Guide 09 30 00 Tile Installation Manual.

27. Underwriter Laboratories of Canada (ULC).
    - CAN/ULC-S115 Fire Resistant and Firestop Products and Systems.
    - CAN/ULC-S302 Installation, inspection and testing of intrusion alarm systems.
    - CAN/ULC-S303 Local burglar alarm units and systems.
    - CAN/ULC-S304 Control units, accessories and receiving equipment for intrusion alarm systems.
    - CAN/ULC-S306 Instruction detection units.
    - CAN/ULC-S316 Standard performance of video surveillance systems.
    - CAN/ULC-S317 Standard for installation and classification of closed circuit video equipment (CCVE) systems for institutional and commercial security applications.
    - CAN/ULC-S318 Power supplies for burglar alarm systems.
    - CAN/ULC-S319 Electronic Access Control.
    - CAN/ULC-S524 Installation of fire alarm system.
    - CAN/ULC-S525 Audible Signal Device for Fire Alarm Systems.
    - CAN/ULC-S526 Visual Signal Devices for Fire Alarm Systems.
    - CAN/ULC-S527 Control Units.
    - CAN/ULC-S528 Manual Pull Stations for Fire Alarm Systems.
    - CAN/ULC-S529 Standard for Smoke Detectors in Fire Alarm Systems.
    - CAN/ULC-S530 Heat Actuated Fire Detectors for Fire Alarm Systems.
    - CAN/ULC-S531 Standard for Smoke Alarms.
    - CAN/ULC-S536 Standard of inspection and testing of fire alarm systems.
    - CAN/ULC-S537 Verification of fire alarm system.
    - CAN/ULC-S541 Speakers for fire alarm and signaling systems, including accessories.
    - CAN/ULC-S553 Installation of Smoke Alarms.
    - CAN/ULC-S576 Standard of mass notification system equipment and accessories.

28. Yukon Regulations.
    - Design Specifications for Sewage Disposal Systems: A Guide to their Design and Maintenance.
    - *Occupational Health and Safety Act.*
    - *Building Standards Act.*
    - Yukon Building Code Advisories.
    - *Drinking Water Regulations.*
    - *Environment Act.*
    - *Public Health and Safety Act.*
    - *Fire Prevention Act.*

13.3. MUNICIPAL BYLAWS AND ORDINANCES

All design and construction work must conform to the requirements of all municipal bylaws and ordinances. This includes requirements for permitting, inspections, waste management, and assurances for design and field reviews.

In the cities of Whitehorse and Dawson, all work must conform to the requirements of the Official Community Plan, Zoning Bylaw, and the Heritage Bylaw. In Whitehorse, all work must also confirm to the Building and Plumbing Bylaw.

For all other municipalities and communities, work must conform to the Government of Yukon Local Area Plans and Zoning Regulations. In these communities, Government of Yukon Building and Safety Standards Branch is the Authority Having Jurisdiction.

13.4. DESIGN PROFESSIONALS

13.4.1. PROFESSIONAL ARCHITECTS

The practice of architecture in Yukon is currently unregulated. However, the Yukon government sometimes requires that architects must be registered with another provincial/territorial association to provide architectural services to the government. This requirement, or other acceptable requirements for registration or licensing will be specified in the terms of reference for consulting services.

13.4.2. PROFESSIONAL ENGINEERS AND LICENSEES

The practice of engineering in Yukon is regulated by the Association of Professional Engineers under the authority of the *Engineering Professions Act*. Where the term Engineer is used within this document, it shall have the same meaning as Licensee, as defined in the *Engineering Profession Act*.

The Act can be found at: http://www.gov.yk.ca/legislation/acts/enpr_c.pdf.

2

Energy and Environmental Design Requirements

1. Sustainability Goals

1.1. The Government of Yukon's objective is to provide buildings for the public that are safe, comfortable, and effective for their intended use, while minimizing energy use, operating expenses, and greenhouse gas emissions.

1.2. Buildings represent a majority of the government's greenhouse gas emissions, so all projects are to prioritize reducing fossil fuel use and their associated carbon emissions. This reduction will be achieved by incorporating thermally efficient and airtight building enclosures with minimal thermal bridging, high performance windows and doors, and efficient, right-sized mechanical systems. Energy modeling and life cycle cost analysis will be used throughout the design phases to verify projects are on track to meet the energy use targets.

1.3. The government is committed to providing healthy spaces for the public and employees and to encourage sustainable construction practices that minimize the use of natural resources and impact on the environment. This section specifies associated requirements for site selection, site planning and construction, and the selection of materials used in construction.

2. Building and Energy Performance

2.1. BUILDING DESIGN FOR ENERGY PERFORMANCE

2.1.1. Achieving the level of performance required to meet the Yukon government's goals for reduced energy use, operating costs, and greenhouse gas emissions will require a holistic design approach that considers all building systems. Designers are expected to use expertise and experience to approach this in consultation with the Government of Yukon.

2.1.2. The Government of Yukon requires the following approach.

2.1.2.(1) Thermal insulation values should meet or exceed the prescriptive requirements stated in this manual. However, alternate thermal insulation values can be considered through LCCA.

2.1.2.(2) A high level of airtightness is critical to prevent air infiltration and associated energy losses. This will require good communication between the designer and builder, with building envelope inspection and commissioning (e.g. blower door testing) required at key points during construction.

2.1.2.(3) Ventilation energy recovery will be necessary to meet the energy consumption targets. Exceptions will be allowed where heat recovery is technically infeasible due to contaminants in the air being exhausted. Demand-controlled ventilation systems can be used to match airflow to occupant demand.

2.1.2.(4) Ventilation, heating and domestic hot water systems should be simple, right sized, appropriate for the application and high efficiency.

2.1.2.(5) Lighting is required to be LED unless otherwise indicated to meet project-specific requirements.

2.1.2.(6) Domestic hot water heating should be independent from the central boiler loop to allow shutdown of the main boilers during the summer. Running large boilers just for DHW heating is inefficient. Provide a conventional fuel or electrical backup heat source as appropriate for the project location.

2.2. MINIMUM ENERGY PERFORMANCE REQUIREMENTS

The following represents the Yukon government's minimum acceptable energy performance standard for construction projects.

Designers are reminded that the minimum energy performance required by this standard and the way in which it is modeled does not supersede local building regulations (e.g. City of Whitehorse bylaws). The AHJ may require additional energy modeling to prove compliance.

2.2.1. REQUIREMENTS FOR CATEGORY 1 BUILDINGS

2.2.1.(1) All new construction and additions **shall be designed to have energy consumption that is less than or equal to 65% of the energy consumption for a building meeting the requirements of the National Energy Code of Canada for Buildings 2017 (35% reduction)**. This shall be proven by meeting the performance path requirements in Part 8 of NECB, including the following.

a) Until the air leakage rate has been determined by final whole building air leakage testing, an air leakage rate of 1.75 L/s·m²at 75 Pa shall be converted to an infiltration rate at operating pressure for use in the energy model, applied to the above-ground wall area. The operating air leakage rate shall be calculated from the assumed or measured air leakage rate using:

$$I_{AGW} = 0.112 \times q_{75Pa} \times \frac{S}{A_{AGW}}$$

Where:
IAGW= infiltration rate [L/s·m²] to be used for energy modelling, and applied to the modelled above-ground wall area
q75Pa= normalized envelope air leakage [L/s·m²] as tested or assumed at 75 Pa
S= total surface area [m²] of the building envelope included in the air leakage test (i.e. the pressure boundary), including ground floors and roofs, and possibly below-grade walls.
AAGW=modelled area [m²] of above-ground wall (including windows).

b) Designers are to use actual projected operating schedules, occupant densities, receptacle loads, and service water heating loads, rather than the default values provided in NECB. These values are to be determined in consultation with the Yukon government.

c) For designers' information, NECB does not consider renewable energy systems. On-site renewable energy systems cannot be used to offset building energy consumption for the purposes of this analysis.

2.2.1.(2) The utility consumption figures calculated for the NECB compliance analysis shall be used to verify that the greenhouse gas emissions of the proposed building do not exceed 65% of the greenhouse gas emissions of the reference building (35% reduction). Greenhouse gases shall be calculated in tonnes of carbon dioxide equivalent (tCO_2e) using conversion factors applicable to Yukon published by The Climate Registry.

2.2.1.(3) To maximize GHG reductions, all new construction projects for buildings connected to diesel-electric grids shall incorporate renewable electricity generation where practical, striving to meet 50% of the building's anticipated annual electrical consumption. Consultants shall provide the following information to the Yukon government project team to determine practicality of renewable electricity generation systems.

a) Greenhouse gas emissions reduction potential
b) Life cycle cost analysis including:
   i) Design options for system sizing and battery storage that optimizes GHG reduction, utility cost avoidance, and construction cost
   ii) Return on investment
c) System suitability including:
   i) technical constraints
   ii) grid connection availability
   iii) seasonal generation potential
   iv) O&M capacity for continuous operation
   v) community impact

All new construction projects for buildings connected to diesel electric grids shall assume renewable electricity generation is practical until determined otherwise by the project team. Please consult Sustainable Infrastructure Branch for guidance on evaluating renewable electricity generation systems.

Installation of renewable electrical systems on buildings connected to the primary electric grid may have financial merit which will need to be proven through the project's LCCA.

2.2.1.(4) To maximize GHG reductions, all Category 1 projects shall incorporate at least one source of supplementary renewable heat where practical, striving to meet 90% of the building's anticipated annual heat load.
To identify the most suitable heat source for the building, projects must provide a detailed analysis of a minimum of two renewable heating systems. District heating system configurations should be considered where appropriate. For each option, consultants shall provide the following information to the Yukon government project team to determine practicality of each renewable heating system:

a) Greenhouse gas reduction potential
b) Life cycle cost analysis
c) System suitability including:
    i) technical constraints
    ii) availability of a renewable heat source
    iii) O&M capacity for continuous operation
    iv) community impact

All Category 1 projects shall assume renewable heating is practical until determined otherwise by the project team. Please consult Sustainable Infrastructure Branch for guidance on evaluating renewable heating systems.

2.2.1.(5) Please refer to the list of renewable energy systems currently considered by YG at:
Yukon.ca/en/renewable-energy-options-government-yukon-buildings. This list is not exhaustive; consultants are encouraged to propose renewable energy alternatives best suited for each project.

2.2.2. REQUIREMENTS FOR CATEGORY 1 RESIDENTIAL OCCUPANCIES

2.2.2.(1) New buildings that are eligible for rating under the EnerGuide Rating System v15 may opt to substitute the requirements of Section 2.2.1 for the requirements of this section.

2.2.2.(2) The energy consumption of the new building shall be less than or equal to 65% of the energy consumption of the ERS reference residential building (35% reduction). This building energy consumption value shall be calculated without the effect of any on-site renewable energy systems. Renewable energy cannot be used to offset a poorer-performing building.

2.2.2.(3) All new buildings shall be supplied with an EnerGuide Rating System label andreport for the building. Consultants are to include this requirement in their specifications.

2.2.3. REQUIREMENTS FOR CATEGORY 2 BUILDINGS

2.2.3.(1) Unless required by the authority having jurisdiction, energy modeling is not required for Category 2 buildings.

2.2.3.(2) Category 2 buildings are to follow the prescriptive energy efficiency measures included in this manual as a minimum.

2.2.4. REQUIREMENTS FOR CATEGORY 3 BUILDINGS

2.2.4.(1) All renovations and maintenance projects shall use components that meet theprescriptive requirements stated below in Section 4.

2.2.4.(2) All Category 3 energy projects shall use the energy modelling requirements as stated in section 2.3. All projects above $1,000,000 that involve substantial modifications to building envelope and mechanical systems must follow energy modelling requirements for Category 1 projects.

2.3. ENERGY MODELING

To better inform the Government of Yukon's decision making and prove compliance with the requirements in this standard, if required in Section 2.2 – Minimum Energy Performance Requirements, designers are to perform energy analysis of their designs and report key information as specified below.

2.3.1. ENERGY MODELLING REQUIREMENTS

2.3.1.(1) Energy modelling software for Category 1 buildings shall meet the requirements specified in NECB. At the time of publication examples of suitable software include but are not limited to: EnergyPlus, IES VE, and Trane Trace 700

(version 6.1 and higher).

2.3.1.(2) For Category 2 residential projects, the energy modelling software is prescribed by Natural Resources Canada as part of the EnerGuide Rating System program requirements.

2.3.1.(3) For Category 3 projects, there is no specific software required for modelling, but the method used must accurately model the projected energy use of the equipment over an average year, considering the equipment capacity and equipment use patterns. The analysis must include the comparison of at least two modeled scenarios: the existing system and the proposed system(s). Supporting figures that are outside of the scope of the project, such as local weather data, building use, and unchanged building systems, should remain the same for all scenarios. Calculations must also consider any direct interaction with other building systems. For example, lighting upgrades reduce electrical energy use but the reduction in waste heat causes a corresponding increase in heating fuel consumption.

2.3.2. ENERGY MODELLING MILESTONES

2.3.2.(1) At each stage of design, the assumptions and level of detail that goes into the energy model are to be appropriate relative to the level of detail of design. For energy models prior to the IFC submission, the energy model must either prove compliance with the energy performance target or must show how compliance will be achieved with changes to the design or assumptions at later stages. For the IFC submission and all subsequent submissions, the energy model must prove compliance with the energy performance target. If it initially does not, the Consultant team will be expected to make changes as necessary to achieve the target, and the energy model will need to be revised as necessary until it is demonstrated the design meets the performance target.

2.3.2.(2) For all Category 1 projects, energy modelling reports and working files are required at the end ofthe following phases.

a) Schematic Design.

b) 65% Construction Documents Submission (or first detailed design submission).

c) 95% Construction Documents Submission.

d) Issued for Construction Submission.

e) Completion of Construction.

2.3.2.(3) For all Category 3 energy projects, energy modelling reports are required at the end ofthe following phases.

a) Schematic Design

b) Issue for Construction Submission

c) Completion of Construction

2.3.3. ENERGY REPORTING REQUIREMENTS

2.3.3.(1) Use metric units for all reports, with energy expressed in MWh.

2.3.3.(2) Include the following information in all reports.

a) Software used.

b) Historical weather data source, where applicable.

2.3.3.(3) For Category 1 projects, report the following information for the reference building, the proposed building, and any other cases analyzed.

a) Energy used by each category of equipment (e.g. space cooling, refrigeration, space heating, heat pumps, domestic hot water, fans, pumps, plug loads, interior lighting, exterior lighting, other building-specific loads, on-site renewable energy generation) broken down by each type of fuel input (e.g. electricity, oil, propane, biomass) as well as a subtotal for each fuel input and an overall total for each case.

b) Total Energy Use Intensity (TEUI), in MWh/m^2·y.

c) Thermal Energy Demand Intensity (TEDI), in MWh/m^2·y.

d) Greenhouse gas emissions for each fuel input and the building as a whole, in tCO_2e/y.

e) Building envelope nominal and effective insulation values, including calculations demonstrating the inclusion of effects from major structural elements that intersect the building envelope, the junction between glazing assemblies, spandrels, parapets, roof-to-wall junctions, corners, and edges of walls or floors, using the Enhanced Thermal Performance Spreadsheet developed by BC Hydro.

f) Building floor area, above-ground wall area, window and door area, roof area, and skylight area.

g) For each space type:

i) Floor area.

ii) Occupant density.

iii) Peak receptacle loads.

iv) Peak domestic hot water loads.

v) Peak lighting power densities (in W/m^2).

vi) Operating schedule assigned.

vii) Heating and cooling loads.

h) Surface-area-to-volume ratio (S/V) of building envelope.

i) Setback schedules for main building systems (if applicable).

j) HVAC and domestic hot water equipment efficiencies.

k) Any assumptions made or equipment not included in the analysis (likely at early design phases).

l) For the schematic design and the first detailed design submissions, a list of potential energy conservation measures (ECMs) with capital costs, energy savings, and payback periods.

2.3.3.(4) If the project is opting for the EnerGuide Rating System path, then follow the standard reporting and labelling forms specified in the EnerGuide Rating System.

2.3.3.(5) For Category 3 projects, report the following information for at least two scenarios comparing the existing system to proposed system(s). The report should include:

a) Identification and description of the existing and proposed equipment as per the project scope of work. Differences between efficiencies for existing and proposed systems should be considered.

b) Energy use, GHG emissions, and utility costs broken down by each type of fuel, for each scenario.

c) Anticipated changes in energy use, GHG emissions, and utility costs based on calculated difference between the existing and proposed system(s).

d) Anticipated capital costs for each proposed scenario, with simple payback based on anticipated utility savings.

e) Any assumptions made.

f) Where applicable, proposal of additional energy conservation measures (ECMs) that can be included to further reduce energy use, GHG emissions, or utility costs.

2.3.4. THIRD PARTY VERIFICATION

2.3.4.(1) For Category 1 projects, the Government of Yukon will have a third party review the energy model following the 65% Design Development and Issued for Construction (IFC) submission to confirm that the methodology, assumptions, and results are sound and in conformance with the project's energy performance target and all other requirements of this section.

2.4. ENERGY MODELING REQUIREMENTS FOR LCCA

2.4.1. In addition to proving compliance with the minimum energy performance standards, the objective of energy modeling is to provide the Yukon government with information that will help inform decisions and ensure the best balance of capital cost, operating costs, and progress towards meeting portfolio-wide GHG reductions.

2.4.2. The minimum energy performance standards specified are considered minimum acceptable values. Consultants are encouraged to use innovative approaches and superior technologies to present a number of performance options to the Government of Yukon. As a long-term operator of public infrastructure, the Yukon government has a strong interest in performing life cycle costing analysis to minimize the total cost of ownership over the full life cycle of the building.

2.4.3. Refer to Chapter 1, Sub-Section 5.2 – Life Cycle Costing for specific requirements related to Life Cycle Cost Analysis.

2.4.4. Energy modelling and life cycle costing analysis is not required for projects with estimated construction costs under $50,000.

2.5. ENERGY METERING

2.5.1. Monitoring of the actual building operation and energy usage after occupancy is critical to ensure that the building is performing in accordance with predictions. This will allow for investigation and correction of identified anomalies or inefficiencies.

2.5.2. Monitoring of electrical equipment is to be done per-panel, with panels serving different end uses as listed below. Heating equipment is to be metered based on fuel input, except biomass systems which are to be metered based on heat output. All submeters are to report back to the central building automation system where the data is stored in increments no longer than ten minutes for a period of at least three years.

2.5.3. The building load group categories to be sub metered are as follows.

2.5.3.(1) Space cooling.

2.5.3.(2) Refrigeration.

2.5.3.(3) Space heating.

2.5.3.(4) Heat pumps.

2.5.3.(5) Domestic hot water heating.

2.5.3.(6) Fans (permanently installed only; portable fans fall under plug loads).

2.5.3.(7) Pumps (permanently installed only; portable pumps fall under plug loads).

2.5.3.(8) Plug loads.

2.5.3.(9) Interior lighting.

2.5.3.(10) Exterior lighting.

2.5.3.(11) Other exterior uses (e.g. car plugs).

2.5.3.(12) Electric vehicle charging.

2.5.3.(13) Other building-specific loads (e.g. commercial kitchens, datacenters, parking ramp heat trace, walk-in fridges/freezers, rink ice plants, airport runway lighting, hospital sterilization equipment, etc.).

2.5.3.(14) Reverse energy metering for main utility service if using peak shaving electric boilers with photovoltaics.

2.5.3.(15) Secondary sales service.

2.5.3.(16) On-site renewable energy systems.

2.5.3.(17) Whole-building water meter.

3. Passive Design Strategies

As noted in Sub-Section 2.1 – Building Design for Energy Performance, one of the encouraged approaches to reducing energy consumption is to utilize passive architectural design strategies as a first step to reducing building energy loads before reducing energy use using active mechanical/ electrical systems. This section summarizes some of these strategies at a high level.

3.1. INTENT OF PASSIVE DESIGN

3.1.1. Passive design strategies in building design refers to the use of the building form and architectural assemblies and components to reduce energy requirements and increase occupant comfort. This approach reduces reliance on mechanical and electrical systems.

3.1.2. The requirements below are not prescriptive but are recommended design approaches to provide energy savings. It is also recognized that in the case of specific uses or sites, form and function may need to take precedence, with passive design considerations being incorporated where practical.

3.1.3. All building designs shall incorporate the use of passive design strategies to minimize the energy used by building prior to utilizing active mechanical or electrical systems.

3.2. RECOMMENDED PASSIVE DESIGN STRATEGIES

3.2.1. ORIENTATION AND FORM

During the schematic design phase review potential building orientations and form, taking into consideration: solar radiation, solar shading for occupant comfort and to reduce overheating, and the percentage of fenestration. Fenestration on east and west elevations will require careful planning to avoid glare and overheating. In northern communities, careful planning is required for windows on all elevations due to long summer days, and long, dark and cold winters, and large seasonal changes in sunlight angles.

3.2.2. BUILDING COMPACTNESS

The surface-area-to-volume ratio (S/V ratio) of buildings has significant impact on the building's energy use requirement. Buildings with a smaller S/V ratio, due to smaller exterior envelope, minimum articulation and projections, and a compact form will achieve better performance. It is recommended that designs meet an S/V ratio less or equal to 0.7 m^2/m^3.

3.2.3. SPACE PLANNING

During building planning, spaces should be located in their ideal thermal location to reduce mechanical heating and cooling requirements, while still maintaining the required functional relationships and program requirements. Spaces with high internal heat loads such as server (LAN) rooms or commercial kitchens, should be located on north or east orientations.

3.2.4. INCREASED THERMAL INSULATION

Appropriate levels of effective thermal insulation on a building is critical to reducing the heat loss/gain through the building's opaque assemblies, and to improving the consistency of temperatures within the building to increase occupant comfort. These improvements can reduce peak heating and cooling loads to allow for reductions in the HVAC system. In order to achieve this, the envelope design should minimize or completely eliminate thermal bridging. Evaluate all proposed improvements over the prescriptive effective thermal resistance values listed in NECB using energy modeling and LCCA.

3.2.5. FENESTRATION

Fenestration is the weakest part of the building envelope and has a major impact on thermal comfort and energy consumption. Although fenestration can be used for passive solar heat gain in the winter months, this needs to be balanced with heat loss during the

heating season and overheating during the summer. The percentage of fenestration on each orientation needs to be carefully considered and compared to the location-specific prescriptive percentage required by NECB.

3.2.6. AIRTIGHTNESS

The exterior envelope of the building should be as airtight as possible to eliminate the undesirable movement of air – and with it heat and moisture – through the building envelope.

3.2.7. PASSIVE COOLING

In many buildings in Yukon, active cooling systems are not required; however, all buildings can still benefit from passive cooling strategies to maintain better control over the indoor air temperature and provide better occupant comfort. Passive cooling can incorporate low- and high-level operable windows to promote cross-ventilation across spaces. Mechanical ventilation can also be used to remove heat at night and draw in coolnighttime air. Window sun shading, IGU coatings and landscaping also reduce cooling requirements and should be considered in the design.

3.2.8. Refer to Chapter 3, Section 2 – Building Envelope.

4. Energy-Efficient and Sustainable Components and Systems

The Government of Yukon is committed to achieving the energy performance targets specified in Section 2 – Building and Energy Performance through the selection of energy-efficient materials and equipment. All energy-efficiency components and systems should be selected in consideration of the stated energy performance target and are meant to reduce the energy used when the building is operational. All designs and equipment must also consider suitability, capital and long-term operating and maintenance costs, ease of operations, availability and durability.

4.1. BUILDING ENVELOPE AND FENESTRATION

4.1.1. For Category 2 and 3 buildings, the following minimum effective thermal resistance values are required to reduce heat loss to the exterior and to increase indoor comfort.

- 4.1.1.(1) Floor on Grade: RSI 3.52 (R20).
- 4.1.1.(2) Below Grade Walls: RSI 6.16 (R35).
- 4.1.1.(3) Walls Above Grade: RSI 7.1 (R40).
- 4.1.1.(4) Suspended Floors: RSI 8.8 (R50).
- 4.1.1.(5) Roofs: RSI 10.6 (R60).
- 4.1.1.(6) Fenestration: RSI 0.87 (R4.9) / U 1.14 W/(m^2·K).
- 4.1.1.(7) Overhead Doors: RSI 3.2 (R18).

4.1.2. All windows and doors are required to have thermally-broken or non-metallic frames.

4.1.3. All windows should incorporate triple-glazed insulated glazing units (IGU) with dual low-e coatings and gas fills.

4.1.4. Storefront glazing and door lites can incorporate dual-glazed insulated glazing units (IGU) with dual low-e coatings and gas fill.

4.1.5. Overhead doors to have a minimum nominal thermal resistance of RSI 4.4 (R25).

4.2. SELECTION OF ENERGY SOURCES

4.2.1. Energy source options must be determined early in the building design process and must be assessed through LCCA.

4.2.2. Oil has traditionally been the default heating fuel in Yukon communities, but due to low cost, reduced GHG levels, and a lower environmental risk due to spills, propane is also being used where it is available. Electric heat should also be considered as a heat source

where it is allowed, and where LCCA justifies its selection.

4.2.3. For all energy sources, Consultants must consider storage capacity based upon location and delivery schedules. Electric heat should also be considered.

4.2.4. Biomass heating systems: recommendedto be considered in locations where these fuel sources may be delivered economically, practically, and where site-specific environmental factor analysis has determined these systems to be feasible for storage capacity and access.

4.2.5. Wind, solar photovoltaic may be a possible supplementary energy source to use, particularly at remote sites.

4.2.6. Solar thermal heating may be considered for occupancies that have a high hot water use component such as pools and vehicle wash buildings.

4.2.7. Geothermal or ground source heat energy may be considered where electricity is hydro-generated and can present an environmentally sustainable thermal energy source.

4.2.8. Available waste heat from diesel generator energy plants (not standby or emergency), data centers, or other sources in close proximity to a building project are practical to consider as a primary source or supplementary source for building heating energy.

4.2.9. District or common heating systems between two or more buildings might be considered where there are several new or renovated buildings located close to each other. It may be economically practical to add to an existing district heating system if there is surplus or unused capacity, or if the central system or components have been upgraded. District heating systems require LCCA prior to being proposed for a project.

4.2.10. Electricity is required in all Yukon government buildings.

4.3. HVAC SYSTEMS

4.3.1. All HVAC systems to meet the requirements of Chapter 5 – Mechanical Design Requirements at a minimum and should be appropriately sized to improve efficiency.

4.3.2. Furnaces to be Energy Star rated high-efficiency with a minimum Annual Fuel Utilization Efficiency (AFUE) of:

4.4.2.(1) 87% for oil; and

4.4.2.(2) 95% for propane.

4.3.3. Ventilation systems to include heat recovery with a minimum sensible heat recovery efficiency (SRE) of 65% at -25C.

4.3.4. All boilers to be high-efficiency with a minimum Annual Fuel Utilization Efficiency (AFUE) of:

4.4.4.(1) 87% for oil boilers < 300,000 BTUs (87.9 kW), and Energy Star rated.

4.4.4.(2) 95% for propane boilers < 300,000 BTUs (87.9 kW), and Energy Star rated.

4.4.4.(3) Boilers > 300,000 BYUs (87.9 kW) to meet the requirements of NECB.

4.3.5. Air-source heat pumps: Minimum coefficient of performance (CoP) of 2 at -18°C.

4.4. PLUMBING

4.4.1. All plumbing components to meet the requirements of Chapter 5 – Mechanical Design Requirements at a minimum.

4.4.2. Hot water heaters to be Energy Star rated high efficiency.

4.5. LIGHTING

4.5.1. All lighting components to meet the requirements of Chapter 6 – Electrical Design Requirements at a minimum.

4.5.2. All lighting fixtures to be LED, and must be provided with lighting controls in meeting the requirements of NECB.

4.6. APPLIANCES

All appliances, including residential dryers, washers, dishwashers, freezer, refrigerators, microwaves and cooking appliances, and commercial washers and food service equipment must be Energy Star rated and within the top 50% of appliances using the current EnerGuide labelling scale.

4.7. ENERGY METERING AND REPORTING

Refer to Sub-Section 2.5 – Energy Metering.

5. Site Selection and Transportation

5.1. BIKE FACILITIES

5.1.1. Provide bicycle storage for 5% of all regular building occupants. 50% of these storage spaces are to be covered. If only one space is required, then this space does not need to be covered.

5.1.2. More stringent municipal or territorial regulations supersede these requirements.

5.1.3. Bicycle storage is not required for buildings with an industrial major occupancy unless specifically required by the functional program.

5.1.4. All bicycle facilities must be within 30 m of the main entrance.

5.2. PARKING REQUIREMENTS

5.2.1. Do not exceed the minimum local code requirements for employee and visitor parking capacity. This requirement does not apply to parking spaces required for Yukon government fleet vehicles.

5.2.2. Provide signed preferred parking for carpools for 5% of total required parking spaces in Whitehorse.

5.3. REQUIREMENTS FOR ELECTRIC VEHICLE CHARGING

5.3.1. Connect electric vehicle charging stations dedicated to YG owned vehicles to the building's electrical service, where possible.

5.3.2. Provide rough-in of conduit to every stall to allow for future Level II electrical vehicle charging for public and staff use.

5.3.2.1 Conduit serving plugs shall be sized to allow for uncontrolled use with standard 120V/15A for each parking stall.

5.3.2.2 Conduit placement must consider the location of infrastructure for a future electrical service separate from the building.

6. Sustainable Sites

6.1. CONSTRUCTION ACTIVITY POLLUTION PREVENTION

6.1.1. For all Category 1 projects, the Contractor is to prepare and implement an erosion and sedimentation control plan for all construction activities conforming to the requirements of the U.S. Environmental Protection Agency (EPA) Construction General Permit (CGP).

6.2. SITE ASSESSMENTS

6.2.1. Environmental site assessments are required on all projects. Refer to Chapter 1 – General Project Requirements.

6.3. STORAGE OF RECYCLABLES AND COMPOST

6.3.1. Provide dedicated indoor or outdoor space for the collection and storage or recyclable materials in all facilities.

6.3.2. Recyclables include: paper, cardboard, glass, plastics, metals, and batteries.

6.3.3. Provide storage for compost where collection is available.

6.4. SITE RAIN WATER MANAGEMENT

6.4.1. Manage on site the runoff from all developed site areas. Confirm using daily rainfall data. Refer to Chapter 7 – Civil and Site Design Requirements.

6.5. LIGHT POLLUTION

6.5.1. Exterior luminaires cannot emit lumens above the horizontal plane. All fixtures are to be full cut-off.

6.5.2. No exterior lighting is to extend (trespass) onto adjacent properties.

6.5.3. Exterior luminaires to be ≤3,500 kelvin.

6.5.4. Provide exterior lighting control to turn off all non-essential lights after expected occupancy times and provide motion sensors as necessary. Refer to Chapter 6, Section 5.3 – Exterior Lighting Control.

6.5.5. Exterior lighting is mainly used during the winter, spring and fall. Consider the impact of snow cover on lighting levels to reduce reflected light.

6.5.6. Exterior accent lighting for art should be full spectrum lighting, and provided with optics to reduce light spill.

7. Water Efficiency

7.1. IRRIGATION SYSTEMS

7.1.1. All landscaping and playing fields require permanent irrigation systems unless it can be proven that plantings will survive without temporary irrigation after a 2 growing-season establishment period.

7.1.2. No temporary irrigations systems are allowed, unless for ≤2 growing seasons. All temporary irrigation to be provided under a maintenance contract with the Contractor.

7.1.3. Reduce irrigation water usage by ≥50% from the calculated baseline using EPA WaterSense Water Budget Tool.

7.2. WATER EFFICIENT FIXTURES AND APPLIANCES

7.2.1. All fixtures are to be low water consumption as follows.

7.2.1.(1) Water closets: ≤4.8 LPF (1.3 GPM), Maximum Performance (MaP) rating of ≥1000 grams of waste per flush, and WaterSense certified.

7.2.1.(2) Flushing urinals: ≤1.0 LPF (0.25 GPF).

7.2.1.(3) Bathroom faucets: Flow rate of ≤2 LPM (0.5 GPM).

7.2.1.(4) Kitchen faucet (does not include commercial kitchens): Flow rate of ≤5.7 LPM (1.5 GPM).

7.2.1.(5) Showerheads: Flow rate of ≤5.7 LPM (1.5 GPM).

7.3. WATER METERING

7.3.1. Provide a building-level water meter connected to building controls system on all buildings regardless of service. A whole building water meter is in addition to any water meters required by the municipality.

7.3.2. Provide a separate water meter for all permanent irrigation systems.

7.3.3. Allow for future water meters to be installed on high water uses, including irrigation and common laundry and commercial kitchen facilities. Allow for space in plumbing and provide rough-in for controls wiring.

8. Building and Construction Materials

8.1. CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

8.1.1. All projects >$100,000 must achieve a waste diversion of ≥50% of the total waste generated on site. This percentage excludes hazardous and excavated material.

8.1.2. Consultants are to include waste management specifications in the contract documents, which include requirements for tracking, documentation and verification.

8.1.3. Contractors are to develop a waste management plan prior to commencing work on site and are responsible for tracking waste diversion.

8.1.4. Contractors must submit updated tracking documentation with all applications for payment.

8.2. LOW-EMITTING MATERIALS

8.2.1. Interior products and finishes to be materials with low volatile organic compound (VOC) and be low-emitting as follows.

8.2.1.(1) Paints and coatings (site-applied): Meet Canadian VOC Concentration Limits for Architectural Coatings (SOR/2009-264).

8.2.1.(2) Adhesives and sealants: Meet SCAQMD Rule 1168 limits.

8.2.1.(3) Ceiling, walls, and flooring: To meet maximum allowable VOC requirements of California Department of Public Health (CDPH) Standard Method v1.1-2010.

8.2.1.(4) Composite wood: Meet requirements for ultra-low emitting formaldehyde (ULEF) to California Air Resources Board ATCM.

8.2.1.(5) Inherently non-emitting sources: Products such as stone, ceramic, powder-coated metals, anodized metal, etc., are not required to have VOC testing as long as they do not include integral organic-based surface coatings, binders, or sealants.

9. Indoor Environment

9.1. CONSTRUCTION INDOOR AIR QUALITY MANAGEMENT

9.1.1. Contractors are to develop and implement an indoor air quality (IAQ) management plan during construction.

9.1.2. IAQ management plans must exceed the recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ guidelines for occupied building under construction.

9.1.3. Protect all absorptive materials stored on-site from moisture.

9.1.4. During construction, provide filtration media with a minimum efficiency reporting value (MERV) of 8, if using permanent air handling equipment. Install at each return air grille or duct inlet. Prior to occupancy replace all filtration media with the final design filtration media.

9.1.5. Smoking is not permitted within 5 meters of building entrances or openings during construction on all projects, and may not be allowed on some specific sites. Confirm construction smoking requirements with the Government of Yukon.

9.1.6. Upon installation, seal all permanent ducts and vents to minimize contamination during construction. Remove any seals after all phases of construction are completed.

9.2. DAYLIGHTING AND OCCUPANT VIEWS

9.2.1. It is recommended that 75% of all regularly occupied spaces are provided with daylighting and direct views to the exterior. This should be achieved without increasing the percentage of fenestration above the allowable fenestration areas in the NECB. If additional fenestration area is required to achieve this target, then a LCCA is required to determine if the additional fenestration provides any cost benefit to the project.

9.2.2. Consultants are not required to provide simulation, but this may be considered beneficial in deeper or larger floor plates to ensure occupants are connected to the outdoors, and to reduce electric lighting requirements.

9.2.3. A daylight space is one that achieves illuminance levels between 300 and 3,000 lux at the hours of 9 am and 3 pm on a clear sky day at the equinox.

9.2.4. Direct views to the exterior refer to unobstructed views to the exterior, considering any permanent interior obstructions.

3

Architectural Design Guidelines

1. General Design Considerations

1.1. BUILDING DESIGN CONSIDERATIONS

The intent of this manual is to provides standards, strategies, and technical requirements for Yukon government buildings, and is not intended to prescribe any particular form or style of building. The rational application of good design principles in response to programmatic, climatic and available resources will generate an appropriate and practical building design.

Building massing and finishes must relate to a community context; however it is recognized that this may not always be possible. To be successful, the design shall address the following items.

1.1.1. The design must communicate the function of the building and the Government of Yukon visual identity so its use is obvious and visually apparent to all users.

1.1.2. Colours, materials and forms are selected to support and enhance design decisions made on the project, and should be reflective and respectful of the community in which it is located.

1.1.3. Scale and appearance of the building should be consistent with the building's intended use and relation to other buildings nearby.

1.1.4. The relationship of the building to the site should be consistent with its function, local traditions, and to allow access under all weather conditions for maintenance and general public access.

1.1.5. The relationship of the building to public access routes like roads should be consistent with the function and local pattern of site access, including vehicle parking consistent with community vehicle use.

1.1.6. The building design and appearance must reflect appropriate use of public funds and resources by being cost effective and optimizing value, and through spatial efficiency.

1.1.7. Finally, the design must be visually appropriate in the community, energy efficient, and simple to build and maintain. This is generally achieved by using simple and compact building forms that optimize fenestration and building envelope. Designs must address client requirements, meet the allocated construction budget, and include a design rationale.

1.2. CONSTRUCTION METHODS

All designs should consider the appropriate construction methods for the project location, schedule, and building type. Combustible construction is considered preferable where allowed by the NBCC, as it reduces capital costs due to the local availability of labour and skills.

1.3. COORDINATION

Refer to Chapter 1 – General Project Requirements for coordination requirements. The architect is required to be the primary coordinating consultant, including reviewing the work to identify conflicts and to confirm compliance with previously agreed decisions, and to manage the consultant team's own internal coordination. This quality assurance process also requires coordination with an integrated design process, the Yukon government's own design review processes, and projects life cycle costing analyses.

2. Building Envelope

2.1. GENERAL DESIGN REQUIREMENTS

2.1.1. CLIMATIC DATA

The building envelope separates the interior environment from the exterior climate. In various regions of the Yukon design air temperatures can range from -53° Celsius in the winter (Snag) to +26° Celsius in the summer (Dawson City and Watson Lake), with periodic lower or higher temperatures in some years. Average hourly wind pressures can range from 0.31 kPa (Dawson City) to 0.60 kPa (Destruction Bay).

The climate is generally very dry with total annual precipitation largely in the form of snow. Total annual precipitation in weather data recorded communities, ranges from only 275 mm in Whitehorse to 410 mm in Watson Lake (as compared to 1,400 mm in Vancouver or 900 mm in Ottawa). Some communities experience concentrated seasonal intensity of wind driven rainfall, increasing the wetting factor for building envelopes.

Climate load variables within the Yukon must be incorporated into building envelope design. These variables include snow-drifting patterns, wind, seasonal temperatures, annual solar exposure, and very high single-day rainfalls.

2.1.2. CONSIDERATIONS FOR CLIMATE CHANGE

The Yukon government has acknowledged that climate change is occurring, and that Yukon must effectively adapt to this change in addition to reducing greenhouse gas emissions. Building infrastructure is potentially vulnerable to these changes, and therefore decisions must be made during the design process to mitigate the associated risks.

Climate change is increasing the typical total annual winter precipitation in most regions of Yukon, increasing the temperature swings (including more above zero temperatures in the winter), resulting in more extreme weather events such as heavy summer rainfall, and also generally increasing temperatures. Although climate change has only increased Canada's average temperature by 1°C between 1950 and 2000, average winter temperatures in Yukon have increased by 3–4°C in the same period.

Although designs should follow the climate design tables in the NBCC, consideration must also be given to the impact of climate change on the building envelope so that it can effectively manage these changes in the future.

2.1.3. CONSIDERATIONS FOR COLD CLIMATES

Building envelopes in cold climates require careful design and construction to ensure water resistant, low air leakage, energy efficient building envelopes. Recommended minimum practices described herein shall be used, unless the designer can show that different recommendations will provide operational efficiency savings over the planned service life of the building, minimizing total cost of ownership.

The recommendations in this section are intended to supplement and clarify the requirements of NBCC and NECB, for practical and effective application to meet northern climate conditions, which require a more demanding building envelope performance than found in southern Canada.

2.1.4. AIR LEAKAGE, VAPOUR DIFFUSION AND WATER MANAGEMENT

Effective air barriers and vapour barriers are environmental separators essential to efficient and sustainable building envelope performance. An initial quality installation and subsequent maintenance of air barriers and vapour barriers comes from knowing how they work, knowing which materials can be used, providing effective quality management and testing during building construction, and knowing how they must be conserved and maintained.

Environmental separation requirements are stated in the NBCC. Successful application of these requirements can be more difficult in Yukon than in other parts of Canada because of a shorter construction season, very cold temperatures affecting the performance characteristics of materials, and shortages of experienced installers.

2.1.4.(1) Air Leakage

Control and reduction of Air Leakage is critical to a building's overall performance, and is an integral part of its heat and moisture control strategy. A large amount of heat load is due to uncontrolled air leakage, while condensation of water vapour travellingin exfiltrating air within assemblies is one of the main sources of moisture.
Uncontrolled air leakage is a major cause of performance problems in building envelopes.

Control of air leakage, is therefore important for the following reasons.

- Moisture Control: Water vapour in the exfiltrating air can condense within assemblies, causing water damage and mould, which results in health, durability, and performance issues.
- Reducing Energy Losses: 30% to 50% of heating energy consumption in many well-insulated buildings can be due to air leakage through the building envelope. Air movement can also reduce the effectiveness of thermal insulation.
- Comfort and Health: Cold draft and dry wintertime air from air leakage affect occupant comfort, and promote condensation, which can support mould growth and affect indoor air quality. Air leakage can also reduce sound transmission control and allow outdoor odors and gases to enter the interior environment.

Control of air flow through the envelope is managed through the air barrier system — this includes the materials, joints and assemblies providing an uninterrupted plane of airflow control — which must be continuous, strong and stiff enough to take the full wind load and differential air pressures, supported on both side of the membrane, able to perform for the its entire service life, and impermeable to air.

This last requirement is specified in Part 5 of the NBCC, where the maximum air leakage characteristics of a material is specified to be 0.02 L/(s·m2) @ 75 Pa, and the NECB specifies that air barrier systems should leak less than 0.2 L/(s·m2) @ 75 Pa. All category 1 and 2 buildings require whole building air leakage testing and reporting in accordance with

- ASTM E779, "Standard Test Method for Determining Air Leakage Rate by Fan Pressurization";
- USACE Version 3, "Air Leakage Test Protocol for Building Envelopes"; or
- The applicable standards and requirements of the EnerGuide Rating System

Buildings are to be designed and built to achieve a maximum air leakage rate of 1.75 L/(s·m2) @ 75 Pa.

In addition to final whole building airtightness testing, mid-construction testing shall be performed to ensure the building is on track to meet its final target. Mid-construction testing shall be performed on a section of the building, or on the whole building.

In all Category 1 buildings, airtightness will be verified as part of the building commissioning process as specified in Chapter 1, Section 10 – Commissioning and Verification.

2.1.4.(2) Vapour Diffusion and Condensation

The control of vapour diffusion is managed in buildings through the installation of a vapour barrier, which may or may not also function as the continuous air barrier. The vapour barrier's role is to control the water vapour diffusion through the assembly, thereby reducing the occurrence of condensation, and as such only needs to meet a specified level of vapour permeance and cover most of the area of the enclosure. If it is not the air barrier, it does not need to be continuous as vapour diffusion occurs equally over the building envelope. Incidental moisture accumulation within the assembly is not normally a concern as long as this moisture has an opportunity to dry to the exterior during warm temperatures by providing vapour permeable materials outside of the vapour barrier.

The required location for the vapour barrier is on the warm side of the assembly in order to avoid the dew point occurring to the interior of that barrier. Best practice in the North has always used a rule of thumb that only 1/3 of the thermal insulation can be located inboard of the vapour barrier. This approach was intended to allow for a protected air/vapour barrier; however, assemblies that separate the air leakage control function from the vapour barrier, allow for the vapour barrier to be located completely to the inside of the envelope, with less concern about air sealing, and locating a continuous air barrier system outside of the building sheathing. Nonetheless, even in these applications, the Yukon government still requires that the vapour barrier be protected by a service cavity to avoid damage and to act as a secondary air barrier.

Where the vapour barrier is not located on the warm side of the assembly, or where other vapour impermeable materials are proposed within the building assembly (such as foamed plastic insulation), hygrothermal simulation is recommended to confirm that the building envelope will be able to dry to the exterior and not create conditions that support mould growth.

In all applications, the vapour barrier is recommended to be the only plane within the envelope with high vapour permeance resistance to promote drying of the assembly.

2.1.4.(3) Control of Precipitation

The building envelope must be designed to withstand precipitation as specified in the NBCC. All building envelopes should seal against the ingress of precipitation into interior spaces, and minimize/manage the ingress of precipitation into building assemblies.

All buildings must be provided with a precipitation shedding surface, and if this surface is not sealed to prevent the ingress of water, the assembly must be drained to the exterior.

In this second instance, it is recommended that rainscreen cladding principles are applied to both walls and roofs. This approach introduces a layer of natural ventilation behind the cladding material allowing for air drying of the material, and for drainage of any incidental precipitation that may enter the assembly through capillary action, gravity or air pressure. This technique requires the installation of a vapour permeable weather barrier to prevent wetting of the substrate and intrusion of precipitation into the building.

Pressure equalization principles should be incorporated to reduce the likelihood of strong air flows behind the cladding due to differences in pressure around the building, particularly at corners. Therefore, all rainscreen should be divided into compartments, no more than 6 m in width on building faces, and 2.4 m wide at corners, and closed at the corner.

2.1.4.(4) Surface and Ground Water

The building envelope must be designed to control surface and ground water as specified in the NBCC. All buildings should direct water away from the building through grading and means for drainage, and must also be waterproofed to protect from ground water.

Refer to Chapter 7 – Civil and Site Design Requirements for requirements on site grading.

2.1.4.(5) Approaches to Managing Water, Air and Vapour

The following methods are considered acceptable for managing air leakage, vapour diffusion, and water management.

a) Split Air and Vapour Barrier

An acceptable approach to complying with the air and vapour barrier requirements in combustible construction is to meet them using two separate materials and locating each in their ideal location within the envelope. This approach allows the vapour barrier to be installed on the warm side of the envelope. As it does not serve as the primary air barrier, the detailing at intersections and penetrations do not have to be airtight. Instead a continuous vapour permeable air barrier system is installed outside of the sheathing.

This system allows insulation to be included within the framed cavities and outboard of the wall sheathing. Much like an inboard air/vapour barrier system, all insulation in the wall assembly needs to be vapour permeable mineral wool.

However, this system also requires coordination and quality control with trades to create an airtight envelope because the air barrier is normally located on the sheathing below the insulation, and is also hard to repair later on without opening up the wall. All penetrations must be 100% sealed to the air barrier to ensure the effectiveness of the air barrier.

In this assembly, it is also still recommended to provide an uninsulated service wall inboard of the vapour barrier to avoid penetrations through this membrane.

The following are the main benefits of this system.

- The air impermeable material and part of the thermal insulation provide continuous coverage over the exterior of the building envelope.
- The materials can be made very airtight, and are easy to inspect before the exterior insulation is installed.
- The smaller amount of insulation located outboard makes it easier to achieve higher thermal insulation values without introducing structural supports for the cladding.
- Both the air barrier and vapour barrier can be detailed as air barriers, to provide improved airtightness.

The negative aspects include the following.

- Vapour impermeable insulation (EPS, XPS, and ISO) generally cannot be used outboard of the vapour barrier.
- Most materials designed for this application are temperature sensitive and should not be installed at low temperatures, as this may result in poor workmanship and airtightness.
- The system requires a great deal of coordination of mechanical penetrations as these need to be installed before the insulation to provide proper air sealing.

- Although it is protected within the assembly, it is also harder to repair in the future if new penetrations are made through the assembly, as exterior finishes would need to be removed to provide effective air sealing.

b) Outboard Air/Vapour Barrier

An acceptable approach to complying with the air and vapour barrier requirements in constructional types of construction is a combined air/vapour barrier membrane located outboard of the sheathing to provide all (or almost all) of the insulation outboard. This has the added benefit of keeping the structure warm and can reduce or eliminate thermal bridging if detailed properly.

In all instances, if an outboard air/vapour barrier is used on a wall, it must be used on the roof to eliminate transitions of the air barrier from the exterior to interior of the building structure.

The main benefits of this system are as follows.

- The air/vapour impermeable material and thermal insulation provide continuous coverage over the exterior of the building envelope.
- The materials can be made very airtight, and are easy to inspect before the exterior insulation is installed.
- Vapour impermeable insulation (EPS, XPS, and ISO) can be used outboard of the air/vapour barrier.

The negative aspects include the following.

- Most materials designed for this application are temperature sensitive and should not be installed at low temperatures, as this may result in poor workmanship and airtightness.
- The system requires a great deal of coordination of mechanical penetrations as these need to be installed before the insulation to provide proper air sealing.
- It is generally a more expensive system.
- Although it is protected within the assembly, it is also harder to repair in the future if new penetrations are made through the assembly, as exterior finishes would need to be removed to provide effective air sealing.
- As all of the insulation is located outboard it is harder to achieve higher thermal insulation values without introducing structural supports for the cladding, which may cause thermal bridging.

c) Inboard Air/Vapour Barrier (Category 2 and 3 projects)

Industry practice for managing air and vapour diffusion is typically through the use of a 6 mil (0.15 mm) thick polyethylene sheet (or in rare instances airtight drywall, OSB/plywood, or an intelligent vapour barrier that increases permeability during the summer to allow the wall to dry) on the interior of the framing behind the finish. Although inexpensive and of low vapour permeance, this installation does not typically meet air barrier system requirements as it is typically penetrated by service and enclosure penetrations and is not very durable.

If this method is used, it must be protected using a minimum 38 mm deep service cavity inboard of the air/vapour barrier upon which the interior finish is installed. This service cavity should be sized to contain all mechanical and electrical services to avoid compromising the integrity of the air/vapour barrier.

This approach also requires a great deal of diligence in providing a continuous air barrier at all penetrations, including floors, transitions, and at all openings. It is required that higher-quality tapes are used in this instance, as they are usually the weak point in the assembly. These tapes must be intended for the specified vapour barrier, and it is important to note that sheathing house wrap tapes are not acceptable.

Insulation is to be installed within the wall cavity, and outboard of the sheathing. However, it is not recommended to install vapour-impermeable insulation outboard of the sheathing in the wall assembly as it will create a double vapour barrier and may trap moisture in the wall cavity. Instead, only vapour permeable insulation should be used.

If this approach is used on walls, it must also be used for the roof to maintain the location of the air/vapour barrier within the envelope. It is also recommended in vented roof assemblies, as the transition from an outboard air barrier or air/vapour barrier to an inboard air/vapour barrier can be challenging due to structural requirements. It usually means that the system will be relying on the framing and gaskets to maintain air barrier continuity.

The main benefits of this system are as follows.

- The system is generally inexpensive.
- As the air/vapour barrier is left exposed during rough-in, it is generally easy to check for air sealing issues prior to the installation of interior finishes.
- As the air/vapour barrier is located to the interior of the wall assembly, the stud cavities can be used for insulation, which reduces the amount of outboard insulation required.
- The repair of the air/vapour barrier generally only required removal and patching of the interior wall finish, leaving the exterior finish intact.
- The location of the air/vapour barrier inside of the insulation allows the vapour barrier to be installed in a controlled environment.

The negative aspects include the following.

- The air/vapour barrier does not provide continuous coverage over the exterior of the envelope, as it is broken by floors.
- Vapour impermeable insulation (EPS, XPS, and ISO) cannot be used outboard of the air/vapour barrier.
- It is difficult to achieve an airtight building envelope, and are easy to inspect before the exterior insulation is installed.
- The air/vapour barrier is at risk of damage unless protected by a service wall.

2.1.4.(6) Other Acceptable Approaches

a) Sprayed Foam Insulation Air/Vapour Barrier

Sprayed foam insulation air/vapour barriers are not allowed unless they are installed continuous over the exterior sheathing or where approved by the Yukon government. This is due to the fact that over time the foam can separate from the framing, creating gaps that will allow air movement. If proposed, the Consultant must provide rationale that is acceptable to the Yukon government.

This system also needs to be installed to a minimum thickness to meet the air/vapour barrier requirements, must be installed by a qualified installer,

and requires careful detailing at transitions and movement joints to ensure airtightness. This minimum thickness is typically 50 mm, but will vary depending on the manufacturer.

b) Insulated Metal Panels and Structural Insulated Panels

Insulated metal panels (IMPs) provide water, air, vapour, and thermal control in a single product installed outside of the structure. The interior metal face of the panel provide air and vapour control, while the exterior metal provides water, air, and vapour control. The panels integrate tongue and groove rainscreen joints, which rely on sealant between the panels to provide continuity of the air barrier, and provide continuity in the thermal layer. As the sealant is critical to building airtightness, it is important that two beads of sealant are applied at all joints. It is also important to note that detailing at all openings, joints and penetrations require additional care to maintain the water, air, and vapour control, and to minimize the creation of thermal bridges.

Structural insulated panels (SIPs) provide air, vapour, and thermal control through the centre of the panels, but unlike IMPs, the joints require work on site to maintain the continuity of these control layers. The exterior and interior OSB layers require sealing at the panel joints to provide an effective air barrier to avoid having condensation form on the exterior OSB layer. Also, as the panels are typically joined with a wood spline (although other options are available), the panels do not completely eliminate thermal bridging. SIPs do not manage water, and require a separate water control layer.

As the interior layer of both panel products form part of the air/vapour barrier, a service wall must be installed inboard to allow for the installation of services and interior finishes. This service wall can be omitted in IMPs in industrial uses where the interior metal liner panel is an acceptable finish, and exposed services are acceptable.

It should be noted that for IMPs, the exterior face sheet is typically used as the finish. This means that a great deal of care needs to be taken during construction to protect this finish throughout the duration as panels are not easily replaceable, and therefore the exterior needs to be refinished in place or re-skinned. An alternative approach, is to install an exterior finish and rainscreen over the panel, but this requires additional clips or girts to tie the cladding to the structure behind, and increases the cost of the system.

The major benefit of both these systems is that they shorten the duration that it takes to make a building weathertight. However, the lead times for shop drawings and fabrication also need to be considered.

c) Membrane Roof Air/Vapour Barriers

A standard membrane “flat” roof is considered a double air/vapour barrier assembly due to the fact that an air/vapour barrier is provided both on the interior of the assembly and on the exterior. The interior membrane’s primary function is as an air barrier (and vapour control) and must be detailed as such to prevent air from entering the assembly. The exterior membrane functions as the primary precipitation control layer but also to control air. The interior and exterior membranes must be connected to the appropriate wall membranes in order to provide air barrier system continuity.

Inverted roofs do not have this issue because they only rely on a single membrane located under the insulation as an air/vapour barrier.

2.1.4.(7) Air, Vapour and Precipitation Control Materials

All air, vapour and precipitation control materials must exceed minimum code requirements, be specified, detailed, and installed to be durable, protected from deterioration (in cold climate conditions), serviceable, and to meet their intended purpose for the expected lifespan of the building. They must also be physically and chemically compatible with other building materials to avoid changes in physical behavior or premature deterioration.

As noted, it is absolutely critical to consider the vapour permeability of all materials in the assembly (including sheathing and insulation) to avoid condensation and moisture damage within assemblies due to trapped moisture. All exterior wall assemblies must have the ability to dry to the exterior.

a) Sealants

i) All sealants used as part of the building envelope must be:

ii) Serviceable to -50°C in their fully cured state.

iii) Able to be installed under temperature and moisture conditions encountered during their installation.

iv) Strong enough to resist the anticipated loads without deforming or moving out of position.

v) Elastic and compressible to accommodate movement of the joint.

vi) Chemically compatible with adjacent materials.

vii) Accessible for service or replacement.

viii) Placed in primed joints of proper dimensions and proportions with backing rod or bond breakers to prevent unintended adhesion to adjacent surfaces.

Silicone and single-component elastomeric sealants are required for general envelope sealing due to their installation and service temperatures. Multi-component elastomeric sealants are only recommended for specialized applications such as curtain walls and exterior panel systems. Acrylic and solvent curing sealants (butyl caulking) typically do not perform as well in the northern environment and are not acceptable, unless recommended by the manufacturer.

2.1.5. THERMAL RESISTANCE AND ASSESSMENT

The thermal resistance of the building envelope minimizes heat loss and thereby reduces building energy consumption, and increases occupant comfort. Refer to Chapter 2 – Energy and Environmental Design Requirements for determining optimum thermal resistance.

Designers are required to perform effective thermal resistance calculations for all exterior building assemblies and must include these within their drawing package to show conformance with NBCC, NECB and the requirements of the Yukon government. These calculations can either be done following the requirements of the NBCC or following ASHRAE standards. Nominal insulation values are not acceptable and do not prove compliance.

Thermal resistance calculations must also be used to determine the dew point within the assembly for the design temperature of the building location. This calculation must show that the dew point occurs outside of the vapour barrier material to prevent moisture condensation on the interior surfaces of the building envelope or a hygrothermal modeling report must be provided. The default in Yukon is that 2/3 of the effective thermal insulation value should be located outside of the vapour barrier, but the correct placement of the vapour barrier should be confirmed through calculations.

2.1.5.(1) Minimum Thermal Resistance Values

As specified Chapter 2 – Energy and Environmental Design Requirements, all Category 1 buildings require an energy model to determine compliance with the stated energy performance requirements. For Category 2 and 3 buildings, the minimum thermal resistance values are specified in Chapter 2, Sub-Section 4.1 – Building Envelope and Fenestration.

Buildings that are energy modeled can use the prescriptive values as a baseline for analysis but can be varied to achieve the required energy performance. However, in all instances, no thermal resistance values should be lower than the prescriptive values of NECB for the climate zone or local bylaw requirements.

Reduced thermal resistance is allowed for all assemblies where the NECB or NBCC allows due to seasonal use, or where areas have no heating requirements.

2.1.5.(2) Thermal Insulation Location and Types

Refer to Sub-Section 2.1.4.5 for recommended exterior assembly approaches and types.

The use of polyisocyanurate (ISO) insulation is not recommended unless it makes up less than 50% of the designed thermal resistance and is located within the most interior half. This is due to reduced performance of ISO at low temperatures. Due to this performance variation, the US National Roofing Contractors Association (NRCA) has revised the in-service thermal resistance of ISO to RSI 0.88 (R5) per 25.4 mm. If comprising more than 50% of the insulation in an assembly, this value must be used for calculating its effective thermal resistance rather than the published manufacturer's long-term thermal resistance (LTTR) rating.

2.1.5.(3) Continuity of Thermal Insulation

a) All thermal bridging by structural members needs to be avoided or minimized and, if required, must be accounted for in energy modeling.

b) A continuous layer of insulation is required over the exterior of the structural framing. This can either be as insulated sheathing, or a separate layer of insulation. Where approved by the Government of Yukon, a double stud wall, Larson truss, or wood I-joists could also be used to reduce thermal bridging.

c) All outboard rigid or semi-rigid board insulation systems must be installed in two layers at right angles to each other.

d) It is recommended to avoid using strapping within the exterior insulation layer, and instead it is recommended to use one of the following approaches.

    i) Screw-installation of vertical strapping or girts through both layers of insulation.

    ii) Non-conductive thermal clip/spacers.

    iii) Wood Larson truss installed outboard of the sheathing.

2.1.5.(4) Preventing Localized Cold Spots

a) Cold spots, with surface temperatures falling below the dew point, can occur in concealed service spaces or near concealed voids in floor/wall and roof assemblies, despite good thermal insulation, unless a heating source is provided.

b) Ensure such spaces are connected to the interior warm zone of the building to avoid moisture condensation and frost formation within such spaces.

2.2. FLOORS ON GRADE

Many buildings in Yukon can be placed on the ground when granular or similar durable soil conditions are available, and where recommended by the geotechnical engineer. In these instances, conventional foundation systems may be used.

However, where continuous permafrost exists, buildings are either elevated above the ground surface to eliminate heat flow into thaw susceptible soils, supported by steel piles or a wood/metal framing system, or utilize a Thermosyphon© or equivalent sub-floor ventilation/heat extraction and control system. Elevated buildings require careful design of air, vapour and thermal barriers because an additional 20% to 30% of exposed exterior envelope surface is created.

Basements and buried strip and pad footings are possible in many locations where the foundation system can be supported deeply enough below the active permafrost layer, or where the ground is unaffected by freezing. Such foundation systems require careful design to minimize heat transfer and ground water intrusion, and require temperature monitoring at the frost level to allow for corrective action prior to degradation of the permafrost layer.

On permafrost bearing thaw-susceptible sites, building foundation bearing capacity can be maintained by artificially cooling the ground, and insulating it from building heat transfer and localized heating from surface water or excessive sunlight exposure. Induced and natural draft cold air systems, powered refrigeration and thermosyphon/thermoprobe refrigeration have all been used to keep permafrost intact beneath heated buildings. In all cases, great care must be taken to prevent building heat transfer into the ground through the foundation system.

Due to warming temperatures as a result of climate change, many areas of permafrost are beginning to thaw, causing unreliable soil conditions. In these areas significant consideration needs to be given to both existing conditions and expected conditions for the lifespan of the building. All buildings constructed on permafrost must be provided with a means of leveling within a range specified by the structural engineer.

Refer to Chapter 4 – Structural Design Requirements.

2.3. BASEMENTS AND CRAWL SPACES

2.3.1. BASEMENTS

2.3.1.(1) All basements are to be provided with a concrete floor finish.

2.3.1.(2) Provide 0.25 mm (10 mil) vapour/moisture barrier below all concrete slabs and above insulation to protect barrier during construction. Lap all joints and penetrations by 100 mm and seal using manufacturer recommended tape.

2.3.2. HEATED OR VENTED CRAWL SPACES

2.3.2.(1) Crawl spaces that contain service equipment must be 1.6 m high between the top of the crawl space floor finish and the underside of floor framing. All other crawl spaces must be a minimum of 1.2 m high.

2.3.2.(2) Provide concrete topping in all heated crawl spaces to protect the vapour/moisture barrier from damage.

2.3.2.(3) Provide heating, ventilation, and moisture protection as required by the NBCC and this Chapter.

2.3.2.(4) Slope all heated crawl spaces in towards floor drains and install water sensors. During design, consultants must confirm with the AHJ whether these drains are permitted to be connected to sanitary or storm water infrastructure. If not permitted, then these lines should be connected to a sump pump system or rock-pit designed by a civil engineer.

2.3.2.(5) Slope all unheated crawl spaces toward storm drainage.

2.3.2.(6) Perimeter footing drainage shall be provided if required by the geotechnical engineer for the selected foundation system. Follow the geotechnical requirements for this drainage system, and connect to a sump pump system.

2.3.3. OPEN CRAWL SPACES

2.3.3.(1) Open crawl spaces below buildings should be securely enclosed with durable metal mesh, heavy-gauge chain link fencing, or louvers, and equipped with a lockable gate to allow for access and to avoid vandalism and animal intrusion.

2.3.3.(2) Grade open crawl spaces 2% to the perimeter of the building, and a minimum of 4% outside the building footprint unless other recommendations are provided by the geotechnical engineer.

2.3.3.(3) The surface finish with the open crawl space should be granular material compacted to the geotechnical engineer's recommendations.

2.3.4. RADON AND HYDROCARBONS

2.3.4.(1) Where sites are located in areas where the average radon level is higher than Health Canada exposure guidelines, building are to include a radon depressurization system and sealed soil gas barrier under floor systems in contact with the ground.

2.3.4.(2) All Part 9 buildings must be provided with rough-in for a radon depressurization building as required by the NBCC.

2.3.4.(3) Sub-slab construction must allow for ventilation including granular material, ventilation layer, and/or piping.

2.3.4.(4) Soil gas barrier must be a product tested for radon resistance and must be installed in accordance with manufacturer's recommendations.

2.3.4.(5) Provide capped pipe penetration for future active depressurization in an accessible location to allow for soil gas testing.

2.3.4.(6) Provide a hydrocarbon membrane under all floors on grade as required by the environmental site assessment.

2.4. EXTERIOR VERTICAL ENCLOSURES

2.4.1. EXTERIOR WALLS

2.4.1.(1) Wall Construction

a) Exterior wall framing or assembly composition will depend on the construction type.

b) Refer to Sub-Section 2.1 – General Design Requirements for the design of exterior wall assemblies.

c) Refer to Sub-Section 3.2.1. – Interior Wall Finishes.

2.4.1.(2) Wall Cladding

Maintenance needs, appearance, durability, delivery timelines, ease of repair and availability of repair materials in remote Yukon communities are all considerations that are to be optimized for durability and economy when selecting wall cladding for Yukon government facilities.

a) All exterior wall cladding should be installed so that it meets the requirements of Sub-Section 2.1 – General Design Requirements.

b) Exterior wall cladding patterns, fasteners and edge joints should provide for easy replacement of individual boards, sheets or panels at locations on the building exposed to intentional vandalism or accidental damage, and where vehicle access barriers are impractical to install.

c) The number of wall cladding types, patterns and sizes used in a building should be limited to simplify building maintenance.

d) Wood Cladding

i) Site finished wood cladding is not recommended.

ii) Lap joint, channel or drop joint siding is recommended to facilitate repairs, although vertical board and batten or tongue and groove joint siding is also acceptable.

iii) A semi-transparent, low-VOC stain finish is recommended for ease of routine maintenance. Solid colour acrylic-latex stains are acceptable provided they are water vapour permeable. Non-vapour permeable paint finishes for exterior wood should be limited to fascia and trim, which should be back-primed to minimize vapour migration and paint blistering.

iv) Wood cladding should not be used on buildings with insufficient maintenance resources or increased vandalism or fire risk, or on south and west elevations.

v) Nail or staple fasteners for the attachment of wood cladding to wood strapping are not to exceed a spacing of 400 mm due to freeze-thaw cycles.

e) Treated Wood Cladding

i) Heat or acetylation treated or polymer grafter wood siding is acceptable without the application of any finish due to its treatment process.

ii) Lap joint, channel or drop joint siding is recommended, although vertical board and batten or tongue and groove joint siding is also acceptable.

iii) Install using manufacturer recommended fasteners only.

f) Fibre Cement Board Cladding (cellulose-reinforced)

i) Fibre cement board exterior cladding siding or panels are recommended for building exteriors which are susceptible to increased weather deterioration, minor abrasion and impact damage, and where non-combustibility for increased fire safety is important.

ii) Cement board cladding on building walls subject to occasional strong impact loads (from snow clearing or vandalism) are recommended to be installed at an elevation above the impact zone, generally above the 1.2 meter elevation, or to be fully backed with 15.9 mm thick plywood.

iii) Provide a factory finish on all cement board cladding.

g) Metal Wall Cladding

i) Metal wall siding panels shall be factory preformed steel sheet, minimum 0.6 mm (24-gauge) base metal thickness. These panels can either be zinc or 55% aluminum-zinc coated or factory pre-finished on the weathering face.

ii) Profiles should be selected from manufacturer's standards. All deep rib profile siding should be installed with the flutes vertical to facilitate snow and ice drainage and minimize vandalism access to upper portions of walls.

iii) Colours should be selected from the manufacturer's standard palette.

iv) Residential grade aluminum siding is not acceptable.

v) Minimum 3 mm thick commercial extruded aluminum siding which is designed for thermal expansion and contraction is acceptable.

h) Phenolic Resin Panels

i) Phenolic core panels are acceptable for use as they are highly durable and come in both laminate and wood veneer finishes.

ii) Provide open joint system to allow for panel expansion and contraction.

iii) Panel installation must allow for individual panels to be removed for maintenance.

iv) Exposed colour-matched fasteners are recommended as this facilitates the replacement of panels if they become damaged, but hidden clip systems are also acceptable if they allow for individual panel removal.

v) Fastening patterns and methods must follow manufacturer's recommendations.

vi) Provide graffiti resistant finish where panels are at risk of vandalism.

vii) Provide a minimum 25 mm ventilation cavity behind panels to avoid delamination due to heat.

i) Aluminum Composite Metal (ACM) Panels

i) Formed aluminum composite panels are not recommended unless the project schedule can accommodate a longer fabrication schedule as they require site measurement prior to fabrication.

ii) If schedule is an issue, then an ACM product with trims can be specified.

j) Through-Coloured High-Density Fibre Cement and Glass-Fibre Reinforced Concrete (GFRC) Panels

i) Through-coloured high-density fibre cement and GFRC panels are acceptable when a high level of durability or level of finish is required.

k) Stucco and Exterior Insulation Finish Systems (EIFS)

i) Stucco and EIFS are not acceptable finishes.

l) Vinyl Wall Cladding

i) Vinyl siding is not an acceptable wall cladding or soffit finish.

2.4.2. EXTERIOR DOORS

Several problems are commonly experienced with exterior doors, including conductive heat loss and air leakage due to loss of material flexibility at cold temperatures, insufficient hardware adjustment, or door panel warpage.

Vestibules are required at all main entrances to separate the inner and outer entrance doors, to prevent heated air loss and drafts, and to increase indoor building comfort. Where both sets of doors may be left open at the same time it is recommended to incorporate an air curtain or a revolving door. If an air curtain is installed, consideration should be given to controlling its cycle time.

The following requirements apply to all exterior doors.

2.4.2.(1) Exterior Doors

a) All insulated hollow metal doors are recommended to be insulated 16 Ga. steel welded seam construction, or 14 Ga. in areas of known high traffic or forced entry.

b) Thermally broken aluminum doors are acceptable at main building entrances.

c) Where security is a concern, minimal glazing should be provided except for at main entrances.

d) All exterior doors are to be outward swinging except where allowed by the NBCC for residential occupancies.

2.4.2.(2) Exterior Door Frames

a) Minimum 16-gauge steel (strengthened with added reinforcement for heavy duty or known vandalism locations), pressed metal thermally broken welded construction frames are required for all exterior doors.

b) Thermally broken aluminum storefront or curtainwall frames are acceptable at main building entrances.

c) Thermally broken metal frames require solid backing of both the interior and exterior frame sections at hardware locations to support the frame and avoid damage to the thermal break material.

d) Thermally broken metal frames require added structural reinforcement (such as inclusion of a 12 Ga. stiffener bar welded inside the exterior side frame stiles) by the manufacturer when they are to be installed in heavy duty high traffic locations, or in facilities that are subject to forced entry or vandalism, so as to increase the frame in-service strength and durability.

e) Removable mullions should not be used with double doors, unless three-point latching is provided for each door leaf, to secure each leaf to the frame head and the threshold plate.

f) Provide high quality door seals around the perimeter of all exterior door frames to maintain the building air barrier, and to minimize corrosion from moisture.

g) Glazing in sidelights and transoms is acceptable and must be insulated glazing units with safety glass. Where window glazing is located beside an exit door or access to exit, it must be provided with a visible graphic or mullion at 1100 mm above finished floor.

h) On high use doors, glass should be kept 200 mm above the ground to prevent damage.

2.4.2.(3) Overhead Doors

a) All overhead doors shall be insulated metal with replaceable metal skinned panels. In locations where there is a risk of impact damage, 16-gauge metal doors should be specified.

b) Large dimension, flexible, angled weather seals designed for extreme exposure shall be installed at the exterior head and jambs. Threshold seals should be of a material that will not freeze to the floor.

c) Thresholds shall be designed to avoid thermal bridging, and the thermal break should be located so that it aligns with the door.

d) Aprons outside the building envelope shall be sloped 2% away from the building to ensure water and ice does not accumulate in front of the door.

e) Provide painted and concrete filled metal bollards on the interior and exterior of all overhead door jambs.

f) Provide a protective wall finish on the overhead door jamb to a height of 1.2 m to protect against scuffing or impact damage.

g) Door operation to be electric unless specified otherwise in the functional program. Coordinate all electrical requirements.

h) On doors that are expected to open frequently, need to be left open for long periods of time, or to achieve a high level of energy performance, it is recommended to consider the use of recirculating air curtains to reduce the loss of heated air to the exterior, thereby creating a more comfortable indoor environment and reducing energy costs.

i) At loading bay doors, provide dock levelers and shelters. Consider the use of inflatable dock shelters or loadhouses to provide an increased energy savings and an improved working environment.

2.4.2.(4) Door Hardware

a) Refer to Sub-section 3.1.3 – Door Hardware.

2.4.3. EXTERIOR WINDOWS

The number, size and location in the building of windows should be carefully selected for energy conservation, building envelope, climate and because of the potential for vandalism in some locations. Views and natural light character (glare, sun angles) must be carefully considered when selecting and locating windows.

The total performance of fenestration products will be based on AAMA/WDMA/CSA 101/I.S.2/A440, NAFS – North American Fenestration Standard/Specification for windows doors and skylights and CSA A440S1, the Canadian Supplement to NAFS.

2.4.3.(1) Window Frames

Frame materials are to be selected for durability and reduced long term maintenance, eliminating the need to refinish weathered frames. Frames with high thermal resistance are required to reduce building heat loss, and minimize the potential for condensation on interior frame surfaces.

a) Commercial or institutional grade thermally broken aluminum, fiberglass frames, or PVC are required on all facilities.

b) Frame stiffness for all types of frame materials and at latch locations for sash lock mounting must be stiff enough to compress operable air seals for tight sealing.

c) Minimum window thermal resistance requirements specified in Chapter 2, Sub-Section 4.1, Building Envelope and Fenestration, are for the entire window as designed, including frame, and glazing unit. The values are not for center of glass.

d) Window frames to meet the following performance classes.

i) 4 storeys and Lower: Class LC.

ii) Higher than 4 storeys, or where heavy use is expected: Class CW.

e) Performance grade to meet the following.

i) Category 1 Buildings: Minimum performance grade of PG35, except in Destruction Bay where a minimum performance grade of PG40 is required.

ii) Category 2 Buildings: Select performance grade according to CSA A440S1.

f) Water Penetration Test Pressure: Minimum 290 Pa to CSA A440S1.

g) Air Infiltration: A3 rated for all operable windows.

h) Condensation resistance factor (CRF): >55.

2.4.3.(2) Sub-Sill Drainage

a) Installation details shall provide sub-sill drainage as a secondary or back-up drainage path to prevent water ingress into the wall framing assembly

between the water shedding surfaces of the window frame and the adjoining wall.

2.4.3.(3) Sealing to Air Barrier System

a) Consultants are required to detail durable, strong and easily constructed connections to satisfy rain-screen and air barrier system principles, and protection from extreme local climate conditions.

b) Sealants used to bond glazing into frames and operable sashes are required to conform to applicable national standards for windows.

c) Contractors are required to provide a mock-up complete with tie-ins to adjacent materials and assemblies to demonstrate the sequence of installation for Consultant approval.

2.4.3.(4) Location in Wall Assembly

a) The window location in the wall assembly should straddle the plane of the air barrier to allow for its continuity through the window frame without requiring an offset. It must also be located towards the centre or warm side of the effective insulation value of the wall to reduce the risk of condensation on the window. Deep interior window jambs create a high risk for condensation due to low temperatures on the window frame and glazing.

2.4.3.(5) Operable Windows

a) Windows must be designed and installed so that the operable sash will not be blocked by accumulations of snow or ice on the exterior window sill. This allows ventilation during transition seasons when the outside air temperature is suitable to introduce into the building.

b) Twin air seals are recommended for operable windows, as a means of reducing air leakage and for minimizing frost-sealing in winter.

2.4.3.(6) Security Requirements

a) Windows located in visually concealed areas should be reviewed for provision of added security measures. (Impact resistant film, security grilles or impact resistance laminated glazing).

b) A single-glazed removable sash of polycarbonate plastic (except in exits), laminated or tempered glass, or an impact resistant security film on the exterior of the glass sheet, integral with the frame, is recommended to protect windows where deemed necessary. Shutters or removable panels are effective window protection methods and are required, where necessary for seasonal-use or isolated facilities where window vandalism is a potential problem, such as in schools. Removable systems require a suitably designed space for storage on site.

2.4.3.(7) Glazing

a) All exterior glazing to be triple-glazed insulated glass, with dual low-E films, 90% argon fill, and non-conductive spacers.

b) Design all glazing thicknesses to meet all building code loads for building height, location, including all wind loads, seismic loads, human impact loads, guard loads, seismic movements, and other expected movements and deformations of the building. Deflection of all glass supporting members to be L/175.

c) Tinted glazing is not recommended for managing solar gain. Building orientation, window configuration, and exterior solar shading should be considered before selecting this solution.

2.5. EXTERIOR HORIZONTAL ENCLOSURES

2.5.1. ROOFS

Building roofs, designed for historically measured snow loads, are expected to require increased structural capacity in future years, as climate change brings heavier annual snowfalls and wetter, denser snow. Design snow load values compiled in NBCC are based upon updated weather record data, but the impact of climate change must also be considered. The total annual precipitation increase in some northern regions requires additional attention be given to roof water drainage design and operation. This is to ensure roof drainage water is not retained in ponds on the roof and is able to move away from the building perimeter once drained off the roof.

Snow accumulations on metal roofs create particular injury risk to people and property from falling snow slabs, unless snow retention guards are installed. All roofs must be designed to shed snow and water away from entrance doors and adjacent pedestrian walkways, roadways and parking areas.

All roofs must incorporate fall prevention systems meeting the requirements of the Workers Safety and Compensation legislation, when equipment is located on the roof, when maintenance staff are required to access the roof on a regular basis, or when workers are present and exposed to a specified falling risk.

2.5.1.(1) Vented Roofs

a) Whenever mineral wool or cellulose insulation is used in a roof assembly, the roof must be vented either below or above the roof sheathing.

b) Provide natural ventilation in accordance with Part 9 of the NBCC.

c) Naturally ventilated roofs are only recommended in areas not affected by the potential for high winds and airborne snow drifting. Care must be taken to prevent snow infiltration through the vents into fibrous mineral insulation.

2.5.1.(2) Exterior Insulated Roofs

a) Protected, fully adhered coincident air/vapour (AV) barrier membranes located above the structural deck are recommended for all un-ventilated building roofs with rigid insulation located outboard of the AV barrier.

2.5.1.(3) Low-Slope Roofs

a) All low-slope roofs are required to be constructed with a minimum drainage slope of 2% (1:50) leading to internal drains positioned at the low points of the roof or to continuous high-performance eaves troughs at the eaves and drain channels or down pipes. Free-fall drip edges are not acceptable.

b) Low-slope roofs rely on using continuous impervious water-shedding membranes which can be visually inspected for breaks and water intrusion locations and can be repaired directly from the top of the membrane. Recommended best practice for continuous water-shedding membranes for roofs is a bonded elastomeric membrane such as SBS (styrene butadiene styrene) modified bituminous membrane.

2.5.1.(4) Water Shedding Membranes

a) Metal Roofing.

Lapped pre-finished sheet steel metal roofing with exposed or concealed fasteners is the preferred roofing on roof slopes greater than 3:12. Machine-seamed double folded standing seam metal roofing with expansion and contraction strain relieving anchors are recommended for low-slope installations.

b) Shingles.

Heavy weight wind-resistant asphalt shingles are acceptable for use in areas not subject to high winds, where the roof slope is 4 in 12 or greater, or 2.5 in 12 where low slope application shingles are used. Wood shingles and shakes are not accepted for Yukon government buildings.

c) SBS Membrane Roofing.

Two-ply styrene butadiene styrene (SBS) modified bituminous membranes are recommended on all low-slope roofs and can be specified as fully adhered or mechanically fastened depending on the assembly. On simple roof forms with a slope >3%, and where there is no rooftop equipment, single-ply membranes may be considered.

d) EPDM or Rubber Roofing.

EPDM or other single ply loose laid membranes are not acceptable.

2.5.1.(5) Stepped Roofs and Penthouses

a) Avoid stepped roofs with different height levels of the water-shedding membrane due to snow drifting and increased loading. If two different roof levels are required, they should be connected by a continuous sloping transition section. It should also be noted that snow accumulates in crevices and between stepped sections of a roof causing a wet film of melted snow against joints, flashings and penetrations in the roof water-shedding membrane under the snow, and on vertical wall segments between the stepped sections of the roof. Ice-lensing and bursting of roof membranes at joints and flashings can result, causing early deterioration of the roof.

b) Mechanical penthouse rooms are recommended to be designed and located so as to minimize the amount of snow build up on low-slope roofs.

2.5.1.(6) Roof Eaves and Canopies

a) Eaves and canopy projections beyond the line of the air barrier must not weaken the air tightness of the building envelope. Where the air barrier is located outside of the structural framing, eaves and canopies should be supported by structural members which do not pass through the air/vapour barrier.

b) Minimal eave projections ranging from 100 to 200 mm are preferred in colder and drier regions of Yukon. Larger eaves projecting 300 to 600 mm are necessary in wetter regions and in specific communities where there is a concentration of annual rainfall in a short period of the year, and where wind driven rain increases the rate of periodic wetting of building walls.

c) Provide extended eaves or canopies to deflect falling snow and water from all primary and secondary exterior entrance doors and pedestrian walkways.

2.5.1.(7) Roof Drainage

a) Eaves troughs shall be designed to accommodate local weather conditions, contain roof water runoff and direct it to suitable locations away from the building walls and grade perimeter, prevent ice damming, and withstand ice and snow structural loading.

b) Low parapet upstands at roof edges in place of eaves are acceptable for internally drained low slope roofs. Parapets are to be avoided on perimeter drained roofs as should through-parapet scuppers.

c) All roofs with parapets must be provided with emergency overflow scuppers. The quantity, size and location of the scupper must be determined through calculations based upon 100-year rainfall quantities.

d) Refer to Chapter 5 – Mechanical Design Requirements for roof drains.

2.5.1.(8) Roof Access and Fall Protection

a) Insulated and thermally broken roof access hatches are required when routine access is required to all low slope roofs.

b) Coordinate the size of access hatches with maintenance personnel.

c) Any roof access, hatches or doors, have to be designed and located to ensure that falling or drifting snow will not impede access.

d) Refer to Sub-Section 5.1.4. – Facility Fall Protection.

2.5.2. HORIZONTAL OPENINGS

2.5.2.(1) Skylights

Unless shown to provide significant benefits to occupants, and unless means are provided to control condensation, skylights are not to be used in Yukon government facilities. The benefit of overhead daylight must be available for significant portion of the year, and inclusion must be justified on a project by project basis.

Successful skylight installation and operation in northern conditions requires exceptional care selecting glazing type, frame materials, condensation and heat loss control features, and positioning the skylight above the main drainage plane for positive water drainage. Placement should also avoid snow and ice accumulation and related water-film deterioration of the skylight and its flashed perimeter seals.

Effective skylight performance requires incorporation of several essential technical design and thermal resistance features matching the windows in the same building, including the following.

a) A steeply glazed surface slope is required for drainage, i.e., 3:12 to 6:12, or a continuous framed self-draining one-piece molded aluminum unit is used.

b) Skylight units should be placed on raised curbs above the roof plane a minimum of 400 mm to allow for drainage, expansion and contraction control, and flashing of joints.

c) Adequate air circulation must be provided across the interior of the skylight to minimize condensation, and ample interior condensation gutters must be provided.

d) Thermally broken or thermally resistive framing members should be detailed with a secondary drainage plane leading to the exterior to meet the environmental separation requirement of NBCC.

e) Skylights should be equipped with blinds or have a tinted shading factor for reducing overly strong sunlight. The blinds must be electrically operated.

f) Skylights are not recommended in a building where the cooling load created by heat gain through the skylight outweighs the benefits of reduced lighting requirements.

2.5.2.(2) Clerestory Windows

a) Clerestory windows are preferable alternatives to skylights, provided careful design allows them to remain clear of snow accumulation and resist driven rain intrusion.

b) Driven rain at clerestory window heads, and drifted snow at the sill, need to be accommodated in the flashing and roofing details to resist the concentrated wind effects around the stepped portions of roofs, or on the vaulted penthouse enclosures above the general roof plane, where clerestory glazing is installed.

c) A minimum height to sill of 200 mm is required. Eaves extensions at the head are also required to divert driven rain away from the window head frame joint to the wall.

d) Clerestory wi ndows need to be placed on the interior side of the wall plane to minimize heat loss and avoid water condensation on the interior frame and glass surfaces. Condensate capture trays in the frame and air system diffusers positioned to direct ventilation air to the glass surfaces are recommended where there is a risk of condensation on the window.

e) Operable clerestory sashes are not acceptable. Rather fixed glazing units are required. Building ventilation from clerestory vaults is better achieved using operable ventilation louvres and controlled by the building controls system.

2.5.3. ABOVE-GROUND EXTERIOR FLOOR ASSEMBLIES

Floors elevated above open crawl spaces are common in permafrost and discontinuous permafrost zones in Yukon. Elevated floors result in heat loss, air leakage, snow infiltration and water vapour diffusion, not normally found in floors constructed on the ground or above basements and crawl spaces.

2.5.3.(1) A false floor is recommended as an effective means of ensuring continuity of the air barrier whenever thermal insulation is located within the structural framing of an elevated floor, the comfort of building occupants is a consideration, or where suitably conditioned space is required to accommodate plumbing drains. These also help reduce heat loss through the floor assembly.

2.5.3.(2) Where thermal insulation is located entirely on the underside of the framing and the air barrier is on the cold (exterior) side of the floor assembly, a false floor is not needed.

2.5.3.(3) The vapour barrier must always be located on the warm side of the thermal insulation. The continuous air barrier — provided it is permeable to water vapour — can be located at any thermal zone in the assembly.

2.5.3.(4) Drains and water supply pipes should not be situated within an elevated floor assembly (just as they should not be installed within the cold portion of exterior walls) unless the thermal insulation and air barrier are on the cold side of the framing, or they can be installed within a false floor system or an accessible suspended utility service space (utilidor/utilidette).

2.5.3.(5) If considered a floor in the NBCC, above ground exterior floor assemblies must be provided with the same fire resistance rating as required by the building construction.

2.5.3.(6) The soffit of elevated floor assemblies must meet the following requirements.

a) Durable.

b) Light weight.

c) Easily installed.

d) Non-combustible cladding if at risk of exposure to fire.

e) Easy to remove and replace for maintenance access to contained services.

f) Installed with the minimum number of exposed joints.

g) Where not exposed to view, galvanized ribbed sheet metal finish is acceptable. Battened plywood is not acceptable due to its combustibility.

2.5.3.(7) Where permafrost is present on site, any sanitary tanks required could be suspended from the building floor structure and enclosed in an insulated enclosed space. This measure will ensure a fixed connection between the indoor piping and the sanitary tank and prevent any damage cause by ground movement should the tank be located on the ground.

2.5.4. FLASHINGS

2.5.4.(1) Flashing should be formed from pre-finished steel with factory-applied paint finish or a 55% aluminum-zinc coating.

2.5.4.(2) Metal flashing details shall follow the recommendations of the Canadian Roofing Contractors' Association (CRCA) Specifications and SMACNA architectural details.

2.5.4.(3) Refer to the CMHC Best Practice Guide: Building Technology – Flashings for additional recommendations on details and specifications.

3. Interiors

Refer to Chapter 2 – Energy and Environmental Design Requirements for volatile organic compound (VOC) requirements for interior products and finishes.

Refer to Chapter 1, Section 8 – Seismic Restraint for structural requirements for all interior construction and finishes.

3.1. INTERIOR CONSTRUCTION

3.1.1. INTERIOR PARTITIONS

Structural framing, sound insulation, durability and maintainability of surface finishes all require consideration for optimal performance of walls and partitions.

Interior wall surfaces and finishes are both very visible and subject to wear and tear damage. The selection of these finishes should be based upon the availability and skill of local maintenance staff. Interior wall surfaces located where impact or heavy usage is expected are recommended to be impact resistant or be suitably reinforced with impact resistant stiff materials. Surfaces should be washable, and easy to repair and refinish by local tradespeople with materials that can be easily obtained and stored.

3.1.1.(1) Wall Framing

a) Wood or steel stud framing is acceptable for all partition walls.

b) Wood framing is preferred for load bearing walls where allowed by code.

c) Non-structural steel studs are preferred for non-bearing walls as they simplify electrical and mechanical installations, are less costly to transport and provide better acoustic ratings.

3.1.1.(2) Fire Separations

a) Provide fire separations where required by the NBC, including all required fire ratings and closures.

3.1.1.(3) Internal Thermal Separations

a) When there is more than a 10°C difference between two spaces, design of construction assemblies must consider the heat transfer between these spaces as per the requirements of the NECB.

3.1.1.(4) Internal Acoustic Separations

a) Provide an STC rating meeting the requirements of the NBCC for all dwelling units, elevators, and refuse chutes.

b) Provide the following minimum STC ratings.

i) Offices: STC 45.

ii) Meeting Rooms and Classrooms: STC 50.

iii) Confidential Rooms: STC 55.

iv) Commercial Kitchens: STC 55.

v) Workshops: STC 55.

vi) Mechanical Rooms: STC 55.

c) Other required STC ratings should be provided in the functional program, or by the Yukon government.

d) Continue all acoustic isolations through the floor to minimize flanking paths through the structure. Clearly detail all acoustic isolations including: all details between acoustic assembly and other assemblies, acoustically rated ceilings, ductwork configurations, locations of outlet boxes, etc.

e) Acoustic design must be considered as part of the complete design and coordinated between all disciplines.

3.1.2. INTERIOR DOORS AND WINDOWS

3.1.2.(1) Door and Window Frames

a) Hollow metal, aluminum, or demountable aluminum frames are preferred due to their durability.

b) Fully welded hollow metal frames are preferred over knock-down frames, except where doors are being installed within existing walls.

c) Wood frames are acceptable within residential suites or where required by specific programs.

3.1.2.(2) Doors

a) Solid wood doors are acceptable for all locations other than service room doors.

b) Hollow metal doors are acceptable at all locations.

c) Aluminum doors are acceptable at building vestibules to match the exterior door.

d) Wood doors should be flush panel stain grade veneer plywood or paint grade. Other types of doors should only be specified if specifically required to suit functional program requirements.

e) In care occupancies, consider the requirements for infection control during the selection of door finishes.

f) All swing doors to be minimum 900 mm wide, except within residential suites where 800 mm is the minimum dimension unless these suites are accessible units.

g) Bi-fold doors should only be used within residential suites due to their susceptibility to damage. In areas requiring additional durability, either bi-pass or swing doors should be specified instead.

h) Pocket doors and barn doors are acceptable in special circumstances to suit programme requirements or in renovations where swing doors are not practical. When specified, high quality hardware is required to reduce maintenance costs.

i) Folding doors, grilles, shutters, and rolling door applications can be considered depending on application and programme requirements.

3.1.2.(3) Glazing

a) Where glass in doors or windows is located below 1100 mm above finished floor, it must be safety glass, and in all other locations required by the NBCC.

b) On high use doors, glass should be kept 200 mm above the bottom of the door to prevent damage.

c) Where window glazing is located beside an exit door or access to exit, it must be provided with a visible graphic or mullion at 1100 mm above finished floor.

d) Wire glass is not acceptable in schools or other assembly occupancies due to the risk of lacerations, but is acceptable in fire rated openings in other occupancies.

e) Glazing sizes to meet the requirements of NBCC and NFPA.

3.1.3. DOOR HARDWARE

After construction, building maintenance staff is often called on to adjust or repair door hardware. As some repairs require immediate attention, it is recommended door hardware replacement parts be stocked at an easy to access location, and that local service is available. A high rate of door usage in some Yukon government buildings requires reliable, durable and easily repaired hardware. Where a building is expected to experience higher than normal vandalism, additional provisions for intrusion resistant door security hardware is recommended, as well as locating the door in a visually prominent well illuminated location.

Consultants are required to develop a door hardware schedule on all projects, and review this with the Government of Yukon for suitability in meeting the functional program, security and building envelope performance requirements. All specified hardware requires coordination and performance verification to ensure a fully functional door.

3.1.3.(1) Acceptable Manufacturers

a) Assa Abloy, Allegion and KN Crowder are acceptable manufactures.

b) For residential suites, other manufacturers may be acceptable if approved by the Yukon government.

c) All door hardware is to be provided by a single supplier that is a member of the Door and Hardware Institute, and employs an Architectural Hardware Consultant (AHC).

3.1.3.(2) Hardware Finish

a) All door hardware to be brushed chrome, satin nickel, stainless steel, or aluminum finish. Other proposed finish options must be approved by the Yukon government.

3.1.3.(3) Locksets

a) Sargent, Schlage, Yale, and Adams Rite are acceptable manufacturers.

b) Provide commercial grade 1 lever door handles on all swing doors, except within residential suites where grade 2 locksets are acceptable.

c) Provide a minimum two locking points — latch and deadbolt — on all exterior doors. It is recommended that three-point latching be considered for where additional security is necessary. All locking points must be released with a single operation to comply with the requirements of the NBCC.

d) Provide mortise locksets where doors require both a lever and deadbolt operation, or where additional durability is required.

e) Confirm operation of all doors with the Government of Yukon prior to preparing hardware schedule.

f) Provide electric latches or hardware as required and as specified in Chapter 1, Section 7 – Asset Security Planning and coordinate with electrical wiring and power requirements.

3.1.3.(4) Exit Devices

a) All exit devices to be push bar rim.

b) Concealed vertical rods are required for additional security.

3.1.3.(5) Keying

a) Develop a keying schedule for review and approval by the Yukon government, that adheres to existing master and grand master keying systems as required.

b) All cores must be selected so that keying can be completed locally. If specialty or high security cores are being considered, it is recommended that the consultant confirm with local companies that the key core can be ordered and keyed.

c) For renovations and additions, all key cores must match the existing building for a consistent keying system.

d) Allow for 5 keys per lock.

3.1.3.(6) Electromagnetic Doors

a) Consider the use of fire alarm connected electromagnetic door hold-open devices where it is expected that a door in a required fire separation may be propped open due to the use of the facility.

3.1.3.(7) Power Door Operators

a) Power door operators are an integral part of building accessibility, and are required on certain entrances in accordance with the NBCC.

b) Select power door operator hardware that can still be operated manually in the event of a power failure or when maintenance is required.

c) Coordinate access control, electric strikes and security requirements with operation of power doors.

d) All doors installed with a power door operator require a vestibule to reduce heat loss due to opening and closing times.

3.1.3.(8) Access Control

a) Coordinate access control, electric strikes, and all other door hardware with electrical requirements. Refer to Chapter 6, Section 8 – Electronic Safety and Security.

3.1.3.(9) Hinges

a) Provide ball bearing full mortise steel hinges on all normal use doors. Select weight based upon door use.

b) On high-use doors, including main entrances, provide 5-knuckle heavy-duty hinges.

c) Plain bearing and spring hinges are acceptable in residential suites.

d) Provide non-removable pins on all exterior doors.

3.1.3.(10) Other Hardware

a) Provide all required stops, gaskets, sweeps, closures, kick plates, push plates, and thresholds as required.

b) All exterior thresholds to be thermally broken.

c) Provide welded full-length astragals on all exterior doors where there is a risk of forced entry.

3.1.4. JOINT SEALANTS

3.1.4.(1) All interior sealants must be:

a) strong enough to resist the anticipated loads without deforming or moving out of position;

b) elastic and compressible to accommodate movement of the joint;

c) chemically compatible with adjacent materials;

d) accessible for service or replacement; and

e) placed in primed joints of proper dimensions and proportions with backing rod or bond breakers to prevent unintended adhesion to adjacent surfaces.

3.1.4.(2) The following joint sealants are recommended in building interiors.

a) Perimeter of plumbing fixtures: Mildew resistant, one component neutral cure silicone sealant is recommended.

b) Interior non-moving joints that may be painted: One component, paintable acrylic latex sealant.

c) Interior moving joints that may be painted: One component polyurethane, very low modulus elastomeric sealant.

3.1.5. FIRE SEPARATIONS AND FIRESTOPPING

3.1.5.(1) Firestopping of penetrations in fire separations shall use firestop and smoke seal systems listed by Underwriter's Laboratory of Canada (ULC) or an approved testing agency.

3.1.5.(2) All firestopping must have identifiable material colours such as red or orange for ease of inspection.

3.1.5.(3) All firestopping to be from a single manufacturer.

3.1.5.(4) Cable and cable tray penetrations must be re-enterable without the use of power tools.

3.1.5.(5) All firestopping, including structural, mechanical and electrical penetrations, must be completed by a single firestopping sub-contractor. Contractor to coordinate this requirement with all trades. Provide field inspection services and verification of all firestopping installations.

3.1.5.(6) Contractor to submit complete shop drawings using architectural plans showing all locations of all fire separations and firestop seals, including mechanical and electrical seals. Indicate applicable listed UL/ULC system and design numbers. Provide cut sheets for each system.

3.1.5.(7) No installation of firestopping systems to occur until shop drawings have been reviewed.

3.1.5.(8) Coordinate installation of firestopping to allow it to be installed at the appropriate time during construction.

3.2. INTERIOR FINISHES AND SPECIALTIES

Durable finishes need to be selected for availability, installation simplicity, and ease of maintenance. Finishes that can be repaired or replaced with materials and skills available in the local community are recommended and preferred over materials requiring specialized maintenance procedures. In health care occupancies, the requirements for infection control must be considered to meet the requirements of CSA Z317.13, and should be noted in functional program requirements.

3.2.1. WALL FINISHES

3.2.1.(1) Gypsum Wall Board (GWB)

a) The preferred interior finish in most facilities.

b) Provide moisture resistant GWB in wet areas and abuse-resistant where additional durability is required.

c) Where additional protection is required, or where wall-mounted equipment or artwork is expected, provide solid plywood or dimensioned lumber backing.

3.2.1.(2) Hardwood Veneer Plywood

a) Acceptable where durability and appearance are important such as in gymnasia, change rooms, lobbies, and school corridors.

b) Use select grade for clear or stain finishes or paint grade for painted finishes.

c) Use recessed screw fasteners rather than nails. No hidden fasteners or clips will be accepted.

3.2.1.(3) Phenolic Panels

a) Acceptable in the same locations as hardwood veneer plywood.

3.2.1.(4) Wood Paneling

a) Acceptable finish in heritage buildings.

b) Provide solid wood tongue and groove board finish.

c) Prefinished laminate wood panels are not acceptable in any facility.

3.2.1.(5) Fiberglass Reinforced Plastic (FRP)

a) Coated FRP is acceptable where durability and appearance are important such as in gymnasia, change rooms, lobbies, and school corridors.

b) Standard FRP panels are required in all commercial kitchens to allow for easy cleaning and include a textured surface to protect against scratching.

3.2.1.(6) PVC Paneling

a) Acceptable in vehicle wash bays.

b) Panels to be watertight and chemical resistant.

3.2.1.(7) Concrete Block

a) Acceptable for projects where the added capital cost outweighs the expected maintenance costs due to heavy use or intentional damage, or where additional durability is required.

3.2.1.(8) Metal Liner Panels

a) In pre-engineered metal buildings, metal liner panels are an acceptable interior finish.

b) Panels are to be pre-formed, and prefinished zinc coated or 55% aluminum-zinc coating.

c) Panels should be a minimum 0.635 mm (24 gauge) thick for walls.

3.2.2. PAINTING AND WALL COVERINGS

3.2.2.(1) Acrylic Latex Paints

a) All systems, products, and installation to meet the requirements of the Master Painters Institute (MPI) Architectural Painting Specification Manual.

b) Institutional low odour/VOC latex paints are required for most interior locations.

c) Where additional durability and ease of cleaning is required, it is recommended to use high performance architectural latex paints.

d) Gloss levels

i) Walls, doors and shelving: Eggshell or semi-gloss.

ii) Door frames and metal doors: Semi-gloss.

iii) Ceilings and exposed structure or ductwork: Eggshell.

3.2.2.(2) Alkyd Paints

a) Alkyd paints are not recommended for building interiors unless low odour/VOC products are specified.

3.2.2.(3) Special Coatings

a) Special high-build acrylic or epoxy coatings are recommended only where they will be applied to a reinforced drywall, plywood or concrete substrate requiring specialized corrosion, chemical, or slip resistant protection.

b) Ensure attention is given to the specification of proper substrate preparation.

c) Water-soluble or low VOC products are required.

3.2.2.(4) Vinyl Wall Coverings (VWC)

a) Vinyl wall coverings are recommended in the following areas.

i) Visible public areas not subject to vandalism or impact damage where upgraded appearance is important and painted wall finishes would show wear quickly, or where other more durable finishes are not provided.

ii) Areas where posters, notices, etc., will be affixed to walls (using tackable surface).

b) In high traffic areas subjected to impact damage, VWC is to be installed so that the lower portion of the wall (up to about 1.2 m) can be replaced independently, i.e., a separate wainscoted section, if another durable wall finish is not provided.

c) Avoid using VWC where frequent cleaning will be required, such as near wet areas and service counters due to textured surfaces.

d) Installation is not recommended in known frequently damaged areas generally accessible to the public as repair can be difficult.

e) Select only low-VOC vinyl wall coverings, meeting the requirements of Chapter 2 – Energy and Environmental Design requirements.

3.2.2.(5) Wall Tile

a) Wall tile is recommended where a high level of durability is required. Typically, it is acceptable in public washrooms and commercial kitchens where FRP is not used.

b) Provide durable, stiff substrate suitable for the location. Acceptable options include concrete masonry units or concrete, screwed and adhered cement board, and glass-mat tile backerboard. Moisture resistant gypsum board is not acceptable.

c) All materials and workmanship to meet Terrazzo Tile Marble Association of Canada (TTMAC) specification section 09 30 00 and assembly details.

d) Ceramic, porcelain and quarry tile are all acceptable materials.

e) When tile is determined to be appropriate, neutral colours should be selected and accent colours avoided due to the material's long installed lifespan.

f) Install control joints and expansion joints in conformance with the TTMAC Tile Installation Manual.

g) Provide waterproof membrane behind tile in showers and other wet areas. Membrane to be part of complete waterproofing/tiling system such as Schluter or wedi. Liquid waterproofing membrane is not recommended unless thickness testing is specified.

3.2.2.(6) Acoustic Treatments

a) Provide acoustic treatment where sound attenuation, soundproofing, or other sound control measures are necessary to create a safe and comfortable environment.

b) Sound control will include: attenuation of sound within spaces; sound isolation between exterior and interior spaces, and between interior spaces; and sound and vibration isolation of building services.

c) It is recommended to select sound attenuating materials that do not accumulate dust and fibres in fissures, but rather should be reasonably smooth surfaced allowing periodic vacuum cleaning without deterioration such as fabric covered panels. Cementitious wood fibre panels (Tectum) may be acceptable, but require approval for the specific application.

d) Design partitions and ceilings to provide the same degree of sound control, and when a partition is used for sound isolation, it must extend from floor to underside of floor or roof deck above.

e) Coordinate the location of recessed components, vents, or penetrations to not affect the integrity of the sound isolation assembly. If penetrations are necessary (such as electrical boxes), they must be staggered one stud space, and sealed.

f) Provide sound attenuation within ducts, and provide acoustic duct configurations to avoid the transmission of sound.

g) Isolate all structure-borne vibrations and sound with resilient mountings on vibrating equipment.

h) Use a combination of acoustic screens, vibration isolators, and equipment selection to prevent exterior noise.

3.2.3. FLOORING

This section identifies different types of appropriate flooring materials and indicates preferences for specific applications. Some adhesives and flooring materials have been found to be incompatible with radiant in-floor hydronic heating. Flooring materials need to be selected based upon the manufacturer's recommended duty environment, the operating temperature of the floor, and durability to meet program requirements.

3.2.3.(1) Resilient Flooring

Resilient flooring includes a range of synthetic and eco-friendly flexible roll

and sheet goods and small format tiles. Commonly available resilient flooring includes linoleum, sheet vinyl, resilient foam backed vinyl, rubber, cork and similar products. Installation of resilient flooring onto substrates with radiant heating (hydronic or electric), and installation onto concrete slabs on grade must be done with added care, and with consideration of the limitations of both the resilient flooring material and adhesives used, as well as the potential for water vapour or moisture to be trapped under the resilient flooring and affect the glue bond.

All resilient flooring requires installation on a stiff and durable substrate material with limited flexibility to limit the strain on joints in the resilient flooring.

a) Linoleum
   i) The preferred resilient flooring for most buildings.
   ii) Avoid using over heated floors or near heating appliances as its maximum operating temperature is 29°C.
   iii) Should not be used where exposed to heavy strain loads such as wheeled carts as the bonding materials can degrade.
   iv) Do not use in locations where standing water and petroleum-based liquids may be present.
   v) Sports flooring: 3.2 mm thickness with welded seams.
   vi) High-use areas: 2.5 mm thickness with welded seams.
   vii) Medium-use areas: 2.0 mm thickness with welded seams.

b) Slip/Skid Resistant Vinyl
   i) The preferred resilient flooring for vestibules, washrooms, change rooms, and kitchens where floors may remain wet.
   ii) All installations should use a minimum 2.0 mm thickness with a marbleized or granite pattern and welded seams.
   iii) Colour and pattern to be homogenous and not print applied.
   iv) Cushion backing is not recommended for areas with furniture as it can be easily damaged.
   v) Heavy duty sports vinyl floor is acceptable in auditoriums or low-impact activity rooms, and must be provided with a resilient backing.
   vi) Confirm operating temperature of flooring before installing over heated floors.

c) Luxury Vinyl Tile (LVT)
   i) Luxury vinyl tile is not acceptable.

d) Vinyl Composite Tile (VCT)
   i) Vinyl composite tile is not acceptable.

e) Rubber Flooring
   i) Rubber flooring is recommended where resiliency, durability and clean-ability are desired, and has a better service life cost than other resilient floors.
   ii) Rubber tile flooring to be formulated with 100% virgin elastomer, reinforcing agents, soil resisting agents, and migrating waxes to create durability, excellent cleaning characteristics and exceptional slip resistance.
   iii) Resilient backed rubber sports flooring suitable for surface painted lines is recommended for use in athletic sports facilities other than school gymnasia as being the most durable, most cleanable, and suitable for both community event uses as well as impact sports.
   iv) Vulcanized rubber skate flooring is preferable for use in community arenas and sports rooms where impact and abrasion resistance is important.

v) For impact court sports over a flexible wood deck, a triple layer 8 mm thick covering would be the best combination of performance in place, durability, and cost.

vi) 6mm thick two-layer material is not recommended for impact sports floors, but is suited for areas like floor gymnastics and weight room floor coverings where skid resistance is needed but impact rebound resiliency is not as important.

vii) Thicker triple layer materials are recommended for installation over concrete slabs where there is less flexibility in the substrate.

viii) Areas surfaced with rubber flooring are to have rubber base.

3.2.3.(2) Wood Flooring

a) Hardwood Flooring

i) Hardwood flooring is not recommended in any facility outside of Whitehorse other than schools, because of the typical dry cold season service environment and risk of deterioration by occasional water damage.

ii) Hardwood floors are acceptable in all school gymnasiums, and should be installed on a sleeper system with a vented rubber perimeter base.

iii) Provide two-component polyurethane lacquer finish.

b) Engineered Wood or Laminate Flooring

i) Not recommended.

c) Plywood Flooring

i) Plywood flooring is acceptable in storage rooms, but is not recommended for mechanical service spaces where fluid spills might occur.

ii) All plywood flooring should be finished with slip-resistant paint.

d) Cork Flooring

i) Not acceptable.

3.2.3.(3) Tile Flooring

a) Tile flooring is recommended where a high level of durability is required. Typically, it is acceptable in building entrances, public washrooms, and high traffic facilities such as airports, retail outlets and recreation facilities.

b) Provide proper substrate, especially in wood subfloors where the tile or grout may crack or de-bond. All materials and workmanship to meet Terrazzo Tile Marble Association of Canada (TTMAC) specification, and details for the installation of crack isolation membranes to resist lateral movement.

c) Ceramic, porcelain and quarry tile are all acceptable materials.

d) When tile is determined to be appropriate, neutral colours should be selected and accent colours avoided due to the material's long lifespan.

e) Floor tile installed in interior wet areas to have the following static coefficients of friction to ASTM standards.

i) Level surfaces: ≥ 0.5 for wet and dry conditions.

ii) Stair treads: ≥ 0.6 for wet and dry conditions.

f) Install control joints and expansion joints in conformance with the TTMAC Tile Installation Manual.

g) Provide waterproof membrane under tile in showers and other wet areas. Membrane to be part of complete waterproofing/tiling system such as Schluter or wedi.

3.2.3.(4) Carpet Flooring

a) Roll carpeting

i) Only acceptable in residential occupancies.

ii) Specify nylon loop pile with minimum density of 12.0 kilotex/cm^2, and static control > 3.0 kV.

iii) Installation: Underlay installation is preferred in residential areas.

iv) Warranty: Minimum 10-year warranty required.

b) Modular Carpet Tile

i) Carpet tile flooring is recommended in all Government of Yukon facilities where carpet flooring is required for acoustics and underfoot cushioning (offices, meeting rooms, lounges, etc.). It is easy to install and maintain, and is more durable than roll carpeting.

ii) For long-term durability solution dyed nylon looped pile is required with integral soil/stain protection.

iii) Specify carpet tile with pile density to be >240 kg/m^3 (6,470 oz/yd^3) and static generation < 3.5 kV at 21°C and 20% RH.

iv) Carpet to be designed to accept wheelchair traffic.

v) Preference should be given to selecting carpet tile that meets CRI Green Label, and includes recycled content.

vi) Install tiles using no glue tile tab installation method to allow for easy replacement of tiles. If adhesive is desired for increased durability, then specify non-solvent, non-toxic, odorless adhesive meeting the requirements of Chapter 2 – Energy and Environmental Design Requirements.

vii) Warranty: Minimum 10-year material warranty required.

viii) Warranty: Minimum 1-year workmanship warranty required.

3.2.3.(5) Epoxy Floor Finishes

a) Epoxy flooring materials are available for installation over cured and dry concrete substrates at lower cost and installation complexity than concrete hardening compounds, and can provide high chemical, abrasion resistance and moderate moisture tolerance.

b) Epoxy flooring is not recommended for use where continuously wet conditions will be encountered, but is recommended for installation in fairly large floor areas where the edge finishing details and joints between dissimilar materials are not critical.

c) If used in wet areas, use water and slip-resistant grade, prevent moisture transmission to the substrate, and provide integral coved base.

d) Epoxy flooring is acceptable in warehouses, garages, wash bays and workshops.

3.2.3.(6) Integral Concrete Hardener

a) Integrally coloured or uncoloured concrete hardener is recommended where abrasion resistance, colour and surface durability and high moisture resistance are required at lower cost than resilient sheet goods installation.

b) The concrete substrate requires carefully controlled moisture and surface characteristics to accept the hardener, which is either added to the concrete when mixed, or steel trowelled into the green concrete surface and bonds chemically with the concrete as it completes the curing process.

c) Not recommended for use where repetitive chemical cleaning or sanitation is required.

d) Acceptable for use where exposed concrete floors are acceptable and additional durability is required such as industrial uses, sewage and water treatment facilities, and heavy pedestrian floor traffic areas.

3.2.3.(7) Floor Paint

a) Floor paint is recommended to be slip-resistant safety paint containing suitably sized abrasive to ensure good traction under both wet and dry conditions.

b) Recommended uses for floor paint are low-traffic, non-public, dry service areas where oil liquid spills are prevented. Provide industrial quality floor paint where protection from water, dirt or spilled oil is required such as service and storage rooms.

c) Application of paint on concrete floors requires minimal moisture in the concrete and only vapour permeable paint is accepted.

d) Floor paint is also an acceptable finish on plywood floors in storage areas.

3.2.3.(8) Stairwells

a) Provide tactile warming strips and colour contrasting stair nosing to assist the visually impaired.

b) Where concrete is not used, use rubber one-piece treads, sheet risers, nosings, and stringers.

3.2.3.(9) Base Trim

a) Wood baseboards are acceptable where wood floors are installed.

b) Provide painted wood baseboard in residential suites, except in wet areas.

c) Provide flash coved bases where resilient flooring is used in wet areas such as commercial kitchens, washrooms, hospitals, etc.

d) Provide tile base or wall tile where tile flooring is used.

e) Provide minimum 100 mm high rubber base trim in all other locations.

3.2.4. ENTRANCEWAY SYSTEMS

3.2.4.(1) Provide exterior non-slip galvanized snow grate and pit at all main entrances.

3.2.4.(2) Locate exterior snow grates under canopies or overhangs to prevent them from filling with snow.

3.2.4.(3) Size snow pits to suit the amount of snow expected due to snow fall, snow clearing, blowing snow, and occupant use.

3.2.4.(4) All grating at entrances required to be barrier-free must be spaced less than 12 mm apart and perpendicular to the path of travel.

3.2.4.(5) Provide non-slip entranceway grids with pans in all entrance vestibules.

3.2.5. CEILING FINISHES

Durability, economy and maintainability are primary considerations for the selection of ceiling finishes for northern buildings. Although generally inaccessible to occupants, ceilings need to be able to withstand occasional accidental impact damage and need to be able to be refinished simply; in the event of water damage. Some ceilings may be subject to periodic wet cleaning (health care facilities, kitchens, change rooms and bathrooms), and therefore require careful selection of materials, textures and colours. The effects of ceiling heights, shapes, materials and colours on room sound quality and

lighting design must also be considered and planned to take advantage of natural light reflection.

3.2.5.(1) Gypsum Wallboard

a) Gypsum board is the preferred ceiling finish for change rooms, washrooms, service rooms, bulkheads, and residential occupancies or patient care suites.

b) Gypsum board provides the advantage of being able to provide a fire resistance rating as the finished ceiling.

c) No textured ceiling finishes are allowed.

3.2.5.(2) Exposed Roof Decks

a) Exposed wood deck material is an acceptable ceiling finish in public spaces such as gymnasia and community halls. Provide tongue and groove joints.

b) Exposed metal deck is also acceptable when painted.

c) Acoustic metal deck can also be considered when sound control is desired.

3.2.5.(3) Suspended Acoustic Ceilings

a) A suspended ceiling system is recommended typically where large ceiling areas need to be covered, and where the ceiling material does not provide part of the thermal, moisture or air barrier functions of the building envelope. It is also recommended where access is required to the mechanical and electrical services located above.

b) Avoid using suspended ceilings with lay-in acoustic units in public use areas where the ceiling height is lower than 2.5 m above the floor, above stairs, or above areas in dusty locations that require frequent cleaning.

c) Ceiling tiles can either be mineral-fibre/fiberglass acoustic or wood lay-in or tegular panels.

d) Provide acoustic ceiling tiles with a noise reduction coefficient (NRC) ≥ 0.70 and a ceiling attenuation class (CAC) of 35.

e) In kitchens and clean room spaces, provide washable, water-repellent, scratch-resistant, and soil resistant lay-in tile.

f) Provide adequate clearance above lay-in tiles to remove panels without damaging them.

g) The space above suspended ceiling systems is not recommended to be used as a plenum for un-ducted ventilation purposes. This reduces the dust and debris entering the ventilation system and allows for improved acoustic separations.

3.2.5.(4) Metal Liner Panels

a) In pre-engineered metal buildings, metal liner panels are an acceptable interior finish.

b) Panels are to be pre-formed, and prefinished zinc coated or Galvalume™.

c) Panels should be a minimum 0.475 mm (26 gauge) thick for roofs.

3.2.6. MILLWORK AND FINISH CARPENTRY

3.2.6.(1) All millwork and finish carpentry to meet the requirements of AWMAC.

3.2.6.(2) All products must be acclimatized prior to installation due to the extremely dry climate.

3.2.6.(3) Millwork

a) All millwork to be custom grade to provide sufficient durability.

b) Casework

i) Cabinet doors to be solid wood, MDF, or plywood construction. Provide PVC or hardwood edge banding on all MDF or plywood. Flush panel, flush overlay design preferred for ease of cleaning.

ii) Casework to be constructed using veneer core plywood. No particleboard is acceptable.

iii) Wood veneer or plastic laminate are acceptable exposed finishes.

iv) No painted or melamine finishes are acceptable except in workshops or low-visibility locations such as storage rooms.

c) Hardware

i) All cabinet hardware to be stainless steel, unless another finish is specified by program requirements.

ii) Cabinet hinges to be concealed and to open a minimum of 110 degrees. Provide soft-close function.

iii) Drawer slides to be full extension, roller bearing, easy close.

iv) Pulls to be simple designs and ADA compliant.

v) Wire grommets to be 75 mm stainless steel.

vi) Provide cabinet locks where security is required.

d) Countertops

i) Counters to be self-edge plastic laminate, or solid surface.

ii) Substrate to be veneer core plywood.

iii) Provide site-installed backsplash and side splash sealed using silicone sealant.

iv) Plastic laminate to be general purpose grade, complete with backer sheets. Avoid wood grain or solid colours for counters.

v) Provide laboratory grade countertop (plastic laminate, stainless steel, or phenolic core) in locations where chemical resistance is required.

3.2.6.(4) Shelving

a) Pre-manufactured wood or metal shelving is preferred, where standard sizes can be accommodated.

b) Custom shelving may be required in display applications and closets and should follow the same construction requirements as casework.

c) Allow for shelf reconfiguration as required.

d) Free-standing shelving will require seismic restraint as determined by the structural engineer.

e) Glass shelving should be limited to display cabinets, and should be project specific.

f) No painted or melamine finishes are acceptable except in workshops or low visibility locations.

3.2.6.(5) Finish Carpentry

a) Solid fir, birch or maple are preferred for all finish carpentry to withstand scratching or denting.

b) Coat hooks should be designed to provide adequate spacing between the hooks to allow for winter clothing.

c) Hooks in school corridors should be installed below a shelf to prevent head injuries and designed in such a way as to prevent eye injuries.

d) Window sills are recommended to be constructed from plastic laminate, solid surface, or anodized aluminum to provide durability.

e) If gypsum wallboard returns are not used, then wood jambs and casing are acceptable. In these instances, painted finger-jointed pine is preferred over MDF as it is more resistant to moisture. Cellular PVC trim boards may also be considered where high abuse or moisture is expected.

f) Radiation cabinet covers should be pre-manufactured steel, and not wood for ease of maintenance and access. Cabinet covers should not include a flat horizontal service which could be used as a shelf or seating.

g)

3.2.7. SPECIALITIES

3.2.7.(1) Gender-Inclusive Requirements

a) Refer to Gender-Inclusive Washroom and Change Room Design Standards for additional requirements.

3.2.7.(2) Handrails

Handrails in stairwells must be durable to avoid damage from moving furniture, equipment and materials in and out of a building, especially if an elevator is not provided. It is recommended that either a painted welded steel or aluminum component handrail should be provided. In main stairwells, a hardwood handrail may also be considered acceptable.

3.2.7.(3) Visual Display Surfaces and Projection Screens

a) Provide whiteboards, tack boards, and projection screens as required by the functional programme.

b) Whiteboards should be provided with a magnetic surface and for use with dry-erase markers.

c) Tack boards should be colour cork or natural fine grain cork. Vinyl tackable surfaces are not permitted.

d) Projection screens are to be provided as part of Furniture Fittings and Equipment either within construction contract scope of work or supplied separately by the Yukon government. Coordinate all electrical and mounting requirements.

3.2.7.(4) Signage

Effective clear signs support good building operation and maintenance by clearly identifying buildings and the spaces within them. The following requirements apply.

a) All signage shall comply with the requirements, principles and definitions of the Government of Yukon Communications Policy.

b) All signage should be written in English and French and should include international graphic symbols as appropriate.

c) Exterior signage is to be provided on all buildings near the main entrance. It is recommended that they be fabricated from cast or cut aluminum (or equivalent) letters for durability.

d) Exterior wayfinding signage may be required when parking is not located near the building entrance or serves multiple buildings, when the main entrance is not visible, or when the building has multiple entrances.

e) Interior signage is to be provided for all service rooms, washroom facilities, and stairs at a minimum.

f) Functional programming will provide definition and requirements for additional interior room or wayfinding signage. Additional signage should consider the use of removable inserts.

g) All signage text should be sized for legibility based upon intended viewing distance following graphic design principles. Sufficient contrast must be provided between letters and background.

3.2.7.(5) Washroom, Shower and Change Room Partitions

Durability and damage resistance are important for compartment partitions as they are often subject to abuse, including scratched or applied graffiti. The following requirements apply.

a) Headrail-braced or floor to ceiling compartments are recommended for long-term durability in most facilities.

b) In facilities, where frequent cleaning of the floor is required, ceiling hung units are recommended. Coordinate structural requirements at the ceiling.

c) Powder coated metal partitions are acceptable in most facilities; however high-use or high-moisture facilities (schools, fitness facilities, hospitals) should consider the use of solid plastic or phenolic construction to minimize maintenance.

d) Privacy must be considered in all washrooms, and it is recommended that partitions are mounted no more than 225 mm from the finished floor and provided with doors and panels than extend to 2 m in height. Compartments are to eliminate all sightline gaps between panels.

e) Provide solid wood blocking as required.

3.2.7.(6) Demountable Partitions

Demountable wall systems are acceptable for use in large floor areas where it is anticipated that there will be reconfiguration required to meet changing program requirements. Smaller offices and administrative spaces are more effectively served using site built partition walls. If used, vinyl finishes must meet the VOC requirements specified in Chapter 2 – Energy and Environmental Design Requirements.

3.2.7.(7) Operable Partitions

a) Where program occupants require flexibility to connect or separate spaces, operable partition walls are acceptable. Consultants must consider required acoustic ratings and ease of operation. If used in meeting rooms or classrooms STC of 48 is required.

b) Continuously hinged electric operation is required for large partitions. All other partitions to use continuous hinges or paired panels.

c) Solid or glass panels are acceptable, but all finishes must be easily cleanable.

d) Accordion doors are acceptable for smaller partitions as long as they meet the required acoustic, security and functional requirements.

e) Coordinate space requirements for stacking of panels and structural and electrical requirements.

3.2.7.(8) Corner Protection

a) Corner guards should be provided in all high-use corridors.

b) In senior and health care facilities corridor handrails are required to provide wall protection and greater accessibility, and required locations will be specified in the functional program for the specific use or occupancy.

3.2.7.(9) Washroom Accessories

Durability and damage resistance are important for washroom accessories are often subject to abuse, including scratched or applied graffiti. The following requirements apply.

a) Fully or semi-recessed paper towel/waste receptacles are recommended to avoid physical damage and provide adequate clearances.

b) All other washroom accessories to be surface mounted.

c) All finishes to be stainless steel.

d) Acceptable washroom accessory manufacturers are: Bobrick, Bradley, and Frost.

e) Provide solid wood blocking as required.

f) Accessible washroom accessories to be provided to meet the requirements of NBCC and CSA B651.

3.2.7.(10) Lockers

Lockers may be required in many different types of facilities for either staff, student, or public use. Where lockers are required the following requirements apply.

a) Determine locker size, type (standard, vented), configuration (including Z-lockers), and latching/locking options based upon application and functional programme requirements.

b) Powder coated metal lockers are acceptable in most facilities, however high-use or high-moisture facilities (school change rooms, fitness facilities, hospitals) should consider the use of solid plastic or phenolic construction to minimize maintenance.

c) Lockers should be provided with sloped tops if they do not extend to a ceiling or bulkhead.

d) If it is expected that storage may include irritants or odorous clothing, then it is recommended to consider mechanically venting these lockers through a plenum located above.

e) In change room applications, consider raising the lockers on a base, and locating a bench directly in front of them.

3.2.7.(11) Mobile Storage Systems

Where storage space is a concern, or where a large amount of storage is required, mobile storage systems can be provided. Typically, these storage systems are a programme specified requirement. They should ideally be included as part of the construction contract to allow their additional structural requirements to be allowed for and to allow their installation to be coordinated, especially where the top of the rails is intended to be flush with the adjacent floor level.

4. Elevators and Lifts

4.1. DESIGN CONSIDERATIONS

4.1.1. All elevators and lifts shall conform to the requirement of CSA B44, Safety Code for Elevators and Escalators and the NBCC.

4.1.2. Elevators or lifts are required in all multi-storey buildings, unless an upper floor is used only for storage. Accessibility requirements apply to any form of disability. Consultants should note that a barrier-free path of travel will therefore be required on all floors served by the elevator or lift.

4.1.3. If the basement or second floor is used for storage, then a lift or dumbwaiter is still recommended to move storage, products, material, and equipment between floors.

4.1.4. Buildings classified as Part 3 under the NBCC are required to be provided with an elevator meeting the requirement of CSA B44.1. Platform lifts are allowed as a means of access between split floors, where an alternate barrier-free means of access is provided to both floors.

4.1.5. Buildings classified as Part 9 under the NBCC are allowed to be provided with a Limited-Use Limited Application (LULA) elevator if the building is only 2 storeys in building height.

4.1.6. It is recommended to avoid multi-storeys in communities outside of Whitehorse due to the availability of elevator maintenance. If an elevator or lift is provided, the requirements of this section apply.

4.1.7. Inclined wheelchair or stair lifts are only acceptable in renovation projects where an elevator or lift cannot be accommodated and must not reduce the required exit width.

4.1.8. Refer to the following for elevator selection criteria.

ELEVATOR SELECTION CRITERIA		
Number of Floors Above Ground	**Type of Elevator**	**Minimum Speed**
4 or less	Hydraulic	100 fpm
5 – 10 Floors	Traction	200 fpm

4.2. DESIGN CONSIDERATIONS

4.2.1. NUMBER OF ELEVATORS

In most Yukon government facilities, only a single elevator will be required; however, the Consultant shall consider the following criteria, and make recommendations for additional elevators as necessary.

4.2.1.(1) Determine the number of elevators based upon the anticipated traffic patterns and demand within the building using accepted elevatoring principles. It is recommended that this analysis be performed by an Elevator Engineer.

4.2.1.(2) In seniors' projects, a minimum of two elevators are required to ensure elevator

service availability at all times.

4.2.1.(3) Supportive housing may create more demand than typical buildings, and should be considered when determining elevator requirements.

4.2.1.(4) In buildings of 6 or more storeys in height, two elevators should be provided.

4.2.2. ELEVATOR LOCATION

4.2.2.(1) Locate elevators near to or visible from the main building entrance.

4.2.2.(2) Provide a minimum STC 60 rated wall assembly around the hoistway and machine room to meet the effective minimum sound transmission requirements of the NBCC.

4.2.2.(3) If more than one elevator is required, they should be grouped.

4.2.3. ELEVATOR LOBBIES

4.2.3.(1) Provide a minimum of 3 m clear in front of the elevator on the ground floor.

4.2.3.(2) On upper floor, provide a minimum 1.5 m clear in front of the elevator.

4.2.4. SIZE OF ELEVATOR

4.2.4.(1) At least one elevator must meet the requirements for a patient stretcher as required by the NBCC.

4.2.4.(2) All elevators must have a minimum rated load capacity of 1,160 kg (2,500 lbs).

4.2.4.(3) Elevators for seniors must have a minimum rated load capacity of 1,587 kg (3,500 lbs).

4.2.4.(4) Elevators for service, or for hospital or long-term care use must have a minimum rated load capacity of 2,050 kg (4,500 lbs).

4.2.5. ELEVATOR FIRE AND LIFE SAFETY FEATURES

4.2.5.(1) On buildings with 5 or more floors above ground, elevators must be equipped with Firefighter's Emergency Operation Phase I and II as defined by CSA B44 regardless of NBCC requirements. Provide automatic recall, alternate floor recall, machine room smoke sensor recall, and recall by hoistway or pit fire detectors in accordance with CSA B44.

4.2.5.(2) Elevator emergency power should only be provided if required by the NBCC.

4.2.6. ELEVATOR SERVICE

4.2.6.(1) As part of the service contract, specify a maximum 4-hour required service technician response time in the event of an elevator malfunction with people stuck in the car.

5. Equipment and Furnishings

Refer to Chapter 1, Section 8 – Seismic Restraint for structural requirements for all equipment and furnishings.

5.1. EQUIPMENT

Most equipment is typically procured by Yukon government as Furniture, Fittings and Equipment (FF+E), and not as part of the construction contract. Coordinate the sizes of all known major equipment with the design, and make allowances where specifics are unknown.

The following equipment is likely to be included as part of the construction contract:

5.1.1. RESIDENTIAL APPLIANCES

In residential projects, major appliances are occasionally included in the construction contract. In these instances, the following requirements apply.

5.1.1.(1) All major appliances are to be national recognized major brands to allow for ease of repair. Confirm preferences with the Yukon government.

5.1.1.(2) Standard sizes are recommended to be specified unless specific sizes are required by the functional programme.

5.1.1.(3) Refer to Chapter 2 – Energy and Environmental Design Requirements for energy requirements.

5.1.2. FOODSERVICE EQUIPMENT

Where commercial foodservice equipment is required, a foodservice consultant registered with the Foodservice Consultants Society International (FCSI) must be included on the Consultant Team. This consultant will be required to work closely with the Government of Yukon to determine service methods and equipment needs.

5.1.3. GYMNASIUM EQUIPMENT

Basketball, indoor sport nets, scoreboards, and gymnasium dividers are typically required in all gymnasia and should be included in the construction contract to allow for proper coordination. Confirm requirements prior to specifying.

5.1.4. FACILITY FALL PROTECTION

Where required by Sub-Section 2.5 – Exterior Horizontal Enclosures, a permanent fall restraint system or arrest will be provided. It is recommended that where possible a fall restraint system (e.g., guardrails) be used to avoid the training requirements necessary for fall arrest. However, fall restraint can sometimes limit access to some areas, and is restricted to low-slope roofs as per ANSI Z359. In these instances, fall arrest systems are acceptable. The following requirements apply.

5.1.4.(1) Fall Restraint Systems

a) Rooftop guardrails should be self-ballasted or fastened to a parapet wall.

b) Roof hatches must be provided with a guardrail system which integrates into the roof hatch without requiring ballast or penetration through the roof surface.

c) If skylights are provided, they may require fall restraint if workers will be working in close proximity and if the skylight is not designed to take the required loads.

5.1.4.(2) Fall Arrest Systems

a) Fall arrest systems may use a combination of point anchors and lifelines. It is recommended that these be designed in consultation with an engineered fall protection system manufacturer to ensure that the layout meets codes and to determine connection details and loading.

b) Permanent fall arrest anchors must be connected to the roof structure and designed to meet the required impact loads.

c) All anchors and lifelines must be designed to allow for connection of fall arrest harnesses.

d) Engineered shop drawings are required for all components.

5.1.4.(3) All roof-mounted fall protection must not impede drainage or affect the integrity of the building envelope.

5.1.4.(4) All fall protection systems to be designed to meet the requirements of ANSI Z359 – Fall Protection Code and the *Yukon Occupational Health and Safety Act and Regulations*.

5.2. FURNISHINGS

5.2.1. WINDOW TREATMENTS

Window coverings are commonly included in construction contracts rather than with furnishing, fit-up and equipment (FFE). Blinds and shades can be used to control day

lighting admitted into rooms in institutional buildings; in residential applications, curtains and blinds are provided both to control outdoor lighting and for privacy considerations. Daylight control is particularly important during the summer months when most northern communities experience eighteen to twenty-two hours of daylight for up to four months of the year. Bedrooms in residential facilities need to be able to be darkened effectively with curtains or blinds provided, as well as any rooms where projected images may be used.

5.2.1.(1) Shades

a) Locations of shades need to be carefully considered based upon their application. Indoor shades can cause condensation on the window depending on the material, while outdoor shades are at risk of damage due to vandalism or weather.

b) Roller shades are recommended to be used in all non-residential buildings as they are easily cleanable, durable, and available in varying light transmission properties, including full blackout.

c) Shade fabric should be selected for maximum clean-ability, durability, and low VOCs. It is recommended that PVC-free fabrics are selected.

d) Room darkening shades should be either 1% or 3% openness to provide adequate glare control where required.

e) Full blackout shades must be provided with a block-out system on the sides and bottom of the blind to prevent light leakage in rooms requiring the use of projection.

f) Where blackout shades are used, combine with a room darkening shade using a dual roller shade system. This provide occupants with options for light control.

g) Provide fascia to conceal the roller shade.

h) Consider electrically operated shades in certain applications where multiple shades need to be controlled at once, where manual operation is not possible due to the location, or where shades are integral to the building daylighting and solar control strategy.

5.2.1.(2) Blinds

a) Horizontal metal venetian blinds are generally not acceptable due to issues with cleaning and durability.

b) Vertical blinds are not acceptable in heavy use applications as they are prone to damage but are acceptable in light commercial applications.

5.2.1.(3) Draperies

a) In residential occupancies, fabric draperies are acceptable.

b) Fabric draperies should be machine washable and durable.

c) Drapery fabric to be selected for maximum clean-ability, durability, and light transmission properties.

d) Do not locate draperies where they will block access to a means of egress.

5.2.2. THEATRE DRAPERY

It is recommended that the Consultant work with an expert in stage curtains to select the correct drapery, track, and hardware for the specific application.

4

Structural Design Requirements

1. Introduction

Yukon is different from southern Canadian provinces in many respects which requires the use of unique and site-specific approaches in structural design, particularly in the selection of appropriate parameters, materials and design methods. For example, the effects of climate change are being felt to a greater extent in the north and have greater critical impacts and implications which must be considered in design.

In addition, there is a wide range of soils types and conditions throughout the territory, including permafrost with varying temperatures (i.e., continuous, discontinuous, and sporadic discontinuous), stressing the need for thorough geotechnical investigations to support appropriate foundation designs. Also, climatic and seismic hazard values vary throughout Yukon and there are often significant local variations. The NBCC does not provide design parameters for most Yukon communities, which requires design values to be generated for specific locations. Such values can be obtained from Natural Resources Canada with their seismic hazard calculation or from seismic reports completed for schools and other projects in communities.

The short construction season in the north demands that structures be constructed quickly and closed in before winter if possible. Cold weather can provide challenges and constraints related to base preparation, concrete work and overall construction efficiency. As such, many factors related to design can come into play to help ensure that the structure can be constructed in an efficient and timely manner.

1.1. CLIMATE CHANGE ADAPTATION

"All indicators agree that the Yukon climate is warming rapidly and more change is projected. Over the past 50 years the annual average temperature has increased by 2 degrees C. Also, the annual precipitation has increased by about 6% over the same period. Summers have seen the largest increase in precipitation. Existing infrastructures have been designed and built based on historical climate data that may not be appropriate for future conditions. Even small increases in snow load, storm severity and frequency, and thawing permafrost can directly affect the structural integrity of infrastructure. Future development will require new design elements to account for ongoing warming which may add to construction and maintenance costs. These costs need to be considered against the cost of infrastructure failure"

Quote from Northern Climate Exchange, Yukon Research Centre, Yukon College "Yukon Climate Change Indicators and Key Findings 2015"

Proper attention must be paid in the early stages to site selection and appropriate foundation design, particularly in areas with permafrost. All projects in permafrost type materials are to include risk-based screening to assess the structure in terms of permafrost sensitivity and failure consequences.

Application of the screening process will result in a preliminary determination of the level of climate warming-related risk associated with a project. This will aid in site selection and appropriate design of foundations. Guidance for such screening can be found in CSA PLUS 4011-10.

2. Substructure

2.1. FOUNDATIONS

The design of foundations will depend largely upon the input and recommendations received from the geotechnical investigation and assessment to suit the soils characteristics as well as the building design and function.

Acceptable foundation types typically used in non-permafrost soils can include:

- **Concrete Strip Footings**: Includes shallow or deep footings supporting foundation walls of poured concrete or ICF. In some cases, pressure-treated wood foundation (PWF) walls may be acceptable, but PWF strip footings are never acceptable.

- **Slab-On-Grade**: May be monolithic with thickened perimeter footing, or strip footing with slab poured onto footing or tied to the footing. Slab-on-grade requires non-frost-susceptible foundation soils, which may include native or engineered fill.
- **Concrete Spread Footings**: May be used for interior foundation support.
- **Steel Pipe Piles**: Driven to refusal or socketed into bedrock.

In permafrost soils foundations can be characterized as either shallow or deep foundations.

2.1.1. **Shallow Foundations** include the following types.

2.1.1.(1) Footings at surface supported on an engineered fill pad with a ventilated air space under the building. Typical footings include pad/crib systems, pad/screw-jack systems as well as space frame support systems.

2.1.1.(2) Buried spread footings with a ventilated air space under the building. A buried spread footing (typically treated timbers) is set either on or in the permafrost with insulation either below the footing (cold permafrost) or above the footing (warm permafrost). Steel columns extend above grade to support the main building support beams.

2.1.1.(3) Slab-on-grade with no air space under the building. This type of foundation typically requires insulation and a method to maintain the permafrost such as a forced ventilation/cooling system or thermosyphons.

2.1.1.(4) Where there is a ventilated space under the building, a method of adjusting the level of the support systems must be provided.

2.1.2. **Deep Foundations** include the following types.

2.1.2.(1) Ad freeze piles with a ventilated air space under the building. These are generally steel piles and provide support from the bond between the pile and frozen soil.

2.1.2.(2) Rock socket or end bearing piles which do not rely on permafrost for support: This system may not require a ventilated space under the building depending on the nature of the sub soils.

2.1.2.(3) Driven piles are typically steel pipe or H-sections (timber is not acceptable). A ventilated space under the building may or may not be required, depending on whether the capacity is derived from end-bearing or from friction.

2.1.3. For all foundations in permafrost soils, the installation of thermistors must be included as an installation requirement in order to allow for ongoing monitoring of ground temperatures. The design and layout of the thermistors shall be carried out by the geotechnical engineer.

3. Superstructure

3.1. GENERAL DESIGN REQUIREMENTS

A variety of materials can be considered for building construction in the North including the following.

- **Wood-Frame Structures**: Conventional wood-frame structures are common in the north due to readily available materials, versatility and construction methods that small, local contractors are most familiar with. Normally, wood framing is best suited for smaller buildings less than three stories in height. These structures may include engineered wood products.
- **Steel Structures**: Steel is often a preferred choice for larger or multi-storied structures. Steel frames with steel decking for floors and roof is common for the main structural support

systems. Pre-engineered and pre-fabricated steel structures can be a cost-effective option for garages, arenas and warehouses.

- **Concrete Structures**: Concrete is commonly used for foundations, foundation walls and structural slabs. It is most often used in combination with other structural support components including steel and wood, or for multi-story non-combustible construction. Most Yukon communities do not have batch plants and therefore providing concrete to these locations can be costly or prohibitive. In such cases it may be best to limit the use of concrete (i.e. foundations only) or consider alternative materials for construction. All projects where a concrete superstructure is proposed must be assessed using LCCA.
- **Insulated Concrete Forms (ICF)**: ICF is often a preferred choice for foundation walls whichprovides structural support as well as insulation value.
- **Prefabricated Panels**: Structural insulated panels (SIP) can be designed for walls, floors and roof support systems. They may be a cost-effective choice of materials, particularly for remote locations. The system allows for greater construction efficiency and can reduce exposure time to cold weather.
- **Heavy Timber**: Structural engineered timber, including glued-laminated (glulam), cross-laminated (CLT), dowel-laminated (DLT) are acceptable structural components within buildings. Timber frame construction can be considered suitable for housing and other smaller buildings as an alternative to wood frame construction.

The choice of materials will depend on a variety of factors including building size and configuration, function, durability, life span, construction and location.

3.2. FLOOR CONSTRUCTION

Acceptable materials commonly used for floor support include dimensional lumber, I-joists, glulam, LVL, steel deck with concrete, structural slab and slab-on-grade.

Floor support systems must be designed to the following for gravity loads.

3.2.1. Part 4– NBCC live loads for the use of the floor.

3.2.2. Provide allowances for future uses and increases in live loads.

3.2.3. For record storage and library shelving areas the design live load should be based on the type and layout of the proposed storage system, but not less than 7.2 kPa. Some mobile storage systems may even impose a greater loading.

3.2.4. Mechanical Loads

3.2.4.(1) Mechanical units are to be considered a live load.

3.2.4.(2) Allow for a minimum of 100mm thick concrete housekeeping pads at any mechanical equipment and allow for future replacement of mechanical or other heavy equipment.

3.3. ROOF CONSTRUCTION

Acceptable materials commonly used for roof support include dimensional lumber, wood trusses, parallel chord wood and steel trusses, glulam, I – joists, engineered wood products, SIP panels and steel framing,

Roof support systems must be designed to the following for gravity loads.

3.3.1. Part 4 – NBCC – snow and rain loads (only available for 9 locations). For locations which do not have climatic information, the designer must obtain climate design data as generated by Environment Canada.

3.3.2. Climate change indicators suggest that snow loads will likely increase over time. As such, it is recommended that consideration be given to increasing live load values beyond code values. Structural design calculations, including safety factors should be determined on a project specific basis.

3.3.3. Additional loads for mechanical or electrical equipment, fall arrest anchors, and any additional roof-mounted equipment or structures.

3.3.4. Additional loads for future photovoltaic panels. These loads will include gravity loads from the panels themselves but may also include live loads from wind and snow build-up, especially on a flat roof where panels may be tilted for more direct solar advantage. The designer should also consider the panel attachment method to the roof system, which may indicate a need for blocking between roof trusses.

The supplier of roof trusses shall be required to engage an engineer to supervise and inspect the fabrication of the trusses and carry out field reviews of the installation. A sealed letter of assurance must be provided from the manufacturers engineer upon satisfactory completion of the work. The engineer must be registered with Engineers Yukon.

3.4. SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS

3.4.1. The structural engineer must identify the non-structural components in the building which must be seismically restrained as per the National Building Code of Canada. This normally includes mechanical, electrical and architectural components.

3.4.2. Note the required categories to be restrained on or near the front page of the structural drawings.

3.4.3. The building must be structurally designed to accommodate the seismic forces generated from all of the non-structural components.

3.4.4. Provide equipment housekeeping pads as required by mechanical and electrical disciplines. Allow for seismic restraint connections by the Contractor's seismic engineer.

3.5. DESIGN INFORMATION ON DRAWINGS

The following design information used in the building design must be included on the construction drawings for review, construction and future reference. The required information is outlined as follows.

3.5.1. National Building Code of Canada (latest version) used for design.

3.5.2. Importance category used for the building (low, normal, high or post-disaster).

3.5.3. Gravity and Live Loads

3.5.3.(1) Roof Loads

a) Show specified gravity loads including additional point loads.

b) Add loads for proposed or future photovoltaic panels which may include additional live loads due to wind and snow build-up.

c) Flat roof structures shall be designed for the 1/50 One Day Rain including the effect of ponding and assuming the roof drains are plugged. Show the rain load including the effect of ponding.

3.5.3.(2) Floor Loads

a) Indicate values used for live and dead loads as per the NBCC plus allowances for possible increases in future loads (i.e., mechanical equipment, potential changes in usage, etc.).

b) Design floors to L/480 maximum live load deflection.

c) Indicate all additional loads (e.g., rolling storage, shelving etc.).

d) Mechanical: Include all mechanical loads including extra loads for housekeeping pads, equipment and future loads.

e) Electrical: Include loads from electrical equipment (e.g., main distribution centre, generator, etc.).

3.5.4. Snow Loads.

3.5.4.(1) List the Importance Factor (Is) for the ULS and SLS, the ground snow load (Ss) and the associated rain load (Sr).

3.5.4.(2) Allow for snow drifting and superimposed dead loads and indicate values.

3.5.5. Wind Loads

3.5.5.(1) Use values as per NBCC or obtain code design values generated by Environment Canada.

3.5.5.(2) Depending on the location, it is recommended that the designer consider increases in wind loads based on climate change indicators.

3.5.6. Seismic Loads

3.5.6.(1) Indicate all values as per NBCC or obtain values from Natural Resources Canada (NBCC seismic hazard calculations) for the specific building location.

3.5.6.(2) Include Ie for ULS, Sa(ti), PGA, Site Class, type of Seismic Force Resisting System (SFRS), force modification factors (Rd, Ro), design base shear, and design inter-storey drift limit.

3.5.6.(3) Indicate all categories of items which require seismic restraint.

3.5.7. Geotechnical Design Parameters

3.5.7.(1) Make reference to the Geotechnical Consultants report and indicate the parameters applicable to the foundation design (i.e., ULS soil bearing capacity, lateral earth pressure coefficient, end bearing capacity for pile foundations etc.).

3.5.8. Notwithstanding the above, the engineer must adhere to the requirements specified in Division C, Part 2 of the NBCC.

5

Mechanical Design Requirements

1. General Design Considerations

1.1. INTENT

The objective of the following mechanical sections is to outline baseline requirements, standards and, best practices over and above minimum requirements relating to mechanical building systems in facilities owned and/or operated by the Yukon government. The content is intended to supplement code requirements to increase building efficiency, safety, comfort and maintainability. The following requirements have been developed with input from building stakeholders to increase overall building value over its useful life and is based on use, operation and design of many building types owned and operated by the Government of Yukon. This manual is intended to be a generic manual applicable to a majority of buildings constructed and operated by the Yukon government but may not address all building types, systems and requirements and in such cases good engineering judgment in conjunction with applicable codes and standards shall form the minimum requirements.

Rising energy costs have a great impact on operational costs of Yukon government facilities. The efficient and economical use of energy is a crucial consideration in building mechanical design. Recent developments in controls and mechanical systems have increased building energy efficiency. However, these sophisticated systems may be more difficult and costlier to maintain, especially in remote locations where qualified maintenance staff are not always available.

For this reason, durable, reliable mechanical systems with complexity suited for the location and skill set of the operations staff are desirable in all buildings. The guidelines and recommendations in this section are based upon installations that have been found to function well and are easy to maintain. A balance must be struck between the sometimes-conflicting demands for occupant comfort, energy conservation, building system simplicity and reliability.

As stated in Chapter 1 – General Project Requirements, an integrated design process is required, and all design disciplines and building stakeholders must work together throughout the design process. This process tends to result in more sustainable, comfortable and energy-efficient buildings than the traditional building design method in which mechanical and electrical services are designed following the architectural solution.

1.2. IDENTIFICATION

1.2.1. The operation and maintenance of mechanical systems requires building operators to have a good understanding of the building systems and their components. The use of a standard system for piping and equipment identification is an important aid in maintenance and troubleshooting. Such a system shall include pipe and duct labeling and direction-of-flow arrows, valve and controller tags indicating valve name, location, and setting (and an associated identification list for reference) and equipment identification tags or labels.

1.2.2. Provide system components with labeling consistent with design documents and the colour standards described herein.

1.2.3. Provide all mechanical equipment with a manufacturer's nameplate which is mechanically fastened to the equipment and is equipped with raised or recessed lettering. Nameplates shall indicate equipment size, model number, manufacturer name and serial number and all power requirements.

1.2.4. Equipment identification nameplates shall be provided on all equipment to display equipment tags as per design drawings. Nameplates shall consist of 3 mm thick laminated plastic or anodized aluminum label with matte finish and letters accurately aligned and machine engraved into core. Labels are to be permanently mounted on equipment in a visible location. Exterior equipment shall be provided with weather resistant nameplates where required.

1.2.5. Piping identification shall be visible from floor level, wrap all the way around the outer diameter of the piping or insulation and be located as per Section 1.2.7. Fit piping with direction of flow arrows, medium by lettered legend and colour coded based on colour standards as listed. Identification labels may be accomplished by paint, stenciling and/or factory fabricated labels.

IDENTIFICATION LABEL SIZING		
Outside Diameter of Pipe or Covering (mm)	**Height of Letters and Numbers (mm)**	**Length of Colour Field (mm)**
19 to 32	13	200
38 to 51	19	200
64 to 150	32	300
200 to 250	64	600
Over 250	89	600
Ductwork	50	450

1.2.6. Ductwork identification shall be visible from floor level and be fitted with 50 mm high stenciled letters and direction of flow arrows and located as per Section 1.2.7. Identification Labels may be accomplished by paint, stenciling and/or factory fabricated labels.

1.2.7. Locate identification labels as follows.

1.2.7.(1) Within 300 mm of any valve.

1.2.7.(2) Adjacent to changes in direction.

1.2.7.(3) Branches.

1.2.7.(4) Where pipes/ducts pass through walls or floors.

1.2.7.(5) On straight pipe/duct runs at 6-meter intervals.

1.2.7.(6) At entry and exit points and at access openings where piping/ducting is installed in chases, ceiling spaces, shafts, or similar confined spaces.

1.2.7.(7) At beginning and end points of each run and at each piece of equipment.

1.2.8. Furnish control systems with identification on all components, wiring, sensors, panels, thermostats and readouts including LED clusters and shall correspond with control shop drawings. Labels shall consist of device name, number and input/output location.

1.2.9. Provide colour-coded, 6 mm round, self-adhesive labels on t-bar framing adjacent to panel to be removed at all concealed valves, air vents, control devices, and devices requiring maintenance.

T-BAR DOT COLOUR STANDARDS	
System	**Colour**
HVAC equipment and duct cleaning access	Yellow
HVAC valves and dampers	Blue
Plumbing equipment and valves	Green
Control dampers and sensors	Black
Fire, smoke, and sprinkler equipment	Red

1.2.10. Identify edges of obstruction or hazards formed by mechanical equipment or their supports with yellow hazard paint or tape. This includes edges of floor mounted equipment in the travel path, tripping hazards and low-level ducting or piping. Tape is not permitted where foot traffic is expected.

1.2.11. Identify systems as per the following colour standards. Items not listed in the table below shall be confirmed with the Yukon government. Where a system contains substances that may be hazardous, it shall be provided with appropriate WHMIS hazard symbol.

SYSTEM IDENTIFICATION STANDARDS			
System	**Valve Tag**	**Primary Colour**	**Secondary Colour**
Domestic Cold Water	D.C.W.	Green	White
Domestic Hot Water Supply	D.H.W.S.	Green	White
Domestic Hot Water Recirc.	D.H.W.R	Green	White
Heating Water Supply	H.W.S.	Yellow	Black
Heating Water Return	H.W.R.	Green	Black
Heating Glycol Supply	H.G.S.	Yellow	Black
Heating Glycol Return	H.G.R.	Yellow	Black
Chilled Water Supply	C.W.S.	Yellow	Black
Chilled Water Return	C.W.R.	Yellow	Black
Chilled Glycol Supply	C.G.S.	Yellow	Black
Chilled Glycol Return	C.G.R.	Yellow	Black
Boiler Feed Water	B.F.W.	Yellow	Black
Sanitary Sewer	SAN.S.	Green	None
Storm Sewer	STORM.S.	Green	Black
Fuel Oil Supply	F.O.S.	Yellow	Orange
Fuel Oil Return	F.O.R.	Yellow	Orange
Propane Supply	PROP.S.	Yellow	Black
Compressed Air	C.AIR	Yellow	Black
Sprinkler Water	S.W.	Red	White
Outdoor Air Supply	O/A	Black	White
Exhaust Air	E/A	Black	White
Return Air	R/A	Black	White
Supply Air	S/A	Black	White

1.3. EQUIPMENT SUPPORT AND RESTRAINT

1.3.1. All mechanical equipment and systems are to be adequately supported and restrained in accordance with the requirements of the NBCC, Part 4. Restraint systems shall be designed, installed and approved by a Professional Engineer registered in Yukon. Refer to Chapter 1, Section 8 – Seismic Restraint. This includes utility supplied equipment such as propane tanks.

1.3.2. Unless otherwise required by the above, mechanical equipment located in a mechanical room shall be located off the ground by means of a nominally 100 mm thick concrete housekeeping pad painted with high visibility orange paint. Pad construction shall be designed to allow for equipment restraint as required.

1.4. COORDINATION AND EQUIPMENT LOCATION

Installation and design of mechanical systems shall be coordinated with each of the other disciplines to ensure a functional and maintainable system. Refer to Chapter 1, Section 9 – Coordination for specific requirements.

2. Plumbing

2.1. GENERAL

2.1.1. Domestic water systems are to be complete with piping, valves, hot water heating, backflow prevention, fixtures and appurtenances for a completely operational and maintainable system.

2.1.2. Provide sanitary drainage systems including drainage piping, clean-outs, traps sumps, pumps, floor drains, fixtures and all other equipment connected to local drainage.

2.1.3. Equipment and materials used in potable water systems shall be listed by an accredited agency recognized in Canada and in accordance with NSF (National Sanitation Foundation) standards and shall be constructed and assembled with lead-free materials (<0.25 parts per million). Any equipment intended for the preparation of food of used in a food service facility shall be listed as food grade.

2.1.4. Install piping and equipment with adequate access for maintenance. Install cleanouts with adequate services space to allow for rodding/cleaning. Where clean-outs or valves are located in a wall or ceiling, provide a metal access door.

2.1.5. Plumbing pipes are to be located inside the thermal envelope, exterior walls or areas subject to ambient temperatures below 5°C are not acceptable.

2.2. DOMESTIC WATER DISTRIBUTION AND STORAGE

2.2.1. CONNECTION TO OUTSIDE SERVICES

2.2.1.(1) Wherever possible, connection to a municipal domestic water service is preferred. However, in instances where municipal services are not available, suitable systems such as wells or water delivery shall be evaluated using Life Cycle Costing in accordance with Chapter 1, Sub-Section 5.2 – Life Cycle Costing.

2.2.1.(2) Water Entry.

a) Locate water entry into the building to minimize extent of piping run under building and through building.

b) Provide a suitable water entry room or mechanical room in close proximity to services to facilitate building entry and access.

c) Piping subject to high flows or thrust loads, such as automatic sprinkler systems or water tank fills, shall be provided with suitably sized thrust restraint on any changes of direction.

d) Thrust restraints shall be sized and designed to resist the anticipated thrust loading.

e) Isolation shall be provided immediately (within 1 metre) upon entry to the building to facilitate water system shut-off. Provide supervisory tamper switches on any valve installed in-line with an automatic sprinkler system in accordance with NFPA 13.

2.2.1.(3) Freeze Protection Systems.

a) Recirculation systems shall be used where feasible for freeze protection of building water services unless the local municipality requires otherwise. Bleeder systems shall not be used unless written approval is given by YG and local bylaws permit their use.

MINIMUM RECIRC PIPE SIZING	
Domestic Water Service Size (mmø)	**Minimum Recirc. Pipe Size (mmø)**
38 to 51	19
64 to 100	32
125 to 150	38
Over 150	50

b) Recirculation and bleeder systems shall be sized and designed to maintain a minimum velocity of 0.07 m/s (0.25 ft/s) in the main supply pipe.

c) In systems with additional risk of freezing, higher water velocities may be required and shall be evaluated on a case by case basis.

d) In applications where recirculation is not feasible, a listed, electrical, self-limiting heat trace, sized to suit the required heat loss, but not less than 5W/m, shall be provided. Heat trace shall be located in a heat trace channel in the insulation, or if suitable, inside the water stream, and shall be replaceable without the need to excavate the piping. See Chapter 6, Sub-Section 4.4 – Heat Tracing for additional requirements.

2.2.2. DOMESTIC WATER STORAGE

2.2.2.(1) Where connection to municipal domestic water services is not possible, domestic water storage tanks may be required as standalone systems or when used in conjunction with a low-yield well.

2.2.2.(2) When considering tank size, review delivery times, usage and delivery cost with water delivery provider to ensure adequate capacity between fill ups while ensuring tank size is not too large to allow residual chlorine levels to drop. Estimated daily usage values shall be consistent with Yukon Environmental Health guidelines and should consider facility usage and anticipated water demand. Supplemental requirements, such as post-disaster storage, must also be considered.

2.2.2.(3) Tanks shall be constructed to CSA standards and be equipped with the following provisions.

a) A low point gravity drain with provision for drainage. Where the storage tank is located below the facility drainage system and a pump is required to fully drain the tank, provide a permanently mounted lift pump piped to drain. Note that tanks shall not drain to septic fields.

b) Accessible access hatch in top of tank, minimum 450 mm diameter, with watertight and lockable lid. Additional access hatch may be required for larger tanks, consult the Yukon Drinking Water Regulations.

c) Dedicated fill, vent and control bungs.

d) All fill and vent piping shall terminate on the exterior of the building with a permanently mounted, weather-proof, reflective sign indicating “POTABLE WATER” in minimum 50 mm black lettering. Fill connection type shall be coordinated with water delivery supplier and termination shall be configured to prevent contamination or tampering. This may include

lockable fill cap and turn down elbow with screen on vent. Provision to prevent backflow through fill connection shall be provided. Slope fill piping to tank and vent/overflow piping to building exterior.

e) Float type level alarms to indicate high level (95%) and low-level tank alarms (installed above the supply outlet). High level condition to illuminate visual and audible alarm at local panel adjacent to fill connection with signage indicating "TANK FULL". Provide reset toggle for audible alarm. Low level condition to alarm as per Sub-Section 5.2 – Alarming and shall de-energize domestic water pressure pumps. Domestic water high- and low-level alarms to be automatic reset and resume normal operation upon tank level returning to normal operating condition.

f) Tanks shall be located indoors in an area with adequate support and sufficient clearance to allow for cleaning. 1 meter clear in front or above of access hatch is considered the minimum clearance for access.

g) Coordinate tank weight when full with structural engineer to confirm adequate support and seismic restraint is provided.

h) Locate tanks in a dedicated storage room with independent temperature control, to allow water to be kept at a reasonable drinking temperature, and a floor drain.

i) Evaluate provisions for tank removal and replacement.

2.2.3. DOMESTIC WATER EQUIPMENT

2.2.3.(1) Domestic Hot Water Tanks and Equipment

a) Select domestic hot water systems with considerations to life cycle costing, system demand and recovery and maintenance. Energy conservation measure shall be considered such as domestic hot water tanks with heat pump technology located in mechanical rooms or recovery from process heating.

b) Overall facility hot water demand should be evaluated to determine peak loads and duration. Hot water tanks shall be sized to provide adequate storage and recovery for the intended use of the facility.

c) Life cycle costing will be required to evaluate the most suitable hot water heating system over the lifespan of the building and should account for available building infrastructure.

d) Electric domestic hot water tanks to have a minimum warranty of 10 years.

e) Indirect DHW tanks shall have double walled heat exchanger coils where the interstitial space is vented to the exterior. This is to prevent cross-contamination in case of a leak in the coil piping

f) Provide drain pans piped to a suitable drain location on all domestic hot water tanks.

g) All domestic hot water tanks shall be equipped with a minimum of two separate restraints in accordance with Part 4 of the NBCC.

h) Where fixtures are located in excess of 15 meters from the central hot water tank, or in applications where hot water delay is unacceptable (e.g., health care facilities or commercial kitchens), hot water recirculation systems should be employed to ensure hot water is available when required. Hot water recirculation pumps shall be configured to operate only during occupied hours.

i) Tempered Water Requirements.

j) Evaluate tempered water requirements for any facility serving youth orthe elderly, including care or health care facilities.

   i) Fixtures without temperature control such as gang showers in public facilities or automatic faucets shall include tempering.

ii) Use of thermostatic mixing valves and hot water recirculation should be used to provide tempered water where required.

iii) Valves shall be accessible to maintenance staff and be included in commissioning procedure to confirm performance.

iv) Tempered water shall not be provided by reducing hot water tank supply temperature.

v) Where tempered water is not strictly required and controlled, scald guards and temperature limit stops shall be provided at fixture outlets to limit water temperature to a maximum of 49°C (120°F). Service sinks such as janitorial mop sinks, scullery sinks and kitchen areas to be provided with 60°C (140°F) water.

2.2.3.(2) Pressure Pumps and Tanks

a) Municipal pressures shall be used whenever possible; however, a booster system may be required if the available pressure is below 276 kPa (40 psi), or if the municipal pressure cannot meet the building requirements.

b) Booster systems shall incorporate the following provisions.

i) System shall be capable of maintaining system domestic water supply at design pressure during facility peak demand. Design pressure shall be based on building requirements but shall not drop below 276 kPa (40 psi). 413 kPa (60psi) would be considered a typical domestic water pressure.

ii) System shall be configured to prevent short cycling of the domestic water pumps by using bladder type pressure tanks or variable speed pumps designed for such a service.

iii) System shall be equipped with pressure gauges before and after booster pumps and shall report to Building Management System where available.

iv) In facilities with septic tanks, domestic water pumps are to shut down and alarm on septic tank high level alarm as per Environmental Health Design Specification for Sewage Disposal Systems.

v) Pumps shall be mounted to prevent excess transfer of noise to structure during operations. Consider use of vibration isolation to suit application.

vi) Isolation valves shall be provided on either side of pump to facilitate replacement.

vii) In facilities where failure of the domestic water booster pump would require facility to be shut down, provide redundant pumps, each sized for 100% of peak demand.

viii) Report pump failure alarms to Building Management System in Category 1 facilities or to the local panel for Category 2 facilities.

2.2.3.(3) Protection from Cross-Contamination and Backflow

a) Domestic water system shall be equipped with backflow prevention where required by CSA-B64 and National Plumbing Code of Canada to prevent cross-contamination and backflow based on anticipated hazard.

b) Risk assessments shall be conducted on each facility to determine potential hazards and appropriate measures shall be implemented on a case-by-case basis.

c) At minimum, appropriate level of backflow prevention shall be provided at the following locations; irrigations systems, RV dumps, kitchen facilities and equipment, automatic sprinkler systems, water truck fill connections, service sinks, faucets with hose attachments and at connection to any systems not containing potable water.

2.2.3.(4) Domestic Water Treatment Considerations

a) For facilities located where municipal or treated water sources are not available, the building owner shall arrange for water quality testing as part of the initial site assessment and in conjunction with the geotechnical review.

b) A suitable well location shall be determined by a Professional Hydro-geologist or Geotechnical Engineer and a representative water sample shall be tested by an accredited lab to determine water quality parameters.

c) A well assessment report shall be prepared to outline the following.

i) Water quality result.

ii) Site conditions.

iii) Well performance parameters including recovery rate, draw down, depth log, screen length and slot sizes.

iv) Well design requirements including GUDI (Groundwater Under the Direct Influence of Surface Water) considerations in accordance with the small and large public drinking system classifications as applicable.

v) Any relevant design parameters as required by the Guidelines for Canadian Drinking Water Quality, *Public Health and Safety Act*, *Yukon Drinking Water Regulations* and Environmental Health requirements. Refer to Chapter 7 – Civil and Site Design Requirements.

d) A suitable treatment system shall be designed by a Professional Engineer to address any items identified in the well assessment and as required to achieve potable water. Emphasis on simple and maintainable systems should be considered in equipment selection and system design. Review availability of maintenance personnel and system operators with the Government of Yukon prior to design.

e) Where water quality monitoring is provided, it shall report to facility's Building Management Systems.

f) In systems with poor well water quality, and where the use of trucked water delivery may be more feasible than providing water treatment, the use of a two-tier distribution system shall be considered with LCCA. Well water may be used for a non-potable systems where practical and potable water system can be provided from a water storage tank.

g) Where on-site chlorine dosing is required to achieve treatment objectives, provide chlorine injection pumps sized based on the anticipated dosing rate, system pressure and turndown. Pumps to be equipped with stepper motors and variable digital control.

i) Standard of Acceptance: Peristaltic Pump.

2.2.4. DOMESTIC WATER PIPING

2.2.4.(1) Potable Water Piping

a) Size piping to maintain a maximum of 2.4 m/s velocity for cold water and 1.5 m/s in domestic hot water and recirculation piping to minimize erosion.

b) Concealed run-outs in walls or from central domestic water manifold can be run in an approved PEX piping to CSA-B1375 where approved by National Building Code of Canada and National Plumbing Code of Canada. Pipe assembly shall be in accordance with manufacturer recommendations and include only lead-free materials. Provide copper stub out from walls to fixtures.

c) Combustible piping systems shall not be permitted in non-combustible construction or where prohibited by the National Building Code of Canada.

d) Domestic water manifolds shall be constructed of brass or copper and remain sealed until installation. Manifolds located in public areas are to be installed behind lockable access doors installed a maximum of 2 meters above floor.

e) Water supply piping shall be run inside the heated space and shall not be run in exterior walls. If drops are required along exterior walls, a chase or service wall shall be provided to conceal piping as required.

f) Piping shall not be run in concrete slabs. Downstream of the water service entry, piping shall not be run under slab or below grade except where absolutely necessary.

g) Piping shall be insulated in accordance with National Energy Code of Canada. Provide a continuous vapour barrier for all cold water and chilled water piping to prevent condensation.

h) Provide accessible isolation valves for each fixture, piece of equipment, suite, riser and branch line. Locate isolation valves on inlet and outlets of all inline equipment.

i) Install domestic water piping parallel to building lines and with clear visible identification.

j) Drain valves shall be provided at all low points.

k) Domestic water piping shall be flushed and disinfected prior to being put into service.

l) Provide supports for piping. Supports shall be design to accommodate anticipated loads and allow for expansion and contraction without enacting undue stress on structure. Supports shall secure piping and prevent vibration. Metallic piping shall be isolated from hangers with a suitable non-conductive isolating material.

m) Provide escutcheons on exposed pipe penetrations through all walls, floors, millwork, etc.

2.2.5. PLUMBING FIXTURES

2.2.5.(1) General Requirements

a) Plumbing fixtures shall be provided in accordance with the functional requirements of the facility.

b) Select fixtures in accordance with the local bylaws/regulations and the requirements of Chapter 2, Section 7 – Water Efficiency.

c) Fixtures of any one type shall be by the same manufacturer throughout the building.

d) Provide barrier-free fixtures where required and install as per the CAN/CSA-B651.

e) All fixtures shall be CSA approved to NSF standards and shall be food grade.

f) Functional program shall identify desired fixture and trim type (material, wall or floor mounted, manual or automatic hands-free operation, etc.).

g) Washrooms that are designated as public use or washrooms in health care facilities shall be incorporate hands-free faucets. Manual faucets may be used where codes allow, and written approval is obtained from the Yukon Government.

h) Consider use of direct flush urinals and water closets where sufficient water supply is available. Coordinate with electrical for provision of power where required.

i) All vitreous china or fiberglass plumbing fixtures are to be white. Coloured fixtures should only be considered under special circumstances and are subject to approval by the Yukon government.

j) Fixtures to be selected based on local availability. Where specialty fixtures are required to satisfy specific functional requirements and are not locally available, select equipment with consideration to maintenance and replacement availability.

2.2.5.(2) Kitchen Fixtures

a) Commercial kitchen fixtures shall be provided in accordance with Environmental Health Food Service Checklist.

b) At minimum all commercial kitchens shall be provided with a three-compartment sink, hand sink, and a grease interceptor where applicable.

2.2.5.(3) Service Fixtures

a) Non-freeze hose bibbs shall be provided around building exterior to suit irrigation requirements. All hose bibbs shall be provided with a vacuum breaker, stop and drain, and isolation valve to facilitate drainage before winter.

b) Janitors rooms shall be provided with a 600 mm x 600 mm x 250 mm service sink made from molded stone or equivalent material. To include stainless steel splash guard, mop hanger, and service faucet with vacuum breaker and pail hook.

i) Standard of Acceptance: FIAT MSB2424.

c) All mechanical service rooms shall be provided with a 610 mm x 610 mm single compartment, 1.5 mm thick stainless steel scullery sink.

i) Standard of Acceptance: Franke SL2424.

2.2.5.(4) Emergency Fixtures

a) Where the eyes or body of any person may be exposed to harmful, corrosive or hazardous materials, provide suitable emergency fixtures to adequately drench body and flush eyes as required by the *Yukon Occupational Health and Safety Act*.

b) Fixtures shall be installed and tested to the requirements of ANSI-Z358.1.

c) Provide tempered water to emergency fixtures. Thermostatic mixing valves shall be listed in accordance with ANSI-Z358.1 and be fitted with integral strainers, adjustable temperature control within ±1.6°C, built-in cold water bypass and positive shut-off of hot water supply.

2.2.5.(5) Installation Requirements

a) Barrier-free fixtures shall be installed in conformance with CAN/CSA-B651 for accessibility.

b) Provide water hammer arrestors on any automatic valve without slow-closing actuators.

c) Provide pressure reducing valves on equipment not rated for distribution pressures.

2.2.6. **EMERGENCY SYSTEMS AND EQUIPMENT**

2.2.6.(1) Fire Halls

a) Fire halls shall be equipped with a water storage tank and pump system to be used to fill fire trucks. The location and capacity shall be coordinated with requirements of the site equipment and the Fire Marshall's Office.

b) Truck fill shall be pumped and sized to fill fire truck in under 15 mins. Coordinate capacity with facility equipment.

c) Water storage tank shall meet the requirements of Sub-Section 2.2.

2.3. SANITARY DRAINAGE AND STORAGE

The combination of the extremely cold climate and the use of low-flow fixtures in a northern building can cause potential drainage problems. A good design provides a drainage system that requires minimal use of supplementary heating (such as heat trace) and allows easy access to drain lines and clean-outs for maintenance.

2.3.1. **GENERAL**

2.3.1.(1) Gravity drainage shall be utilized wherever possible.

2.3.2. **CONNECTION TO OUTSIDE SERVICES**

2.3.2.(1) Wherever possible, a connection to municipal sanitary is preferred. However, in instances where municipal services are not available, connections to septic system may be required in accordance with Chapter 7 – Civil and Site Design Requirements.

2.3.2.(2) Coordinate invert, material and insulation of sanitary service leaving building with the requirements of Chapter 7 – Civil and Site Design Requirements and the building foundation. Depth of cover shall be sufficient to prevent freezing.

2.3.2.(3) Locate sanitary service exit to facilitate access to building cleanout.

2.3.3. **SANITARY SEWERAGE EQUIPMENT**

2.3.3.(1) Sanitary Waste Interceptor and Separators

a) Interceptors and or separators shall be provided to prevent the discharge of oil, grease, sediment, solids or other substances that may be harmful or hazardous to the building drainage system, municipal system or environment as per the National Plumbing Code of Canada. At minimum the following hazards shall be addressed.

i) Sanitary waste containing grease such as food preparation areas.

ii) Sanitary waste containing petroleum products such as vehicle storage and maintenance areas.

iii) Sanitary waste containing sediment such as parking areas.

iv) Sanitary waste that could be acidic such as school laboratories or heating appliance condensate.

b) For systems discharging to municipal services, interceptor discharge shall be below concentration limits defined by the municipality. Refer to municipality bylaws as applicable.

c) For systems not discharging to a municipal sewer, discharge limits shall be in accordance with the Environment Act O.I.C. 1995/047.

d) Interceptors shall be designed and installed in accordance with the manufacturer's instructions.

e) Interceptors to be constructed of non-ferrous materials, such as plastic or stainless steel.

f) Sanitary waste not containing substances requiring separation shall not be discharged through a separator.

g) Cast in place arrangement is not acceptable. Interceptors shall be removable without requiring demolition of building infrastructure. Where required, locate interceptors in a formed pit with a watertight lid rated for the expected loads from foot/vehicle traffic.

h) Oil Interceptors: Shall be designed for the expected flows and hydrocarbon levels and incorporate the following provisions.

i) Shall be equipped with means of storing separated oil.

ii) Storage shall be of sufficient size to accommodate expect flows without compromising system operation.

iii) Storage tank shall be equipped with level sensor and alarm to indicate tank full condition.

iv) Interceptor shall be provided with isolation valves and unions to allow removal.

v) In systems where large flows could compromise interceptor effectiveness, a means of restricting flow shall be provided upstream of interceptor. Provide surge pits where required to ensure unrestricted drainage without comprising interceptor effectiveness.

vi) System design and selection shall be reviewed and approved by the Yukon government prior to construction.

2.3.3.(2) Sanitary Sewerage Pumps and Lift Stations

a) In instances where elevations do not permit gravity drainage, sewage pumpsmay be used.

b) If pumps are needed, route only piping that cannot be drained by gravity through pump.

c) Lift stations shall consist of a basin sized to ensure a minimum of one minute run time on the pump. Basin configuration shall allow full drainage to prevent tank from going septic.

d) Basin shall be equipped with lift off lid, pump lift out rail assembly, level control support rail and 4 position float assembly.

Floats shall be arranged as follows.

i) Float 1: Pumps Off.

ii) Float 2: Lead Pump On.

iii) Float 3: Lag Pump Start, Alarm Lead Pump Failure.

iv) Float 4: High Level Alarm.

e) Where required, systems shall be equipped with a duplex redundant macerator type pumping system.

f) Pump shall be controlled to automatically alternate between lead/lag and have alarms for lag pump start and high level.

g) Alarms shall report to Building Management System where one is installed or at the local panel.

2.3.3.(3) Floor and Trench Drains

a) Floor drains and trench drains shall be provided as required to adequately collect any anticipated water.

b) At minimum, floor drains shall be provided in all washrooms, service rooms, laundry rooms, kitchens, mechanical rooms, crawlspaces and sprinkler rooms.

c) Sprinkler room drains shall be a minimum of 100 mm and must accept the full flow of main drain test.

d) Drain body shall be epoxy coated cast iron and be selected based on floor construction. Drain body shall be fitted with a nickel plated strainer.

e) All floor drains shall be equipped with trap seal primer or other suitable means of maintain the trap seal.

f) Floor drains located in mechanical rooms and service areas shall be funnel floor drains to facilitate piping of drains from equipment.

g) Trench drain shall be equipped with a means of collecting sediment and grating suitable to resist any loading (e.g. foot or vehicle). Provisions for cleaning of drain and sediment trap shall be provided.

2.3.3.(4) Roof Vents

a) Combine vent stacks inside building to minimize roof penetrations.

b) Provide an appropriate means of preventing freeze over. Insulated stack jack flashing shall be used wherever practical.

c) Roof vents shall be located to minimize possibility of recirculating sewer gasses. Maintain required clearances to building opening and mechanical intakes.

2.3.3.(5) Installation Requirements

a) Coordinate to determine the rough-in requirements and provide provisions for owner supplied equipment such as laundry facilities, kitchen equipment, pressure washers etc.

2.3.4. SANITARY SEWERAGE PIPING AND MATERIALS

2.3.4.(1) Exposed P-traps to be chrome construction.

2.3.4.(2) P-traps on emergency and occasional use fixtures, such as floor drains, to be equipped with trap seal primer. Trap seal primers shall be located on domestic cold water lines with sufficient flow to ensure proper operation. In the case of low-flow fixture supply lines, the use of electronic trap primers or mechanical trap seals should be considered.

2.3.4.(3) All underslab piping shall be a minimum of 50 mm and be sloped as per the following table. In applications where the resulting pipe drop would require the addition of a lift pump to connect to outside services or excessive trench depth would adversely affect site compaction, minimum slopes as defined by the National Plumbing Code of Canada may be used where specifically approved by the Government of Yukon.

MINIMUM PIPE SLOPES FOR UNDERSLAB PIPING		
Pipe Size (mmø)	**Minimum Pipe Slope (%)**	**Where approved by YG**
50 to 75mm	3%	2%
100mm and larger	2%	1%

2.3.4.(4) Piping supports on gravity drainage system shall allow for grading adjustment at hanger.

2.3.4.(5) Provide escutcheons on exposed pipe penetrations through all walls, floors, millworks etc.

2.3.4.(6) Drainage piping in noise sensitive areas, such as residential sleeping areas or assembly occupancies, shall be cast-iron throughout and shall be isolated from structure to minimize noise transfer.

2.4. STORMWATER DRAINAGE

2.4.1. CONNECTION TO OUTSIDE SERVICES

2.4.1.(1) At a minimum, stormwater drainage systems shall be designed and installed to the requirements of the municipality, National Plumbing Code of Canada and the requirements of Chapter 7 – Civil and Site Design Requirements.

2.4.1.(2) Stormwater and roof drainage piping shall connect to outside services in a manner that will prevent freezing and/or back-up onto the roof. Where depth of cover is insufficient to provide appropriate levels of freeze protection, a means of preventing freezing shall be installed.

2.4.1.(3) Flow control roof drain systems shall not be used.

2.4.1.(4) Surface Drainage

a) Where storm drainage is addressed by draining to surface, water shall not discharge onto areas designated for pedestrian or vehicle traffic.

b) Terminate rain water leader drains with a down-turned elbow located above the highest anticipated snow level and discharge onto a splash pad sloped to drain away from building.

c) Coordinate with architect or civil consultant to ensure site grading directs water away from building.

d) Drain termination shall not impede snow clearing and shall be provided with heat trace or other suitable means of preventing freezing during winter.

2.4.2. STORMWATER DRAINAGE EQUIPMENT

2.4.2.(1) Roof Drains

a) Install roof drains on all flat roof assemblies. Roof drains to be provided with metal dome strainers. Plastic is not allowed.

b) Locate drains to minimize the number of vertical rain water leaders in building.

2.4.2.(2) Installation Requirements

a) Protect roof drains against freezing by means of electric heat trace installed to the requirements of Chapter 6 – Electrical Design Requirements or by other approved means.

b) Drains shall be compatible with roofing system and the requirements of the architect or building envelope consultant.

2.4.3. STORMWATER DRAINAGE PIPING AND MATERIALS

2.4.3.(1) Roof drainage piping shall be insulated for a minimum of 3 meters from building penetration when concealed.

2.4.3.(2) Exposed rain water leaders run through buildings shall be insulated along its entire length. Insulation thickness shall comply with requirements of National Energy Code of Canada and be provided with a continuous vapour barrier.

2.4.3.(3) Stormwater drainage piping in noise sensitive areas, such as residential sleeping areas or assembly occupancies, shall be cast-iron throughout and shall be isolated from structure to minimize noise transfer.

2.5. COMPRESSED AIR SYSTEMS

2.5.1. Compressed air systems shall be installed in accordance with CAN/CSA-B51.

2.5.2. Coordinate rough in requirements with owner-supplied appliances and hose reel locations to ensure outlets are provided where required.

2.5.3. Compressors shall be CSA, ULC or NFPA listed according to their intended use and installed with air dryers to minimize moisture in compressed air lines.

2.5.4. Pressure gauges shall be located at compressor outlet in a visible location.

2.5.5. Install compressor to manufactures requirements.

2.5.6. Located compressor to minimize noise transfer between adjacent noise sensitive areas. Provide vibration isolation on unit supports.

3. HVAC

3.1. FACILITY FUEL SYSTEMS

3.1.1. GENERAL REQUIREMENTS

3.1.1.(1) The fuel source for the facility shall be selected based on the local availability of fuel, local service staff, and suitability of associated heating system.

3.1.1.(2) Selection of facility fuel source shall be incorporated into the Integrated Design Process and shall be included in energy modeling, life cycle costing and total cost of ownership analyses as outlined in Chapter 1 – General Project Requirements, and Chapter 2 – Energy and Environmental Design Requirements.

3.1.1.(3) For all category 1 projects, renewable heating options such as biomass shall be included as part of design

3.1.1.(4) Systems shall be sized to provide a minimum of two (2) weeks capacity while operating at peak building demand. Provide additional capacity where required by local conditions.

3.1.1.(5) Mechanical vehicle protection consisting of concrete filled bollards designed and spaced as per the applicable installation standard shall be provided around any tank system located in areas subject to vehicle traffic. Wooden or other removable means of protection will not be accepted.

3.1.2. FUEL OIL SYSTEMS

3.1.2.(1) Fuel Oil System Arrangement

a) System shall be designed and installed to the requirements of CAN/CSA-B139, National Fire Code of Canada, CCME and good engineering practice.

b) System shall be functional, safe and maintainable.

c) Provisions for preventing fuel spill under normal operation and maintenance shall be provided.

d) System design shall consider anticipated suction lift, air entrainment and require flow rates and design shall be arranged to mitigate effects on system performance.

e) Select system arrangement (gravity, lift, pressurized lift, elevated loop or day tank) with consideration to appliance burner elevation, pipe length, rated capacity of equipment and possibility of fuel leaks.

f) Suction pressure on appliance feed lines shall not exceed 30 kPa (9" Hg).

g) Where day tanks are used, each appliance to be fed from a dedicated suction line. A common header may be used at the day tank to minimize the require number of tank fittings and connections.

h) Provide day tanks and associated lift pumps for systems with elevated burners, where long suction lines would result in excess vacuum pressure that exceeds burner rating, where air entrainment could adversely affect system operation, and where independent appliance suction lines are required to minimize effects of burner operation on adjacent appliances.

3.1.2.(2) Fuel Transfer Areas

a) Consideration shall be given to the fuel transfer area as defined in the "Federal Petroleum Product and Allied Petroleum Products Storage Tank Systems Regulations". Allowances for the safe transfer of fuel from the delivery truck to storage tank system shall be considered.

b) Ladders and platforms shall be provided where fill location is located more than 1200 mm above adjacent surface.

c) Tank fill connection shall be located in a lockable spill container.

3.1.2.(3) Fuel Oil Equipment – General Requirements

a) Fuel oil equipment shall be listed for its intended use and installed in accordance with its listing and as per manufacturers written instructions.

b) Listing shall be consistent with the requirements of the referenced standard.

3.1.2.(4) Fuel Oil Tanks

a) Fuel oil tanks shall be listed and shall be located above ground. Underground tanks require justification and must be approved by the Yukon government.

b) Tanks shall be located on the site where accessible by the fuel delivery truck.

c) Tanks shall be located on a suitable foundation, designed by a Professional Engineer registered in Yukon, and in accordance with the requirements of the referenced standard.

d) Tanks located in public areas where tampering is a concern shall be located in a fenced enclosure.

e) Tanks shall be provided with sufficient number of bungs to facilitate all the required appurtenances. Ensure two additional 50 mm bungs are provided for future use. Additional bungs to remain unused until final completion.

f) Where energy metering is required, fuel consumption for each major energy user shall be metered by in-line fuel meters and reported to Building Management System. Refer to Chapter 2 – Energy and Environmental Design Requirements.

g) Fuel oil level shall be monitored by means of a ULC listed visual gauge. Where a Building Management System is provided, digital level sensors shall also be provided to report fuel levels.

i) At-A-Glance plastic or glass gasketed liquid level float gauges are not acceptable.

ii) Hydrostatic, remote levelometer type listed to ULC/ORD-C180 are preferred. Standard of Acceptance: Ktech Model 277.

h) Indoor tanks shall be located as per CSA-B139 with all required protection, clearances, and fire separations.

i) Fuel oil supply tanks greater than 250 Imperial gallons (1137 L) shall have an overfill protection device limiting the maximum tank fill volume to 95% of tank capacity. Where local fuel delivery trucks do not have the capability for pressurize fill, alternate overfill prevention means in accordance with CSA B139 are to be provided.

3.1.2.(5) Fuel Oil Pumps

a) Fuel oil transfer pump shall be duplex style with redundant 100% capacity.

b) Pumps shall be equipped with a control panel to control pump operation and shut down in the event of an alarm. Control panel shall include a hand-off-auto control for each pump and indicate pump status, lead pump failure with lag pump start relay, high and low pressure cut outs, leak alarm.

   i) Standard of Acceptance: Viking DFO, Albany Pump Co FO Series Transfer Pump Set

c) Pumps controls alarms and safeties to be installed in accordance with CAN/CSA-B139.

3.1.2.(6) Filters, Gauges and Appurtenances

a) Filters shall be provided upstream of all burners and pumps and shall be replaceable cartridge type with a 10-micron rating housed in a cast iron body. Filters shall be sized for the maximum flow rate of all downstream appliances.

   i) Standard of Acceptance: General Filters.

b) Provide dial-type pressure or vacuum gauges with a 90 mm diameter dial (scaled to the application) upstream and downstream of all transfer pumps, as close are practical to each appliance and on all suction lines from tanks to facilitate troubleshooting.

c) Provide isolation valve and snubber on all gauges.

d) Isolation valves to be provided as per CAN/CSA-B139 and upstream of all filters, at each burner or fuel burning appliance and around pumps. Fusible valves are not an acceptable means of isolation.

e) Where anti-siphon valves are provided, they shall be ULC listed and shall be adjustable type rated for the anticipated liquid head pressure.

   i) Standard of Acceptance: Franklin Fueling Systems 605-300.

3.1.2.(7) Fuel Oil Piping

a) Piping shall be well supported and protected against physical damage including falling ice and snow.

b) Exterior and interior piping shall be primed and painted with minimum of two coats of orange corrosion resistant paint.

c) On rigid piping systems, braided flex connections shall be installed in-line between tanks, buildings or independent support structures to allow for differential movement.

d) Installations subject to vibration from equipment shall be isolated using a listed braided stainless steel flexible piping and fitted with protection to prevent rubbing and wear.

e) Connections to burners or items requiring removal for servicing to be done in type k copper tubing or with a listed braided stainless steel flexible connector.

f) Piping shall be sized to minimize potential air entrainment while managing suction losses.

g) Provisions for thermal expansion relief shall be provided in accordance with CSA-B139.

3.1.2.(8) Installation Requirements

a) Piping and equipment shall be located to avoid large suction head on pumps and burners.

b) Where possible, locate oil burning equipment and close as possible to fuel source to minimize losses and long pipe lengths.

c) System arrangement shall be configured to facilitate visual inspection.

d) Concealed piping and equipment should be avoided where possible.

3.1.3. PROPANE SYSTEMS

3.1.3.(1) Propane Tanks

a) Propane tanks shall be located outdoors and aboveground where accessible by the propane delivery truck.

b) Coordinate with propane supplier for supply and install of propane storage tank. Propane tank requirements to be coordinated during design and confirmed by tank supplier.

c) Tanks shall be located on a suitable foundation, designed by a Professional Engineer registered in Yukon and in accordance with the requirements of the referenced standard. Provide seismic restraint on tanks to the requirements of Part 4 of the National Building Code and Chapter 1 – General Project Requirements.

d) Tanks located in a public area, where tampering is a concern, shall be located in a fenced enclosure.

e) Where energy metering is required, propane gas consumption shall be metered by an approved gas meter and reported to Building Management System. Refer to Chapter 2 – Energy and Environmental Design Requirements.

f) Tanks shall be equipped with a digital level gauge. The level gauge readings shall be accessible remotely to GY staff.

g) Refer to Propane System Design, Installation and Operation Standards for additional requirements.

3.1.3.(2) Propane Regulators

a) Propane regulators shall be commercial grade regulators sized for the sum of all maximum input capacity of all appliances served by the propane system at the intended operating temperature.

b) First stage regulators shall be rated for local outdoor design temperature.

c) Second stage regulators shall be installed indoor with vents piped to the exterior.

d) Coordinate regulator location to ensure minimum clearances from vent termination to sources of ignition or building opening/intakes.

3.1.3.(3) Propane Piping

a) Propane piping shall be installed in accordance with CAN/CSA-B149.

b) Piping shall be protected against mechanical damage and corrosion. Provide two coats of corrosion resistant yellow paint on all propane distribution piping, including interior piping.

c) Piping run from exterior tank to grade level shall be adequately supported unless run in a rated pipe with an appropriate level of flexibility to allow for movement such as copper tubing to CAN/CSA-B149.

d) Provide mechanical protection on any piping within 300 mm of grade level.

e) Provide tracer wire and/or tape on underground piping in accordance with CAN/CSA-B149.

f) Include pressure gauge with shut off valve after second stage regulator, near equipment, for propane system pressure verification.

3.1.3.(4) Installation Requirements

a) Where vaporizers are required to meet system demand, electric vaporizers are preferred.

b) Where vaporizers are not required, propane tanks shall be provided with an appropriately sized tank blanket to aid in cold weather operations.

c) Tank blankets shall be provided with a hard wired, lockable, and weatherproof disconnect fed from a dedicated circuit. Plug in type is not acceptable. Provide means to indicate blanket function, including testing during off season. Refer to Chapter 6 – Electrical Design Requirements.

i) Standard of Acceptance: Thermon RT FlexiPanel.

3.1.4. BIOMASS SYSTEMS

Life cycle costing, along with owner's capacity for system operation and maintenance shall be reviewed in accordance with Chapter 2 – Energy and Environmental Design Requirements. Options for district heating shall be reviewed with adjacent facilities where practical.

3.1.4.(1) Biomass Storage Facility

a) Biomass heating plants shall be provided with infrastructure for fuel storage in conformance with the requirements of CAN/CSA-B365.

b) Storage area/equipment shall be capable or keeping fuel dry and out of the elements.

c) Where possible, fuel storage shall be integral to or in close proximity to the heating plant.

d) System shall include provisions for transporting the fuel from the storage area to the combustion system automatically.

e) Biomass storage shall be designed and sized to facilitate delivery and storage of biomass. Facility design should allow delivery truck to drop wood chips into the storage or handling area without supplemental equipment or intermediate drop off locations.

f) Where required to facilitate delivery, large access doors sized based on delivery truck requirements shall be installed.

g) Storage bunker or hopper should be sized to allow for a minimum of three-week supply of fuel, unless site conditions or facility requirements dictate otherwise. Consider size of delivery vehicles and shipment loads when determining storage requirements.

h) Systems shall include provisions for ventilation, dust control, spark, fire or explosion detection/prevention and suppression systems as required.

i) For wood chip storage, below grade bunkers located to allow direct tip delivery are preferred. Above-ground bunkers may be used when fuel delivery vehicles are equipped with suitable equipment to facilitate direct delivery. Provide agitators as required to facilitate chip extraction.

j) External hoppers and bunkers used for pellet storage shall be designed and arranged to promote free flow of pellets into extraction equipment.

Consider pellet degradation when choosing extraction system. Gravity feed or auger extraction is preferred.

k) Confirm any specific infrastructure requirements based on local conditions with the Yukon government and design facility to accommodate local fuel sources where available. Consider fuel quality parameters when selecting equipment.

l) In retrofit application, containerized systems may be used subject to the approval of the Government of Yukon.

3.2. HEATING SYSTEMS

Heating systems shall be selected, designed and installed with a priority on efficiency, comfort, serviceability, availability of local services and simplicity. Performance criteria shall be coordinated with the requirements of the code and energy targets outlined in Chapter 2 – Energy and Environmental Design Requirements.

Projects are required to exceed minimum code requirements and achieve higher efficiency standards. The selection of the heating system should be consistent with the proposed energy targets. As such, unless restricted by more stringent requirements, all new buildings shall comply with the requirements set out in Chapter 2.

Combustion of heating fuels is the primary source of GHG emissions for nearly all institutional buildings in Government of Yukon's portfolio. Ensuring low-carbon and energy efficient heating systems is one of the most important components to reducing greenhouse gas emissions.

The chosen heating system shall be outlined in the schematic design phase and reviewed with the Yukon government, at which time they shall provide sign-off for the design prior to commencement of the construction drawings to ensure the proposed system is suitable and within the capability of the maintenance staff.

For renovation and addition projects, the systems and equipment should be consistent with existing infrastructure and designed and selected to ensure proper integration.

3.2.1. GENERAL REQUIREMENTS

3.2.1.(1) Heating system shall be designed and sized based on the 1% design temperatures outlined in the National Building Code of Canada.

3.2.1.(2) Systems shall be arranged to ensure optimal energy efficiency, and comfort are achieved. Select equipment on the basis of maintainability, minimizing GHG emissions, energy efficiency and life cycle costs.

3.2.1.(3) Heating requirements shall be determined using project specific calculations to determine peak building heating load.

3.2.1.(4) System design shall incorporate redundancy to ensure failure of any one component will not result in system failure.

3.2.1.(5) Provide heating in all areas in the building inside the building's thermal envelope including crawlspaces and service spaces.

3.2.1.(6) Select equipment with consideration to local availability.

3.2.1.(7) Install all equipment with sufficient clearances and access to facilitate maintenance. Increase manufacturer's recommended clearances where deemed necessary.

3.2.1.(8) Design and size heating systems to be able to maintain indoor design temperature of 21°C during winter months unless facility use requires alternate indoor design conditions. Coordinate with owner to meet functional requirements.

3.2.1.(9) All heating equipment shall be designed and installed in accordance with good engineering practice, the requirements of manufacturer and code.

3.2.1.(10) Thermal comfort considerations in accordance with ASHRAE 55 and ASHRAE Applications Handbook shall be reviewed and integrated into the mechanical system design. Where specific thermal comfort considerations are to be included, they shall be outlined in the functional program.

3.2.1.(11) Allowances for maintenance shall be considered and implemented. Equipmentshall be accessible with sufficient clearance to facilitate removal without destructive measures.

3.2.1.(12) Locate heating terminal units and diffusers to minimize drafts and manage minimize thermal gradients within a space.

3.2.1.(13) Consider effects of stratification on thermal comfort, control and energy efficiency when selecting and locating equipment.

3.2.1.(14) Any heating plant upgrade, installation, and design shall, where the design option are available, ensure that it does not require the supervision of a person holding a certificate of competency under the Yukon Boiler and Pressure Vessel Act, and whenever possible should aim to achieve a rating of no more than 750 KW based on the Heating Surface Area calculations laid out in the aforementioned Act.

3.2.2. FORCED AIR SYSTEMS

3.2.2.(1) Application and Installation Considerations

a) Forced hot air systems are not suitable for all types and sizes of facilities, but their simple servicing requirements sometimes make them a preferred choice in small facilities or remote locations.

b) Limitations for zoning shall be reviewed to ensure thermal comfort can be achieved with the proposed heating system.

c) Refer to Sub-Section 5.6 – Thermal Comfort Control.

3.2.2.(2) Forced Air Heating Equipment General Requirements

a) Where forced air heating systems are designed to temper outdoor air, stainless steel heat exchangers shall be provided.

b) All forced air heating system shall be equipped with filters installed as per manufactures requirements. Select filter type based on the anticipated contaminates and facility use.

3.2.2.(3) Furnaces

a) Furnaces shall not be used in systems requiring multiple zones to achieve adequate thermal comfort.

b) In facilities where a simple, low maintenance system is a priority over thermal comfort, furnaces may be used subject to approval by the Yukon government.

c) Furnaces equipped with fresh air intake and intended to circulate ventilation air shall be two-speed units. Fan shall be configurable to allow continuous low speed operation while ventilation air is required.

d) Furnaces shall be provided with venting systems to the requirements of the manufacturer and Sub-Section 3.2.7.

3.2.2.(4) Roof Top Heating Units

a) Rooftop units can be considered in buildings requiring minimal zoning and where building layout has been coordinated to group areas with similar thermal requirements. Areas served by a single forced air zone shall have similar aspects, sizing and occupant loads.

b) Rooftop units shall be sized for free cooling and employ the use of an economizer with sensible control features to modulate damper assembly. Economizers shall be equipped with high-performance damper sections with sealed blades meeting leakage rates outlined in ASHRAE 90.1 and Title 24.

c) Equipment shall meet minimum equipment efficiencies outlined in Chapter 2 – Energy and Environmental Design Requirements.

d) Zone control shall be provided through the use of bypass terminal units in a constant volume arrangements or through a pressure based (dependent or independent to suit application) variable air volume system with dedicated

zone VAV terminal units. Terminal unit shall be sized to the design air flow to ensure proper damper modulation and control.

e) Rooftop units equipped with cooling and heating capabilities shall be configured to prevent simultaneous heating and cooling operation. Where free cooling is used, controls shall be capable of modulating economizer to maintain supply air set point without the use of reheating.

f) In systems equipped with mechanical cooling and zone reheat, interlocks shall be provided to prevent simultaneous heating and cooling.

g) Areas requiring supplemental cooling for extended periods during the heating season, such as LAN or data rooms, shall be provided with an independent heating/cooling system.

h) Systems employing zone reheat shall be configured to automatically increase zone air flow to maximum design flow when operating in heating mode.

i) Terminal units shall be equipped with automatic heating/cooling switchover.

j) Rooftop units shall be equipped with filter sections and filters to suit the intended occupancy.

k) Where rooftop units are used to provide ventilation air to space, they shall be sized and configured to provide only ventilation air required above the building exhaust heat recovery system. Consider use of demand ventilation where practical. See Sub-Section 3.4 – Ventilation.

3.2.3. HYDRONIC HEATING SYSTEMS

3.2.3.(1) Application and Installation Considerations

a) Hydronic heating systems shall be designed to maximize heating fluid temperature drop (ΔT) in an effort to reduce pump, coil and piping sizes. Balance this requirement with limitations of heating equipment and system performance.

b) When selecting the type of hydronic heating system for a building, consider the building size, complexity and independent space requirements. Ensure heating system can react to the needs of the space including reasonable temperature recovery times, ability to manage/react to temperature swings due to external factors in a timely manner and offers adequate zoning/ control to provide adequate thermal comfort.

3.2.3.(2) Boilers

a) Hydronic fuel oil, propane and electric boilers shall be sized to provide 150% capacity using multiple boilers arranged in a lead/lag arrangement as per the table below.

BOILER PLANT REDUNDANCY		
Facility Type	**Minimum Number of Boilers**	**Minimum Boiler Capacity**
Category 1	3	50%
Category 2	2	75%

b) Gas-fired appliances with input ratings over 117kW (400MBH) are not acceptable unless approved by FMRS. Facility capacity to be met using additional boilers as required.

c) Boilers with input over 87 kW (300 MBH) shall be provided with multi-stage or modulating burners.

d) Boilers shall be provided with hand-off-autos, meeting the following requirements.

i) Hand shall energize the boiler to operate based on the internal controls while still maintaining the required safeties.

ii) When in automatic mode, boiler operation to be controlled by the Building Management System or boiler controller.

e) Heating equipment safeties such as low water cut-off and high-limit shall be manual reset and testable.

f) Condensing Boilers

i) Where condensing propane boilers are being proposed, they shall be reviewed and approved for use by the Yukon government during the schematic design review.

ii) System design shall be arranged to ensure low return water temperatures in order to make use of condensing efficiency.

iii) Low temperature heating systems or large-drop systems with return water temperatures below 60°C (140°F) would be considered suitable applications. Consult manufacturer recommended best practices.

iv) High temperature systems with return water temperatures above 65°C (150°F) shall not be used with condensing boilers.

v) Provide a condensate neutralizer on condensate drains.

g) Biomass Boilers

i) Biomass boilers should be sized to minimize short cycling and should take into account boiler turndown capabilities with consideration to loads under normal and peak operation.

ii) Consideration should be given to multiple biomass boilers each sized at a reduced load to allow system to operate at optimal efficiency and promote high fire operation during a majority of the heating season. Select biomass appliances with consideration to local fuel quality and availability.

h) Boiler supply water setpoint shall not be below 60°C for propane and 71°C for fuel oil.

i) Boilers shall be located with a minimum of 600 mm clearance around all sides. Where manufacturer requires increased clearances to facilitate maintenance, the manufacturers clearances shall be maintained.

3.2.3.(3) Installation Requirements

a) All hydronic systems to be cleaned and treated with IPAC LWT PN 39 and LWT 750 as recommended by manufacturer.

b) Provide distilled water treated with IPAC corrosion inhibitors as the heating fluid when fluid is run through boilers and other heating appliances.

c) Provide propylene glycol heating fluid in all hydronic systems that may be subject to freezing conditions. Glycol shall be DowFrost HD factory pre-mix unless equipment manufacturer recommends alternate products, and these are reviewed and approved by the Yukon government.

d) In systems using glycol-based heating fluids, the boiler system shall be separated from the heating distribution system by means of a heat

exchanger. The heat exchanger shall be sized to requirements of the buildings.

e) System pressure shall be maintained automatically by means of a glycol fill tank.

f) Provide union, isolation and drains for all pieces of equipment. Isolation shall be provided on each heating loop and zone.

g) Provide means of flushing system. Install hose bibbs around heating equipment, such as heat exchangers, to facilitate flushing and draining.

h) Temperature gauges shall be provided upstream and downstream of all boilers, heat exchangers, coils and on heating zone return.

i) Pressure gauges shall be provided around all pumps and shall be arranged to allow a single gauge to display upstream and downstream pressure independently and be provided with isolation and snubbers.

j) Provide pressure relief valves in each closed system, pipe discharge to a safe location, such as a funnel floor drain or glycol fill tank.

k) Hydronic systems shall be arranged to ensure full and balanced flow through each boiler while firing. Provide provisions for pre and post purge in high mass boilers such as cast iron boilers.

l) All boiler installations shall include a tie-in for a future connection to an additional renewable heating source, such as a standalone system or a district heating system.

3.2.3.(4) Distribution Equipment

a) Main distribution pumps provided to circulate through the primary heating loop shall be arranged in a redundant parallel pumping arrangement. Pumps to operate in a duty-standby configuration as per Section 5 – Integrated Automation Facility Controls.

b) Circulators shall be standardized throughout the facility wherever possible to minimize required spares on site.

c) Circulating pumps using mechanical seals are not acceptable.

d) Circulators exceeding 745 W (1Hp) or requiring modulating control, shall be provided with a variable speed drive.

e) Wall Fin Radiation

i) Where wall fin radiation is used it shall be accessible for cleaning.

ii) Size cabinet to accommodate valves or other appurtenances.

iii) Cabinets shall be a minimum of 14 gauge epoxy coated steel.

iv) Locate cabinet with consideration to thermal comfort and space use.

f) Consider use of radiant panels in areas were furniture would obstruct finned radiation. Locate panels and thermostat with consideration given to radiant operation.

g) Locate air vents with isolation valve at all high points in a hydronic system. Provide sufficient clearance to allow access for maintenance.

h) Provide an air separator for each closed heating loop. Locate separator at the point of highest water temperature and lowest pressure or as per manufacturers recommendation (typically this is located downstream of boilers and upstream of primary circulators).

i) Expansion Tank

i) Provide an expansion tank for each closed heating loop.

ii) Tank should be sized for the maximum expected expansion volume based on the system parameters.

iii) Ensure tank ratings are suitable for intended use. Locate expansion tank at point of lowest pressure in system.

j) Select hydronic heating terminals with consideration to requirements of space to achieve adequate zoning and temperature control.

k) Provide forced flow or unit heaters in areas requiring high recovery such as vestibules or enclosed areas with exterior access. Control shall be achieved by cycling fan.

l) Hydronic Unit Heaters

i) To be used only for spaces that are normally unoccupied, such as mechanical rooms, large storage areas, garages, fire halls, and crawlspaces where noise levels are not a consideration.

ii) Unit heaters are to be hung with appropriate vibration isolation.

iii) Provide balancing, isolation, drain valves, air vents and unions on unit heaters.

iv) Unit heaters are to be equipped with fan guards.

m) Radiant In-Floor Heating

i) Design shall indicate heating system requirements including heating zones identifications, heat loss requirements, floor coverings, supply water temperature, temperature drop, flow rate, length of tubing and location of headers and thermostats.

ii) Tubing in slab shall be continuous and shall not contain buried joints or fittings.

iii) Consider reduced tubing spacing at perimeter loops.

iv) Tubing shall be in accordance with ASTM F876 and be equipped with an oxygen barrier.

v) Coordinate tubing placement in slab with structural engineer.

n) Select equipment to suit heating fluid properties.

o) Each closed heating loop to be equipped with a side-stream filter and sight-glass, chemical pot feeder, strainer and air separator.

p) Allow sufficient clearance in front of equipment such as coils to allow for removal. Provide unions where required to facilitate removal.

q) Equipment requiring cleaning in place shall be equipped with access as required.

3.2.3.(5) Hydronic Piping

a) Hydraulic separation is required between heating appliances and load piping.

b) Reverse return piping systems shall be used wherever possible unless system limitations prohibit its use and other safe-guards against flow imbalance are provided.

c) Flushing and Cleaning

i) Piping shall be flushed, cleaned and degreased prior to returning to service.

ii) In retrofit applications, installations exceeding 10 years since last flush shall be flushed with IPAC PN39 and cleaned.

iii) Heating fluid shall be replaced and treated with IPAC corrosion inhibitors as per manufactures requirements.

d) Piping shall be installed to control expansion and limit undue stress on equipment.

e) Piping shall be insulated to the requirements of the National Energy Code of Canada.

3.2.3.(6) Provisions for Balancing and Monitoring

a) Provide means of balancing and measuring flow through each heating loop and piece of equipment requiring a minimum specified flow to achieve the required performance.

b) Provide balancing valves on terminal units, zone loop and heating loop.

c) Balancing valves shall be provided for each pump, coil, bypass loop or equipment whose operation depends on a design flow.

d) Balancing valves shall be calibrated and be provided with a scale from which flow can be established.

e) Equipment with rated pressure drops, such as heat exchangers and coils, shall be provided with a means of measuring pressure both upstream and downstream of equipment. Provide pressure gauges or pressure ports as required.

3.2.4. STAND-ALONE HEATING SYSTEMS

3.2.4.(1) Application and Installation Considerations

a) Standalone heating systems can be considered for facilities with minimal zoning, comfort and noise requirements.

b) Consideration should be given to occupancy type, location and control requirements.

3.2.4.(2) Radiant Tube Heaters

a) May be used in industrial applications such as workshops or vehicle storage bays.

b) Tube heaters shall be located to provide coverage as per manufacturer's instructions.

c) Consider both permanent and movable obstructions when evaluating minimum mounting heights and clearances to ensure manufactures requirements are met. Tall vehicles, such as graders, should be able to be parked such that radiant heater clearances can be maintained.

d) Locate burners to facilitate access.

3.2.4.(3) Electric Heat

a) Electric resistive heat shall not be used in communities not connected to the primary hydro grid and where diesel fuel is the primary source of power generation.

b) If electric heat is considered on a project, life cycle costing shall be used to determine feasibility over the life cycle of the building.

c) Electric heat shall not be used in communities not connected to the primary hydro grid and where diesel is the primary source of power.

d) Electric heating terminal units installed in occupied areas shall have remote mounted thermostats.

e) Refer to Chapter 6 – Electrical Design Requirements.

3.2.5. HEAT PUMP SYSTEMS

3.2.5.(1) Application and Installation Considerations

a) Heat pump systems should be considered in facilities requiring both heating and mechanical cooling and where life cycle costing demonstrates that they are feasible to satisfy energy targets, project budget and occupant comfort objectives.

b) Heat pump systems should be selected with consideration to the local climate constraints and the low ambient temperature operation.

3.2.5.(2) Heat Pump Equipment General Requirements

a) Heat pump equipment shall be suitable for the intended comfort and energy objectives.

b) Heat pump systems equipped with auxiliary heating systems shall be configured to prevent heater operation during cooling cycle and where heating load can be satisfied by heat pump system alone.

c) Consideration shall be given to acoustic performance for any equipment located indoors.

d) Locate all equipment and piping to the requirements of CAN/CSA-B52.

e) Equipment shall employ only refrigerants not containing ozone depleting substances.

f) Systems shall be leak tested and commissioned prior to being put into service.

g) Systems shall be installed, tested and decommissioned in accordance with the Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

h) Provide test reports for inclusion in mechanical Operation and Maintenance Manual.

i) System shall be selected with consideration to project's energy targets.

3.2.5.(3) Air Source Heat Pumps

a) Air source heat pumps shall be selected with consideration to low ambient operation.

b) Provide accessories as required to maximize run times.

c) Heat pumps used for space heating shall be supplied with a fully redundant heating system to address peak heating loads when heat pumps are not operational or at ambient condition below operating capacity of the equipment.

d) Consider systems employing Variable Refrigerant Flow (VRF) technology to allow maximum heat recovery where practical to do so.

e) Refer to Chapter 2 – Energy and Environmental Design Requirements for energy performance requirements.

3.2.5.(4) Water Source Heat Pumps

a) Water source heat pumps shall be considered only in systems employing low temperature heating loops with supplemental means of heat rejection.

3.2.5.(5) Ground Source Heat Pumps

a) Feasibility study and life cycle costing shall be conducted for consideration of ground source heating.

b) While many sites in Yukon would be suitable for ground source heating, drilling and installation may be cost prohibitive.

c) Systems shall be installed to minimize environmental impact and shall be approved for use by the Department of Environment, the Yukon Water Board, and shall be in accordance with the *Yukon Water Act*.

d) System design and installation shall comply with CSA C448.

3.2.6. WASTE HEAT SOURCES

3.2.6.(1) Where facility infrastructure creates waste heat that can be used to offset building heating requirements, system shall be reviewed for feasibility of heat recovery. Systems such as ice plants, power generation plants, or process systems shall be recovered to the building heating system wherever practical.

3.2.6.(2) Mechanical system design shall be designed to maximize use of waste heat sources wherever practical.

3.2.6.(3) In systems with low temperature waste heat, mechanical system shall be designed around low temperature heating loops or suitable means of utilizing available heat.

3.2.7. VENTING AND COMBUSTION AIR

3.2.7.(1) Sidewall venting shall not be used unless approved by the Government of Yukon.

3.2.7.(2) Condensing Propane Appliances

a) Provided with through the roof, vertical flues where permitted by the manufacturer.

b) Concentric vents shall not be used.

c) Terminate vents in a location least affected by the prevailing wind.

d) In applications where adjacent buildings, structures or obstructions could create a recirculating wind condition and result in ice buildup around flue, vents shall be relocated and/or arranged to minimize effects of wind.

e) Consult manufacturer's recommendations for best practices.

f) Flue length shall be confirmed with draft calculations.

3.2.7.(3) Combustion air ducting shall be located and sized based on the manufacturer's requirements and installation code.

3.2.7.(4) Provide means of preventing entry of cold air into building by means of a cold air trap or other suitable method. Coordinate termination with adjacent equipment such that cold combustion air will not freeze, damage or adversely affect equipment operation.

3.2.7.(5) Dedicated venting shall be provided for each appliance.

3.2.7.(6) Manifold venting shall only be permitted where required by manufacturer.

3.2.7.(7) Chimney type and arrangement shall be in accordance with appliance listing and the relevant installation standard.

3.2.7.(8) Allowances for cleaning of the chimney shall be provided.

3.2.7.(9) In applications with horizontal breeching, flue sizing shall be confirmed by means of pressure loss calculations in accordance with chimney manufacturers requirements. Calculations shall account for actual conditions with all required fittings.

3.2.7.(10) Vent connectors shall be insulated and clad with aluminum jacketing.

3.3. COOLING SYSTEMS

3.3.1. GENERAL REQUIREMENTS

3.3.1.(1) Consider project specific factors affecting indoor temperature such as local climate, building envelope, orientation, shading, glazing, and internal heat gains to determine cooling requirements for the project.

3.3.1.(2) Where indoor design temperature cannot be achieved, mechanical cooling may be required. Consider use of passive strategies to reduce or eliminate requirement for mechanical cooling.

3.3.1.(3) Select equipment and systems on the basis on efficiency, controllability, maintainability and life cycle costing.

3.3.1.(4) Provide cooling in LAN room and data centers where required to maintain temperature below design temperature. Consider heat recovery where possible.

3.3.1.(5) Provide free-cooling where practical.

3.3.1.(6) Cooling equipment subject to condensate shall be equipped with a suitable drain pan piped to drain. Ensure suitable means of protecting against backflow and odor recirculation is provided.

3.3.1.(7) Equipment shall be located to facilitate maintenance as outlined by manufacturer.

3.3.1.(8) Cooling zones shall be consistent with heating zones where practical. Areas within a single zone shall have similar aspect, sizing and occupant load.

3.3.1.(9) Provide insulation on any cooling distribution system in accordance with National Energy Code of Canada.

3.3.1.(10) Equipment shall be mounted with vibration isolation to reduce noise transfer to structure.

3.3.1.(11) Each piece of air conditioning equipment shall have the refrigerant type and total refrigerant charge (including pre-charge and any refrigerant added on site) permanently mounted adjacent to equipment nameplate.

3.3.1.(12) Each condensing unit shall have an independent gravity condensate drain line run to a suitable location. If drain runs through a space subject to freezing temperatures, means of preventing freezing shall be provided.

3.3.1.(13) Outdoor units shall be equipped with a lockout feature to prevent operation when ambient temperature is below the equipment rating. Reset function shall incorporate a time delay to allow equipment to warm up above low ambient shut down limit prior to resuming operation.

3.3.1.(14) Each terminal unit shall be provided with an electrical lockable disconnect.

3.3.2. COOLING EQUIPMENT

3.3.2.(1) Locate equipment with consideration to maintenance access, service clearance and acoustics.

3.3.2.(2) Cooling equipment with output rating of 5 ton and above shall be provided with multiple stages of cooling.

3.3.2.(3) Where refrigerant based systems are installed, requirements of CAN/CSA-B52 shall be followed.

3.3.2.(4) Outdoor units

a) Shall be elevated above the anticipated snow level on a suitable stand rated to support the equipment and resist seismic loads.

b) Allowances for condensate drainage shall be provided.

c) Locate units to minimize transmission of noise into occupied space and onto adjacent properties.

3.4. VENTILATION

3.4.1. GENERAL REQUIREMENTS

3.4.1.(1) Air Intakes

a) Locate outdoor air intakes to maintain minimum required clearances to potential contaminates in accordance with the requirements of ASHRAE 62.1.

b) Consider the effect of the predominate wind direction, local sources of contamination such as dirt roads or parking areas and increase the distances as appropriate.

c) Where other codes or standards require larger separation distances, adhere to the more stringent requirement.

3.4.1.(2) Provide ventilation systems with required filtration levels as required by ASHRAE 52.2 to maintain adequate indoor air quality for the intended application. Facilities requiring higher filtration, such as health care facilities, shall meet the requirements of the applicable standards.

3.4.1.(3) Ventilation equipment shall be provided with summer and winter filter section where subject to frost.

3.4.1.(4) Filter sections and rack shall be provided with sufficient clearance to facilitate filter removal and installation without bending filters.

3.4.1.(5) Exhaust systems shall be provided with suitable means of make-up. Make-up air shall be provided with a means of tempering.

3.4.1.(6) Locate access doors around any in-duct equipment such as coils, damper, filter, and fire dampers.

3.4.1.(7) Consider the use of demand-controlled ventilation.

3.4.1.(8) CO_2 control should be used in facilities where variable occupancy is expected.

3.4.1.(9) Occupancy sensors shall be used in intermittently occupied facilities.

3.4.1.(10) In systems where ventilation equipment is used to provide space heating or cooling, unit shall operate in recirculation mode during un-occupied times.

3.4.2. VENTILATION EQUIPMENT

3.4.2.(1) Heat Recovery Equipment

a) Heat recovery shall be incorporated into all exhaust systems unless life cycle costing confirms it is not practical.

b) Heat recovery system shall be selected based on exhaust and intake air design conditions. Consider use of heat recovery ventilators, energy recovery ventilators, heat pipes or glycol run-around loops to suit application. Utilize latent heat recovery on systems where high relative humidity is expected.

c) Systems where continuous ventilation is required to maintain adequate indoor air quality and low ambient operation will result in intermittent defrosting, or where low incoming air temperature may damage equipment, provide a means of pre-heating incoming air. Preheat coils shall be sized to allow maximum heat recovery.

d) System where cross contamination is a concern shall utilize equipment with separated air streams and leakage rates within acceptable range for the application.

e) In systems utilizing free cooling with outdoor air, system shall be provided with a means of bypassing air around heat recovery system.

f) A means of balancing shall be provided on all equipment. Use of Electrically Commutated Motors or Variable Frequency Drives are preferred.

g) Refer to Chapter 2 – Energy and Environmental Design Requirements for minimum energy performance requirements.

3.4.2.(2) Distribution Equipment and Ducting

a) Ductwork shall be designed and installed to facilitate cleaning. Provide access doors where required to ensure ductwork is accessible. Refer for National Air Duct Cleaners Association (NADCA) for cleaning guidelines.

b) Design and install ductwork in accordance with Sheet Metal and Air Conditioning Contractors National Association (SMACNA) standards with consideration for reducing noise and static pressure.

c) Provide sufficient developed length around all fans and fittings.

d) Configure fans to control room pressurization.

e) Provide a means of balancing distribution ducting and terminal units. Locate balancing dampers away from duct openings. Balancing dampers shall be lockable quadrant type and shall be set and locked with a setting indicator marked by the balancer.

f) Insulate all distribution equipment and ducting in accordance with current National Energy Code of Canada standards.

g) Provide remote grease nipples on exterior of all ventilation equipment.

h) Zoning of ventilation system shall be consistent with space function, occupied hours and air quality requirements. Coordinate with heating and cooling zones as much as possible.

i) Where displacement ventilation is determined to be suitable, it shall be identified at the schematic design phase and shall include the services of a consultant for the production of temperature variation analysis or fluid dynamics simulations as required to evaluate locations of supply air outlets, return air outlets and ventilation effectiveness.

j) Gymnasiums and other spaces that will be used for after normal occupied hours shall be provided with an independent ventilation system that can be activated from within the space.

k) Coordinate ducting and diffuser location with lighting and other building systems. Locate to prevent short-cycling and drafts.

l) Select and size diffusers to suit air-flow requirements of the space and minimize noise. Conventional ceiling level, adjustable cone, mixed flow diffusers with vertical and horizontal flow are preferred. Consider air flow, velocity and throw to minimize drafts and excessive noise while ensuring adequate coverage.

m) Intakes and exhaust shall be located and designed to prevent snow or rain entrance. Locate above highest expected snow level.

n) Motorized dampers installed in ductwork that communicates directly with the outdoors shall be located as per the National Energy Code of Canada and shall be insulated, thermally broken, low-leakage dampers suitable for cold weather operation.

o) Fire Dampers

i) Fire dampers shall be “gate out of airstream” wherever possible. If a “gate in air stream” damper is to be installed, it shall be on ductwork 300 mm diameter and larger and shall be accounted for in static pressure loss calculations.

ii) Dampers shall be selected and installed in accordance with the National Building Code of Canada, NFPA 80 and its listing.

iii) Damper shall have access on both sides of the fire separation.

iv) Consider upsizing dampers when damper size would limit access for testing.

p) Flexible connections constructed of an approved fire resistant material, are required at the suction and discharge connections of fans and air handling units.

q) Fan equipment is to be installed so that the connecting ductwork is aligned with the fan inlet or outlet, and the flexible connection does not obstruct the air flow.

r) Duct shall be sealed in accordance with SMACNA requirements. Tape shall not be used for sealing duct joints.

s) Provide silencers on equipment where required to meet space noise requirements. Refer to Sub-Section 3.4.7 – Acoustics.

t) Destratification

i) Consider the use of de-stratification ceiling fans in high ceiling areas (e.g., in garages, theatres, etc.).

ii) Size the fans for total area coverage.

iii) Provide protective guards over fans where they may be subject to damage.

iv) In occupied areas where noise may be a concern, provide speed controls in an accessible location.

3.4.3. EXHAUST SYSTEMS

3.4.3.(1) Provide exhaust systems where required by National Building Code of Canada, ASHRAE or where required to exhaust local containments, smoke, odours, fumes or heat.

3.4.3.(2) Consider heat recovery on all major exhaust systems as per Sub-Section 3.4.2.(1).

3.4.3.(3) Provide tempered make-up air for all exhaust systems in accordance with National Building Code of Canada.

3.4.3.(4) Exhaust systems shall be ducted and sealed to prevent recirculation or leakage.

3.4.3.(5) Discharge exhaust to minimize risk of re-entrainment. Consider intake locations and prevailing wind.

3.4.3.(6) In systems sharing a common exhaust between multiple occupancies or areas and where the system operates intermittently, provide protection against back-flow or cross contamination on branch ducting.

3.4.4. SPECIALTY SYSTEMS

Specialty system shall be installed to suit requirements of the space. Install system in accordance with good engineering practice and relevant installation and safety guidelines. Project specific systems shall be identified during development of the functional program.

3.4.4.(1) Commercial Kitchen Ventilation Systems

a) Commercial kitchen systems shall be designed and installed in compliance with the Authorities Having Jurisdiction, NFPA 96, NFPA 13, National Fire Code and Environmental Health Guidelines.

b) Where required, provide ULC listed commercial cooking appliances and exhaust system to NFPA 96.

c) Provide listed grease filters in exhaust hoods with minimum extraction efficiency of 65% at 8 microns.

d) Kitchen equipment to be NSF certified.

e) Maintain all required clearances and safety shut-offs.

f) ULC listed factory-supplied grease duct shall be used wherever possible.

g) Provide provisions for all fire suppression, tempered make-up air and controls for a functional and reliable system.

h) Recirculation systems shall not be installed in commercial applications.

3.4.4.(2) Local Exhaust Systems

a) Install local exhaust systems where harmful contaminants are produced.

b) Design in accordance with ASHRAE guidelines to ensure proper capture velocities and containment are achieved.

c) Residential range hood to exhaust directly to exterior.

3.4.4.(3) Emergency Exhaust Systems

a) Provide vehicle exhaust extraction where identified by the functional program or where vehicle operation inside the space is expected.

b) Fire Hall extraction systems shall be in accordance with Fire Marshall's requirements, as follows.

i) Exhaust system shall be a rail type and allow for vehicle to exit building with extraction system still connected.

ii) Fan shall energize with vehicle ignition and hose shall automatically release from vehicle at end of rail.

c) In areas with welding or dust producing activities such as schools, or where identified by the functional program, a suitable extraction and collection system shall be designed and installed in accordance with ASHRAE and SMACNA guidelines.

d) Parking/maintenance garages shall be provided with CO and NO2 sensors with manual override timers to energize exhaust and make-up air systems in accordance with National Building Code of Canada requirements.

3.4.5. ENVIRONMENTAL SEPARATION

3.4.5.(1) Consider requirements of the space and maintain environmental separations.

3.4.5.(2) Design all ventilation system to prevent cross-contamination or recirculation of contaminants.

3.4.5.(3) Design systems to maintain pressurization in occupied areas as required to maintain environmental separations. Pressurization shall not exceed ASHRAE levels or affect other areas. Positive pressurization shall be used over negative pressurization where practical to limit air flow from one area to another.

3.4.6. PROVISIONS FOR BALANCING AND MONITORING

3.4.6.(1) Provide means of monitoring the outdoor air temperature, return air temperature, mixed air temperature, supply air temperature, and status of all fans and dampers.

3.4.6.(2) Provide means of balancing in accordance with Sub-Section 3.4.2.(2).

3.4.6.(3) Consider the use of variable speed motors drive to allow for fan speed adjustment.

3.4.6.(4) Where possible, direct drive fans are preferred. Where belt-driven fans are used, they shall be provided with adjustable sheaves to allow for speed adjustment.

3.4.7. **ACOUSTICS**

3.4.7.(1) HVAC systems shall be designed and selected to ensure acoustic levels attributed to HVAC equipment are in accordance with ASHRAE guidelines and the acoustic requirements of the space.

3.4.7.(2) Fan speeds shall be selected and installed to limit fan noise.

3.4.7.(3) Air velocity shall be within the limits outlined by SMACNA.

3.4.7.(4) Coordinate with architectural to provide sufficient attenuation around equipment to limit sound transfer.

3.4.7.(5) Coordinate with architectural to maintain acoustic separations between spaces and limit sound transfer between sensitive areas identified in the functional programme.

3.4.7.(6) Acoustic insulation is to be provided on all ducting in a fan room, on minimum first 10 meters of any duct run to or from a fan, on all transfer ductwork and wherever fan and duct noise may be a problem. Insulation shall be secured with pin spot fasteners.

3.4.7.(7) Commissioning of HVAC system to include sound testing in all spaces to ensure compliance with ASHRAE guidelines and the functional requirements of the space.

4. Fire Protection

Automatic sprinkler systems, standpipe systems and fire extinguishers shall be provided where required by the National Building Code of Canada and installed to the relevant NFPA standards. Special cases, such as heritage buildings, may require automatic sprinkler systems regardless of the requirements of the code requirements and should be prescribed in the Functional Program. Where automatic sprinkler systems are provided, they shall be designed and installed to the requirements of NFPA.

In applications where specialty systems should be considered, such as heritage facilities, data center, and archives areas, the relevant design guidelines combined with good engineering practice and the requirements set out in this document shall be used to determine the most suitable system.

4.1. WATER-BASED FIRE SUPPRESSION

4.1.1. **WATER STORAGE TANKS**

4.1.1.(1) Install all fire water tanks in accordance with NFPA 22.

4.1.1.(2) In facilities requiring water storage tanks for the provision of fire water, dedicated fire water tank shall be provided inside the building. Underground tanks subject to freezing and with restricted access are not acceptable.

4.1.1.(3) Tanks shall be located to allow for inspection, cleaning and draining. Where the storage tank is located below the facility drainage system and a pump is required to fully drain the tank, provide a permanently mounted lift pump piped to a suitable drain location. Note that drainage systems that drain to a septic field are not considers suitable.

4.1.2. FIRE PUMPS

4.1.2.(1) Fire pumps to be installed to the requirements of NFPA 20 and NFPA 13.

4.1.2.(2) Electric fire pumps are preferred due to the decreased testing and maintenance requirements compared to diesel fired pumps. However, the Consultant shall perform life cycle costing analysis to compare increased cost of emergency generator supplying stand-by back-up power to an electric fire pump to the cost and maintenance requirements of a diesel pump with consideration to facility location and availability of maintenance personnel.

4.1.3. DRY-PIPE SYSTEMS

4.1.3.(1) General Requirements

a) Dry-pipe systems shall be used only in areas where piping is subject to freezing and adequate coverage cannot be provided using dry heads fed from an interior wet system.

b) Dry systems shall be installed to provide proper drainage to common auxiliary low point drains located to facilitate annual maintenance.

c) Low point drains shall be clearly identified and a legend indicating the drain valve locations shall be clearly displayed at the sprinkler tree.

d) Drains shall be located inside the warm space wherever possible and be pipe to a suitable drain capable of handling the expected flow.

e) Dry valves shall be equipped with galvanized trim package and be selected with pressure rating consistent with the air compressor.

f) Nitrogen based dry systems may be used where life cycle costing and total cost of ownership analysis shows it is favourable over a conventional compressed air system and where approved by the Yukon government.

4.1.3.(2) Air Compressors

a) Dry system air maintenance devices shall be selected and designed in accordance with NFPA 13.

b) Compressor sizing shall be designed and selected based on the dry valve requirements, systems size and the requirements of NFPA 13.

c) Tank mounted oil-less compressors are preferred.

d) For small systems requiring less than 28.3 L/min (1cfm), a small riser mounted unit may be considered.

e) Compressors shall be equipped with integral regenerative desiccant air dryers and filtration capable of providing compressed air with a -40°C dew point. Compressor units shall be factory assembled and complete with all necessary controls for automatic operation. Shall include run time meter.

i) Standard of Acceptance: General Air Products Dry Air Pack.

4.1.3.(3) Piping and Fittings

a) Piping shall be selected to minimize corrosion. Hot-dipped galvanized piping, or equal shall be used throughout dry systems.

b) Piping above 50 mm shall be assembled with grooved fitting complete gaskets rated to a minimum ambient temperature of -40°C.

c) Gaskets shall not protrude into the pipe such that it would impede water drainage or cause water to collect at joints.

i) Standard of Acceptance: Victaulic Firelock with Grade E, Type A gaskets.

4.1.4. WET-PIPE SYSTEMS

4.1.4.(1) Wet-pipe systems shall be installed where required to the requirements of the Authority Having Jurisdiction, NBCC, and NFPA 13.

4.1.4.(2) Sprinkler heads shall be selected based on the intended hazard and area of coverage. Upright heads are preferred in areas with exposed piping. Provide concealed type heads where installed under 2.4m above floor in facilities that may be subject to vandalism such as institutional facilities.

4.1.4.(3) Wet piping shall not be run in exterior walls or areas subject to temperature below 5°C.

4.1.5. STANDPIPE SYSTEMS

4.1.5.(1) Install standpipe system in accordance with the NBCC. Coordinate with requirements of municipal Fire Department, Yukon Fire Marshal and Authority Having Jurisdiction.

4.1.5.(2) Standpipe valve shall be located in valve cabinets in areas accessible to the public or where they may be subject to vandalism.

4.1.5.(3) Assess cabinet door closure and requirements for locks with respect to location and hazard. Doors without locking closures are preferred where practical.

4.1.5.(4) All cabinets to have breakable glass front if locked.

4.1.6. INSTALLATION REQUIREMENTS

4.1.6.(1) Piping 50 mm and under to be Sch. 40 and shall be assembled using threaded, FM approved, fittings.

4.1.6.(2) Quick response heads should be used wherever permitted by NFPA 13.

4.1.6.(3) Systems shall be equipped with all required allowances for maintenance as required by NFPA. Arrange system to facilitate servicing and draining.

4.1.6.(4) All drain valves, inspector tests and testing appurtenances shall be clearly labeled and identified on record drawings submitted at the completion of the project.

4.1.6.(5) Provided all signage and identification in accordance with NFPA.

4.1.6.(6) Zoning shall be in accordance with NFPA and the Authority Having Jurisdiction. Coordinate with fire alarm system. At minimum, provide individual zone at each floor and in attic.

4.1.6.(7) Protect water service against back flow in accordance with National Plumbing Code.

4.1.6.(8) Sway bracing shall be accordance with NFPA 13. Size bracing to resist thrust loads during operation. Connection to structure to be coordinated with structural engineer and seismic requirements.

4.1.6.(9) Provide electrical supervision on all control valves. Locked handles are not permitted.

4.1.6.(10) Coordinate fire department connection with local fire department.

4.1.6.(11) Seismic restraint of all piping and equipment must be completed in accordance with NFPA 13 and Chapter 1, Section 8 – Seismic Restraint. A Letter of Assurance from the seismic engineer will be required as confirmation that the installation meets relevant requirements for local seismic conditions.

4.1.6.(12) Conduct all required testing and include NFPA Contractors Material and Test Certificate in Operations and Maintenance Manual.

4.2. FIRE EXTINGUISHING

4.2.1. SPECIALTY/SUPPLEMENTAL SYSTEMS

4.2.1.(1) Where supplemental protection requiring specialty system, such as kitchen hoods or protection of sensitive equipment, is identified in the functional requirements of the facility, provide specialty system to the requirements of NFPA.

4.2.1.(2) Specialty system shall not be used to replace the automatic sprinkler system as required by NFPA 13 but rather as supplement protection.

4.2.1.(3) System (e.g., dry/wet chemical, FM-200 clean agent, etc.) shall be installed to the relevant standards and the requirements of the manufacturer.

4.3. FIRE PROTECTION SPECIALTIES

4.3.1. FIRE EXTINGUISHERS

4.3.1.(1) Fire extinguishers shall be installed in accordance with the NBCC, the NFC, and NFPA 10.

4.3.1.(2) Fire extinguishers in public areas shall be located in recessed or semi recessed cabinets. Coordinate cabinet type, finish, and location with the architect.

4.3.1.(3) Fire extinguishers located in service areas may be wall mounted.

4.3.1.(4) Fire extinguishers shall be located along the path of egress with the required signage.

4.3.1.(5) Commercial kitchens shall be fitted with minimum 9.l kg (20 lbs) Type K extinguisher regardless of size or commercial designation. This does not apply to kitchens inside residential dwelling units.

5. Integrated Automation Facility Controls

5.1. ENERGY MONITORING

5.1.1. In buildings requiring energy monitoring as outlined in Chapter 2 – Energy and Environmental Design Requirements, the control system shall be capable of measuring and displaying energy consumption values on the control graphics for the following systems.

5.1.1.(1) Domestic water usage shall be monitored at building entrance by means of a water totalizer measured in litres.

5.1.1.(2) Energy input to domestic hot water system shall display energy consumption values consistent with heating system used. (litres of fuel oil/propane, kWh of electricity etc.).

5.1.1.(3) Energy input to heating system (eg. energy input to boilers in litres or kWh as applicable) and energy output from heating plant (kWh or GJ) for the purpose of space heating and air tempering.

5.1.1.(4) Time log displaying operating hours for heating equipment in a lead lag arrangement.

5.1.1.(5) Outdoor air temperature.

5.2. ALARMING

5.2.1. Control system shall be capable of receiving building alarms and taking the necessary action to alert operator of failure.

5.2.2. All critical building alarms shall be processed through building security system. Non-critical alarms shall alarm locally at panel or graphic display.

5.2.3. In buildings where a Building Management Systems are installed, provision for secondary email callout shall be provided. Arrange with the Yukon government for email addresses to be included in alarm notifications.

5.2.4. Buildings without access to security call-out, phone, or internet shall be provided with visual alarms, pro-talk or satellite call out. At minimum, critical alarm shall illuminate exterior strobe located in a visible location, non-critical alarms to indicate at local panel.

5.2.5. In seasonally occupied buildings, alarm function shall be capable of being disabled during unoccupied periods.

5.2.6. At a minimum the following critical alarms shall be provided as applicable.

5.2.6.(1) Building low temperature alarm, based on any one room thermostat.

5.2.6.(2) Sprinkler room low temperature alarm.

5.2.6.(3) Domestic water tank low level alarm.

5.2.6.(4) Septic holding tank high level alarm with domestic water shut-off interlock.

5.2.6.(5) Sewage lift station high level alarm, and lead pump failure.

5.2.6.(6) Low fuel alarm.

5.2.6.(7) Fuel spill sensor.

5.2.6.(8) Fuel transfer pump failure.

5.2.6.(9) Boiler failure.

5.2.6.(10) DCW frost protection failure.

5.2.6.(11) Generator failure.

5.2.6.(12) Propane tank heater failure.

5.2.7. At a minimum the following non-critical alarms shall be provided as applicable.

5.2.7.(1) Domestic water tank high level alarm to notify fill operator.

5.2.7.(2) Lead domestic water pump failure.

5.2.7.(3) Lift station lag pump start.

5.2.7.(4) Ventilation system freeze protection.

5.2.7.(5) Lead boiler failure/lockout.

5.2.7.(6) Lead pump failure.

5.3. SYSTEM CONTROL REQUIREMENTS

5.3.1. Control system shall be engineered, installed and commissioned by trained personnel employed by companies that can provide troubleshooting and service after the completion of the project.

5.3.2. Systems shall consist of low voltage and line voltage control as required to achieve proper actuation and control of mechanical equipment and systems.

5.3.3. Pneumatic system shall not be accepted unless work includes renovation to an existing pneumatic system.

5.3.4. Significant modifications to existing systems may warrant control replacement and must be reviewed with the Yukon government.

5.3.5. Control system shall be equipped with UPS protection as required to provide continual operation after power outages.

5.3.6. System shall be commissioned in accordance with Chapter 1 – General Project Requirements.

5.3.7. Hydronic Heating Systems

5.3.7.(1) Shall be capable of adjusting heating fluid temperature set point based on an outdoor reset schedule, and/or building based reset control.

5.3.7.(2) Heating fluid temperature shall be reduced as low as practical while still being able to maintain building temperature. Balance this requirement with heating equipment constraints.

5.3.8. Occupied/unoccupied modes, including capability for night set back, shall be provided for all systems/zones. Schedules and parameters are to be adjustable.

5.3.9. Ventilation Systems

5.3.9.(1) Shall be configured to manage and maintain indoor air quality, ambient temperature and airflows as required by building occupants.

5.3.9.(2) Ventilation rates shall be occupancy based when possible. Air quality and code required ventilation shall not be affected.

5.3.9.(3) Ventilation system control shall be in accordance with ASHRAE 62 requirements or other applicable codes and standards as required.

5.3.10. Control programming shall be configured to conserve energy by:

5.3.10.(1) Monitoring and configuring operation of primary energy consuming equipment.

5.3.10.(2) Controlling start and stop times for equipment not operating 24hrs a day.

5.3.10.(3) Providing adequate means of equipment control, modulation and sequencing to minimize hunting or over/under shooting. Establish adequate dead bands, time delays and switch-over to maximum system efficiency.

5.3.10.(4) Resetting air and fluid supply temperatures based on space demand or outside air temperature.

5.3.10.(5) Controlling fan and pump speeds to achieve optimal efficiency.

5.3.10.(6) Prevent simultaneous operation of heating and cooling equipment serving a single space.

5.3.10.(7) Meeting control requirements of National Energy Code of Canada where applicable.

5.4. CONTROL COMPONENTS

5.4.1. Control components shall be commercial grade, non-proprietary, and suitable for the intended purpose.

5.4.2. Components be consistent with installed control system and shall communicate with any central controller as applicable.

5.4.3. Control components shall be from a single manufacturer throughout the building. In renovation projects, new equipment shall be consistent with existing infrastructure.

5.4.4. Components shall be fail-safe as per the following.

5.4.4.(1) Outdoor air and relief dampers shall fail in the closed position.

5.4.4.(2) Return air dampers shall fail into the full open position.

5.4.4.(3) Hydronic system zone valves should fail to the full heat position.

5.4.4.(4) All valves and damper actuators need to be operational without power — hand or manual operation.

5.4.4.(5) Where system design is such that “fail in place” will not result in building envelope or heating system being compromised or result in space temperature dropping, “fail in place” actuators may be used.

5.4.5. Zone valves shall be non-ferrous metal construction and be sized for the intended flow and control parameters.

5.4.6. Control valve flow coefficient (Cv) shall be selected to achieve desired flow characteristics to suit application.

5.4.7. Ball valves with rubber ball are not acceptable.

5.4.8. Control systems shall be provided with a UPS battery backup in accordance with Chapter 6 – Electrical Design Requirements.

5.4.9. Control system shall monitor power loss and be equipped with a shutdown sequence to retain all programmed settings. Once normal power is restored, controls will perform a start-up sequence and resume operation.

5.4.10. Room controls located in areas subject to physical damage, such as gymnasiums, loading bays or storage facilities, shall be provided with a suitable cover.

5.4.11. Areas accessible by the public or where tampering may occur, such as schools or assembly areas shall be provided with a locking cover.

5.4.12. Thermostats shall be in Celsius scale with sufficient range and deadband to suit application.

5.4.13. Flow switches shall be vane type on piping 50 mm and smaller. Paddle type switches are acceptable on larger piping.

5.4.14. Damper actuators shall be sized for sufficient torque to achieve proper actuation and shall be spring return to fail safe.

5.4.15. Systems introducing outdoor air into space shall be equipped with suitable means of preventing freezing in the event of a damper or coil failure.

5.4.16. Coordinate with electrical for the provision of relays on heating equipment control where required to shut off heat when system is operating in cooling mode.

5.4.17. Hydronic Radiation Zones

5.4.17.(1) Shall be controlled using low-voltage thermostats and normally open zone valves.

5.4.17.(2) Each enclosed room/area shall be provided with a dedicated zone control valve and thermostats.

5.4.17.(3) All hydronic zones/units require control valves. Unit heaters and force flow units shall be provided with wild loops and fan control.

5.4.18. Hydronic pumps shall be provided with exercising functionality to ensure a minimum of 5 minutes per week run time when de-energized.

5.4.19. Thermostats

5.4.19.(1) Shall be located to accurately sense ambient temperatures.

5.4.19.(2) Do not locate thermostats where environment can adversely affect reading.

5.4.19.(3) Thermostats located in public areas shall be lockable or limit adjustability.

5.4.20. Where gas detection is required to activate ventilation systems, they shall be located as per manufacturer's instructions to achieve full coverage of the area served. Location shall be at a suitable height for early detection based on density of the Contaminant relative to air.

5.4.21. Labelling:

5.4.21.(1) Control components shall be labeled in accordance with Sub-Section 1.2.

5.4.21.(2) Provide permanently fixed labels to all indicator lights, control panels and control equipment.

5.4.21.(3) Labelling shall be consistent with control schematics.

5.4.22. In retrofit applications where zoning or room layouts are being altered, suitability of temperature control and thermostat locations shall be reviewed and revised as required to suit new layout.

5.5. FUNCTIONALITY AND SYSTEM REQUIREMENTS

5.5.1. SYSTEM REQUIREMENTS FOR CATEGORY 1 BUILDINGS

5.5.1.(1) Category 1 buildings and in buildings requiring energy monitoring as per Chapter 2 – Energy and Environmental Design Requirements, shall be provided with a BACnet compliant Direct Digital Control (DDC) system.

5.5.1.(2) The DDC system shall consists of a modular control hierarchy with programmable controllers and a web-based software graphics package networked together to provide an integrated building automatic control system.

5.5.1.(3) At minimum, system shall be capable of the following control functions.

a) Heating, cooling and ventilation system control and monitoring.

b) Trend logging to monitor performance and energy consumption of mechanical system.

c) Configuration of system operation based on energy conservation strategies.

d) Remote access through non-proprietary web-based connection to allow for off-site monitoring and adjustment of system performance without specialty software. Access to control system shall be arranged to allow four (4) levels of access.

i) Level One: Monitor only.

ii) Level Two: Level one plus adjust all setpoints.

iii) Level Three: Level two plus manual override of all automatic control features.

iv) Level Four: Level three plus change programming and passwords.

e) Complete graphic package showing equipment status, setpoints and control parameters. System control functions and setting shall be user adjustable through graphic package.

f) Provide alarming and integration with call-out system.

5.5.1.(4) Contractor shall provide adequate training in accordance with Chapter 1, Section 10 – Commissioning and Verification to allow operator to utilize and adjust control system to ensure optimal energy efficiency and thermal comfort. User shall be instructed on how to interpret energy consumption values, adjust set points, and modify sequences where required.

5.5.1.(5) DDC control system shall be capable of expansion and maintain a minimum of 10% additional spare input and output capacity for each board/controller at the time of project completion. Dedicated equipment controllers are not required to have spare capacity.

5.5.1.(6) DDC graphic package shall be capable of the following functions.

a) Provide a simple user-friendly interface for the monitoring and adjusting the following.
i) Set points.
ii) Equipment operation parameters.
iii) Sequencing.
iv) Equipment status.
v) Energy consumption values.
vi) Schedules
vii) Alarms
viii) Space Temperature Set Points
ix) Trend logs
x) Set point offset parameters.

b) Provide dynamics graphics for all mechanical systems. Graphics pages shall be limited to a single system with a maximum of 35 points per page.

c) System control zones shall be displayed on an accurate floor plan of the area being served and allow for “point and click” navigation through each individual system with dedicated system schematics.

d) Graphics package shall provide clickable adjustment of any adjustable parameters and set points as well as monitoring and trend logging of system performance.

e) All equipment shall have a status indicator to indicate operation. Green status indicator shall indicate system “running”, Red shall indicated "error" or "alarm", White shall indicate “ready”, and Grey shall indicate "not ready"

5.5.1.(7) Brownout and Blackout protection shall be provided on all control systems with UPS and battery backup (min 24 hours supply), to ensure equipment start-up and shutdown sequencing can be completed prior to control system shutdown.

5.5.1.(8) All control sequences shall be stored in non-volatile memory to be retained upon brownout or blackout.

5.5.1.(9) Controller shall resume full operation following brownout or blackout without manual intervention.

5.5.1.(10) All hardware and software points shall be trended on a single resident host controller in 10 minute intervals.

5.5.1.(11) Operator shall be able to view a single or multi-trend display that is time scrollable from active points to archived points.

5.5.1.(12) Control system shall be approved by YG prior to installation. Pre-approved systems include:

a) Johnson Controls

b) Siemens

c) Honeywell

d) Delta.

e) KMC.

5.5.2. SYSTEM REQUIREMENTS FOR CATEGORY 2 BUILDINGS

5.5.2.(1) Control systems serving Category 2 buildings may incorporate stand-alone equipment controls where a DDC system is not required to achieve building performance, energy monitoring or energy targets and where it can be shown that stand-alone controls can provide efficient system control.

5.5.2.(2) Stand-alone control systems shall be capable of maintaining required functionality, thermal comfort and energy efficiency without the requirement for system integration.

5.5.2.(3) Control system shall provide minimum safety requirements required by the relevant installation codes and the manufacturer’s instructions.

5.5.3. SYSTEM REQUIREMENTS IN REMOTE/FLY-IN COMMUNITIES OR CAMPS

5.5.3.(1) Control systems for remote communities or camps, such as Old Crow, shall focus on simplicity and maintainability.

5.5.3.(2) Standalone controls systems utilizing direct reading systems should be considered wherever practical.

5.5.3.(3) Systems should incorporate all required safeties and functionality required to achieve energy targets while ensuring systems can be adequately maintained by local maintenance staff.

5.5.4. MODIFICATIONS TO EXISTING SYSTEMS

5.5.4.(1) Where modification to building mechanical systems require control upgrades, new equipment shall be consistent with the existing infrastructure.

5.5.4.(2) Buildings containing outdated equipment, or where existing controls system is not capable of providing adequate control of the facility, shall be reviewed with the Yukon government to determine the best course of action.

5.6. THERMAL COMFORT CONTROL

5.6.1. Coordinate mechanical system zoning with the occupancy and building layout to minimize the external factors that would adversely affect occupant comfort or the system's ability to maintain indoor design temperature in the occupied space.

5.6.2. Locate temperature sensing controllers in locations that are representative of actual space conditions and where external heat sources will not adversely affect readings.

5.6.3. Where practical, consider providing each occupied and enclosed area with a dedicated zone with dedicated controls. Balance these requirements with project budget and other design constraints.

5.6.4. Office area zones shall not include multiple building facades or occupancy types in a single zone. Exterior zones shall be limited to 10 meters of exterior wall along a single building facade.

5.6.5. Coordinate control requirements with HVAC system selection and design. Ensure control parameters/requirements are consistent with equipment capabilities.

5.7. GRAPHICS STANDARDS

5.7.1. To be added to the manual at a later date.

6

Electrical Design Requirements

1. General Design Considerations

1.1. INTENT

The objective of the electrical design requirements is to provide reliable, and relevant electrical installations for the Government of Yukon projects. These requirements address both quality of materials and quality of installation and is intended to represent a minimum standard. The content of this section addresses what has been found to function well in Yukon, but it may not be relevant to all building types. Note that these design requirements do not supersede contract requirements

1.2. CONSIDERATIONS FOR COLD CLIMATES AND REMOTE LOCATIONS

1.2.1. PERMAFROST AND FROZEN GROUND

Permafrost ground conditions are sporadic throughout Yukon, and can be localized and site specific. The geotechnical report will identify the presence of permafrost, if the information is available. Generally speaking, permafrost is comprised of two portions, the active layer (which freezes and thaws annually), and the inactive layer (a somewhat fixed, frozen layer of ground below). The inactive layer is receding in some areas, which can create overall settling of ground over the lifespan of a building. In extreme cases, this can be as much as a meter over 10 to 15 years. The depth of the inactive layer can vary depending on location, but it is generally below the level in which electrical shallow utilities are buried.

In permafrost regions, it is important to assume a degree of ground movement will occur seasonally. The resultant movement can damage conduit, expose grounding rods, lift or disturb kiosks and light standards, transformers or exterior enclosures (such as generators). In poor ground conditions, where loamy soil or clay exists, avoid buried services altogether, or use flexible armoured cable (Teck or equal) below grade.

Wherever electrical equipment will be installed below ground, ensure that free draining (frost resistant) fill is used, and avoid re-use of native fill that contains clay or vegetative soil. Obtain site geotechnical information and engage a civil engineer to provide suitable gravel pad design for exterior enclosures. Slab on grade concrete pads for electrical equipment should be avoided in favor of vault-style foundations with mouse holes. These will allow for future entry without disturbing compacted materials.

Spring thaw will often fill low lying vaults and conduit with water, which can freeze and damage conductors. Where exterior equipment is provided, ensure that the locations are coordinated with the site plan and civil design to permit positive drainage away from this equipment.

Where services enter or exit the ground, allow for flexible connections. Where ground movement is expected adjacent to footing walls, any services that penetrate the footing wall should be provided with a rigid galvanized steel conduit sleeve, extending 1 meter from the footprint of the building.

1.2.2. SNOW ACCUMULATION AND CLEARING

1.2.2.(1) Locate electrical kiosks and pedestals out of equipment areas and protect with bollards.

1.2.2.(2) Consider areas which aren't directly subject to vehicle traffic may be accessible by snow machine in winter and can also be used for the storage of snow.

1.2.2.(3) Concrete bases for parking plugs, site lighting, and kiosks should be raised 200 mm above finished grade (minimum), to allow for snow buckets to make contact without damaging electrical equipment, and to allow kiosk doors to open without removing snow and ice.

1.3. CONSIDERATIONS FOR HAZARDOUS LOCATIONS

1.3.1. DECLASSIFICATION OF SPACES THROUGH VENTILATION – NOT PERMITTED

1.3.1.(1) The design of installations in hazardous locations often declassify an environment (e.g., from Zone 1 to Zone 2) in order to reduce the complexity and cost of the electrical installation. This is most common in wastewater treatment applications; but can be found elsewhere. The process generally requires a higher ventilation rate, which impacts heating, maintenance, and operational costs over the life of the building.

1.3.1.(2) Regardless of the ventilation rates provided in design, electrical installations in all hazardous locations are to follow the most stringent design application.

1.3.1.(3) Effective coordination in design should be used to locate electrical equipment outside of the hazardous area where possible.

1.3.1.(4) One approach to reducing the amount of electrical equipment within hazardous areas, is to locate the disconnecting switches for pumps, motors, and other equipment outside of areas classified as hazardous locations (CEC Section 18).

1.3.1.(5) The use of Lock-out/Tag-out procedures (where permitted by the AHJ) will be accepted by the Yukon government on a case-by-case basis.

1.3.2. OTHER HAZARDOUS LOCATION REQUIREMENTS

1.3.2.(1) Where possible, minimize the use of hazardous location seals (EY) through the use of HL rated cables installed in free air. Examples can be found in the CEC, and NFPA 820 for Wastewater applications. Provide engineering justification and detail the distance requirements (dimensioned) on construction documents.

1.3.2.(2) Where EY type fittings are required at the boundary of a hazardous location, provide an Ex junction box within the hazardous location, so that cables do not need to be removed and replaced through the EY fitting.

1.3.2.(3) Where pumps and rotating machines must be installed in hazardous location environments, provide hazardous rated plug and socket. Where spare equipment is supplied, provide additional hazardous rated plug and cord, pre-terminated and rotation checked. This is to facilitate efficient changeout of pumps and equipment, and will reduce the number of trades required for call-out.

1.3.2.(4) Where possible, provide intrinsic barriers for instruments in hazardous locations, rather than specifying explosion proof instruments. Clearly label instruments protected by intrinsic barriers, and do not share any conduit system, or section of a controls cabinet with unprotected wiring.

1.4. IDENTIFICATION

1.4.1. EQUIPMENT LABELLING

1.4.1.(1) Identify all electrical equipment with permanent nameplates.

1.4.1.(2) Use 3mm lamicoid nameplates for general use, and nameplates of suitable material for use in corrosive environments.

1.4.1.(3) Lamicoids to be black with white lettering.

1.4.1.(4) Labelling to be in English. French labelling also provided for buildings primarily intended for French occupants (such as francophone schools, offices, or community centres) or as requested by the Yukon government.

1.4.1.(5) Label Type and Size Table

LABEL TYPES AND SIZES	
Type	**Letter Height (mm)**
A	9.5
B	6
C	3

1.4.1.(6) Type A and B labels are to be mechanically fastened. Type C labels can use adhesive backing.

1.4.1.(7) Labelling to include the following electrical equipment.

REQUIRED LABELLING	
Equipment Type	**Type**
Main service entrance/CDP	TYPE A: Name of facility, year installed, equipment ratings (including fault interrupting capacity), name of Electrical Engineer and Contractor.
Electrical distribution equipment	TYPE B: Panel Designation, ratings, fault current/interrupting capacity, source
Motor control and contactors: starters, drives and cabinets	TYPE B: MCC Designation, ratings, indicate equipment controlled on each compartment, drive or starter.
Disconnects, safety switches	TYPE B: Indicate equipment controlled and voltage, circuit # and panel.
Controls cabinets, kiosks and pedestals	TYPE B: Indicate equipment controlled and voltage, circuit # and panel.
Transformers	TYPE B: Indicate designation, fed from, ratings, and required protection
Emergency lighting battery packs, mini-inverters, and emergency power ups	TYPE B: Indicate designation, ratings, and list lighting circuits monitored
Fire alarm devices	TYPE C: Thermo-tape label: Zone number, device address. Affix to device, or device base plate (smoke/ heat detectors), and mark inside edge of device box with same designation(s)
Receptacles	TYPE C: Thermo-tape label: Circuit number. Affix to cover plate. Mark inside edge of device box with same designation
Structured wiring outlets	TYPE C: Thermo-tape label: LAN room number, port number, or as indicated with appropriate cover

1.4.2. 347/600V EQUIPMENT COLOUR

All 347/600V distribution equipment, including 120/208/600V transformers to be colour "sand" (RAL 1001, or equal).

1.4.3. CONDUIT COLOUR BANDING

1.4.3.(1) Identify conduit with painted colour bands. Tape is not permitted for colour coding.

1.4.3.(2) Major bands to be 30 mm wide, minor bands 20 mm.

1.4.3.(3) Identify at either side of walls and penetrations, where conduit enter cabinets or boxes, and at each 10-meter interval.

1.4.3.(4) Painted fittings are acceptable for major band identification only, minor band not acceptable.

1.4.3.(5) Conduit colour banding to be as follows.

CONDUIT COLOUR BANDING		
System	**Major Band**	**Minor Band**
Normal Power: 120/208/240V	Grey	
Normal Power: 347/600V	Beige	
Emergency Power: 120/208/240V	Grey	Red
Emergency Power: 347/600V	Beige	Red
Structured Wiring and Telephone	White	
Exit and Emergency Lighting	Black	Red
Fire Alarm	Red	
Public Address	White	Blue
Mechanical Alarms & Controls	Yellow	

1.4.4. CONDUCTOR IDENTIFICATION

1.4.4.(1) Identify conductors at both ends with permanent, indelible, numbered markings.

1.4.4.(2) Identify Panel designation and circuit number.

1.4.4.(3) Labels to be manufactured or printed. Handwritten labels and glue-on labels are unacceptable. Labels to be shrink-on, snap-on, or ty-wrap fastened on cables.

1.4.4.(4) Identify phase throughout using CSA C22.1 colour code.

1.4.4.(5) Maintain phase sequencing throughout.

1.4.4.(6) Phase sequence to be A/B/C, red/black/blue as viewed from the front of equipment.

1.4.5. SYSTEM RISER DIAGRAMS AND SINGLE LINES

1.4.5.(1) Provide system riser diagrams and single line diagrams in the electrical service room.

1.4.5.(2) Text to be minimum 12-point font and sized to suit the system and application.

1.4.5.(3) Permanently mount with clear cover (polycarbonate or equal).

1.4.5.(4) Single line diagram to include main distribution equipment, equipment between branch circuit panels, and all equipment down to branch circuit panels. Include all labels

1.4.5.(5) Single line diagrams required for:

a) Electrical distribution equipment, single line diagram.

b) Fire Alarm System, and Fire Alarm Zone Plan.

c) Emergency lighting system.

d) Communications/network distribution.

1.4.6. ARC FLASH WARNING LABELS

1.4.6.(1) Provide arc flash warning labels for all electrical distribution equipment, in accordance with CSA C22.1 Section 2-306.

1.4.6.(2) Include incident energy, flash hazard boundary, date of calculation, limited and restricted approach boundaries, risk category and required level of PPE.

1.5. EQUIPMENT SUPPORT AND RESTRAINT

1.5.1. BACKING FOR ELECTRICAL EQUIPMENT

1.5.1.(1) Provide 19 mm good one side plywood backing in all electrical rooms, LAN rooms and equipment closets.

1.5.1.(2) Paint backing with grey fire-retardant paint prior to installation of electrical equipment. Install over any required fire ratings.

1.5.1.(3) Backing to extend minimum 2.4 meters from finished floor and fastened through to structure with structural rated fasteners.

1.5.2. HOUSEKEEPING PADS

1.5.2.(1) Provide concrete housekeeping pads for all floor-mounted electrical equipment.

1.5.2.(2) All housekeeping pads to be a minimum 100 mm high painted with high visibility orange paint.

1.5.2.(3) Final dimensions to be confirmed by the structural engineer.

1.5.2.(4) Housekeeping pads are to be structurally engineered, reinforced and connected through to the building structure. Pad construction shall be designed to allow for equipment restraint as required.

1.5.2.(5) All housekeeping pads to be painted as indicated in Chapter 1.

1.5.3. SEISMIC RESTRAINT

1.5.3.(1) Provide seismic restraint and anchorage for all electrical equipment and services as specified in Chapter 1 – General Project Requirements.

1.5.4. COORDINATION AND EQUIPMENT LOCATION

Installation and design of electrical systems shall be coordinated with each of the other disciplines to ensure a functional and maintainable system. Refer to Chapter 1, Section 9 – Coordination for specific requirements.

2. Electrical Service and Distribution

2.1. ELECTRICAL SERVICE

2.1.1. UTILITY OVERVIEW

Yukon is comprised of several power grids: the main grid operating primarily on hydroelectricity, and a few smaller grids operating on fuel-fired generators with limited grid-tied renewables. The communities serviced by generators are more susceptible to power quality issues and will also experience more frequent power outages.

Generator communities will not accept electric space heating loads and may be limited to the amount of renewable energy generation that can be exported back to the utility. Coordinate with the electrical utility to review the impacts on each project.

Rate schedules and calculators for the respective communities can be found on the following websites.

www.ATCOelectricyukon.com

www.yukonenergy.ca

2.1.2. ELECTRICAL SERVICE SIZING

2.1.2.(1) Size all electrical services in accordance with Canadian Electrical Code, in addition to the following requirements.

a) Maintain a minimum of 20% spare capacity.

b) Assume a power factor of 0.8 lagging.

c) Do not de-rate electrical heating loads to 75% as permitted by CEC Section 62-118.

d) Allow for future electric car charging stations by allowing for conversion of electrified parking stalls to be converted to Level I and Level II EV charging stations. Refer to Chapter 2 – Energy and Environmental Design Requirements for quantities.

e) Provide oversized bussing for the main distribution, to allow for a future addition of a grid-tie photovoltaic system. To be 15% of overall service size, and no less than 25 kW. Provide a suitable location for future connection. Locate spare breaker at the service entrance equipment.

2.1.3. UTILITY COORDINATION

2.1.3.(1) Utility construction in remote Yukon communities is scheduled in advance and can be timed to match availability of equipment or ground conditions.

2.1.3.(2) During design and construction, the typical roles and responsibilities will be as follows (this does not supersede contract requirements).

a) Electrical Engineer

i) Service sizing.

ii) Design coordination with utility.

iii) Obtain available fault currents and utility servicing quote.

iv) Preparation of servicing drawings, which indicate the utility service location, extent of easements required, service equipment required, extent of utility and contractor responsibility.

b) Contractor

i) Provide installation of equipment, in accordance with utility servicing manual.

ii) Provide construction coordination with utility, including scheduling. Obtain connect permits.

iii) Provide temporary service if required during construction.

iv) Pay electrical costs during construction.

c) Government of Yukon

i) Pay initial utility deposit begin site surveying and budget estimating.

ii) Pay for utility servicing costs associated with permanent service.

2.1.4. SERVICE ENTRANCE EQUIPMENT

2.1.4.(1) Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.

2.1.4.(2) For services up to and including 200 A:

a) Provide in-line metering, with service entrance rated breaker or combination panelboard.

b) Provide bus bolted surge suppression device, breaker style device.

2.1.4.(3) For Services over 200 A up to 400 A:

a) Provide combination service entrance equipment, complete with main breaker, CT, and CDP board.

b) Provide customer owned metering equipment.

c) Provide bus connected surge suppression device.

2.1.4.(4) For Services over 400 A up to 1200 A:

a) Provide auxiliary wireway compartment for service entrance conductors. Compartment to be full height, and no less than 300 mm wide (12").

2.1.4.(5) For services over 1200 A:

a) Provide Arc Flash Energy-Reducing Maintenance Switching. When enabled, this mode will reduce the fault clearing time of the breaker.

2.1.4.(6) Locate service entrance equipment, utility and customer metering in a room that can be accessed from the exterior of the building.

2.1.4.(7) Metering equipment to measure utilities including, but not limited to, vehicle plug-ins, electric heat, general electric, etc. Refer to Chapter 2 – Energy and Environmental Design Requirements.

2.1.5. CUSTOMER-OWNED METERING

2.1.5.(1) Provide customer-owned metering for services over 200A. Customer metering to be equipped with following minimum features:

a) Volts (AC): Line to Line, Line to Neutral for each phase.

b) Current (Amps): Per phase and neutral.

c) Frequency.

d) Real (kW), Reactive (kVAR), and Apparent Power (kVA).

e) Power factor.

f) Real (kWh), Reactive (kVARh) and Apparent energy (kVAh).

g) Current Demand.

h) Power Demand (real, reactive and apparent).

i) Communications capable, and suitable for networking as part of a larger energy monitoring system. Compatible with BMS BACnet communication.

j) Reverse power monitoring

i) Provide 4-20 mA analog, or an open source communications protocol suitable for outputting the reverse power observed at the customer service entrance. Signal to be compatible with mechanical controls (BMS) system.

ii) Provide integration between the customer-owned metering and the mechanical controls system.

iii) To be used for connection of peaking boilers or other electric loads, when surplus power is generated.

2.1.5.(2) Provide metering of alternative energy generated on site. This can be integrated with the inverter system provided; however, the metering must combine all sources to show a total figure.

2.1.6. CONNECTION OF ALTERNATIVE ENERGY SOURCES

2.1.6.(1) Prior to designing for alternative electrical energy sources (solar, co-gen, wind), confirm with the electrical utility that there is acceptable capacity to export to the grid. Consult the power export program agreements in effect at the time of design to determine the limitations for power export, rules of connection, rates of pay and other relevant information.

Overall limits for grid saturation have been established, which may prevent a building from exporting to the grid.

Identify options to manage renewable electricity. Where export of alternative energy is not available, this may entail use of reverse power metering, controls, and a load dump, for storing or utilizing excess energy generated. Please refer to Chapter 2, Section 4.2 for Selection of Energy Sources.

2.1.6.(2) Oversize distribution buffering by 20% for the connection to future alternative energy sources and as required by Section 64 of the CEC.

2.1.6.(3) Make allowance for connection to a roof mounted and ground mounted alternative energy source.

2.1.6.(4) Provide minimum 50 mm conduit from the main electrical service to the roof, and to the building exterior (locate below grade, in an open space away from the building), each sized for 20% of the overall service size.

2.1.6.(5) Provide an independent conduit, sized 35 mm (1-¼") for grounding cable connection to an independent grounding electrode. Connect both the PV grounding electrode and the building main grounding electrodes together.

2.1.6.(6) Provide additional, minimum 27 mm (1"), conduits for future communications and control interconnections to the electrical room.

3. Facility Power Generation

3.1. DETERMINING REQUIREMENT FOR A GENERATOR

The requirements for a generator must be determined at the project outset, in coordination with the design team and the Government of Yukon. The following are guidelines for where generators are required.

3.1.1. Where building is classified as Group B-1 or B-2 occupancy. Critical water and wastewater facilities, sewage lift stations or pumping facilities.

3.1.2. Airports, air traffic control towers, and major transportation infrastructure.

3.1.3. Critical administration facilities.

3.1.4. Where the building provides a central community gathering space, is fully self-supporting, and has been identified as a building of refuge.

3.1.5. Other facilities or installations as required under the currently applicable National Building Code of Canada.

3.2. SCHOOLS AND HIGH-VALUE ASSETS EMERGENCY VERSUS STANDBY GENERATORS

Generators can be broken into two categories: emergency generators and standby generators.

3.2.1. **Emergency generators**: Code required generators installed within post-disaster facilities,as well as where generators are used to supply power to life safety equipment such as electric fire pumps, emergency lighting and exit signage and life support equipment.

3.2.2. **Standby generators**: Can be provided for non-life safety loads, such as protection of schools and other high-value assets. Typical acceptable standby loads include heating plants, non-emergency lighting, and distribution. Life-safety loads are not permitted to be connected to standby generators.

3.2.3. Yukon government prefers to classify generators as standby generators where permitted by code; and provide emergency lighting and exit signage power using DC battery packs and mini-inverter style packs.

3.2.4. All generators, regardless of category, will be designed and tested at the time of commissioning to the CSA C282 standard.

3.3. STANDBY GENERATOR FUEL SUPPLY

3.3.1. Emergency generator fuel supplies to meet the code requirements of CSA B-139 and CSA B-149.1.

3.3.2. There are two primary fuel supplies for generators in Yukon.

3.3.2.(1) **Diesel fuel**: Commonly stored and distributed in all Yukon communities, and can be transported in a tidy tank or fuel cans in an emergency. It should be equipped with a day tank, or fuel warmer, to achieve optimal efficiency.

3.3.2.(2) **Propane**: Propane generators are sometimes required for installation near drinking water wells, since propane fuel does not pose a risk of groundwater contamination. Propane generators are less common and should not be used unless required to do so by the Authority Having Jurisdiction.

3.3.3. If a propane generator is required, pay special attention to the vaporization requirements of the generator, and provide the propane vaporizer with suitable backup power. Connect to the highest priority branch in the distribution system (life safety or emergency), as these loads are required by the generator for reliable operation.

3.3.4. Size the generator fuel supply to operate the generator for a minimum of 24 hours at full load, with a minimum 4-hour day tank, if connected to a larger tank with automatic refill for the day tank.

3.3.5. For emergency generators, provide fuel polishing skids to automatically dewater and condition diesel fuel.

3.4. GENERATOR ASSEMBLIES

The following are a list of minimum requirements for generators to be used on Government of Yukon projects:

3.4.1. GENERATOR

3.4.1.(1) Diesel engine (or propane where required by the AHJ).

3.4.1.(2) Engine control panel, suitable for monitoring engine status and providing output monitoring in accordance with CSA C282 requirements. Refer to fire alarm section for additional requirements.

3.4.1.(3) Engine block heater, circulation pump style, thermostatically controlled. Provide isolation valves.

3.4.1.(4) Engine oil pan heater, thermostatically controlled.

3.4.1.(5) 12 or 24 Volt starting battery, battery charger/conditioner with automatic equalizing and battery enclosures for each battery.

3.4.1.(6) Electronic governor.

3.4.1.(7) Shaft-driven fan and radiator.

3.4.2. ALTERNATOR

3.4.2.(1) The alternator is to be equipped with Permanent Magnet Generator (PMG) excitation (shunt excitation not permitted), for reliable operation and suitable for use with harmonic loads such as VFD Drives.

3.4.2.(2) Alternator windings are to be minimum 150°C rated windings, connected in aWYE configuration, with solidly referenced Xo.

3.4.3. LOCATION AND ENVIRONMENTAL CONTROLS

3.4.3.(1) The generator assembly is to be located within an insulated and fire rated room (or standalone exterior enclosure where permitted).

3.4.3.(2) The generator room is to be equipped with recirculating dampers, thermostatically controlled to maintain a room temperature of 17 degrees Celsius in winter. Dampers are to be connected to the standby power branch.

3.4.3.(3) Dampers for combustion air and fresh air are to be provided to balance the overall pressure in the room, and to provide combustion air for the engine. These dampers are to be DC powered, and set to open simultaneously with generator start.

3.4.3.(4) Mount the generator assembly on spring isolated snubbers, to reduce the transmission of noise through the structure.

3.4.3.(5) Silencers provided in residential areas, or within normally occupied buildings are to be critical grade.

3.4.4. TESTING PROVISIONS

3.4.4.(1) Provide a second generator breaker, for connection to portable load bank and full load testing.

3.4.4.(2) Provide a testing port to allow cables to be run into the generator room fromthe load bank outside, so that doors can remain sealed during testing of the generator ventilation system.

3.4.4.(3) Consider including a permanently mounted and connected exterior load bank for projects located in remote communities based on LCCA.

3.4.5. COMMISSIONING

3.4.5.(1) Factory test the generator prior to shipping.

3.4.5.(2) When on site, fully test and commission the generator in accordance with C282 requirements. Record all information and incorporate into the O&M manual as a baseline.

3.4.5.(3) Refer to Chapter 1 – General Project Requirements.

3.5. TRANSFER SWITCHES

3.5.1. The generator transfer switch is to be located in the electrical room, away from generator equipment. Provide fire-rated cables as required for emergency generators.

3.5.2. The transfer switch is to operate automatically, with adjustable pickups for voltage dips, time to start, phase loss and transfer.

3.5.3. Transfer switches are to be breaker type, with provisions for manual open and close.

3.5.4. Provide bypass switching where transfer switches may require maintenance when energized.

3.5.5. Provide single side isolation bypass for buildings required to be equipped with emergency generators, and provide dual isolation bypass for Group B occupancies, and where directed.

3.5.6. Provide 3 pole (single phase) 4 pole (three phase) transfer switches where ground fault service breakers are required, and where portable (construction type) cord connected generators will be provided.

3.6. PHOTOVOLTAIC (PV) COLLECTORS

3.6.1. PROVISION FOR FUTURE PV

3.6.1.(1) Make allowance in the building design to support the future installation of roof and ground mounted PV panels.

3.6.1.(2) During design, coordinate with Government of Yukon and the design team to ascertain the available roof area, and environmental factors; such as location and shading.

3.6.1.(3) Size electrical equipment in accordance with the requirements of CSA C22.1, Section 64 – Renewable Energy Systems, and any amendments by the Authority Having Jurisdiction.

3.6.2. DESIGN OF PHOTOVOLTAIC SYSTEMS

3.6.2.(1) Coordinate with the structural engineer and provide ballast and roof loading data for incorporating into the building structure. Coordinate for roof anchors where required and detail the mounting arrangements into the structural design.

3.6.2.(2) Ascertain the available wind loading for the site, and for the proposed EPA of the solar array. Model the array for possible snow accumulation and confirm that the racking selections are suitable for the proposed orientation and wind loading.

3.6.2.(3) Coordinate with the architect to review the effects of thermal bridging through roof anchors, as well as the impacts of ballasts and mounting equipment on the roof membrane.

3.6.2.(4) Size the array, number of panels, inverters and ancillary equipment, and provide an estimate of annual energy production based on the proposed orientation. Conduct a life cycle costing analysis to be used in support of the project.

3.6.3. GROUNDING AND BONDING OF PV SYSTEMS

3.6.3.(1) Design and install grounding of PV system in accordance with CSA C22.1 section 64 and section 10.

3.6.3.(2) Make connection between the PV system bond, and the main system ground.

3.7. POWER DISTRIBUTION

3.7.1. PANELBOARD AND CENTRAL DISTRIBUTION PANELS (CDP)

3.7.1.(1) Load Centres: Permitted within suites of residential occupancy.

3.7.1.(2) Panelboards: Required for all other applications.

a) Provide fully rated breakers throughout and provide bolt on breakers (not plug on type).

3.7.1.(3) CDPs: required for all service entrance in excess of 200 A.

3.7.2. ELECTRICAL DRY TYPE TRANSFORMERS (600V OR LESS)

3.7.2.(1) Locate electrical transformers in open, ventilated spaces where possible, to recover waste heat.

3.7.2.(2) Provide housekeeping pads.

3.7.2.(3) Transformers over 45 KVA, and installed within buildings are to be ground mounted, and provided with housekeeping pads where installed on concrete floors.

3.7.2.(4) Transformers 45 KVA and under, installed within buildings, may be wall mounted under the following conditions.

a) A manufacturer supplied wall mount kit is provided.

b) A Professional Engineer assesses the wall assembly to assess whether the wall is suitable to carry the proposed weight.

c) A Seismic Restraint System (SRS) is provided for the transformer, or the SRS is deemed as not required by a Professional Engineer.

3.7.2.(5) Electrostatic Shield: Provide grounded copper shield between primary and secondary windings to attenuate electrical noise.

3.7.2.(6) Minimum Standards: Class 220C insulation with 150°C rise over 40°C ambient winding temperature rise.

3.7.2.(7) Construction: Copper or Aluminum windings.

3.7.2.(8) Special Applications: K factor for non-linear loads.

3.7.2.(9) Efficiency: Minimum 97.89% efficient.

3.7.3. STARTERS AND MOTOR PROTECTION

3.7.3.(1) Starters

a) To be combination type, full size, with adjustable overload settings and electronic resettable trip facilities.

b) To be equipped with HOA facilities, green (start) and red (stop) LED pilot lights, external reset pushbuttons, phase unbalance and phase loss protection, visible trip indication.

c) Combination starters to include motor circuit interrupter circuit breaker with operating lever on the outside of the enclosure and provision for locking in the on or off positions.

d) Provide two sets of NO and NC auxiliary contacts.

e) Control Voltages shall be no higher than 120V ac.

3.7.3.(2) VFD drives are to be equipped with manual speed control, HOA with green (start) and red (stop) LED pilot lights.

a) VFDs for critical loads to be equipped with secondary, across-the-line contactor starter with manual HOA control. This includes water pumps for municipal water systems or firefighting applications, smoke control equipment, and other life safety fans, pumps, or motors.

b) VFDs driven systems shall be designed as to not exceed 100% or 60Hz VFD output.

3.7.3.(3) Motor controls to be grouped where possible.

3.7.3.(4) MCC Units: required whenever 3 or more motors, 1/2 hp or larger, are located within 30 meters of one another and controlled by starters or VFD drives.

3.7.3.(5) Provide 10% spare (empty) bin space.

3.8. ANCILLIARY EQUIPMENT

3.8.1. OWNER-SUPPLIED EQUIPMENT

3.8.1.(1) Survey owner-supplied equipment at the beginning of the project.

3.8.1.(2) Provide cords, plugs and electrical capacity as required to service owner-supplied equipment.

3.8.2. SAFETY CONTROL FOR MACHINES

3.8.2.(1) In workshops, kitchens, and industrial areas, provide contactor shutdown of electrical equipment. Contactors to be wired in series, with a push-to-open, and twist-to-reset operation.

3.8.2.(2) Provide signage to indicate “emergency shutoff”.

3.8.2.(3) Locate shutdown controls near work stations. User should not have to travel further than 6m to reach a controller.

3.8.2.(4) In education facilities, provide the contactor with a key-reset, so that staff are required to inspect (and shut off) equipment prior to re-energizing, and so that equipment can be de-energized when staff are not present.

3.8.3. AUTOMOTIVE BLOCK HEATER PLUGINS

3.8.3.(1) Provide automotive block heater plugins for vehicle parking areas. Coordinate with Government of Yukon for the required number of energized stalls.

3.8.3.(2) All automobile plugins are to be automatically controlled, to cycle power on/off depending on the outside temperature.

a) Standard of acceptance: IPLC – Intelligent Parking Lot Controls.

3.8.3.(3) Emergency vehicle plugins are to be equipped with standard 20A 5-20R configuration outlets, without control.

3.8.3.(4) Conduit to exterior automobile block heater outlets is to be oversized to allow for future conversion to electric vehicle charging stations (Level II). Refer to Chapter 2 – Energy and Environmental Design Requirements for quantities.

3.9. POWER SYSTEM STUDIES

3.9.1. For all systems over 400A, provide a power system study to assess the electrical distribution for short circuit, protective device coordination.

3.9.2. Studies to include all external and internal sources, including scenarios for proposed future renewable energy systems.

3.10. POWER QUALITY

3.10.1. VOLTAGE DROP

3.10.1.(1) Size all electrical distribution and branch circuits for voltage drop in accordance with CEC requirements.

3.10.2. POWER FACTOR CORRECTION

3.10.2.(1) During design, make allowance for power factor correction equipment, if power factor will lag to less than 0.8 PF.

3.10.2.(2) Upon completion of the project, monitor the building for a period of 3 months, to determine the appropriate power factor correction equipment required for the building.

3.10.3. HARMONIC MITIGATION

3.10.3.(1) Provide K-Rated Transformers in buildings with harmonic loads, such as switching power supplies, and VFD drives.

3.10.3.(2) Provide power filters on VFD drives to reduce the impacts of harmonics generated.

3.10.3.(3) Adhere to the minimum harmonic current ratings for new equipment installed.

a) Photovoltaic Inverters: Less than 5% THD.

b) Battery Emergency Power Supplies: Less than 10% THD at full load.

3.11. FACILITY GROUNDING

3.11.1. SERVICES UP TO 200 A

3.11.1.(1) Follow CEC requirements for Service Grounding.

3.11.2. SERVICES OVER 200 A

3.11.2.(1) Provide ground electrode made up of a minimum 3 ground rods or plates, spaced 6 meters apart. Additional grounding methods (water pipe, UFER, etc.) may also be employed to provide the required grounding resistance.

a) Where rebar is used as a UFER ground, provide rebar that is independent of structural rebar.

b) Where water piping or structural piles are used for grounding connection, provide 19 mm welded stud for connection. Do not rely on bolted connections.

c) Where rods or plates are installed, ensure that these are installed outside of soil excavation limits, and they are not placed in gravels or other poorly conducting soils.

3.11.2.(2) Main ground conductor to be #3/0 AWG copper.

3.11.2.(3) All connections to be thermite welded, or hypress compression type.

3.11.2.(4) Provide a main grounding bus bar at the service entrance, minimum 300 mm (12") long, and attach the main grounding electrode to the bus bar prior to entering the main switch.

a) Use through lug connection to allow the grounding conductor to remain continuous, and accessible for visual inspection and re-torque.

b) Do not cut or splice the grounding conductor.

3.11.3. GROUND RESISTANCE TESTING

3.11.3.(1) Provide ground resistance test to determine effective ground contact. Provide additional grounding as required to meet the minimum effective ground resistance.

a) For general building grounding, provide maximum 25 Ohm to earth.

b) For health care facilities, office buildings, and buildings containing process water/wastewater equipment, provide 5 Ohm to earth.

3.11.4. SEPARATELY DERIVED SYSTEMS

3.11.4.(1) Connect separately derived systems using a minimum #1/0 AWG green copper grounding conductor, connected directly to the main system grounding bus.

3.11.5. GROUNDING AND BONDING BUSS NETWORK

3.11.5.(1) Provide grounding buss bars in the main electrical room (service entrance), sub-electrical rooms, LAN rooms, and as required.

3.11.6. EQUIPMENT AND CONDUIT BONDING

3.11.6.(1) Provide bonding in accordance with CSA C22.1 section 10.

3.11.6.(2) Notwithstanding, the use of conduit is not permitted as a bonding means. Provide separate insulated bonding conductor in all conduit.

3.11.6.(3) Where lightning protection is required, provide a separate grounding system, direct to earth. Interconnect the lighting ground with the building main grounding system using a buried conductor or impedance ground connection.

4. General Purpose Electrical Power

4.1. BRANCH WIRING

4.1.1. CONDUCTORS, CABLES AND CONDUIT

4.1.1.(1) Conductor Material

a) Feeders 100 A and larger, intended for non-cyclical loads, may be aluminum.

b) All other wiring to be copper.

4.1.1.(2) Minimum Conductor Size

a) #12 AWG for all applications for line voltage 120 VAC and up, including suites of residential occupancy.

4.1.1.(3) Coordination with Equipment Lugs

a) Equipment lugs to be specified as compatible with copper or aluminum conductors.

b) Where conductors are oversized such that they are too large for equipment lugs (due to voltage drop or other derating factors):

i) Provide a tap conductor with appropriate reducing barrel connector, OR

ii) Provide an appropriate reducing pin-style connector.

c) Barrel connectors and pin-style connectors to be compression type, complete with insulating sleeve. Split bolts, bolted or keyed tap connectors are not acceptable as they require retorquing.

4.1.1.(4) Use of Conductors, Cables and Conduit

a) General

i) Conductors, cables and conduit to be selected according to the environment where they are installed, to meet the requirements of the CEC and NBC.

ii) In sprinklered areas, generator rooms, water and wastewater areas, washdown or food processing areas, or on the building exterior: Connectors to be wet type or rain tight listed, where used in continuous conduit runs, or when entering the sides or top of equipment.

iii) Insulated throats required for all metallic conduit connectors, regardlessof conductor size.

b) Non-Metallic Sheathed Cable

i) Permitted in Part 9 buildings of combustible construction.

ii) Permitted to be exposed only in heated crawlspaces of residential occupancy, where run underside of floor joists and provided with mechanical protection to the CEC.

c) AC-90 Cable

i) Permitted for single drops to wall mounted devices, devices mounted in accessible ceilings, final connections to motors and vibrating equipment in dry areas. Limited to 3 meters maximum length.

ii) Permitted for single circuit horizontal runs within stud walls (limited to 20 A and under).

4.1.1.(5) EMT Conduit

a) General application for building wiring (interior and exterior).

b) To be provided with bonding conductor for all conduit (except for service entrance conduit). Bonding through the conduit system is not acceptable.

c) Not to be used as a race way in concrete.

4.1.1.(6) RGS (Rigid Galvanized Steel Conduit)

a) For applications in hazardous locations.

b) Where subject to mechanical damage on building exterior (below 2.5 meters and subject to vehicle damage).

c) Epoxy coated for corrosive environments.

d) Where exposed for exterior plugs (i.e. landscaping plugs). Make transition to RGS below grade.

e) To be provided with bonding conductor for all conduit (except for service entrance conduit). Bonding through the conduit system is not acceptable.

f) Bends for underground feeder conduit (53 mm conduit and larger).

4.1.1.(7) RPVC Conduit

a) For underground wiring.

b) Provide RGS factory bends for 53 mm and larger conduit 45's and 90's. Field bent sweeps in PVC are acceptable.

c) Permitted to stub into buildings before transitioning to EMT/RGS. (Where permitted by the NBC).

d) Sleeved in RGS steel conduit, or schedule 40 steel piping, where transitioning through building footing walls or other areas subject to settling or frost movement.

4.1.1.(8) DB2 Conduit

a) For underground wiring.

b) Provide RGS factory bends for 53 mm and larger conduit 45's and 90's. Field bent sweeps in PVC are acceptable.

c) Permitted to stub into buildings before transitioning to EMT/RGS. (Where permitted by the NBC).

d) Sleeved in RGS steel conduit, or schedule 40 steel piping, where transitioning through building footing walls or other areas subject to settling or frost movement.

e) Subject to YG approval, on a case-by-case basis.

4.1.1.(9) Liquid-Tight Flexible Conduit (non-metallic)

a) For use in corrosive environments (non-hazardous), as part of a PVC conduit system (boxes, fittings, etc.).

4.1.1.(10) Liquid-Tight Flexible Metal Conduit:

a) For use in wet or dry locations, for final connections to movable equipment, and vibrating equipment (less than 3 meters).

4.1.1.(11) Teck90

a) Temporary power (e.g., for sequenced work).

b) Where required in hazardous locations.

c) In industrial process environments, water and wastewater processing areas.

d) Subject to YG approval: For use in wet or dry locations, for final connections to equipment.

e) Subject to YG approval: Direct bury, direct bury in permafrost locations, for use in retrofit applications.

4.1.1.(12) All Other Cable and Conduit

a) Subject to YG approval.

4.2. WIRING DEVICES

4.2.1. MINIMUM QUALITY

4.2.1.(1) All wiring devices to be minimum commercial specification grade, suitable for back and side wiring, with provisions for connection with #10 AWG conductors.

4.2.2. APPEARANCE

4.2.2.(1) Maintain like-appearance throughout each building.

4.2.2.(2) Match colour and style (decora or traditional).

4.2.3. COVER PLATES

4.2.3.(1) Cover plates to be brushed stainless steel throughout finished areas.

4.2.3.(2) Sheet steel cover plates permitted for service spaces.

4.2.3.(3) For exterior outlets, where while-in-use covers are required; provide cast metal hinged covers, marked extra duty.

4.2.3.(4) Plastic covers are not acceptable outdoors.

4.2.3.(5) In splashdown areas, provide suitable gasketed covers and while-in-use covers for outlets.

4.3. FUSES

4.3.1. Fuses should be used only where absolutely necessary.

4.3.2. Service entrance fuses shall be Bussmann JJN series for up to 1200 A at 208 V and JJS series for up to 800 A at 600 V.

4.3.3. Fuses protecting motors shall be time delay Bussmann LPJ-SP series up to 60 A.

4.3.4. Provide three spare fuses of each size and type used on the project, stored in wall mounted steel cabin in the main electrical room.

4.3.5. Acceptable alternate: Gould-Shawmut are approved equals, provided a series combination study is provided.

4.4. HEAT TRACING

4.4.1. DESIGN CALCULATIONS

4.4.1.(1) Conduct heat tracing design calculations prior to ordering or installing heat trace materials.

4.4.1.(2) Calculations to incorporate material type, insulation thickness, ground (or air) ambient temperature, and desired heating temperature.

4.4.2. ACCEPTABLE MATERIALS

4.4.2.(1) All heat trace to be equipped with a grounded sheath and connected to a Ground Fault interrupting device in accordance with CSA C22.1.

4.4.2.(2) Coordinate the heat trace cable selection with the piping and tank materials, and insulation materials. Some heating cables are incompatible with plastics (or well pump conductors) due to their high skin temperature.

4.4.3. DESIGN CONSIDERATIONS

4.4.3.(1) Design and install in accordance with manufacturers instructions.

4.4.3.(2) Allow for additional heating cable at valves, pipe bends and pipe fittings.

4.4.3.(3) Where pipes are connected, provide additional heating cable if mechanical joints are used, such as Victaulic type, or fusion collars for HDPE piping.

4.4.3.(4) Where additional cable is provided at valves and removable equipment, passthe cable under and on both sides, to allow for future removal of the fitting, without damaging the heating cable.

4.4.3.(5) Storm, water and wastewater applications require constant monitoring, and must be connected to remote monitoring to alarm in the event of freezing.

4.4.3.(6) Rainwater leaders are less critical, and often only require operation for a few hours to clear accumulated water after warm days in winter or spring.

4.4.3.(7) Design heat tracing, and controls, to account for different environments wherethe cables will be installed. An example of this is where piping transitions from above grade to below grade outside a building. During spring days, it is common for ambient air temperatures to be 5 to 10 degrees C, while ground conditions remain frozen. Provide dual monitoring heat trace controllers whererequired, and separate heat trace into two systems if required.

4.4.3.(8) Confirm the temperature settings on heat trace controllers. Some controllers do not display C or F after the temperature. Where controllers are only available in F. Provide lamicoid label to read: “Temperature display in Fahrenheit, set at xxxdegrees F.”

4.4.3.(9) All heat trace, regardless of type, is to have operating temperature control with sensor monitoring pipe temperature and limiting temperatures to those below the contacted materials ignition temperature.

4.4.4. CONTROLS

4.4.4.(1) All electronic heat tracing controls to be provided with manual “on” feature.

4.4.4.(2) All water and wastewater heat tracing to be provided with intelligent controls, complete with self-diagnostic circuit, ground fault detection, and dry contact output to BMS or the building security system (mechanical partition).

4.4.4.(3) Roof scuppers and rainwater leaders fitted with heat tracing cable are to be fitted with one of the following controls.

a) For maintenance buildings, 2 stories or less; provide a spring wound timer, 4 hours, without hold feature.

b) For all remaining buildings, provide an intelligent controller with rain water leader freeze sensor.

i) Standard of Acceptance: ETI Technologies or equal.

4.4.4.(4) Heat tracing for fire water to be monitored by the fire alarm panel. Provide an integrated heat tracing controller with self-testing, GFCI protection, and thermostatic control. Monitor on supervisory circuit.

4.4.4.(5) Control system to include manual override.

4.4.5. TESTING

4.4.5.(1) Test heating cables, and controls, in accordance with manufacturer instructions.

4.4.5.(2) Incorporate test results into O&M manuals as a reference baseline.

5. Lighting

The intent of this section is to provide effective and efficient lighting. Products are specified as a minimum standard for longevity, as well as their ability to be integrated with future lighting controls.

All lighting to be designed to the IES handbook standard.

5.1. LIGHTING INTENSITIES AND COLOUR

5.1.1. Interior lighting to be standardized at 4000 K for interior general-purpose lighting.

5.1.2. Lighting to be 3000 K for residential occupancies.

5.1.3. Exterior lighting to conform to Dark Sky Society lighting intensity requirement as to not exceed 3,500 K.

5.2. INTERIOR LIGHTING CONTROL

5.2.1. Provide interior lighting control to meet the requirements of NECB, and as follows.

5.2.1.(1) Category 1 Buildings

a) Provide an integrated NECB compliant lighting controls path, to match whatever energy modelling approach is used for the building.

b) Integrated lighting controls is preferred for larger buildings (schools, offices, community centres, etc.), since it allows for flexibility of programming within the space, more control points (3-way, 4-way, ganged on/off, etc.), and integration with BMS/security cameras for occupancy detection.

5.2.1.(2) Category 2 Buildings

a) Preference is for fixtures with internal occupancy sensors or daylight harvesting sensors for stairwells, corridors, and circulation areas. These are very cost effective when integrated into the fixtures.

b) Secondary controls and occupancy sensors should be provided for offices, and other commercial occupancies. Line voltage type (decora style).

5.2.2. Lighting controls, other than fixture mounted controls or daylight harvesting sensors, are excluded from the following areas.

5.2.2.(1) Detention occupancies.

5.2.2.(2) Seniors living facilities (where occupants control their own lighting).

5.2.2.(3) 24-hour staffed areas (specifically those areas that require 24-hour access), such as an entryway for a hospital.

5.2.2.(4) Service spaces where maintenance tasks are routinely performed.

5.2.3. Sensors

5.2.3.(1) Sensors shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options.

5.2.3.(2) Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.

5.3. EXTERIOR LIGHTING CONTROL

5.3.1. Exterior lighting to be separated into essential lighting, and site/ambient lighting.

5.3.2. Essential lighting to be controlled by contactor and photocell for dusk to dawn operation or astronomical timer.

5.3.3. Site/Ambient lighting to be equipped with photocell control + time clock override. Integral photocell and motion sensing is acceptable on Category 2 buildings where approved by Government of Yukon.

5.3.4. Where integrated lighting control systems are employed, zone exterior lighting by areas. Provide for connection between the exterior lighting control system and the CCTV system and security system for exterior occupancy sensing.

5.3.5. All exterior lighting and lighting control to be capable of electronic dimming, 0-10 V.

5.4. SWITCHED PLUGS

5.4.1. The requirement for switched plugs in offices is not required on Government of Yukon projects.

5.5. LUMINAIRES

5.5.1. LED

5.5.1.(1) All lighting to be LED type, with integral dimming on 0-10 V control.

5.5.1.(2) LED lighting to be oversized for the application. Size to IESNA standards and provide 15% oversize to allow for lumen depreciation of the fixtures.

5.5.2. EXTERIOR LIGHTING

5.5.2.(1) Provide all exterior lighting with sharp cut-off optics, and dark sky compliant.

5.5.2.(2) Exterior lighting to be vandal resistant and finished to match the building façade. Coordinate design with the architect.

5.5.2.(3) Provide exterior lighting to IES standards, plus additional 15% to account for future lumen depreciation.

5.5.2.(4) Illuminate exterior pathways, parking areas, awnings and entryways, and paths to egress.

5.5.3. INTERIOR LIGHTING

5.5.3.(1) Provide all interior lighting to meet the design guidelines of the IESNA handbook.

5.5.3.(2) All interior lighting adjacent natural light sources (within 5 meters) to be equipped with daylight harvesting photocell.

5.5.3.(3) Provide multi-level lighting control for lighting in all buildings, except for industrial occupancies.

5.5.3.(4) In industrial occupancies, provide nightlight fixtures on separate circuits from remaining fixtures. Night lights to be connected to an emergency lighting source.

5.5.4. EMERGENCY LIGHTING

5.5.4.(1) Minimum Requirements

a) Sized for required runtime in accordance with NBCC.

b) All remote heads to be LED Type, minimum 4 W, but sized for the application.

c) Provide 24 VDC battery packs for all remote head fixtures and exit signage.

d) Centralize battery packs to reduce overall maintenance.

e) Coordinate lighting circuits with pack layouts to minimize lighting circuits that require monitoring by the battery pack.

f) For open areas (corridors, industrial occupancies, gymnasiums, etc.): Provide mini-inverter style battery packs, connected to the lighting circuit.

g) DC wiring to be minimum #10AWG and sized for no greater than 3% voltage drop at the furthest point.

h) Provide weatherproof remote heads to illuminate all exterior ramps and stairwells, and any contained exterior yards that form a means of egress from the building.

5.5.4.(2) Use of Battery Packs vs Generators

a) In group B-1 and B-2 occupancies, emergency lighting may be connected to the emergency generator.

b) For all other occupancies, provide separate emergency lighting unit equipment.

5.5.4.(3) Testing

a) Test emergency power to verify that emergency lighting is maintained for a period of:

i) 2 hours for a building within the scope of subsection 3.2.6 of the National Building Code.

ii) 2 hours within generator rooms, and at transfer switch equipment, and where exterior, portable generators are connected. 1 h for a buildingof Group B major occupancy classification not within the scope of subsection 3.2.6 of the National Building Code.

iii) 1 hour for a building constructed in accordance with article 3.2.2.50 or 3.2.2.58 of the National Building Code.

iv) 30 min for a building of any other occupancy.

v) Test emergency power to verify that emergency lighting is maintained for a duration as required for the occupancy type under the conditions of the National Building Code, or above requirements where National Building Code durations are exceeded.

5.5.5. EXIT SIGNS

5.5.5.(1) Minimum Requirements

a) Standard exit lighting: LED source, ISO standard pictogram exit signage (“Green running man”).

b) Coordinate signage types with architectural finishes.

c) For finished areas, use clear acrylic style (edge lit) exit signs.

d) For standard commercial/industrial, use thermoplastic type signage, and NEMA 3R or 4X where installed in service spaces, or shops.

e) Provide self-illuminating exit signs in hazardous and hard to wire locations.

f) Provide oversized exit signs for large shop areas and areas with visibility up to 50 meters (150').

i) Standard of acceptance, T&B LN10 series.

6. Miscellaneous Electrical Systems

6.1. LIGHTNING PROTECTION

6.1.1. For high value buildings, treatment and care facilities, facilities with sensitive equipment, post disaster buildings, and communications infrastructure, conduct a lightning assessment in accordance with CSA B72 – Code for Lighting Protection Systems.

6.1.2. Provide the results to the Yukon government during design, and prepare lightning protection designs upon request.

6.2. TRANSIENT VOLTAGE PROTECTION

6.2.1. SURGE SUPPRESSION

6.2.1.(1) Provide surge suppression for all new electrical services, at each distribution centre over 75 kVA, and panels that are provided for critical loads (such as IT and office equipment).

6.2.2. EQUIPMENT

6.2.2.(1) Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended.

6.2.2.(2) UL 1449 Voltage Protection Ratings (VPRs)

a) 208Y/120 V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.

b) 600Y/347 V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2,500 V for L-L mode.

6.2.2.(3) UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

6.2.2.(4) For service entrance locations

a) Minimum 120 kA per mode/240 kA per phase. Nominal discharge current rating of 20 kA. Rated for available fault current at the building.

b) Complete with contacts for monitoring by BMS system, audible alarm, and status indicator LED lights.

6.2.2.(5) For distribution locations

a) Minimum 80 kA per mode/120 kA per phase. Nominal discharge current rating of 20 kA. Rated for available fault current at the building.

b) Complete with contacts for monitoring by BMS system, audible alarm, and status indicator LED lights.

6.3. ACCEPTABLE VOLTAGES

6.3.1. Whenever possible equipment shall be selected to connect to available utility power or accepted Canadian voltages (120/240, 120/208, 347/600) without the need for additional transformation. Equipment for other voltages (277/480V) requires prior approval and shall only be selected if no alternative is available.

7. Communications

7.1. STRUCTURED WIRING SYSTEMS

7.1.1. GENERAL REQUIREMENTS

7.1.1.(1) All structured wiring systems are to be designed, installed and tested to a minimum Category 6 level.

7.1.1.(2) Do not separate structured wiring into voice/data. All structured wiring systems are to be treated the same.

7.1.1.(3) Label structured wiring ports as LANRM-Port#.

7.1.2. CABLING AND TERMINATIONS

7.1.2.(1) Provide all cabling and terminations to a Category 6 level.

7.1.2.(2) Category 3 riser cables are only permitted for provision of Centrex service between LAN rooms. Terminate on Category 5e patch panels.

7.1.2.(3) All cabling in accessible ceiling spaces are to be plenum rated, FT-6 minimum.

7.1.2.(4) Provide minimum 1-meter spare cable at outlets, and 3 meters of spare cable at head end.

7.1.2.(5) All free cabling to be in D-rings or cable trays.

7.1.2.(6) Cables to be gathered and fastened with Velcro straps, or approved for data cable rubber straps. Zip ties are not acceptable.

7.1.3. EQUIPMENT RACKS

7.1.3.(1) Provide equipment racks during as part of construction contract.

7.1.3.(2) Provide anchorage and seismic restraint.

7.1.3.(3) All racks to be keyed alike, and keyed to Government of Yukon requirements.

7.1.3.(4) Primary LAN room racks: required for servers, backup/archiving, p/a and sound equipment.

a) Minimum 1070 mm deep, 765 wide (double depth).

b) Seismically rated rack enclosures with power management.

c) Standard of acceptance: Hammond Manufacturing NEBS Telcordia Certified Zone 4 Seismic Cabinet.

7.1.3.(5) Secondary LAN room racks: required for switches patch panels, small rack-mount UPS systems.

a) Minimum 765 wide, 765 deep.

b) Standard of acceptance: Hammond Manufacturing Economy Server Cabinet RB-DC Series.

7.1.4. LAN ROOMS

7.1.4.(1) LAN rooms are to be sized for minimum 1 meter working clearance on front and back of racks.

7.1.4.(2) Provide 19 mm G1S plywood backing on all four walls, to a height of 2.4 meters. Paint backboards with fire retardant grey paint.

7.1.4.(3) Provide grounding bus in each LAN room, minimum 6 x 50 x 300 mm, double drilled and mounted on insulated standoffs. Make connections to racks, and cable tray using minimum #6 AWG green bond conductor. Make connections to conduit using minimum #10 AWG green insulated bond. Connect to main distribution bar.

7.1.4.(4) Provide a minimum of two service receptacles, opposite to each other for service equipment and tools.

7.1.4.(5) Provide LAN rooms with basket style cable tray, sized for 150% of the cable used in that specific LAN room.

7.1.4.(6) Basket cable tray to be run around perimeter of the room, with one section running across all cabinets.

7.1.4.(7) Provide ceiling or wall mounted plugs for UPS equipment. Minimum L5-30 receptacles, with dedicated circuits. Minimum #8 AWG wiring. Coordinate with Yukon government requirements.

7.1.4.(8) Coordinate cooling requirements with mechanical engineer. Assume that server equipment will require cooling loads, equal to the electrical ratings of the equipment.

7.2. TELEPHONE AND DATA SYSTEMS

7.2.1. All structured wiring within the building to be modular, plug-and-play, and interchangeable between voice and data applications.

7.2.2. VOIP switches are to be provided with UPS backup to operate phone systems for 2 hours during a power fail.

7.2.3. UPS to cover, but not limited to, related modems, LAN racks, switches, and routers.

7.3. DISTRIBUTED COMMUNICATIONS AND MONITORING

7.3.1. PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS

7.3.1.(1) Provide public address and mass notification systems in all health care facilities, schools, convention centres, major air terminal buildings, arenas and sports complexes.

7.3.2. SOUND MASKING SYSTEMS

7.3.2.(1) Provide sound masking systems in all open office workstation areas.

7.3.3. INTERNAL CELLULAR, PAGING AND ANTENNA SYSTEMS

7.3.3.(1) Access to reliable cellular signals is becoming more important, since landlines (and payphones) are becoming less prominent in buildings. As such, Government of Yukon requires reliable cellular service within its buildings.

7.3.3.(2) Coordinate with serving cellular utilities for provision of internal antennas where conditions dictate.

7.3.3.(3) For small buildings, provide cellular amplifier antennas.

a) Standard of acceptance: weBoost or equivalent.

8. Electronic Safety and Security

Refer to Government of Yukon Security System Specifications and Design Guidelines for additional requirements.

8.1. ACCESS CONTROL AND INTRUSION DETECTION

8.1.1. ACCESS CONTROL

8.1.1.(1) Provide access control for all buildings accessed by the public, and for buildings containing 20 or more full-time occupants.

8.1.1.(2) Access control to consist of electronic access passes (fobs or cards), card readers, door hardware and door access control system.

8.1.1.(3) System to be fully integrated and connected to a centralized security workstation at the Government of Yukon Main Administration Building.

8.1.1.(4) Access control to be designed to record events (enter/exit requests), as well as forced entry through REX detection.

8.1.1.(5) Provide system programming to Yukon government requirements. Allow for 1 fob per staff member, plus 25% spare.

8.1.1.(6) Connect to building management system to determine areas of occupancy or unoccupied areas. Armed and locked indicates no occupancy.

8.1.2. INTRUSION DETECTION

8.1.2.(1) Provide intrusion detection for all Yukon government buildings.

a) Standard of acceptance: DSC Security Products.

8.1.2.(2) For buildings with 24-hour access (hospitals, residences, etc.) intrusion detection is limited to service spaces, LAN rooms and medication storage rooms.

8.1.2.(3) Provide passive infrared sensor (PIR) detection within the space, and perimeter detection of exterior and secure doors and windows using position switches and glass break devices.

8.1.2.(4) Provide separate partitions based on the functional requirements, so that one area can remain locked, while others are open (this is particularly important for after-hours access, such as in schools).

8.1.2.(5) Zone areas accordingly for after-hours access.

8.1.2.(6) Make allowance for the physical separation of spaces in the architectural design.

8.1.2.(7) Provide a mechanical partition within the security panel, to allow for critical alarms to be passed to the alarm monitoring company. Refer to Chapter 5, Section 5 – Integrated Automation Facility Controls for list of critical alarms.

8.2. ELECTRONIC SURVEILLANCE

8.2.1. VIDEO SURVEILLANCE

8.2.1.(1) Where required by the functional program or where indicated by the Yukon government, provide networked video surveillance of the building to allow for local storage of video surveillance on the premises and within the building.

8.2.1.(2) Provide cameras for the following locations.

a) Parking areas.

b) Building exterior faces.

c) Building entrances/exits.

d) Areas where employees interact with the public (service counters, cash registers).

e) Loading and delivery areas.

f) Storage areas for high value or confidential items or files.

8.2.1.(3) Provide networked video surveillance of the building to allow for local storage of video surveillance on the premises and within the building.

a) Allow for a minimum of 30 days of on-site recording at high resolution.

b) Minimum camera quality to be 720p, 30 frames per second.

8.2.1.(4) Provide a client workstation to be suitable for searching, reviewing and exporting video footage.

8.2.1.(5) All cameras to be IP based, and capable of being ported through building LAN equipment.

8.2.1.(6) Select camera type based upon location and application.

a) Provide IR sensing, low light cameras for exterior locations.

b) In large open parking lots, outside schools, or high value installations, provide IR source lights, for improved visibility of IR cameras.

8.2.1.(7) During design, work with the Government of Yukon on providing documentation to or attending coordinat on meetings with the Government

of Yukon Privacy Commission staff as required to review the orientation of cameras, and to identify any areas of the camera coverage that require masking to protect sensitive information or personal privacy.

8.3. PERSONAL PROTECTION

8.3.1. PANIC ALARMS

8.3.1.(1) Where required by the functional program or where requested by the Yukon government, provide a panic alarm system for staff safety.

8.3.1.(2) Locations that should be considered are areas where staff work in high risk environments (group home, detox, prisons, Group B-1 occupancies), work alone for periods of a time, where staff are regularly engaging with the public, in a sales or regulatory capacity, or where staff regularly work after hours.

8.3.1.(3) Panic alarm system to consist of the following.

a) Master station to visually indicate origin of call via flashing light.

b) Audible intermittent signal on master station and interior horn when push button is activated.

c) When master station goes into alarm, audible intermittent signal on master station and interior horn shall sound and a signal shall activate the auto-dialer and, where included in the project, exterior strobe and exterior horn.

d) System can only be reset from master station.

e) Alarm system to include red push buttons with locking action.

f) Alarm to be connected to a programmable voice dialer that will call local numbers, provided by owner.

g) Where deemed appropriate by the project and occupant needs, consider a system with silent trigger and latching alarm condition.

h) Provide additional wireless pendants where staff regularly travel throughout a facility.

8.4. DETECTION AND ALARMS

8.4.1. FIRE DETECTION AND ALARMS

8.4.1.(1) The standard of acceptance for all fire alarm components is as follows.

a) Fire alarm control panel: Notifier NFS or Advanced AXIS series.

i) Complete with 24 DC power supply, supervisory circuit, alarm initiating circuit(s) and alarm indicating circuit(s), trouble circuit(s) and auxiliary alarm and trouble relays.

b) Remote annunciator: Notifier LCD80 series.

i) Wired in class A configuration to the main FACP.

ii) LCD or LED type, capable of annunciating 3 or more zones simultaneously. With matching recessed or surface box to meet application.

iii) To CAN/ULC-S527.

c) Smoke detectors

i) Photoelectric type for general applications.

ii) Multi-Criteria detectors shall only be installed in areas where required by code or AHJ. All other areas shall have single criteria detectors only.

iii) Duct type where required.

iv) to CAN/ULC-S529.

d) Pull stations
   i) Single or Two Stage as required.
   ii) Provide covers for gymnasiums, shops, or where otherwise subject to physical damage or abuse.
   iii) To CAN/ULC-S528.

e) Horn, horn/strobe, strobe
   i) Wall or ceiling mount, red colour, unless otherwise approved by YG.
   ii) Field selectable Strobe CD ratings (15CD through 85CD), high output CD ratings as required.
   iii) To CAN/ULC-S525/526.

f) Suite buzzers
   i) Red or white in colour.
   ii) Provided with integral silencing means where required.
   iii) To CAN/ULC-S526.

g) Heat detector
   i) Rate of Rise (ROR) or Fixed Temperature (FT) Type to suit application.
   ii) High temperature rating for mechanical rooms and kitchens.
   iii) Fixed element type (non-restorable) only permitted for harsh locations. Provide 5% spares.
   iv) To CAN/ULC-S530.

h) Magnetic door holders
   i) ULC Listed. Style and type to YG approval.
   i) To be fixed type, with swing arm or swivel base. Chain type only acceptable on a case-by-case basis (Chain type hold opens tend to damage door and wall finishes).

i) Red Document box: Honeywell E002 key or approved equal.

j) Approved alternate manufactures: Simplex, Edwards and Mircom.

8.4.1.(2) Minimum Design Requirements

a) Provide detailed fire alarm device drawings, with locations of devices shown, initiating and annunciating zones listed, and all fire separations shown.

b) Coordinate with mechanical designs for the selection of duct detectors, and order suitable duct probes to suit the duct dimensions.

c) Locate duct detectors in accordance with CAN/ULC S524 requirements and allow for access and maintenance of the device. Provide access hatches as required. Consultant to provide duct detector locations on drawings, and list duct dimensions for correct ordering and review of probe lengths.
   i) Duct detectors to be tested operational using a differential pressure meter. Allow for relocation of the duct detector as required to suit site conditions.

d) Provide fire alarm connection to all ventilation units as required by the National Building Code.

e) Category 1 projects: Annunciator to be graphic LED type with location indicators.

f) Devices to be included in annunciator, but not limited to, with locations: Zone valves, sprinkler tree, gas valve, fire department connections, generator status, pre-action and isolation valves.

8.4.1.(3) Monitoring of Specialized Equipment, and Ancillary Devices in Support of Life Safety Systems

a) Provide monitoring of all equipment that impacts the fire alarm system, even if not specifically called for by the CAN/ULC documents, or the NBCC. Examples include:

i) Low temperature sensors located in sprinkler tree rooms, and locations where fire water is stored (supervisory to fire alarm panel).

ii) Water presence detection in sprinkler tree rooms (supervisory to fire alarm panel).

iii) Where electric fire pumps are provided, provide monitoring of the generator, the transfer switch (life safety branch), and the fuel supply. Report these items individually to the fire alarm panel as supervisory conditions.

iv) Low storage water condition (for sprinklered buildings), (supervisory to fire alarm panel).

v) Where heat trace is provided for water service entrance (sprinklered buildings), or for wet sprinkler piping in parking garages or other locations, (supervisory to fire alarm panel).

vi) Status of pre-action and/or clean agent release panels.

8.4.1.(4) Methods of Installation

a) Fire alarm wiring to be installed in AC-90, armored FAS Cable, for short drops (maximum 3 meters) to devices only or where fished into existing finished walls.

b) All remaining wiring to be installed in EMT.

c) For Category 3 buildings, AC90 and armoured FAS are permitted to be fished into walls and behind finished surfaces.

d) Wiring sizes shall be in accordance with manufacturer's recommendations.

e) Maintain separate conduit for each SLC circuit, NAC circuit, and power supply circuits.

8.4.1.(5) As-Built Requirements

a) Include the following (at minimum) for all fire alarm project as-builts.

i) All device locations, addresses and designations.

ii) Detailed conduit routing plans. Clearly identify each circuit.

iii) Locations of power supplies, control and monitoring modules.

iv) Location of isolation modules and known fire separations.

v) Size of duct detector probes, and orientation of sampling holes.

8.4.1.(6) Minimum Testing Requirements

a) Fire alarm verification will be completed as outlined in CAN-ULC-S537

b) Fire alarm verification services are to be as prescribed in the Yukon Government – Building Safety Advisory #4 – Verification of Fire Alarm Systems and Signals to a Municipal Fire Department.

c) For all Yukon government projects, only scenario #1 will be acceptable: 3 party verification process consisting of the Engineer of Record, the Contractor, and the fire alarm company technician.

d) The Engineer of Record is required to attend all fire alarm testing. The Engineer must be equipped to provide direction on site, and oversee both the technical aspects of the installation and testing, but also understand and interpret the required NBCC, NFC and CAN/ULCC standards.

8.4.1.(7) Visual Signal Devices

a) Provide visual signal devices for all YG buildings.

b) Design visual signal devices to the requirements of the NBCC and CAN/ULC S524, as though these areas are occupied by hearing impaired persons.

c) Provide a weatherproof signaling device on the exterior of the building, located at the fire fighters entrance (location of fire department connection and fire alarm annunciator). Location to be visible upon approach to the building.

8.4.1.(8) Provision for Monitoring

a) A ULC Certificate of Monitoring or other similar proof of monitoring acceptable to the Engineer, in accordance with CAN/ULC S561.

8.4.1.(9) Provision of ULC Certificates

a) Upon completion of the fire alarm installation, Contractor will arrange for verification of the fire alarm system in accordance with CAN/ULC-S537 and local building codes.

b) Contractor to provide the following to the Engineer.

i) Proof of liability insurance for the verification.

ii) A copy of the inspecting technician's report, including detailed verification of each fire alarm devices.

iii) Certificate of Verification: Certificate to be free from defining and qualified statements which would make it unacceptable by the owner.

iv) If requested or as otherwise required, system verification to be conducted in the presence of the Government of Yukon's representative.

v) Prior to end of warranty, provide first annual test and inspection as per CAN-ULC S536I by an independent, ULC listed company. This company must be a separate from the parties that conducted the initial installation/verification. Include issue of ULC certificate. Test should be fault free or corrected.

8.4.2. CARBON MONOXIDE DETECTION AND ALARMS

8.4.2.(1) Provide carbon monoxide alarm in rooms sharing an adjacent wall, floor, or ceiling with a service room containing a fuel fired appliance.

a) In Group B occupancies, this is to be integrated with the fire alarm panel.

b) In all other occupancies, this can be stand-alone, hardwired devices with battery backup. Interconnect between devices.

8.4.2.(2) For vehicle storage and maintenance areas: refer to mechanical sections.

8.4.3. LOW TEMPERATURE ALARMS

8.4.3.(1) Refer to Chapter 5, Section 5 – Integrated Automation Facility Controls.

8.4.4. WATER INTRUSION DETECTION AND ALARM

8.4.4.(1) Provide water intrusion detection at the following locations.

a) Floor drains in all crawl spaces.

b) Sprinkler tree rooms.

c) Locations where process water, or sanitary water is stored.

d) Incoming water service room.

8.4.4.(2) Monitor water detection by the BMS system. Provide discrete contact monitoring.

8.4.4.(3) Standard of acceptance: WaterBug.

7

Civil and Site Design Requirements

1. General Design Considerations

1.1. SITE DEVELOPMENT CONDITIONS

There are a great variety of site conditions in Yukon communities, including those found in different permafrost and soils types. Permafrost is a temperature description of the ground, being at or below zero degrees Celsius for at least two consecutive years. It does not describe the ground materials or soils, which may vary from bedrock and ice-free gravels, to ice rich soils and even ice. Permafrost may be continuous, discontinuous, sporadic, or isolated, generally depending on how far north the site is located.

Refer to Chapter 1 – General Project Requirements and Chapter 4 – Structural Design Requirements for additional requirements for geotechnical assessments and permafrost.

Reasonable development conditions include a site that:

- is well drained and not subject to periodic flooding;
- is not too steeply sloped;
- is not situated near unstable land forms such as the edge of a riverbank, or at the base of a potentially unstable hill;
- does not require excessive fill or levelling;
- has boundary dimensions suitable to accommodate the shape and size of the proposed building, with ample perimeter space around the proposed building for vehicle access on the property, and for any required utilities including wells and septic drainage fields, and any required utility setbacks;
- is zoned for the intended use, and the zoning requirements are not overly arduous to accommodate the building and site functional requirements;
- does not disrupt practical well-established community use patterns or create the need for access through a separate property;
- does not disrupt, or considers First Nations traditional uses;
- has access to municipal water or a well, and access to power and communications infrastructure;
- has soil which is receptive for septic drainage fields (where required); and
- has been tested for and does not include any soil contamination.

Sitework includes all work required to:

- prepare the site for building foundations;
- grade the site to promote drainage away from the foundation and to direct all surface drainage and roof drainage water to a suitable drainage course;
- provide access to the site and building during the construction phase, and for staff, visitors and services (pedestrian and vehicular traffic) once completed;
- provide sufficient on-site parking for all expected types of vehicles;
- create outdoor activity areas such as playgrounds;
- create suitable conditions for plant landscaping for use in microclimate control (such as snow drifting), building sun-shading, and aesthetics; and
- provide landforms for building security provisions (such as limiting public access to vulnerable building elements) or at building access points and entrances.

1.2. INSTALLATION CONDITIONS

1.2.1. SCHEDULE

In many northern communities, there is a very limited period of time when sitework can be completed. Buildings are often completed in the winter or spring, before the completion of seasonal siteworks. Temporary facilities providing vehicle and pedestrian access, and surface water control are necessary to allow the completed building to operate safely and economically until the siteworks are completed.

1.2.2. GRANULAR MATERIALS

Access to local granular fill is often limited in small communities. It is important to confirm access to nearby gravel sources during project development to reduce project costs.

1.2.3. LOCAL EQUIPMENT

Sitework should be designed to ensure work can be completed using equipment and operators which are locally available, especially in remote and fly-in communities.

1.3. MAINTENANCE CONDITIONS

1.3.1. SNOW MANAGEMENT

The long-term annual duration of snow cover, and the need to clear snow from portions of a developed site, are normal conditions in all Yukon communities. Any aspect of a site that does not function well when covered in snow does not function well for a large portion of the year.

Consideration is to be given to:

- how the snow is to be removed (typically by machine);
- minimum clearing width required (normally 1.6 m minimum);
- where removed snow will be placed and the snow drifting patterns and melt-water drainage in spring that may be affected or caused by storage location; and
- protection of building, vegetation and fixed site improvements from accidental impact damage caused by snow removal equipment.

1.3.2. SPRING AND MID-WINTER THAWS

In most Yukon communities the spring thaw occurs suddenly and some communities are experiencing more frequent short periods of mid-winter thaw. Surface water from melting snow and ice, both from the ground and from building run-off, must be diverted away from buildings and into effective drainage courses to avoid:

- flooding of tank rooms, crawl spaces and basements from surface water accumulation against foundation walls;
- water-permeable granular pads supporting building foundations becoming severely eroded by water seeping under or through the granular materials, resulting in soils consolidation, settlement and damage to the substructure;
- unsafe conditions around the building due to ice; and
- damage to building foundations due to freeze-thaw action.

1.3.3. PLANTED AREAS

Planted areas and planting materials are recommended to be selected for harsh northern climate conditions and minimal maintenance attention. Effective selection of plant materials can provide good surface water management, wind and water-based erosion control, shading from excessive sunlight, and protection from wind scouring and snow drifting.

Native northern plant species adapted to the local climate and environment are to be selected for tolerance to water stress. Plant species requiring additional regular irrigation to what is provided by the annual precipitation cycle are not recommended for use in site development. Lawns should be avoided unless required by the functional program due to their high maintenance requirements.

2. Site Preparation

2.1. FILL

Granular materials can be quarried from suitable local land sites or transported from a remote source and stockpiled near the community. Where local supplies have been identified, the contractor or the subcontractor must obtain permission to quarry from the appropriate authority:

- the territorial government (Transportation Engineering), or
- First Nations governments and/or their respective development corporations.

The Government of Yukon through Transportation Engineering, manages stockpiles of granular materials in some remote communities where commercial pits are not available. In this case, fill can be supplied to the contractor by the Yukon government. Quantities need to be estimated well in advance of construction (generally the summer preceding construction) to ensure availability. PMD typically coordinates with Transportation Engineering Branch and Transportation Maintenance Branch to determine availability and project timing.

Contractors are responsible for estimating quantities, testing, and quality control to suit the proposed use. If no Yukon government pit in the immediate area of the project site meets the specifications, the Contractor is responsible for obtaining and hauling material.

2.1.1. GRANULAR PADS

2.1.1.(1) All engineered granular pads to follow the recommendations of the project specific geotechnical report.

2.1.2. EXCAVATION

2.1.2.(1) All excavations to follow the recommendations of the geotechnical report.

2.2. GRADING

Although frozen for much of the year, building sites can be susceptible to significant damage during mid-winter or spring runoff or as a result of ponding or erosion and saturation by moving surface water.

2.2.1. FINISHED GRADES

2.2.1.(1) Provide elevations for all finished grades and surfaces to ensure there is sufficient detail for construction.

2.2.1.(2) Finished grades should have a minimum 4% slope away from the building for a minimum distance of 2 metres to obtain effective surface water drainage and disposal away from the building perimeter walls.

2.2.1.(3) Grading beyond 2 metres from the building should be designed to ensure water is not being directed back towards the building.

2.2.1.(4) Parking lots and walkways must not have grades more than 5% to maintain accessibility.

2.2.1.(5) Grades greater than 25% must be provided with erosion control measures, including revegetation seeding, plantings, or washed river rock. Retaining walls may also be considered where required.

2.2.2. DRAINAGE CHANNELS

Provide drainage channels or shallow ditches (swales) to manage initial drainage on sites as required. Coordinate with overall site storm water management approach.

3. Site Improvements

3.1. ROADWAYS AND PARKING LOTS

In many Yukon communities, there are no municipal physical requirements for parking or service vehicle access to buildings. Where these requirements are specified, they shall be incorporated in the design, but in general, requirements should consider the following.

- Vehicles commonly in use in the community may include cars, trucks, snowmobiles, all-terrain vehicles, or bicycles.
- Parking areas for building users may require exterior electrical outlets for vehicle heaters.
- Type and size of service (fire response, ambulance response, fuel, water and sewage) vehicles and personnel that must be able to approach and park their vehicles next to building entrances or connection points on the exterior of the building year-round, with minimal difficulty. This includes no obstruction by snow, standing water or steep slopes, and clear lines of sight to verify that the access route is safely clear of pedestrians.
- Building surfaces may require protection from vehicle impacts.

3.1.1. ROUTES AND PARKING

3.1.1.(1) Access routes and parking must accommodate the turning radius of local vehicles, including service vehicles and firefighting equipment. Simulation shall be performed for the major types of vehicles expected on site.

3.1.1.(2) Vehicle routes and parking areas on site should be clearly marked, using physical barriers that remain visible in winter conditions. This allows the control of vehicle traffic to protect pedestrians, landscaping, or buildings. Boulders, heavy timber barriers, concrete barrier, bollards, or fencing can all be considered.

3.1.1.(3) Provide adequate space for delivery vehicles to park when they are servicing a building.

3.1.1.(4) Parking for water delivery trucks should be graded and finished with appropriate surfacing to direct water away from the building in case of overflow.

3.1.2. PARKING STALLS

3.1.2.(1) Minimum dimensions for car or truck parking stall is 2.5 metres x 6 metres or as required by the municipality.

3.1.2.(2) Recommended sizes are generally larger, 3.0 metres x 7.0 metres for stipulated truck parking spaces.

3.1.2.(3) Provide accessible parking stall as per municipal and NBCC requirements. Recommended size is 3.9 metres x 6 metres. Accessible parking stalls must be located in close proximity to the main entrance, and must be identifiable year-round with signage.

3.1.2.(4) Minimum dimensions for an ATV or snowmobile parking stall are 2 metres x 2 meters. Drive-through parking spaces are recommended for snow machines.

3.1.2.(5) Locate parking stalls a minimum of 10 m away from building air intake louvers and consider prevailing winds.

3.1.2.(6) Vehicle wheel stops are required when no curbs are provided.

3.1.3. PLUGINS

Refer to Chapter 6 – Electrical Design Requirements.

3.1.3.(1) Plugins (including pedestal-style) are to be mounted on a minimum 950 mm high reinforced concrete or 140 mm x 140 mm PWF bollard to protect against impact damage from bumpers. Finished receptacles to be mounted at 1150 mm above grade to meet barrier-free requirements.

3.1.3.(2) If surface mounted, receptacles are to be mounted on the reverse face of the bollard facing away from the parking stall to protect from damage.

3.2. WALKWAYS, SIDEWALKS AND ACCESS

Buildings accessible to the public should be easily identifiable, with prominent, clearly visible entrances. All pathways, ramps and stairs leading to entrance ways should be easy to keep clear of snow and must also be protected from vehicle traffic.

3.2.1. WALKWAYS

3.2.1.(1) Minimum width for a walkway is 1.6 meters to allow for snow clearing and shall be clear of obstructions.

a) Walkway design shall accommodate the movement of snow clearing equipment, like skid steer. Turns and directional changes shall be navigable by this equipment. If necessary, the width may need to be increased to accommodate the equipment.

3.2.1.(2) Finished walkways should be provided, leading from the edge of the roadway and community walkway system and from all parking areas, to all regularly used building entrances.

3.2.1.(3) Surfaces should be well drained and finished with contained, finely crushed granular material, non-slip wood boardwalk, or pavement.

3.2.1.(4) Concrete, paving or grating surfaces should be considered at entrances to intercept dirt, gravel, and snow before it is tracked into the building.

3.2.1.(5) All walkways must be finished with non-slip materials.

3.2.1.(6) Avoid locating walkways immediately adjacent to building walls unless provided with a canopy, or where falling snow and ice from roofs is a potential safety hazard. Direct access to building facades can also result in increased vandalism where not visible from the street.

3.2.1.(7) Areas of granular fill materials leading to or from exits must be evenly graded for effective drainage and contained with wood, stone, concrete or metal retainer curbs.

3.2.1.(8) Design of cross falls should consider ice formation so that at driveway locations, cross falls should not be greater than at non-driveway locations.

3.2.1.(9) At road intersections, road pavement levels should be designed to avoid the ponding of water as this can create a pedestrian hazard when it freezes.

3.2.2. EXTERIOR RAMPS AND STAIRS

3.2.2.(1) All buildings to be provided with barrier-free access.

3.2.2.(2) Whenever possible, eliminate the need for ramps and stairs by grading the site.

3.2.2.(3) Grade elevation at building entrances should be as close to finished floor elevation as possible, while still providing effective water drainage away from building walls.

3.2.2.(4) One ramped path of travel to a building entrance is recommended instead of providing both stairs and a ramp. Wherever possible, a ramp with a straight run is recommended.

3.2.2.(5) Where the height requirement dictates that a ramp must be long enough to be returned upon itself through landings, then stairs are required in addition to the ramp.

3.2.2.(6) Provide access stairs and platforms wherever people must access fill/pump-out points or connect to services located more than 1.5 metres above ground level. Ladders or ships ladders are not acceptable due to the risk and injury potential.

3.2.2.(7) Low maintenance open metal or fibreglass grating is the preferred surface material for exterior ramps, stairs and landings where canopies are not provided. Gratings should meet the requirements of applicable codes and the referenced standards, including all barrier-free design requirements.

3.2.2.(8) Wood surfaces are acceptable for some pedestrian stairs and ramps, but surfaces must be made non-slip.

3.2.2.(9) Concrete stairs and ramps are acceptable where required by the project.

3.2.3. SNOWDRIFTING

3.2.3.(1) Locate building entrances where snowdrifts will not normally form. If there are none, find another means of reducing the snow accumulation, including the use of canopies.

3.2.3.(2) Avoid locating entrances and exits at the inside corners of buildings where prevailing winds will accumulate snow.

3.3. ATHLETIC, RECREATIONAL AND PLAYFIELD AREAS

3.3.1. ATHLETIC FIELDS

3.3.1.(1) All athletic fields to be irrigated.

3.3.2. PLAYGROUNDS

3.3.2.(1) Wooden components are not allowed in any play structures or playgrounds.

3.4. SITE DEVELOPMENT

3.4.1. FENCES AND GATES

3.4.1.(1) Wood fences are generally acceptable where they are used for screening andare visible to the public.

3.4.1.(2) Chain link fences are acceptable where larger areas require enclosure, or where additional security is required. In some instances, screened chain link fences are acceptable.

3.4.1.(3) Confirm site security requirements prior to developing fence designs and specifications.

3.4.1.(4) Provide screening around all garbage storage areas and as required by the municipality.

3.4.1.(5) Provide minimum 900 mm wide gates for pedestrian access, and 1200 mm wide gates for maintenance areas. Size gates to allow for sufficient space to move garbage containers and equipment in an out of the enclosure. Ensure that both snow removal and landscaping equipment can be moved in and out of fenced areas.

3.4.1.(6) Select gate hardware that provides long-term durability, particularly at gates, and provide security hardware as necessary.

3.4.2. SITE FURNISHINGS

3.4.2.(1) All exterior site furnishings are to be durable.

3.4.2.(2) Accepted materials include stainless steel, galvanized steel, powder-coated metal, painted metal (bollards only), recycled plastic lumber, and high-density paper composite. Wood is not recommended for long-term durability.

3.4.2.(3) All site furnishings must be secured and located so that they will not be damaged by vehicles and snow clearing.

3.4.2.(4) Site furnishings may include: benches, cluster seating (picnic tables), trash or recycling containers, bike racks and covered bike storage, bollards, and ash receptacles.

3.4.3. EXTERIOR SIGNAGE

Refer to Chapter 3 – Architectural Design Guidelines.

3.4.4. FLAGPOLES

Flagpoles are typically not required on projects and should only be included if requested by Government of Yukon. If they are required, the following requirements will apply.

3.4.4.(1) Height and spacing of flagpoles should be determined by the size of flag being used.

3.4.4.(2) The pole material should be 6063 T-6 aluminum with a clear anodized finish.

3.4.4.(3) Provide an internal halyard with a lock and door and a rotating trucking ball.

3.4.4.(4) Flagpoles shall be provided with a reinforced concrete foundation and a tilt base.

3.5. LANDSCAPING

A comprehensive landscaping plan is required to incorporate requirements noted in the sections above. Landscaping using lawns, however, is not usually a practical consideration in most of Yukon. Nonetheless, care needs to be taken in finishing sites around northern buildings for beneficial appearance, as well as for public safety and to control erosion.

3.5.1. EXISTING VEGETATION

Maintain as much existing mature boreal forest on site as possible and protect from vehicular traffic. Mature boreal forest is a natural asset in Yukon and takes a long time to grow. It should be maintained whenever possible.

Existing vegetation should be assessed for fire-smarting to mitigate the risk of forest fire. Fire smarting of any remaining vegetation on the site must be completed by the Contractor as part of the construction contract.

3.5.2. PLANTINGS

Any plant material added to the site must be hardy, suitable for the locality and require little or no maintenance. Transplanting of local species may be considered where an acceptable source can be found in the community.

3.5.3. SOIL

Generally, if soil or topsoil is required, it will need to be imported to the site. Most sites do not have a significant layer of topsoil that can be used. All soil must be provided with the necessary additives to achieve effective plant nutrition.

3.5.4. IRRIGATION

Permanent irrigation systems are recommended and are preferred over temporary irrigation when landscaping is installed. Where installed the following requirements apply.

3.5.4.(1) The irrigation system must be designed by a certified irrigation designer.

3.5.4.(2) Design irrigation system to minimize water waste including head spacing and spray patterns, watering times and length, head type, low-flow components, and re-use of rainwater.

3.5.4.(3) Design system to allow for access to draining and blow out points for winterizing the system.

3.5.4.(4) Provide irrigation vaults within irrigation system in planting beds or open areas to allow for access to system components.

3.5.4.(5) All irrigation equipment is to be commercial grade using HDPE or LDPE pipe.

3.5.4.(6) Provide PVC sleeves under all hard surfaces for distribution piping and control wire.

3.5.4.(7) Provide separate water meter for irrigation system.

3.5.4.(8) System to be designed to anticipate future expansion.

3.5.4.(9) System to be designed to irrigate turf, shrubs, and trees on different zones, and must consider microclimate.

4. Site Services and Utilities

With winter conditions lasting from six to eight months of the year in many Yukon communities, it is important that building service points are easily accessed by trucks and personnel and protected from snow and ice build-up. Municipal services (water and sanitary) in many communities outside of Whitehorse is by tanker truck and fuel is delivered exclusively by truck. Power and telephone are generally provided by overhead service distribution in communities, and by overhead and underground installations in Whitehorse.

Care must be taken to ensure earthwork digging on a developed site identifies buried utilities locations before digging. Broken underground pipes and wires take much longer to repair or replace in northern communities, where trades and materials may be located far away from the community. Interruption of power, fuel or water in winter, whether above ground or buried, can have negative consequences.

4.1. WATER UTILITIES

4.1.1. WATER UTILITIES

In communities which have a piped water distribution system, service connections will normally be made to the existing water main system. All work must be carried out in compliance with the servicing standards that are followed or administered by the municipality. Applications must be made to the appropriate authorities having jurisdiction for approval to install the service. Every community has either a Servicing Standards Manual or a set of set of servicing requirements which must be followed.

In communities which are on water delivery, the water storage and delivery system in the building must receive approval from Yukon Environmental Health Services.

4.1.2. WELLS

For buildings which must be supplied by a drilled well, it must be carried out in accordance with “Guidelines for Water Well Construction” by the Canadian Groundwater Association. If the water supply system will serve more than the equivalent of 15 service connections, it will require approval from Yukon Environmental Health Services, who administer the “Drinking Water Regulation”.

This regulation sets out the requirements for large public drinking water systems. The approval will address all infrastructure related to supply, treatment and distribution of potable water. The “Guidelines for Canadian Drinking Water Quality” are followed in assessing the level of water treatment required. A well source will require a “groundwater under the direct influence of surface water” (GUDI) assessment that must be carried out by a qualified Hydrogeological Consultant. The assessment must be carried out in

accordance with "Assessment Guideline for Well Water or Groundwater under the Direct Influence of Surface Water (GUDI)".

4.1.3. ABOVE GRADE DISTRIBUTION

In some cases, utilidors may be an appropriate method to convey liquids. General design considerations include the use of maintenance-free materials (i.e., galvanized steel, fibre-reinforced shotcrete), weather resistance, adequate foundation support, secure connections for physical and seismic resistance, ease of access for maintenance and inspection, pre-insulated water or sewage piping, and heat tracing as required.

4.1.4. FIRE PROTECTION

Provide required fire hydrants on the property as required by the design to meet municipal design requirements.

4.2. SANITARY SEWERAGE COLLECTION AND DISPOSAL

4.2.1. SANITARY SEWERAGE

In communities with a sanitary sewer collection system, connection will normally be made to the existing sewer system. As with the water service, all work must be carried out in compliance with the servicing standards that are administered or followed by the community. Approvals must be obtained from the appropriate authority having jurisdiction.

4.2.2. ON-SITE SEPTIC SYSTEMS

Where connection cannot be made to municipal sewage collection system, on-site treatment and disposal may be appropriate. The design of an on-site septic system must adhere to "Design Specifications for Sewage Disposal Systems – A Guide to Their Design and Maintenance". If the system will serve less than 50 persons, an "Application for a permit to install a sewage disposal system" must be submitted to Yukon Environmental Health Services who administer the "Sewage Disposal Systems Regulation". Depending on the size and complexity of the system, it may have to be designed and sealed by a qualified professional engineer registered in Yukon.

If the system will serve greater than 50 persons and there will be a direct or indirect discharge of wastewater into surface water or groundwater, a Type "B" Water License will be required under the *Yukon Waters Act*. Application for a Water License must be made to the Yukon Water Board and the system would normally have to be designed and sealed by a qualified engineer registered in the Yukon. In addition to a Water license, YESSAB screening may be required and is normally carried out in tandem with processing of the Water License application. The processing time for Water Licensing and YESSAB approval is generally lengthier than for Environmental Health approval and may take many months.

However, if there will not be any direct or indirect discharge of wastewater into surface water or groundwater, such as with a no-discharge lagoon system (i.e. evaporation pond), then it may be possible to obtain a permit from Environmental Health Services, even if it serves more than 50 persons.

Further clarification and details on obtaining approvals for on-site sewage disposal systems shall be obtained from Environmental Health Services and the Yukon Water Board.

The design and operational principles of on-site septic systems in the Yukon differ in a number of ways from conventional systems in other parts of Canada. Some of these differences are outlined as follows with some design considerations:

- Yukon's colder climate requires that drain fields be installed at greater depths than in southern Canada to prevent winter freezing problems. Because of this, the soil treatment and breakdown of organics occurs anaerobically for the most part. A minimum of 1.2 metres of earth cover is normally required, however the earth cover can be reduced if rigid insulation is installed over the field. In more northerly or colder communities, depending on ambient temperatures it may be necessary to design the drain field with greater than 1.2 metres of cover or with added insulation.
- In order to prevent freezing of drain lines, they are normally insulated, and depending on length of pipe runs and depth of bury, in some cases heat tracing may be necessary.

- Due to colder soil temperatures, septic tanks are usually insulated with sprayed foam material and in some cases, immersion heaters are appropriate to prevent freezing if the septic system will not be receiving sewage over winter periods. Tanks without insulation must have at least 1.2 meters of earth cover.
- All tanks must conform to the latest version of CSA- B66 “Design, material, and manufacturing requirements for prefabricated septic tanks and sewage holding tanks”.
- The siphon flush volume or pump discharge volume should be sized to allow for the effluent to reach all areas of the bed with each cycle.
- In order to help protect the drain field from clogging from solids, effluent filters are recommended at the outlet of the septic tank.
- The drain field must be designed and sized according to Environmental Health Guidelines. A conservative design and/or safety factor in sizing is recommended to allow for unknowns which can arise due to increased future organic loading or inaccuracies in determining the soil rating etc.
- During the site planning stage, it is recommended that an additional area be identified for a future replacement drain field, should the current one fail.

4.2.3. SEWAGE HOLDING TANKS

A sewage holding tank may be an appropriate method of handling sanitary sewage in some cases and requires a permit from Yukon Environmental Health Services. However, in order to obtain approval for a holding tank, it must be proved that an on-site septic system cannot be designed to comply with requirements in the Design Specifications assuming a conventional gravity system. For example, holding tanks may be approved where permafrost prohibits the use of in-ground disposal and/or where there are space limitations.

4.2.4. ABOVE GRADE DISTRIBUTION

Refer to Sub-Section 4.1.3.

4.3. STORM DRAINAGE UTILITIES

4.3.1. STORM DRAINAGE UTILITIES

Storm drainage facilities must be designed using best practices. In Whitehorse municipal storm drainage utilities are available but require approval for building connections.

4.3.2. SITE STORMWATER MANAGEMENT

An on-site disposal system for storm water must be designed to handle at least a 1-in-50-year storm without causing damage to any site infrastructure. The design of an in-ground disposal system must be supported by soils information demonstrating that the system will adequately disperse the storm water at the storm design flow rate. The design must be carried out by an engineer registered in Yukon using best practices.

4.4. SITE ENERGY AND FUEL DISTRIBUTION

4.4.1. CENTRAL ENERGY PLANTS

4.4.1.(1) Central heating and cooling plants shall be designed and operated in accordance with the relevant sections of this manual.

4.4.1.(2) Where central plants service more than one building and may experience large load swings, the system shall be designed with sufficient turndown and controls to manage and balance varying loads.

4.4.1.(3) Review opportunities for expansion to adjacent buildings and design with allowances for future. Provide additional capacity, allowances for addition connections to distribution piping, and providing space for additional equipment when doing so would not compromise the operation of the facility.

4.4.1.(4) Coordinate the location of the facility to minimize distribution piping, to facilitate fuel delivery and servicing, and maximize the use of the central plant were possible.

4.4.1.(5) Provide allowances for control wiring to be run between central plants and the building they serve. Provide buried conduit to allow control wiring.

4.4.1.(6) Provide dedicated branch isolation on distribution piping such that each loop or facility can be isolated without affecting the operation of other systems.

4.4.2. BELOW GRADE DISTRIBUTION

4.4.2.(1) Where below grade piping is required to convey fluid for the purpose of heating, cooling or fuel transfer it shall be listed for underground use.

4.4.2.(2) Piping shall be bedded in screened stone or sand and backfill shall be free of debris and in conformance with Part 7, Section 2 - Site Preparation. Maintain a suitable depth of cover to provide insulation and mechanical protection. Provide additional protection, such as culverts, when crossing areas with heavy loading such as roadways.

4.4.2.(3) Piping shall be insulated to suit the application. Insulation shall be closed cell and provided with a watertight jacket listed for use below grade. All materials shall be corrosion resistant. Where the potential for freezing exists, provide heat trace or other approved method of ensuring piping is protected. In permafrost applications, a fusion collar assembly should be provided.

a) Standard of acceptance: Urecon UIP piping.

4.4.2.(4) In heating and cooling applications, consider the effects of thermal expansion and provide allowances for movement through the use of expansion joints or offsets in piping. Designs shall account for anticipated expansion with consideration to temperatures, material properties and lengths.

4.4.2.(5) Where possible, avoid the use of buried joints in piping systems. If joints or valves are required provide access vaults such that a failure can be accessed and repaired.

4.4.2.(6) Where failure of the piping would result in environmental concerns, such as hydrocarbon distribution, double wall piping systems shall be used in accordance with the relevant installation standards. Provide transition sumps and access point with leak alarms as required to ensure potential fuel leaks are contained and alarmed.

4.4.2.(7) Maintain sufficient clearances to adjacent structures or infrastructure to avoid disturbing foundations and prevent unnecessary loading on piping.

4.4.2.(8) Utilize common trenches for services where minimum separation distances would not result in excessively large excavations.

4.4.2.(9) In areas where permafrost is present and the installation of below grade distribution would result in permafrost degradation, such as district heating applications, distribution system shall be above grade to prevent damage caused by settling.

4.4.3. ABOVE GRADE DISTRIBUTION

4.4.3.(1) Piping shall be well supported and protected against mechanical damage. Provide ice guards when overhead hazard exists or vehicle protection in area subject to vehicle traffic. Support structures shall be well anchored and shall resist seismic, wind or snow loading in accordance with Part 4 of the NBCC.

4.4.3.(2) Piping shall be protected against corrosion and UV damage through the use of paint or protective coatings.

4.4.3.(3) Provide allowances for differential movement between adjoining structures through the use of flexible connections or piping.

4.4.3.(4) Piping not required to be concealed or insulated should be run to facilitate a visual inspection.

4.4.3.(5) Distribution lines conveying liquids that may be subject to freezing shall be run below grade unless it can be demonstrated that sufficient protection can be provided in an energy efficient way.

4.5. ELECTRICAL SITE IMPROVEMENTS

Also refer to Chapter 6 – Electrical Design Requirements.

4.5.1. SHALLOW UTILITIES

4.5.1.(1) Above and Below Grade Servicing

a) The selection of above ground, or buried service entrance distribution varies by site, and by availability from the utility. For Yukon government buildings, bias should be towards buried services wherever possible, to reduce maintenance required for overhead infrastructure, to reduce the change of damage by graders and other heavy vehicles, and to improve the access and aesthetic of the site.

b) In permafrost regions, the use of cable or conduit below grade requires careful consideration and site preparation. Use of proper design methods, bedding materials (frost stable), and cable/conduit type is required. Consider access and availability of fill and bedding material, trenching equipment, and compaction equipment, particularly in small communities.

c) Where pole risers are used, always assume that these may be subject to vehicle damage. The use of ATV or snow machine, or snow clearing equipment, is common, and designers should assume that these vehicles will not follow established paths.

d) Site services should be buried to a depth of 1 meter. Other shallow utilities, such as parking plugs, lighting, can be buried to CEC minimums. Assume that site grading can change with time, and with snow removal or regrading of gravel parking lots.

e) Buried services are often subject to flooding, due to freshet, and spring thaw. Between the months of March to June, it is common for the snow to melt, but the ground to remain frozen. This allows water to collect in vaults and other entrances to buried distribution. Avoid placing service entrance equipment below grade (where water from outside could enter distribution). Also, assume that conduit can flood seasonally, and they may remain frozen until June.

f) Buried distribution should be grouped where possible, and set back from mechanical and civil deep utilities to allow for maintenance. Where required to cross, cross perpendicular to deep services to allow for ease of excavation and shoring.

4.5.1.(2) Use of RPVC, DB2 Conduit

a) The use of PVC conduit requires attention to expansion and contraction coefficients above ground, and appropriate expansion joints are required. Below ground, PVC conduit can often shift or settle.

b) When passing through footing walls, or across varying ground conditions, consider sleeving conduit with steel.

c) Generally, DB2 conduit it not acceptable for service entrance use.

4.5.2. SITE ELECTRICAL DISTRIBUTION

4.5.2.(1) Electrical Utilities

4.5.2.(2) Power distribution is provided by two utilities in the Yukon.

a) ATCO Electric Yukon (formerly Yukon Electric)

i) Whitehorse
ii) Haines Junction
iii) Old Crow *
iv) Teslin
v) Tagish
vi) Carcross
vii) Watson Lake *
viii) Beaver creek *
ix) Destruction Bay *
x) Burwash Landing *
xi) Swift River *
xii) Ross River
xiii) Keno Hill
xiv) Stewart Crossing
xv) Pelly Crossing

b) Yukon Energy

i) Dawson City
ii) Mayo
iii) Elsa
iv) Faro

4.5.2.(3) In each of the communities, the availability of power can be limited by existingdistribution, voltage and phase available, and the availability of maintenance and servicing. It is common for the serving utility to provide a set voltage or transformer size, based on the availability of spares. Likewise, pad mounttransformers are not available in some communities.

4.5.2.(4) Communities marked by (*) are generator driven communities, and are not connected to the main distribution grid. In these communities, designers should expect the quality of power to fluctuate from time to time. Generator communities do not permit the use of electric heating, and significant loads can be rejected by the supply authority.

4.5.2.(5) Secondary Sales Service

The power utilities offer a secondary sales power program, which allows customers to purchase surplus power at a reduced rate. The program is eligible for customers who have a primary heating or process system that does not operate on electricity as a primary heating source.

A second utility service is required, complete with metering, RTU and contactor that is controlled by the utility. When surplus hydroelectricity is available, the utility activates the service remotely, allowing electric boilers, or process equipment to function. When the power is not available, or when communication fails, the secondary sales service is turned off automatically.

The availability of secondary sales is not guaranteed, can vary from year to year, and depends on the amount of water reserve, and customer demand.

4.5.3. SITE LIGHTING

4.5.3.(1) Site lighting should be designed to complement the site, provide safety, and accommodate multiple user groups and schedules.

4.5.3.(2) Reduce light pollution wherever possible, through the use of appropriate fixtures, glare control, and positioning. Use low level lighting where possible, to reduce the overall required lighting intensity.

4.5.3.(3) Fixture heights must match the aesthetic of the building, and generally should be no taller than ½ the height of the building in question, and no taller than 18', subject to good lighting design practice. Exceptions may be made for grader stations where taller lighting may reduce the chance of impact by machinery.

4.5.3.(4) Exterior lighting intensities should be designed to IES required levels.

4.5.3.(5) During winter months, snow covered ground creates reflectance which can contributed to light pollution. It is therefore important to employ lighting control systems that can reduce the overall light levels aggressively. Exterior lighting control should be zoned to separate essential lighting from non-essential, and non-essential from lighting that can simply be turned off during certain hours.

4.5.3.(6) For buildings equipped with an integrated lighting control system, exterior lighting must respond to occupancy, through motion control, or intelligent occupancy detection via CCTV cameras or security systems.

4.6. SITE COMMUNICATIONS

Also refer to Chapter 6 – Electrical Design Requirements.

4.6.1. TELEPHONE AND INTERNET

Telephone and cable television services are provided by Northwestel in Yukon. Generally speaking, these services can be run in the same conduit.

Cellular telephone and data services are provided by several carriers: Bell, Telus, Virgin.

4.6.1.(1) Telephone Service

Most areas of Yukon relies on copper networks; however, this is changing in some cases where copper service is being upgraded to coax telephone service.

Cellular reception is available in most Yukon communities.

The Government of Yukon generally uses Centrex style phone service, though some departments favor phone switches and common lines.

Generally, the trend is heading towards IP based phone switches. At this time, all YG buildings should be equipped for IP based phone switches. Where copper

service is available, confirm with the YG project manager, and provide sufficient copper pairs to service Centrex style telephone service.

4.6.1.(2) Internet

Internet in Yukon ranges widely in speed and service quality. Data usage caps and overage rates apply to all internet service in Yukon.

Internet within Whitehorse is generally by coaxial cable or fibre service, with speeds between 150 and 300 Mbps commonly available. Outside of larger communities' speeds can range as low as 5 Mbps or lower for ADSL service.

Consideration should be paid to how the quality of internet service impacts remote monitoring of systems, such as CCTV or other high-bandwidth applications. A remote desktop application for example, may be more suitable than transmitting significant data remotely.

4.6.1.(3) Considerations for Servicing

Communications services should be run separate from civil or mechanical deep services, and should be physically separated from buried power services where possible. Utility services are generally overhead, or provided into a utility owned pedestal.

In some cases, Northwestel may provide materials such as conduit to be used for servicing commercial buildings. Provide at least one 4" conduit to be used for servicing, owned by YG, (materials and installation) even if left as spare.

4.6.2. FIBRE-OPTIC CABLE

4.6.2.(1) Fibre-optic service is currently limited to specific areas in downtown Whitehorse.

4.6.2.(2) In some areas of Whitehorse, limited YG-owned fibre is also available for connection. Preference would be to connect to these services if available.

4.6.2.(3) Where specified as part of the project, fibre cable should be pre-terminated with connectors, tested prior to installation and following installation. Coordinate connector style, single-mode or multi-mode with YG information services.

4.6.2.(4) Fibre used for exterior services to be provided with sheath rated for exterior use (water proof and UV rated), with integrated tracer.

4.6.2.(5) Conduit for fibre to be oversized to accommodate bend radius of cable, as well as pulling pre-terminated ends.

4.6.2.(6) Conduit for fibre is to be dedicated for that use, to eliminate the possibility of future services being pulled over top.

4.6.3. SATELLITE COMMUNICATIONS AND TELEVISION

4.6.3.(1) Satellite communications are still used in specific applications and remote camps.

4.6.3.(2) Provide surge suppression on communications cabling, prior to entering the building. Size communications cable to mitigate losses on analog systems.

4.6.3.(3) Satellite television typically requires two runs of coax cable to provide HD reception. Make allowances in conduit installation to allow for multiple runs of coax, to accommodate up to two separate dishes.

4.6.3.(4) Oversize communications conduit bending radius on larger cables.

4.6.3.(5) Provide weather heads under gable ends where possible.

4.6.3.(6) Provide grounding point on exterior of building to accommodate surge arresters.

4.6.3.(7) Generally speaking, satellite dishes are southward facing.

8

Construction General Requirements

SPEC DESCRIPTION*: Use this Section to specify administrative and procedural requirements for various types of project meetings.*

The amount of detail required to adequately and appropriately specify "Project Meetings" is a variable, depending on project size and complexity. This Section is appropriate for projects of medium to large size and complexity. This Section is not appropriate for small, simple projects, where the requirements for project meetings can easily be reduced to a single paragraph elsewhere in Division 01. Conversely a very complex project or a project involving work in an occupied facility may require additional details or meetings.

Part 1 General

1.1 ADMINISTRATIVE

.1 Schedule and administer project meetings throughout the progress of the work at the call of the Consultant and Owner.

.2 Prepare agenda for meetings.

.3 Distribute written notice of each meeting five working days in advance of meeting date to Consultant and Owner.

.4 Provide physical space and make arrangements for meetings.

.5 Preside at meetings.

.6 Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.

.7 Reproduce and distribute copies of minutes within three working days after meetings and transmit to meeting participants, affected parties not in attendance, Consultant, and Owner.

.8 Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

1.2 PRECONSTRUCTION MEETING

.1 Within 15 working days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.

.2 Owner, Consultant, Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.

.3 Establish time and location of meeting and notify parties concerned minimum 5 working days before meeting.

.4 Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.

.5 Agenda to include:

.1 Introduction of Owner’s and Contractor’s representatives.

.2 Code of conduct for the place of the Work.

.3 Appointment of official representative of participants in the Work.

.4 Status of permits, fees and requirements of the Authority Having Jurisdiction.

.5 Schedule of Work: in accordance with Section [01 32 16 - Construction Progress Schedule].

.6 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section [01 33 00- Submittal Procedures].

.7 Schedule for progress meetings.

.8 Requirements for notification for reviews. Allow a minimum of [48] hours' notice to Consultant for review of the Work.

.9 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section [01 52 00- Construction Facilities].

.10 Delivery schedule of specified equipment in accordance with Section [_____]

.11 Site security in accordance with Section [01 56 00- Temporary Barriers and Enclosures].

.12 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.

.13 Owner provided products.

.14 Requirements for firestopping.

.15 Record drawings in accordance with Section [01 33 00- Submittal Procedures].

.16 Commissioning requirements.

.17 Maintenance manuals in accordance with Section [01 78 00- Closeout Submittals].

.18 Take-over procedures, acceptance, warranties in accordance with [Section 01 78 00- Closeout Submittals].

.19 Monthly progress claims, administrative procedures, photographs, hold backs.

.20 Appointment of inspection and testing agencies or firms.

.21 Insurances, transcript of policies.

.22 Contractor's safety procedures and clearance letters.

1.3 PROGRESS MEETINGS

.1 During course of Work schedule progress meetings as directed by the Consultant.

.2 Contractor, Contractor's site superintendent(s), major Subcontractors involved in Work, Consultant and Owner are to be in attendance.

.3 Frequency: Every [two weeks], or as otherwise directed by the Owner.

.4 Location: Contractor's site office, or other location agreed to between the Owner and Contractor.

.5 Agenda to include the following:

.1 Review, approval of minutes of previous meeting.

.2 Review of Work progress since previous meeting.

.3 Field observations, problems, conflicts.

.4 Problems which impede construction schedule.

.5 Review of off-site fabrication delivery schedules.

.6 Corrective measures and procedures to regain projected schedule.

.7 Revision to construction schedule.

.8 Progress schedule, during succeeding work period.

.9 Review submittal schedules: expedite as required.

.10 Maintenance of quality standards.

.11 Review of Contract modifications and interpretations for affect on construction schedule and on completion date.

.12 Review of commissioning pre-facility start-up progress and form preparation.

.13 Other business.

1.4 COMMISSIONING PROGRESS MEETINGS

.1 During commissioning and facility start-up, schedule commissioning progress meetings every 2 weeks.

.2 Contractor, Contractor's site superintendent(s), major Subcontractors involved in Work, Commissioning Agent, Consultant and Owner are to be in attendance.

.3 Location: Contractor's site office, or other location agreed to between the Owner and Contractor.

.4 Agenda to include the following:

.1 Review, approval of minutes of previous meeting.

.2 Review of Commissioning progress since previous meeting.

.3 Identification of problems impeding progress towards achievement of Commissioning (Facility Start Up) milestones.

.4 Review of outstanding Contract Deficiencies.

.5 Review of Contract modifications and interpretations.

.6 Other business.

1.5 PRE-TAKEOVER MEETING

.1 A minimum of 10 working days prior to application for Substantial Performance, schedule a pre-takeover meeting.

.2 Contractor, Contractor's site superintendent(s), major Subcontractors involved in Work, Consultant and Owner are to be in attendance.

.3 Agenda to include the following:

.1 Review, approval of minutes of previous meeting.

.2 Review of procedures for Substantial Performance, Total Performance, and handover of the Work.

.3 Field observations, problems, conflicts.

.4 Review of Contract modifications and interpretations for affect on construction schedule and on completion date.

.5 Problems which impede Substantial Performance of the Work.

.6 Review of procedures for deficiency reviews and corrective measures.

.7 Review of arrangement for building services.

.8 Progress schedule, during succeeding work period.

.9 Review submittal requirements for close-out submittals, all demonstrations and documentation required for Substantial Performance.

.10 Review of keying and hardware requirements.

.11 Review of status of as-built documents.

.12 Status of commissioning and training.

.13 Review of Contractor's deficiency list and status.

.14 Cleaning for occupancy.

.15 Demobilization.

.16 Other business.

1.6 POST CONSTRUCTION MEETING

.1 Prior to application for Total Performance, schedule a post-construction meeting.

.2 Agenda to include the following:

.1 Review, approval of minutes of previous meeting.

.2 Confirmation of completion of the Contract, and handover of reviewed documentation from the Consultant to the Owner.

.3 Confirmation of completion of Contract modifications.

.4 Problems which impede Total Performance of the Work.

.5 Identification of unresolved issues or potential warranty problems.

.6 Confirmation of completion of deficiencies.

.7 Corrective measures required.

.8 Confirm submittal requirements for Closeout submittals and Total Performance are in order.

.9 Review of procedures for communication during post-construction period.

.10 Handover of record documents by the Consultant to the Owner.

.11 Handover of Contract completion insurance policy transcripts to the Owner.

.12 Submission of final application for payment.

.13 Review and finalize outstanding claims, pricing, and allowance amounts.

.14 Status of commissioning and training.

.15 Demobilization and restoration.

.16 Other business.

1.7 WARRANTY MEETINGS

.1 Owner reserves the right to require meetings during the warranty period to review Contract deficiencies, to determine action required for their correction, and to monitor progress of corrections related to previously identified Contract deficiencies.

.2 Contractor, affected Subcontractors, Consultant and Owner are to be in attendance.

1.8 SPECIAL MEETINGS

.1 Owner and/or Consultant reserve the right to require special meeting which may be held on short notice and at which the attendance by the Contractor and representative of the affected Subcontractors and Suppliers is mandatory.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

.1 Activity: element of Work performed during course of Project. Activity normally has expected duration, and expected cost and expected resource requirements. Activities can be subdivided into tasks.

.2 Bar Chart (GANTT Chart): graphic display of schedule-related information.

.1 In typical bar chart, activities or other Project elements are listed down left side of chart, dates are shown across top, and activity durations are shown as date-placed horizontal bars.

.2 Bar Chart should be derived from commercially available computerized project management system.

.3 Baseline: original approved plan (for project, work package, or activity), plus or minus approved scope changes.

.4 Critical Path: sequence of activities that represents longest path through a project, which determines shortest possible duration.

.5 Critical Path Activity: activity on critical path in a project schedule.

.6 Critical Path Method (CPM): method used to estimate minimum project duration and determine amount of scheduling flexibility on logical network of paths within schedule model.

.7 Construction Work Week: Monday to Friday, inclusive, will provide five-day work week and define schedule calendar working days as part of Bar (GANTT) Chart submission.

.8 Duration: number of work periods (not including holidays or other nonworking periods) required to complete activity or other project element.

.1 Usually expressed as workdays or workweeks.

.9 Master Schedule: summary-level schedule that identifies major activities and key schedule milestones.

.10 Milestone: significant event in project, usually completion of major deliverable.

.11 Non-Critical Activities: activities which when delayed, do not affect specified Contract duration.

.12 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must be accomplished to satisfy Project objectives. Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout project life cycle.

.13 Project Planning, Monitoring and Control System: overall system operated by Owner to enable monitoring of project work in relation to established milestones.

1.2 REQUIREMENTS

.1 Ensure Master Plan and Detail Schedules are practical and remain within specified Contract duration.

.2 Plan to complete Work in accordance with prescribed milestones and time frame.

.3 Limit activity durations to maximum of approximately 10 working days, to allow for progress reporting.

.4 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Interim Certificate and Final Certificate as defined times of completion are of essence of this contract.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section [01 33 00- Submittal Procedures].

.2 Submit Master Plan to Consultant within 5 working days of Contract Award.

.3 Submit Project Schedule to Consultant within 5 working days of receipt of acceptance of Master Plan.

1.4 PROJECT MILESTONES

.1 Project milestones form interim targets for Project Schedule.

.1 Excavation completed within [_____]

.2 Substructure completed within [_____]

.3 Superstructure completed within [_____]

.4 Building closed-in and weatherproofed within [_____]

.5 Interior finishing and fitting, mechanical, and electrical work completed within [_____]

.6 Interim Certificate (Substantial Completion) within [_____]

1.5 MASTER PLAN

.1 Structure schedule to allow orderly planning, organizing and execution of Work as Bar Chart (GANTT).

.2 Consultant will review and return revised schedules within 5 working days.

.3 Revise impractical schedule and resubmit within 5 working days.

.4 Accepted revised schedule will become Master Plan and be used as baseline for updates.

1.6 PROJECT SCHEDULE

.1 Develop detailed Project Schedule derived from Master Plan.

.2 Ensure detailed Project Schedule includes as minimum milestone and activity types as follows:

.1 Award.

.2 Shop Drawings, Samples.

.3 Permits.

.4 Mobilization.

.5 Excavation.

.6 Backfill.

.7 Building footings.

.8 Slab on grade.

.9 Structural Steel.

.10 Siding and Roofing.

.11 Interior Architecture (Walls, Floors and Ceiling).

.12 Plumbing.

.13 Lighting.

.14 Electrical.

.15 Piping.

.16 Controls.

.17 Heating, Ventilating, and Air Conditioning.

.18 Millwork.

.19 Fire Systems.

.20 Testing and Commissioning.

.21 Supplied equipment long delivery items.

.22 Engineer supplied equipment required dates.

.3 Clearly show sequence and interdependence of construction activities and indicate:

.1 Start and completion of all items of Work, their major components, and interim milestone completion dates.

.2 Activities for procurement, delivery, installation and completion of each major piece of equipment, materials and other supplies, including:

.1 Time for submittals, resubmittals and review.

.2 Time for fabrication and delivery of manufactured products for Work.

.3 Interdependence of procurement and construction activities.

.3 Include sufficient detail to assure adequate planning and execution of Work. Activities generally range in duration from 3 to 15 workdays each.

.4 Insert Change Orders in appropriate and logical location of Project Schedule. After analysis, clearly state and report to Consultant for review of effects created by insertion of new Change Order.

1.7 PROJECT SCHEDULE REPORTING

.1 Update Project Schedule on monthly basis reflecting activity changes and completions, as well as activities in progress.

.2 Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation.

.3 Provide proposed updated project schedule with all proposed change order proposals indicating impact of change on baseline schedule.

1.8 PROJECT MEETINGS

.1 Discuss Project Schedule at regular site meetings, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule.

.2 Weather related delays with their remedial measures will be discussed and negotiated.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Yukon Territory

.1 Occupational Health and Safety Act, R.S.Y.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section [01 33 00- Submittal Procedures].

.2 Submit site-specific Health and Safety Plan: Within 5 Working Days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:

.1 Results of site-specific safety hazard assessment.

.2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.

.3 Submit copies of reports or directions issued by Territorial health and safety inspectors.

.4 Submit copies of incident and accident reports.

.5 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section [02 81 01- Hazardous Materials] .

.6 Owner will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 5 Working Days.

.7 Owner's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.

.8 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to Owner.

.9 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.

.1 [_____]

.2 [_____]

1.3 FILING OF NOTICE

.1 File Notice of Project with Territorial authorities prior to beginning of Work.

.2 Contractor shall agree to install proper site separation and identification in order to maintain time and space at all times throughout life of project.

1.4 SAFETY ASSESSMENT

.1 Perform site specific safety hazard assessment related to project.

1.5 MEETINGS

.1 Schedule and administer Health and Safety meeting with Owner prior to commencement of Work.

1.6 REGULATORY REQUIREMENTS

.1 Do Work in accordance with Section [01 41 00- Regulatory Requirements].

1.7 PROJECT/SITE CONDITIONS

.1 Work at site will involve contact with:

.1 [_____]
.2 [_____]

1.8 GENERAL REQUIREMENTS

.1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.

.2 [DCC Representative] [Consultant] [Owner] may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.

1.9 RESPONSIBILITY

.1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.

1.10 COMPLIANCE REQUIREMENTS

.1 Comply with Occupational Health and Safety Act, General Safety Regulations, O.I.C.

1.11 UNFORSEEN HAZARDS

.1 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Territory having jurisdiction and advise Owner verbally and in writing.

.2 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, advise Safety Officer or Health and Safety co-ordinator and follow procedures in accordance with Acts and Regulations of Territory having jurisdiction and advise Owner verbally and in writing.

1.12 HEALTH AND SAFETY CO-ORDINATOR

.1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must:

.1 Have site-related working experience specific to activities associated with [_____]

.2 Have working knowledge of occupational safety and health regulations.

.3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.

.4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.

.5 Be on site during execution of Work and report directly to and be under direction of the site supervisor.

1.13 POSTING OF DOCUMENTS

.1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Territory having jurisdiction, and in consultation with Owner.

1.14 CORRECTION OF NON-COMPLIANCE

.1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction, Consultant, or by Owner.

.2 Provide Owner with written report of action taken to correct non-compliance of health and safety issues identified.

.3 Owner may stop Work if non-compliance of health and safety regulations is not corrected.

1.15 BLASTING

.1 Blasting or other use of explosives is not permitted without prior receipt of written instruction by Owner.

.2 Do blasting operations in accordance with Section [31 23 16.26- Rock Removal].

1.16 POWDER ACTUATED DEVICES

.1 Use powder actuated devices only after receipt of written permission from Owner.

1.17 WORK STOPPAGE

.1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Canadian Construction Documents Committee (CCDC)

.1 CCDC 2-2008, Stipulated Price Contract.

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Acceptance of Work Procedures:

.1 Pre-Substantial Performance Tasks:

.1 Contractor's Inspection: Contractor: conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.

.1 Notify Consultant in writing of satisfactory completion of Contractor's Design-Builder's inspection and submit verification that corrections have been made.

.2 Submit list of incomplete items with an attached estimated value for each item.

.3 Submit a schedule for completion of all remaining work.

.2 Pre-Substantial Submittals:

.1 Submit all submittals as required by Section 01 78 00 – Closeout Submittals.

.2 Operation of systems: submit written certificate verifying demonstration to Owner's maintenance personnel, and that all required training complete.

.3 Submit to Owner a letter of Good Standing from the Yukon Workers' Compensation Board and the required Statutory Declaration.

.3 Request Consultant's inspection in writing.

.2 Consultant's Inspection:

.1 Owner, Consultant and Contractor to inspect Work and identify defects and deficiencies no later than 10 working days after receipt of the application from the Contractor.

.2 Consultant to establish a list and estimated value of all deficient an/or incomplete items of the Work.

.3 Contractor to correct Work as directed.

.3 Completion Tasks: submit written certificates in English that tasks have been performed as follows:

.1 Work: completed and inspected for compliance with Contract Documents.

.2 Defects: corrected and deficiencies completed.

.3 Equipment and systems: tested, adjusted, balanced and fully operational.

.4 Certificates required by Authorities Having Jurisdiction: submitted.

.5 Commissioning of systems: completed in accordance with [01 91 13- General Commissioning Requirements] and [_____].

.6 Work: complete and ready for final inspection.

.4 Final Inspection:

.1 When completion tasks are done, request final inspection of Work by Consultant, Owner, and Contractor.

.2 When Work incomplete according to Consultant, complete outstanding items and request re-inspection.

.5 Declaration of Substantial Performance: when Consultant considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance.

.6 Commencement of Lien and Warranty Periods: date of Owner's acceptance of submitted declaration of Substantial Performance to be date for commencement for warranty period and commencement of lien period.

.7 Payment for Deficiencies: The Owner will not, except in special circumstances, approve application for payment for partial completion of deficiencies after the issuance of Substantial Performance.

.8 Final Payment:

.1 When Consultant considers final deficiencies and defects corrected and requirements of Contract met, make application for final payment.

.2 Refer to CCDC 2 when Work deemed incomplete by Consultant, complete outstanding items and request re-inspection.

.9 Payment of Holdback: after issuance of Certificate of Substantial Performance of Work, submit application for payment of holdback amount in accordance with contractual agreement.

1.3 FINAL CLEANING

.1 Clean in accordance with Section [01 74 11- Cleaning].

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

.1 Pre-warranty Meeting:

.1 Convene meeting one week prior to contract completion with Consultant, Departmental Representative, and contractor's representative, in accordance with [Section 01 31 19 - Project Meetings] to:

.1 Verify Project requirements.

.2 Review warranty requirements.

.2 Owner to establish communication procedures for:

.1 Notifying construction warranty defects.

.2 Determine priorities for type of defects.

.3 Determine reasonable response time.

.3 Contact information for bonded and licensed company for warranty work action: provide name, telephone number and address of company authorized for construction warranty work action.

.4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00- Submittal Procedures.

.2 Prior to placing concrete slabs, submit one set of project record documents showing the locations of:

.1 Underground site services.

.2 Under or in slab services, equipment and materials.

.3 10 Working Days prior to Substantial Performance of the Work, submit to the Consultant for review, one electronic copy of the closeout submittals specified in this section. This first submission must include the following data:

.1 Contractor Designed System Data.

.2 Shop Drawings Stamped by Contractor and Consultant.

.3 Installation Instructions.

.4 Operating Instructions.

.5 Maintenance Instructions.

.6 Spare Parts Lists.

.7 Suppliers and Contractors Lists.

.8 Product Data.

.4 The Consultant’s review to determine Substantial Performance of the Work will not take place until the Consultant has received acceptable copies of the Closeout Submittals.

.5 Provide spare parts, maintenance materials and special tools of same quality and manufacture as products provided in Work.

.6 Provide evidence, if requested, for type, source and quality of products supplied.

.7 Submit three printed copies and one electronic copy of completed closeout submittals prior to Total Performance of the Work.

1.3 FORMAT

.1 Organize data as instructional manual.

.2 Binders:

.1 Bound using expanding spine catalogue binders complete with plated piano hinges, hard covered, expandable pots, 210 x 275 mm with spine and face embossed with Project title and identification in white. Maximum thickness of 100 mm.

.2 Provide sufficient volumes to allow each binder to hold system data while in full closed position, and to be no more than 75% full to allow for additional data.

.3 Provide artwork and colour to Owner for approval prior to binder construction.

.4 Binder Colours:

.1 Architectural:/Structural/Specialties: Green

.2 Mechanical: Blue

.3 Electrical: Red

.4 Binders containing multiple disciplines: Green.

.5 Divider Tabs:

.1 Heavy weight coloured paper, mylar laminated with tab number and title printed on tab as follows:

.1 Main Divisions: White tabs, labeled with division name, two bank tab length.

.2 Sections of a Main Division: tabs of same colour as Binder fabric for Mechanical, Electrical or Architectural sections of a Main Division, labeled with section name, four bank tab length.

.3 Subsections: tabs of same colour as Binder fabric for Mechanical, Electrical or Architectural subsections, printed label, eight bank tab length.

.3 When multiple binders are used correlate data into related consistent groupings.

.1 Identify contents of each binder on spine.

.4 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.

.5 Arrange content by systems, under Section numbers and sequence of Table of Contents.

.6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

.7 Text: manufacturer's printed data, or typewritten data.

.8 Language: All text to be in English.

.9 Drawings: provide with reinforced punched binder tab.

.1 Bind in with text; fold larger drawings to size of text pages.

.10 Electronic Copy: Provide electronic copy of all closeout submittals on a USB storage device as follows:

.1 File type to be a composite electronically indexed portable document format file (PDF).

.2 Name each indexed document file in the composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.

.3 Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

.4 File Names and Bookmarks:

.1 Enable bookmarking of individual documents based on file names.

.2 Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents.

.3 Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree.

.4 Configure electronic manual to display bookmark panel on opening file.

.5 Enable inserted reviewer comments on draft submittals.

1.4 CONTENTS - PROJECT RECORD DOCUMENTS

.1 Table of Contents for Each Volume: provide title of project;

.1 Date of submission; names.

.2 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties.

.3 Schedule of products and systems, indexed to content of volume.

.2 For each product, major equipment, system, material or finish, organize operation and maintenance data as follows:

.1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.

.2 Operation Division: include the following, as applicable:

.1 System Design Criteria.

.2 System and Controls Descriptions.

.3 System and Controls Schematics.

.4 Operating Instructions.

.3 Maintenance Division: include the following, as applicable:

.1 Maintenance Tasks and Schedules.

.2 Spare Parts.

.3 Suppliers and Contractors.

.4 Tags and Directories.

.4 Contract Document Division: include the following, as applicable:

.1 Drawings List.

.2 Shop Drawings and Product Data.

.3 Certifications.

.4 Warranties and Bonds.

.5 Maintenance Brochures.

.6 Reports.

.3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.

.4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

.5 Typewritten Text: as required to supplement product data.

.1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section [01 45 00- Quality Control].

.6 Training: refer to Section [01 79 00- Demonstration and Training].

1.5 AS -BUILT DOCUMENTS AND SAMPLES

.1 Maintain at site for Consultant one record copy of:

.1 Contract Drawings.

.2 Specifications.

.3 Addenda.

.4 Change Orders and other modifications to Contract.

.5 Reviewed shop drawings, product data, and samples.

.6 Field test records.

.7 Inspection certificates.

.8 Manufacturer's certificates.

.2 Store record documents and samples in field office apart from documents used for construction.

.1 Provide files, racks, and secure storage.

.3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.

.1 Label each document "PROJECT RECORD" in neat, large, printed letters.

.4 Maintain record documents in clean, dry and legible condition.

.1 Do not use record documents for construction purposes.

.5 Keep record documents and samples available for inspection by the Consultant and Departmental Representative.

1.6 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

.1 Record information on set of black line opaque drawings, and in copy of Project Manual, provided by Owner.

.2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.

.3 Record information concurrently with construction progress.

.1 Do not conceal Work until required information is recorded.

.4 Contract Drawings and shop drawings: mark each item to record actual construction, including:

.1 Measured depths of elements of foundation in relation to finish first floor datum.

.2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

.3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.

.4 Field changes of dimension and detail.

.5 Changes to equipment layout and services.

.6 Changes made by change orders.

.7 Details not on original Contract Drawings.

.8 Referenced Standards to related shop drawings and modifications.

.5 Specifications: mark each item to record actual construction, including:

.1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.

.2 Changes made by Addenda and change orders.

.6 Other Documents: maintain inspection certifications, manufacturer's certifications, and field test records required by individual specifications sections.

.7 Provide digital photos for site records.

1.7 FINAL SURVEY

.1 Submit final site survey certificate in accordance with Section [01 71 00- Examination and Preparation], certifying that elevations and locations of completed Work are in conformance, or non-conformance with Contract Documents.

1.8 EQUIPMENT AND SYSTEMS

.1 For each item of equipment and each system include description of unit or system, and component parts.

.1 Give function, normal operation characteristics and limiting conditions.

.2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

.2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.

.1 Include regulation, control, stopping, shut-down, and emergency instructions.

.2 Include summer, winter, and any special operating instructions.

.5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.6 Maintenance schedule for all system components and types of maintenance and inspections, indicating frequency and type of maintenance/inspection required up to a daily level of detail.

.7 Provide schedules for all required maintenance materials, including filters and belts.

.8 Provide schedules for all valve tags and paints used.

.9 Provide servicing and lubrication schedule, and list of lubricants required.

.10 Include manufacturer's printed operation and maintenance instructions.

.11 Include sequence of operation by controls manufacturer.

.12 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.13 Provide installed control diagrams by controls manufacturer.

.14 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.

.15 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

.16 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.17 Include test and balancing reports as specified in Section [01 45 00 - Quality Control] [01 91 13 - General Commissioning Requirements].

.18 Additional requirements: as specified in individual specification sections.

1.9 MATERIALS AND FINISHES

.1 Building products, applied materials, and finishes: include product data, with catalogue number, size, composition, and colour and texture designations.

.1 Provide information for re-ordering custom manufactured products.

.2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.3 Moisture-protection and weather-exposed products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.4 Additional requirements: as specified in individual specifications sections.

1.10 MAINTENANCE MATERIALS

.1 Spare Parts and Extra Stock Materials:

.1 Provide spare parts, maintenance and extra materials, and special tools in quantities specified in individual specification sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to site; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to Consultant.

.2 Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit prior to final payment.

1.11 DELIVERY, STORAGE AND HANDLING

.1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.

.2 Store in original and undamaged condition with manufacturer's seal and labels intact.

.3 Store components subject to damage from weather in weatherproof enclosures.

.4 Store paints and freezable materials in a heated and ventilated room.

.5 Remove and replace damaged products at own expense and for review by Consultant.

1.12 WARRANTIES AND BONDS

.1 Develop warranty management plan to contain information relevant to Warranties.

.2 Submit warranty management plan, 30 days before planned pre-warranty conference, to Consultant for approval.

.3 Warranty management plan to include required actions and documents to assure that the Government of Yukon receives warranties to which it is entitled.

.4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.

.5 Submit, warranty information made available during construction phase, to Consultant for approval prior to each monthly pay estimate.

.6 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:

.1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.

.2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

.3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within [ten] days after completion of applicable item of work.

.4 Verify that documents are in proper form, contain full information, and are notarized.

.5 Co-execute submittals when required.

.6 Retain warranties and bonds until time specified for submittal.

.7 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.

.8 Conduct joint [9-month and 12-month] warranty inspection, measured from date of Substantial Performance, by Consultant.

.9 Include information contained in warranty management plan as follows:

.1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.

.2 Listing and status of delivery of Certificates of Warranty for extended warranty items specified in individual specification sections.

.3 Provide list for each warranted equipment, item, feature of construction or system indicating:

.1 Name of item.

.2 Model and serial numbers.

.3 Location where installed.

.4 Name and phone numbers of manufacturers or suppliers.

.5 Names, addresses and telephone numbers of sources of spare parts.

.6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.

.7 Cross-reference to warranty certificates as applicable.

.8 Starting point and duration of warranty period.

.9 Summary of maintenance procedures required to continue warranty in force.

.10 Cross-Reference to specific pertinent Operation and Maintenance manuals.

.11 Organization, names and phone numbers of persons to call for warranty service.

.12 Typical response time and repair time expected for various warranted equipment.

.4 Contractor's plans for attendance at 9-month and 12-month post-construction warranty inspections.

.5 Procedure and status of tagging of equipment covered by extended warranties.

.6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

.10 Respond in timely manner to oral or written notification of required construction warranty repair work.

.11 Written verification to follow oral instructions.

.1 Failure to respond will be cause for the Government of Yukon to proceed with action against Contractor.

1.13 WARRANTY TAGS

.1 Tag, at time of installation, each warranted item. Provide durable, oil and water-resistant tag approved by Consultant.

.2 Attach tags with copper wire and spray with waterproof silicone coating.

.3 Leave date of acceptance until project is accepted for occupancy.

.4 Indicate following information on tag:

.1 Type of product/material.

.2 Model number.

.3 Serial number.

.4 Contract number.

.5 Warranty period.

.6 Inspector's signature.

.7 Construction Contractor.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

9

Appendices

1 Revisions and Alternates Form

1. Revisions and Alternates Form

The Government of Yukon will be undertaking periodic revisions to confirm, revise or update the content of the manual. Comments, recommended revisions or additions, and proposals for alternative requirements or standards should be submitted using this form.

Submit the form to:

Manager, Technical Services Unit
Property Management Division
Highways and Public Works, Government of Yukon
Email: buildingmanual@gov.yk.ca

Referenced Chapter, Section and Clause:

Description of proposed change, addition or alternate *(use additional pages if necessary)*:

Rationale for proposal *(include experience on other projects, alternative means of achieving compliance with the intent of the clause, and/or how it complies with the 5 objectives of the manual)*:

Name	Occupation/Position
Organization / Company / Department	Mailing Address
Email	Phone

REVISIONS AND ALTERNATES FORM V1.0 – OCTOBER 1, 2019


Yukon