Northwest
Territories

# GOOD BUILDING PRACTICE FOR NORTHERN FACILITIES

Second Edition - 2009

Prepared and published by

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# GOOD BUILDING PRACTICE FOR NORTHERN FACILITIES 2009

## Second Edition

The material presented in the *"Good Building Practice for Northern Facilities 2009"* guidebook has been prepared in accordance with generally recognized architectural and engineering principles and practices, and is to be used for general information only. It reflects and acknowledges the state of the art as known to authors at the time the guidebook was prepared. However, the Department of Public Works and Services, Government of the Northwest Territories does not accept responsibility for errors and omissions in the document. Users are responsible for ensuring that information extracted from this guidebook is suitable and correct for their particular application. The mention of the names of manufacturers, products, service companies, or consultants does not imply endorsement; however, it does indicate the recognized northern preferences.

Department of Public Works and Services
Government of the Northwest Territories

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# TO THE READER

The Northwest Territories is a special place, but its climate and environment also offer special challenges to the building industry. I am pleased to introduce this guidebook that is designed to assist all facets of the industry in designing and constructing quality buildings for the NWT.

*"Good Building Practice for Northern Facilities 2009"* has been put together by the Department of Public Works and Services of the Government of the NWT. It was not done in isolation, though. The experiences of a wide variety of people and companies contributed to the final product. It is this kind of cooperation and mutual support that will continue to build a strong and competitive North.

Honourable Michael McLeod
Minister
Public Works and Services
Government of the Northwest Territories

# FOREWORD

Building in the North is indeed more demanding than building in more temperate climates. The *"Good Building Practice for Northern Facilities 2009"* guidebook serves to illustrate the technical differences encountered when building in the cold northern environment. It is aimed at providing all groups involved with buildings – building developers, building designers, building constructors, suppliers, and administrators and operators – with a comprehensive set of practical recommended technical best practice northern building guidelines.

*"Good Building Practice for Northern Facilities 2009"* originated from "*Design Standards and Guidelines for New Public Buildings"* which until 1999 documented directives that project personnel were required to follow for public sector buildings. "*Good Building Practice for Northern Facilities 2000"* assumed a more advisory stance appropriate to sustainable building development by the northern development community.

*"Good Building Practice for Northern Facilities 2009"* updates northern construction recommended best practice by incorporating nine years of changed codes and standards since 2000, and adds recommendations for more sustainable development and improved energy conservation for all northern buildings.

The recommended best practices format of *"Good Building Practice for Northern Facilities 2009"* renews the challenge to builders and designers to be innovative when applying recommended best practices. Building constructors and designers are encouraged to present alternatives to the recommended best practices found in the newly revised edition of the guidebook, and share in the continued renewal of the guidebook by presenting new or innovative ways of resolving technical problems, reducing building life-cycle cost, and improving building energy conservation.

*"Good Building Practice for Northern Facilities 2009"* was developed then refined by incorporating input from building designers, building contractors, suppliers, facility operators, members of the general public, research consultants, Public Works and Services and other GNWT department staff, who worked together to achieve a consensus regarding northern building practices that are appropriate, economic and realistic.

*"Good Building Practice for Northern Facilities 2009"* goes beyond the four stated objectives of safety, health, accessibility for persons with disabilities, and fire and structural protection of buildings in the *National Building Code of Canada 2005* and *National Fire Code of Canada 2005,* both adopted in the NWT by the NWT Fire Prevention Act and Regulations.

*"Good Building Practice for Northern Facilities 2009"* supplements the minimum stated objectives of the building and fire codes, specifically when experience and information gathered from members of the northern building development and management community indicate that:

- when there is a demonstrated economic value benefit to northern building durability and energy conservation, to be gained by incorporating specific products, systems or methods, those features are recommended to be incorporated;

- more technically sustainable practices are needed to be applied in northern building, relative to the minimal requirements of the *National Building Code of Canada 2005* and the *National Fire Code of Canada 2005* applied in more temperate regions;

- code requirements should be clarified to take into account differences in northern community climate factors, infrastructure and services; and

- northern building development and operation experience has demonstrated that conditions particular to remote northern communities require an approach different from typical Canadian building industry practice.

We are confident that all northern builders will find *"Good Building Practice for Northern Facilities 2009"* to be an indispensable guidebook, and challenge users to contribute towards its further development in the next edition.

Mike Aumond
Deputy Minister
Public Works and Services

# ACKNOWLEDGEMENTS

In preparing *"Good Building Practice for Northern Facilities 2009"* the Asset Management Division, Department of Public Works and Services, Government of the Northwest Territories has drawn upon the assistance of numerous individuals from within the Department and from private sector agencies. Many of them contributed technical writing and comments to this guidebook. *"Good Building Practice for Northern Facilities 2009"* became a reality because of their participation, and I hope this kind of shared learning experience and cooperative effort can continue during the production of the 2009 edition.

Department of Public Works and Services in-house technical and administrative staff have played a key role in contributing to and coordinating the development of this guidebook. Special acknowledgements are due to Bill Wyness, Sr. Technical Officer, Architectural/Structural. Heather Hayne, Sr. Mechanical Technical Officer; John Dick, Sr. Electrical Technical Officer; Cameron Wilson, Sr. Architectural/Structural Technical Officer; Richard Cracknell, Sr. Mechanical Technical Officer; David Mahon, Sr. Electrical Technical Officer, Doug Mckie, Sr. Maintenance Advisor, Kim Hawkins, Sr. Maintenance Advisor, and Dwayne Wohlgemuth, Energy Management Specialist.

Many thanks are expressed to John Dick for consolidating the sections of the document and producing it in its current form, in addition to his technical assistance in updating the Electrical Section, Bill Wyness for coordinating all additions and deletions, in addition to updating the General, Site, Architectural and Structural Sections, and to Kevin Campbell, Sr. Advisor Planning and Dave Prichard for their editorial assistance.

Finally, our appreciation is extended also to Sukhi Cheema, Manager, Technical Support Services, who initiated and coordinated the overall production of this guidebook.

Paul Guy, P.Eng.
Director
Asset Management Division
Department of Public Works and Service

# TABLE OF CONTENTS

(Summary)

# PREAMBLE

## INTRODUCTION

*Good Building Practice for Northern Facilities 2009* (GBP) contains performance guidelines, preferred materials or methods, and logistical considerations for the design and construction of northern facilities. Over time, certain products or approaches to construction have proven successful and have been adopted by property developers, design consultants and builders working in the NWT. It is hoped that your comments and opinions will lead to further revisions and additions that will keep the document current and relevant.

### Criteria for *Good Building Practice for Northern Facilities 2009:*

*Good Building Practice for Northern Facilities 2009* supplements the minimum stated objectives of the building and fire codes, specifically when experience and information gathered from members of the northern building development and management community indicate:

a) more technically sustainable practices are needed to be applied in northern building, relative to the minimal requirements of the *National Building Code of Canada 2005* and the *National Fire Code of Canada 2005* applied in more temperate regions;

b) code requirements should be clarified to take into account differences in northern community climate factors, infrastructure and services;

c) northern building development and operation experience has demonstrated that conditions particular to remote northern communities require an approach different from typical Canadian building industry practice, and

d) there is a demonstrated economic value benefit to northern building durability and energy conservation, to be gained by incorporating specific products, systems or methods, those features are recommended to be incorporated.

Detailed studies or reference materials are noted within GBP for interest only, and unless otherwise stated, do not constitute a part of *Good Building Practice for Northern Facilities 2009.*

### Application of Guidelines

*Good Building Practice for Northern Facilities 2009* has been prepared as suggested guidelines for obtaining good value and quality buildings. The GBP may be applicable for renovations to existing buildings, tenant improvements in leased facilities, or utility buildings.

The guidelines come from studying buildings typical of the majority of buildings found in most northern communities, which are small scale low-rise structures designed to accommodate people. *Good Building Practice for Northern Facilities 2009* may be less immediately applicable to highly specialized buildings, or unusually large buildings, where the technical content goes beyond small scale low-rise structures. In such cases it is recommended *Good Building Practice for Northern Facilities 2009* be referenced for more general guidance, and such buildings be designed and developed in **general accordance** with the requirements of *Good Building Practice for Northern Facilities 2009.*

## Development of *Good Building Practice for Northern Facilities 2009:*

*Good Building Practice for Northern Facilities 2009* follows the technical content of the first edition of *Good Building Practice for Northern Facilities,* issued in 2000. While the technical content and scope is followed, the language has been revised to meet a broader set of readers than in past editions.

The new document incorporates collected observations from builders, designers, building operators and users obtained since the first edition was composed. A substantial portion of the new information was collected by staff of the GNWT Public Works & Services, Asset Management Division and Regional Project Management, in consultation with other stakeholders in the building development and construction industry.

# Revisions

Periodic reviews will be undertaken to reconfirm, revise or update the content of the “Good Building Practice 2009”. Your comments and suggestions are invited. Proposed changes or additions should be submitted to:

***Manager, Technical Support Section,***
***Asset Management Division,***
***Department of Public Works and Services, GNWT,***
***Box 1320, Yellowknife, NT, X1A 2L9***
***Phone (867) 920-8088***

______________________________________________________________

***Fax (867) 873-0226 E-mail: GBP@gov.nt.ca*** *(attach additional pages if necessary)*
Referenced section # and section name: ______________________________
A brief description of your proposed changes or addition:

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

Rationale (relate experiences that have led you to make this recommendation):

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________
Your Name Occupation / Position

______________________________________________________________
Organization / Firm / Department Mailing Address

______________________________________________________________
Phone (work) Fax (work)

______________________________________________________________
Date E-mail

# Table of Contents

# GENERAL BUILDING OBJECTIVES

The primary objective of *Good Building Practice for Northern Facilities 2009* is to provide a technical reference handbook to help building developers produce the best value in northern buildings. Buildings designed specifically for the northern climate and physical site parameters, for minimum capital cost consistent with lowest life cycle cost, will provide ongoing economic service and good quality accommodation for program delivery. The goal of *Good Building Practice for Northern Facilities 2009* is to incorporate proven methods and materials, while supporting improved building performance and new technology.

## G1 LOCAL RESOURCES

Construction projects provide important opportunities for communities to gain experience in building development. Input by community residents can provide valuable information on project definition and construction methodology. Local expertise can benefit building design with information on snow drifting patterns, preferred orientations, anticipated use patterns and examples of successful materials or methods. Local contractors and certified trades persons typically present the best value for initial construction and ongoing maintenance, by being both familiar with local conditions and near at hand to the building, and able to provide local labour.

### 1.1 EQUIPMENT SUPPLIES AND PRODUCTS

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

### 1.2 OPERATION AND MAINTENANCE

Given the growing number of building projects and the limited numbers of experienced trades persons in the North, new building construction should be seen as an opportunity to develop building maintainers in the community.

## G2 TOTAL SERVICE LIFE COST or TOTAL COST OF OWNERSHIP

Wherever alternative designs are considered, the alternative representing the lowest total service life cost is recommended to be selected. Wherever alternatives are shown to have the same total service life cost, the alternative with the lowest capital cost is recommended to be selected. The total service life costing should be based on the expected design service life of the building and its systems. For comparative purposes a 40 year design service life is recommended, corresponding to the “Medium Life” category of 29 to 49 years specified in Table 2 of “Guideline on Durability in Buildings”, CSA Standard S478-95(2001). Refer to GBP G4.4, “Durability”.

The goal should be to balance other project development considerations, such as, for example, where direct benefits to the community will be realized (e.g., incorporating locally available materials); or where a product preference is stated in another GBP article, with current cost and technical performance capacity to support the design service life.

## G3 ENERGY MANAGEMENT

Energy use has a significant cost both for the environment and for building owners. Fuel cost and fossil fuel utilization are both high in the North, and buildings consume a large portion of total northern energy.

The goal of energy efficient-buildings should be to use less energy, both fossil fuel and electrical, and to use it as efficiently as possible.

If an existing building is to be made more energy-efficient, the quantity of energy it uses for various functions and the duration of those functions, and whether the functions can be reduced or altered, must be determined. Equipment and system efficiencies must be studied and improved. For a new building, the components, systems and operations must be chosen to complement each other, work efficiently and be easily maintained.

Greenhouse gas emissions reduction is also a major consideration. Some reduction will naturally occur as less fuel is used. Fuel sources which emit lower quantities of greenhouse gases during combustion are recommended to be used whenever possible. Some electricity within the territories is generated from hydro, and thus produces no greenhouse gas emissions. This makes the task of finding the right systems and balancing economics against environmental impact more challenging.

During the building design phase, theoretical building energy efficiency can be predicted and optimized with the help of design tools such as the operational program, technical design guidelines, and computer modeling. Energy consumption targets may be useful to benchmark desired performance for a particular type of building (for example, a school).

Once the building is built and commissioned, it must be operated in accordance with the operational program. Monitoring of the actual building operation and energy usage after occupancy is vital, to ensure that the building is performing in accordance with predicted energy use efficiency. Noted anomalies or inefficiencies can then be investigated and operationally corrected.

Over the design service life of a building, its energy consumption cost may amount to more than the initial cost of construction. It makes economic as well as environmental sense to minimize operating costs and energy consumption.

## 3.1 CHOICE OF ENERGY SOURCES

Energy source options must be determined early in the building design process.

Oil has traditionally been the default heating fuel in northern communities, but other options are recommended to be considered. Natural gas and propane, available in certain areas, can be more economical to burn and do produce fewer greenhouse gas emissions than oil. Biomass heating systems using wood pellet fuel are recommended to be considered in locations where pellets may be delivered economically. In small buildings, residential type wood pellet appliances or woodstoves may be considered, and wind may be a possible energy source to use, particularly at remote sites. Geothermal or ground source heat energy may be considered where electricity is hydro-generated and can present an environmentally sustainable thermal energy source.

Available waste heat from diesel generator plants, data centres, or other sources are practical to consider as a primary source or supplementary source for building heating energy.

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.

Electricity is required in all northern buildings. Where cheaper rate interruptible power is available or likely to be developed, electricity can be considered a primary heating fuel source, when a permanent backup heating system is provided. Photo-voltaic and small scale wind generation can provide small environmentally benign supplementary electric power for controls and building system condition monitoring.

## 3.2 BUILDING DESIGN AND SYSTEMS OPERABILITY

Detailed building design and construction quality have a major effect on building energy efficiency. Building envelopes must be air tight and well-insulated, with properly-installed vapour and air barriers with minimal thermal bridging.

Siting, orientation, day lighting, solar gain and shading features of a building are recommended to be optimized.

Building systems need to be selected for simplicity and ease of operation. The use of systems and controls which could conflict with each other, such as simultaneous heating and cooling, should be avoided.

If operators are comfortable with their building systems, it is much more likely that buildings will be operated efficiently. If systems are too complicated, energy saving potential can be lost due to energy saving subsystems, components or control features being turned off or ignored. Conversely, informed and energy-conscious occupants and operators can also a positive impact on building energy use.

Electrical energy usage is to be minimized within the building by the use of energy-efficient fixtures, the use of day lighting and occupancy sensors for lighting, and variable speed drives, efficient motors, and similar features. Electrical demand charges are to be considered in the energy cost budget projections.

Ventilation systems are one of the largest consumers of heating energy. The required amount of fresh air and total airflow may be minimized while maintaining sufficient quantities of outdoor air through the use of displacement ventilation air supply or other efficient systems. The use of heat recovery devices, such as heat wheels, glycol run-around loops, and similar heat recapture devices on exhaust air systems is recommended to be evaluated during design.

More detailed information on architectural, mechanical and electrical systems and their energy efficiency may be found in the applicable sections of *Good Building Practice for Northern Facilities 2009.*

## 3.3 ENERGY-EFFICIENT DESIGN GUIDELINES USED BY THE GNWT

There are a number of design guidelines for building energy efficiency.

- *Good Building Practice for Northern Facilities 2009*

This GNWT publication *Good Building Practice for Northern Facilities 2009* considers building energy efficiency, construction, maintenance and operation. Use of this recommended technical best practice guidebook has been shown to ensure that buildings meet or exceed targeted energy efficiency for buildings developed and operated by the GNWT. It provides practical energy utilization benchmarking for all northern buildings.

- *EcoENERGY Validation for Institutional and Commercial Buildings*

GNWT buildings with gross floor areas greater than 600 square metres must meet energy efficiency requirements of the Federal EcoENERGY program for new buildings. This program has the same requirements as the discontinued Commercial Building Incentive Program (CBIP), requiring that buildings be 25% more energy efficient than a comparable building built to the minimum requirements of the *Model National Energy Code for Buildings 1997* (MNECB). This target will continue as long as the current EcoENERGY Program and current version of the national energy code are in place. The target may be updated in future when the new energy code version, *National Energy Code of Canada for Buildings 2011* is issued.

- *Leadership in Energy & Environmental Design (LEED)*

The LEED standard for new buildings includes energy efficiency, but goes much further to promote environmentally-sustainable construction in five principal categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. Credits are awarded for various criteria within each category, and a rating is given based on the total number of credits a building receives. LEED certification in northern environments requires extra diligence in adapting the LEED rating system to the unique northern conditions.

## 3.4 ENERGY MODELLING

In some cases, simple adherence to set or prescriptive design criteria listed in the *Model National Energy Code of Canada for Buildings 1997* (MNECB) will ensure good building energy performance. For very simple buildings, a hand calculation can be used to estimate the annual energy consumption with a reasonable degree of accuracy.

For the vast majority of buildings, computerized energy simulation programs are recommended to be used to properly simulate building energy consumption and performance over time. Computerized energy use simulation programs are meant to supplement, not replace, the use of prescriptive design features which incorporate tried and true energy saving assemblies, equipment, or practices into a building design.

There are numerous computerized energy use simulation programs available to analyze energy use in buildings. Listed below are several programs which can be used for medium and larger buildings:

- EE4: an NRCan energy use simulation program often used with the EcoENERGY program for commercial and institutional buildings.
- DOE-2: an hourly building energy use simulation program that was developed in the United States, with funding from the United States Department of Energy. It is the backbone of many other programs, including EE4.
- RETScreen, or Renewable Energy Technology Screening Tool, is a computerized simulation program used primarily to analyze renewable energy systems. It also includes a module to analyse energy efficiency in buildings. It is widely regarded as one of the best tools for modelling and sizing renewable energy systems such as solar water heating and solar electricity generation systems. It was developed by Natural Resources Canada.
- EQuest: another DOE-2 based computerized energy utilization program which will be the program associated with the 2011 Model National Energy Code for Buildings.

### 3.5 ENERGY MONITORING AND BENCHMARKING

The first step in reducing energy use in existing buildings, or to check performance of newly built or recently renovated buildings, is to track energy use. All buildings are recommended to be provided with the means to monitor electricity and fuel use.

In most cases, energy use can be determined from fuel delivery records, or fuel and electrical meter readings. Electrical meters and fuel meters are normally installed on the electrical and fuel supply to each building.

However, if fuel or electricity is used for two or more significant purposes in a building, it may be helpful to meter fuel or electrical use at each large piece of equipment to identify the pattern of energy use.

### 3.6 BUILDING ENERGY PERFORMANCE INDEX (BEPI)

Energy monitoring allows building owners and operators to compare energy use in one facility to that in other facilities with similar uses. Energy use is normalized with regard to factors such as floor area, number of occupants, or heating degree days. The result is a Building Energy Performance Index (BEPI) that can be used to compare buildings of different sizes, different numbers of occupants, or which are located in different climate zones. The BEPI is most often given in mega joules, (MJ), or kilowatt-hours, (kWh), per year per square metre of gross floor area. Having such a benchmark value for a particular type of building allows operators and owners to identify inefficient buildings and to focus their energy conservation and efficiency retrofit efforts on those buildings.

### 3.7 BUILDING ENERGY COST INDEX (BECI)

The BECI is another normalized index: total energy costs in dollars per square metre per year. Building energy costs are high in the northern climate and vary greatly by community. Variance in energy costs and energy sources means that different building systems and energy-efficient technologies may be selected in different communities to optimize energy utilization.

## G4 APPROPRIATE TECHNOLOGY

To achieve the previously described goals and produce buildings that perform well and keep occupants comfortable, several basic principles have evolved. These principles can help guide building choices, to ensure they are appropriate for northern conditions.

### 4.1 SIMPLICITY AND EFFICIENCY

Available funding dictates "lean" buildings. It is recommended all building design solutions strive to:

- Minimize enclosed volumes and building perimeter for the required floor areas;
- Provide efficient program delivery by careful planning of related activity areas using uncomplicated floor plan layouts;
- Provide adequate and well-planned but efficient service and circulation areas;
- Plan for future expansion as simply as possible without major disruption to building users.

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

- be kept simple to improve the speed of construction in a curtailed construction season and to offer greater opportunity for employment of local trades persons and labourers;
- incorporate materials and methods that will permit quality construction under adverse environmental conditions in a curtailed construction season;
- limit the variety of materials and minimize the number of specialized trades required on the project;
- ensure procedures needed to operate and maintain the building can be put into practice using readily available labour, maintenance products and equipment.

## 4.2 RELIABILITY

Essential building systems like heating, ventilation and fire protection must be reliable in the harsh winter conditions of the NWT. Standby equipment and installations that facilitate quick repairs are an essential characteristic of building systems. 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 equipment or system that needs servicing by specialized trades people or parts that are difficult to obtain, is not recommended, though at times unavoidably necessary.

## 4.3 STANDARDIZATION

The intent of *Good Building Practice for Northern Facilities 2009* is to standardize system elements based on proven successes, so that the final product is cost effective, energy efficient, readily operable and maintainable by local people. Given the vast size and regional variation within the NWT, buildings must respond to differences in:

- community settings
- climatic zones
- transportation systems
- site conditions

Variations to recommendations reflecting local or regional differences and preferences are noted in this document where applicable.

## 4.4 DURABILITY

A basic durability requirement that helps buildings achieve lowest total service life cost is cited in “Guideline on Durability in Buildings”, CSA Standard S478-95(2001). Total service life cost includes necessary repairs and renovations during the design service life. The Basic Durability Requirement states, “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”.

Essentially a conservation requirement, basic durability requirements apply to building operation and maintenance, in addition to initial construction. In the event of repairs necessary to correct damage or premature deterioration, the repairs shall be designed, constructed, and maintained to provide the required performance over the design service life agreed upon between the Owner and the Designer.

### 4.5 COMMISSIONING

Durability and quality assurance can be assessed in advance of building operation commencement by commissioning. Commissioning of northern buildings is recommended for assuring the building can perform adequately in the harsh climate conditions of the northern environment. Commissioning tests and verifies the operation and performance of building systems, subsystems and components at the completion of construction, but actually commences early in the development, design and construction process.

"Commissioning GNWT Funded Buildings", an advisory document explaining commissioning, is a good example of recommended commissioning procedures developed to meet northern conditions and can be found at (http://www.pws.gov.nt.ca/pdf/publications/CommissionBldg.pdf).

## G5 OTHER DESIGN CONSIDERATIONS

### 5.1 ARCHITECTURAL CONSIDERATIONS

It is not the intent of *Good Building Practice for Northern Facilities 2009* to prescribe any particular form or style of northern building. Rational application of good design principles in response to programmatic, climatic and available resources will generate practical northern building style. Developing a particular architectural style appropriate for buildings in the north is a real challenge to designers.

Previous suggestions that buildings should fit into the immediate site unobtrusively, with the massing and finishes related to the context of the community still apply. Although this can be a justifiable design approach, it is nearly impossible to achieve in many small northern communities when adding large new buildings. To be successful, it is recommended a design thoroughly address the following concerns:

- the design must communicate the function of the building so its use is obvious and visually apparent to all community members;
- the design should incorporate recognizable local symbols appropriate to the design;
- colours, materials and forms are selected to support and enhance other design decisions;
- scale and bulk appearance of the building should be consistent with the building's intended use and other buildings nearby;
- whether it blends into, contrasts with or dominates a site, the relationship of the building to the site should be consistent with its function and local traditions for access under all weather conditions for all community residents for maintenance as well as general public access;
- whether it is private, public, friendly or decorous, the relationship of the building to the public access routes like streets should be consistent with the function and local traditions for access, including vehicle parking consistent with community vehicle use;
- whether they contrast with or are similar to adjacent buildings, the relationship between buildings should allow clear access for safety and maintenance consistent with the building functions.

Finally, the design of northern buildings must strike a balance between buildings that are stylistically appropriate in small communities, and the demand for buildings that are energy efficient, and simple to build and maintain. This is generally achieved by using uncomplicated shapes for doors and windows, and simple uncomplicated roof shapes that minimize snow and ice accumulation.

## 5.2 OTHER RELATED DOCUMENTS

Design encompasses a number of activities within architecture and engineering. During the design phase of any project several documents are produced, each with a specific objective. *Good Building Practice for Northern Facilities 2009* provides recommended best practice performance criteria, preferred materials or methods, and logistical considerations as a technical supplement to other related documents such as functional programs, specifications and pre-design documents like space programs. The following provide examples of the distinctions that can be made between the documents:

| Document | Example of contents |
|---|---|
| Functional Program | • a coffee maker and small appliances such as a toaster and microwave oven will be used |
| GBP (electrical) | • recommends use of split receptacles wherever coffee making is anticipated |
| Specifications | • “Flooring to be 4.5 mm thick Mondoflex by Mondo Rubber” |
| GBP | • recommends sports flooring may be either PVC or rubber depending on the type of use the floor will have |
| Submission Requirements | • provide consumption estimates for heating and electricity |
| GBP | • provides recommended energy consumption targets |

The objective of *Good Building Practice for Northern Facilities 2009* is to provide a benchmark of technically effective design choices bridging from the intent of the functional program to the myriad of technical solutions available.

## 5.3 GEOTECHNICAL VERIFICATION OF SITE STRUCTURAL CAPACITY

A geotechnical investigation is recommended to be conducted for all northern facilities in order to determine the structural capacity, recommended foundation structural alternatives, and identify in advance of design building durability influences, like surface and ground water presence.

The great variability of site conditions in the NWT, including many of the conditions found in different kinds of permafrost types, and the potential that the permafrost may thaw, or warm sufficiently within the design service life of the structure, requires addressing larger and different number of technical issues than is required in the design of foundations in southern Canada with temperate climate. 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.

The geotechnical investigation is recommended to include the assessment of the current ground temperature and expected climate warming during the life span of the structure. It has to address the availability of construction materials and schedule, tolerance of the structure to differential settlement and surface drainage that may affect the thermal regime of the foundation.

For larger structures subsurface geotechnical investigation in fine grained frozen soils with ground temperature above - 6°C should be sufficiently deep enough to obtain temperature and soils typification data to allow considerations of different foundation design options. The reference publication, *Geotechnical Site Investigation Guidelines for Building Foundations in Permafrost*, developed by Dr. Igor Holubec for GNWT Public Works & Services, completed in 2009, is available at the “Publications” section of GNWT Public Works & Services Asset Management Division web page.

### 5.4 UNIVERSAL ACCESSABILITY – BARRIER FREE DESIGN

The policy of inclusivity for all northerners to benefit from access to northern buildings is supported by the National Building Code of Canada 2005 Div. B. Section 3.8, "Barrier-Free Design". All northern buildings to which the general public has access are recommended to meet these requirements as a minimum.

Because of the wide variation of local weather conditions across the north, barrier-free access ramps are recommended to be installed including weather protection appropriate for the local weather conditions of the community in which the building is located. Snow and ice build-up can be reduced by canopy extensions and orientation to avoid snow-drifting. Surface materials should be selected for ease or snow and ice removal as well as meeting traction characteristics for wheel chairs, walkers, canes and crutch tips.

### 5.5 ASSET SECURITY

The inclusion of security considerations into the design of northern buildings is best done during the initial stages of project planning. That way security measures are incorporated into all building systems and subsystems early in the design process, assuring a high value being assigned to them.

The selection of security measures specified for a building should consider the costs of security in relation to capital and operating costs, and any potential restriction on service program delivery capacity. The combination of security measures and flexibility for increasing or decreasing levels of security in keeping with program requirements can be considered for the most cost effective protection.

## G6 CODES AND REGULATIONS

### 6.1 NATIONAL BUILDING CODE OF CANADA and NATIONAL FIRE CODE OF CANADA

The *National Building Code of Canada 2005* and the *National Fire Code of Canada 2005* have been adopted without change in the NWT, in the *NWT Fire Prevention Regulations* enabled by the *NWT Fire Prevention Act.* The *Authority Having Jurisdiction* is the Northwest Territories Fire Marshal, operating from the Office of the Fire Marshal at the Department of Municipal and Community Affairs in Yellowknife.

**The Fire Prevention Act and Regulations** can be found at

- http://www.justice.gov.nt.ca/PDF/ACTS/Fire_Prevent.pdf and
- http://www.justice.gov.nt.ca/PDF/REGS/FIRE_PREVENT/Fire_Prevention.pdf.

**Bulletins from the Office of the Fire Marshal**

Bulletins from the Office of the Fire Marshal clarify NBC requirements, or give notices of exemptions acceptable to the Fire Marshal. Copies are available through the Office of the Fire Marshal in Yellowknife, and Regional offices, and at

- http://www.maca.gov.nt.ca/ofm/docs/bulletins/index.html

## 6.2 NATIONAL ENERGY CODE of CANADA for BUILDINGS 2011

The “*Model National Energy Code of Canada for Buildings 1997”* was published in 1997, but it has not been adopted by the NWT. A new version, *“The National Energy Code of Canada for Buildings 2011”*, expected to be available in 2011, will continue to include both prescriptive and performance compliance methods for determining building energy consumption conformance to recommended performance benchmarks. For more detailed information, refer to GBP Article G-3, “Energy Management”.

## 6.3 MUNICIPAL BYLAWS

All municipal bylaws and ordinances must be observed in the design and construction of facilities in the NWT. Construction outside of a municipality on Commissioner’s Land is regulated directly through the Department of Municipal and Community Affairs (MACA).

## 6.4 DESIGN PROFESSIONALS

Professional Engineers

The practice of Engineering is regulated by the Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists. (NAPEG), under the authority of the “Engineering and Geoscience Professions Act”. The act can be found at http://www.justice.gov.nt.ca/PDF/ACTS/Engineering_Geoscience_Professions.pdf and the web site of NAPEG at http://www.napeg.nt.ca/.

Professional Architects

In the NWT, the Practice of Architecture is regulated under the “NWT Architect’s Act”, and through the Northwest Territories Association of Architects (NWTAA). The act can be found at http://www.justice.gov.nt.ca/PDF/ACTS/Architects.pdf and the web site of the NWTAA at www.nwtaa.ca.

Professional Landscape Architects

In the NWT, the Practice of Landscape Architecture is conducted by members of the NWT Association of Landscape Architects (NWTALA). The Association can be reached at NWT Association of Landscape Architects, P. O. Box 1394, Yellowknife NT, X1A 2P1.

## 6.5 SI METRIC REQUIREMENTS

All new construction in the NWT is recommended to be designed in SI metric units because the NBCC 2005 and NFCC 2005, as well as the standards and design data referred to in them, are designated in metric SI units. Actual materials may be designated in metric or feet and inches, and soft conversion to metric is acceptable.

Note that this requirement may be relaxed when these guidelines are applied to renovation projects and where the original documents are in feet and inches measures: either metric or feet and inches measure are recommended to be considered for use in that case.

Soft conversion

Physical size remains unchanged. Products are described to the nearest metric unit. For example, a 24 x 48 (inches) ceiling tile is 610 mm by 1220 mm (actual size).

Hard conversion

Physical sizes are changed and products designated in metric.

For example, a 24 x 48 (inches) ceiling tile is changed slightly in size to become 600 mm x 1200 mm (actual size).

## END OF SECTION

# Table of Contents

## SITEWORK

# SITEWORK

## INTRODUCTION

## SITE DEVELOPMENT CONDITIONS

There is a great variety of site conditions in northern communities, including conditions found in different kinds of permafrost as well as different 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.

The potential that the permafrost may thaw, or warm significantly within the design service life of the structure, requires the design address a broader and more varied set of technical issues than required for site development in southern Canada's more temperate climate. Northern communities located near lakes or rivers experience unique seasonal ground temperature fluctuations and ground and surface water movement, making thorough investigation of a site near a water body prior to development more essential to construction success and future facility operation. More detailed information is provided in *GBP 2009 - General Building Objectives Article 5.3, "Technical Verification of Site Structural Capacity."*

A geotechnical investigation is recommended to be conducted for all northern facilities in order to determine the structural capacity, recommended foundation structural alternatives, and identify in advance site influences on building durability, such as surface and ground water existing and future conditions. Complete geotechnical information is also recommended to be obtained for site grading and surface profiling - including recommended fill materials - for effective surface water management, and to include identification of, and recommendations for existing vegetation, which provides ground cooling shading from the sun, and which if removed, will cause rapid change in the buried portions of the site.

The geotechnical investigation should include the assessment of the current ground temperature and likely climate warming during the life span of the structure. It has to address the availability of construction materials and schedule, tolerance of the structure to differential settlement and surface drainage that may impact the thermal regime of the foundation.

Reasonable site 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;
- does not disrupt practical well-established community use patterns or create the need for access through a separate property.

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 for the construction phase, and for staff, visitors and services (pedestrian and vehicular traffic) of the completed building;
- provide sufficient on-site parking for all expected types of vehicles;
- create outdoor activity areas such as playgrounds;
- create suitable preparation and conditions for plant landscaping for microclimate control (such as snow drifting) and building sun-shading and appearance;
- provide landforms for any building security provisions (such as separation space from public access to vulnerable building elements) or at building access points and entrances.

## L1 CODES AND REGULATIONS

Refer to *GBP Subsection G6, "Codes and Regulations"* for an overview of applicable requirements. In addition, a particular site may also be subject to additional regulatory requirements, including:

| | |
|---|---|
| Zoning and Land Use: | Local municipality or GNWT - MACA |
| Water and sewer: | Refer to local municipality |
| Garbage removal: | Refer to local municipality |
| Parking: | Refer to local municipality |
| Fuel delivery: | Refer to local distributor |
| Power: | See Section E 1 |
| Telephone: | See Section E 8 |

## L2 INSTALLATION AND MAINTENANCE

### 2.1 INSTALLATION CONSIDERATIONS

#### 2.1.1 Schedule

In many northern communities, there is a very limited period of time when sitework can be done. Buildings are often completed in the late winter or spring, before the sitework can be finished. Temporary facilities providing access, vehicle and pedestrian traffic, and surface water control are therefore required to allow the completed building to operate safely and economically.

#### 2.1.2 Granular Materials

Local equipment for hauling, spreading and compacting fill is often limited in small communities. It is generally desirable to ensure that fill and grading work can be completed by the local municipality or local contractors, not only to benefit the local economy, but to minimize costs.

#### 2.1.3 Local Equipment

Sitework should be designed to ensure work can be completed using equipment and operators which are locally available.

## 2.2 MAINTENANCE CONSIDERATIONS

### 2.2.1 Snow Management

The long-term annual duration of a ground snow cover, and the need to clear snow from portions of a developed site, are normal conditions in all northern 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 recommended to be given to:

- how the snow must be removed (hand or machine);
- where removed snow will be piled and the snow drifting patterns and melt water drainage in spring that may be affected or caused by the snow pile;
- protection of building, vegetation and fixed site improvements from accidental impact damage by snow removal equipment.

### 2.2.2 Spring Thaw

In most northern communities the spring thaw occurs suddenly. Surface water from melting snow and ice, both from the ground and from building roofs, 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 and seeping into the building interior below grade;
- water or sewage holding tanks located in crawl spaces or basements floating and damaging rigid pipe connections;
- 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.

### 2.2.3 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 community climate environment are recommended to be selected for water stress tolerance. Plantings and plant species requiring additional regular irrigation to what is provided by the annual precipitation cycle are not recommended for use in northern site development.

# L3 ACCESS

## 3.1 PEDESTRIAN 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 also be protected from vehicle traffic.

| Recommendation | *Rationale* |
|---|---|
| **3.1.1 Walkways** | |
| 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. Surfaces should be well drained and finished with contained, finely crushed granular material, or pavement. | *This minimizes mud tracked into buildings during spring and fall. This is particularly important for facilities with high rates of public access such as schools, health centres, community recreation facilities, shops, stores, hotels, restaurants, and general office buildings.* |
| Concrete, paving or grating surfaces should be considered at entrances. | *Clean hard surfaces intercept dirt before it is tracked into the building.* |
| Avoid locating walkways immediately adjacent to walls of buildings, or where falling snow and ice from roofs is a potential safety hazard. | *Traffic near the building face can increase the incidence of vandalism damage to building finishes. Variable snow and ice packing on roofs in some years needs to land away from pedestrian walkways.* |
| **3.1.2 Ramps and Stairs** | |
| Whenever possible, eliminate the need for ramps and stairs by shaping the site. Grade elevation at building entrances should be as close to finished floor elevation as possible, while still providing effective water drainage away from the building walls. | *Sloped grade often permits removal of snow with small motorized equipment rather than by hand, such as is normally the case with stairs and ramps.* |
| 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 to be provided. Where the height requirement dictates that a ramp must be long enough to be returned upon itself through landings, then stairs are recommended to be provided in addition to the ramp. | *Stairs and ramps are often installed independently, though they lead to a common landing. This creates two paths of travel. A single access ramp that can accommodate all traffic including freight and furniture can reduce costs, reduce snow clearing requirements and satisfy barrier-free access requirements and policy referenced in GBP subsection G5.4, "Universal Accessibility – Barrier Free Design."* |
| 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. | *This controls erosion from normal use, while still providing effective water disposal off the walking surface.* |

Low maintenance open metal or fibreglass grating is the preferred surface material for exterior ramps, stairs and landings. Gratings should meet the requirements of applicable codes and the referenced standards.

*This allows snow to pass through, diminishing accumulations at entrance ways. NBCC 2005 Div. B Section 3.8, "Barrier-Free Design" provides guidance for design.*

Wood surfaces are acceptable for most pedestrian stairs and ramps.

*Wood is easily damaged by snow clearing, but is easily repaired or replaced using universally available materials and carpentry skills.*

Concrete stairs and ramps are acceptable.

*Where available, concrete can provide a durable, easily cleaned surface. The cost of long ramps and high stairs made of concrete may be prohibitive.*

### 3.1.3 Snowdrifting

Locate building entrances where snowdrifts will not normally form. If there are none, find another means of reducing the snow accumulation, including canopies and wind deflectors to improve wind-scouring of snow.

*Entrances are typically located so that predominant winds scour the area. Certain building configurations are also prone to snow accumulation, such as inside corners, but other building shape features can be positioned to help the wind prevent snow accumulating at entrances.*

Avoid locating entrances and exits at the inside corners of buildings.

*Inside corners are prone to snow accumulations.*

## 3.2 VEHICULAR ACCESS AND CONTROL

In many northern communities there are no municipal requirements for parking or service vehicle access to buildings. In general, requirements should be determined considering the following:

- vehicles commonly in use in the community may include cars, trucks, snowmobiles or all-terrain vehicles;
- where parking for users of northern buildings is to be provided as a requirement, and where location of exterior electrical outlets for vehicle heaters may be required;
- 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 a minimum of difficulty, meaning no obstruction by snow, standing water or steep slopes, and clear lines of sight to verify the access route is safely clear of pedestrians;
- required protection of building surfaces from vehicle impacts.

| | Recommendation | *Rationale* |
|---|---|---|
| **3.2.1** | **Routes and Parking** | |
| | Access routes and parking must accommodate the turning radius of local vehicles, including service vehicles and fire fighting equipment. | *Normal mode of transportation and type of service vehicles vary from community to community.* |
| | Vehicle routes and parking areas on site should be clearly marked, using physical barriers that remain visible in winter conditions if necessary. | *This is done to identify and control vehicle traffic around buildings and to provide some protection for pedestrians, landscaping, slopes of building pads or buildings. Boulders, logs, heavy timber or fencing can all be considered.* |
| **3.2.2** | **Parking Stalls** | |
| | Minimum dimensions for car or truck parking stall is 2.5 m x 6 m. Recommended sizes are generally larger, 3.0 m x 7.0 m for stipulated truck parking spaces. | *Use standard parking stall dimensions, especially in communities where no area requirements exist. Many communities have a large number of full-sized and extended frame pickup trucks.* |
| | Minimum dimensions for an ATV or snowmobile parking stall is 2 metres x 2 meters. Drive-through parking spaces are recommended for snow machines. | *ATVs and snow machines or snowmobiles are the most common vehicle in many communities - not all are able to back up.* |
| **3.2.3** | **Plug-ins** | |
| | See Electrical Section E6.3.6. | |

### 3.3 SERVICES AND UTILITIES ACCESS

With winter conditions lasting from six to eight months of the year in many northern communities, it is important that building service points are easily accessed by trucks and personnel, and protected from snow and ice build-up. Municipal utilities and fuel service in the majority of northern communities is by tanker truck. Fuel (primarily heating oil) is delivered exclusively by truck. Power and telephone are generally provided by overhead service distribution, but occasionally by underground installations. Some northern communities have access to piped natural gas, and others have propane distribution buried on sites.

Care must be taken to ensure earthwork digging on a developed site must take extra precautionary measures to identify buried utilities locations before digging. Broken underground pipes and wires take much longer to repair or replace in northern communities, where skilled trades and repair or replacement materials may be located far away from the community. Interruption of power, gas or water in winter, whether above ground or buried, can have expensive consequences and place buildings and occupants at substantial risk from extreme cold.

| Recommendation | *Rationale* |
|---|---|
| **3.3.1 Delivery Vehicles** | |
| Provide adequate space for delivery vehicles to pull off main roadway when they are servicing a building, yet still come close to building service connections without risk of impact. | *This keeps service vehicles from blocking other traffic, a municipal requirement in some communities.* |
| **3.3.2 Service Connection Access** | |
| Provide access stairs and platforms wherever people must access fill points or connect to services located more than 1.5 m above ground level.<br>Ladders or ships ladders are not acceptable due to the winter slipping risk and injury potential. | *Proper stairs allows delivery people to connect to raised building service access points easily and safely.* |

## 3.4 BUILDING ORIENTATION

Snowdrifts can impede access and exits from buildings, cause excessive structural loads on roofs, block windows, and provide easy access to the building roof by unauthorized persons.

| Recommendation | *Rationale* |
|---|---|
| **3.4.1 Snowdrifting** | |
| Snowdrifting around buildings should be managed through careful orientation on the site, and designed so that problems can be minimized or avoided. Wind control devices, such as scoops or accelerators, can be beneficial if supported by snow-drifting simulation studies. | *Although such devices have proven effective, they are an expensive alternative to proper building orientation on the site to take advantage of natural wind scouring. In certain communities, wind frequently shifts directions, making it difficult to rely on scouring by predominant winds, so well-designed wind deflection devices are recommended to be included as an effective snow management tool. Refer also to GBP Articles L2.2.1 and L3.1.3.* |

## L4 FILL AND GRADING

### 4.1 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 (MACA)
- the Federal Government (DIAND)
- and in many cases ownership may have recently been transferred through a land claim settlement to beneficial control by a local development corporation.

The GNWT through PW&S' Granular Materials Program manages stockpiles of granular materials in some communities. In this case fill can be supplied to the contractor by the GNWT through the PW&S granular program. Quantities need to be estimated well in advance of construction (generally the summer preceding construction) to ensure availability.

| | Recommendation | *Rationale* |
|---|---|---|
| **4.1.1** | **Built-up Granular Pads** | |
| | Provide an impermeable liner on slopes of pads that lie in the path of runoff in permafrost areas. | *This is done to divert water around the pad, rather than allowing it to seep under or through it, potentially degrading permafrost. See also GBP Subsection S3, "Foundations", for additional information*. |
| **4.1.2** | **Excavation** | |
| | Avoid cutting into existing soils where permafrost is present. | *This exposes frozen soil causing degradation of permafrost*. *See also GBP Subsection S3, "Foundations", for additional information*. |

### 4.2 GRADING

Although frozen for much of the year, building sites can be susceptible to significant damage during spring runoff or as a result of ponding or erosion and saturation by moving surface water:

- flooded crawl spaces have caused sewage holding tanks to float;
- structural integrity of foundations can be jeopardized by degrading permafrost;
- access to building by users or services can be impeded;
- water accumulating against foundation walls can seep into the building or saturate the foundation system with risk of water-based deterioration.

| | Recommendation | *Rationale* |
|---|---|---|
| **4.2.1** | **Finished Grades** | |
| | 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. | *This provides drainage away from the foundation without promoting erosion by runoff.* |

### 4.2.2 Retaining Walls

Where grade differences cannot be accommodated by slopes of less than 1:4 (25%), because of site constraints or limited fill materials, retaining walls may be considered.

*Using retaining walls can reduce the total amount of fill required; however, is generally a more labour intensive and expensive means of stabilizing slopes*.

### 4.2.3 Drainage Channels

Drainage channels or shallow ditches (swales) to manage initial drainage on newly developed sites must be in place on site before spring runoff: this may require temporary installation of swales or berms.

*Construction schedules dependent on barge delivery generally result in winter construction: the building is usually ready for occupancy by spring or early summer, but sitework cannot be completed until mid to late summer.*

## L5 SITE REHABILITATION AND LANDSCAPING

A comprehensive landscaping plan is recommended to incorporate requirements noted in the sections above. Landscaping using lawns, flower beds, trees and shrubs, however, is not usually a practical consideration in most northern communities. 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.

Recommendation

*Rationale*

### 5.1 EXISTING VEGETATION

Maintain as much existing vegetation on site as possible and protect from vehicular traffic.

*This protects the soil from erosion, insulates permafrost and generally improves appearance of site. Below the tree line, trees and bushes can provide shelter from wind, trap drifting snow and provide shade in the summer.*

### 5.2 VEGETATION - NEW/ADDED

Any plant material added to the site must be hardy, suitable for the locality and require little or no maintenance - transplanting of local species is encouraged where an acceptable source can be found in the community. See also *GBP Article L2.2.3, "Maintenance Considerations for Planted Areas".*

*Growing conditions are too harsh for most plants commonly used elsewhere in Canada. Development of landscape maintenance and gardening can provide specific technical benefits to site durability and building safety and comfort.*

### 5.3 SOIL

If soil or topsoil is required, it must be available within the community, along with any necessary additives to achieve effective plant nutrition.

*Mixed, prepared topsoil is simply not available in most communities. If required in any quantity, costs can be high.*

## 5.4 PLAYGROUNDS

Soft, sandy surfaces should be provided wherever play structures are installed. Play structures should be constructed primarily of wood, with minimal metal fastenings or fittings.

*To provide a safe play area: metal parts become hazardous during extremely cold weather. Sand and gravel surfaces require continuous maintenance for removing dog feces and other contaminants. Sandy surfaces are recommended for use where dogs are barred from access or the sand can be routinely replaced.*

END OF SECTION

# Table of Contents

# Table of Contents

# Table of Contents

# Table of Contents

# ARCHITECTURAL

## A1 CODES REGULATIONS & STANDARDS

See article General G6, Codes Regulations and Standards.

Documents referenced in GBP Section A, Architectural, in addition to those noted in "General G6", include the *AWMAC "ARCHITECTURAL WOODWORK STANDARDS - 1st Edition - 2009", "Best Practice Guide on Fire Stops and Fire Blocks and their Impact on Sound Transmission" Document No.NRCC-49677*, available as a free download from the URL site:
http://irc.nrc-cnrc.gc.ca/pubs/fulltext/nrcc49677/nrcc49677.pdf

## A2 INSTALLATION AND MAINTENANCE

### 2.1 INSTALLATION CONSIDERATIONS

Simple and uncomplicated designs that use readily available materials and components work best in the North. Building systems, subsystems and components should be selected to encourage uncomplicated installation by as few subtrades as possible. A design that can be built by fewer subtrades concentrates quality control responsibility, reduces construction co-ordination time, and leads to improved construction process efficiency. Improved quality and improved technical performance for a sustainable service life of the completed building is the result.

### 2.2 MAINTENANCE CONSIDERATIONS

Operational efficiency is the primary post-construction goal of good building practice. Operational efficiency is measured by time and cost. Four primary O&M time and cost considerations are:

- Fuel and power consumption

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

- Operation and maintenance of equipment

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

- Selection of building finish materials for efficient maintenance

  Building materials and finishes selected should be readily available, durable and simple to maintain and repair, reducing time and cost, and increasing operational efficiency.

- Building custodial services

  The choice of building finishes and floor layout, as well as convenient location and adequately sized storage for janitorial supplies and cleaning equipment will affect regular caretaking operations contributing to improved operational efficiency.

### 2.3 MAINTENANCE MATERIALS

Maintenance materials are supplied by the construction contract as spare parts for the use of the building maintenance staff after the construction warranty period has expired. The building owner should determine, in consultation with maintenance personnel and design consultants, what maintenance materials, and what quantity, should be supplied under the construction contract, how such materials should be delivered and stored, and how such materials should be accepted into inventory for use in the newly completed building.

Recommended maintenance materials include:

- Flooring material
- Prefinished interior wall covering materials such as plywood, plastic laminate or veneer-faced materials, such as sheet vinyl clad gypsum wall board
- Custom-tinted paint to match installed paint
- Custom-coloured exterior wall cladding materials
- Replacement parts for door hardware
- Precut replacement glass for exterior and interior windows
- Plastic laminates and cabinet hardware
- Paint or stain for exterior building cladding
- Roof water-shedding membrane material

## A3 BUILDING ENVELOPE

The building envelope separates the interior environment from the exterior climate. In various regions of the NWT design air temperatures range from about -48° Celsius in the winter to +28° Celsius in the summer, with periodic lower or higher temperatures in some years. Average hourly wind pressures can range from 0.26 kilopascal to 0.85 kilopascal. 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 150 mm in Hay River to 425 mm in Inuvik (as compared to 1,935 mm in Vancouver or 846 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 NWT such as the differences above and below the tree line must be incorporated into building envelope design. These variables include snowdrifting patterns, wind, seasonal temperatures, annual insolation, and very high one day rainfalls (75 mm, Ft. Simpson). Climate change appears to be increasing the typical total annual precipitation in most regions of the NWT, and updated weather data for the climate design tables in the National Building Code is expected to be available with the 2010 code edition.

Careful design and construction are required to ensure water resistant, low air leakage, energy efficient building envelopes. Recommended minimum practices in Good Building Practice should 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 *NBC Part 5*, and *NBC 9.25* for practical and effective application meeting northern climate conditions, which often create a more demanding building envelope performance environment than found in many other parts of Canada.

## 3.1 AIR MOVEMENT, WATER AND VAPOUR PROTECTION

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

Environmental separation requirements are well-stated in *NBC 2005 Div. B Part 5, “Environmental Separation”* and *NBC 2005 Div. B Section 9.25, “Heat Transfer, Air Leakage and Condensation Control”*. Successful application of *NBC 2005 Div. B Part 5*, or *NBC 2005 Div. B Section 9.25* requirements can be more difficult in the North than in other parts of Canada because of a short construction season, very cold temperatures affecting the performance characteristics of materials, and periodic shortages of experienced installers. Additional reference information, if available, about building envelope precipitation control, moisture control, condensation control and air leakage control are provided in the rationale column in the following articles.

Performance verification of northern building envelopes is recommended to be provided using infrared thermographic surveying for final commissioning with the building pressurized and with adequate differences between the interior and exterior air temperatures.

| Recommendation | *Rationale* |
|---|---|
| **3.1.1 Control of Rain and Snow Penetration** | |
| The requirements of *NBC 2005 Div. B Subsection 5.6.1, "Protection from Precipitation"*, and *NBC 2005 Div. B Subsection 5.6.2, ‘Sealing, Drainage, Accumulation and Disposal”* apply. Additional recommended best practice for snow and ice drainage from exterior wall cladding is found in *GBP Article A3.5.1, “Exterior Wall Cladding*”. | *NBC 2005 Div. B technical provisions for precipitation when used comprehensively have been found to be effective for northern buildings.* |
| **3.1.2 Control of Moisture from the Ground** | |
| The requirements of the *NBC 2005 Div. B Section 5.8 "Moisture in the Ground"* apply. Recommended best practice is to apply these requirements in combination with effective surface water control, as required *by NBC 2005 Div. B Section 5.7, “Surface Water”*, and effective site grading best practice recommendation in *GBP Sitework Article L4.2.4*. | *NBC 2005 Div. B technical provisions for moisture in the ground when used in combination with good surface water drainage have been found to be effective for northern buildings.* |

### 3.1.3 Control of Vapour Diffusion and Condensation

The requirements of *NBC 2005 Div. B Section 5.5 Vapour Diffusion* apply. Location of the vapour barrier in the warmest portion of the building envelope, on the interior side of the thermal insulation, is recommended best practice for Northern buildings. Providing only one plane of high water vapour resistance (low water vapour permeance) is recommended best practice for walls and suspended floors, along with natural ventilation for drying the assembly of incidental condensate or frost, and draining the assembly to the exterior.

*The objective of controlling vapour diffusion and condensation is to eliminate water vapour migration from the warm interior air into the building envelope, and to ensure that any water vapour that does pass through gaps in the vapour barrier is not trapped permanently in the envelope where it can rot or rust materials, or support mould and fungus growth. Water vapour that migrates toward the cold exterior portions of the building envelope can accumulate in the envelope as frost over the winter months. The moisture resulting from melted frost must be able to drain away or evaporate during the warm season before the next winter.*

Recommended best practice for control of air leakage, a major cause of moist air migration into building envelope assemblies, by using effective air barrier installation, is provided in *Article GBP A3.1.4, "Air Leakage Rates"*.

Control of vapour diffusion and condensation in Northern roof systems similarly relies on positioning the vapour barrier on the warm side of the thermal insulation, preferably in the same plane as the required continuous air barrier. Refer to Article *GBP A3.6.1, "Roof Air Movement, Water and Vapour Protection*", for additional recommended best practice.

*Snow and ice covered unventilated low-slope Northern roofs present a special case envelope assembly which is at greater risk when retaining trapped water. Whether from frost formation, from air leakage into the assembly, or from precipitation ingress, unventilated roofs rot much faster than ventilated roofs because they trap heat from solar radiation as soon as the reflective snow cover is lost, speeding up the rotting process.*

### 3.1.4 Air Leakage Rates

The maximum recommended air leakage rate values for air barrier system in opaque insulated portions for Northern building envelopes are:

*Although the NBC 2005 Div. B Section 5.4 and NBC 2005 Div. B Section 9.25 require all buildings to have an effective air barrier system, the maximum leakage criteria provided of 0.02 L/s/$m^2$ in NBC 2005 Div. B Sentence 5.4.1.2.(1) applies to buildings in all parts of Canada, including the more temperate regions. The NRC-IRC has suggested these lower air leakage values in NBC 2005 Div. B. Appendix Articles A-5.4.1.2.(1) and (2) are applicable to all parts of Canada, as guidance when testing air barrier systems as opaque insulated portions of a building envelope. Theoretically, this amount of air leakage through the opaque insulated portions of the envelope will limit the introduction of water vapour into an envelope assembly to what can be 'managed' on an annual moisture deposition and drying cycle. See GBP Article A3.1.3.*

.1 0.15 litre/sec/$m^2$ @ 75 Pa for all buildings with a low indoor air relative humidity less than 27%.

*This will typically apply to buildings with low to moderate part day occupant loads and few sources of water vapour, or to buildings that have dehumidification systems, typical of warehouses, large volume stores, low occupant load offices, vehicle storage and repair facilities, and similar.*

.2 0.1 litre/sec/$m^2$ @ 75 Pa for all buildings with a normal indoor air relative humidity between 27 and 55%.

*This will typically apply to buildings with moderate to high part day occupant loads, schools, community halls, health centres, libraries or higher occupant load offices.*

.3 0.05 litre/sec/$m^2$ @ 75 Pa for all buildings with a normal indoor air relative humidity greater than 55%.

*This will typically apply to residential occupancies including group homes, student residences or long term care facilities, and to humidified portions of hospitals, indoor pools and spa rooms.*

### 3.1.5 Rainscreen Cladding and PERSIST Techniques

Building envelopes are to be designed in accordance with the 'rainscreen cladding technique' (pressure equalization practice) providing natural air ventilation and air drying of the exterior cladding material. When continuous thermal insulation is installed completely on the cold (exterior) side of the structure, and combined with a rainscreen cladding, the system is called a PERSIST system, for Pressure Equalized Rain Screen Insulated Structure Technique.

*The objective of the rainscreen cladding technique is to ensure that wetted exterior surfaces of walls are not subjected to constant air pressures. Capillary action, gravity or air pressure can force water on the sheathing surface of the wall to move into the interior portions of the wall through construction joints or other fissures. Refer to CBD-40: "Rain Penetration and its Control", and the URL:*

*http://www.bcbuildinginfo.com/display_topic.php?division_id=8&topic_title_id=16&topic_id=55 for detailed information about all aspects of rainscreen cladding technique.*

With the rainscreen cladding technique, a self-draining naturally ventilated air compartment is required between the exterior water shedding cladding and the sheathing of the wall, and the sheathing is recommended to be lined with a water vapour permeable weather barrier like building paper or Tyvek, to help limit incidental wetting of the sheathing.

*The self-draining compartment behind the exterior wetted cladding is naturally ventilated to allow the face and back of the cladding to be at the same air pressure. The natural ventilation allows air drying of the compartment and of both faces of the cladding. The compartment is intended to keep the sheathing surface from being wetted from intrusion of precipitation from the exterior.*

- Divide all self-draining naturally ventilated air compartments behind the exterior cladding into pressure equalization compartmented voids (i.e., into cells where the air pressure is equal to exterior air pressure) no more than one storey in height, and no more than 6 m wide along building faces. At corners, compartments should be no more than 2.4 m wide, with compartments closed at corners.

*Strong air flows behind the exterior cladding can carry rain or snow into pressure equalization compartments and into contact with the interior sheathing, which is required to be kept dry. Smaller compartmentation reduces the likelihood of strong air flows developing, and therefore the likelihood of wetting the sheathing. Pressure equalization compartments must also incorporate openings to provide the drainage required by NBC 2005 Div. B Article 5.6.2.1.*

### 3.1.6 Building Envelope Materials and Assembly

.1 Vapour Barriers

Materials used to form the vapour barrier must be:

*See GBP Article A3.1.3 "Control of Vapour Diffusion and Condensation". The purpose of a vapour barrier is to restrict diffusion (water vapour movement through the materials of the assembly).*

- Durable, mechanically supported and protected from deterioration, and accessible for repair if needed during the entire service life of the building.

*To meet or exceed the service life of the building*.

- Impermeable to water vapour and meeting the requirements of NBC 2005 and reference standards *CAN/CGSB 51.33-M or CAN/CGSB 51.34-M.*

*CAN/CGSB 51.33-M, “Vapour Barrier Sheet, Excluding Polyethylene, for Use in Building Construction”.*

*CAN/CGSB 51.34-M, “Vapour Barrier, Polyethylene Sheet for Use in Building Construction*.

- Physically and chemically compatible with other building components.

*Differences in chemical composition, creep behaviour, elasticity, thermal expansion, shrinkage, and moisture changes could result in reduced permeability or durability of the vapour barrier*.

Vapour barriers must be installed so as to never create moisture entrapment between layers of impermeable materials. Any material with low vapour permeance that is located on the low vapour pressure (generally cooler) side of the envelope assembly, must be installed in such a way that vapour can migrate past it to the exterior, or to the naturally ventilated compartments of a rainscreen cladding installation.

*Vapour barrier installation must meet the requirements of GBP Article A3.1.3. Materials with low vapour permeance, such as plywood sheathing made with vapour impermeable glues, or rigid foamed plastic insulation with vapour impermeable facings, will be barriers to vapour movement. Vapour that is passing through the assembly toward the exterior during the drying phase must be allowed to migrate to the exterior through open joints between sheets or perforations, or moisture will risk becoming trapped between water vapour tight layers. Performance verification of Northern building envelopes is recommended to be provided using infrared thermographic surveying for final commissioning with the building pressurized and with adequate differences between the interior and exterior air temperatures.*

.2 Air Barriers

Materials used to form the air barrier system, must be:

*The purpose of an air barrier system is to prevent air movement and eliminate pressure driven air flow through fissures in the building envelop.*

- Durable, mechanically supported, protected from deterioration, and accessible for repair if needed during the entire service life of the building.

*To meet or exceed the service life of the building*.

- Impermeable, to eliminate the movement of air through the building envelope.

*To minimize the movement of air through the barrier.*

- Recommended best practice leakage rates for Northern building envelopes are noted in *GBP Article A3.1.4.*

*An air barrier system, consisting of air leakage resistiant materials and sealed joints, typically fails at the joints between different materials or near penetrations of the materials. Air leakage resistance of the principal materials used will therefore typically be greater than the air leakage resistance of the complete air barrier system.*

Materials used to form the air barrier system are recommended to have air permeance test values less than 1/10th of the air leakage rate recommended in *GBP Article A3.1.4* for the opaque insulated portions of a Northern building air barrier system.

*Measuring the performance of the entire building envelope is difficult; however, the materials themselves can be easily tested: these values have been suggested by the NRC in the expectation that once installed, the air leakage rate of the entire air barrier system will be below values recommended in GBP Article A3.1.4.*

- Continuous

  Verifiable sealing of joints, corners and penetrations is recommended for all Northern building envelope air barrier systems.

  *Testing air barrier continuity ensures that there is an acceptably low uniform level of air leakage when doors, windows and similar closures in the entire envelope are included. Excessive air leakage at any one location is a failure of the entire system.*

- Rigid and strong

  Rigid and strong to withstand both positive and negative air pressures due to wind, mechanical equipment and stack effect, in accordance with *NBC 2005 Div. B Subsection 4.1.7, "Wind Load"*. Air barriers must be designed to transfer such pressures to the structural framing with minimal deflection.

  *If it were not rigid and strong, the material would be easily displaced by the air pressures acting on it - the movement can then cause the material to tear at attachment points, or the joints to fail.*

- Physically and chemically compatible with other building components.

  *Differences in chemical composition, creep behaviour, elastic movement, thermal expansion or shrinkage or expansion due to moisture changes could result in the loss of strength, continuity, impermeability or durability of the air leakage barrier.*

.3 Air and Vapour Barrier Location

Mechanically supported (fully adhered to a stiff material) coincident air/vapour (AV) barrier membranes located on the outside of structural framing or sheathing are recommended for all buildings.

*By locating the AV barrier (and thus the thermal insulation) on the exterior of structural framing or sheathing, rather than on the interior, the structure is maintained at warm interior temperature, and:*

- *the potential for moisture damage to the structure due to condensation is virtually eliminated;*
- *interior finishes can be applied directly to structural framing without the need for additional strapping or protecting the AV barrier from puncture;*
- *penetration of the AV barrier by mechanical and electrical systems is reduced to those elements that must exit the building at accessible locations where permanent sealants can be installed and repaired;*
- *with fewer penetrations and use of a mechanically supported air barrier, a good quality installation is simpler to achieve.*

Coincident AV barriers located on the inside of structural framing are acceptable, and as noted in *GBP Article A3.6.3* for roofs, only for small naturally ventilated roofs located in areas not affected by high winds and airborne snow drifting.

Performance verification of Northern building envelopes is recommended to be provided using infrared thermographic surveying for final commissioning with the building pressurized and with adequate differences between the interior and exterior air temperatures.

*A common practice for smaller buildings is to install polyethylene sheet on the interior of framing as a coincident vapour retarder and air barrier, and although this assembly meets the requirements of the NBC for vapour protection, it requires that a number of precautions be taken to ensue air barrier continuity, including:*

- *plumbing and electrical wiring routes in exterior floors, walls and roofs must be carefully detailed to minimize AV barrier penetrations;*
- *interior strapping or other means of attaching finish materials is recommended to be provided to accommodate electrical wiring and outlets without the need for air/vapour barrier penetrations, or the need for enclosure boots and specialized seals, or,*
- *a continuous moisture permeable air barrier can be installed at another location in the envelope.*

.4 Sealants

Sealants used as part of a building envelope assembly must be:

*The performance of sealants is dependent on choosing the correct sealant for the substrate as well as installation of the sealant under manufacturer's recommended temperature and moisture service conditions.*

- Serviceable to -50ºC in their fully cured state.
- Able to be installed under temperature and moisture conditions to be encountered during their installation.
- Strong enough to resist the anticipated loads without deforming or moving out of position.

*Construction typically occurs during cool or cold temperatures in the NWT. Silicone and elastomeric sealants are available that can be applied at sub-zero temperatures and remain serviceable at temperatures down to -50ºC. Many other sealants cannot be properly applied at sub-zero temperatures and lose their ability to fulfill functional requirements at cold temperatures.*

- Elastic and compressible to accommodate movement of the joint.
- Chemically compatible with adjacent materials.
- Accessible for service or replacement.

*See also Canadian Building Digest #155 - Joint Movement and Sealant Selection".*

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

*Silicone based or one component elastomeric sealant types that meet the performance criteria are recommended. Acrylic and solvent curing types (example Butyl caulking) have been found to perform less effectively in the Northern environment. Multi-component products are recommended for specialized applications, such as curtain walls and exterior panel or pan systems.*

- Performance verification of Northern building envelopes is recommended to be provided using infrared thermographic surveying for final commissioning with the building pressurized and with adequate differences between the interior and exterior air temperatures.

## 3.2 THERMAL RESISTANCE AND INSULATION

The thermal resistance of the building envelope serves two important functions: to minimize heat loss through the envelope and thereby reduce building energy consumption, and to prevent moisture condensation on surfaces interior to the building envelope. *GBP Subsection G3, "Energy Management"* provides a comprehensive recommended best practice overview for Northern buildings.

The National Energy Code of Canada for Buildings, available from NRC-IRC in 2011, is a national model code document on energy performance that can be adopted by provincial and territorial jurisdictions. It contains a methodology for determining optimum thermal resistance of building envelopes. Refer to *GBP Article G6.2, "The National Energy Code of Canada for Buildings*", or "*The Model National Energy Code of Canada for Buildings, 1997"* until the 2011 version is available.

Performance verification of Northern building envelopes is recommended to be provided using infrared thermographic surveying for final commissioning with the building pressurized and with adequate differences between the interior and exterior air temperature.

Recommendation

*Rationale*

### 3.2.1 Recommended Thermal Resistance Values

In the absence of an energy model, the minimum recommended overall thermal resistance of the opaque insulated portions of building envelope assemblies to maintain optimum human comfort for Northern buildings is recommended to be:

- Suspended Floors: RSI 7.0
- Floors above Thermosyphon Grids or Thaw Susceptible Soils: Custom Design Value
- Floors on grade on non-frost susceptible soils: RSI 3.5 or Custom Design Value
- Walls: RSI 5.6
- Roofs: RSI 8.75

*An acceptable overall level of thermal resistance is to be achieved regardless of the type and placement of the insulation in the assembly. The recommended minimum overall thermal resistance values provided are benchmark values to be used in the absence of an energy utilization study.*

Buildings or portions of buildings not intended to meet typical human comfort conditions may have lower envelope thermal resistance values and still meet energy consumption standards.

*For unheated or minimally heated buildings, such as ice arenas and parking garages, thermal resistance may not be a functional requirement of the building envelope. Seasonal use buildings may have reduced overall thermal resistance values specifically designed for the period of the year they are to be occupied.*

### 3.2.2 Thermal Insulation Location in the Envelope

All thermal insulation is recommended to be located on the cold side of the coincident AV barrier system.

.1 Where the coincident AV barrier is located on the exterior side of the structural framing, rigid insulation or semi-rigid Mineral Fibre Thermal insulation is recommended to be used. Mineral Fibre Thermal Insulation conforming to *CAN/ULC-S702-97* is recommended.

*Insulation applied to the exterior of the building structure provides a uniform insulating value over the entire building envelope. Compressible mineral fibre insulation can also be used, provided it is protected, drained and vented to keep it dry as required by NBC 5.3.1.3.*

.2 Combustible rigid insulation or Mineral Fibre Thermal insulation is recommended to be appropriately fire-stopped.

*Fire stopping is recommended to be done in general compliance with configuration and location requirements of NBC 2005 Div. B Subsection 3.1.11 or Subsection 9.10.16.*

.3 Where the coincident A/V barrier is located on the interior side of structural framing, compressible fibrous thermal insulation may be used in the structural framing space, provided the requirements of *NBC 5.3.1.3* are met. (A layer of insulating sheathing is recommended in addition to the insulated structural cavities; see *GBP Article A3.2.3*).

*The overall thermal resistance of the assembly is reduced by the structural members. Heat loss by thermal bridging through structural members is recommended to be minimized by using insulating sheathing on their exterior. Thermal resistance varies at the junctions of floor and wall, and wall and roof; it is difficult to avoid thermal bridging by framing members at these locations. Insulating sheathing is a practical method for increasing thermal resistance at such locations.*

### 3.2.3 Continuity of Thermal Insulation

Thermal bridging by structural members needs to be recognized and minimized in the building envelope design.

.1 Where insulation is installed outside the structural framing, it should be installed in two layers at right angles. The insulation may be secured with two layers of girts or strapping installed at right angles, or with one outer layer of girts screw-fastened through the lower layer of insulation into structural framing.

*The intent is to reduce thermal bridging through girts or strapping.*

.2 Where insulation is installed within structural framing, a layer of insulating sheathing should be provided on the exterior of the framing or the exterior structural sheathing.

*The intent is to reduce thermal bridging through structural members. This is already common practice in Northern buildings.*

### 3.2.4 Preventing Localized Cold Spots

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

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

Ensure convection air from radiation is free to move up walls and beneath windows to avoid localized cold spots.

*The location of furniture, fixtures and fittings can block warm air movement within a space so that some surface temperatures in the interior normally warm zone of the building may fall below the dew point. A typical instance is cabinets positioned on an exterior wall, without an air inlet in the toe space to allow room air to circulate to the radiator at the back of the cabinet. Some shelving and stacked storage of boxes can also block warm interior air flow to the exterior surfaces of a building. Corners where two cold exterior surfaces join (roof to wall and wall to suspended floor connections) are especially prone to becoming localized cold spots.*

## 3.3 BUILDING ENVELOPE FLOOR ASSEMBLIES

Northern buildings can be placed on the ground when rock or similar durable soil conditions are available. Often Northern buildings are elevated above the ground surface to eliminate heat flow into thaw susceptible soils. Elevated buildings require careful design of air, vapour and thermal barriers because an additional 20% to 30% of heat-losing building exterior envelope surface is created, compared to a building placed on the ground.

Basements and buried strip and pad footings are possible in many locations where the foundation system can be supported deeply enough below the active layer, or where the ground is unaffected by freezing. Such foundation systems require careful design to minimize heat transfer and ground water intrusion.

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 refrigeration have all been used to keep permafrost intact beneath heated buildings by using seasonal winter re-freezing. In all cases, great care must be taken to prevent building heat transfer into the ground through the foundation system. (Refer also to *GBP Subsection S3, "Foundations"*).

### 3.3.1 Floor Assemblies Air Movement, Precipitation and Vapour Protection

All recommendations of *GBP Subsection A3.1, "Air Movement, Precipitation and Vapour Protection*" apply to building envelope floors, including floors elevated above grade, and floors built in basements below grade.

*GBP Subsection A3.1 clarifies the NBC 2005 environmental separation requirements for floor assemblies of Northern buildings.*

All building envelope floors subject to differential temperature, water vapour pressure or air pressure require air barriers (AB) and vapour barriers (VB) meet the recommendations outlined in *GBP Articles A3.1.3* and *A3.1.4*.

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

### 3.3.2 Floor Assemblies Thermal Resistance

Recommended thermal resistance values for floor assemblies is contained in *GBP Article A3.2.1 "Recommended Thermal Resistance Values".*

### 3.3.3 Floor Assemblies Materials and Assembly Air/Vapour Barrier

.1 Air/Vapour Barrier

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, and the comfort of building occupants is a consideration, or where suitably conditioned space is required to accommodate plumbing drains. See *GBP Articles A3.1.6.1, A3.1.6.2* and *A3.1.6.3*.

*A false floor will reduce thermal bridging heat loss through the floor structural components. A false floor provides benefit for residential and institutional occupancies such as residential care facilities, schools and day care facilities, halls, auditoriums and gymnasiums, and similar buildings where occupant comfort at floor level is a consideration.*

*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 in Northern buildings) 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.*

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.

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.

*The joints of some water vapour impermeable exterior soffit finish materials should not be sealed in an effort to create an external air barrier. The glue layers in a plywood soffit for instance resist water vapour migration and create a cold side vapour barrier if the joints are sealed. A second vapour barrier in the floor system will trap moisture within the assembly. See GBP Article A3.1.6.1.*

Extra construction care and performance test verification and commissioning of the AV barrier continuity is recommended to be provided, including special detailing where floor AV barriers are located on a different plane from that of the walls. Commissioning, including construction verification and performance testing of mockup sample floors including floor to wall joints and seals is recommended for complex wall assemblies and/or large buildings.

*Environmental separation requirements for building envelope elements are contained in the relevant Sections of Part 5, NBC 2005, Div. B. Since it is very impractical and expensive or almost impossible to correct AV barrier and thermal insulation failures after exterior elevated floors are assembled and the components concealed by finishes, commissioning and verification in advance of the building completion is essential to obtain the intended design quality and operational performance efficiency.*

.2 Sealants

See *GBP Article A3.1.6.4*.

.3 Insulation

See *GBP Section A3.*2 and following subsections.

.4 Drainage and Ventilation

*GBP Subsections A3.1.1 and A3.1.3* address precipitation and water condensation management.

*GBP Subsection A3.1.2* addresses control of moisture originating in the ground.

.5 Exterior Finishes

.1 Recommended exterior soffit materials for elevated floor assemblies are:

- durable
- light weight
- easily installed
- easily removable and replaceable for maintenance access to contained services with locally available trades skills
- installed with the minimum number of exposed joints

*The underside of a suspended floor is not generally in contact with water, snow or soil, nor is it generally visible. Batten strips covering soffit material joints prevent snow, dust and insect entry, but should be positioned to allow enough air movement to effectively ventilate an elevated floor.*

*Materials considered to satisfy these requirements include sheet materials such as plywood, exterior grade particle and oriented strand board suitably battened at the joints, and corrosion protected, ribbed sheet metal with lapped mechanically fastened joints.*

.2 Preservative-treated materials for floor soffits are recommended where continually high moisture levels are anticipated.

*The dry climate of the North, where suspended floor systems are typically used, generally makes the use of preservative-treated materials only necessary where excessive air humidity is expected.*

### 3.3.4 Thermal Break

A thermal break should be provided between highly conductive structural materials such as steel piles used as foundation units, when they might conduct building heat from the heated portions of the floor assembly into thaw susceptible soils in the bearing stratum. Long term continuous transfer of building heat into the frozen bearing stratum can affect the long term durability and stability of the building substructure in a warm permafrost environment by causing the permafrost to soften or thaw. See *GBP Article S3.1.7, “Thaw Susceptible Soils*”.

*To minimize heat loss from the building, which could potentially reduce the bearing capacity of thaw susceptible warm permafrost soils and to prevent the introduction of cold spots and excessive heat loss due to thermal bridging across the building envelope.*

### 3.3.5 Basements and Crawl Spaces

.1 Open Crawl Spaces

Open crawl spaces below buildings should be securely enclosed with durable metal mesh, and equipped with a lockable gate to allow for access.

*The objective is to prevent unauthorized and unsafe uses of the open crawl space under the building.*

.2 Heated or Semi-Heated Enclosed Crawl Spaces

Enclosed crawl spaces should be treated as environmentally different spaces when temperature and humidity conditions of the crawl space will be different from adjacent spaces within the building. Enclosed crawl spaces require protection from moisture in the ground.

*The different crawl space environment can result in air/vapour leakage, unwanted heat transfer, or condensation and mould infestation. Separation requirements for heat, air and water vapour between interior environments are identified in NBC 2005 Div. B Sections 5.3, 5.4 and 5.5. Protection from moisture in the ground is identified in NBC 2005 Section 5.8.*

.3 Crawl Space Drainage

An open crawl space is to be graded to prevent water from ponding under the building. A minimum graded slope of 4% or greater to sump points, or away from the building, is recommended for all crawl space ground surfaces. An enclosed crawl space is required to be drained to a sump pit or sewer drain which must not break the continuity of the ground moisture barrier.

*This conforms to NBC 2005 Div.B. Section 5.7, to ensure that surface and ground water does not accumulate in crawl spaces. The objective is to dispose of any surface water from spring runoff away from an open crawl space, and to collect and remove and dispose of ground water that might enter an enclosed crawl space.*

.4 Utilidettes

Where pipes and ducts are incorporated into a suspended floor system above an open crawl space, provide a suspended utility space or utilidette to enclose them within the environmental separation provided by the building envelope.

*Using utilidettes to enclose grouped pipes and ducts in a floor system elevated above an open crawl space can eliminate the need for an expensive continuous suspended utility space.*

Utilidettes should be constructed to allow maintenance staff ease of access.

.5 Service Spaces/Trenches Below Building

Where maintenance staff are required to access mechanical and electrical service equipment, service spaces will be a minimum of 1.5 m. tall and 1.0 m wide.

*Sufficient space is required to allow maintenance personnel ease of access to conduct maintenance tasks on equipment and services installed in basements, crawl spaces and service trenches.*

## 3.4 BUILDING ENVELOPE - WALLS

Walls make up a large part of a building envelope. Walls usually incorporate a large number of openings and penetrations such as doors, windows, ducts and chimneys, pipes and electrical conduits. Care must be taken to make the air and vapour barrier systems in building envelope walls continuous at all openings and penetrations, and at joints with floors and roofs and thermal resistance (insulation) systems continuous at all structural elements to prevent thermal bridging and excessive heat loss and cold spots.

### 3.4.1 Envelope Walls Air Movement, Precipitation and Vapour Protection

All recommendations of *GBP Article A3.1, "AIR MOVEMENT, PRECIPITATION AND VAPOUR PROTECTION*" with the exception of *A3.1.2,"Control of Moisture from the Ground"* apply to building envelope wall assemblies**.**

*GBP Subsection A3.1 clarifies the NBC 2005 environmental separation requirements for envelope walls of Northern buildings.*

All walls forming part of the building envelope and interior walls separating building compartments with different temperature and humidity require thermal insulation air leakage barriers and vapour diffusion barriers meeting all requirements outlined in *GBP Articles A3.1.3* and *A3.1.4.*

*Although this applies primarily to exterior walls forming the weather enclosing envelope, interior walls that subdivide buildings may also be subject to differential temperature, air pressure and water vapour effects. Examples include community arenas, or combined office and unheated or minimally heated warehouse and cold storage buildings, buildings similar to firehalls, vehicle storage and repair garages containing heated portions, such as offices, or buildings containing minimally heated vehicle storage bays.*

### 3.4.2 Envelope Walls Thermal Resistance

See *GBP Article A3.2.1*.

### 3.4.3 Envelope Walls Materials and Assembly

Extra construction care and performance test verification and commissioning of the AV barrier continuity is recommended to be provided, including special detailing where roof or floor AV barriers are located on a different plane from that of the walls. Commissioning, including construction verification and performance testing of mockup sample walls including doors and windows is recommended for complex wall assemblies and/or large buildings.

*Environmental separation requirements for exterior walls are contained in the relevant Sections of Part 5, NBC 2005, Div. B. Since it is very impractical and expensive or almost impossible to correct AV barrier and thermal insulation failures after exterior walls are assembled and the components concealed by finishes, commissioning and verification in advance of the building completion is essential to obtain the intended design quality and operational performance efficiency.*

.1 Air/Vapour (AV) Barrier

See *GBP Articles A3.1.6.2* and *A3.1.6.3*.

.2 Sealants

See *GBP Article A3.1.6.4*.

.3 Insulation

See *GBP Subsection A3.2*. and *Articles A3.2.1, A3.2.2, A3.2.3*, and *A3.2.4*.

.4 Drainage and Ventilation

| | |
|---|---|
| See *GBP Article A3.1.5, “Rainscreen Cladding and PERSIST Techniques*”. | *To meet NBC 2005 Div. B Subsection 5.6.2.1 requirements, including application of the rainscreen principle.* |

## 3.5 EXTERIOR WALL CLADDING

“Good Building Practice for Northern Facilities” does not specify where particular materials are to be used. Materials selected by the designer are however expected to conform, for function and maintenance requirements, to the best practice recommendations noted in the various articles in this document. Maintenance needs, appearance, durability, ease of repair and availability of repair materials in remote Northern communities are all considerations that are expected to be actively made and optimized for durability and economy when selecting wall cladding.

### 3.5.1 Exterior Wall Cladding General

| Recommendation | *Rationale* |
|---|---|
| All exterior wall cladding should be installed so that the requirements of architectural *GBP Subsection A3.1, “Air Movement, Precipitation and Vapour Protection*” are met. | *Air pressure equalization compartments for rainscreen wall design can be created by using strapping applied to support the exterior cladding.* |
| Exterior wall cladding patterns, fasteners and edge joints should provide for easy replacement of individual boards or panels at locations on the building exposed to intentional or accidental damage, and where vehicle access barriers are impractical to install. Reference *GBP Subsection L3.2, “Vehicular Access”*, for recommended practice to limit mechanical equipment access to building exterior walls. | *Recurring damage can be caused to the cladding on the lower portion of exterior walls of buildings accessible to the public, and where service vehicles or snow clearing or other mechanical equipment is used near the building wall. These locations typically occur on walls next to walkways, water, sewage and oil service points, around exterior stairs and landings and exterior corners of all buildings, or near overhead doors of garages, loading docks, and similar locations.* |
| Exterior wall cladding texture, profile shape and installation configuration should encourage rapid drainage of melting adhered ice and snow, and allow wind-driven rain to drain rapidly from the surface, and the cladding to dry naturally. | *Vertical installation of fluted, board or grooved materials promotes faster drying and reduces weather deterioration of materials.* |

### 3.5.2 Wood Exterior Wall Cladding

Wood cladding is acceptable where weather conditions and maintenance resources support its use. Lap joint, channel or drop joint siding is recommended. Board and batten or tongue and groove jointed siding is acceptable, but these board styles should be installed vertically to speed water drainage and promote rapid drying. Spruce or cedar siding is acceptable, and siding may be air-dried or kiln-dried.

*Wood is readily available, relatively inexpensive, and can be installed with basic carpentry skills and tools available in most communities, but requires periodic refinishing to offset weathering. Horizontally installed boards retain melt water and rain, wetting the wood for longer duration. Research has found shorter service life and splitting, warping and staining results when wood cladding stays wet for long periods.*

A semi-transparent oil-based stain finish is recommended for ease of routine maintenance, and 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.

*Although wood siding requires regular maintenance, semi-transparent stain is easily applied and a variety of colours and lustres can be used. Non-vapour permeable paint seals wood and does not allow moisture from the concealed side of the rainscreen to migrate freely outward. As a result, non-breathing paint can peel prematurely.*

Wood siding should not be used on buildings with insufficient maintenance resources or increased vandalism or fire risk, and not on south and west elevations with intense sunlight exposure.

*Metal and cement composite cladding products are preferable for such conditions. See A3.5.6, "Cement Composite Exterior Cladding".*

Prefinished plywood siding, such as "Ranch-Wall", minimum 15.5 mm thick, is an acceptable wall cladding material, if installed with adequate venting. Medium density overlaid (MDO) plywood (exterior type plywood with a weather-resistant resin overlay bonded to the wood by heat and pressure) is not recommended as an exterior finish for Northern buildings.

*Temperature and humidity extremes cause the overlay to come loose due to water vapour migration over time, because the overlay is non-vapour permeable, MDO installations have been found to be difficult to repair finish damages. Without back-priming and edge sealing panels, the MDO kraft paper surface is subject to delaminating, and peeling at edges.*

Nail or staple fasteners for attachment of wood cladding are recommended to not exceed a spacing of 400 mm for attachment to wall studs. Attachment to sheathing only is not recommended.

*Northern building walls encounter more strain of cladding materials caused by weather conditions and foundation movement from freeze-thaw cycling, than buildings in the more temperate regions of Canada.*

### 3.5.3 Metal Exterior Wall Cladding

Metal wall siding panels should be factory preformed steel sheet, minimum 0.6 mm (24 gauge) base metal thickness, zinc coated, and factory prefinished on the weathering face.

*Metal cladding is typically used to clad prefabricated metal buildings such as recreational facilities or service buildings. Metal cladding is susceptible to moderate to large impact damage, and because repairs are not always easily undertaken by locally available tradespersons, the damage is often left unrepaired.*

*Physical protection to metal cladding should be considered at areas most susceptible to damage, such as entrance ways.*

Profile and colours should be selected from manufacturer's standard profiles and standard colours. 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.

*The extra cost and delivery time for using custom profiles or colours is generally not warranted for Northern buildings. Standard profiles and colours allow for easier and less costly future purchase of matching repair materials.*

Aluminum siding is not recommended for Northern buildings.

*Aluminum is typically vulnerable to impact damage, and subject to large thermal expansion and contraction. With typically large Northern temperature fluctuations, rippling and "oil-canning" occur more readily.*

### 3.5.4 Vinyl Exterior Wall Cladding

Vinyl exterior cladding is not recommended as a first choice for Northern buildings, based on the material's intolerance for temperature extremes and high fuel contribution to a structural fire.

*Expansion and contraction in hot and cold temperatures causes warping and splitting at the fastening points. Vinyl also becomes very brittle in cold temperatures suffering impact damage easily. Vinyl is highly combustible, rapidly advancing a flame front once ignited, and contributing large amounts of fuel to a fire on the exterior of a building, outside the reach of sprinklers.*

### 3.5.5 Stucco Exterior Wall Cladding

Stucco exterior cladding is generally not recommended for use on Northern buildings, as it is not flexible enough to accommodate typical stresses on exterior walls caused by foundation system movement. Stucco use should be limited to building walls above the zone of potential impact damage (above 1.2 m elevation), and when the building foundation is very stiff and not expected to move from temperature and moisture changes in the soil conditions.

*Moderate to large impacts from vehicles, such as might occur during snow removal operations near the building walls, can damage stucco. Matching colour and texture materials are generally unavailable or difficult to obtain for simple repairs, forcing costly larger areas of required wall replacement.*

### 3.5.6 Cement Board Exterior Wall Cladding

Cement board exterior cladding siding or panels (such as Hardie Panel or Hardie Plank or GreenE-Board) 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.

*Cement based cladding resists deterioration from wetting and drying, resists minor abrasion damage, and is noncombustible (important where firefighting resources are variable or remote from the building location), and does not expand and contract very much with temperature and humidity changes.*

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 metre elevation, or to be fully backed with 15.9 mm thick plywood or 19 mm thick oriented strand board (OSB).

*Impact resistance of some types of cement based cladding is less than that of wood cladding, requiring location on the wall, use of backing boards, and attachment methods to be carefully selected.*

### 3.5.7 Exterior Insulation Finish Systems (EIFS) Exterior Wall Cladding

EIFS systems can provide superior thermal insulation and air/vapour barrier technology, but can also cause moisture retention in the wall assembly. Back-vented or water vapour permeable EIFS systems are less susceptible to trapping moisture. Combustible EIFS systems provide extra challenges to structural fire fighting, because they are installed on the exterior surfaces of a building, outside the range of active fire suppression systems (sprinklers). For this reason they are recommended for use where proven and experienced community structural fire fighting resources are available, and limited to materials and systems conforming to *NBC 2005 Div. B Article 3.1.5.5.*

*Exterior Insulation and Finish Systems (EIFS) are multilayered exterior wall cladding systems incorporating rigid foamed plastic combustible thermal insulation. They provide superior energy efficiency because they reduce thermal bridging, offer much greater design flexibility than many other cladding products, but require careful consideration so as to not exceed available community fire protection resources.*

EIFS systems for use on Northern buildings are recommended to meet the testing requirements of standard *CAN/ULC-S134, "Fire Test of Exterior Wall Assemblies"* for vertical surface flame spread. Combustible EPS or polyisocyanurate foamed plastics in EIFS cladding, increases the risk of fire spread on the exterior surface of a building, so fire blocking or fire stopping is recommended to be installed within an EIFS cladding system, at the same intervals and locations where fire blocking would be installed inside a framed wall cavity.

*Care must be taken to prevent combustible EIFS cladding on the exterior face of a building acting as a flame front bridge between a fire compartment and another compartment above, bypassing the floor system fire separation by moving through windows or other openings in the exterior wall.*

## 3.6 BUILDING ENVELOPE – ROOFS

Northern Roof Climate Conditions

Northern 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, more dense snow. Design snow load values compiled in *NBC 2005 Div. B Appendix C, "Climate and Seismic Information for Building Design in Canada"* are expected to increase in future National Building Code editions, based upon updated weather record data. The total annual precipitation increase in some Northern regions requires additional attention be given to roof water drainage design and operation, 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 and ice accumulations on metal roofs create particular injury risk to people and property from falling ice and snow slabs, unless snow and ice retention guards are installed.

Northern Roof Fall Safety Technical Requirements

All Northern roofs must incorporate fall prevention systems, meeting the requirements of the Workers Safety and Compensation Commission of the NWT and Nunavut, when workers are present and exposed to a specified falling risk. Recommended best practice is to incorporate permanent fall restraint anchors into the roof, connected to structure as required to meet the impact loads required by legislation, and designed for connection of fall restraint apparatus. Anchors need to be installed to provide for continuity of the drainage plane, and occasional repair or replacement of the water-shedding membrane.

### 3.6.1 Roof Air Movement, Water and Vapour Protection

All roofs are subject to differences in temperature, water vapour pressure and air pressure, and as such require air barriers and vapour barriers meeting all environmental separation requirements outlined in *GBP Articles A3.1.3 and A3.1.4,* as found in the *National Building Code (NBC) 2005 Div. B Part 5, "Environmental Separation".*

*Clarifies recommended best practice for Northern roof air and vapour barriers, with respect to NBC environmental separation requirements.*

### 3.6.2 Roof Thermal Resistance

See *GBP Article A3.2.1, “Recommended Thermal Resistance Values”*.

### 3.6.3 Roof Assembly and Materials

.1 Air/Vapour (AV) Barriers

Protected, fully adhered coincident air/vapour (AV) barrier membranes located above the structural deck are recommended for all building roofs, naturally ventilated or un-ventilated, located in areas of continuous airborne snow drifting.

The location of the AV barrier on the interior of roof framing is recommended only for small naturally ventilated roofs located in areas not affected by high winds and airborne snow drifting. Great care must be taken to ensure continuity of AV barriers, and a means of naturally ventilating the roof assembly, that will prevent snow infiltration through the vents into fibrous mineral insulation.

*Fully adhered AV barrier membranes have proven to be the most durable and reliable in use. Condensation and water build-up within roof materials has caused rot deterioration of a number of Northern roofs. Locating the structural roof inside of the AV barrier in the warm zone is a reliable means of preventing condensation; because the structure remains warmer than the dew-point temperature. Venting roof assemblies in areas of continuous airborne snow drifting is problematic, as vents allow snow infiltration. Successful AV barrier membrane installation depends in the Northern climate on careful control of field temperature and humidity conditions of bonding surfaces during construction.*

Sealants See *GBP Article A3.1.6.4.*

Thermal Insulation

See *GBP Articles A3.2.2, A3.2.3*. Un-ventilated roofs are recommended to be constructed using the ‘PERSIST’ technique, *GBP Article A3.1.5.*

.2 Ventilation and Drainage

Wherever fibrous mineral insulation is used in a roof assembly, the requirements of *NBC 2005 Div. B Sections 5.4, 5.5, and 5.6* must be met, and drainage must be provided from the interior membranes of the assembly to the exterior of the roof.

*Slow drying porous mineral fibre thermal insulation retains drifting snow and water and must be kept dry by natural air ventilation to be effective.*

*Water that accumulates within the assembly due to snow infiltration, roof leaks or AV barrier leaks can drain to the exterior.*

.3 Water Shedding Membranes

- Shingles

  Heavy weight wind-resistant asphalt shingles are recommended 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 are not recommended for Northern buildings.

  *Shingles can be blown off steep slope roofs in areas subject to high winds. Asphalt shingles are readily available and present a lower fire hazard than wood shingles, which deteriorate in low humidity environments and with long solar exposure.*

- Modified Bitumen Membrane

  (MBM) Two-ply fully adhered (torch applied or cold-process base sheet) MBM roof systems are recommended best practice for Northern buildings. Mechanically anchored base sheet systems are acceptable when a fully bonded air/vapour barrier is installed on the warm side of the roof insulation.

  *Two-ply, fully adhered hot-process MBM membranes can be installed with good bonding in temperatures as low as - 5 Deg. C., and have performed well to date. Repairs are relatively simple to perform.*

- EPDM or Rubber Roofing

  EPDM or other single ply loose laid membranes are not recommended for use on Northern buildings.

  *Loose-laid membranes will allow water to migrate laterally beneath the membrane, making it difficult to trace leaks.*

- Metal Roofing

  Machine sealed double folded standing seam metal roofing with expansion and contraction strain relieving anchors is recommended best practice for low slope installation.

  *This type of roofing has performed well on Northern buildings.*

### 3.6.4 Low Slope Roofs

All low-slope roofs are recommended to be constructed with a minimum drainage slope of 4% (1:25) leading to internal drains positioned at the low points of the roof, to continuous high performance gutters (eaves troughs) at the eaves and drain channels or down pipes, or to a free-fall drip edge on buildings where the cladding is selected to resist water and dust staining.

*Without a dedicated slope ensuring adequate water drainage, water retention and early water-shedding membrane deterioration occurs when ponding retains dust, and organic acids form along with moulds and occasionally moss in the more humid areas, and ice expansion and contraction causes surface deterioration of granule protected membranes.*

Low-slope roofs rely on using continuous impervious water-shedding membranes which can be visually inspected for breaks and water intrusion locations, and which can be repaired directly from the top of the membrane. Recommended best practice for continuous water-shedding membranes for Northern low slope roofs is a bonded elastomeric membrane such as (Styrene Butadiene Styrene) SBS-Modified Bituminous Membrane or a vented low-slope standing seam metal roof membrane.

*Low slope roofs retain accumulated snow and ice. Low slope roof membrane selection influences snow retention characteristics and total snow accumulation and structural loading over the Northern winter, and influences ice-slab formation, migration and injury risk exposure beneath roofs without installed snow and ice guard protection.*

### 3.6.5 Stepped Roofs and Rooftop Penthouses

Avoid stepped roofs with adjacent different height levels of the water-shedding membrane. If two different roof levels are required, they should be connected by a continuous sloping transition section.

*Stepped roofs accumulate extensive snowdrifting causing unbalanced structural loading and potential overloading, increasing the risk of structural collapse or deformation of the roof structural components. Snow accumulated in crevices and between stepped sections of a roof traps building heat and infra red heating from the sun, causing a wet film of melted snow to be held 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.*

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

*Obstructions on flat roofs such as mechanical penthouses can create areas for snow to build up, increasing the snow loading of the roof.*

### 3.6.6 Roof Eaves and Canopies

.1 Eave Projections

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

*Eaves provide an effective way to divert rain and meltwater away from low building walls, windows, doors and the building perimeter at grade. Careful design is necessary to make sure the AV barrier is continuous from wall to roof. Continuity of the AV barrier may be compromised if the structure is extended through the building envelope to provide eaves projections, rather than attached to the exterior face of the AV barrier.*

Minimal eaves projections ranging from 100 to 200 mm are preferred in colder and drier regions of the NWT. Larger eaves projecting 300 to 600 mm are necessary in wetter regions and in specific communities where the rainy season concentrates annual rainfall into a short period of the year, and wind driven rain increases the rate of periodic wetting of building walls.

*Minimal eaves projections are considered adequate in colder drier regions, where structural wind loads on eaves need to be minimized, and rain and meltwater runoff is less severe than in wetter regions below the tree line. Cold eaves are a location for ice-damming when the roof snow pack melts, creating falling ice injury risk and trapped meltwater seepage into non-continuous water-shedding membranes.*

.2 Eavestroughs

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.

*Ice build-up renders traditional light sheet metal eaves troughs positioned at the eaves top line ineffective, as well as easily damaged during spring melt. Stronger steel eaves troughs with a designed spillway rim well below the eaves line will prevent ice damming and ice buildup at the eaves edge.*

Eaves or canopies are recommended to be provided on all new and renovated buildings and designed to divert falling snow, ice and water originating on roofs away from exterior doors.

*Lack of weather protection above doors creates a potentially unsafe condition from falling ice and snow.*

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

*Parapet height should be limited to what is needed for preventing snow, ice and water from being blown off an internally drained roof. Parapets on perimeter drained roofs, using scuppers or through parapet leaders for draining roof water perform inadequately during thawing and re-freezing cycles due to ice damming and backup of drainage water on roof surfaces.*

### 3.6.7 Roof Access and Fall Protection

Where roof foot traffic is anticipated, the surface material at walkways and access routes should be slip resistant, well marked for all northern weather conditions and clearly indicating hazard locations such as unprotected skylights, and should not interfere with normal drainage of water or cause abrasion to or other deterioration of the water-shedding membrane.

*Access to the roof will be required for inspection, cleaning and maintenance of roof equipment and the roof itself. Providing wear-resistant, slip-resistant and clearly identified walking routes, helps direct routine foot traffic access and egress safely on and off the roof under varying weather conditions.*

A permanent fall restraint anchorage system is required to be installed on all roofs or elevated areas where a fall of three metres or greater is possible, to provide for anchoring a fall restraint system, as and when required by NWT Workers' Safety and Compensation Commission requirements.

*Fall arrest anchor points need to be available for securing fall restraint safety equipment used by personnel accessing the roof. Fall arrest anchor locations and design must be acceptable to the authority having jurisdiction.*

All weather roof access hatches are recommended to be installed for routine access to all low slope roofs, to allow all-season safe access for maintenance personnel, equipment, tools and materials.

*Even smaller building roofs require safe and convenient access for maintenance personnel, in order to encourage regular preventive maintenance work to be carried out in timely fashion, and maintenance needs identified well in advance of deterioration of equipment and installed materials.*

Skylights installed in potentially snow covered roof areas should be defined by visually apparent permanent physical markers that extend above the anticipated accumulated snow depth.

*Identification of skylights that may be snow covered will reduce the risk of impact damage or someone accidentally falling through the skylight.*

### 3.6.8 Roof Skylights

Well-designed and well-positioned skylights provide significant dividends to human comfort and utility of a space located far away from exterior windows. 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 and to avoid snow and ice accumulation and related water-film deterioration of the skylight and its flashed seals.

*An example where the use of skylights would not be recommended is a building where the cooling load created by heat gain through the skylight increased the energy management budget unreasonably.*

Effective skylight performance for Northern buildings requires incorporation of several essential technical design features, in addition to thermal resistance matching the windows in the same building, including:

*Past experience with skylights in the North has been mixed. Skylights (including translucent structural panels such as Kalwall) have provided a number of facilities with light in areas where windows were not possible.*

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

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

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

*The quality of overhead natural lighting from skylighting is comparable to lighting from windows, but the northern and cold climate performance limitations experienced with skylights cannot be ignored: condensation has caused damage to interior furnishings and adjacent wall and ceiling surface. Occupant discomfort complaints include overheating and glare. Extensive roof damage has occurred as a result of poorly sealed skylight units.*

*A maintenance review of skylights proposed for locations where vandalism or forced entry is a known problem is recommended, in order to also provide increased building security at such locations.*

*Air circulation minimizes condensation by warming the interior glazed surfaces and gutters or trays can be positioned to accumulate condensation and allow it to re-evaporate.*

.4 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 *NBC 2005 Div. B Part 5.*

*Accumulation of water cannot be totally eliminated on sloped surfaces intersected with framing members. Joints exposed to standing water will eventually leak. Secondary drainage allows the water that passes through the primary weather seal to drain to the exterior.*

.5 Skylights should be equipped with blinds or have a tinted shading factor for reducing overly strong sunlight. The blinds must be easily operable by facility users.

*Glare and overheating during long solar days can be reduced by blinds or reduced infrared spectrum light.*

### 3.6.9 Clerestory Windows

Clerestory windows are acceptable alternatives to skylights, provided careful design allows them to remain clear of snow accumulation and resist driven rain intrusion. 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. A minimum height to sill of 200 mm is recommended, and eaves extensions at the head are needed to divert driven rain away from the window head frame joint to the wall.

*Weathering effects from driven rain and snow drift accumulation are concentrated around penthouses, vaulted construction and similar projections extending above the basic shape of the roof. Concentrated weather effects require well designed and constructed flashings and weather seals at all openings and service penetrations, including clerestory windows. Insufficient weather protection at clerestory window head and jamb seals to the building is a major cause of water intrusion and deterioration of interior finishes in clerestory window vaults.*

Clerestory windows 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 or air system diffusers positioned to direct ventilation air to the glass surfaces are recommended.

*Clerestory windows are positioned in the warmest upper potion of the building interior air shed and encounter the largest thermal stress gradient between interior and exterior environments. Placing windows in the warm side of the wall minimizes the thermal gradient across the window, reducing expansion and contraction of the glass and frame, extending glazing seals service life and reducing heat loss.*

Operable clerestory sash is not advised, fixed glazing is recommended. Building ventilation from clerestory vaults is better achieved using operable ventilation louvres.

*Operable sash maintenance is problematic and expensive for clerestory windows and the air and weather seals between operable sash and frames allow more air transfer and energy loss than with fixed glazing.*

# A4 DOORS AND WINDOWS

Doors and windows can be significant sources of heat loss and of air leakage, but are necessary elements of the building envelope. Although door and window performance standards have improved considerably with the development of precise test standards, doors and windows are often manufactured to meet performance requirements found in less severe cold weather conditions than are found throughout the NWT. Care should be taken to select doors and windows that will meet the extreme cold weather performance requirements of the North.

## 4.1 EXTERIOR DOORS AND FRAMES

Several problems are commonly experienced with exterior doors. Conductive heat loss is typically greater through doors than through walls, as doors are not typically insulated to more than RSI 1.8. Air leakage at door edges is common, as weather seals lose flexibility in extreme cold. Excessive air leakage is common in doors that are loose fitting or difficult to close properly, due to insufficient hardware adjustment and poor alignment, or door panels (E.g. Fibreglass facings) which shrink in extreme cold causing door warping. Door and frame misalignment can occur from high volume door use, physical damage from impacts or from structural movement of the frame and frame supports, such as could be caused by structural movement of the foundation system or structural frame. All exterior doors require weather protection at the head with extended eaves or canopies to deflect falling snow, ice and water, as recommended in article *GBP A3.6.7*. In buildings where vandalism and forced entry are known problems, exterior doors should not be located in exterior walls which are recessed into the building, but rather in areas of high visibility. Exterior doors are recommended to be equipped with closers, and to be provided with overhead weather protection in the form of roof canopies or extended eaves.

### 4.1.1 Exterior Doors

All exterior doors are recommended to be insulated 16 Ga. steel construction, (14 Ga. in areas of known high traffic or forced entry), minimum RSI 1.3 and rated for climate zone “D”, for durability, energy conservation and frost prevention. Refer also to hardware recommendations.

*Solid core or hollow wood doors cannot achieve an adequate level of insulation, warp easily in extreme dry cold, and are less durable than suitably strong metal doors.*

Vestibules should be used at busy main building public entrances, to separate the inner and outer entrance doors, and keep warm air inside the building. *(See A4.1.6)* Storm doors, common in residential buildings to reduce air leakage around doors, are impractical at busy public entrances and should not be used.

*Vestibules save costly energy and increase building comfort in winter by reducing warm air loss and stopping drafts. Vestibules between outer and inner door sets are more practical and more durable than storm doors. Storm doors are available only with a light duty rating for residential application. They wear out quickly from the heavy use encountered in public buildings, and are easily damaged.*

Where physical door security is a concern on schools and similar public access buildings, all steel welded doors with heavy duty hardware, minimal glazing and no hardware on the exterior unless it is a primary entrance to the facility are recommended. (*See GBP subsection A4.3*)

*Some types of buildings require stronger security provisions, and that can be determined by a detailed review with the client.*

Exterior doors should be located in exterior walls which are not inset to the building and positioned in areas of high visibility, and should not swing outward over landings where they may be blocked by ice and snow.

*Landings are recommended to be depressed 38 mm if an exit door is required to swing outwards, or the outward swinging door recessed for weather protection, with increased lighting provided for surveillance.*

### 4.1.2 Overhead Doors

All overhead doors should be metal with replaceable panels. Manufacturer’s standard metal gauge doors are adequate, unless there is a particular danger of impact damage. Where that is the case, use heavier 16 gauge metal.

*Typical uses for overhead doors include arenas, firehalls, and garages. Damaged panels can be easily replaced in sections rather than having to replace the whole door. Heavier than normal gauge metal overhead doors may be special order items needing longer order time, but the increased durability reduces life cycle cost.*

Overhead doors in insulated walls should have a high thermal resistance, RSI 2.8, and can be selected from manufacturer’s standard products.

*Insulated doors provide the best value in insulated walls. Thermal resistance ratings of RSI 1.8 are common in plastic foam, insulated metal pan overhead doors.*

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

*Weather strip designed for extreme exposure is most effective and is more durable.*

Slopes should be provided at the exterior of thresholds to ensure water and ice does not accumulate.

*To ensure water and ice do not accumulate.*

### 4.1.3 Exterior Door Frames

Minimum 16 gauge steel (strengthened with added reinforcement for heavy duty or known vandalism locations), pressed metal thermally broken welded construction frames are recommended for all exterior doors. Knock-down frames are not recommended.

*Door frame failure arising from wear and tear and from forced entry has been an ongoing problem in schools and arenas. Added frame strength is provided by mitered, reinforced and welded corners. Additional structural reinforcement connecting the door frame to the wall system is recommended.*

Thermally broken 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.

*The thermal break, required for energy conservation and frost prevention weakens the frame where strength is required to support connections for hinges and latching hardware.*

Wood frames may be used where security will not be compromised.

*Thermally insulating wood frames are suitable for light duty locations where forced entry is not a problem.*

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.

*A removable mullion (positioned in the centre between the two leaves of the door) can be forced to one side from the exterior, and allow easy forced entry if the only latching point is on the astragal bar. This weak security point can result in exit door chaining, which is a serious safety violation. The best way to correct this security weak point is to install fixed mullion frames or use three point latching.*

*Another solution to correct this problem is to install two single doors side by side. This will still allow for the exiting requirements and alleviate the problem of using a mullion. Doors can be secured with single point latching panic hardware, which will resolve the problems associated with the high maintenance requirements of the three point latching panic hardware.*

A good air barrier seal to the door frames is essential for energy conservation and to minimize corrosion from moisture.

*Air leakage out around door frames is a common cause of energy loss. Warm interior air can condense at loose air barrier joints, and the resulting water causes corrosion of fastenings and rotting of wood members in the wall. See GBP Article A3.1.3.*

### 4.1.4 Sealants

See *GBP Article A3.1.6.4.*

### 4.1.5 Glazing in Doors and Sidelights

Sidelight frames should be independent of door frames.

*The intent is to permit replacement of door frames without replacement of the sidelights. The smaller independent frames are also easier to transport and handle on the site.*

### 4.1.6 Vestibules

Vestibules are recommended at all main entrances or other high traffic entrances.

*Vestibules help keep warm interior air inside the building, conserving fuel energy.*

| | |
|---|---|
| Vestibules and hallways in high usage buildings such as schools are to have plywood installed behind the gypsum wallboard. | *High traffic areas such as school vestibules, halls and gym change rooms are prone to rough usage. Installing plywood behind the gypsum wallboard will provide support for the gypsum wallboard thus reducing the amount of impact damage to the wall.* |
| Laminated glazing is preferred for the exterior pane of glazing in doors and all sidelights at building entrances. | *See NBC 2005 Div. B A9.6.8.1. Typically used for schools, community halls, health centres, court facilities, libraries, airport terminals and other public access buildings. Laminated glass breaks easier than tempered glass, but stays in the opening when broken. Laminated replacement panes can be cut from stock sheet to suit the opening sizes. Tempered glass may also be considered; however, it is less secure and replacement panes must be cut at the factory, resulting in either a large stock of replacements or long delivery times.* |

## 4.2 INTERIOR DOORS AND FRAMES

Interior doors and frames are subject to extreme fluctuations of air humidity within Northern buildings from winter to summer. Doors must be manufactured for particular resistance to warping out of plane, and for veneer delimitation resistance. Recommended manufacturing industry standards are contained in the Architectural Woodwork Manufacturer's Association of Canada AWMAC *“ARCHITECTURAL WOODWORK STANDARDS - 1st Edition - 2009”* in the Wood Doors subsection.

| Recommendation | *Rationale* |
|---|---|
| **4.2.1 Interior Doors** | |
| Solid core wood doors are preferred for all interior locations where heavy duty or rough usage is expected, or where acoustic resistance for sound privacy is needed. | *Solid core doors are more expensive than hollow core interior doors. Institutional grade HC interior doors are lighter to ship and just as durable as their solid core counterparts for most buildings. Solid core doors are only warranted where increased impact resistance or increased sound resistance is mandatory for speech privacy.* |
| Grade of door should be appropriate to proposed finish. | *Paint grade birch veneer plywood faces are acceptable for paint finish, ‘Select White’ appearance grade suggested for clear finish.* |
| Interior door frames requiring a Fire Protection Rating (FPR) should be metal. | *Solid core wood doors are available with Fire Protection Rating (FPR) labels, and may be appropriate for use in some areas of low traffic.* |
| **4.2.2 Interior Door Frames** | |
| Interior door frames may be wood or metal. | *Metal frames require less attention over their service life than wood and are generally less expensive to install.* |
| Fully welded metal frames are recommended over knock-down frames, particularly in high use locations. | *Metal frames are more durable in high use locations and therefore more dependable as a part of a fire separation. Labeled wood frames should be considered only at areas of very light traffic.* |

Interior door frames requiring a Fire Protection Rating (FPR) should be metal.

*Easily damaged wood frames can compromise the effective level of fire protection needed where FPR frames and doors are required.*

### 4.2.3 Interior Bi-fold Doors

Bi-fold doors are considered appropriate for use only in residential facilities, or at door locations with very low use rates. Storage closets in offices can use Bi-fold doors for a space saving advantage over other types of doors.

*Bi-fold doors are commonly used in residential facilities and offer both utility and economy, but sliding mechanisms of Bi-fold doors are susceptible to damage from heavy use. Bi-fold doors are impractical for most locations except storage closets.*

### 4.2.4 Interior Pocket Doors

Horizontal rolling top - suspended interior wood doors that retract to park inside a wall orifice (pocket doors) are a practical technical alternative where door swing space is limited and traffic volume is low. The suspension hardware track selected should allow the door to be removed and replaced without opening up the wall finishes.

*Pocket doors may be technically appropriate to use where space is limited and traffic through the doorway is less frequent - such as for low-volume use washrooms or storage closets. Pocket doors are more expensive to install than swinging doors, and may present maintenance and repair problems unless the track hardware and latching mechanisms are robust and durable.*

### 4.2.5 Interior Door Glazing

The use of glass in the lower portion of doors (closer than 600 mm to the finished floor) is discouraged. Where glass must be used in the lower section of doors, it must be reinforced or laminated.

*Although glass can be important for visibility, the lower portion of door is vulnerable to damage.*

## 4.3 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. A high rate of door usage in some Northern 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.

| Recommendation | *Rationale* |
|---|---|
| **4.3.1 Preferred Products** | |
| Locksets | |
| Selection should be coordinated with maintenance staff so that operational and maintenance preferences and standard keying systems are accommodated. | *Maintainer preference for keys and manufacturer's brands should be adhered to where a master and grand master keying system applying to a group of buildings is in place. However, limiting hardware to preferred manufacturers reduces the available selection of technically suitable alternative maintenance materials.* |
| Other Hardware | |
| Continuous full length hinges are recommended for institutional doors with high utilization rates and where cyclical building movement causes seasonal door misalignment. | *Northern buildings are often more vulnerable to doors jamming, caused by racking of the frames in walls influenced by foundation movement, than buildings in more stable foundation environments.* |
| **4.3.2 Overhead Door Openers and Operation** | |
| Manual operation by chain hoist is preferred. Motor driven electric door openers are recommended only where they are essential to facility operation. | *Motor driven electric overhead doors require more ongoing maintenance and are more susceptible to problems than manual doors. The additional cost is not usually justifiable.* |
| The use of Air Curtains on overhead doors should be considered on buildings that are heated and the doors are opened and closed frequently or need to be left open for long periods of time. | *The use of an air curtain for overhead doors reduce heating costs by re-circulating the interior heated air reducing the maintenance requirements of the door due to reduced use.* |
| **4.3.3 Power Door Operators** | |
| Power door operators meeting the requirements of sentence (*NBC 2005 Div. B 3.8.3.3.5)* have become increasingly available in buildings accessible to the public in NWT communities. Electric power door operators recommended for installation in Northern buildings are units which do not prevent a door from being operated manually when the power is periodically interrupted, or when the power unit becomes non-operational. | *Some Northern communities do not have the available service resources to suitably maintain electric power door operators. An electric power door operator can be chosen which will not prevent manual operation of the door. Only in exceptional circumstances should it be considered to approach the Office of the Fire Marshal to relax the requirement of sentence NBC 2005 Div. B 3.8.3.3.5 in communities where repairs and maintenance for power door operators are not available.* |

### 4.3.4 Exterior Door Latching and Door Security

Building security relies on secure exterior door latching. At least two point, and preferably three point latching, should be considered for all exterior doors where forced entry is a concern. Retracting latching auto bolts at the head frame and sill frame, internal or surface mounted, are recommended in addition to the rim or mortise latch device on the jamb.

*Although more expensive initially than single point latching, three point latching provides higher security. Forced entries are a recurring problem in buildings where single point rim device latching is used.*

A threshold plate, sloped to the exterior for drainage and cleaning of debris, is required where bolt latch cups are used in the sill assembly.

*Bolt latch cups tend to become blocked by ice and debris and need to be easy to clean.*

Push bar rim exit devices should be considered in place of crossbar exit devices for all exterior doors.

*Crossbar rim exit devices can be chained closed by building users to prevent forced entry. Push bar rim exit devices do not lend themselves to be chained closed thus reducing the risk of building users being trapped if the building has to be evacuated.*

Electromagnetic door locks set up to release with a fire alarm are a viable alternative to three-point latching for exterior exit doors. Magnetic door locks can be used in conjunction with crossbar and push bar rim exit devices for areas that are prone to forced entry.

*Electromagnetic locks increase the security of exit doors without bypassing or disabling the emergency release hardware.*

### 4.3.5 Keying

Building owner and maintainer preference for keys and manufacturer’s brands should be adhered to where a master and grand master keying system applying to a group of buildings is in place. However, limiting hardware to preferred manufacturers reduces the available selection of technically suitable alternative maintenance materials.

*This allows buildings to be keyed separately for security reasons, master keyed or grand master keyed, and allows for cutting keys and providing submaster keys where required.*

### 4.3.6 Hinges

Full length continuous hinges such as Pemko are recommended on exterior doors subject to high traffic volume. Pivot-reinforced hinges are recommended for doors with high usage rates, overhead frame and door mounted closers and severe impact-abuse conditions. Four hinges per leaf are recommended for doors exceeding 25 Kg mass, and ball-bearing hinges recommended for all high traffic volume doors and any door equipped with a closer.

Interior doors are to be equipped with ball bearing butt hinges for high traffic volume locations in institutional and commercial buildings.

*Continuous hinges and pivot-reinforced hinges require less-frequent servicing and last longer than conventional hinges. Continuous hinges stiffen the door and the frame connection to resist racking and twisting better than conventional hinges.*

## 4.4 WINDOWS

The number, size and location in the building of windows should be carefully selected for energy conservation, northern building envelopes, and the extreme northern climate and because of the potential for vandalism in some locations and communities. Views and natural light character (glare, sun angles) must be carefully considered when selecting and locating windows. For more information about day lighting, see *GBP Section E7.1.3 “Daylight”.*

The size of windows and the glazed units comprising them needs to be kept to the minimum number of sizes, to allow the minimum amount of replacement glass to be inventoried. The size of the glazing units selected should accommodate transportation limitations for communities off the road system. Window glazing is recommended to be of a consistent size and of a dimension to be easily shipped by small plane for access to many northern communities. See *GBP Article A4.4.5, “Glazing*”.

### 4.4.1 Window Frames

Commercial or institutional grade thermally broken metal frame, or metal reinforced vinyl (PVC) frames are preferred. Wood framed windows clad with vinyl or prefinished metal are acceptable. All of these types are robust enough to accommodate effective air and vapour connection to the building envelope.

*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. Air leakage around northern building frames is a common problem.*

Fiberglass framed windows with stiff deep frame cross-sections are acceptable, provided the cold-process connection of the wall air-vapour barrier to the frame has adequate mechanical support and durability, allowing inclusion of the window in a rain screen designed wall assembly.

*Fiberglass frames are inherently more flexible than metal or reinforced PVC frames for equivalent material thickness. Torch-applied air-vapour barrier materials cannot be used on fiberglass frames as the bonding resins in them are combustible, requiring a cold-process air-vapour barrier connection, more problematic in cold northern construction conditions.*

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

*Poor air seal compression is the main cause of air seal failure and excessive air leakage between the operating sash and frames of northern windows.*

Large windows require special consideration to ensure that the frames are adequately reinforced, that the hardware mounting is strong enough, and that the frame will remain straight and provide an effective seal. (*See GBP Article A4.4.5 "Glazing"* for additional recommendations.)

*Large pane sizes are not recommended because large sealed glazing units are expensive and difficult to transport into most northern communities, and more difficult to maintain tight perimeter air seals caused by thermal expansion and contraction cycles of the frames.*

### 4.4.2 Sealants

Sealants and methods recommended for connecting the window frame to the air/vapour barrier system of the wall are found in article *A3.1.6.4*. Designers are expected to provide durable, strong and easily constructed connections satisfying rain-screen and air/vapour barrier continuity, and weather protection from extreme local climate conditions prevailing in the community for which the building is designed.

*Extra attention needs to be provided for sealing windows into the air/vapour system of northern walls because of the extreme environmental demands on performance brought by prolonged deep cold, wall deformation caused by foundation system movement, excessive wetting of wind and rain exposed walls at certain seasons of the year, and variable and high air pressures caused by vigorous northern winds.*

Sealants used to bond glazing into frames and operable sash are required to conform to applicable national standards for windows. Refer to *NBCC 2005 Div B Section 5.1 "Standards*".

### 4.4.3 Location in Wall Assembly

Windows should be located in the wall assembly such that the interior of the frame is located on the warm side of the insulation. The window frame should straddle the plane of the AV barrier.

*Setting of windows at exterior wall should not create a wide interior ledge because this reduces airflow over the glass, which can allow condensation or frost to build up on the inside of the window. The intent of such placement is to provide AV barrier continuity through the window frame without offset. Windows designed with nailer flanges for installation over the exterior wall sheathing are usually poorly connected to the air vapour system and become positioned in the outside portion of the wall. As such they are prone to frost and condensate formation problems.*

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).

*Window locations are driven by program requirements but some window locations are at a natural higher risk of forced entry and should be technically upgraded.*

### 4.4.4 Operable Sash

Windows comprise inoperable sections called fixed glazing, and movable sections called operable sash. All operable sash is recommended to be casement or awning type with rugged hinges, simple rugged push bar handles and rugged cam locks, with metal rather than plastic components. Vertical sliding or by-passing operable sash is not recommended.

*Camlocks have been found to provide the best air seal for awing and casement operating sash. Sliding or by-passing operating sash tends to jam with frost or ice in the northern climate.*

Windows must be designed and installed so that operable sash, or ventilator units (vents) will not be blocked by accumulations of snow or ice on sill plates. Outward opening awning vents located in the top one third of the window are preferred, and operating sash in the lower portion of the window not recommended.

*Awning ventilator sash in the lower portion of a window is more likely to allow wind, dust and snow to blow in, and can be easily reached for break-ins or intrusion when the window is left open to provide natural ventilation.*

Twin air seals are recommended for ventilating sash, as a means of reducing air leakage and for minimizing frost-sealing in winter. This allows ventilation during transition seasons when outside air is not too cold to introduce into the building.

*Durable effective and easily replaceable air seals are required in the harsh northern environment. Twin air seals stop interior humid air near the interior warm portion of the window frame and cold dry exterior air at the exterior (cold) portion of the frame, providing a transition air lock that resists condensate freezing between the operable sash and the frame.*

### 4.4.5 Glazing

All windows are recommended to have as a minimum double-glazed sealed glazing units with low "E" coating, or triple-glazed sealed units. Use of tinted glass with shading coefficients greater than 10% is not recommended for most windows, due to the relatively short cooling season that prevails at most locations in the North.

*Double-glazed low-emissivity sealed glazing units or triple-glazed sealed glazing units provide the lowest life-cycle cost of any commonly available glazing system. Tinted glazing for northern latitudes is only cost effective when the window configuration and orientation will cause excessive heat gain in the long solar day of the short summer season.*

A single-glazed removable sulsash of polycarbonate plastic (except in exits), laminated glass or tempered glass, or an impact resistant security film on the exterior of the glass sheet, integral with the frame, on the exterior of the window, is recommended to protect windows where deemed necessary. Shutters or removable panels are effective additional window protection methods, and are recommended for seasonal-use or isolated facilities where window vandalism is a potential problem.

*Wherever recurring vandalism is identified as a potential problem, protection of glazing is recommended. (See notes in NBC 2005 Div B A9.6.8.1 for glazing near doors). Some additional protection is strongly recommended for buildings where windows are subject to vandalism. Schools are periodically high-risk window vandalism targets and must be included in this class of facility.*

A major function of windows is to provide natural light. Selection of both the quantity and location of glazing must consider cold season heat loss, increased by greater areas of glazing, glare from windows which can result in occupants closing blinds and turning on electric lighting; increase of the mechanical system cooling load by warm season direct solar radiation, and limitation of day lighting effectiveness in winter by shorter solar days at higher northern latitudes.

*Glazing system selection must take into consideration functional requirements for effective energy utilization and day lighting as well as maintenance and technical needs. Standardizing window glazing will reduce the amount of different sizes of window glass to be stored in the community for replacement due to breakage.*

Glazing unit size and weight should be limited to what can be transported by the commercial carrier (air or truck) that serves the community and transported within the community by local trucks without specialized handling equipment. This is typically 1.2 m x 1.8 m, and 100 kg.

*For communities not on the highway system the only way to transport glass is by air. The dimension of the glass should be no greater than what will fit in the aircraft regularly servicing the community.*

# A5 INTERIOR CONSTRUCTION AND FINISHES

Durability, practicality, ease of maintenance and simplicity are desirable qualities in northern buildings, and are particularly applicable to obtain sustainable interior construction and finishes. Well-chosen durable materials, uncomplicated colour schemes and careful placement of building elements must be relied upon to create attractive and pleasing interiors as the range of appropriate materials and architectural details can be limited by cost. Materials selected for interior finishes should be commonly available, expected to be available in future years for repair and replacement selection and chosen for ensuring indoor air quality is not adversely influenced by VOC's from paints, carpets, panel products and resilient flooring materials.

## 5.1 FLOORS

Although a large number of floor finishes have been used in northern buildings over the years, only a few have gained overall acceptance by users, maintenance staff, contractors and designers. This section identifies different types of appropriate flooring materials, and indicates preferences for some 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, and the operating temperature of the floor as well as for durability to meet program requirements. Where a suitable local flooring material is available and work will contribute to the local economy, that material should be given preference if practical. Local materials suitable for floors could include stone or wood. Use of local materials can provide opportunities for local employment and skill development, as well as result in a more distinctive community building. Stone flooring was successfully used in the Lutsel K'e community office building completed in 1989, for example.

### 5.1.1 Resilient Flooring

Resilient flooring includes a range of synthetic flexible roll and sheet goods and small format tiles. Commonly available resilient flooring includes linoleum, sheet vinyl, polymer modified linoleum, resilient foam backed vinyl, rubber, cork and similar vapour impermeable and air impermeable products. Installation of resilient flooring onto substrates with radiant heating (hydronic of 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.

| Recommendation | *Rationale* |
|---|---|
| .1 Resilient Flooring Linoleum | |
| This is the preferred flooring for many northern buildings, but glue-loosening and drying deterioration has been found in some installations of linoleum on floors with radiant in-floor heating. | *Linoleum has proven durability, a good range of colours, and is easy to maintain. Compared to vinyl composite tiles, linoleum is only slightly more expensive to install, requires much less maintenance, and is far more durable. It should be noted that linoleum surface texture is too slippery for wet areas such as shower rooms.* |

Floor operating temperatures need to be verified and kept within the floor material manufacturer recommendations, typically 29 degrees Celsius (85 Degrees Fahrenheit) to ensure durability and long service life, Floor areas expected to withstand repeated stress loads (such as rolling wheeled carts or vibratory impact loads) are not recommended for linoleum, because the linseed oil based bonding materials in the linoleum are typically not strong enough to withstand repetitive heavy strain loads. Linoleum flooring is not recommended for warehouses or display showrooms or similar locations where petroleum based liquids are present. Recommended minimum thickness of linoleum are:

*Linoleum contains natural oils which can dry over time causing shrinkage, brittleness and edge cracking at seams if installed over heated floors, or exposed to concentrated heat from a commercial stove or similar appliance.*

Heavy use high traffic areas:

Minimum 2.5 mm thickness with welded seams.

*Typical heavy use high traffic areas would include all public lobbies and corridors, private health care facilities and mercantile uses, educational facilities, passenger terminals, and major public buildings like court houses, correctional facilities and hospitals.*

Medium and light traffic areas:

Minimum 1.8 mm lino with welded seams.

*Typical medium duty moderate to light traffic areas would include seasonal use facilities, private offices, and residential accommodation and storage rooms.*

.2 Skid Resistant Sheet Vinyl

Minimum 2 mm thick, homogeneous colour and pattern detail throughout thickness of product. Marbleized or granite patterns and welded seams are recommended. Surface patterned materials or cushioned backing are not recommended for areas containing tables and chairs, unless sled base furniture supports are used.

*Typically used in vestibules, washrooms and change rooms where floors may remain wet for some time or for residential uses where only small areas are required. Welded seams are required to provide a durable, watertight joint. Products with print-applied surface colours and patterns should not be selected because they show wear too readily on floors with medium or heavier traffic. Patterns can serve to hide dirt more easily than plain colours. Cushioned flooring is not practical because it can be easily damaged by furniture.*

Heavy duty vinyl sports flooring with slip resistant surface and resilient backing, suitable for surface-painted lines, is recommended over other types of materials only for activity rooms and low impact use areas, but must be protected from scuffing and puncturing unless compatible footwear usage is enforced. High impact use areas such as sports courts are best covered with the more durable cushion backed resilient rubber flooring.

*Typically used in auditoriums or low impact activity rooms such as community halls, a resilient subfloor is essential to prevent welded flooring seams opening up from repeated impacts of occasional indoor sports play. Vinyl provides less dynamic rebound than cushioned rubber, and therefore is suitable for short duration low impact sports (tumbling, ringette and similar) rather than basketball or volleyball.*

When installed over heated floors, floor operating temperatures need to be verified and kept within the floor materials manufacturer’s recommendations to ensure durability and long service life.

*Some types of adhesives used for bonding sheet vinyl flooring to subfloors will deteriorate over time with concentrated heat from an in-floor radiant heating system, leading to blistering or early delamination of the flooring material from the subfloor.*

.3 Vinyl Composite Tiles (VCT)

Recommended use of variegated marbleized or granite patterns and 2.5 mm minimum thickness, colour and pattern detail throughout the thickness of the tile.

*Because VCT is easily installed using local labour it is especially appropriate where small quantities do not warrant the expense of bringing in specialized trades for installing sheet goods.*

Do not use vinyl composite tiles in cold porches or unheated rooms. Typically appropriate only in light traffic areas in smaller buildings.

*Typical uses would include smaller buildings such as offices in maintenance garages or firehalls, field offices or summer use staff quarters. Shrinkage in cold temperatures makes VCT an unsatisfactory choice for most unheated areas.*

Vinyl composite tiles are not recommended for use in wet areas or areas subject to spills.

*Water and spilled fluids can enter the joints and deteriorate the adhesive. Spilled fuel oil and antifreeze are particularly bad as they also infuse the subfloor and prevent adhesion of new floor coverings.*

.4 Rubber Flooring

Rubber flooring is generally recommended for special purpose use in northern buildings, where superior resiliency, durability and clean ability are sought.

*Rubber flooring is a better total service life cost choice than linoleum or vinyl.*

Resilient backed rubber sports flooring suitable for surface painted lines is recommended for use in athletic sports facilities such as community or school gymnasiums as being the most durable, most cleanable, and suitable for both community event uses as well as impact sports (court games and similar).

*Rubber flooring is suitable for sports activities, and is resistant to damage from sand or mud tracked in by footwear. Rubber flooring to buy can be 10 to 13 percent more expensive than vinyl, but the rubber lasts longer (typical 30 year service life with normal maintenance) and provides better performance over its service life. Installation over a deck with in-floor radiant heating is no different than installation of vinyl over the same type of deck. Attention to heat tolerant glues and limiting the floor contact temperature to about 32 Deg. Celsius. is recommended.*

Depending on the substrate, rubber is better for very hard substrates like cast in place slabs, and more able to accommodate the flexing of lighter decks such as double 15.9 mm T&G plywood. It is the most resilient choice, giving back more kinetic energy than vinyl based resilient sports flooring, and has better long-term traction control for fewer slips, falls and injuries, and has better sound absorption characteristics.

*For impact court sports over a flexible wood deck, a triple layer 8 mm thick covering would likely be the best combination of performance in place, durability, and cost. 6 mm thick two layer material is not recommended for impact sports floors, but is suited for areas like floor gymnastics (tumbling) and weights room floor covering where skid resistance is needed but impact rebound resiliency is not as important. Thicker triple layer materials are recommended for installation over concrete slabs and suspended infil concrete slabs where there is less flexibility in the substrate.*

Vulcanized rubber skate flooring is preferable for use in community arenas and sports rooms where impact and abrasion resistance is important.

*Typically installed only between ice surface and areas where skates are put on or removed.*

.5 Cork Flooring

Generally not recommended for general use in northern buildings other than for residential and light traffic small office occupancies.

*Cork can be difficult to maintain in moist and abrasive use environments, and is relatively expensive to install. There is no inherent advantage that makes cork flooring an exceptional choice for use in northern buildings.*

### 5.1.2 Wood Flooring

Hardwood flooring is generally not recommended for use in northern buildings, including gymnasiums, because of the typical dry cold season service environment and risk of deterioration by occasional water damage.

*Capital, installation and maintenance costs are high, and wood is easily damaged by water exposure or immersion. Wood floors in public use facilities require protective coverings when used for community events, which is inconvenient for users: where protective coverings are not used, floors are easily damaged.*

Laminated wood veneer ("click-lock") flooring, more dimensionally stable with humidity changes than wood, is recommended only for areas where the building occupancy consists of light duty use with non-abrasive furniture, and with no exposure to water deterioration.

*Laminated wood or synthetic plastic laminated plank flooring is difficult to maintain and repair once damaged by abrasion or water spills or floods. Surface damage cannot be easily repaired or touched up, and immersion in water for even a short period of time causes swelling and bursting of the joints between planks, which are difficult to replace individually.*

Plywood flooring for storage rooms is acceptable, but not recommended for mechanical service spaces where fluid spills might occur (furnace rooms and similar).

*Dry service areas with low traffic rates generally can use slip-resistant paint finished plywood as a durable low-cost floor material. Occasionally wet service areas where fluid spills periodically occur are recommended to have floors with less porous coverings than plywood.*

### 5.1.3 Ceramic Tile Flooring

Ceramic tiles are recommended for use in northern buildings where the advantages of durability and toughness outweigh the disadvantages of high initial cost. Extremely stiff substrates of concrete or concrete board underpayment are required because wood subfloors are too flexible to accommodate the tile bedding, adhesive and grout brittleness.

*Although it is recognized that ceramic tile can be low maintenance, easy to clean, and very durable, initial costs are generally high in the North (especially due to transportation costs). There is also a high risk of breakage in transit, and flexible wood structures typical of most facilities do not provide a suitably stiff substrate for ceramic tiles. Susceptibility to cracking, de-bonding and grout repairs can lead to expensive maintenance. Installation requires skilled tradespersons, and repairs require special attention by maintainers.*

*Examples of where ceramic tile may be appropriate would include specialized facilities such as laboratories or hospital operating rooms, where the tile is applied over stiff substrates.*

When tile is appropriate, neutral colours should be selected and accent colours avoided.

*The tile finishes will outlast adjacent finishes so the colours must be able to work with changes of decor and changing colour trends.*

### 5.1.4 Roll Carpeting

Roll carpeting is preferred for use in northern buildings.

*Carpet is typically used in classrooms, libraries, office areas, courtrooms. Not suitably durable or soil resistant for use in such areas as kitchens, main entrances, stairs or bathrooms.*

.1 Properties

- Yarn: nylon preferred.

*Durability, appearance and cost of nylon loop has been found to be most suited to northern buildings.*

- Pile: loop only - do not use cut pile.

*Hard wearing and easier to maintain than cut pile.*

- Density: minimum 12.0 kilotex.

*Density is the standard measure of carpet "wear ability", not carpet weight (i.e., 28 oz. or 32 oz.).*

- Static control: carpets should be rated at less than 3.0 kV.

*The dry cold climate of the North promotes static build-up, which can be uncomfortable to users and damage electronic equipment.*

- Colours: prefer patterned carpets only in medium colour ranges. Avoid using solid colours, with the exception of accent borders.

*Patterns do not show wear or dirt as easily as solid colours.*

.2 Installation

Direct glue-down installation of carpet is generally preferred. Avoid using underlay except for limited residential lounge areas. Only loop pile carpeting that is warranted against zippering is recommended to be installed.

*Gives a tight, low surface carpet that does not shift or stretch under heavy traffic. Although underlay can be more comfortable for residential lounge areas, it is not recommended for use in most northern buildings. Zippering occurs when tufts are pulled from the backing resulting in long lengthwise threads pulling out of the carpet. It occurs in loop pile carpet when the backing compound does not securely encapsulate the tuft base.*

.3 Warranty of Carpeting

- Heavy Traffic Areas:
  Minimum 15 year warranty required. Typically includes schools or colleges, airports, or public corridors in multi-unit housing.

*The manufacturer's warranty is probably the best indication of its durability. Warranties typically cover wear, anti-static performance, zippering, edge ravel or other seam defects. Warranties do not cover damage by burns, tears, pulls, cuts, use of improper cleaning agents, or inadequate protection from wheeled chairs.*

- Medium Traffic Areas:
  Minimum 10 year warranty required. Typically includes community offices, student hostels or group homes.

*Using less durable carpeting will generally result in higher life cycle costs because of the high cost of shipping materials and installation trades.*

- Light Traffic Areas:
  Minimum 10 year warranty required. There are few northern buildings where light traffic carpeting would be durable.

### 5.1.5 Modular Carpet Flooring

Modular carpet flooring, consists of dense vinyl-based composite sheet backing material integrally bonded with a dense low-profile covering of carpet fibre, and is suitable for most moderate or low traffic occupancies in northern buildings, such as classrooms and offices. Product manufacturers include InterfaceFLOR modular flooring and Mannington MODULAR TILE carpet. Care must be taken to ensure substrates are smooth, contaminant free and not subjective to excessive local heating (maximum 34 Deg. Celsius) for a durable installation.

*Improved product manufacturing and performance for cleaning ability, bacteriological contamination resistance, wear resistance and installation maintenance have made this material more suitable for demanding northern conditions, as compared to the product available even ten years ago.*

Installation of modular carpet flooring in heavy duty high traffic areas is not recommended.

*Sustainable operation of modular carpet flooring in high traffic areas requires periodic reinvestment to cycle high wear area units to lower wear rate areas.*

### 5.1.6 Epoxy Floor Finishes

A broad range of epoxy flooring materials are available for installation over cured and dry concrete substrates at lower cost and installation complexity than integral coloured concrete hardening compounds. Some epoxy flooring compounds can be specified with high chemical, abrasion resistance and moderate moisture tolerance. 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.

*Careful application is required, and it is difficult to keep maintenance materials in stock because of reasonably limited shelf life of epoxy based chemicals. Warehouses, repair and storage garages and similar large floor areas are examples of where epoxy flooring may be installed with reasonable service life expectations. Epoxy coatings are less durable than integrally coloured concrete hardeners.*

### 5.1.7 Integral Concrete Hardener

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. 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 trawled into the green concrete surface and bonds chemically with the concrete as it completes the curing process. Not recommended for use where repetitive chemical cleaning or sanitation is required.

*Integral hardeners form a simple protective coating to concrete that still allows water vapour to pass through the concrete, avoiding blistering and delimitation problems created when a vapour impermeable seal is used.*

### 5.1.8 Floor Paint

Floor paint is recommended to be slip-resistant safety paint containing suitably sized abrasive to ensure good traction of shoe soles under both wet and dry conditions. Recommended uses for non-skid concrete floor paint are dry service areas where oil liquid spills are prevented. Application of paint on concrete floors requires minimal controlled moisture in the concrete. Using only vapour permeable paint is recommended.

*Industrial quality slip-resistant floor paint is typically suitable for low traffic, non-public areas where protection from water, dirt or spilled oil is required, such as mechanical or fan rooms, and equipment storage rooms.*

### 5.1.9 Granular or Sand Floors

When arenas are located in areas of permafrost, or on sites where subsurface conditions will trap melted water due to persistent seasonal frozen ground creating water impervious soil conditions.

.1 A water-impermeable fabric liner should be installed below the ice surface.

.2 A permanent means of collecting and directing meltwater away from the building should be provided.

*Floors under the ice surface in natural ice arenas have typically been left as compacted granular or sand fill. Allowing meltwater to seep through the granular or sand floor has resulted in damage to the foundation system of a number of community recreation buildings containing natural ice arenas. Softening of ice-rich thaw susceptible soils (permafrost) by meltwater seeping out from arena ice sheets changes the soil bearing capacity. Increased moisture in the soil can increase frost heaving forces by creating frost balls within and outside the building perimeter.*

### 5.1.10 Base Trim

Wood baseboards are recommended where the additional cost of installation and dedication of suitable maintenance facilities, available for repair and abrasion damage touch up, are considered worth the appearance benefit.

*Wood baseboards require ongoing maintenance to repair abrasion damage from impacts and scuffing from floor cleaning equipment.*

Integral base trim is recommended for wet areas.

*Floor materials used for typical wet service areas form the least problematic base trim materials where the joint between the floor and the wall can be periodically resealed to compensate for water deterioration.*

Resilient rubber base trim is recommended for light and medium duty general service areas in northern buildings. Vinyl base trim is less durable and more problematic to maintain, and is recommended to be used only in passive service areas such as storage rooms.

*Care must be taken to ensure durable yet strippable adhesive and controlled installation conditions are provided, including suitable use of moulded corners.*

### 5.1.11 Entrance Mats and Grilles

Avoid building in recesses for foot-cleaning mats or grilles at building entrances. Use seasonably removable foot cleaning mats instead.

*Northern buildings experience ice and snow trackage for up to half the year, making recessed for cleaning grilles not only difficult to keep operational, but a slipping hazard. The difficult to build, recessed detail cannot function with season melt water unless adequately connected to a floor drain, which typically will plug with residual tracked soil and ice.*

## 5.2 INTERIOR WALLS AND PARTITIONS

Interior walls and partitions may be Fire Separations *(GBP Article A5.2.3)* having a Fire Resistance Rating, or separations without rating. Interior load bearing walls support the superstructure in addition to separating rooms and spaces within the building, while partitions are not structurally load bearing. Structural framing, thermal insulation, sound insulation, durability and maintainability of surface finishes all require diligent consideration for optimal performance of walls and partitions in northern buildings.

Interior wall surfaces are both very visible and subject to wear and tear damage. Regular maintenance by cleaning, patching and refinishing should be based on locally available skills. Interior wall surfaces located where impacts or rough usage are known to exist are recommended to be impact resistant or be suitably reinforced with impact resistant stiff materials. Surfaces should be washable, and easily repairable and refinishable by local tradespeople with materials that can be easily obtained and stored.

### 5.2.1 Framing of Walls

Wood or steel stud framing is acceptable for all interior non-load bearing walls.

*The use of steel studs simplifies work of electrical and mechanical trades, is relatively simple to install, and may be reusable when renovations are undertaken. For non-load bearing partitions, steel stud framing is generally less expensive to ship into a community.*

Interior load bearing (structural) walls are recommended to be framed with wood studs.

*Load bearing steel studs typically required specialized design and installation standards, including increased gauge specification, specialized blocking and engineered treatment of beams, while wood framing can follow building code-based design criteria.*

### 5.2.2 Demountable Wall Systems

Demountable wall systems typically using vinyl-faced prefinished gypsum wall board (GWB) panels are recommended primarily for use in large floor areas where reconfiguration of rooms to meet changed program requirements is frequently required. Small offices and administrative areas installed within other occupancies can be effectively served with site built painted GWB partitions.

*Demountable systems can allow flexibility for room layouts, provided detailed construction at joints provides for effective acoustic separation and matching prefinished vinyl faced GWB panels are available to replace damaged and discarded panels. Vinyl facing styles, colours and patterns often are not available beyond a certain date, so adequate quantities of spare maintenance materials should be provide, or using vinyl compatible paint for refinishing can extend the usable service life of vinyl-faced demountable wall claddings.*

### 5.2.3 Fire Separation Walls

Fire Separations are required around service rooms, some exits, and at other locations where the building has been divided into fire compartments as required by the building code. The intent of a fire separation is to slow the progress of fire by restricting movement of combustible gases and smoke, allowing evacuation of occupants, and fire fighter response. Doors in fire separations require a fire protection rating indicated by a certification label found on the hinge side, and typically require a closer to automatically return the door to the closed position. Fire separations must be continuous, with doors and other closures maintained in operating condition. Fire separations must not be damaged with unsealed holes or gaps.

*Fire separation walls are a first line of fire safety in most northern buildings and can be relied upon when active systems (sprinklers) are unavailable or insufficient. Damaged fire separation walls need to be repaired with fire-stopping sealants, and should be inspected yearly to determine if new pipes and wires have been installed through them without the proper fire-sealing at the hole, and whether fire dampers in mechanical ducts have been maintained in good operating condition where they go through the fire separation wall.*

*The need to correctly maintain fire separations becomes increasingly important to include in the GBP guide for renovation, as well as new construction. GBP Article A5.2.3 currently dealing with only mechanical room walls is therefore expanded to include all fire separation walls, and the special case of fire separations around mechanical service spaces and service rooms has been rewritten to a new GBP Article A5.2.3.2.1 referencing the issues of noise and heat transfer from mechanical equipment in “mechanical rooms”. The term “mechanical rooms” (which is not defined in building codes) has been revised to “mechanical equipment service rooms” which is consistent usage with the building code terminology.*

### 5.2.4 Mechanical Equipment Service Room Walls

.1 Heat Transfer

The preferred means of reducing heat transfer from mechanical rooms to other occupied rooms is to avoid locating them adjacent to one another. Where this cannot be avoided, the interior walls separating the rooms should be thermally insulated. Coordinate with acoustic separation requirements below.

*Overheating of rooms adjacent to mechanical rooms is a common problem in larger buildings such as schools, apartment buildings and similar residential accommodation such as group homes and health centres.*

.2 Sound Transfer Reduction

The preferred means of acoustically separating mechanical rooms from occupied spaces is to avoid locating them adjacent to one another. Where this cannot be avoided, walls, floors and ceilings of mechanical rooms should be rated to STC 50. Whenever possible, the acoustic isolation should continue through the floor to minimize sound transmission by the structure.

*Equipment noise from mechanical equipment service rooms disturbs users of adjacent spaces in many existing buildings. Refer to NBC 2005 Div. B Section 5.9, "Sound Transmission" and NBC 2005 Div. B, Section 9.11, "Sound Control".*

*STC (Sound Transmission Class) measures the acoustic separation capacity of a wall. The higher the STC rating, the better is the acoustic separation.*

*See also GBP Articles Mechanical M8.2.10 and Electrical E4.2.3 of the GBP.*

### 5.2.5 Interior Wall Finishes

Interior wall surfaces are both very visible and subject to impact damage in many northern buildings. Regular maintenance by cleaning, patching and refinishing should rely on local skills. Walls subject to intentional or unintentional damaging impacts need to be reinforced where they are likely to be kicked, hit with projectiles, or bumped. Surfaces should be washable, and easily repairable and able to be refinished by local tradespersons with materials that can be easily obtained and stored in the community.

*Wall surfaces in Northern buildings benefit more from durability and low maintenance demand than on continual expensive repair. Lower total service life costs are obtained by providing initially more durable wall finishes.*

### 5.2.5.1 Interior Wall Finish Materials

.1 Gypsum Board

Gypsum board is the preferred wall finish in most Northern buildings.

*An industry standard providing good fire resistance and a smooth, easily repaired surface.*

.2 Plywood Backing

Gypsum board finishes should be backed by or surfaced with plywood in vestibules and washrooms in buildings where experience shows a potential for vandalism activity, and in sports facilities where projectile impacts can damage surfaces.

*High traffic volume areas are subject to damage (i.e., from doors or impact damage from users) that will damage un-strengthened gypsum board.*

.3 Birch Walnut or Similar
Hardwood Veneer Plywood

An acceptable wall finish where appearance and durability are important.

*Provides a reasonably durable wall finish. Suitable for use in gymnasiums, change rooms, lobbies and foyers to enhance wall appearance and be easily refinished by sanding and varnishing.*

Use select grade for clear finish, or paint grade for a painted finish.

Use recessed screw fasteners in heavy use areas like gymnasium walls.

*Nails not to be used due to tendency to "back out".*

.4 Wood Panelling

Tongue and groove board finish is acceptable. Wood veneer panelling is recommended to be limited to communities where skilled trades people are available for maintenance.

*Hardwood veneer panelling requires skilled finish carpenters to install and maintain it. Prefinished vinyl veneer panelling should be avoided because it is difficult to repair if damaged, and difficult to match in replacement.*

.5 Laminate Prefinished Wallboard

Not recommended for use in northern buildings

*Appearance and durability concerns; any damage requires replacement of entire panels because the thin veneer cannot be field re-finished for appearance matching, and flame spread ratings often are high.*

.6 Metal Wall Liner Panels

Where metal panels are used as an interior wall finish, such panels should be factory performed steel sheet, zinc coated, refinished on the exposed face. Thickness should be minimum 0.5 mm (26 gauge) base metal thickness, where not exposed to traffic and 0.6 mm (24 gauge) if within reach of occupants.

*Typically used with pre-engineered metal buildings for the interior finish of garages and fire halls. Lighter gauge material is easily dented and should only be used where there is no exposure to impact damage.*

## 5.3 CEILINGS

Durability, economy and maintainability are primary considerations for the selection of ceiling finishes for northern buildings. Although generally inaccessible to occupants, ceilings do 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 and bath rooms), 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.

Recommendation | *Rationale*

### 5.3.1 Gypsum Wall Board

Seamless construction such as gypsum board is generally recommended as most northern building ceilings require a fire resistance rating such as can be provided by easily repaired gypsum board.

*Gypsum board is an industry standard with skilled trades persons available at most northern locations.*

### 5.3.2 Exposed Roof Decks

Exposed painted or clear finished wood deck material is an acceptable ceiling finish where tongue and groove board deck is used. Tight-knot appearance grade is the recommended minimum grade of material.

*Typically used in gymnasiums, community assembly buildings and schools, but may be considered wherever roof assembly allows decking to be exposed and such a finish provides sound control and light reflectance appropriate to the use of the space.*

### 5.3.3 T-Bar Suspension Grid

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

*Acoustic units (lay-in tiles) can provide a practical finish concealing ducts and wiring, and providing some sound absorption. They are mainly intended for ceilings where access to the plenum space above is routinely needed.*

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.

*Susceptible to impact damage and very difficult to clean. Adequate clearance above the ceiling grid needs to be provided for easy removal and replacement of lay-in acoustic units without damaging them.*

Use of the plenum space above suspended ceiling systems for un-ducted ventilation purposes such as relief or return air distribution is not recommended.

*Accumulated dust and debris deposited by the ventilation system or re-distributed from debris left in the plenum space encourages development of moulds and bacteria colonization of the fissures in lay-in acoustic units, and adhesion of the same in dust-laden surfaces which are impossible to clean. The cumulative bad effect on indoor air quality is difficult to correct without tearing out the complete ceiling assembly and replacing it.*

### 5.3.4 Textured Ceiling Finishes

Porous or soft textured ceiling finishes are not recommended for use in northern buildings. Dust and smoke from wood burning appliances (where present) cause discolouration and increase the retained dust load on of interior surfaces.

*Easily damaged, and difficult to refinish because of particle release when re-wetted with water-soluble paints.*

Low-relief rolled plaster skim coat finishes (California stucco) are recommended alternatives to soft spray-textured stipple coat finishes.

*Hard reasonably impervious surfaces are easily vacuum cleaned of dust and readily repainted without particle release.*

### 5.3.5 Metal Ceiling Liner Panels

Where sheet metal panels are used as an interior ceiling finish, panels are recommended to be factory preformed steel sheet, zinc or Galvalume finish coated, and prefinished on the exposed face with factory applied corrosion resistant paint. Thickness should be minimum 0.475 mm (26 gauge) base metal thickness, where not exposed to impact damage, and 0.635 mm (24 gauge) if within a potential impact damage zone.

*Typically used with pre-engineered metal buildings as an interior finish for garages, vehicle service storage buildings such as firehalls, and similar industrial occupancy buildings. Lighter gauge material is easily dented and should only be used where there is no exposure to damage. Pre-coated steel with a durable protective coating is recommended to resist the rusting caused by moisture condensation on the metal surfaces caused by typical northern humidity and temperature seasonal fluctuations.*

## 5.4 PAINTING AND WALL COVERINGS

Durable wall finishes need to be selected for availability, installation simplicity, and reparability for most northern locations where the range of products and trades people is limited. Wall 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.

Recommendation

*Rationale*

### 5.4.1 Acrylic/Latex Paints

Water-based acrylic latex paints are recommended for use in Northern buildings. Durable recommended products are listed with the (MPI) Master Painting Institute (APL) Approved Products List, found in the MPI Manual, available from:

http://www.paintinfo.com/mpi/store/archman.htm

*Environmental and health concerns have encouraged manufacturers to develop water-based paints that are now comparable with oil-based alkyd paints for durability. Painting trades preferences are also beginning to stipulate the use of water-based products because of health concerns. Minimizing the availability of harmful products (including solvents) and off-gassing of solvents and paint dryers is also an important concern in many Northern communities. Recommended best practice is found in the MPI Manual. The U.S. and Canadian copyrights both of this manual and the companion manual (Maintenance Repainting Manual) are owned by Master Painters & Decorators Association, a not-for-profit industry association.*

### 5.4.2 Alkyd Paints

Oil-based alkyd paints are recommended for use in northern buildings where the risk of cold weather damage to stored, shipped or newly installed paint is a consideration. Water-based acrylic latex paints are recommended for use in northern buildings. Durable recommended products are listed with the (MPI) Master Painting Institute (APL) Approved Products List, found in the MPI Manual, available from:

http://www.paintinfo.com/mpi/store/archman.url

*Although able to withstand freezing during shipping and storage, VOC (volatile organic compounds) emissions, and the need to use and store solvents for cleaning, make alkyd-based paints more demanding in application than water-based paints. Painting trades preferences are also beginning to stipulate the use of low VOC paint products because of health concerns. Minimizing the availability of harmful products (including solvents) and off-gassing of solvents and paint dryers is also an important concern in many northern communities. Recommended best practice is found in the MPI Manual. The U.S. and Canadian copyrights both of this manual and the companion manual (Maintenance Repainting Manual) are owned by Master Painters & Decorators Association, a not-for-profit industry association.*

### 5.4.3 Special Coatings

Special high-build acrylic or epoxy coatings are recommended to be used only where they will be applied to a reinforced drywall, plywood or concrete substrate requiring specialized corrosion resistant protection. Water-soluble or low VOC products are recommended.

*The purpose of special coatings is generally to provide a very damage or corrosion resistant finish, and so the substrate should be equally resistant.*

### 5.4.4 Vinyl Wall Coverings (VWC)

Vinyl wall coverings are recommended for:

- visible public areas not subjected to vandalism or impact damage where upgraded appearance is important and painted wall finishes would show wear quickly
- areas where posters, notices, etc., will be affixed to walls

*VWC provide a more durable surface than painted drywall. Tape or tacks can be used on vinyl wall surfaces with less visible damage than would occur on a painted surface. Although durable, vinyl wall coverings can be damaged by impact; they are expensive; installation requires more skill than painting; and textured surfaces can be difficult to clean once soiled. To repair surfaces properly the section of damaged VWC has to be removed and a new section installed by qualified personnel.*

Where used in high traffic areas subjected to impact damage, VWC is recommended to be installed so that the lower portion of the wall (up to about 1.2 m) can be replaced independently, i.e., separately wainscoted section.

*Advances in coating technology have resulted in durable spray-applied coatings to refinish vinyl wall coverings in place.*

Avoid using vinyl wall coverings where frequent cleaning will be required, such as near wet areas and service counters. Installation is not recommended in known frequently damaged areas generally accessible to the public.

*The textured surface has proven to be difficult to clean. The use of VWC is not recommended in high traffic and impact areas of buildings accessible to the public, due to the amount of abuse these surfaces receive and the difficulty in repairing these surfaces.*

### 5.4.5 Ceramic Tiles

Ceramic wall tiles are recommended for use for wall coverings in northern buildings, where it can be shown that the advantages of durability and ability to withstand routine sanitation cleaning, as is required in commercial food preparation facilities and similar buildings, overcome the disadvantages of high initial cost, cracking and debonding susceptibility, and problematic grout maintenance.

*Although it is recognized that ceramic tiles can be low maintenance, easy to clean, and very durable, capital costs are generally high in the North due to a combination of transportation and trades cost considerations.*

Very stiff substrates are recommended to increase the durability and initial installation quality of ceramic wall tiles. Cement board securely screwed and adhesive fastened to wall structural framing is a minimum substrate requirement for ceramic wall tile installation.

*Examples of where ceramic tiles may be appropriate would include specialized facilities such as laboratories or hospital operating rooms where applied over stable substrates. Stable substrates include concrete masonry units (CMU's), cast concrete, and Portland cement bearing wall panel materials such as Wonder Board, Unifix PermBase or similar materials.*

### 5.4.6 Acoustic Treatments

Acoustic conditioning of some interior walls and ceilings is essential for good sound quality in some buildings and room types. Acoustic sound dampening materials recommended for use in northern buildings should be selected to not accumulate dust and fibres in fissures, but rather should be reasonably smooth surfaced allowing periodic vacuum cleaning without deterioration.

*Porous surfaced materials (such as Tectum acoustic panels) will help modify sound conditions by reducing reverberation time, but trap dust particles and mould spores, over time contributing to a potential reduction in indoor air quality. Smooth surfaces fabric covered attenuation panels are recommended for northern buildings where airborne dust and fibres are a common occurrence.*

# A6 FINISH CARPENTRY

Finish carpentry requires specialized trades skills often scarce in Northern communities. For this reason, as well as for cost considerations, the extent of finish carpentry in northern buildings is recommended to be limited and plain: complex details are generally difficult to execute on remote buildings and should be avoided. AWMAC (Architectural Woodwork Manufacturers Association of Canada) Standards should to be used as a quality benchmark for finish woodwork.

## 6.1 CABINETS AND SHELVING

Refer to the relevant sections of AWMAC *"ARCHITECTURAL WOODWORK STANDARDS "- 1st Edition – 2009* Effective September 1 2009, published by the Architectural Woodwork Manufacturer's Association of Canada, and available from the northern Alberta AWMAC Chapter at 15327 - 116 Avenue Edmonton, AB T5M 3Z5. (northernalberta@awmac.com)

| Recommendation | *Rationale* |
|---|---|
| **6.1.1 Casework** | |
| Custom grade casework, including drawers, shelving, doors and edge banding as described in AWMAC *"ARCHITECTURAL WOODWORK STANDARDS – 1st Edition"* is the recommended quality reference for casework in northern buildings. | *AWMAC "ARCHITECTURAL WOODWORK STANDARDS – 1st Edition" establishes three quality grades: economy, custom and premium. Custom grade detailing is recommended for most northern buildings as being the best combination of economy and durability to accommodate the seasonal fluctuations in northern air humidity.* |
| Cabinet Doors:<br>Edge banded hardwood plywood doors are acceptable if they do not exceed 450 mm(w) x 1200 mm(h) in size. | *Large plywood doors are prone to warping due to seasonal humidity fluctuations (mainly excessive dryness in winter) in northern regions.* |
| For larger doors:<br>Hollow core door construction is preferable, but composite board slab core construction is acceptable with appropriate humidity protection to the core construction to eliminate warping. | *Some particle fibre composition boards absorb and disperse moisture from the air in step with the seasonally changing air humidity, resulting in dimensional instability of the material and warping of constructions made from it.* |
| **6.1.2 Clear Finish** | |
| .1 Materials<br>Where a clear finish is to be used, birch veneer hardwood plywood is preferred. To be Select White or Red, as described in AWMAC *"ARCHITECTURAL WOODWORK STANDARDS – 1st Edition".* | *Reasonable appearance and cost.* |

.2 Matching

Book matching is preferred.
Slip matching is acceptable.
Random matching is not acceptable.

### 6.1.3 Paint Finish

Where a paint finish is to be used, paint grade plywood, as described in AWMAC *"ARCHITECTURAL WOODWORK STANDARDS – 1st Edition",* is acceptable.

*Where a smooth surface is important, but wood grain appearance is not.*

### 6.1.4 Hardware

Finish:
- brushed metal or plastic coated preferred

*Good quality, durable and simple hardware is best suited to all northern buildings, where durability and long service life is sought.*

Cabinet hinges:
- concealed hinges preferred

Drawer glides:
- ball bearing type preferred

Cabinet door and drawer pulls:
- simple design preferred

### 6.1.5 Shelving

The use of premanufactured shelving systems is preferred to custom millwork for most northern buildings, particularly in libraries, resource centres and storage rooms. Metal storage shelving should be considered as an alternative to built-in shelving where appearance is not critical.

*Premanufactured shelving is generally less expensive than custom millwork and provides users with more flexible furnishings.*

.1 Supports

Generally to be supported on metal standards for adjustable shelf brackets. Lateral support to prevent overturning is required on free-standing shelf units.

*To allow shelf reconfiguration to meet changed requirements.*

.2 Materials and Finishes

- Clear finish birch plywood or plastic laminate finish complete with hardwood edge banding is preferred in all public or visible locations.

*Visually apparent shelving is typically recommended for libraries, schools, community offices, health care facilities and similar areas accessed by the general public.*

- Plastic, plexiglas or glass shelving should be limited to display cabinets.

*Display shelving has limited application in schools or community centres, but would more often be found in visitor centres, cultural centres or museums. Because glass or clear plastics need to be kept very clean, and are subject to scratching or breakage, their use is recommended to be limited.*

- Melamine surfaced or painted shelves are acceptable for storage rooms or low visibility locations.

*A less expensive alternative to clear finishes where appearances are not as important. Typically acceptable for storage rooms, garages, fire halls, or seasonal use buildings.*

Note: Special attention must be paid to ensure acclimatizing of wood prior to installation, because of the extremely dry climate in the North.

## 6.2 COUNTER TOPS

These can be a major visual element in rooms, making the choice of colours and patterns important. Refer to AWMAC *"ARCHITECTURAL WOODWORK STANDARDS – 1st Edition".*

Recommendation

*Rationale*

### 6.2.1 Counter Tops

Self-edge type, with back splash and side splash sections site installed and sealed using transparent silicone sealant. Hardwood edge may be appropriate in some applications.

*Experience has shown that post-formed counter tops are often damaged in transit, and exposed edges at nosings/overhangs are easily chipped.*

Avoid the use of post-formed laminate counter tops with integral back or side splashes.

### 6.2.2 Plastic Laminate

General purpose grade, complete with backing sheets, velour or suede finish. Texture patterns preferred in all high rate of use areas. Solid colours acceptable only in low-use areas. Generally avoid using wood grain laminate patterns.

*Typical high-use areas include kitchens and washrooms of all public use or residential buildings, library counters, visitor centre information counters and classrooms. Low-use areas, where solid colours are acceptable, would typically include office reception counters, courtrooms, seasonal-use buildings and staff washrooms. Wood grain patterns are difficult to repair and match for replacement.*

### 6.2.3 Chemical Resistance

Where chemical resistance is required, laboratory grade plastic laminate should be used.

*Typically required in school science labs, health centres, labs and film development rooms, and biological analysis labs.*

## 6.3 MISCELLANEOUS FINISH CARPENTRY

Refer to AWMAC *"ARCHITECTURAL WOODWORK STANDARDS – 1st Edition",* various applicable sections.

| Recommendation | *Rationale* |
|---|---|
| **6.3.1 Grade** | |
| Custom grade as described in AWMAC *"ARCHITECTURAL WOODWORK STANDARDS – 1st Edition.* | *Fir, birch and oak are hard enough to withstand scratching or denting, whereas pine is soft and susceptible to damage from everyday activities.* |
| Recommend clear fir, birch or oak throughout. Avoid pine. | |
| **6.3.2 Coat Racks** | |
| Ensure spacing and size of parka pegs are adequate for heavy winter parkas, coveralls and similar garments. | *Typically provided in schools, community offices and group homes.* |
| Parka hooks in school corridors should be installed with a protective over shelf to help prevent head height injuries. | *Wood dowel coat hooks mounted at child access heights can present an eye injury hazard.* |
| **6.3.3 Radiation Covers** | |
| Premanufactured metal radiation cabinets are preferred for most northern buildings. Custom wood radiation cabinets or covers are acceptable only for special use northern buildings if a simple means of removing sections to allow cleaning of fins and access to valves is provided. Covers that require dismantling of millwork to access valves are not acceptable. Wood radiation cabinets or custom covers are not recommended for use in intensively used buildings such as arenas and schools and similar northern buildings used by the general public. | *Higher initial cost than standard metal cabinets, and increased repair and maintenance cost. The design of custom wood radiation cabinets in past installations has made it impossible to clean the fins without dismantling woodwork. Experience shows that a lot of garbage and debris is dropped into radiation cabinets making ready access for cleaning essential.* |

# A7 SPECIALTIES

Specialties include fixtures, furnishings, fittings and installed equipment not addressed in other GBP sections or articles. Specialties need to be selected for availability, installation simplicity, and repair ability for most northern locations where the range of products and trades resources are limited. Specialties that are robust and resist damage and 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 not available within the local community.

## 7.1 WASHROOM ACCESSORIES

Durability and damage resistance are important because washroom accessories are often subject to abuse, including scratched or applied graffiti. Washroom accessories should normally be surface-mounted or free-standing for ease of installation, servicing and replacement. Fully recessed accessories (such as compact towel dispensers with integral waste receptacles) may be considered in small washrooms with low traffic volumes.

| Recommendation | *Rationale* |
|---|---|
| **7.1.1 Shower Surrounds** | |
| Glass fibre, reinforced acrylic moulded units, or PVC pre-formed units are recommended for most northern buildings. Integral grab-bar systems or the ability to attach standard grab bars are recommended. | *Pre-moulded units are easily cleaned, easy to install, and provide a durable surface.* |
| Ceramic tiles or prefinished panel materials requiring jointing on site are less preferable for small installations, but are acceptable in institutional settings where routine maintenance is provided to maintain grouted joints and fixtures. | *Routine sanitation using antibacterial and anti fungal chemical cleaners causes early deterioration of plastic surfaces, but work well with impervious ceramic faced wall tiles. Periodic re-grouting as an ongoing operational cost needs to be considered.* |
| **7.1.2 Toilet Partitions** | |
| Standard manufacture plastic laminate or baked enamel finish metal partitions for toilet stall compartments are recommended. Site-built partitions are not recommended. | *Typically required in all public washrooms, so durability and ease of cleaning are important. Site-built partitions generally cannot withstand heavy use and become a maintenance problem for cleaning and repairs.* |
| Floor mounting is recommended. Suspended units should be considered when frequent sanitation cleaning of the floor is required, such as in a health care facility or similar washroom used by the general public. | *Suspended partitions generally require additional bracing to achieve the same robustness and impact resistance as floor mounted systems. Suspended systems are more expensive because of the extra structural support required at the ceiling, and the additional fittings needed to attach the system to the building overhead structure.* |

### 7.1.3 Washroom Accessories

Recommended washroom accessories are products manufactured by:

- Bobrick
- Bradley
- Frost Metal
- Watrous

*These brands have proven to be an acceptable standard for a broad range of northern buildings*.

### 7.1.4 Backing

Solid wood blocking or backing must be installed for all fixtures, fittings, furnishings, equipment and hardware to be mounted on wood framed or steel stud framed walls.

*Secure, safe and vandal-resistant installation is aided by solid anchor points for installed accessories, including toilet compartment partitions where they are attached to walls and ceilings.*

## 7.2 SIGNS

Effective clear signs support good building operation and maintenance by clearly identifying buildings and the spaces within them. The following recommendations describe sign types and styles currently recommended for the environmental conditions affecting northern buildings.

| Recommendation | *Rationale* |
|---|---|

### 7.2.1 Language

Signs provided to help user and visitor orientation should be written in English, local northern languages and international graphic symbols as appropriate.

*Official government language policies have broad practical application for all sign requirements in Northern communities. Buildings typically affected include public facilities like air terminals, schools and health care facilities, in addition to commercial and mercantile occupancies.*

Northern buildings accessible to the public are recommended to follow the current official languages policies in effect in the jurisdiction in which the building is located.

*Official language policies for each jurisdiction are available from the appropriate senior government agencies in each Northern jurisdiction.*

### 7.2.2 Exterior Signs

Cast bronze letters or painted cast aluminum letters, individually mounted, 12.7 mm thick, 200 mm high are recommended for durability. Syllabics should be in modules of 50 mm to a maximum of 200 mm. Roman Orthography (English) lettering is recommended to be upper case Helvetica for facilities designated for general public access.

*These have proven to be acceptable and practical in use for the past several years.*

### 7.2.3 Interior Signs

.1 Room Names

Laminated plastic, 3 mm thick plates, engraved or subsurface printed lettering and symbols are durable and practical.

*These have been proven to be acceptable where used for the past several years.*

Colours should be coordinated with building interiors.

.2 Directory Boards

Removable inserts are preferred. Avoid using individually mounted letters.

*These are simple to install and provide a neater appearance than individually mounted letter systems.*

.3 Interior Doors

All doors are recommended to be identified with names and space designation numbers to match the names and room numbers on the building record drawings and updated as changes are made to the floor plan.

*Maintenance co-ordination and way-finding for persons unfamiliar with a particular building are improved with clear and up to date room and space identification.*

## 7.3 WINDOW COVERINGS

Window coverings are commonly included in construction contracts rather than with furnishings. Blinds and blackout curtains can be used to control day lighting admitted into rooms in public use 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-four hours of daylight for as many as 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 photographic slides or other projected images may be used.

Recommendation

*Rationale*

### 7.3.1 Draperies

Fabric draperies are recommended to be machine washable. Fabrics should be selected for durability, ease of vacuum cleaning, and light transmission properties to meet the need of the program, including appropriate fire-resistance.

*Dry cleaning is not available in most northern communities. Heavily textured fabrics that retain dust are not recommended for general use in Northern buildings.*

Draperies are not recommended to be located where they can be deployed to block access to a required means of egress.

*Glazed doors situated in exterior walls are recommended to have their glazed portions covered with curtains mounted on curtain rods fixed to the door, rather than with curtains or drapes on valance or wall mounted tracks or rods.*

### 7.3.2 Blinds

Adjustable vertical blinds are recommended where control of incident sunlight and retention of visual access is required at the same time. Horizontal blinds are acceptable where windows are located to minimize incidental damage from rough use or impacts, and excessive raising and lowering is not a requirement.

*Vertical blinds do not collect dust as readily as horizontal blinds, and typically are less prone to impact damage. Horizontal blinds relying on fabric cord suspension have a reduced service life compared to vertical louvered blinds.*

Perforated plastic (accordion style folding) or small slatted metal blinds are recommended.

Fabric blinds are recommended to not be used unless the fabric has an easily cleanable surface. Fabric blinds should be selected for durability, ease of vacuum cleaning, and light transmission properties to meet the need of the program, including appropriate fire-resistance.

*Plastic or metal are simple to clean, compared to fabric blinds.*

*Some fabric blinds have tightly woven smooth textured surfaces allowing vacuum cleaning.*

*Caution: Some flame resistant finishes can be washed out by cleaning. Selection of fabrics must take this into account.*

## 7.4 MAJOR APPLIANCES

Built-in appliances are occasionally included in construction contracts rather than with furnishings. Nationally recognized major appliance brands, supported by strong North American distributor and repair agencies, are recommended to be selected for installation in northern buildings where repair services for less commonly available appliance brands are not always available.

Recommendation

*Rationale*

### 7.4.1 Kitchen Appliances

Preferred manufacturer brands of stoves, fridges, freezers and other major kitchen appliances are recommended to be confirmed with local building asset management agencies. Standard sizes and energy efficient models meeting current Energy Star ratings should be selected.

*The objective is to simplify the number of parts stocked, and simplify repair trade’s maintenance routines and time requirements.*

### 7.4.2 Laundry Equipment

| | |
|---|---|
| Preferred manufacturer brands of washing machines, dryers or other laundry equipment are recommended to be confirmed with local building/asset management agencies. Standard sizes and energy efficient models are recommended to be selected. | *The objective is to simplify the number of parts stocked, and simplify repair trade's maintenance routines and time requirements.* |

# A8 COORDINATION

This section identifies some structural, mechanical, electrical or site considerations that typically require design integration with architectural building components and systems.

## 8.1 MECHANICAL EQUIPMENT

Mechanical equipment major installations such as boiler rooms and ventilation fan rooms should be positioned in the building for easy and convenient access. Situating ventilation rooms in upper stories of buildings and on roofs, whether exposed to the weather or enclosed in mechanical penthouses, creates access problems for servicing, routine inspection and major component replacement, requiring space for access stairs. Wherever possible, it is recommended to locate mechanical equipment service spaces at or near convenient ground floor access, and near a building perimeter location near service vehicle parking spaces. See also *GBP Article A8.1.3, "Access to Service Spaces",* and *GBP Article A8.1.5, "Stair Access to Mechanical Service Spaces".*

### 8.1.1 Space Requirements

| Recommendation | *Rationale* |
|---|---|
| Adequate space should be provided in mechanical rooms for plumbing, heating and ventilation equipment, including required clearances and access for maintenance. See notes in GBP 2009 Mechanical Section. | *Cramped mechanical rooms with minimal clearances and inadequate access for maintenance, limits efficient maintenance and operation, reducing the service life and economic benefit of efficient operation of mechanical systems and components.* |
| Space in wall and floor assemblies is often required to accommodate plumbing and ducts. Great care must be taken that these spaces do not deteriorate the continuity and effectiveness of the environmental separation functions (air, vapour and thermal separation) of the building envelope. | *Providing adequate space can be problematic where long plumbing runs are required and structural floor space is limited.* |

### 8.1.2 Location

The location of mechanical equipment, ducts, pipes, grilles and louvres, and servicing points is recommended to be coordinated through integrated design review early in northern building design activity with structural systems and architectural systems and components.

*Equipment location and its integration into the structural and architectural systems of the building is recommended in order to effectively balance all building technical requirements, including best value for project cost. Giving one building system priority over other equally essential building system requirement typically results in system clashes that are expensive to correct when revealed during construction, or left unresolved to become an ongoing operating inefficiency to the building operator.*

### 8.1.3 Access to Service Spaces

Control and maintenance of heating and ventilation system equipment requires access to controls and equipment. Access panels are typically required to be provided in ceilings and walls.

*Fairly frequent access is typically required, especially when building is newly occupied and operator is becoming familiar with system, or during seasonal weather changes or renovation to building subsystems.*

### 8.1.4 Windows and Skylights

Heat gain and heat loss through windows, clerestory glazing and skylights must be taken into consideration by heating and ventilation system designers. Long solar days in the more northerly latitudes, combined with a generally warming mean annual air temperature (MAAT) trend in northern communities requires thorough analysis for the energy modelling of northern buildings. Refer to *GBP Subsection G3, “Energy Management”.*

*Changes to architectural design are recommended to be systematically passed on to mechanical design consultants as standard operating procedure for the integrated design process. When ventilation systems cannot manage unexpected summer heat gains, the facility can become uncomfortable and exceed workplace environmental standards required by the Workers’ Safety and Compensation Commission.*

### 8.1.5 Stair Access to Mechanical Service Spaces

The use of vertical ladders to access elevated mechanical rooms or service spaces is not recommended. Stairs, including alternate tread stairs, are the recommended means of accessing these spaces.

*Vertical ladders make access to mechanical spaces very difficult and unsafe because both hands and feet are required to use a vertical ladder safely, making equipment, replacement parts and tool carrying difficult.*

A ships ladder is only acceptable if it is the only possible means of access. Ships ladders must be accompanied by a hoisting mechanism to allow equipment and tools to be hoisted to and from these areas.

*Ships ladders are acceptable if it is not possible to install stairs, and there are no other means to access the mechanical areas. Recommended use of alternate tread stairs which are more compact than standard stairs and comparable in footprint to a ship’s ladder is encouraged. A hoisting mechanism is also required to enable tools and equipment to be raised and lowered.*

## 8.2 ELECTRICAL EQUIPMENT

Electrical equipment major installations such as standby generators, main entrance switch gear, primary control centres and building communication and control service equipment rooms should be situated in the building for easy and convenient access. Wherever possible, it is recommended to locate standby generator service rooms near to, or combined with, mechanical equipment service spaces at or near convenient ground floor access, and by a building perimeter location that is near service vehicle parking spaces. Refer to GBP Electrical Section for detailed requirements.

| Recommendation | *Rationale* |
|---|---|
| **8.2.1 Space Requirements** | |
| Adequate space is required for electrical equipment, including required clearances and access for maintenance. This may require coordination with mechanical design as well as electrical design. See GBP Electrical Section. | *Cramped electrical and mechanical rooms with minimal clearances and inadequate access for maintenance limits efficient maintenance and operation, reducing the service life and economic benefit of efficient operation of mechanical and electrical systems and components.* |
| **8.2.2 Access** | |
| Pull and junction boxes need to be accessible in the event electrical changes are required. | *Although access is not frequently required, lack of access means that ceilings and walls will have to be patched any time they must be accessed. GBP Electrical section and the Canadian Electrical Code requirements are recommended to be fully complied with.* |
| **8.2.3 Electrical Outlets** | |
| Electrical service equipment and distribution components are recommended to not be installed in the building exterior envelope unless they are positioned fully on the interior (warm) side of the air-vapour barrier system. Outlets located on exterior walls, roofs and floors, and conductors that run through the building envelope must be positioned so that they do not interrupt the continuity of the building air and vapour barriers, or create thermal bridges across the thermal insulation components of floors, walls or roofs. | *Electrical components poorly sealed into the building envelope are a primary cause of excessive heat and air leakage and uncontrollable energy losses. Positioning wires and conduits and the service points they feed fully within the insulated and interior air shed portion of walls, roofs and floors provides the most sustainable and economical operation of the building.* |

## 8.3 LIGHTING DESIGN

Fixture locations need to be coordinated with structural and mechanical components to provide effective maintenance access. Lighting fixtures need to be positioned to allow access to the lighting fixture to change bulbs and ballasts.

*The objective is to avoid the need for on-site changes and to prevent lighting obstructions. Electrical and mechanical rooms with high ceilings and minimal clearances around piping etc., make it extremely difficult to access lighting fixtures when changing ballasts, bulbs and fluorescent tubes.*

Exterior lighting fixtures situated higher than three meters above the ground are to be equipped with fall arresting wall hooks for worker safety harness attachment.

*Wall hooks are required for personnel to attach to whilst accessing the lighting fixtures for maintenance.*

Fixture styles are recommended to be coordinated with decorative or architectural themes.

*Fixtures should be selected collaboratively by the electrical designer and the architectural designer.*

Day lighting zones and electrical lighting zones are recommended to be coordinated.

*Adequate daylight can make electric lighting redundant at times; however, energy savings can only be realized if electric lighting can be selectively turned off when not required.*

## 8.4 RECESSING OF FITTINGS

It is recommended to avoid mounting electrical service equipment where risk of injury to persons exists because individually projecting fittings, hardware, or similar items within two metres of the floor level without providing protective enclosure guards or recessing the equipment.

*The intent is to minimize the risk of people running into installed equipment or hitting it with carried tools or equipment.*

**END OF SECTION**

# Table of Contents

## STRUCTURAL

# Table of Contents

# STRUCTURAL

## INTRODUCTION

Structural design of northern buildings must consider several conditions not typically found in the rest of Canada. Permafrost is the most significant geophysical factor, but strategic factors due to climate and location play a greater part. Transportation costs can be a large portion of total project cost. Size restrictions apply, and weight and volume should be minimized for sealift, barge or air freight. Providing designs that encourage local labour and use and develop construction skills is an important long range strategy for lowering northern construction labour costs.

A short construction season demands structures that can be erected quickly so buildings can be closed in before winter. Simple wood frame construction has been found to satisfy most northern building conditions. Pre-engineered metal buildings are common because steel framing also satisfies many northern building conditions. Structural concrete is seldom used because of difficulty with quality control, climate and the higher cost of winter hoarding, materials freight cost, variable aggregate resources and lack of batch plants in small communities. However, as trade skills, materials, batching plants and roads all become more readily available, structural concrete will become more economical.

## S1 CODES AND REGULATIONS

- NWT Fire Prevention Act
- NWT Fire Prevention Regulations
- NWT Architects Act
- NWT Engineering and Geoscience Professions Act

## S2 LOGISTICS

### 2.1 TRANSPORTATION AND HANDLING

Equipment available to move materials is often limited in northern communities. Suitable local equipment may be required for other essential uses around the community, so work must be scheduled carefully. In larger communities this may be less problematic, but it is important to know what construction and transportation equipment will be available in the community before design starts. All components should be sized small enough and light enough so they can be moved to the site and erected with available equipment. Getting materials to the building site at the right time can be more difficult in communities served by annual sealift or summer barge, or only by winter roads.

### 2.2 SCHEDULE

The construction season is much shorter in the North than elsewhere in Canada. Closing buildings in before severe winter conditions set in is critical. Structural work must proceed quickly and smoothly; extra care must be taken to ensure it is also completed correctly in one operation. Material delivery schedules and seasonal soil conditions generally determine optimum foundation work schedules. Variables include the transportation system to be used (barge, sealift, air, all weather road or winter road) and the foundation system selected (piles, shallow footings, buried footings or slab). Site preparation may be performed a year in advance to permit consolidation of placed fill. Foundation work can be installed in advance of the superstructure to meet delivery or other scheduling constraints. This is particularly appropriate with foundation designs that are not affected by their remaining in place without the superstructure load in place.

## 2.3 STANDARDIZATION

The size and type of structural elements used in a building should be standardized. This may help decrease waste and will simplify construction procedures, reducing erection time and complexity. Whenever possible, simplify detailed design and minimize the number of operations required to install components. Uncomplicated details are likely to bring about a better building.

## 2.4 SITE SELECTION IN PERMAFROST AREAS

Northern soils conditions often contain permafrost at depth, defined as a region where the ground is continuously frozen for two or more years. The importance of proper investigation and selection of sites and access routes in permafrost areas cannot be overstated. Research including detailed site geotechnical investigation is required, environmental considerations and the availability of construction materials must be taken into account. Increased construction cost, and increased operation and maintenance over a building's service life is the usual consequence of incomplete information about site geotechnical characteristics and terrain.

Recommended best practice for all northern site investigations other than for undisturbed solid rock bearing sites, consists of a preliminary condition assessment and site characterization, verification by field sampling techniques based on the proposed building size, form and required service life, then laboratory testing of field samples to determine the physical performance limitations of the soils, and finally preparation of a comprehensive report recommencing prioritized foundation design alternatives.

Continuous, discontinuous and sporadic permafrost zones, each with different performance characteristics for the structural support of buildings, are found throughout the North. When undisturbed rock is available, foundations can be simple, dependable, durable and virtually free of design performance uncertainty. Foundations designed for bearing support in frozen ground or frozen fractured rock need to accommodate both periodic and long term change of bearing conditions, strongly affected by surface and ground water movement. Most of the North is also affected by seasonal freezing and thawing of a portion of the ground at the surface, called the active layer.

A geotechnical investigation in permafrost is more complex than in temperate climate regions because of the potential presence of ice within soil or rock the properties of which are temperature and salinity dependent, seasonal variance of ground water and surface water quantities, climate change gradually warming the ground and causing weakening or extinction of structural capacity in thaw-susceptible soils, and presence of variable salinity in coastal areas or soils historically inundated with sea water.

## 2.5 CLIMATE CHANGE DESIGN ADAPTATION

Climate change is increasing the air and ground temperatures of many northern communities, leading to new climate driven structural design factors for building support and environmental loads, including snow and rain precipitation loads, and wind loads. Additionally, increased variability of climate related weather events is tending to decrease predictability of future building engineering performance conditions, requiring a risk-assessment based approach to building engineering design to accommodate expected broader future variance of weather events.

Building design and development will increasingly need to accommodate greater amounts of denser snow; deluge rainfall and snow melt events leading to more water-related risk to building foundations; increased variability of wind events and gust levels in some communities, and increased variability in mean annual air temperature, skewing historical norms of winter and summer site condition boundaries, leading to earlier or later freeze-ups and earlier or later spring thaw. Research into the effects of climate change on northern buildings is a valuable activity recommended to be supported by all agencies engaged in northern building and infrastructure development.

## S3 FOUNDATIONS

Foundation systems for most northern buildings are designed for typically light structural loads, recognizing the limits imposed by partially or permanently frozen soils. Permafrost soils often have a high water content and, as a result, remain stable only when frozen. As noted in the National Building Code, foundation design for permafrost soils requires the services of "a person especially qualified in that field of work". Additional qualifications include applying climate warming trend analysis to foundation design in warm permafrost areas affected by ground temperature warming. Geotechnical investigations should be undertaken as soon as a site is identified, and well in advance of design. Buildings located in thaw-susceptible permafrost ground conditions are typically raised above grade to protect the permafrost from deterioration caused by building heat loss. Thermosyphons have also been installed in a number of northern buildings to maintain permafrost, while allowing buildings to be set on grade. Basements are practical only in locations where well drained soil is free of permafrost, or where bedrock is near enough to the surface to be used for bearing.

### 3.1 PILES

Steel pipe piles have become one of the most common foundation systems used in the North. Considered one of the most stable and low maintenance systems, piles also allow the heated building envelope to be raised above frozen ground, which can decrease the build-up of drifting snow at the base of the building. Wherever possible, piles are socketed into bedrock, but in areas of permafrost, piles can be supported by the frozen soil. Developments in the use of "adfreeze" piles have included adding welded rings to increase bearing capacity. Saline permafrost found near the sea shoreline has different bearing characteristics than freshwater permafrost and must be treated differently. Increased salinity decreases the strength of the permafrost and increases the deformation of foundations in permafrost. Saline permafrost is widely distributed beneath coastal communities in the Canadian North. Scheduling of piling work has to take into consideration the availability of materials and equipment in the community, as well as seasonal soil conditions that might impede construction. It is best if piles are installed while soils are frozen and before early summer, so that the site will bear the traffic of equipment, bored holes will be less prone to sloughing, and foundations are ready for a superstructure start in the late winter or spring, particularly when materials arrive by winter road or sealift.

| Recommendation | *Rationale* |
|---|---|
| **3.1.1 Site Preparation** | |
| Avoid cutting into existing slopes to accommodate building foundations where permafrost is present. Grade adjustment is recommended to be limited to the active layer as required for drainage. | *Permafrost soils with a high water content can melt and/or lose bearing capacity when the insulating top cover is removed. Very wet permafrost soils may even flow when they thaw. Any modification of the terrain must carefully address the effect it will have on the natural balance of the site.* |

### 3.1.2 Pile Types

.1 Steel Pipe Piles

Most commonly used and preferred pile system. Installed as recommended by Structural Engineers: driven to refusal; drilled and frozen in place with slurry or grout; or socketed to bedrock.

*Equipment and expertise are readily available, and experience has proven steel pipe piles perform satisfactorily in most cases.*

.2 Wood Piles

Acceptable only where wood piles have been used successfully in the past. Wood piles must be pressure treated with chemical preservatives, and installed only in a reasonably dry or air free service environment, where they can be expected to provide a service life no greater than 20 years in most northern service conditions. Untreated wood piles are not recommended for any northern building use.

It is essential that the grade adjacent to wood piles be well drained to ensure the piles are never exposed to standing surface water, and that there is not a high water content in the active layer surrounding the piles.

*Untreated wood piles have been used extensively in some northern regions since the 1960s and have reached or exceeded the end of their service life under numerous structures. Load capacity is limited by timber pile lengths available, resulting in the need for many and closely spaced piles. Because equipment time accounts for majority of pile installation costs, pressure preservative treated wood piles are typically more expensive than steel piles when transportation and market factors are the same.*

.3 Concrete Piles

Concrete piles are not recommended for any northern building use.

*Concrete piles are seldom used because it is difficult to assure adequate concrete quality in most northern communities, and because of the problems related to casting concrete in frozen ground.*

### 3.1.3 Active Layer Bond Breakers

Grease or polyethylene wrap should be provided as a bond breaker on all surfaces of steel piles that reside in the active layer. (This is true for all steel piles, whether adfreeze or pinned to bedrock.)

*Seasonal freezing of the active layer, as deep as 3 metres in some areas of the North, can subject piles to considerable uplift force as the active layer freezes. The dead load of a typical one or two storey building is not adequate to counteract uplift force, so bond breakers are usually used to keep the ice from adhering to and lifting the steel piles. Although bond breakers can initially reduce forces acting on piles by as much as 75%, the long-term performance of grease or poly wrap is not known.*

Bond breakers on pressure preservative treated wooden piles must be carefully selected and detailed so that they do not trap moisture against the pile in the active layer.

*Trapped moisture can accelerate deterioration of even pressure preservative treated wooden piles.*

### 3.1.4 Pile Caps

Adjustable pile caps are recommended for use wherever piles cannot be pinned to bedrock, or when installed in any soils conditions where short term freeze-thaw cycling pile movement is a possibility, or long term pile settlement might occur.

*There is always a potential for pile movement because underground soil characteristics can change, or long-term creep of adfreeze piles can occur. Adjustable pile caps permit levelling of differential settlement.*

### 3.1.5 Grade Beams and Void Forms

If used in conjunction with piles, void form is required below grade beams to allow the ground to move without pushing the grade beam up.

*Void form creates a cushion between the soil and the underside of a grade beam. When frost expands the soil, the void form is compressed, absorbing forces that could otherwise lift the structure. Closed cell foam materials are recommended as they re-expand to maintain the void and do not readily absorb water.*

Void form materials that compress readily and do not absorb water are recommended for use where ground water levels are predictably high around building substructure.

*Water-saturated void form materials freeze and transfer the force from freezing subsoils upward affecting grade beam stability and durability.*

### 3.1.6 Monitoring Performance

The installation of equipment to measure, record and report the performance of pile foundations and thermosyphon supported foundations of northern buildings is recommended to be provided as part of building commissioning wherever a need for verifying foundation settlement rates can be identified, and monitoring is supportable by the owner.

*Monitoring projects may be instigated by the building owner, by building design specialists or researchers, educational institutions or cold-climate research agencies.*

Results of foundation performance monitoring are recommended to be made available by the owner to the design community, and to the building design authority as part of post-occupancy technical performance evaluation. See also *GBP Subsection S2.5, “Climate Change Design Adaptation”*.

*Monitoring projects may be instigated by the building owner, by building design specialists or researchers, educational institutions or cold-climate research agencies.*

*Measurement of building performance and sharing the information with the design community and the national agencies responsible for developing building climate design criteria helps adjust new buildings to be more resilient and risk adverse to changing climate factors*.

### 3.1.7 Piles and Thaw Susceptible Soils

.1 Where a proposed building site contains thaw-susceptible soils such as warm permafrost used to support adfreeze piles, geotechnical investigation of the site should include adequate thermal analysis of the potential heat transfer effect that the proposed foundation system will have on the structural bearing capacity of the soils, and estimate the effect of accelerated thaw on the long-term durability of any recommended adfeeze pile foundation system and the supported building.

*Soil thaw susceptibility has been increasing with climate change related increase in mean annual air temperature (MAAT) and mean annual ground temperature (MAGT) in the Discontinuous and Continuous permafrosted regions of the Canadian North. The accurate prediction of long term foundation performance and building durability increasingly relies on more detailed geotechnical investigation which takes into account a greater range of warm-season affecting factors.*

.2 Geotechnical investigations for sites containing thaw susceptible soils should include evaluation of surface and ground water levels and flow volumes, and a determination of their influence on soil thaw susceptibility and the structural bearing capacity of the soils, and the impact on pile foundation system long term performance.

*Sites in warmer permafrost zones are demonstrating increased susceptibility to foundation system deterioration due to increased and prolonged seasonal movement of perched ground water and surface water, increasing the uncertainty of foundation system long-term performance and durability.*

## 3.2 SHALLOW FOOTINGS

Shallow footings are generally recommended to be used only in combination with built-up granular pads in most northern soils conditions, or in fully draining sandy soil conditions for smaller buildings with lightly loaded foundations. Seasonal movement is to be anticipated with this type of foundation in moisture rich soils, unless thermosyphons are installed to maintain the frozen soil beneath the footings. Granular fill work is recommended to be completed by local community contractors, as equipment and skilled operators are available for this type of work in most northern communities. Work on a gravel pad for a shallow footing foundation cannot proceed until early summer when conditions permit excavation and proper compaction of fill. Adequate diversion of surface runoff water away from the building is essential for long-term stability of this type of foundation.

Recommendation

*Rationale*

### 3.2.1 Site Preparation

Avoid cutting into existing slopes to accommodate building foundations where permafrost is present.

*Permafrost soils with a high water content can melt and/or lose bearing capacity when the insulating top cover is removed. Very wet permafrost soils may even flow when they thaw. Any modification of the terrain must carefully address the effect it will have on the natural balance of the site.*

### 3.2.2 Granular Pads Water Protection

Where granular pads are installed as a part of a foundation system on a site which may be subjected to surface water accumulation, it is recommended an impermeable geotextile liner be installed to divert surface water away from the pads.

*Surface water and freeze-thaw will consolidate and heave granular materials. The objective is to divert water around the pad, rather than allow it to seep under or through it, and potentially degrade permafrost or form ice lenses which could cause foundation heaving.*

### 3.2.3 Shallow Footings and Related Substructure Components

Pressure preservative treated shallow wood pads are preferred. Concrete is acceptable where quality of concrete can be assured, and only recommended when it is precast. Compressible thermal insulation to place concrete on frozen ground is not recommended.

*Wood can be easily shipped and assembled, and can also be easily adjusted on site to line up with column grid lines.*

*Variably wet service environments combined with extreme deep cold climate conditions can greatly affect the service life of preservative wood materials. A national certification program has been implemented by the Canadian Lumber Standards Accreditation Board (CLSAB) to deal with the treatment, inspection and application of a certification mark for pressure treated wood products to Canadian Standards.*

When pressure preservative treated wood for footings and related buried substructure components is to be used, pressure preservative materials are recommended to conform to the type of preservative and treatment appropriate for the service environment of the foundation system.

*Pressure treated wood products are marked with a tag showing the preservative used, the type of use, the product group and the plant certification number. Site inspections can now look for these tags or marks to determine whether the pressure treated wood comes from certified producers and is being applied for the right use.*

*http://www.cwc.ca/NR/rdonlyres/E034683E-6306-4ECD849B0933C7B14D00/0/CanadianNationalSystemforCertificationofPressureTreatedWood.pdf*

### 3.2.4 Adjustment for Footing Movement

Adjustable wedges or screw jacks allowing 100 to 150 mm of vertical adjustment are recommended. A minimum clear height of 600 mm must be available for maintenance.

*Periodic or annual height adjustment should be anticipated for levelling buildings supported on shallow foundation, and adequate clearance is essential for workers who may be under the building for several hours at a time.*

### 3.2.5 Thermosyphons

Wherever thermosyphons are installed as part of the foundation system:

*Thermosyphon design and installation is an unregulated technology in the Canadian building codes and standards therefore requires exceptional care and diligence for successful sustainable deployment.*

- the cooling medium should be a fluid that, if leaked below the foundation, will not degrade the permafrost or cause other environmental long-term effects

*The objective is to prevent accumulation of persisting chemicals in the sub base below a building where their presence may interfere with maintaining the permafrost.*

- the system should allow for loops to be isolated

*The objective is to isolate failed thermosyphon units from functioning units.*

- radiators must be protected from damage by vehicles, and be situated away from warm air exhaust vents
- thermisters and temperature reading equipment should be permanently installed as part of the foundation system

*The objective is to ensure that equipment is available to allow building operators to regularly monitor the operation of the thermosyphons as outlined in the Maintenance Management System (MMS) Manual. See also GBP S3.1.6, “Monitoring Performance”.*

## 3.3 BURIED FOOTINGS

Buried footings are typically used in conjunction with a granular pad in areas of permafrost. Because the footings are installed bearing on frozen soil, work must be scheduled and thermal insulation provided so that installation of footings does not result in melting or loss of bearing capacity of frozen materials beneath footings.

| Recommendation | *Rationale* |
|---|---|
| **3.3.1 Site Preparation** | |
| Avoid cutting into existing slopes to accommodate building foundations where permafrost is present. | *Permafrost soils with a high water content can melt and/or lose bearing capacity when the insulating top cover is removed. Very wet permafrost soils may even flow when they thaw. Any modification of the terrain must carefully address the effect it will have on the natural balance of the site.* |
| **3.3.2 Granular Pads** | |
| Refer to GBP Article S3.2.2 and GBP Article L4.1.1, “Built-up Granular Pads”. | |
| **3.3.3 Active Layer Bond Breakers** | |
| Grease, polyethylene wrap or torch-applied membranes are recommended to be provided as a bond breaker on all surfaces of structural elements that pass through the active layer. | *The objective is to eliminate uplift forces on the structural elements that may be caused by seasonal freezing adhesion of the soil to the structural element, and expansion of the soil in the active layer.* |
| **3.3.4 Buried Footings and Buried Substructure Components** | |
| Pressure preservative treated buried wood pads are preferred. Concrete is acceptable where quality of concrete can be assured and only recommended when it is precast. Compressible thermal insulation to place concrete on frozen ground is not recommended. | *Wood can be easily shipped and assembled, and can also be easily adjusted on site to line up with column grid lines. Concrete cast in place on frozen ground does not cure correctly and can cause thawing of soils at the underside of the footing pad.* |

| | |
|---|---|
| When pressure preservative treated wood used for footings and related buried substructure components is used, pressure preservative materials used are recommended to conform with the type of preservative and treatment appropriate for the service environment of the foundation system. | *Variably wet service environments combined with extreme deep cold climate conditions can greatly affect the service life of preservative wood materials. A national certification program has been implemented by the Canadian Lumber Standards Accreditation Board (CLSAB) to deal with the treatment, inspection and application of a certification mark for pressure treated wood products to Canadian Standards. Pressure treated wood products are marked with a tag showing the preservative used, the type of use, the product group and the plant certification number. Site inspections can now look for these tags or marks to determine whether the pressure treated wood comes from certified producers and is being applied for the right use.*<br>*http://www.cwc.ca/NR/rdonlyres/E034683E-6306-4ECD-849B0933C7B14D00/0/CanadianNationalSystemforCertificationofPressureTreatedWood.pdf.* |

### 3.3.5 Adjustment for Footing Movement

| | |
|---|---|
| Adjustable wedges or screw jacks allowing 100 to 150 mm of vertical adjustment are recommended. A minimum clear height of 600 mm must be available for maintenance. | *Periodic or annual height adjustment should be anticipated for levelling buildings supported on buried foundations, and adequate clearance is essential for workers who may be under the building for several hours at a time.* |

### 3.3.6 Thermosyphons

Refer to *GBP Article S 3.2.5*.

## 3.4 STRUCTURAL SLABS ON GRADE

Concrete slabs would seem an ideal choice for many buildings such as garages, firehalls or warehouses, given that they act both as a foundation system, and provide a durable, smooth floor surface. Problems caused by heat transferring from the building to underlying frozen soils have to be overcome, or the slab will fail in a very short time. Extreme care is required during the installation of the heat removal systems beneath the concrete: once the slab is in place, inspections and repairs become difficult.

| Recommendation | *Rationale* |
|---|---|

### 3.4.1 Site Preparation

| | |
|---|---|
| Avoid cutting into existing slopes to accommodate building foundations where permafrost is present. | *Permafrost soils with a high water content can melt and/or lose bearing capacity when the insulating top cover is removed. Very wet permafrost soils may even flow when they thaw. Any modification of the terrain must carefully address the effect it will have on the natural balance of the site.* |

### 3.4.2 Ventilated Slabs

.1 Natural Ventilation

Naturally ventilated slab foundations for northern buildings are not recommended.

*Ventilation can easily fail if ventilators are blocked by snow or fill with water, causing heat transfer from the building into the frozen soils causing potential substructure settlement and building superstructure movement.*

.2 Mechanical Ventilation

Mechanically ventilated slab foundations for northern buildings are not preferred.

*Similar problems as for natural ventilation systems, with added risk of mechanical failures and increased maintenance requirements, and higher initial cost.*

### 3.4.3 Thermosyphons

Refer to *GBP Article S 3.2.5.*

### 3.5 ARENA FOUNDATIONS WATER DAMAGE PROTECTION

Ice arena foundations and similar structures which are vulnerable to deterioration through the action of ground water need to be protected from underground flooding with a drainage liner installed beneath the ice rink area. The drainage liner is to be sloped to dedicated drain points so that meltwater from the ice can be pumped or completely drained away from the foundations and the building perimeter each spring.

## S4 WOOD STRUCTURES

Due to their versatility and general availability, conventionally framed stick-built or factory assembled wood structures are appropriate for many northern conditions. Wood materials have a high strength-to-weight ratio, are more compact, and less susceptible to damage in transit than some prefabricated assemblies. Rigid framed timber structures, weather-enclosed with insulated non-structural panels, while not commonly found in northern construction, have the potential to be a viable energy conserving alternative to conventional frame construction.

### 4.1 FLOORS

The structural requirements of floors in the North are no different than requirements elsewhere in the country, except that special attention must be paid to coordination of the structure with the building envelope and mechanical systems: floor assemblies must often accommodate thick thermal insulation, plumbing runs and ventilation ducts, so the special environmental separation requirements of floors elevated above grade are reviewed in detail in *GBP Subsection A3.3, “Building Envelope Floor Assemblies”*.

Recommendation

*Rationale*

### 4.1.1 Joists

Consider using plywood web joists, steel tube web wood joists or light wood trusses in place of dimensional lumber greater than 210 mm depth.

*Engineered joists provide improved strength-to-weight ratio, thereby reducing shipping costs, and are less prone to shrinkage than dimensional lumber. Engineered joists and trusses can also accommodate increased spans and may require fewer lines of foundation bearing.*

## 4.2 WALLS

There are no design practices unique to northern environments when it comes to structural systems for walls. Although wind pressures can be very high, especially in the central and high arctic, they are similar to those experienced in other parts of Canada. The structure must be coordinated with the building envelope design to ensure adequate space is provided for insulation, and that elements such as sheathing and blocking are located to benefit both structural and envelope design. Special attention must be paid to the structural support of air barriers, particularly at building corners where wind loading is greatest.

## 4.3 ROOFS

Structural systems for roofs of northern buildings require no unique design considerations that are not found in other parts of Canada, but attention must be directed to climate change induced changes in design snow loads and wind loads, which appear to affect the northern portions of Canada sooner than most southern regions. Wind pressures can be very high, especially in the central and high arctic. Transient loads from snow accumulation typically are lower in most parts of the North than in mountainous regions of Canada. The roof structure must be coordinated with building envelope design to ensure ventilation, air barrier and vapour barrier functions are satisfied, particularly since high air humidity and moisture levels will cause rapid deterioration of wood structural members. When insulation systems are installed above the primary deck, fastening systems must be designed to resist the wind uplift forces acting upon the insulation and roof finish.

### 4.3.1 Roof Slope

Refer to GBP Subsection A 3.6. Structural design protocols for snow loads on roofs of buildings likely to be used as places of refuge during emergencies need to follow newly incorporated structural design analysis procedures in *NBC 2005 Div. B Part 4*.

*Increased incidences of roof collapse in various parts of Canada in the past ten years have resulted in the recognition that historically defined snow loads may be increasing, and buildings designed for a long service life are more likely to be exposed to unforeseen heavier snow loads.*

## 4.4 TIMBER FRAME CONSTRUCTION

Timber frame construction for housing and small northern buildings is an acceptable construction alternative to conventional stick framed construction.

*Timber framed structural systems permit simpler building envelope weather enclosures to be installed more rapidly and with improved environmental separation.*

### 4.5 STRUCTURAL INSULATED PANELS

Structural Insulated Panels (SIPS) are an acceptable construction technique for northern buildings where conventional stick-framing in the field is used.

*Rapid enclosure of the exterior weather protecting envelope for small buildings increases construction efficiency and reduces exposure time to cold weather. Segments of walls, floors and roofs assembled in controlled factory conditions provide the potential for higher quality of framing and and sheathing assembly, and lowered cost.*

Joints between SIPS need to be well-sealed for continuity of the air and vapour barriers. Refer to *GBP Section A3, "Building Envelope"*.

*"Building With Structural Insulated Panels" by Gary Pugh of Alternative Building Concepts, Santa Rosa, California. http://www.altbuild.com/images/JLC___Bldg_with_SIPS_8%5B1%5D.06.pdf*

## S5 STEEL STRUCTURES

Pre-engineered and prefabricated steel frame buildings are common in the North. The many different types and number of distributors have made prefabricated metal buildings competitive and an option worth considering for certain types of building. These include garages, firehalls, arenas and warehouses - all buildings with regular and uncomplicated floor plans, which are easily defined and require large open spaces. Custom steel structures may be appropriate for larger non-combustible buildings. Before deciding to use a steel structure, the designer must be satisfied that local equipment is available to move and lift components into place, that shipping costs are reasonable in comparison to wood systems, and that local labour and businesses can provide construction resources. Bolted connections are preferable to extensive specialized field welding.

### 5.1 FLOORS

No special structural requirements. See recommendations of *GBP Section S4*.

### 5.2 WALLS

No special structural requirements. See recommendations of *GBP Section S4*.

### 5.3 ROOFS

No special structural requirements. See recommendations of *GBP Section S4*.

## S6 CONCRETE

The use of concrete is challenging in the Canadian North because granular materials, mixing equipment and construction phase testing facilities are not available in many communities. Variable soil conditions and a curtailed construction season can also make using concrete problematic as a structural material. In communities where ready-mix concrete is available, concrete is recommended for multi-story non-combustible construction, as deck infill for steel frame construction, and for some precast structural elements. Where very small quantities are required, so as to make hand batching feasible, concrete use is recommended to be limited to foundation elements, which are covered in *GBP Section S3*. Concrete masonry units for wall construction are recommended where substructure conditions and transportation availability support competitive economics.

## 6.1 FLOORS

### 6.1.1 Slabs

Refer to GBP Subsection S3.4 “Structural Slabs On Grade.”

## 6.2 WALLS

Cast-in place concrete is not recommended for wall construction, except where no other assembly can be used to meet NBC requirements, or where it can be shown that concrete would be the most economical choice. Precast concrete facing panels, concrete tilt-up construction, and concrete masonry units for wall construction is recommended where substructure bearing conditions and transportation availability support competitive economies.

## 6.3 ROOFS

Cast-in-place concrete is not recommended for roof construction, except where no other assembly can be used to meet building code requirements, or where it can be shown that concrete would be most economical choice.

END OF SECTION

# Table of Contents

Page

## MECHANICAL

# Table of Contents

# Table of Contents

# Table of Contents

# Table of Contents

# Table of Contents

# MECHANICAL

## INTRODUCTION

People have come to expect a closely controlled, comfortable indoor environment and ample supplies of hot and cold running water in the buildings where they live and work. Making buildings comfortable in a Northern climate requires more energy than in a temperate zone, and rising energy costs have a great impact on operational costs of Northern facilities. The efficient and economical use of energy is an important 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 costly to maintain, especially in remote locations where qualified workers are not always available.

For this reason, 'simple and reliable' mechanical systems are desirable in all buildings. Of course, the demands made of a system limit just how simple it can be. There are no trouble-free systems. The guidelines and recommendations in this section are based upon installations that have been found to function well and require the least maintenance. A balance must be struck between the sometimes conflicting demands for occupant comfort, energy conservation, and building system simplicity and reliability, not only in the field of mechanical system design but in all aspects of facility design. Whenever possible, a team or "integrated design" approach should be considered, in which all design disciplines and building stakeholders work together throughout the design process. This process tends to result in more sustainable, comfortable and efficient buildings than the traditional building design procedure in which mechanical and electrical services are fitted in to a completed architectural plan.

## M1 CODES AND REGULATIONS

Note: The latest edition of a code, regulation, standard, or other referenced document is to be used. "Latest Edition" is herein deemed to mean the latest edition of a code or standard adopted by the local "Authority Having Jurisdiction" or referenced in the relevant codes. It is the responsibility of the designer to ascertain which version is the "Latest Edition" of any relevant Code or Standard.

- National Building Code of Canada
- Fire Prevention Act of the Northwest Territories (and enabled regulations)
  (See G6 "Codes and Regulations")

**Other Related Documents**

- Documents referenced by the NBC or this document include:

- National Fire Code of Canada
- National Fire Protection Association (NFPA) Codes
- National Plumbing Code of Canada
- ASHRAE Handbooks, Standards and Guidelines
- SMACNA (Sheet Metal and Air Conditioning National Association) Publications and Guidelines
- American Society of Plumbing Engineers Data Book
- GNWT "Good Engineering Practice for Northern Water and Sewer Systems"
- GNWT Department of Health and Social Services Building Standards for Potable Water and Sewage Holding Tanks
- CAN/CGSB 41.22-93 Fibreglass-Reinforced Plastic Corrosion-Resistant Equipment

- CSA Z317.1 Special Requirements for Plumbing Installations in Health Care Facilities
- CSA Z317.2 Special Requirements for Heating, Ventilation, and Air Conditioning Systems in Health Care Facilities
- CCME Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum Products and Allied Petroleum Products
- Canadian Construction Association Mould Guidelines for the Canadian Construction Industry CCA 82
- CSA B214 Installation Code for Hydronic Heating Systems
- (Model) National Energy Code of Canada for Buildings
- Natural Resources Canada Eco Energy For Buildings Initiative Protocol
- GNWT Petroleum Products Division Standard Specifications, Detail Drawings, and Design Rationale for Northern Fuel Storage Facilities
- The Government of Canada “Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations
- Other documents as applicable

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*The design process for certain types of facilities listed below shall include an Energy Modeling analysis utilizing the EE4 program and, where called for by the Client, an Energy Modeling Workshop, to maximize the energy savings potential of the facility while maintaining the cost effectiveness of the relevant payback period. Building energy modeling before design must indicate that the proposed design will be 25% more efficient than a similar base building, as indicated in the (Model) National Energy Code for Buildings.

Typical facilities to which the Eco Energy for Buildings Incentive Protocols shall be applied:

- Schools
- Community Learning Centers
- Correctional Facilities
- Healthcare Facilities
- Large Office Buildings
- Recreation Centers
- Libraries

Typical facilities to which the Eco Energy for Buildings Incentive Protocols shall NOT normally be applied:

- Maintenance Garages
- Parking Garages
- Warehouses
- Firehalls
- Small Office buildings
- Residential

# M2 OPERATION AND MAINTENANCE

## 2.1 GENERAL

See G1 “Local Resources” and G4 “Appropriate Technology”.

## 2.2 ACCESS

The design of mechanical systems must take into account building, systems and equipment location and ease of maintenance access. For example, the quality and frequency of servicing can be adversely affected if maintenance must be carried out in cramped, uncomfortable and inaccessible spaces by a maintainer wearing heavy winter clothing. Concealed ducts or equipment are to be located and provided with access so that servicing is made easy. Mechanical rooms and crawl spaces should be designed to provide adequate space for servicing or replacement of all equipment.

In mechanical equipment spaces, adequate service access is required for the transport of equipment, material and tools in or out of the space. Vertical or ship’s ladders are not an acceptable means of access to any equipment room above the main floor. It is dangerous to climb a ladder while carrying tools or materials. A full stair is to be provided, preferably one accessed from the outside of the building, so as to avoid the need to transport equipment through the building.

For equipment (i.e., fans) suspended from the ceiling in any space, adequate servicing access is to be provided for maintenance and repairs. This may require installation of a platform or portable lift (and the allowance for adequate storage space for this unit). Fall restraint equipment may also be required.

Provision is to be made for the hoisting of heavy replacement parts where equipment is installed above the floor level or on mezzanine levels.

## 2.3 MAINTENANCE PREVENTION

Facilities should be designed and equipment selected so that maintenance is minimized and servicing is made easy. During the planning and design review processes maintenance concerns should be addressed and incorporated into the building design. (In other words, build something that can be readily maintained).

## 2.4 PREDICTIVE MAINTENANCE

It is desirable to determine the life expectancy of a facility and equipment components, so the components may be replaced at optimum times. (If the building is going to outlast its major components, have this clearly stated up front so everyone knows where they stand).

## 2.5 SPARES

Spare parts are required for certain elements and equipment in a building. Replacement equipment and parts are often difficult to transport to small remote communities. Spare parts used for repairs during construction are to be replaced at the end of the warranty period. Some codes (i.e., NFPA 13) mandate numbers of spare parts to be provided.

## 2.6 STANDARDIZATION

In the interest of maintenance, the equipment for any particular function should be compatible with the existing O&M parts inventory currently used in the area, region or community.

## M3 IDENTIFICATION

The operation and maintenance of mechanical systems requires maintainers 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 should include pipe colour-coding 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.

## M4 PLUMBING AND DRAINAGE

The selection of the type of plumbing system has a significant impact on mechanical construction costs and building operational costs.

Some questions to consider are:

- Does the community have a municipal system?
- If it has a municipal system, whether to connect to it or not.
- If a tanked system is selected, what is the size of the water tank and where in the building will it be located?
- If the building has a fire sprinkler system, what size of the tank is needed for fire water?
- If a tanked sewage system is selected, what is the size of the sewage tank and where will it be located?

These requirements generally apply to systems contained within the building. Refer to the document “Good Engineering Practice for Northern Water and Sewer Systems” for a more complete discussion of municipal servicing requirements which affect building construction.

### 4.1 DOMESTIC WATER - PIPED SERVICE

Less than 25% of all NWT communities have piped service. In some of these locations water lines are buried; where lines are not buried, they are run in above-ground utilidors.

Water treatment in all communities consists of the addition of chlorine and/or filtration, and is the responsibility of the municipality. Even though the NWT has abundant fresh water, capital and operating costs of delivered water are high, making water conservation very important.

| Recommendation | *Rationale* |
|---|---|
| **4.1.1 Municipal Connection** | |
| Connection to a municipal system is preferred, when available. | *While this is usually more costly, especially when a manhole is required, connection to the municipal system has the following advantages:*<br>• *lower cost than water truck delivery*<br>• *the building will not run out of water*<br>*Where municipal water supply pressure exceeds 551 kPa (80 psi) the National Plumbing Code of Canada requires provision of a pressure-reducing valve (PRV). In some areas of Yellowknife, municipal water supply pressures may exceed this level.* |

Municipal water pressures must be checked to determine if a pressure-reducing valve will be required on the incoming main.

*Some areas of Yellowknife can experience large pressure surges.*

### 4.1.2 Water Meters

Water meters are to be installed only in buildings that are connected to a municipal water system.

*Metering of water is required for buildings connected to a municipal water supply in order to monitor water consumption. Buildings supplied by a truck delivery system do not require water meters, as the truck meter measures the quantity of water delivered.*

## 4.2 DOMESTIC WATER SUPPLY - TANKS

Water delivery by truck for storage in holding tanks located within buildings is common in most NWT communities. Deliveries are generally made once or twice a week on a regular schedule. Water conservation is especially important where tanked water is used. The space required to store adequate water for a building can be considerable. A structural designer should be consulted regarding proper tank support.

Recommendation

*Rationale*

### 4.2.1 Potable Water Supplies

.1 Consumption Estimates

In the case of additions to existing buildings, it must be determined whether the existing tank is large enough; if it is not, more water storage must be provided. The actual water consumption records from the past three years can be reviewed to determine the actual water use. This figure can be used (in conjunction with the recommended minimum storage quantities below), to determine whether the existing tank has sufficient capacity.

The following are the recommended minimum acceptable amounts to be used in calculating the estimated total daily consumption of potable water for new buildings:

*Actual building water consumption may deviate significantly from the estimated consumption used to size the original water tank. Actual consumption often is much lower than anticipated. The lower consumption may be due to changes in usage (for example, little use of showers in school change rooms) or installation of low-water-use fixtures during earlier renovations.*

*Consumption estimates for new buildings are normally based on program information or engineering standards; however, such information is not always available or appropriate for NWT conditions.*

.1 Residential Occupancies:
90 litres/resident/day; 25 litres/staff/day is sufficient for non-resident staff.

*This is the GNWT MACA standard for residential occupancies.*

.2 Non-residential Occupancies:

25 litres/person/day.

*This figure is based on a review of actual consumption figures for NWT buildings.*

.2 Supply

Water storage capacity for any given building is established by calculating daily usage rates based on the usage figures noted above, multiplied by the usual number of days between deliveries in the community.

*It is important to consider the correct number of days between water deliveries in the community when sizing the water tank. If an arbitrary and too-large delivery frequency is used, the tank will be oversized and more costly. But more importantly, the tank water will not be refreshed as frequently and will tend to stagnate.*

### 4.2.2 Emergency Water Supplies

Potable water storage capacity may be increased up to a maximum of 10 day supply if:

.1 a building is designated as a community reception or evacuation centre under the "Civil Emergency Measures Act", or

*There are currently no regulations which govern water supplies for community reception or evacuation centres. A 10-day supply is suggested since water delivery service could be interrupted or delayed during emergencies.*

*Typically schools are often designated as community evacuation or reception centres, but this emergency water guideline could apply to other community buildings as well.*

.2 a prolonged shortage of water would require the relocation of residents.

*This would apply to any long-term care or detention facilities and student or staff residences.*

### 4.2.3 Fire Protection Sprinkler System Reserve

See Section M5.2.

.1 Separate Tanks for Fire and Potable Water

Potable water supplies must be stored in dedicated tanks, separate from any water supplies reserved for fire protection.

*In the past, potable water and fire water were often stored in the same tank, to the detriment of drinking water quality.*

A connection between the potable water storage tanks and fire protection system may be provided so that potable water is added to total capacity of water available to fight a fire.

*The provision of separate tanks ensures that drinking water is constantly replenished and kept fresh. The use of separate tanks also facilitates tank cleaning. Potable water storage tanks require frequent cleaning, while fire water supply tanks do not.*

Some kind of supervised valve should be used so if the valve is left open it does not go unnoticed. The location of the valve has to be in a very accessible location so as not to endanger the life of the person who opens the valve.

The connection should be complete with a double backflow preventer, and should be controlled by a normally-closed (N.C.) solenoid valve, wired to a float switch provided for this purpose in the firewater tank. A pump may be required for this connection depending on the tankage configuration.

*All available stored water in a building should be made available for fire-fighting.*

### 4.2.4 Tank Construction

- All water storage tanks should be fibreglass or polyethylene and constructed to CAN/CGSB 41.22-93 Fibreglass-Reinforced Plastic Corrosion-Resistant Equipment.

*The CGSB standard is a more suitable standard for water storage tanks than the AWWA C95 standard. The rated test pressures of the AWWA standard far exceed those required for an atmospheric tank. Construction to CGSB ensures better longitudinal strength of pipe tanks.*

Water tanks must be provided with:

- a drain or tap, situated so the entire tank may be drained by gravity.
- easily-accessible access holes of minimum inside diameter 450 mm, with water-tight child-proof cove. For large tanks, the number of access holes is specified in the NWT Safety Act and regulations.

To prevent over-pressurization of the water tank when overfill pipes freeze, an interior vent line is required.

*The CGSB standard does not state a working tank pressure. Tank manufacturers have stated they cannot build straight-walled tanks to meet high pressure requirements. Pressure requirements for tanks should be limited to the head in the tank, plus a slight margin of safety. Low-profile tanks must meet CGSB standards.*

### 4.2.5 Location of Domestic Water Tanks

Potable water tanks must be located in a heated area where the temperature is kept between 5 and 15°C.

*This temperature range prevents tank contents from freezing or from becoming tepid.*

Avoid locating tanks in areas heated by wild loops.

*This can lead to unwanted overheating of the water.*

On no account are tanks to be installed below grade level.

*Tanks installed below grade will over-pressurize and fail due to overfilling.*

Do not locate tanks in the same room as boilers or furnaces.

*Warm potable water can support bacteria and algae growth, and is unpleasant for users.*

.1 Small Tanks (up to 4200 litre capacity)

  .1 It is preferable to locate small tanks in occupied building areas.

  *This is possible when a tank is small enough to be located in an occupied building area where it would be easily accessible.*

.2 Large Tanks (over 4200 litre capacity)

  .1 It is preferable to locate large tanks in a heated crawl space or basement. However tanks should not be located below grade.

  *Tanks of this size take up considerable space, and locating them beneath the main floor does not increase the building footprint. Although the main floor level may have to be raised to accommodate tanks and their access clearance this is generally preferable to increasing the main floor area, building envelope size and structural capacity.*

  .2 It is acceptable to locate large tanks in a suspended tank room.

  *Where a heated crawl space or basement cannot be provided because of soil or site conditions, a suspended tank room is acceptable. This may require the main floor to be raised. Where possible, suspended tank rooms should be located to take advantage of any natural slopes of the building site.*

  .3 The location of large tanks in the occupied building area may be considered.

  *The cost of providing the main floor area with adequate structural support and site limitations may make this alternative undesirable.*

  .4 On all large storage tanks, provide bulkhead fittings with valves, circulating pump, cartridge filter and piping to allow future installation of a circulating system. Provide one fitting at low elevation at base of tank and one at high level or on top of tank.

  *Larger capacity tanks may not be used as much as anticipated. Circulation and filtering of the water prevents stagnation and the build-up of sediment in the tank.*

### 4.2.6 Fill and Vent Piping

Fill and vent piping is to be Schedule 80 PVC within the building. Where fill and vent pipe penetrates exterior walls or fire separation penetrations, the piping shall be changed to copper. Water fill pipe connections must match the connection of the local water delivery vehicle.

*Plastic pipe gets very brittle in cold outdoor temperatures and can easily crack or break.*

*See NBCC Section 3.1.9 regarding penetrations of fire separations.*

The fill pipe is to be located so water delivery personnel do not have to pass a sewage pump-out connection when connecting the water truck hose to the building fill pipe. The water fill point must also be located at least 1500 mm from the sewage pump-out connection, and at least 1000 mm above it.

*This reduces the risk of the water hose being dragged through spilled sewage at pump-out location. Fill and sewage pump-out service points are to be determined based on the access route, with the water fill point being the first point accessible to arriving vehicles.*

A lamacoid identification label is to be provided at the fill point. If the fill pipe location is too high for easy access from the ground, permanent steps are to be constructed.

Fill and vent piping is to be graded back to tanks.

*This is done so that water drains back to the tank, rather than spilling on the ground, where it freezes and creates a hazard for water delivery personnel.*

Vent outlets are to be located on the side of water tanks or extended 100 mm into the top of the tank.

*Vent outlets are necessary to vent the tank and protect it from damage, even though they may reduce the effective capacity of the tank.*

Provide dual venting for all water tanks: a 75 mm primary vent to the exterior of the building and a 75 mm secondary vent terminating at an interior drain (i.e., over a janitor sink), or piped to a main building vent.

*Frozen condensation from the tank can block the exterior vent in winter months, and this could cause the tank to rupture during filling.*

Vents terminating outside the building may be screened, where dual venting is provided.

*Environmental Health Standards allow either vent termination method. However it should be noted that a screen fine enough to exclude insects during summer will freeze over in the winter. The second vent (in duel venting systems) is required for relief.*

### 4.2.7 Access to Water Tanks

Water tanks must be accessible to maintainers for cleaning and repairs when necessary, and must be drainable without use of an auxiliary pump. The drain must be piped to either the waste tank or to a drain point outside the building foundation. This piping can be permanent or temporary. The following access locations are preferred:

.1 Top access with a minimum of one meter clear space above the top of at least one manhole(s). Built-in steps or ladders are to be provided where the access is located more than 1200 mm from adjacent ground level. The diameter of the tank should be sufficient to allow a person access for cleaning and maintenance.

Drain valves are to be installed at the low point of the tanks to allow draining of the tank for cleaning.

*Access to the interior of tanks should be as easy as possible to facilitate frequent cleaning. Maintainers must work in enclosed tanks in uncomfortable conditions, so the tanks themselves should be constructed to make the chore as easy as possible. Providing easy access should result in fewer complaints about contaminated water supplies.*

*Access to these tanks may be seen by WCSS (Worker's Safety and Compensation Commission) to be confined space entry, and may require an air pack and line. The manhole should be sized to accommodate this. The designer should consult WCSS, to determine what rules apply and design accordingly.*

.2 End or side access to tank is acceptable where service space height is restricted, if the tank has removable ends. Drain valves are to be installed at the low point of the tanks to allow draining of the tank for cleaning.

*End or side access may provide easier access for maintainers than top access; however, tank construction is complicated by the need to provide a sealed closure at the tank ends.*

### 4.2.8 Level Alarms

The domestic water tank must be provided with a high level float-type switch, wired to an exterior "Tank Full" light located adjacent to the fill point and a low level float-type switch which turns off the domestic water pressure system when the water tank level is low. This also protects the pump from burning out.

## 4.3 DOMESTIC HOT WATER (HW) SUPPLY

Heating of domestic hot water can account for a significant portion of a building's energy costs. Systems must be selected based on initial capital costs as well as operating costs of the equipment.

### 4.3.1 Indirect-Fired Domestic Hot Water Heaters

| Recommendation | *Rationale* |
|---|---|
| Dedicated indirect-fired HW heaters can be used in larger buildings with hydronic heating. | *This type of heater is the most energy-efficient and has a low operating cost. These heaters are normally provided for larger buildings with high hot-water usage.* |
| See “M7 Heating” for equipment and configuration requirements of a heating plant for provision of indirect hot water heating. | |
| Consideration should be given to provide a back-up electric hot water heater in facilities where major occupancy is seasonal. This water heater could be used by cleaning staff during times when a building is not generally occupied; for example in schools during summer. | *Schools fall into this category. They may be used for recreational purposes or other reasons in the summer months. The provision of a back-up water heater allows the boiler plant to be shut down in summer.* |
| (If electrical costs are high, a small fuel-fired water heater may be considered.) | |

### 4.3.2 Oil-Fired Domestic Hot Water Heaters

| | |
|---|---|
| Dedicated, oil-fired HW heaters are preferred for smaller buildings where fuel oil is used for the building heating system. | *This type of heater has the second lowest operating cost (after the indirect-fired water heater). These heaters are typically installed in small to medium-size buildings, and in residential facilities.*<br>*Fuel oil usually costs substantially less than electricity.* |
| Exceptions to the above are: | |
| .1 Fort Smith See “Electric HW Heaters”, Mechanical M4.3.2. | *In the town of Fort Smith and surrounding area, electrical cost are lower than in other areas of the NWT. For a project in Fort Smith, unless very large quantities of domestic hot water are required, it is probably more economical to use an electric hot-water heater than an oil-fired one.* |

.2 Inuvik

Natural Gas heaters are preferred.

*Most of Inuvik has a piped natural gas system. Designers should ascertain whether natural gas will be available at their project site.*

.3 Yellowknife

Propane heaters or oil-fired heaters are acceptable.

*Propane and oil are available in Yellowknife.*

See “Propane/ Natural Gas HW Heaters”, Mechanical M4.3.3

*Propane or oil-fired heaters are both acceptable, with preference given to the one which uses the least expensive fuel. The designer should to specify a unit which can be easily converted between oil and propane. The unit must be rated for dual fuel by the manufacturer.*

High efficiency burners only (80% or better) are to be used.

*This minimizes fuel consumption.*

Non-combustible block bases with 6 mm steel plates are to be used under all oil and gas-fired HW heating equipment installed on combustible floors.

*Past experience has shown that even equipment approved for use on a combustible base has burned into the floor.*

The high limit control on fuel oil or gas-fired domestic water heaters is to be the auto reset type.

Refer to Section M7.2.2 for chimney and vent requirements.

### 4.3.3 Electric HW Heaters

Electric HW heaters as the sole source of hot water should be used only where few fixtures are served and estimated daily hot water use is less than 1000 litres per day in the town of Ft. Smith, or less than 100 litres per day in all other Regions.

*These heaters are typically used in smaller buildings with low HW use, in conjunction with forced air heating systems. The life cycle cost will generally be lower than that of oil-fired heaters for this type of application. Lower electrical costs in the town of Fort Smith make electric HW heaters more desirable there than in other regions of the NWT.*

Small under-the-counter, electric, domestic hot water heaters may be used alone or in addition to an oil-fired HW heater. Electric HW heaters should also be considered where a few fixtures must be located some distance from a central domestic HW source, and a recirculating system would otherwise be needed to maintain HW.

*The high cost of a recirculating system is not justifiable where the fixtures use is not high. Local heaters should be considered for complex or multi-purpose buildings where hot water is required at remote areas of the buildings. Typically this would include public washrooms where HW is only required for hand washing.*

### 4.3.4 Propane/Natural Gas-Fired HW Heaters

Propane/natural gas-fired heaters should be used where propane or natural gas is used as the fuel for the building heating system.

*There use should be restricted to communities where propane/natural gas is available: Hay River, Enterprise, Yellowknife, Norman Wells, and Inuvik.*

### 4.3.5 Heater Installation

Regardless of type of heater used, all heaters are to be installed within a metal drip pan. Heaters should be piped to a drain or equipped with a battery-operated moisture alarm.

*A drip pan provides protection from minor leaks.*

### 4.3.6 Temperature

Refer to the (Model) National Energy Code of Canada for Buildings.

.1 When less than 50 percent of the total design flow of a service water heating system has a design discharge temperature higher than 60°C, separate remote heaters or booster heaters shall be installed for those portions of the system with a design temperature higher than 60°C.

*This system allows primary domestic HW heaters to be set at lower temperatures to save energy. This is typical for where large volumes of hot water are not required.*

.2 Tempered water is required for showers, lavatories and classroom sinks in elementary schools and similar applications. The tempered water is to be provided by using a pressure-balanced mixing valve located at the fixture and set at 42°C.

*This is a more cost-effective method of providing tempered water than having two separate domestic storage and distribution systems.*

### 4.3.7 Provision for Monitoring Performance

.1 Provide thermometers in domestic water heaters.

*Thermostats and gauges provide information for the building maintainers about the system’s performance.*

.2 Provide pressure gauge(s) at domestic hot water recirculation pumps.

.3 Provide a cushion tank on all hot water systems for expansion protection of the system.

## 4.4 DOMESTIC WATER SYSTEM

Domestic water pressure is provided either by a municipal system, or by individual pressure pumps in buildings with holding tanks. In older buildings, freezing of water circulation lines was a common problem, but changes to standard design principles have decreased this risk. The use of higher insulation levels, more tightly-constructed envelopes, the grouping of plumbing fixtures and the locating of fixtures away from outside walls and floor assemblies are now common practices in cold climate building design.

### 4.4.1 Insulation

| Recommendation | *Rationale* |
|---|---|
| Insulation is not required on domestic cold water piping systems where the domestic water is supplied from a storage tank in the building. | *Insulation is not required because water supplied from ambient temperature domestic water tanks will not be cold.* |
| Insulation is not required on small domestic hot water piping systems without domestic hot water circulating pumps. | *There is little benefit from installing insulation on domestic hot water systems that do not have circulating pumps (i.e., demand systems).* |
| Refer to the (Model) National Energy Code of Canada for domestic hot water piping insulation requirements. | |

### 4.4.2 Domestic HW Circulation

| Recommendation | *Rationale* |
|---|---|
| Domestic hot water re-circulating lines should be provided only where heat loss due to the distance of fixture from HW tank would cause users to waste more water than they need while waiting for hot water, and where HW requirement at the fixture is estimated at more than 30 litres per day. | *These are typically required wherever showers, baths or laundry facilities are provided and hot water use is high. The cost and complexity of re-circulating systems is generally not warranted in the case of small buildings where only a small amount of hot water is used.* |
| When required, re-circulating lines are to be controlled by a time clock and kept off during unoccupied hours. The pump is to be of smallest motor size (kW) possible. | *This reduces energy requirements.* |
| Extend the circulating line directly to the fixture or group of fixtures to ensure hot water is readily available. | *Use of the most the direct route (as opposed to running lines down corridors) means less pipe used and less water wasted.* |

### 4.4.3 Drain Valves

| | |
|---|---|
| All water pipes must be sloped and drain valves must be provided at all low points. | *To drain water lines, it is simple to use drain valves. However the National Plumbing Code also allows pipes to be blown out with air if drain valves have not been provided.* |

### 4.4.4 Location

| | |
|---|---|
| Avoid locating water piping in the exterior wall and floor assemblies. | *This reduces the possibility of pipe freezing.* |
| Domestic water piping is to be installed only in the heated portion of the building. | *Domestic hot and cold water lines installed in utilidettes are difficult to heat trace and may freeze.* |

### 4.4.5 Tees

| | |
|---|---|
| Use factory tees only. Do not use a T-drill. | *Factory tees can be repaired without replacing the tee. Repairs to T-drills require special equipment that may not be readily available.* |

### 4.4.6 Access

| | |
|---|---|
| Easy access must be provided to all valves and faucets. All fixture supplies must be provided with shut off valves for maintenance purposes. | *This allows easy maintenance and repair.* |

### 4.4.7 Domestic Water Pressure Pump

| | |
|---|---|
| Pump to be typically selected to operate at 140-280 kPa. | *Higher pressure (210-350 kPa) pumps are not needed in most small buildings.* |
| Shallow-well jet pumps are recommended | *These jet pumps are readily available. Select a brand preferred by local maintenance staff.* |
| Enough valves are to be installed so pumps can be changed without draining the system. | |

### 4.4.8 Domestic Water Pressure Tank

| | |
|---|---|
| Bladder-type pressure tanks are preferred. | *Non-bladder type tanks tend to become water logged, making the system ineffective. Select a brand preferred by local maintenance staff.* |
| Enough valves are to be installed so pressure tanks can be changed without draining the system. | |

### 4.4.9 Provision for Monitoring Performance

| | |
|---|---|
| A standard pump-mounted pressure gauge on the discharge is usually acceptable. | *This gauge indicates the pump outlet pressure.* |

## 4.5 SANITARY WASTE AND VENTING

The combination of the extremely cold climate and the use of low-flow fixtures in a Northern building can cause drainage problems. A good design provides a drainage system which requires minimal use of supplementary heating (such as heat trace), and allows easy access to drain lines and clean-outs for maintenance.

| Recommendation | *Rationale* |
|---|---|
| **4.5.1 Grade** | |
| All waste lines 75 mm and smaller must be graded a minimum of 2%. | *This is the minimum allowed by the NBC for plumbing lines within a building.* |
| **4.5.2 Material** | |
| Avoid the use of ABS piping for drainage lines. | *ABS piping tends to break down in contact with urine.* |
| **4.5.3 Location of Drain Lines** | |
| Do not locate drainage lines in exterior wall or floor assemblies. | *This reduces the possibility of pipe freezing.* |
| **4.5.4 Location of Floor Drains** | |
| Floor drains should be provided in boiler rooms. Provide floor drains in washrooms in public buildings or institutional buildings. Floor drains may be required in other locations depending upon the project. | |
| **4.5.5 Trap Seal Primers** | |
| If a floor drain is provided for occasional use, a trap seal primer is required. | *Floor drain traps may dry out (especially in mechanical rooms) and sewer gas odours will be noticed in the building.* |
| The use of “Trapguard” drain inserts may be considered when installation of trap seal primers would be difficult. “Trapguard” are not to be used with very hot water, such as boiler supply water. | |
| **4.5.6 Clean-outs** | |
| Clean-outs are to be installed at **all** changes in direction greater than 45º on sanitary waste lines. | *This requirement exceeds that of the National Plumbing Code. However it is strongly recommended to use this more stringent design guideline to reduce the incidence of blocked drain lines which require costly maintenance work.* |

### 4.5.7 Roof Vents and Roof Drains

.1 Uninsulated copper vent piping is to be used for the last three metres of piping before the vent exits the roof. Uninsulated copper drainage piping is to be used for the last three metres of drain line below the roof.

*Uninsulated vent jacks can freeze over. Rising vapour condenses and freezes where the vent exits the heated building. Frost build-up can eventually close the vent entirely.*

*Heat trace has been used in the past to rectify this problem, but an insulated copper vent jack reduces frost build-up by keeping the vent surface warm. The cost and maintenance needs of heat trace are avoided.*

.2 Pre-insulated sloped copper plumbing vent jacks are required. Plumbing vent jacks made by Thaler Roofing Specialties or equivalent are the suggested standard.

*Insulation installed on the copper vent pipe within the building will prevent heat from being conducted up the roof vent and melting ice which may form in the vent pipe. Hence vent pipes should be uninsulated below the roof.*

.3 All roof drains connected to building internal drain lines shall be connected by mechanical means only. Only roof drains or drain connector seals that provide a compression seal by mechanical means are acceptable for use to install drains to internal lines. O-rings, mastics, caulking and friction fit seals are not acceptable methods to connect internal roof drains.

*Most roofing problems involve water leaks.*

### 4.5.8 Special Traps and Piping

.1 Plaster Traps

Plaster traps should be installed on sinks used for any biology, horticulture, dental or art activities.

*These traps are required to prevent drain blockage caused by materials draining into the sink. The traps must be located so they are easily accessible for maintenance.*

.2 Grease Interceptors

Interceptors must be installed wherever deep-fat frying equipment may be used.

*Grease interceptors are required wherever commercial kitchen equipment is installed. They must be installed to be easily accessed or removed for cleaning. Larger interceptors may require a separate waste pump-out line.*

.3 Acid Dilution Traps and Piping

Acid dilution traps and tanks must be installed wherever acids are used, and they must be independently vented.

*Acid dilution tanks are required in photo developing facilities, science or laboratory rooms, and elsewhere as required.*

All piping and fittings used in these applications must be resistant rated for the application. (For example, acid resistant and fuse-sealed pipe may be required.)

*The use of proper piping and fittings will extend the service life of the system.*

.4 X-Ray developing fluids

These require suitable traps and piping.

### 4.5.9 Lift Stations and Sumps

If possible the use of sewage lift stations and sumps is to be avoided.

*Lift stations and sumps are maintenance-intensive. If the lift station or pump fails, there will be flooding.*

However, where provision of such is unavoidable:

.1 Lift Stations

Lift stations are to be provided with duplex pumps, a full-access manhole with lift-out rail assembly, and four float switches for the following alarms:

- pump 1 off
- pump 1 on
- pump 2 on
- high-level alarm

The high-level alarm is to be to an audible and visual alarm.

The lift station is to be vented to requirements as required by code.

Provide an emergency pump-out line from the lift station to a convenient exterior location. A valve is required on this line with a tag indicating “Normally Closed” and “Open for Pump-out Only”.

.2 Sumps

Sumps are to be provided with:

- a sump pump piped to drain the sump, with a check valve on the riser to prevent backflow into sump,
- a full-access manhole, and
- a float switch wired to provide an audible and visual alarm in the event of pump failure.

The sump is to be vented to code requirements.

Provide an emergency pump-out line from the sump to a convenient exterior location.

## 4.6 SEWAGE DISPOSAL - PIPED SERVICES

Less than 25% of all NWT communities have piped sewer systems (with buried or above-ground piping). When a new building is connected to existing sewer mains, the building owner is responsible for all costs associated with the connection. The work required generally extends beyond the property line and is completed as part of the general construction contract.

In every community with piped services, there may be areas still served by truck. Consultation with the municipality is essential to determine the capability and capacity of existing services, and to become aware of any planned changes or improvements to the system that may affect the project.

| Recommendation | *Rationale* |
|---|---|
| These requirements generally apply to systems contained within the building. The document "Good Engineering Practice for Northern Water and Sewer Systems" issued by GNWT Public Works and Services should be referred to for a more complete discussion of municipal servicing requirements affecting building construction. | *Complete descriptions and standard details are included in these manuals.* |

## 4.7 SEWAGE DISPOSAL - HOLDING TANKS

Where piped services are not available, septic fields or holding tanks must be used for sewage.

There are very few areas of the NWT with soil conditions suitable for septic fields. The majority of buildings rely on holding tanks serviced by pump-out trucks operated by the municipality. The frequency of pump-out is different in each community. Sewage tanks can be located either in an enclosed crawl space within the building, or buried outside the building. In order for the sewage system to work well, regular servicing is necessary, and sewage must be emptied as often as water is delivered.

| Recommendation | *Rationale* |
|---|---|
| Building structural design must allow for adequate tank support. | |
| **4.7.1 Health Standard** | |
| Refer to GNWT Department of Health, Environmental Health "Building Standards - Sewage Holding Tanks" | *Note: This document was developed in consultation with PWS and the NWT Housing Corporation. It is currently issued as a guideline for Environmental Health Officers, but will eventually be incorporated as Regulations under the Public Health Act.* |
| **4.7.2 Capacity** | |
| Sewage holding tanks are to be sized relative to the capacity of the domestic potable water supply only (i.e., excluding reserve for fire protection), as follows:<br>• large or interconnected buildings: equal<br>• small/simple buildings: 1.5 times | *This is a clarification of the Environmental Health Standards, which could be interpreted to include fire and emergency reserves. It also clarifies and modifies the previous interpretation of the 1.5 times capacity requirement, which was intended to apply to small buildings only and not to buildings with large tanks, such as those with interconnected occupancies.* |
| **4.7.3 Full Indicator** | |
| The sewage tank must be provided with a high-level float type switch to turn off the domestic water pressure system when the sewage tank is filled to capacity (but can still accommodate a volume of waste water equal to that of all the fixtures in the building). | *This specifies the type of device referred to in Environmental Health Standards.* |

### 4.7.4 Construction

Sewage holding tanks shall be designed and constructed in accordance with CSA standards. The design and construction of tanks larger than 4500 l must be certified by a professional engineer.

Sewage tanks must have a means of access for inspection and repair, with access holes of minimum inside diameter of 450 mm with water-tight secure covers.

Fibreglass, polyethylene or CPVC are recommended tank materials.

*Metal tanks are unacceptable because of their tendency to corrode. Concrete tanks should not be used north of Great Slave Lake as weather and ground conditions may cause the tanks to crack.*

If these tanks are to be buried they should be double-walled, insulated, and heat traced (hydronic).

Buried concrete tanks can be used south of Great Slave Lake.

*Buried concrete tanks have performed well in these areas. Due to their weight they do not require anti-flotation systems.*

Buried tanks must be prevented from floating or lifting.

### 4.7.5 Removal of Solid Matter

Environmental Health Standards state that, "Sewage holding tanks shall be designed and constructed to allow the complete removal of solid matter that can be expected to settle in any part of the holding tank".

*A clarification provided by Environmental Health notes that this was intended to mean removal of solids by sewage pump-out vehicles. There was concern over reports that sewage tanks have, on occasion, been cleaned out manually. Tanks should be designed to allow sludge to be effectively removed by the vacuum truck - whether by sloping the tanks or by providing extra access points.*

### 4.7.6 Location of Sewage Holding Tanks

To prevent tank contents from freezing, tanks must be located in a heated area, or must be double-walled, insulated and heat traced. The following preferences should serve as a guide:

*See Figures 4-4 and 4-5 on pages 27 and 28.*

.1 Tanks buried outside the building are acceptable wherever the soil conditions and water table permit. Buried tanks must be located not less than 15 m from any subsurface portion of the potable water system.

*This is possible in the Fort Smith Region. Buried tank installation allows tanks to be located close to roads for servicing and does not require additional building space.*

.2 Tanks enclosed within the building (including enclosed crawl spaces) are acceptable where gravity flow is provided. The use of lift stations and/or grinder pumps is not generally acceptable.

*This is typical of many buildings in areas with permafrost. Lift stations and grinder pumps increase maintenance problems and costs.*

.3 Tanks located in unheated crawl spaces are not acceptable.

*Heat trace would be required to prevent contents from freezing, and would be costly.*

.4 Tanks located on grade or partially buried are acceptable. These tanks must be double walled, insulated and heat traced.

*The placing of a tank on grade is usually less costly than locating the tank in a tank space.*

Where a boiler exists, the tank should be heat traced with the heating glycol system.

*Heating provided by the boiler is less costly than electricity, despite the higher construction cost.*

Tanks located on grade or partially buried must be prevented from lifting during periods of high ground water conditions.

Provide flexible piping to the tank to allow for differential movement between the tank and the building.

*Movements of over 100 mm due to frost heaving are not uncommon.*

The tank should not be located under the building.

*Repair of a tank under a building is very expensive.*

### 4.7.7 Pump-out and Vent Piping

The sewage tank pump-out suction line is to be complete with a Kamlok fitting termination to match the community sewage truck connection. The pump-out connection shall be securely anchored to the building and the sewage line graded back to the sewage holding tank.

*This prevents sewage spills on the ground around the pump-out.*

The building drainage system must be adequately vented to prevent siphoning of building traps during pump-out.

Pump-out piping is to be:

- black iron piping outside the building and extending 2 metres into the building
- Schedule 80 PVC within the building (with the exception of the first 2 metres)
- insulated within 2 metres of the building penetration
- securely anchored to the building

*Plastic pipe is not to be used outside, as it may crack or break in very cold temperatures.*

### 4.7.8 Utilidette Piping

All utilidette piping should be copper.

*Heat tracing of non-copper piping is not effective.*

## 4.8 FIXTURES AND BRASS

Fixtures are generally required to be low-flow to conserve water and reduce waste water. This requirement is most important for buildings on trucked water and sewage.

Recommendation

*Rationale*

### 4.8.1 Colour

All vitreous china or fibreglass plumbing fixtures are to be white. Coloured fixtures should only be considered under special circumstances.

*This is to unify appearance and to make matching of fixtures simple if replacement is necessary.*

### 4.8.2 Fittings and Trim

Exposed fitting and trim are to be triple chromium-plated.

*The quality and durability of this finish is good.*

.1 Infrared-Sensing Plumbing Trim

This is acceptable where the higher cost can be justified provided the trim is hard-wired to a power source.

*Infrared sensing trim has been tried in several installations and works satisfactorily. The benefits are a cleaner public washroom, fewer odours and lower water usage.*

*Battery-powered infrared sensors should not be used. The batteries run out and require replacement.*

.2 Spring-loaded Faucets

Spring-loaded faucets are acceptable.

*Spring-loaded faucets prevent water wastage.*

Wing-handle faucets are not acceptable in facilities to be used by children.

*Children can break the faucet by pushing the handle back beyond its travel point.*

### 4.8.3 Sinks

Stainless steel sinks are preferred.

*Stainless steel sinks are good for durability.*

P-traps for copper piping are to be cast brass. ABS or PVC traps are to match the installed drainage piping.

*Lighter gauge traps require frequent replacement.*

Traps on wheelchair-accessible sinks must have insulation installed on P-traps to prevent scalding.

All faucets should have flow restrictors to ensure low water use.

*This reduces water consumption and waste.*

### 4.8.4 Hand Basins

Stainless steel basins are preferred for all high use facilities.

*Fixtures in high-use buildings must be durable enough to withstand the level of abuse to which they are often subjected.*

Vitreous china or stainless steel basins are acceptable in all non-public use facilities.

*Non-public-use facilities are less prone to vandalism than are public buildings.*

Enamel on steel and plastic or fibreglass basins are not acceptable in buildings with heavy use.

All faucets and shower heads are to have flow restrictors to ensure low water use.

*This reduces water consumption and waste*

Traps on wheelchair-accessible hand-basins must have insulation installed on P-traps to prevent scalding.

### 4.8.5 Toilets and Urinals

All toilet fixtures should be low water use type with a maximum flush volume of 6 litres per flush. All urinals are to be low water use type. The exception to this is to provide full flush water closets at the end of long drainage runs with minimal grade to assist in scouring the drain line of debris.

*The objective is to reduce water use.*

Water closets in areas susceptible to vandalism are to be complete with flush valves, not tanks.

*Flush valve toilets are less susceptible to vandalism.*

Vitreous china toilet fixtures are preferred. Fibreglass or plastic models are acceptable only in very low-use facilities.

*Fibreglass and plastic models are not durable enough for most buildings, although they may be acceptable for installation in facilities normally occupied by fewer than 6 people.*

Use of propane-fired incinerating toilets is not acceptable.

*The installation of a propane supply may be difficult and installation and maintenance costs are high.*

Waterless urinals are NOT acceptable in most buildings.

*Waterless urinals may produce unacceptable odors.*

Toilet seats in public washrooms shall be extra heavy open front, elongated bowl seat ring type only.

*Requirement of National Plumbing Code.*

*Toilet seats in public facilities are vandalism targets.*

### 4.8.6 Drinking Fountains

Drinking fountains must be self-contained refrigerated type. Remote refrigeration units are not acceptable.

*Water is wasted when people run the water to empty warmed water from lines. Self-contained units are easier to access for maintenance and repairs.*

### 4.8.7 Hose Bibs

Hose bibs must be keyed, non-freeze, self-draining type, 18 mm complete with stop and drain valves inside building and a backflow prevention device.

*They are simple to drain in preparation for winter.*

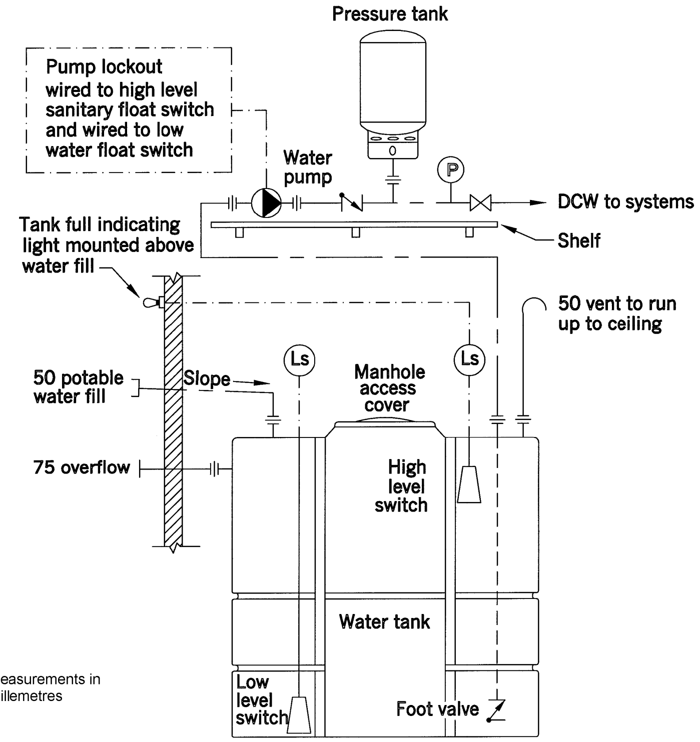
### 4.8.8 Shock Absorbers

Manufactured water hammer arresters, c/w isolating valves, are required at all groups of fixtures.

*Shock absorbers reduce water hammer and damage to fixtures and piping.*

## 4.9 WATER AND SEWAGE TANK CONFIGURATIONS

Figure 4-1: Typical Water Tank



Measurements in millemetres

Figure 4-2: Water Tank in Crawl Space

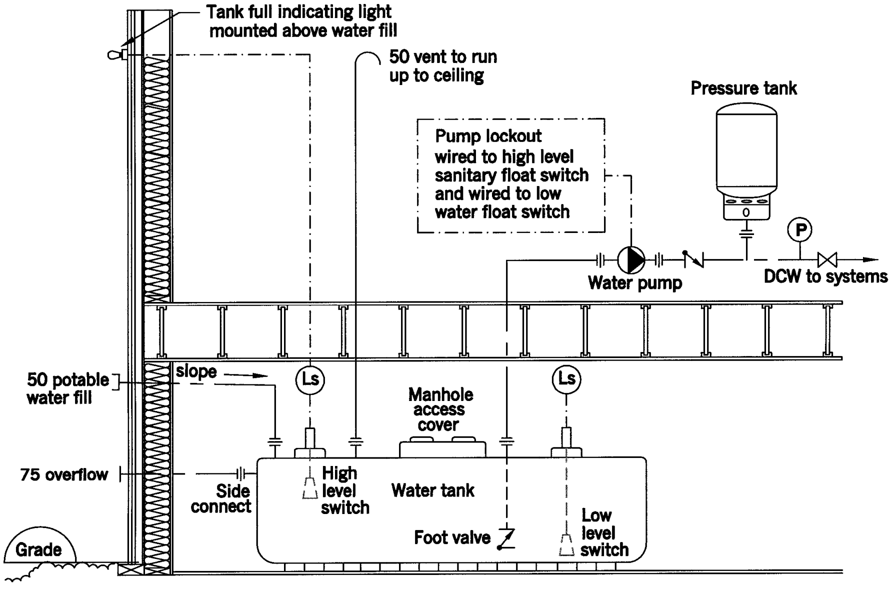


Figure 4-3: Tube Tank in Crawl Space

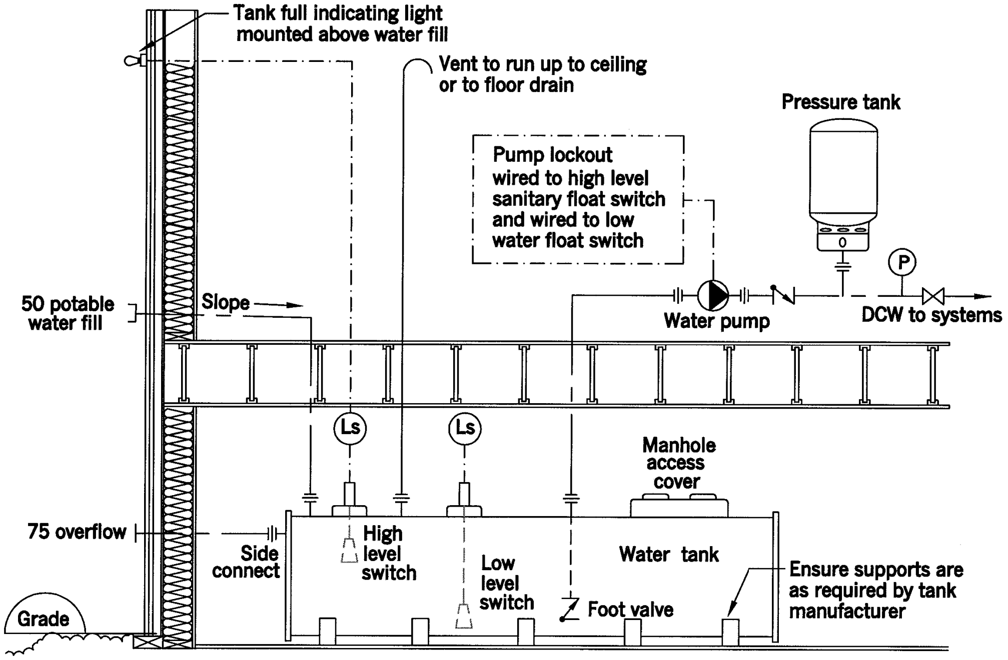
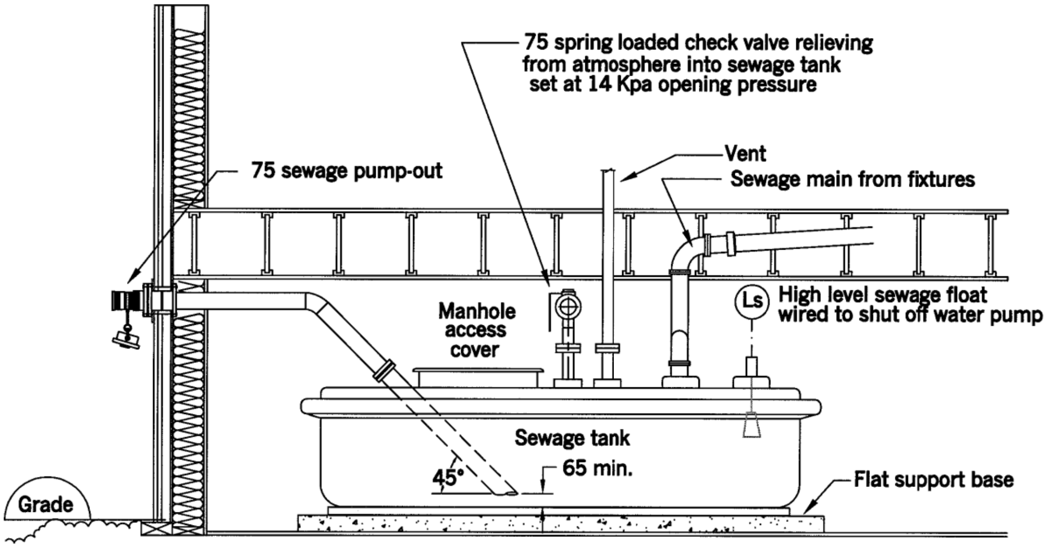
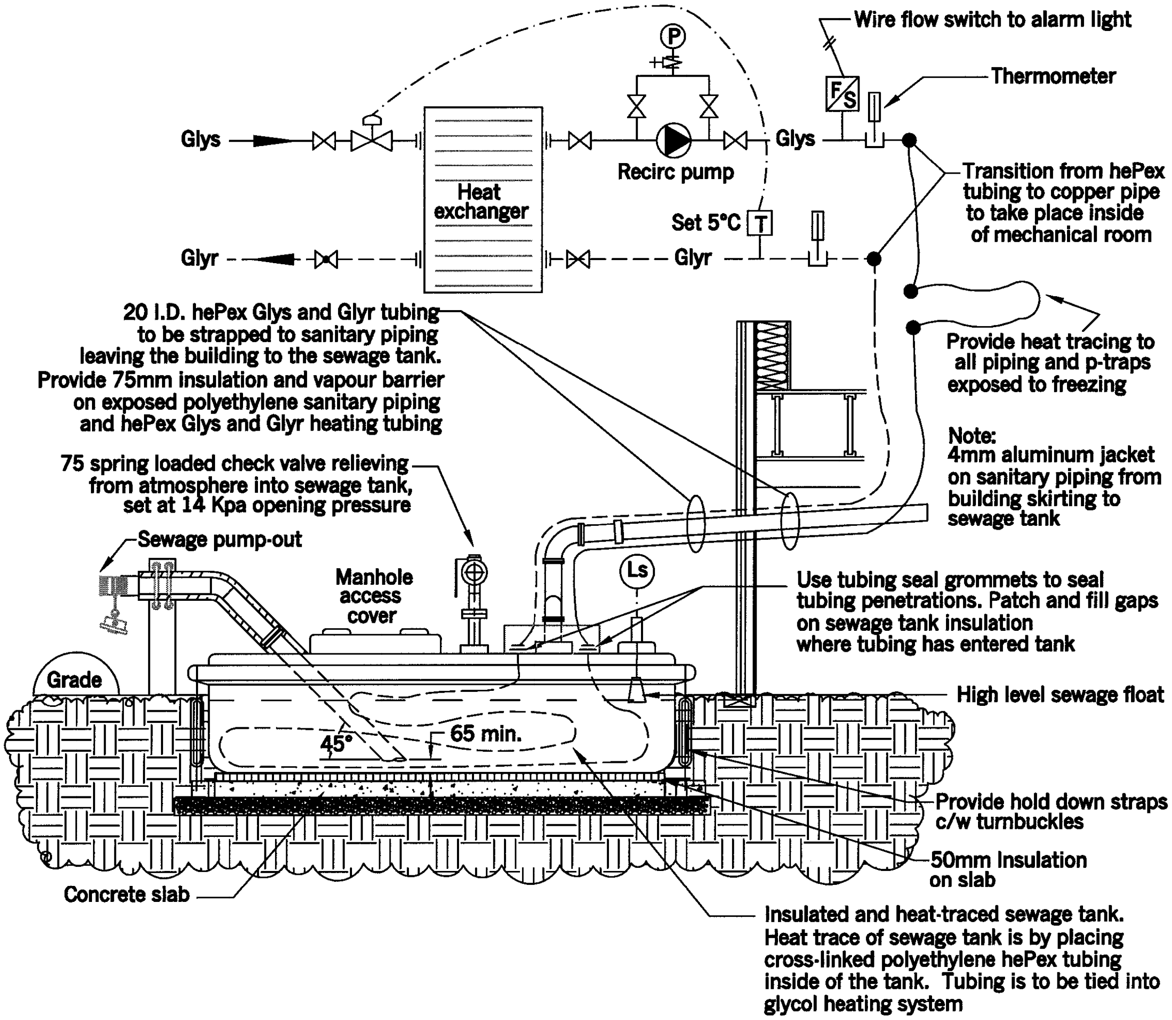


Figure 4-4: Sewage Tank in Heated Space



## Figure 4-5: Sewage Tank Outside



## 4.10 SPECIALITIES

Recommendation

*Rationale*

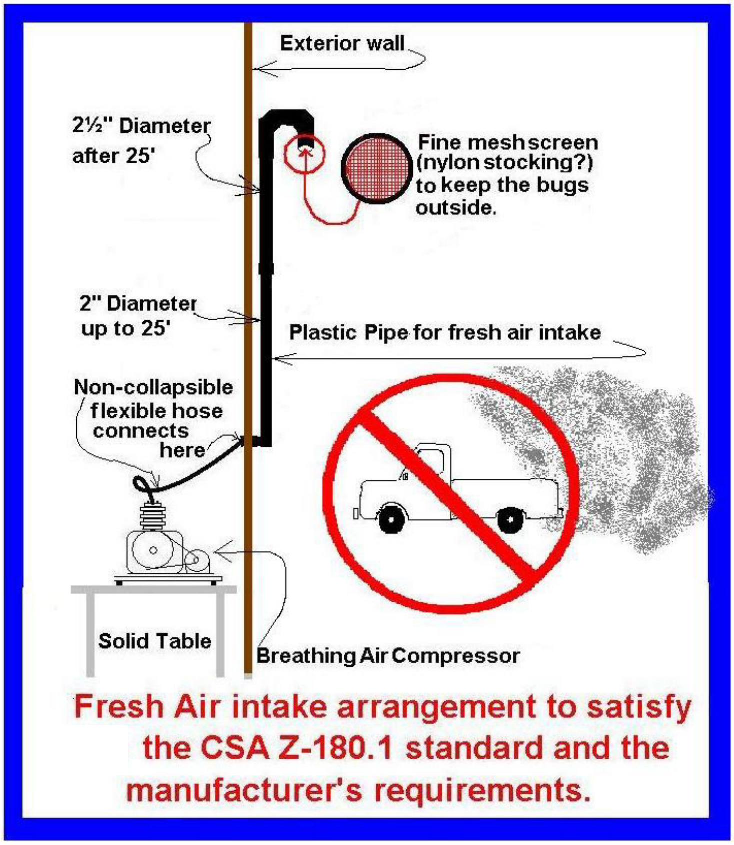
### 4.10.1 Breathing Air Compresser for Firehalls

The design as indicated in Figure 4.10.1 is to be provided for all Firehalls with the following exception:

- Remove nylon stocking and leave pipe open.

*Any insect-barring material will freeze over in winter conditions.*

**Figure 4.10.1: Air Intake**



Fresh Air intake arrangement to satisfy the CSA Z-180.1 standard and the manufacturer's requirements.

## 4.11 OPERATION AND MAINTENANCE

| Recommendation | *Rationale* |
|---|---|
| **4.11.1 Spare Parts** | |
| The following spare parts are to be provided if appropriate:<br>• One domestic water pressure pump or recirculating pump.<br>• One domestic hot water recirculating pump. | *All spare parts are to be available at the end of the warranty period. Typically spare parts get used to make repairs during the warranty period.* |
| **4.11.2 Regional Equipment Preferences** | |
| Select equipment based upon local preference. | *Maintainers should be able to provide their recommendations for equipment.* |
| **4.11.3 Code Requirements** | |
| The following code-required items shall be called for in specifications:<br>• Hydrostatic test of entire systems for 4 hours at a pressure of 860 kPa without measurable leaks.<br>• Fill, flush and fill of system. Copy of test results to be signed by owner's representative.<br>• Chemicals and disinfection as required by Northern Health Services. | |

# M5 FIRE PROTECTION

Fire fighters and fire-fighting equipment available in most NWT communities is limited, and the consequences of a fire in a small remote community can be severe. The basic principles here are to ensure occupants are alerted and can get quickly and safely out of the building and to stop localized fires quickly.

## 5.1 PORTABLE EXTINGUISHERS

Portable extinguishers are to be provided in all buildings. It is intended that occupants use them to extinguish small fires immediately.

| Recommendation | *Rationale* |
|---|---|
| **5.1.1 Room Temperature Operation** | |
| ULC approved stored-pressure ABC rechargeable fire extinguishers are acceptable for use in all facilities that are occupied on a daily basis, are not subject to sudden temperature drops, are always maintainable at ambient temperature above freezing, and are equipped with low temperature alarms. Extinguishers are to be ABC rated. | *ABC-rated stored-pressure extinguishers require less maintenance than other types allowed by code, such as pressure water types.* |
| Kitchen fire extinguishers to be Type K. | *Required by code.* |
| **5.1.2 Low Temperature Operation** | |
| If a fire extinguisher is located where temperatures may fall below freezing, the extinguisher must be multiple purpose dry chemical type rated for -40ºC. | *Typical applications are maintenance garages, firehalls, warehouses or any other facility that may not be occupied daily; where opening of large garage doors can cause temperatures to drop quickly; or anywhere extinguishers are intended for outdoor use.* |
| **5.1.3 Location** | |
| Extinguisher positions are to be identified by permanent labeling such as lamacoid giving the location number and NFPA 10 rating of extinguisher required. | *NFPA 10 requires records be kept which record fire extinguisher locations in the building. After extinguishers are used or discharged there is a tendency to install larger units if the proper size replacements are not available. Subsequent installations tend to be larger than required by code.* |

## 5.2 SPRINKLER SYSTEMS

Sprinkler systems have been installed in many new buildings since the 1980s, as required by code or regulation, at the request of the Fire Marshal, or at the request of the owner.

In remote communities where competent staff is not on site, the cost to perform code-required testing of fire equipment can exceed the value of the system. These testing costs can easily exceed $100k per year. Sprinklers should be installed only if required by code. Stamped as-built drawings must be provided and the installed sprinkler information must be documented: brand, type, K-factor, head count by temperature rating, length of dry pendant heads and identification by location.

It is the responsibility of the designer to confirm there is sufficient flow available in the municipal water mains for a sprinkler system.

### 5.2.1 General Requirements

| Recommendation | *Rationale* |
|---|---|
| Pipe sizes, type of piping, and fire protection system layout must be reviewed and approved by the Fire Marshal of the GNWT. Systems are to be hydraulically designed, with as-built drawings and calculations signed by a professional engineer. | *The NWT Fire Marshal is the authority having jurisdiction (AHJ).* |
| In schools, which are classed as Light Hazard Occupancies, certain areas such as Science Labs, Home Economics Classrooms, Equipment Rooms etc., are to be designed to Ordinary Hazard Group 1 characteristics, but with a 30 minute flow duration used to size tanks (in lieu of 60 minutes required by code). | *This is an exception made by the AHJ: see Fire Marshal's Technical Bulletin FM-020-92.* |
| Dry systems are only acceptable for use in places which are subject to freezing temperatures, such as maintenance garages, warehouses etc., and, even then, only if the size of the building makes the provision of glycol loop(s) excessively expensive. | *Dry systems in areas subject to freezing are required, by code, to be tested or have all heads replaced every 10 years. This large operational cost can be avoided by the use of glycol loops. However, this expense should be assessed against the additional maintenance costs to service glycol loop backflow preventers.* |
| In general, all crawl spaces are to be sprinklered, regardless of code requirement or the crawl space compartmentalization. | Unless the sprinkler coverage is designed for storage of combustible material, the installation of sprinklers in a crawlspace does not make it an approved storage area. |
| All concealed spaces shall be sprinklered, as mandated by the Fire Marshal. | |

### 5.2.2 Sprinkler Heads

| | |
|---|---|
| Quick response heads rated to 74ºC are required except as noted below. | *If heads respond fast, the hazard can be quickly extinguished and the quantity of water reserved for fire protection can be reduced.* |
| High temperature heads rated at no less than 100ºC are required in mechanical equipment rooms, such as generator and boiler rooms. | *High space temperatures can be found in these areas, which could cause non-high temperature heads to activate prematurely.* |

Dry pendant heads are required in entrance foyers.

*There is a greater potential for freezing in entrance ways where doors are opening to the outside. Dry heads must be tested or replaced every 10 years.*

A glycol loop is required wherever sprinkler piping is installed in crawl spaces close to outdoor air vents, louvres or intakes, or in other locations subject to freezing such as drive in Ambulance Bays, Correctional Facilities Intake Entries etc.

*Pipes in these locations are subject to freezing.*

A Fire Department connection is to be provided as required by code.

*Thread size, count and pitch must be confirmed to be compatible with local fire-fighting apparatus.*

### 5.2.3 Piped Water Service Systems

Systems supplied from piped water service systems shall have incoming water main sized to provide flow rate required for occupancy of building calculated as required by relevant NFPA document. The incoming main shall be common for sprinkler water and domestic water, but will be sized to provide the greater flow requirement for either system.

A ULC-approved backflow prevention assembly shall be provided on the sprinkler side of the system to prevent backflow into domestic water system. This is required by the National Plumbing Code.

An excess pressure pump and a retarding chamber or flow switches with a built in retard time are to be provided as methods of preventing false alarms during water surges etc.

*Water pressure in municipal and pumped mains systems in the NWT are known to fluctuate considerably.*

### 5.2.4 Pumps and Controllers

Fire pumps and controllers must be ULC listed and conform to the requirements of NFPA 20.

All fire pump systems shall be designed and installed such that access to and usage of regularly required testing features shall be easy and not require any provision of additional equipment.

*Code-required system testing should be performed so there is minimal extra work for the maintainer. As an example, drain tests should be able to be run without a need to run a hose connection to the exterior of the building. Testing of systems is a code requirement, and systems should be designed to meet these code requirements in all aspects.*

As required by code, a Fire Pump system must be provided with a circulation relief system. A simple pressure relief system will not be acceptable.

### 5.2.5 Water Reserve - Tanked Water Supply

Coordinate with the structural designer for proper tank support.

Wherever an automatic sprinkler system is installed, water supply calculations must be approved by the Fire Marshal, but can generally be based on the following:

.1 Buildings where NFPA 13D applies will require a capacity calculated by multiplying the required flow rate by the required duration of flow as laid out in NFPA 13D.

*This will apply to single and two family dwellings only.*

.2 Buildings where NFPA 13R applies will require a capacity calculated by multiplying the required flow rate by the required duration of flow as laid out in NFPA 13R.

*Typically this will apply to student hostels and group homes.*

| | |
|---|---|
| .3 Buildings where NFPA 13 applies will require a capacity calculated by multiplying the required flow rate by the required duration of flow as laid out in NFPA 13 dependant on the occupancy classification of the building. (Except schools, wherein certain areas are to be designed to ordinary hazard occupancy group 1, where duration shall be 30 minutes). | *This will typically apply to all public sector buildings which require sprinkler protection as laid out in NBC Part 3 latest edition, excluding those noted previously.*<br>*The GNWT Fire Marshal has the authority to require a building to be sprinklered.*<br>*Designers are advised to confirm sprinkler requirements with the Office of the Fire Marshal for ALL building designs.* |
| Tankage to be provided with means of draining of the tank and access to the tank for periodic cleaning. | *This is a code requirement.* |
| Firewater storage tanks are to be provided with a “Fire Water Low Level Alarm” float switch wired to a trouble signal at the Fire Alarm Panel to indicate water level in the firewater tank has lowered to less than required. This may be due to evaporation. | *Water evaporation reduces the water volume available to fight a fire.* |

### 5.2.6 Carbon Dioxide ($CO_2$)

| | |
|---|---|
| Use is limited as to where it is required for commercial range hoods, unless approval is given for use where special electronic equipment is installed. | *It is difficult to clean up.* |
| Wet chemical systems are now preferred for commercial range hoods. | *Easier to clean up.* |

### 5.2.7 Halon

| | |
|---|---|
| Not permitted**.** | *Halon use is restricted because of environmental damage (ozone destruction) and transportation hazards.*<br>*Where previously Halon was used, use a clean agent, two stage system.* |

### 5.2.8 Tees

| | |
|---|---|
| Use factory tees only. T-drill fittings are not acceptable. | *Factory tees can be repaired without replacing the tee. Repairs to T-drill require special equipment that may not be available to maintainers.* |

## 5.3 STANDPIPE SYSTEMS

Standpipe systems provide a system of fire hoses in buildings. They have not usually been required in NWT buildings as the NBC does not require these systems for small buildings, nor does it require them for large sprinklered buildings.

| Recommendation | *Rationale* |
|---|---|
| Standpipe systems should be considered for large buildings even though they are sprinklered and standpipes are not required by code. | *Hose cabinets in large buildings provide more fire-fighting capacity.* |
| The means to perform code-required regular flow tests must be incorporated into the building overall design. | *During the design stage, the problem of how to handle the full-flow water from a hose cabinet must be considered.* |

## 5.4 OPERATION AND MAINTENANCE

Recommandation

*Rationale*

### 5.4.1 Spare Parts

The following spare parts are to be provided as per requirements of NFPA 13 for sprinkler systems:

- Not less than 6 spare heads of each type installed for buildings up to 300 heads total.
- Not less than 12 spare heads of each type installed for buildings from 300 to 1000 heads total.
- Not less than 24 spare heads of each type installed for buildings with over 1000 heads total.
- A head wrench suitable for each type of head installed.

### 5.4.2 Equipment Preferences

Equipment preferences are to be obtained from the maintenance staff at each project location.

### 5.4.3 Code Requirements

The following code-required items shall be called for in specifications:

- a hydraulic design information plate to be mounted at the location from which the hydraulically calculated system is fed.
- a hydrostatic test of entire system for 2 hours at a pressure of 1400kPa without measurable leaks.
- performance of operational tests and final operating test to the requirements of NFPA 13.

# M6 FUEL SUPPLY

## 6.1 GENERAL

Electricity and fuel are required in most buildings. In the NWT most electrical power is generated by diesel power plants, and is quite expensive. Where hydro-generated electricity is available, it is cheaper.

Natural gas is available only in Norman Wells and Inuvik. A few communities (e.g., Hay River, Fort Simpson and Yellowknife) use propane. However, propane is susceptible to gelling in cold temperatures and a vapourizer is required at temperatures below -30ºC. Propane must be transported in accordance with dangerous goods regulations.

Diesel fuel is the most common heating fuel in the Territories. It has been designed to flow at temperatures as low as -50ºC. Most northern communities receive an annual supply by barge or winter road. It is stored in large tanks (a grouping of which is called a fuel storage facility or tank farm) for distribution (via truck) to required facilities and buildings for the community's use. The GNWT's Petroleum Products Division (PPD) provides sales, storage, distribution and delivery services for fuels, and publishes standard specifications, design rationale and drawing details for the design of northern fuel storage facilities.

However, where possible and practical, it is desirable to use less, or no, fossil fuels and reduce greenhouse gas emissions. As mentioned in the Energy Chapter, alternative forms of heating (including the use of recovered heat from NWT Power Corporation power plants) should be considered for use in buildings where possible. Note that heat recovery from power plants may require more expensive initial construction.

Biomass is a viable fuel to use as a primary heating fuel but a backup heating plant using conventional fuels must also be provided.

The following information is intended to introduce readers to some of the unique characteristics and challenges of storing and safely distributing fuel in northern Canada:

## 6.2 TYPICAL ARRANGEMENTS

All oil installations must be in compliance with the CSA B139 Installation Code for Oil-Burning Equipment and other applicable regulations. While the most recent edition of the CCME "Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum products", and the 2008 "Federal Petroleum Product and Allied Petroleum Products Storage Tank Systems Regulations" have not yet been adopted officially by the AHJ, they are referenced in the National Fire Code so must be followed.

It will be the designer's responsibility to ascertain and comply with the most stringent requirements of all relevant codes.

The "Federal Petroleum Product and Allied Petroleum Products Storage Tank Systems Regulations" will requires all existing storage systems to meet the requirements laid out therein within 2 years of the regulations becoming law. Therefore, for any new building, or for any building renovations, it is expeditious to provide a storage system that meets these requirements now.

The "Federal Petroleum Product and Allied Petroleum Products Storage Tank Systems Regulations" require the following for all storage tank systems (except those for home heating with a volume less than 2500 liters):

- Design drawings stamped by a Professional Engineer.
- Registration with Environment Canada (this includes existing systems).
- The provision of spill protection at storage tanks, either by dike or double wall construction, regardless of tank volume, and at product transfer areas.
- The provision of corrosion protection, leak detection, and overfill protection.
- Keeping of as-built drawings on site.

**Due to the stringent requirements these regulations will require, the capital and operating costs of underground storage tanks will be prohibitive. Underground storage tanks will, therefore, not be acceptable under any circumstances.**

The storage and handling of fuel oil for building heating systems generally falls into 4 categories of installations described below.

### 6.2.1 Fuel Storage Tanks Less Than 2500 Litres (550 I.gal) Located Outside Building

Fuel oil tanks located outside the building are usually mounted adjacent to the building on a tank stand 1500 mm minimum from any means of egress from the building and from any property line.

The height of the external tank is set to minimize the need of the burner pumps to lift the fuel oil to the burner. Thus, the tank stand is specified to sit the tank at or above the mechanical room floor height.

A safe ladder or stair should be provided to allow the fuel truck driver access to fill the tank. Fuel fill lines and vent lines are normally located on top of the fuel tank. The vent line is fitted with a vent whistle and must be terminated a minimum of 2400 mm above finished grade. The tank stand should be field measured by the Contractor for actual required height and must be supported on a non-combustible support.

Oil should be heated to an appropriate temperature ready for use in oil-burning appliances. Typically, fuel flows by gravity from the outside storage tank to the appliance. If the length of oil pipe inside the heated building is short, a large diameter pipe or warming pipe should be provided to allow the fuel oil time to warm up.

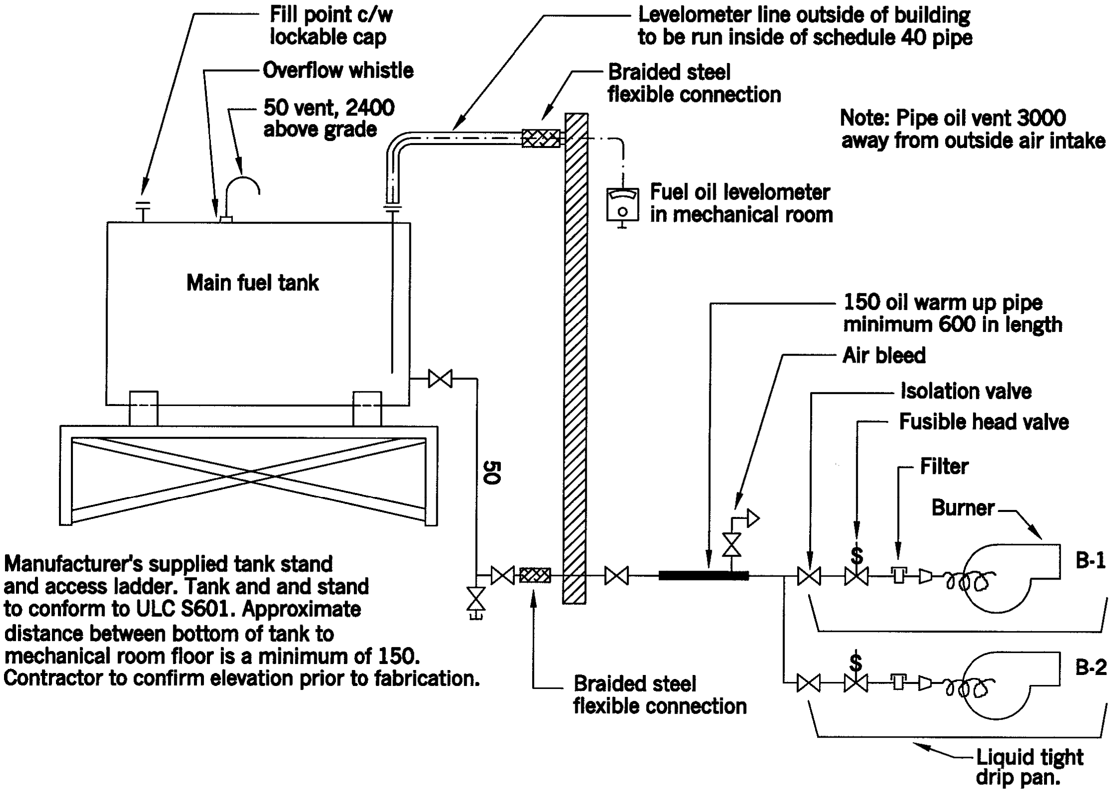


Figure 6-1: Fuel Tank Located Outside of Building

### 6.2.2 Fuel Storage Tanks Less Than 2500 Litres (550 I gal) Located Inside Building

When the total fuel storage is less than 2500 litres (550 Imperial gal.), the fuel may be stored either inside or outside the building. Storing the fuel inside the building is not the best option. It is generally more expensive as the tank takes up building floor area, requires clearance of 1500 mm between tank and burners, and must be set in a catchbasin sized to hold 110% of the total tank volume.

Fuel oil stored inside the building must be located on the lower floor. (It is prohibited to locate a fuel tank in a crawl space.) Fuel fill lines and vent lines are run out through the building wall. The vent line is fitted with a vent whistle and should be at least 2400 mm above ground, within hearing distance of the fuel truck operator and a minimum of 1500 mm from windows and fresh air intakes.

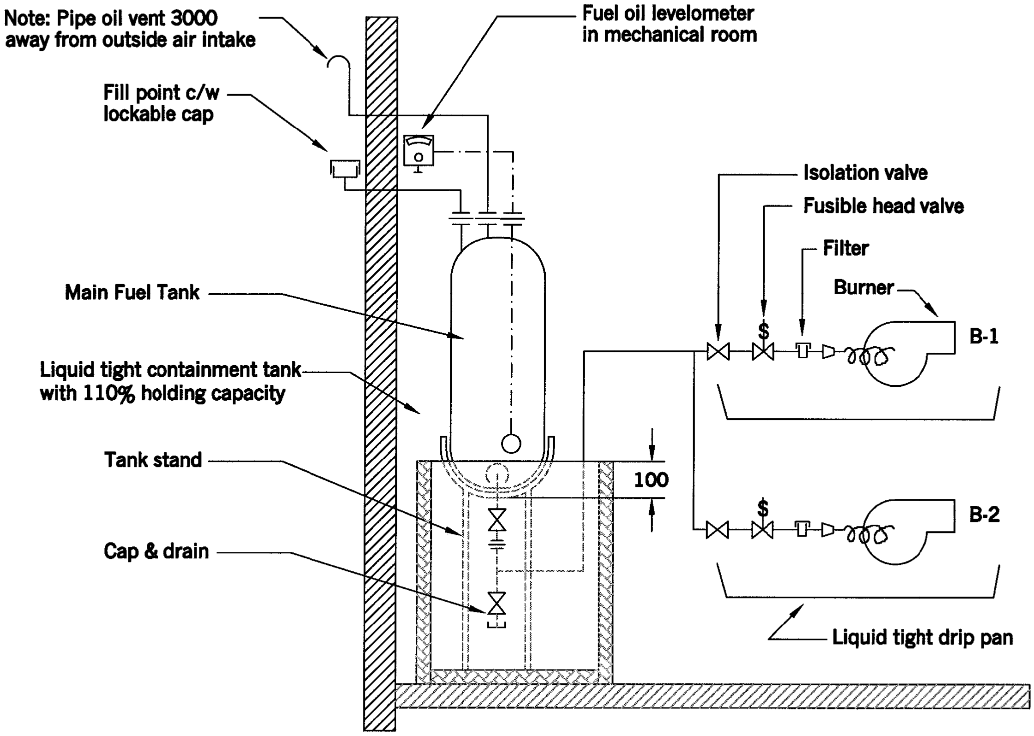


Figure 6-2: Fuel Tank Located Inside Building

### 6.2.3 Fuel Storage Tanks Over 2500 litres (550 I. gal) Located Outside Building

Fuel tanks over 2500 litres (550 I.gal) located outside the building must be a double-walled environmental tank, located a minimum of 1500 mm from the building or from any means of egress from the building, and 1500 mm from any property lines.

Usually, these storage tanks are located above ground, as soil conditions in the majority of the arctic communities are not suitable for underground (buried) tanks, and environmental protection requirements are cost-prohibitive.

The larger fuel tanks are usually mounted at grade as they are too large to mount readily on stands.

These fuel tanks must comply with CSA-B139, be ULC approved, and come complete with stairs, fill fittings, vents, etc. There are several types of fuel tanks available.

The site will dictate the tank arrangement. If the outside fuel storage tank (located at grade) is significantly below the mechanical room, then a transfer pump system should be used (Figure 6.3). If the fuel storage tank is located significantly above the mechanical room, then again transfer pumps should be used. If the tank is approximately level with the mechanical room, then transfer pumps are not required (Figure 6.4).

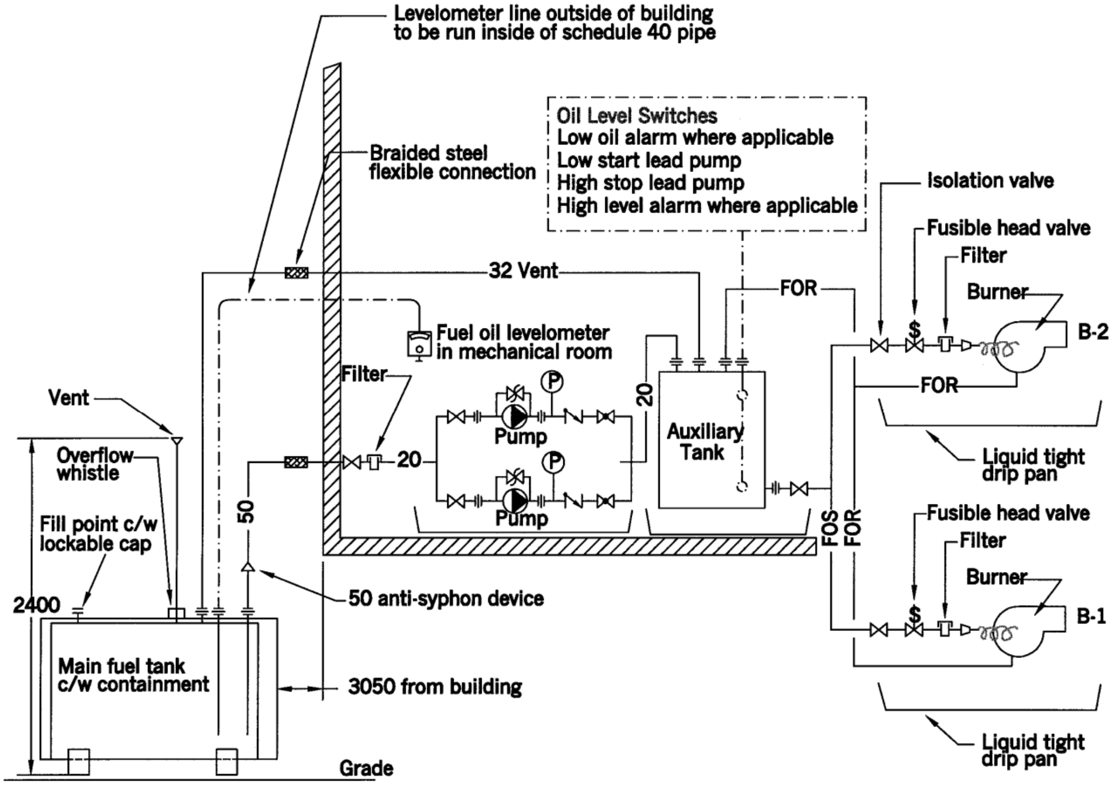


Figure 6-3: Outside Tank with Transfer Pump

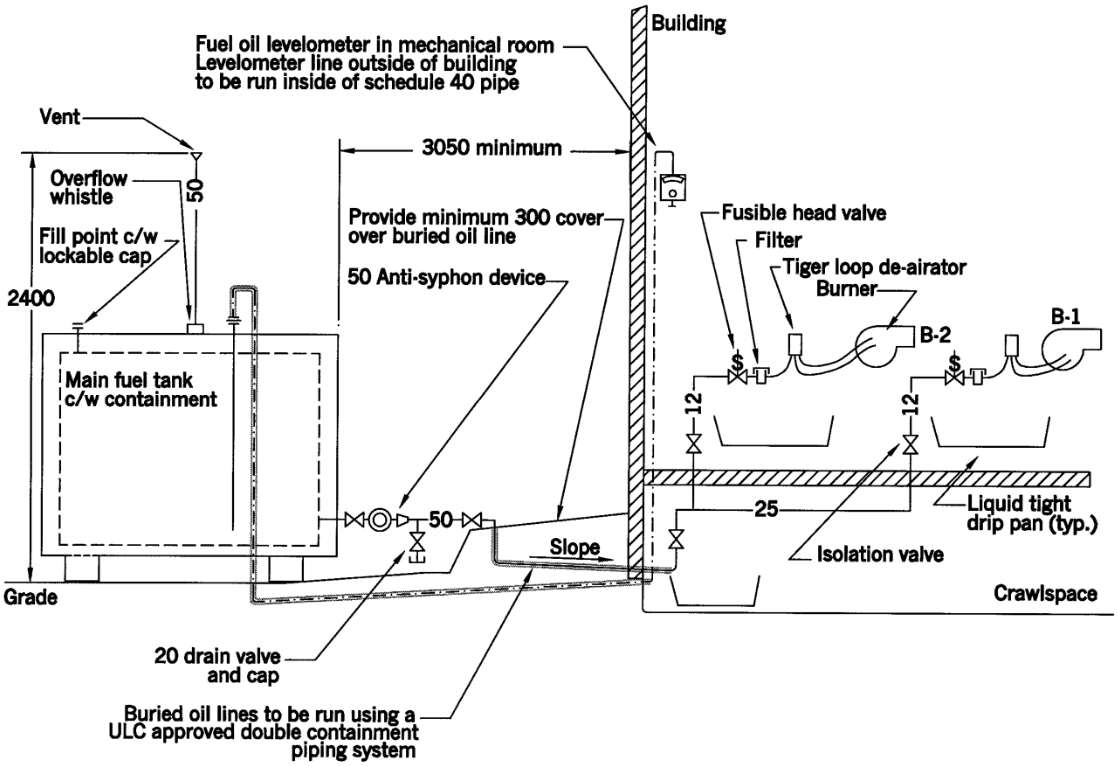


Figure 6-4: Outside Tank Over 2500 Litres

### 6.2.4 Fuel Storage Tanks Over 2500 Litres (550 I. gal) Located Inside Building

If large quantities of fuel need to be stored inside buildings (due to property line restrictions or other considerations), a fuel vault must be used. This situation is rare and is not discussed here.

### 6.2.5 Underground Fuel Storage Tanks

Underground fuel storage tanks are not acceptable, as explained above.

### 6.2.6 Value Engineering

The most important consideration in fuel system design is the selection of the fuel storage volume. If too much fuel is stored, tank and system costs will be higher than necessary. If too little fuel is stored, then more frequent delivery is required, which may overload the local delivery service and result in increased fuel costs.

## 6.3 FUEL OIL DELIVERY AND STORAGE

Fuel delivery is either by contract with the Petroleum Products Division of the Department of Public Works and Services, or through private distributors.

| Recommendation | *Rationale* |
|---|---|
| **6.3.1 Fuel Meters and Gauges** | |
| Totalizing fuel oil meters are not required unless one tank is serving more than one unit in the same building and meters are required to monitor consumption for each unit. | *Meters allow maintainers to monitor fuel consumption; however, fuel is metered by the delivery truck meter and billings reflect consumption.* |
| All tanks should be equipped with a remote reading level gauge. | *The Code requires some means of measuring the fuel in the tank, and the remote gauge can be located in the mechanical room where it is easy for the maintainers to monitor.* |
| **6.3.2 Tanks** | |
| .1 Primary Tanks | |
| If under 2500 litres, either a circular horizontal tank or up to two 1135 litre oval tanks may be used. If over 2500 litres, double-walled, self-contained, self-bermed fuel storage tanks are required. | *A dike is required by code for tanks over 2500 litres, whereas a self-contained tank is usually less costly and provides the best flexibility in its location and relocation in the future.* |
| .2 Auxiliary Tanks | |
| Auxiliary tanks may be up to 1135 litres (250 I. gal) in size, and must be installed in a catchbasin sized to hold 110% of tank volume. | *An auxiliary tank is required if a transfer pump system is used, and may be required if an emergency generator is in the building. An auxiliary tank provides storage for the purpose of warming fuel oil for use by oil-burning appliances and for an emergency generator. It provides the minimum 2 hour fuel requirement for operating the generator (when nothing else works).* |

.3 Stands

Fuel storage tank stands should be fabricated from steel. Combustible stands are not acceptable.

*Although required by code, this is sometimes overlooked*.

Coordinate with the structural designer for proper tank support.

*See Bulletin #16 issued by the Office of the Fire Marshal in March 1992 waiving the code requirement for 2 hour fire protection of steel stands. This is a waiver of CSA B139 requirement in the NWT.*

.4 Oil-Warming Pipe

An oil-warming pipe is to be used in all applications where gravity feed from an exterior storage tank is possible. The pipe is to be constructed of standard schedule 40 pipe and is not to exceed 45 litres capacity.

*When an oil pipe enters a building, the first one or two metres of the pipe will build up frost on the outside of the pipe as the fuel warms up. To facilitate this process, usually an oil-warming pipe is installed. However if there is an auxiliary tank, the auxiliary tank will act as the warm-up pipe. In the case of where there is a crawl space, the pipe looping through the crawl space will act as a warm-up pipe.*

Warming pipe to be equipped with a manual bleed valve at high point and a drain valve at low point, and be set in a galvanized steel drip pan with sides at least 38 mm high so as to contain condensation dripping from pipe.

### 6.3.3 Fuel Tank Capacity

.1 Primary Tanks

.1 In remote communities, a two-week supply, calculated at continuous maximum operating load (including heat and standby power), is the minimum required wherever a standby generator is to be installed, or when a long disruption in heating would require relocation of residents, or could potentially damage essential equipment.

*Blizzards or storms can delay or prevent fuel delivery for up to two weeks.*

In main centres, such as Yellowknife, Hay River, Fort Smith, Fort Simpson, Inuvik and Norman Wells, a one-week supply is the minimum required.

.2 A one-week supply, calculated on continuous maximum operating load, is the minimum required for all buildings that are not essential in the event of power failures and which can be prepared for freezing conditions (i.e., water lines drained).

*Current codes and regulations will dictate the requirements for auxiliary tanks.*

.3 For additions to existing buildings, use the actual fuel consumption over the preceding three years to determine whether the building fuel storage capacity needs to be increased.

*Actual fuel consumption may be higher or lower than anticipated during design.*

### 6.3.4 Location and Access

.1 Primary Tanks

Suitable platforms with steps and handrails are to be provided at the fill line on exterior tanks.

*This provides a safe condition for the fuel deliverer.*

Buried fuel tanks are unacceptable for public sector buildings.

*Most areas of the Arctic and sub-Arctic have ground conditions which are unsuitable for burying fuel tanks. In any case, environmental protection requirements make buried tanks costly.*

No fuel tanks are to be located in crawl spaces.

*This is because spills might go undetected in crawl spaces.*

Wherever possible, elevate the primary storage tank to allow the tank to gravity feed to the fuel burning appliances. Ensure the tank and piping are installed at an appropriate elevation and grade to allow the contents of the tank to be fully utilized.

*A gravity feed fuel oil system is the most cost-effective means of providing fuel oil to a building.*

.2 Warming Pipe

Where the locations and elevations of primary storage tanks and warming pipes allow fuel oil to flow by gravity, the oil-warming pipe is to be located in the mechanical or boiler room near the oil burning equipment.

*Gravity feed from an auxiliary tank or oil-warming pipe to all oil-burning equipment, including a standby generator, is cost-effective and still provides warmed oil for improved combustion.*

Where an auxiliary tank is used, a warming pipe is not required.

### 6.3.5 Spill Protection

.1 Exterior Tanks

If a fuel tank is required to have spill protection because of its size, the tank is to be of the horizontal type for above-ground installation. Preference is given to a double-wall environmental tank. However, a single wall tank installed inside a dike will be accepted as an alternate in certain circumstances. In this alternate, the containment dike is to be closed off and secured with a removable cover, and the tank is to be enclosed on all sides by a fence, leaving adequate access on all sides of the tank for maintainer access and fuel delivery.

*The Environmental Protection Act specifies when spill protection must be provided; unprotected dikes are a safety hazard, as they can fill with water.*

*Fencing discourages vandalism and tampering.*

*A fence is not required if the containment access covers cannot be removed.*

.2 Interior Tanks

Containment with 110% capacity is required beneath all interior tanks.

*Interior tanks are usually located in mechanical rooms. Such rooms may have painted plywood floors that would permit seepage of fuel into the floor assembly if the fuel were not contained.*

.3 Auxiliary Tanks

Auxiliary tanks must be vented to the exterior tank. Vents must not be trapped.

*Proper venting eliminates the possibility of tank overflowing through the vent pipe onto grade, if the transfer pump controls were to fail and interior tank overfilled. If this venting arrangement cannot be provided, additional safety controls should be incorporated into the transfer pump controls.*

## 6.4 OIL SUPPLY (DISTRIBUTION)

| Recommendation | *Rationale* |
|---|---|
| **6.4.1 Fuel Temperature** | |
| Fuel stored in exterior tanks should be warmed before reaching the burners. This can be done by providing an auxiliary tank, an oil warming pipe or an extended run of supply pipe in the mechanical room long enough to allow oil to warm to room temperature. | *Oil burners operate at higher efficiency when fuel oil is at room temperature.* |
| **6.4.2 Transfer Pumps** | |
| Two bulk fuel oil transfer pumps are required wherever an auxiliary fuel tank is installed that will be controlled by electric liquid level controllers for on-off automatic pump operation. Pressure gauges and a pressure relief valve (integral or external) are to be installed on all fuel transfer pumps. | *These pumps transfer fuel from exterior primary tank to interior auxiliary tanks.*<br>*One pump is operational and the second is a standby pump that can be put into operation quickly and easily. Pressure gauges indicate pump performance.* |
| Standby fuel pumps are to be installed and sized to handle 100% of full system load. Do not use automatic start/alternators; use hand selector switches only. | *In the event of primary pump failure, a maintainer should be called to the facility. The standby pump is permanently installed to ensure it is there when needed, and the system can be quickly and easily switched over.* |
| **6.4.3 Piping** | |
| .1 Materials | |
| All exterior fuel oil piping is to be schedule 40 steel screwed pipe, minimum 50 mm in dia., valved at the tank and immediately inside the building, and properly supported. Buried lines should be welded when used - however their use is to be avoided whenever possible. | *The use of a ULC-approved, double-walled, environmental pipe is required for any buried pipe*. |
| .2 Weather Protection | |
| All exterior oil piping (buried or exposed) should be protected with weather-resistant tape. | *This is intended to protect the pipe from rusting.* |

.3 Two-Pipe Systems

Where an auxiliary tank is installed, a two-pipe system (supply and return) is preferred for all oil-burning equipment.

*This eliminates problems with air lock. The return of fuel to the interior tank maintains it at room temperature.*

.4 Gravity Feed

If fuel is gravity-fed to the burners directly from an exterior tank, do not use a two-pipe system.

*This would cause preheated fuel to be returned to the exterior tank and condensation would occur in the tank.*

.5 Drip Leg

A valved 50x50 mm nipple and cap are to be installed on all fuel tank piping, as follows: tank, valve, 90º elbow, tee (branch to building), valve, 50x50 mm nipple, and cap.

*This will serve as a dirt pocket. It also allows condensation to be drained from the tank to prevent water and ice build-up in the tank and piping.*

On a 1135 litre tank the drip leg at the bottom take off on a tank may require a double bushing to prevent freezing.

### 6.4.4 Flex Connectors

Exterior fuel piping (supply and return) should have braided steel flex connectors installed just before the pipe enters the building.

*The flex prevents piping stress caused by differential settlement of the tank and building.*

Flexible connectors should be long enough to allow for the expected differential movement. A length of at least 600 mm is preferred.

*Pipe movements of up to 100 mm are not uncommon.*

An acceptable alternate to the flexible connector is a swing joint allowing deflection in all planes.

The burner is to be connected to the fuel piping with flexible connectors, using either Type K copper or braided steel flexible connectors.

*The burner is disconnected and reconnected during routine maintenance. The flexible connector allows this to be done more easily. Braided steel connectors are preferred as the copper connectors will kink over time.*

UL Listed, braided steel flexible connectors are required on the supply and return lines to the emergency generator.

### 6.4.5 Isolating Valves

Isolation valves must be provided on the supply line immediately adjacent to tank connection at exterior and immediately upon supply line entry into the building.

Each piece of fuel-burning equipment must also have isolating valves.

*These valves allow equipment to be disconnected for maintenance or replacement.*

On a two-pipe system, the return line must not have an isolation valve.

*This is not allowed by code.*

Fusible valves are to be used for all supply lines to all oil-burning equipment, including generating plants.

*The CSA B139 code specifies that heating equipment requires fusible valves. However generating plants also require fusible valves to stop flow of fuel in case of fire.*

As per the Fire Marshal Technical Bulletin #FM-023-93:
The location of the fusible link valve shall be:

- On the supply side of fuel filter, where the fuel oil filter is located 1 m or less from the burner.
- Within 1 m of the burner on the appliance side of the burner, where the fuel oil filter is located more than 1 meter from the burner.

### 6.4.6 Pressure Gauges

Provide dial-type pressure gauges with a 90 mm dia. dial (scaled to the application) located at the discharge of each pump.

*Pressure gauges installed at appropriate locations assist the building operators to monitor system performance.*

*The small addition cost for gauges is offset by increased operational efficiency.*

Provide an isolation valve for each gauge, a snubber for pulsating operation, and a diaphragm for corrosive service applications.

### 6.4.7 Filters

An adequate oil filter is to be provided at each oil burner.

*Filters ensure clean fuel to all burners.*

Pentak Model STI oil filters are preferred by the GNWT.

### 6.5 PROPANE DELIVERY & STORAGE

All propane installations are to be installed in accordance with the requirements of the authority having jurisdiction and the Propane Installation Code CAN/CSA - B149-M95.

### 6.6 OPERATION AND MAINTENANCE

| Recommendation | *Rationale* |
|---|---|
| **6.6.1 Spare Parts** | |
| The following spare parts are to be provided:<br>• One oil filter cartridge. | |
| **6.6.2 Regional Equipment Preferences** | |
| Provide equipment brands preferred by and familiar to local maintainers. | *Local maintainers should be consulted for their preferences.* |

## M7 HEATING

Where fuels costs are high and the heating season is long and severe, it is important to minimize energy consumption of buildings. Within the Northwest Territories itself the climate varies; heating degree days vary from 7,786 in Ft. Smith to 11,086 in Holman, as compared to an average of 3,000 in Vancouver or 5,782 in Edmonton.

All buildings, except seasonal use buildings or cold-storage facilities require some type of heating. Buildings can have their own heating system or be heated by a central plant located in or near the facilities. In some locations it may be possible and practical to use recovered heat from local power plants to heat individual or groups of buildings.

Fuel sources other than fossil fuel should be used if it is practical to do so. The reduction of greenhouse gas emissions should be a design priority.

Biomass (wood-pellet) boilers have been successfully used in the NWT. These systems may be owned and operated by the building owner, or provided and maintained by an Energy Service Provider who sells energy back to the client at a certain cost.

| Recommendation | *Rationale* |
|---|---|
| The design temperature for indoor occupied spaces during winter is 21ºC; during summer, 24ºC. | *Heating and cooling systems should be properly-sized for the actual requirements of the building*. |
| For buildings with radiant heating these space design temperatures may be reduced by several degrees. | *This reduces energy consumption.*<br>*Radiant heating heats up objects and people. The apparent temperature in a radiantly-heated space is higher than the actual measured air temperature.* |
| Whenever possible and economical, use temperature setback within buildings during unoccupied periods. | |

| | |
|---|---|
| The outdoor air design temperature shall be according to the 2.5% January or July design temperature indicated in the National Building Code. Use similar data available from Environment Canada for specific communities not listed in the supplement. | *These are acceptable building design criteria in the NWT.* |

## 7.1 FORCED HOT AIR SYSTEMS

Forced hot air heating systems are as common in the NWT as elsewhere in the country. However, as few buildings in the NWT have basements, counter-flow furnaces are generally required, with ducts running in a raised floor. Forced hot air systems are not suitable for all types and sizes of facilities, but their relatively simple servicing requirements make them a preferred choice in small facilities or remote locations. Suspended furnaces, which are higher than 3 m off the floor surface are not to be used unless a permanent service platform is provided.

### 7.1.1 Furnace Type

| Recommendation | *Rationale* |
|---|---|
| Two-speed fans are required where ventilation is provided by the furnace. | *At either high or low fan speed, good air circulation is provided, preventing air stratification.* |
| Provide stainless steel heat exchangers on forced hot air heating systems where more than 10% outdoor air for ventilation is required, and/or where the entering air temperature is below 13ºC. | *Standard (non-stainless) heat exchangers corrode and fail prematurely when exposed to low inlet air temperatures.* |
| Refer to Mechanical M7.2.2 for chimney and vent requirements. | |
| Non-combustible block bases with 6 mm steel plates are to be used under all oil-fired heating equipment installed on combustible floors. | *Even equipment which is approved for use on a combustible base can burn into the floor.* |
| Oil-fired furnaces suspended at high level are NOT acceptable for any facility. | *Maintenance access is difficult, and oil dripping from overhead fuel lines is unsafe.* |

### 7.1.2 Combustion Air

| | |
|---|---|
| All fuel-burning appliances require a properly-sized combustion air supply. | *This is a code requirement*. |
| Combustion air ducts shall be configured so that cold air does not pool at the floor, where it may freeze equipment or pipes. | |

### 7.1.3 Heading Capacity

Forced air heating is suitable only for buildings where multiple heating zones are not required.

*Forced air heating is typically used for small buildings such as small offices, sewage lift stations, water intake pump-houses, residences, or the office portion ONLY of fire-halls, garages, and small air terminal buildings.*

### 7.1.4 Distribution

Ducts located in a raised floor are preferred over those located in ceiling spaces.

*This gives better heat distribution and avoids the need to penetrate the building envelope with ductwork.*

All ducts in raised floors are required to be insulated.

Where exposed ducts are acceptable, they may be located overhead**.**

*Overhead ducts do not provide as good air distribution as underfloor, but may be acceptable in some situations where comfort levels are not critical.*

## 7.2 HYDRONIC HEATING SYSTEMS

Hydronic heating is the most commonly-used heating system in larger buildings because of its ability to heat large areas with multiple heating zones. It provides better control and comfort than forced air systems. See Figures 7.1, 7.2 and 7.3.

The total boiler plant size is one factor in determining what operators are needed. In small communities, sufficiently-qualified staff may not be available for the proposed plant size.

When selecting the type of hydronic heating system for a building, consider the building size, complexity and special requirements. For example, perimeter hot water radiators are the most commonly-used form of heating in many buildings, as they are easy to maintain and allow individual controls. For large open spaces where quick temperature swings are not required, radiant floor heating systems may be the best solution. High-traffic entrance vestibules require quick-response intense heating and so cabinet unit heaters are often used in those areas.

When using biomass boilers as a primary heating source, the best method is to use the biomass boilers to cover the load most of the time. (Back-up boilers on conventional fuel are also required.) The biomass boilers should be sized at 50% of the maximum building load, so they operate about 80% of the time. The back-up boilers (on conventional fuel) will cut in and act as peaking boilers.

If heat recovery from power plants is used refer to Figure 7.4.

| Recommendation | Rationale |
|---|---|
| **7.2.1 Boilers** | |
| Two oil-fired, cast iron, wet base boilers, suitable for use with propylene glycol heating solution, are preferred. Each boiler is to be sized to handle 50% of the design load. | *Sizing the two-boiler heating plant to no more than 100% of the building design heating load ensures that the heating plant capacity will not exceed the actual building heating load. The heating plant will operate more efficiently when not oversized.* |
| Exception is in Parking Garages or Storage Facilities which are not temperature-critical, where a single boiler may be use to simplify operation and minimize capital costs. | *With two boilers each sized at 50% capacity, one boiler can provide freeze protection if the second boiler fails. One boiler can heat the building with the air system(s) shut down to reduce heating load.* |
| Multiple pass, forced draft, fire-tube boilers are preferred in larger buildings where the boiler required exceeds 250 kW. | *This is typically only required in large schools or colleges.* |
| Exceptions are in Hay River, where all boilers should be provided with oil/propane dual fuel burners. In Norman Wells, boilers should have natural gas burners, and in Inuvik, boilers should have oil/natural gas dual-fuel burners. | *Hay River has both oil and propane supplies. Some areas of Norman Wells have abundant natural gas, although this may change as gas becomes less available there. Inuvik has a piped-in natural gas supply, but buildings in Inuvik require fuel oil backup in case the gas pipeline fails.* |
| Plants exceeding 750 kW input should be avoided whenever possible. | *Plants over 750 kW input require qualified operators, who may not be available outside larger centres.* |
| Condensing boilers are more efficient than high-efficiency boilers but the designer must ensure that the condensing boilers will operate satisfactorily in the local climate. | *Refer to the Boiler and Pressure Vessel Regulations of the Northwest Territories regarding plant classifications and the required plant engineers.* |
| Only retention-head type burners are to be used. | *They are the most efficient burners available.* |
| Single-stage firing (not high - low) or a modulating firing arrangement is required on boilers. | *During extreme cold conditions, single-stage firing reduces the danger of damaging boiler venting when products of combustion condense on it.* |
| Supplier must provide documentation from the boiler manufacture that the burner provided is compatible with the boiler. | |

Hour meters must be installed on each boiler.

*Hour meters indicate runtime. This is useful information for operators.*

A boiler installation permit is required for any burner retrofit to which the Boiler & Pressure Vessels Act & Regulations applies (for boilers greater than 30 kW or 102,390 Btuh).

*As required by Boiler Safety Section Policy Directive.*

Burner retrofits up to and including 400 MBh shall be done by a certified oil or gas burner mechanic. Retrofits exceeding 400 MBh shall be carried out by either the burner manufacturer, the boiler manufacturer, or, if acceptable to the burner and boiler manufacturer, a certified oil or gas burner fitter of the appropriate class.

### 7.2.2 Chimneys and Vent Connectors

A separate chimney for each oil-burning appliance is preferred.

*Although this may increase the number of penetrations through the building envelope, shared chimneys are always oversized, which can lead to condensation and inadequate draft.*

Note: Although the terms “stacks” for “chimneys” and “breechings” for “vent connectors” are commonly used, CSA Standard B139 no longer includes these terms in its definitions.

Forced draft appliances require pressure-rated chimneys.

Provide a base-tee for cleaning access for all chimneys.

All connections and bends are to be “swept” type.

Chimney lengths should be minimized and kept within the heated building envelope as much as possible, with the exposed exterior length also kept to a minimum.

*Cold chimneys cause condensation of moisture in combustion gases. The condensate freezes and builds up over the winter. It can eventually block the chimney. This condensate is also very corrosive and will lead to the premature failure of the chimney. Back pressure due to blockage or leakage through perforations can result in dangerously toxic conditions.*

Where vent connectors are necessary, they are to be installed to permit easy removal for cleaning.

*This encourages regular cleaning and inspection of vent connectors and chimneys.*

Vent connectors must be insulated.

*Insulation is required to prevent accidental burns to maintenance staff. The insulation must be easily replaceable, or there is a risk that it will be improperly replaced.*

Each oil-burning appliance is to be provided with its own barometric draft regulator.

*The pressure in the chimney varies considerably because of wind conditions, stack effect from temperature difference, and, in the case of multiple fuel-burning appliances, according to the number of appliances operating at one time. Barometric dampers eliminate one major variable, and stabilize draft conditions for each fuel-burning appliance.*

Cleanouts are required on all changes of direction of the vent piping for fuel-burning appliances.

*All portions of venting are to be easily accessible for cleaning.*

### 7.2.3 Combustion Air

Where possible, bring the air in at a low point in the mechanical room and duct to an outlet at a high level close to the ceiling. Alternatively, provide an air trap near the boiler.

*This installation controls the amount of cold air drawn in for oil-burning equipment, and avoids cold air from flooding in at floor level, which can freeze water lines.*

If combustion air cannot be ducted within the mechanical room to a high level outlet, then the air must be preheated using a unit heater. Quantities of preheated air are required (i.e., after expansion) to be calculated as per CSA B139, considering that special engineering practice is necessary in the extremely cold climate of the NWT. Calculations are to be based on maximum heating loads, not including standby generators.

*Combustion air intakes are commonly oversized, causing more cold air than is necessary to enter mechanical rooms. This can result in the freezing of water lines and pumps located in the mechanical room. It is important to recognize the extremely cold temperature of outdoor air and problems associated with bringing it directly into a building. A 33% reduction in air quantity should be allowed to allow for the expansion of cold air to room temperature.*

### 7.2.4 Heating Fluids

.1 Glycol

A factory pre-mixed glycol and water mix is the preferred fluid for use in hydronic heating systems.

*Systems using 100% water are liable to freeze, resulting in high maintenance costs and disruption to users. Glycol can be tested regularly and inhibitors (di-potassium phosphate) added as required. Glycol does have corrosive effects, but so far these effects have been considered less dangerous than the possibility of building freeze-up.*

The heating fluid used in all hydronic heating systems is to be Dowfrost HD propylene glycol factory premixed 50/50 water and propylene glycol. Under certain circumstances premixed Dowfrost 60/40 may be used.

*Dowfrost HD is currently the only product acceptable to the GNWT. Use of premixed Dowfrost HD makes operator training and product storage easier, and requires the use of fewer types of test kits. A premixed glycol solution eliminates problems caused by the on-site mixing of glycol and local water. Water in a community that has more than 50 ppm of hardness ions, Ca++ or Mg++, or more than 25 ppm of chloride and sulphate is considered unsuitable for use in heating fluid. Water quality varies unpredictably between seasons and communities. A premixed glycol solution has good thermal and corrosion-inhibiting characteristics.*

.2 Glycol Fill

Glycol can be charged to the system using either a motor-driven pump or an automatic pressure-controlled makeup system. The building maintainers may have a preference for automatic or manual fill.

*Since most hydronic heating systems do not have continuous supervision, it is preferable to have system pressure maintained for as long as possible in cases of leaks. Piping of the glycol relief back to the glycol tank or to a container prevents glycol waste if the pressure relief valve is activated.*

The pressure relief valve on the boilers is to be piped back to a polyethylene glycol fill tank or container, not to a drain. A manual diaphragm-type pump is acceptable on hydronic heating systems under 117 kW in size. Manual vane pumps should not be used.

*Manual diaphragm pumps work well. Manual vane-type pumps have not been satisfactory.*

Axiom Industries packaged glycol fill systems do not provide high capacity to fill a large system due to the low flow rate from the pump. These systems should not be used on large heating systems.

*Direct quote from Axiom literature:*
*"NOTE: Do not use the SF100 to fill large systems. The pump does not have a high flow rate; using it to fill large systems will cause unnecessary wear on the pump and may void the warranty".*

### 7.2.5 Circulation

.1 Piping

Primary/secondary, reverse/return piping loops, which allow constant flow on both loops under varying load demands, are preferred for systems over 117 kW in size.
A single reverse/return loop is acceptable for systems up to 117 kW.

*The continuous flow of heating fluid through the boiler and the controlled flow of heating fluid through the heating loops prevents boilers being subjected to temperature shocks.*

*The use of variable flow pumps for the secondary pumping system reduces energy consumption in buildings. This type of control is only recommended on larger systems where Direct Digital Control (DDC) is available.*

Unions, isolating valves and drains are to be provided at all heating equipment connections.

*They facilitate the isolation of heating coils, heat exchangers, pumps, and heating zones for periodic maintenance and/or repair.*

Isolation and by-pass valves are to be installed so that the flow through each heating coil in an air handling system can be adjusted, even if the secondary coil circulating pump and/or the three way control valve is out of service.

*It must be possible to operate the system manually when the three-way control valve is removed for maintenance or repair. The forced shutdown of systems could result in loss of ventilation and heating in certain applications.*

Hydronic system piping arrangements are to be designed to maintain full and balanced flow through each boiler when it is operating. Provide balancing valves in each boiler circuit to facilitate balancing of the system.

*This prevents damage to boilers by overheating of boiler sections or tubes.*

The T-drill pipe fitting system is not acceptable.

*There has been a history of failures of T-drill joints.*

Avoid using Victaulic fittings on glycol heating piping, even if suitable gaskets are used.

All systems, once completed, are to be flushed and degreased as follows:

On completion of hydrostatic testing, drain the entire system, fill with a 3% solution of non-foaming phosphate-free detergent and circulate for 8 hours. Drain and flush system with clean water for 4 hours, drain, check all strainers, refill and circulate for an additional 2 hours. Check strainers and repeat flushing until flush is clear and there is no debris. Then fill the entire system with new, pre-mixed, inhibited propylene glycol. Record the total volume of glycol.

.2 Equipment

| | |
|---|---|
| Pumps and other heating equipment must be selected allowing for the different properties of glycol and water. For example, expansion tanks must have an EDPM bladder compatible with propylene glycol, and the tank must be sized to accommodate the increased expansion of glycol over water. | *Since use of the 50/50 or 60/40 glycol/water heating fluid is not common in other parts of the country, designers may not be used to designing glycol systems.*<br>*Glycol expands more than water does.* |
| Standby pumps are to be installed with each pump sized to handle 100% of a full system load. Do not use automatic start alternators. Use manual selector switches only. | *In case of primary pump failure, a maintainer must come to site and will see that the primary pump has failed. The standby pump is permanently installed to ensure it is there when needed, and the system can be quickly and easily switched over.* |
| Do not use dual pump combination units. | *In a dual pump unit, neither pump can be isolated for repair, which negates the value of the dual configuration.* |
| Circulation pumps are to be sized to circulate water through all boilers in multiple boiler installations. | *This assures there will be a continuous flow through all boilers under all operating conditions.* |
| Circulating pumps are to have mechanical seals. Do not use packings. | *Mechanical seals are more reliable.* |
| One set of strainers is required for each building heating system. | *Strainers catch suspended particles in the system as they circulate. Strainers are not required at every pumped loop.* |
| Side stream filters with sight glass are required on hydronic heating systems over 117 kW in size (400,000 Btu). However, side stream filters are beneficial for all heating systems. Each side stream filter is to be provided with one case of replacement 10-micron filters. | *Side stream filters provide an economical, effective means of keeping the heating fluid clean. Sight glasses provide a means of determining cleanliness of the heating fluid.*<br>*Smaller heating systems are less likely to require continual cleaning, and it is not cost effective to provide side stream filters.* |

.3 Insulation

Insulation is required on all circulation piping located in mechanical rooms. Refer to the (Model) National Energy Code for Buildings for minimum thermal insulation for heating and cooling piping. Insulation may be omitted from valves, unions and strainers where piping is 63 mm and smaller. Removable prefabricated insulation is to be used at all valves and unions on all piping over 63 mm.

*Heat from uninsulated piping can cause overheating of the mechanical room, wasting energy and creating uncomfortable working conditions for maintenance personnel.*

*Periodic access to valves and unions requires the removal and replacement of insulation at these locations, in such a way that it does not damage adjacent pipe insulation.*

### 7.2.6 Distribution

.1 Wall Fin Radiation

Wall fin radiation is preferred for most applications.

*It is simplest, most commonly-used, and most familiar to system maintainers.*

Wall fin covers or enclosures are to be sloping top model, minimum 14 gauge steel.

*Sloped tops prevent people from placing things on them and obstructing heat flow. The heavier gauge steel will be less easily damaged than standard gauge covers.*

When permanent cabinets or built-in furniture must be located against the same wall as radiation units, appropriate inlet and riser vents are to be installed.

*Cabinets obstruct air flow, and vents will alleviate this problem.*

A shut-off valve is required for each zoned section of radiation.

*This allows the zones to be isolated for repairs.*

A balancing valve, either a globe valve or a lockshield valve, must be provided on the return line for each zone of radiation.

*This permits proper balancing of the heating system.*

Isolation valves and unions are to be provided on both sides of zone valves, and a drain valve is to be provided on the discharge side of the zone valve. A piggy-back drain valve will not work in this situation unless there is adequate clearance to install it in its intended configuration for ease of access and drainage.

*This reduces the chance of system air lock.*

In low traffic vestibules and entrances/exits, wall fin radiation is preferred over a force flow unit. The wall fin radiation should be controlled by a zone valve and a wall thermostat c/w tamper proof metal guard.

*This reduces installation costs and overheating.*

.2 Force Flow Units

Force flow units are required for typical high traffic vestibules and entrances. Floor and wall mounted models should be recessed where structural conditions allow, but ensure that insulation values are not reduced where the recessed heaters are located.

*Force flow heating units provide quick heat recovery in high traffic areas such as entrances.*

Force flow heaters should not be installed higher than 3 metres above the floor, unless a work platform and man lift are provided.

*Keep it simple. Zone valves add to the complexity of the unit operation*.

Heating is controlled by cycling the fan. Zone valve control is not to be used.

.3 Radiant Floor System

Where it is important that a warm floor be provided and in-floor heating is approved, a radiant floor system may be used.

*The functional program should clearly outline this requirement, which will generally be considered where people will be sitting on the floor (e.g., kindergartens or play rooms).*

The radiant floor piping must have an oxygen barrier.

*The oxygen barrier prevents oxygen from entering the heating system and causing premature system failure due to corrosion.*

Provide closer-spaced loops where heat losses are greater (at outside walls and windows).

Consider using a radiant floor heating system as a “base” system to cover a portion of the building load, and using another, quicker-acting system to supplement the heat and make the combined system more responsive to changing requirements.

Manifold panels should be located at work height and be easily accessible. Panel doors shall be lockable and have two latching points.

.4 Radiant Ceiling Panels

Radiant ceiling panel heating systems may be used in specific building locations and building types.

*Radiant ceiling panel systems allow the walls to be free of radiation cabinets and/or convectors, thus increasing the viable floor area and improving floor cleaning and maintenance.*

.5 Radiant Wall Panels

These may be used in particular instances but it is important to ensure that furniture or other objects will not block the path of the radiant heat.

.6 Fuel-fired Radiant Heating

This type of heating may be used in buildings such as arenas or garages. However it is not particularly efficient so it is not recommended if there is a better alternative.

.7 Air Curtains

In facilities which include large overhead door openings, such as Firehalls and Garages, it is recommended to provide air curtains across the openings (e.g., Enershield type).

*Air curtains block outdoor air from entering into the facility and cooling down the work area. Reheating the space takes a considerable time and is uncomfortable for occupants.*

### 7.2.7 Provisions for Monitoring Performance

.1 Low Heating Fluid Cut-offs

Devices installed to allow testing of low water fuel cut-offs must allow testing without draining the boiler.

*This minimizes the loss of the heating medium. See also the March 25, 1992 Technical Bulletin issued by Electrical / Mechanical Safety Section, "Installation of Low Water Fuel Cut-Offs".*

.2 Boiler High Limit Controls

The high limit controls on boilers are to be the automatic reset type.

*In cases where there is not a daily inspection carried out on the boilers, it is undesirable to have the boilers remain down until the high limit is reset manually. If the resets are not reset promptly, considerable damage could result to the building from frozen piping and fixtures.*

Each automatically fired boiler is to be provided with a high limit control to prevent overheating, with maximum setting of 121ºC.

*The requirement for an extra high limit control is as per NWT Boiler Safety Section Policy Directive.*

The sensing element shall be installed either directly in the boiler or in a part adjacent to the boiler where there are no valves or obstructions between the medium in the part and the medium in the boiler.

The limit control shall be connected so as not to permit start-up unless all conditions are safe or, if disconnected, start-up cannot occur.

This shall be deemed the “extra high limit control”.

Each boiler shall be provided with an operating control to operate temperature control, which shall have an independent sensing element also. This will be deemed the “high limit control”.

.3 Thermometers

Provide thermometers scaled to the intended application in the following locations:

*Thermometers installed in appropriate locations assist the building operators in system operation and performance evaluation.*

- heating fluid supply and return to each heat generating device
- chilled water supply and return to each cooling coil
- return piping from each heating zone
- supply and return piping to each main heating coil (not required on reheat coils)
- converging side of three-way control valves

In piping systems, brass or stainless steel bulb wells complete with thermal grease are required. Thermometers to be located in a visible and readable location.

.4 Gauges

Provide dial-type pressure gauges (complete with snubbers) located to measure pump suction and discharge pressure at each pump.

### 7.2.8 Alarms

See Electrical E9.3 “Mechanical System Alarms” and Section M9.5 “Mechanical Alarms”.

### 7.2.9 Maintenance

.1 Air Vents

Manual tee handle type air vents should be installed at all high points of hydronic heat piping throughout the building and provided with clearly identified access covers.

*This facilitates the maintenance of system and releasing of air locks.*

Auto air vents are to be used in mechanical rooms only. All air vents must have isolation valves.

*Propylene glycol quickly deteriorates the seats of auto vents. Auto vents should be used only in the mechanical room where leaks will not damage carpeting.*

.2 Air/Dirt Separator.

All hydronic heating systems are to be provided with an air and dirt separator.

Spirotherm air and debris eliminator is the preferred product.

.3 Hose Bibbs Near Boilers

A 19 mm combination cold and hot water hose connection is required close to boilers. Hose bibbs must be equipped with hose vacuum breakers.

*This is needed for flushing of boilers. Vacuum breakers are required to prevent backflow and to eliminate the potential of contamination of the potable water supply.*

| | |
|---|---|
| .4 Access to Valves<br>Access doors to all control valves and isolation valves are required. | *For ease of maintenance.* |
| .5 Radiation Fins<br>Radiation cabinets should be secure, but easily removable by maintainers, and should be slope-topped to prevent item storage on top of cabinetry. | *For ease of maintenance.* |

## 7.3 UNIT HEATERS

| Recommendation | *Rationale* |
|---|---|
| **7.3.1 Unit Heaters** | |
| Hydronic unit heaters are to be used only for spaces that are normally unoccupied, such as mechanical rooms, large storage areas, etc., and in Garages and Firehalls, where noise levels are not a consideration. Unit heaters are to be hung with appropriate vibration isolation. Balancing, isolation, drain valves, air vents and unions are required on unit heaters. Unit heaters are to be equipped with fan guards. | *Unit heaters are an inexpensive yet effective means of providing a controlled heat source in unoccupied spaces. They are generally considered too noisy for other applications.* |
| Heating is to be controlled both by cycling the fan and closing of a control valve. | *The control valve is necessary to prevent overheating.* |
| In Garages and Firehalls, unit heaters are, where possible, to be wall-mounted at an elevation which allows for easy maintenance access.<br>Unit heaters are not to be mounted higher than 3 metres off the floor unless a work platform or man lift is provided. | *In the past, unit heaters in these types of facilities were ceiling mounted at extra high level to provide clearance for vehicles housed below. This high-level mounting resulted in access and safety problems. Legislation now calls for scaffolding, man lifts and other safety features to be used if equipment is mounted above a specific height.* |

## 7.4 HEAT RECOVERY FROM POWER PLANTS

### 7.4.1 Heat Recovery Recommendations

Heating systems unitizing heat from NTPC must be designed and built as “Primary/Secondary” systems. This system means the boiler provides heat to the building through a heat exchanger not directly through the piping. NWTPC also provides heat through a heat exchanger on the return side of the building system. With the NWTPC system a thermostatically-controlled bypass valve must be installed so if the temperature from NWTPC is lower than the return temperature, the system bypasses the heat exchanger. See Figure 7-4, Residual Heating System.

*This arrangement prevents heat from flowing back from the building to the power plant.*

## 7.5 SCHEMATICS

The following schematics provide various typical and preferred boiler and heating loop configurations used in the North.

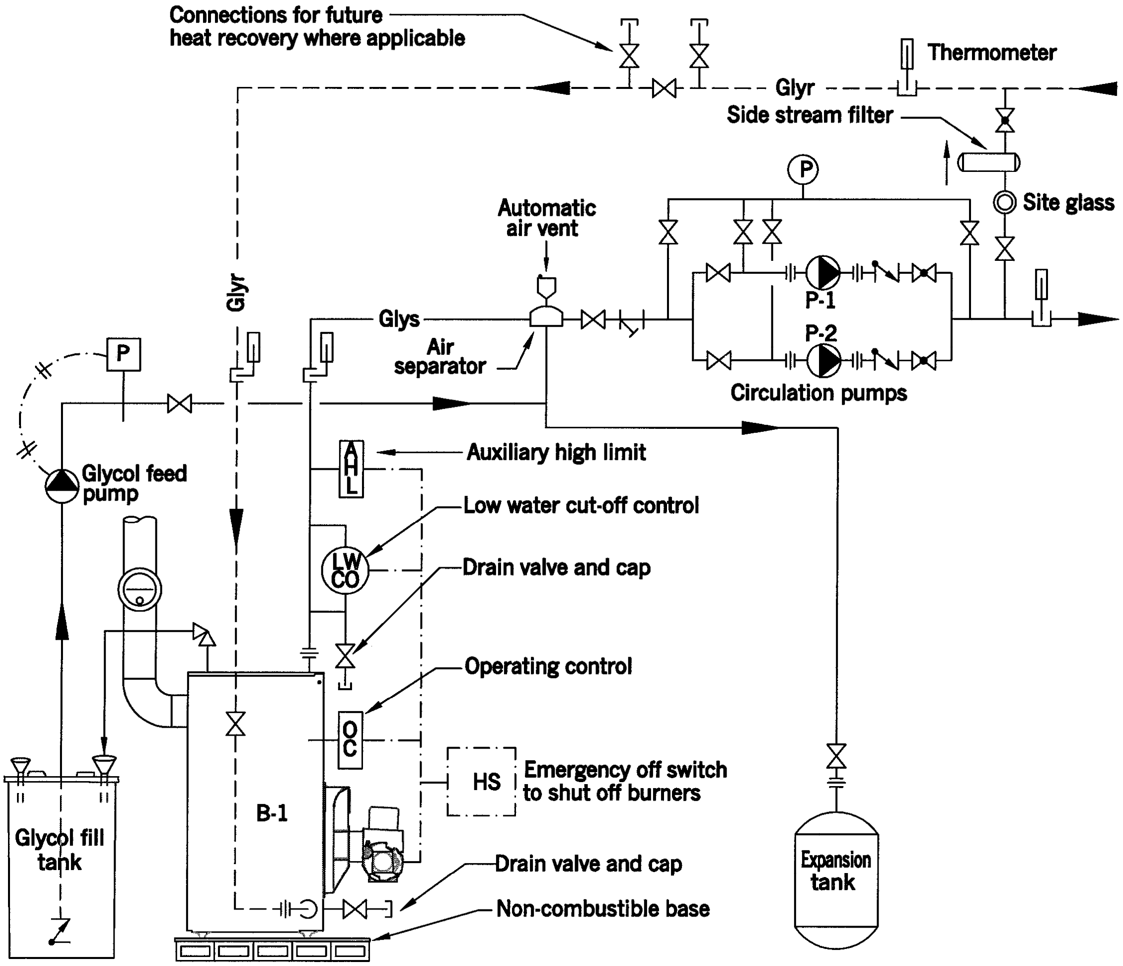


Figure 7-1: Single Boiler Double Pump

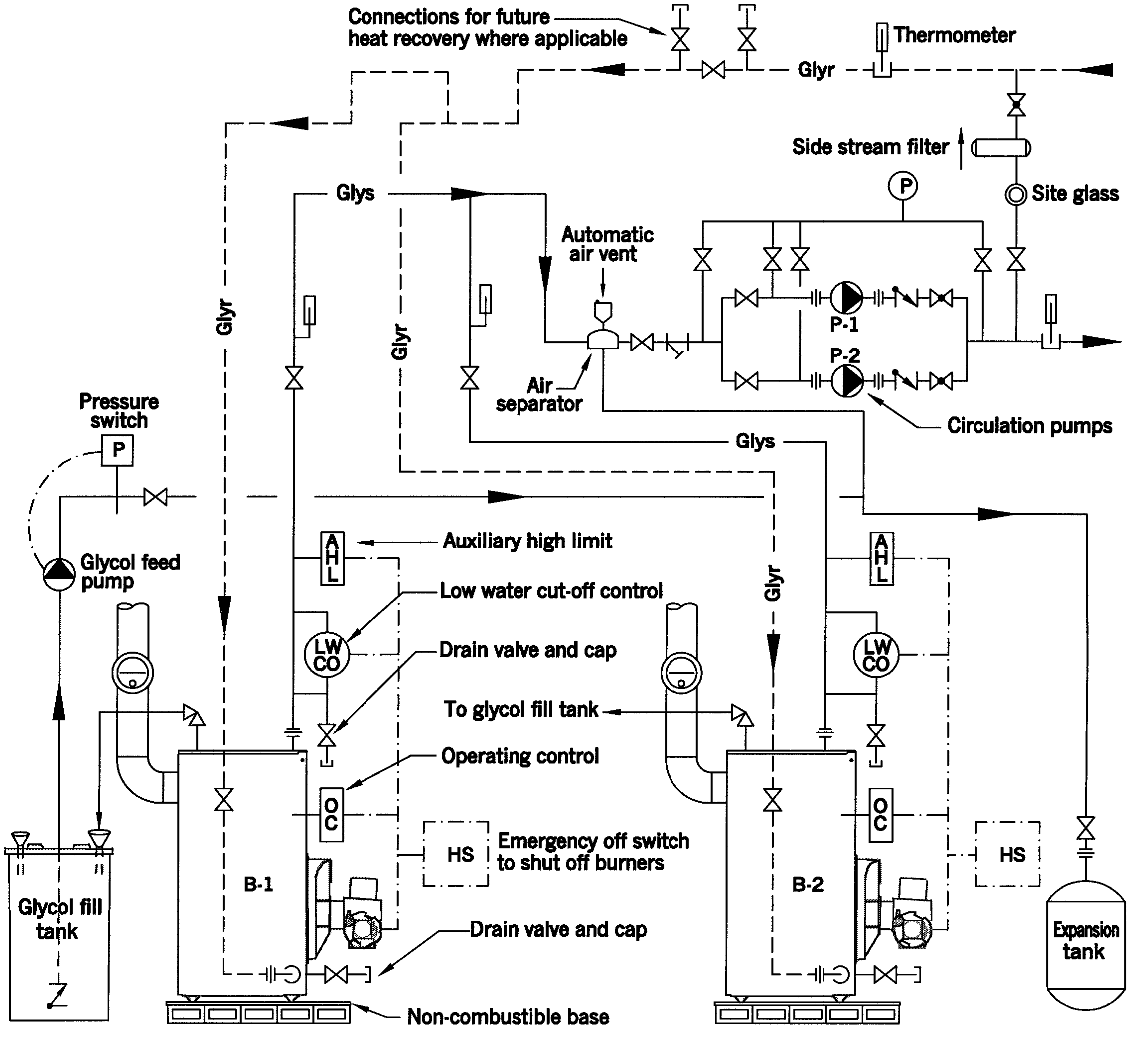


Figure 7-2: Double Boiler Double Pump

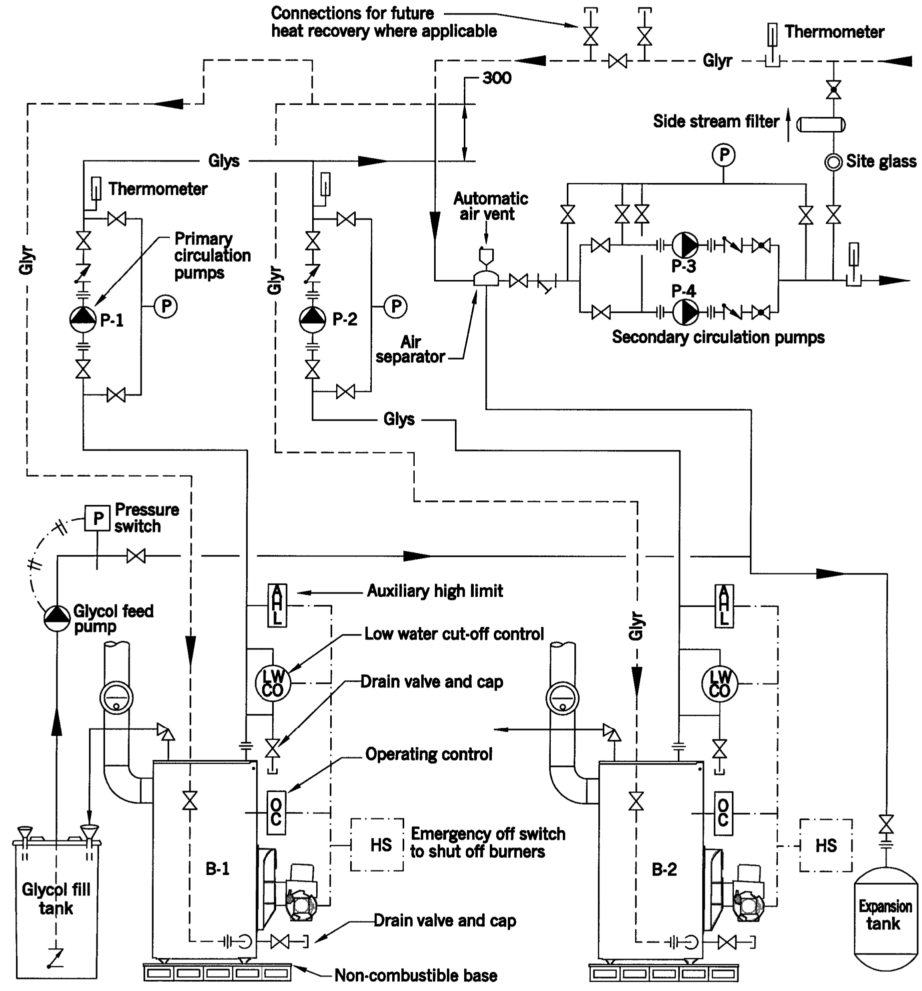


Figure 7-3: Primary-Secondary Boiler System

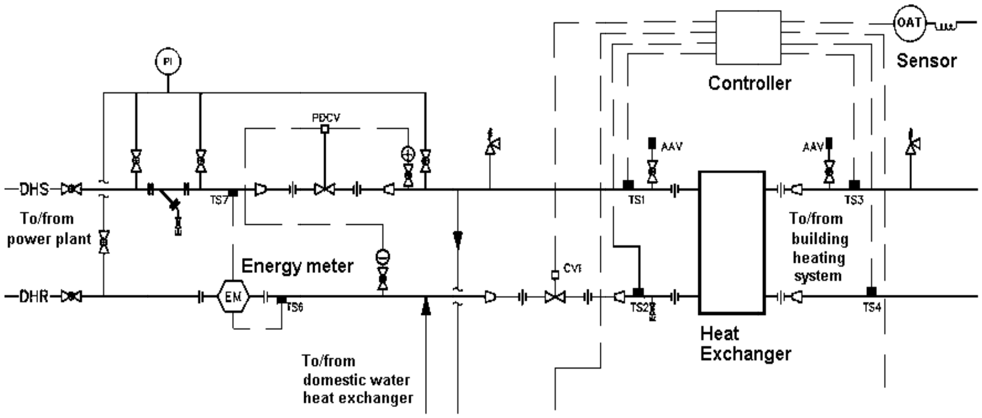


Figure 7- 4: Residual Heating System

## 7.6 OPERATION AND MAINTENANCE

Recommendation *Rationale*

### 7.6.1 Spare Parts

The following spare parts are to be provided:

- One set of belts for each piece of machinery.
- One spare pump for each type and size of pump in the system.
- One additional sealed drum of Dowfrost HD.
- 12 sidestream cartridge filters (if applicable).
- One motor and fuel pump for each type of oil burner installed.
- A six month supply of chemicals for steam boilers.

### 7.6.2 Regional Equipment Preferences

Regional preferences should be considered when selecting equipment.

### 7.6.3 Code Requirements

Hydrostatically test entire system at 150% normal operating pressure for 12 hours with no measurable leaks.

Drain system, fill with non-foaming phosphate free detergent and circulate for 8 hours, drain and flush for 4 hours, drain and clean all strainers, refill and circulate for a further 2 hours, and repeat until strainers have no debris, then fill entire system with Dowfrost HD.

Perform hydronic balancing on entire system where required.

Perform combustion analysis tests on heating appliance(s).

## M8 AIR DISTRIBUTION

Air quality of a reasonable standard is a basic human need, not a luxury. As buildings have become increasingly air-tight in the interest of reducing energy consumption, the supply and control of ventilation has grown to be increasingly important. When ventilation is inadequate, users are not only uncomfortable, but may experience health problems. The extreme cold experienced during much of the year in the NWT can make it more difficult and costly to achieve adequate ventilation than in other areas of North America. Toxic and noxious chemicals released by building materials and finishes, dust, moulds and microbiological organisms, as well as air used by occupants, must be removed by the ventilation system.

The pressure regime in a building must be considered during design and construction. A slight positive pressure inside the building during winter is important to prevent infiltration.

### 8.1 NATURAL VENTILATION

Building users commonly believe that opening windows provides the most satisfactory form of ventilation in a building, even though this is not really a very effective way of introducing adequate fresh air or ensuring even distribution during winter months. Blasts of cold air, often accompanied by snow particles, coming in through a window are not comfortable. This is not to say that natural ventilation is undesirable; however, opening windows is probably not the best means of providing it, if users expect consistently comfortable conditions. A properly-designed system relying on natural air flows can provide adequate ventilation without adding to the mechanical and electrical complexity of a building.

For occupied buildings that require ventilation, the harsh climate of the Arctic makes mechanical ventilation the only practical alternative during the heating season. Systems that require the opening of windows or portholes as an integral part of the mechanical ventilation system design have proven to be unsatisfactory in winter conditions. This does not preclude use of natural ventilation as an overall part of the ventilation strategy for a building, during shoulder or summer seasons. Natural ventilation aids in reducing the cost of electrical power and fuel.

| Recommendation | *Rationale* |
|---|---|
| **8.1.1 Supply** | |
| Whatever the means of supply air, it must prevent entry of snow and dust.<br>Any filters or screens required to do so must be easily accessible and easy to clean. | *Ventilation hoods are often used in place of operable window sections. They are typically used for residential occupancies, or small offices and schools where users are capable and willing to control ventilation. Operable windows are preferred for summer use buildings only.* |
| **8.1.2 Exhaust** | |
| Exhaust must be located to create an even flow of fresh air through rooms, without creating uncomfortable or disruptive drafts. | *A common shortcoming of natural ventilation is that air is not mixed, or air currents are so great that paper flies off tables and desks! Users must be able and willing to control exhaust.* |

## 8.2 MECHANICAL VENTILATION

Many buildings are too large or configured in such a way so that natural ventilation systems are not capable of providing good ventilation all year. Mechanical systems are needed to ensure that adequate ventilation is provided in most buildings to attain a certain indoor air quality and comfort level. The climate, even in the milder areas of the NWT, also makes mechanical ventilation preferable for much of the year. The quantity and temperature of outdoor air brought into a building must be adjusted frequently to suit changing outdoor conditions and indoor requirements. Automatic controls can perform this function for the building users, while maintaining simplicity in operation and maintenance.

In the interest of economy, designers are encouraged to consider more energy-efficient ventilation strategies while continuing to meet the requirements of ASHRAE 62 (Current Edition) and maintaining optimum occupant comfort levels of indoor air quality.

The heat required for ventilation air is often the largest contributor to a building heating load. Heat recovery between exhaust and ventilation air is viable in most systems and should always be considered.

Where mechanical ventilations systems are used it is preferable to locate the equipment inside the building, in a fan or mechanical room. If rooftop units must be used, there must be inside access to the roof (via stairs or ship's ladder).

### 8.2.1 Choice of Systems

| Recommendation | *Rationale* |
|---|---|
| .1 Natural air supply and mechanical exhaust: | *This system relies on the users. Users must open windows for supply air. Kitchen or bathroom fans are used for exhaust, and are usually on manual switches.* |
| Limited to use in residential or seasonal use buildings. | *This system is considered unsuitable for buildings used by the public, or by groups of people who will not likely take on the responsibility of controlling ventilation, or who are not concerned with energy conservation.* |
| .2 Mechanical air supply and natural exhaust:<br>Limited to use in small residential, group homes or seasonal use buildings, where a forced air furnace is provided for heating. | *This system relies on the users to control the exhaust. Hence it is not considered suitable for public use buildings, or for groups of people who will not likely take on responsibility of controlling ventilation, or who are not concerned with energy conservation. This system does not work well in schools.* |
| .3 Mechanical air supply and mechanical exhaust:<br>To be used in most buildings.<br>A two-fan system is required. | *Both supply and exhaust can be automatically controlled using temperature sensors and timers. Control does not rely on users. Improper maintenance or operational difficulties (which may be design-related) can lead to user complaints, but that is true for any building system.* |

.4 Mechanical air supply and mechanical exhaust in combination with natural ventilation (hybrid ventilation):

*Both supply and exhaust can be automatically controlled using temperature sensors and timer. Control does not rely on users.*

This system should be considered for use in larger buildings which have sufficient height to allow the “stack effect” to be utilized.

## 8.3 SYSTEMS WITH NO MECHANICAL COOLING

### 8.3.1 Outdoor Air Supply

.1 Supply

A minimum outdoor air flow rate per person is required, based upon the “normal” occupancy of the building as quoted in ASHRAE 62 (current edition).

*Ventilation systems are to be sized to provide ventilation to the area served based upon the normal occupancy of that area. The use of ventilation systems sized for occasional peak occupancy within gymnasiums or halls results in oversized heating plants and ventilation equipment. These have higher capital, operating and maintenance costs, and are not as efficient as smaller systems.*

For facilities which have a high “Occasional Occupancy” level, such as Gymnasiums or Community/Assembly Halls, outdoor air volumes should be calculated using the “intermittent occupancy rule” from ASHRAE 62.

.2 Free Cooling

Free cooling is not required in buildings provided with natural ventilation, either by outdoor air intake hoods or by operable windows.

*Most new buildings are very energy efficient. Even at quite low temperatures (i.e., -10ºC to -15ºC), there may be a need to cool the core of the building during occupied hours in order to dissipate internal heat gains from lights, equipment and people. This can be accomplished with free cooling or natural ventilation.*

Where natural ventilation is not provided, air volumes and system arrangement must allow up to 100% outdoor air to be used to prevent overheating of occupied spaces. Do not preheat outdoor air.

## 8.4 AIR CONDITIONING

Although outdoor air temperatures can rise above comfortable indoor levels during the summer months, the additional cost of providing air conditioning is not justifiable in many buildings given the short period of time it will be required. There are instances, however, where air conditioning is required.

| Recommendation | *Rationale* |
|---|---|
| **8.4.1 Cooling** | |
| For most of the year, the supply air temperature can be controlled by varying the amount of outdoor air introduced into the system, and adjusting the heat supplied to heating coils. Free cooling is generally adequate for the hottest days of the year. | *The additional expense of cooling equipment must be weighed against the benefit of cooling. Where cooling may be needed only for a few days of the year, the use of cooling equipment is discouraged because of the added capital and O&M costs.* |
| When even the maximum amount of outdoor air (see M8.3.1 “Outdoor Air Supply” - reference to free cooling) will produce supply air above 18ºC for an extended period of time, the need for cooling equipment should be reviewed. Cooling equipment should be considered for projects in the Fort Smith, Inuvik and North Slave Regions. | |
| Where air conditioning is installed, equipment must be designed in conformance with the National Building Code. | *Provision must be made for proper system shutdown in fall and startup in the spring.* |
| **8.4.2 Installation** | |
| All air conditioning and refrigeration systems shall only be installed and commissioned by a qualified refrigeration mechanic. The engineer is to ensure that this requirement is included in the specifications. | *In the past some systems were installed by non-qualified persons, and problems resulted.* |

## 8.5 GENERAL

### 8.5.1 Humidification

Humidification is not typically required or recommended in most Northern buildings.

*In the past, humidification systems in the North have proven to be very difficult to operate and maintain because of poor water quality in many communities and lack of maintenance attention. During extremely cold outdoor temperatures, humidification levels in a building must be kept low to prevent excessive condensation on windows and deterioration of the building envelope. This constraint reduces the benefit of humidifying the building and contradicts the rationale for providing a humidification system in the first place.*

Where humidification is deemed necessary and specifically stipulated as a functional program requirement, it should be steam-generated, and the system equipped with controls that automatically reset the humidity level to the outside air temperature. Supply water to the system must be properly treated.

*Steam-generated humidification is more reliable than atomization systems, which malfunction due to calcium build-up. A proper treated water supply to the humidification system is required to ensure long-term system operation.*

### 8.5.2 Outdoor Air Intakes

Outdoor air intakes must be provided with downturn hoods designed to stop snow being drawn into the system.

*See Figure 8.1.*

*Properly designed hoods prevent the air intake from filling up with snow (a frequent occurrence where precautions have not been taken).*

To ensure acceptable indoor air quality is maintained within buildings at all times, it is critical that outdoor air intakes are located far from possible contamination sources. The location of roadways, parking and service points and prevailing winds must be considered during building site selection and design.

*Many problems (even closure of buildings) have occurred when vehicle exhaust, diesel fumes, sewage gases and products of combustion were drawn into the building through the outdoor air intakes*.

The following design guidelines apply.

.1 Intake hoods must have sufficient vertical length (a minimum of 600 mm). Intake air velocity must be less than 1.5 m/s.

*This design prevents contaminants (snow, wind and insects) from entering the air system.*

| | |
|---|---|
| .2 Hoods are to be set out approximately 200 mm from the wall surface, not tight up against it. | *Winds hitting the face of the building can force snow up into the hood. Setting the hood out from the wall reduces snow entry during windy conditions*. |
| .3 Hoods should be mounted high enough to avoid becoming blocked by snow accumulations expected in the project location. | |
| .4 Outdoor air intakes should be located on the sides of buildings scoured by the wind, or, where possible, on the underside of the building where it is swept clear of snow. | *A review of snowdrifting patterns is required before locating the air intake, as drifts may impede system operation for many months of the year. Setting the hood out from the wall reduces snow entry during windy conditions.* |
| .5 Hood finish is to be either natural galvanized steel or a factory coating (baked-on or powder-coated). | *Normal on-site painting is not good enough, as it does not produce a tough and durable finish.* |
| .6 Do not install insect screen on outdoor air intakes. | *Insect screens can become blocked by snow and insects can be trapped in filters. If the building location (i.e., South Slave Region) absolutely requires screens, provide removable type so screens can be removed in winter.* |
| .7 Outdoor air intakes should be located on the opposite side of the building from the sewage tank pump-out connection. Where that is not possible, the intake should be at least 10 metres (horizontal distance) from all trucked service points, including sewage pump-out, water fill, fuel delivery and from chimneys and exhaust outlets. | *This reduces the chance of bringing in objectionable odours, vehicle exhaust or flue gases from chimneys with the outdoor air.* |

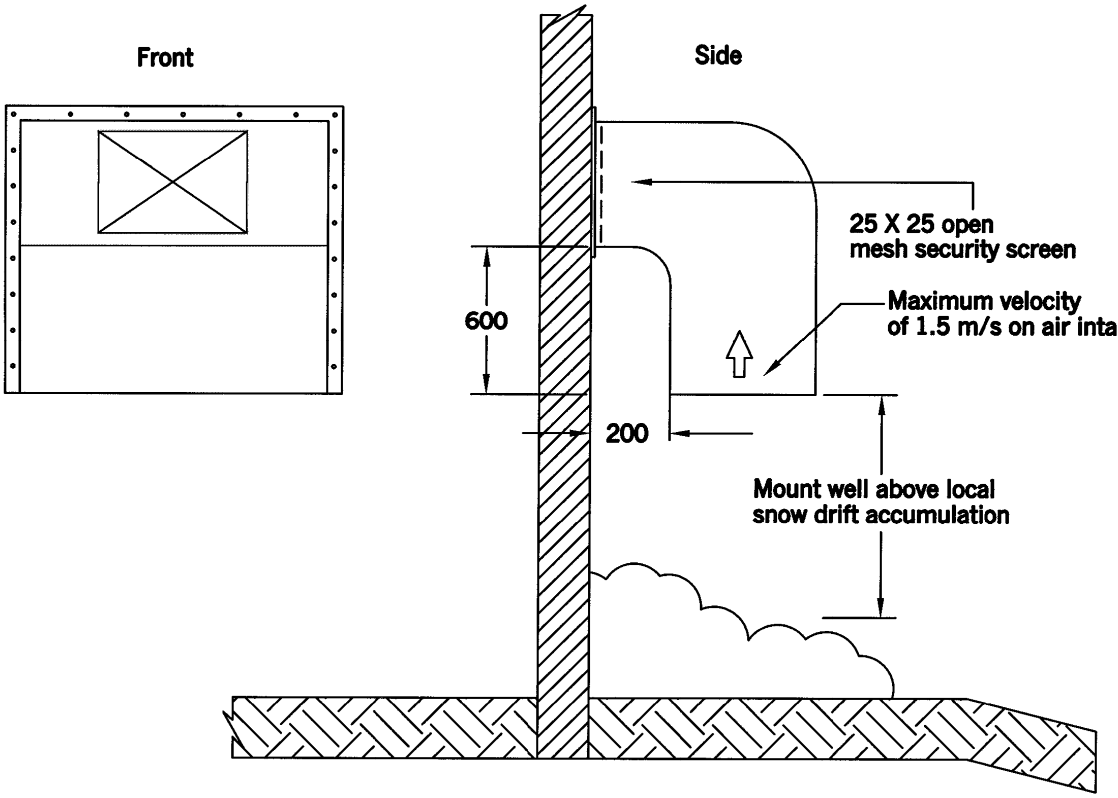


Figure 8-1: Outdoor Air Intake

.8 Dampers

Outside air dampers are to be low leakage type.

*This limits the infiltration of outdoor air.*

.9 Insulation

Insulate outdoor air ducts using external duct insulation.

*The use of a duct liner in an outside air intake duct is not recommended by ASHRAE.*

### 8.5.3 Air Mixing

Packaged mixing boxes are not recommended.

*Conventional equipment is designed for conditions in southern Canada or central U.S.A. In the NWT, where outdoor air temperatures may be as low as -50°C, mixing of cold outdoor air with room temperature air is more difficult, and standard mixing boxes cannot mix the air properly.*

There must be adequate provision for outdoor and return air to mix to a uniform temperature before reaching the filter and heating coil in the air handling unit. A variance of no more than about 2 degrees Celsius from one point to another should be achievable.

*Supply air is a mix of fresh outdoor air and return air from the building. A temperature sensor is provided to read the mixed supply air temperature. The amount of outdoor air admitted is controlled by this sensor. If return and outdoor air are not thoroughly mixed when they arrive at this sensor, it will read the temperature of either a warm or cold stream of air and will let in either more or less than optimum amounts of outdoor air.*

The following guidelines are suggested in order to ensure thorough mixing in most severe conditions:

- Arrange mixing dampers so the coldest air stream (outdoor air) is located at a higher level than the point of return of the warmer (return) air.

  *This promotes the mixing of warm and cold air by taking advantage of convection.*

- Use opposed-blade dampers.

  *These dampers mix air thoroughly by directing streams of air towards each other*.

- Locate the incoming air ducts at least 3 meters upstream of the heating coil, with at least one duct elbow in the mixed air before it connects to the air handling apparatus.

  *This gives the air more distance in which to mix well before it reaches the heating coil.*

Air blenders or stratification eliminators are recommended to ensure mixing of (cold) outdoor air and return air.

*Packaged air handling units with integral mixing boxes are not designed for arctic winter conditions. Their use should be avoided where possible. During extreme cold conditions, good air mixing is important to allow air handling systems to operate normally, without nuisance tripping from low temperature controls. Effective temperature control is difficult to achieve without good air mixing.*

Exhaust, relief air, and outdoor air ducts are to be insulated for a length of 3 meters from the connection to the louver.

*Insulation prevents the formation of condensation on ductwork exposed to cold air when the system is operating or shut down.*

All moving equipment is to have permanent directional indicators.

*To show that it is moving in the proper direction.*

### 8.5.4 Air Distribution

When designing a building, the interior air pressure regime inside must be considered. It is desirable to have a slight positive pressure inside the building, particularly in winter, so infiltration through the envelope is not encouraged.

The stack effect will affect all buildings to some extent, as will the prevailing wind intensity and direction. The stack effect can be intentionally used in the design to encourage airflow through a building, as in the case of natural ventilation.

.1 Diffusers

For conventional mixed-air systems, ceiling diffusers, adjustable for horizontal and downward flow, located at the midpoints of approximately equal divisions of room area, are preferred. The use of several sidewall supply registers located along the longest interior wall (facing the perimeter wall) is also acceptable.

*Other systems, such as fixed horizontal diffusers or floor registers, do not promote proper air flow under all conditions and may result in stratification in the winter, which is to be avoided.*

Floor diffusers (for return or forced hot air heating systems only) are to be heavy gauge, not the domestic type (unless it is for a residence).

*Residential grilles and registers are unsuitable for buildings such as schools, where they may be easily damaged or manipulated. Registers designed for residential use are of a light gauge metal and have built-in balancing dampers, which, if wrongly adjusted, can cause air balancing problems.*

Air diffusers, located in the floor and supplying through the baseboard radiation are not acceptable.

*Air supply through the baseboard radiation does not permit proper air diffusion and temperature control.*

Displacement ventilation systems, used with radiant-floor heating, require a different design approach. 100% fresh air is introduced at low level to rooms through displacement supply registers. The airflow is at low velocities and at a temperature only slightly less than that of the room. For example, air at 18 degrees C is supplied to a room temperature of 21 degrees C.

*Displacement ventilation uses less total air than similar-size mixed-air systems. Less fresh air is needed because of better air mixing in the space.*

.2 Dampers

Balancing dampers are required on all main branches at each branch duct take-off. Dampers should be in-line mounted locking-quadrant type. Duct splitter dampers are not acceptable for use for balancing. Volume control dampers (at diffusers) are not an acceptable means of controlling air volume.

*Line-mounted dampers are a reliable means of balancing. The results of adjustments made with splitter dampers are unpredictable, as the air flow in the main ducts as well as in the branch duct is changed. Dampers located near to supply outlets may be noisy, due to the high duct air velocity.*

.3 Fire Dampers

Fire dampers are to be installed as per ANSI/NFPA 90A (complete with sleeve, fire stopping, and breakaway connections on ductwork on each side of the fire separation). Access doors are required on both sides of the fire separation, and these doors must be easily accessible for maintenance and resetting.

Use Type B fire dampers (in which the airflow area is not reduced by protruding damper blades) rather than Type A wherever possible. If Type A must be used, ensure that the system static pressure is not compromised by the penetration into the airstream (by increasing duct size at that location).

.4 Flexible Ductwork

Flexible ductwork shall be limited to short lengths (within one meter) of equipment to be connected. Flexible duct is to be fastened to the sheet metal ductwork and diffuser with an approved tie wrap or metal clamp (not with duct tape).

*Improperly-fastened and/or exceedingly long flexible ducts increase the duct pressure loss, and can cause airflow problems.*

*Duct tape does not provide a secure seal; it tends to fall off after some time in use.*

.5 Flexible Connections

Flexible connections of approved, fire resistant design are required at the suction and discharge connections of fans and air handling units. 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.

*The use of flexible duct connections reduces noise and vibration transmission from fan equipment through the building structure to the occupied spaces. Fan performance is adversely affected and energy use increases if the ductwork connection is off-set, or if the flexible connection projects into the air stream.*

.6 Branch Take-off Ducts

Branch take-off ducts to each air supply or exhaust outlet are to be a minimum of 0.5 m in length, located in an accessible location with a duct-mounted balancing damper positioned near the take-off fitting.

*Supply or exhaust (return) air outlets mounted directly on the main branch ductwork tend to cause uneven air velocities and are noisy and uncontrollable. Balancing dampers located too close to the actual air outlets cause noise.*

.7 Duct Sealant

An approved duct sealant is to be used for sealing ductwork, such as Duro-Dyne duct sealant. Duct tape is **not** acceptable.

*Duct tape is not satisfactory for sealing ducts. It loses adhesive properties, particularly on cold ducts.*

.8 Protection

Ducts located under other mechanical equipment shall be protected by a removable catwalk to allow service of equipment without damage to the duct.

*If ducting is handy for access to equipment, it will get used and subsequently damaged.*

.9 Thermal Insulation

Thermal insulation is to be provided on outdoor air intakes up to the heating coil, and on exhaust ducts leading outside.

Insulation of supply and return ducting is only required where mechanical cooling is provided.

.10 Acoustic Insulation

Acoustic insulation is to be provided on all ducting in a fan room, on minimum first 10 m of any duct run to or from a fan.

Acoustic insulation is to be provided on all transfer ductwork and wherever fan and duct noise may be a problem.

.11 Silencers

Where the designer deems these are needed to satisfy space noise level requirement, silencers are to be provided.

.12 De-stratification Fans

Consider use of de-stratification ceiling fans in high ceiling areas (i.e., in garages, theatres, etc.) Size the fans for total area coverage. Provide protective guards over fans where they may be subject to damage.

*Ceiling fans improve tempered air distribution during heating and cooling seasons, and reduce energy cost. Provide timers to prevent fans running when they are not needed.*

### 8.5.5 Air Exhaust

.1 Location

Outdoor exhaust vents are to be located where they will not be susceptible to snow accumulation, or discharge directly into the prevailing wind. Avoid locating in the vicinity of the outdoor air intake (i.e., within 10 m).

*Snow accumulation can hamper or eliminate exhaust capability. A review of snow-drifting patterns must be done before locating exhaust vents, as drifts can impede system operation for many months of the year.*

Also avoid location whereby exhaust air discharges onto building Thermosyphon radiators.

#### .2 Insulation

The exhaust air stack must be insulated where contact is made with outside air.

*This reduces the amount of condensation that may freeze and build up, reducing the size or closing off of the exhaust opening.*

#### .3 Local Exhausts

Local exhausts should be provided in all rooms and spaces where high levels of contaminants or odours are generated.

*They are typically provided in industrial arts rooms, change rooms, washrooms and kitchens.*

Recirculating exhaust systems, such as range hoods, are not acceptable.

*If the recirculation air filters are not maintained, the system is less effective.*

- Individual major exhaust fans are to be interlocked with the air handling system.

*Unless air is being brought in to replace exhaust air, a strong negative pressure can be created in the building which can cause infiltration.*

- Local exhaust fans must not discharge into boiler rooms.

*Unstable draft conditions will affect burner combustion efficiency.*

- Manually-controlled exhaust fans are to be provided with timed switches.

*This avoids the possibility of exhaust fans being left operating for long periods of time.*

### 8.5.6 Maintenance

600 mm x 600 mm access doors are required for fresh air dampers.

*This allows operators and maintainers access for adjustments and repairs.*

300 mm x 300 mm access doors are required for fire dampers.

*Ensure that doors to fire dampers are easily accessible.*

500 mm x 500 mm access doors are required for:

- exhaust air dampers
- return air dampers
- filters and coils
- balancing dampers
- mixing boxes
- reheat boxes
- turning vanes
- heat wheels
- heat pipes

Isolating and balancing valves must be installed so that the flow through each heating coil in the air handling system can be adjusted with the coil circulating pump on or off.

*It must be possible to operate the system manually if the three-way valve is removed for maintenance or repairs.*

Adequate access should be provided to allow complete removal of heating coils.

*Basic maintenance requirements.*

Provide enough unions and valves to allow equipment removal with minimal system impact.

Provide access panels upstream and downstream of heating coils, adequately sized to allow steam or compressed air cleaning of coils *in situ.*

### 8.5.7 Provisions for Monitoring Performance

.1 Balancing

For ventilation system balancing, instrument test holes, drilled on site and sealed with duct plugs, are preferred to permanent test ports.

*Test ports are costly and not required often enough to warrant the extra expense of installing them. Test holes can be drilled on site by the balancing contractor where and as required.*

.2 Adjusting Outdoor Air

Instrumentation must be installed to allow operators to monitor the temperatures of outdoor air, mixed air and supply air. Dial-type thermometers are preferred.

*By monitoring temperatures, the operator can set correct proportions of outdoor air and mixed air to give desired supply air temperature. When supply air is not at the correct temperature, users are uncomfortable.*

*Dial-type thermometers should be used rather than other types, as they are easier to read.*

Each air handling unit is to have supply air, mixed air, return air and outdoor air thermometers.

*Thermometers give an indication to building operators of system performance. Thermometers and other gauges or indicators must be easily visible to a person standing in an accessible location in the room.*

### 8.5.8 Heat Recovery Systems

Due to the need for energy efficiency in buildings, heat recovery ventilators (HRVs) are to be used wherever savings from their use can be demonstrated to provide acceptable payback against the added capital costs of provision of the system.

Packaged heat recovery ventilators are acceptable for small facilities such as community air terminal buildings, small offices etc., but they must be provided with a pre-heat coil on the outdoor air intake to counter defrost cycles.

Heat wheels, heat pipes and glycol heat recovery runaround loops may be acceptable for larger facilities.

### 8.5.9 Filters

All air shall be filtered before entering coils, equipment or occupied spaces. Filters should be throw-away type, standard size.

*Filters prevent dust and debris buildup. The use of standard size throw-away filters makes replacement easy and quick.*

Filtering shall be achieved by one set of filters, not by a summer-winter filter arrangement.

*A summer-winter filter bank arrangement is unsatisfactory because if it is maintained properly, snow can get into the air handling system. In locations where this system was used, maintainers were not always aware that they had to remove one filter set in each season.*

On re-circulating air systems, provision should be made for having filters capable of an 80% average efficiency. Typically, only 60% efficiency air filters should be installed.

*While the higher efficiency filters may not be needed at present, sufficient space in the ventilation system should be provided to accommodate them.*

Size, number and designed type of filter are to be permanently labeled (lamacoid) on the unit near the filter access door.

*This makes it easier for maintainers.*

### 8.5.10 Acoustic Control

.1 Duct Lining

Acoustic lining should be provided in the supply air, return air and exhaust air ducts 5 m downstream and 2 m upstream of fans. Pin spot fasteners, not self-adhesive clips, are to be used.

*This is required to minimize noise transferred from fans to the occupied space.*

*Past experience has shown that self-adhesive clips may detach and duct liner can loosen and block ducts. For this reason, a more secure fastening method is required.*

Adhesive must be applied to the **entire** adhering surface area of acoustic duct lining.

*There have been cases where the duct liner has come loose because of inadequate adhesion. Loose duct insulation can totally block ductwork and may not be noticeable to a maintainer.*

.2 Acoustic Separations

All components of the mechanical ventilation system must be designed so that the sound level will be within noise limits recommended by ASHRAE or by particular client or space requirements.

*Mechanical noise and vibration of fans and pumps can be objectionable to building occupants. The national Building Code requires HVAC systems to be designed, constructed, and installed in conformance with good engineering practice, as outlined in the ASHRAE Handbooks and Standards, and others.*

### 8.5.11 Mechanical Room Cooling

In mechanical rooms and boiler rooms, provide mechanical make up and/or exhaust systems to maintain the rooms at acceptable operating temperatures. Care should be taken when venting boiler rooms to ensure that the increased or decreased air pressure in the room does not affect the operation of the oil burners.

*Continuous high temperatures in mechanical and boiler rooms shorten the service life of mechanical and electrical equipment and create uncomfortable working conditions for maintenance personnel.*

## 8.6 ENERGY RECOVERY AND DEMAND CONTROL SYSTEMS

Higher energy costs and indoor air quality requirements place increasing demands on energy recovery and control system technologies.

To maintain good indoor air quality and conserve energy, consider controlling the ventilation rate so it varies according to the needs of building occupants.

Technologies such as Demand Control Ventilation (DCV), Direct Digital Control (DDC), new energy recovery equipment and associated controls provide opportunities to reduce energy consumption.

### 8.6.1 General

When designing new building systems, whether heating, ventilation, and/or services, every effort should be made to incorporate energy recovery and/or control systems.

The higher installation costs versus overall operational cost reductions should be weighed, especially on smaller systems. The client may wish to see a capital cost recovery summary as part of the system design and analysis.

*These systems reduce the size of primary load equipment (i.e., boilers, chillers, burners, pumps, etc.), and so reduce overall building energy consumption. In new buildings, the cost savings resulting from the smaller size of cooling and/or heating equipment offset any initial added cost for heat recovery units.*

### 8.6.2 Energy Recovery

Devices - General

When selecting heat recovery equipment, select devices that recover sensible heat.

*Sensible heat is the most readily-recoverable energy, especially considering the low humidity levels encountered in the North.*

Heat wheels can recover latent as well as sensible heat (heat pipes, heat exchangers and glycol loops cannot). Note that heat wheels cannot be used where there is danger of cross-contamination between airflows. The efficiency of heat wheels is higher than that of heat pipes or glycol loops. However, the use of heat wheels should be avoided in remote communities because they may be too complex for local maintainers.

Use counter-flow energy recovery equipment only.

*Generally, counter-flow provides the greatest temperature difference and heat transfer rate across the recovery exchanger.*

The designer must bear in mind the project location and maintenance preferences when selecting types of heat recovery systems.

*When selecting equipment, consider such factors as installation and operational costs, ease of operation, simplicity and maintenance, etc.*

### 8.6.3 Demand Control Systems

On large volume systems (i.e., greater than 8500 l/s), consider using demand control ventilation (DCV) systems with sensory controls (i.e., $CO_2$ sensors, time control and/or occupancy sensors). $CO_2$ control is best utilized in rooms where occupancy variation is high and/or unpredictable. Timed control is best used in situations where the occupancy load and load variations of a building are known over time, while occupancy sensors are best utilized in low occupancy, intermittent use areas.

*When properly located and installed, DCV systems offer greater payback than energy recovery systems and generally range from two to five year payback.*

### 8.6.4 Variable Frequency Drives (VFDs)

VFDs can be used to control mechanical equipment such as pumps and fans. Installation of VFDs is to be coordinated with the Electrical Designer.

*VFDs can save building operating energy when used on mechanical equipment which has varying use patterns. The mechanical designer determines the need for a VFD; the electrical designer ensures that its installation is in accordance with electrical codes and standards.*

Some equipment (i.e., circulating pumps) can be ordered with a built-in VFD.

A VFD should be rated to match the electrical characteristics of the motor, the starter and the circuit protection.

## 8.7 SERVICE FACILITIES

### 8.7.1 Air Curtains

Overhead garage or service doors which are often used should be provided with air curtains. Air curtains supply a flow of air down over the door openings when doors are open. This reduces infiltration and saves energy. Enershield Energy Savings Barriers are a recommended type.

*Where air curtains are installed on overhead doors, significant heating energy savings can result.*

Control for air curtains can be either automatic (by activation of a door opener) or manual (switch).

## 8.8 OPERATION AND MAINTENANCE

Recommendation

*Rationale*

### 8.8.1 Spare Parts

The following spare parts are to be provided:

- One set of belts for each piece of machinery.
- A one year supply of filters of each type used in the system(s)
- 12 fusible links for use in fire dampers.
- A six-month supply of chemicals for cold water type humidifiers.

### 8.8.2 Regional Equipment Preferences

Use equipment preferred by regional maintainers.

### 8.8.3 Code Requirements

Thoroughly clean all ductwork and equipment internals and externals, and final filters installed.

Perform drop test on all fire dampers installed.

Provide air balancing to NEBB/AABC Standards.

## M9 AUTOMATIC TEMPERATURE CONTROLS

A properly-designed, installed, maintained and operated automatic control system provides the best possible occupant comfort and the most efficient mechanical system operation.

### 9.1 GENERAL

| Recommendation | *Rationale* |
|---|---|
| Conventional, low voltage (24 volt) electric control systems are acceptable for most buildings. | *Compared to pneumatic controls, electric controls are simpler to operate and to service. They should be used in remote communities.* |
| Pneumatic control systems may be used where they are specifically approved for use. They can be used in combination with electronic or direct digital control (DDC) systems. The sensing and logic is to be electronic, and controlled devices are to be operated by pneumatic operators. | *Although pneumatic control systems are more complicated and require proper servicing, they are cheaper in large installations and they can provide full modulation.* |
| Direct digital control systems with electronically operated control devices may be used where appropriate, provided they are equipped with full UPS protection. | *The control industry is changing to DDC controls. DDC systems are now robust and easy to operate and can be used readily by most maintainers.*<br>*In remote communities, it can be very useful to have a DDC system with remote monitoring capabilities, so problems can be diagnosed and fixed without a costly site visit.* |

## 9.2 CONTROL COMPONENTS

### 9.2.1 Components - General

| Recommendation | *Rationale* |
|---|---|
| All controls, regardless of type, are to be calibrated in degrees Celsius, whenever possible. | *The metric system is standard.* |
| CSA approval is required for all control equipment, including alarm panels. | |
| Stand-offs are required for all duct-mounted controls and accessories which are mounted on externally-insulated ducts. | *Stand-offs keep these items fully accessible for operation and servicing.* |

### 9.2.2 Thermostats and Sensors

| Recommendation | *Rationale* |
|---|---|
| Thermostats and/or sensors located in gymnasiums are to be located at a suitable height above the floor. They should be protected with a heavy duty metal guard or other means. | *Gym thermostats and sensors must be protected from damage, and the students need to be protected from sharp corners.*<br>*Gyms and halls may be for public function, so thermostats require tamper-proof covers.* |
| In cases where a space thermostat controls both a heating control valve and a variable-air volume (VAV) or cooling control in sequence, a dead-band of 2 degrees Celsius is required between the heating and cooling ranges. | *This will prevent energy waste by avoiding simultaneous heating and mechanical cooling, or heating and free cooling.* |
| Thermostats located in public areas must have vandal-proof guards. | *The guards prevent intentional or unintentional tampering.* |
| Locking-type thermostats are to be used in public facilities where only the maintainers should be able to adjust temperatures. | *Where there are many building users, it is often best to allow only maintenance staff to control temperatures in public areas of facilities.* |
| Locking type thermostats are not to be used where it is desirable to allow users to adjust room temperatures (refer to functional program for direction). Where users should be able to adjust room temperatures, range limits are to be used to restrict the amount of adjustment above or below predetermined values. | *In some cases it is more appropriate to allow users to adjust room temperatures themselves, rather than having to rely on maintainers. Range limits should be provided so users cannot set temperature too high or too low.* |

Low voltage electric heating thermostats are to be SPST (single pole, single throw; such as the Honeywell T86A).

*In cases where SPDT (single pole, double throw) thermostats have been used, the wiring has sometimes been installed incorrectly. The SPST thermostats are simpler, and less likely to be installed incorrectly.*

### 9.2.3 Control Valves

Control valves (i.e., two and three-way control valves at heating or cooling coils) are to be sized based on a Cv rating at a pressure drop of 21 kPa (or by other sizing means so there will be no “hunting” at low flow rates).

*Incorrectly-sized control valves do not give good control.*

Normally-open (NO), electrically-operated heating zone valves are to be used. Do not use thermostatic valves.

*There is some indication that NO valves cause more maintenance problems than NC type. However the NO type should be used, so that space heating is still possible if actuator fails.*

*Thermostatic valves are not recommended as they require constant calibration.*

Do not use copper-to-copper zone valve. Use flare type.

*Copper-to-copper valves have caused maintenance problems.*

### 9.2.4 Flow Switches

Flow switches are to be vane type on piping 50 mm in diameter and smaller. Paddle-type flow switches are acceptable on larger piping.

*On smaller piping sizes, paddle-type flow switches are difficult to install properly and do not function well. The sensitivity cannot be adjusted, which can result in nuisance alarms.*

### 9.2.5 Control Transformers

The number of control devices per transformer is to be limited to 3 devices for each 40 VA transformer.

*Limiting the number of control devices on a circuit prevents excessive voltage drop for each controlled device, which could cause the device to fail.*

### 9.2.6 Damper Actuators

Independent damper actuators are to be appropriately sized and installed on each outdoor air, return air and relief air control damper.

*Common damper actuators have a long connecting rod which is nearly impossible to set up, and the quality of control is reduced.*

## 9.3 VENTILATION UNIT CONTROL

### 9.3.1 Outdoor Air

The amount of outdoor air brought in to the system is to be controlled by a mixed-air temperature sensor with minimum outdoor air settings to recommended ASHRAE standards.

*Outdoor air (normally cold) is mixed with room temperature return air to produce supply air (mixed air). The amount of outdoor air is varied to provide more or less cooling as needed. A minimum supply rate of outdoor air must be provided by code. Note that in VAV systems, the lowest VAV box airflow must have sufficient fresh air to meet code requirements.*

### 9.3.2 Return Air

In no case should the heating coil in the air handling system be controlled by the thermostat in the return air duct.

*Normally air returns to the mixing chamber from the space at or above 20ºC. If for any reason the return air temperature falls below this, the heating coil activates and the ventilation system ends up acting as a heating system (like a forced air system), rendering the hydronic heating system thermostat controls ineffective.*

### 9.3.3 Supply Air (Mixed Air)

A supply air controller is required to control the temperature of the supply air to be between 13-16ºC. For most of the year, the supply air temperature can be controlled by varying the amount of outdoor air introduced into the system. When the maximum amount of outdoor air will produce supply air above 18ºC for extended periods of time, the need for cooling equipment should be reviewed. See Mechanical M8.4 “Air Conditioning”.

*Air is normally supplied at a high level in a room or space. If it is supplied at a temperature equal to or warmer than the room, it tends to remain at a high level in the room and not come down into the occupied space where it is needed.*

The mixed air controller in the air handling system (controlling outside and return air dampers) must be the averaging type.

*The averaging type sensor provides accurate temperature measurement by averaging colder or warmer air streams.*

An automatic reset type freezestat must be provided downstream of the heating coil, and must be set at 5ºC.

*The automatic reset type freezestat is used to reduce the likelihood of the air handling systems shutting down and remaining off during cold weather extremes.*

### 9.3.4 Heating Coils

The sensor controlling the heating coil in each AHU (air handling unit) should be located a minimum of 3 m downstream of the coil in the supply air duct, preferably downstream of the supply fan.

*This distance from the coil ensures the sensor reads the actual supply air temperature (not the temperature immediately next to the heating coil).*

Heating coil control valves should be controlled by fast response type controllers.

*Without fast response controllers, the control valve hunts from full open to full closed position, never reaching a position of equilibrium, and occupied spaces can overheat.*

Electric modulating controls are preferred for heating coils. They must remain energized even when the AHU fan is shut down.

*If the controls are de-energized when the air handling system is shut down, the heating medium circulates freely to the heating coil (given that normally open valves are used) when not required, and overheating can occur.*

### 9.3.5 Time Clocks

The operation of mechanical equipment such as ventilation units is to be controlled by operator/user-activated time clocks, appropriately located in the area being served. The timers should be manual spring-wound type or electronic count-down type with operating ranges selected to match the occupancy of the area served.

*Operator/user-activated timers that are conveniently located in the area served ensure that the mechanical equipment will operate only as required, thus reducing energy consumption and reducing operating and maintenance costs.*

Where it is not possible or appropriate to provide the above mentioned user-activated control, provide a 7-day programmable time clock c/w quartz control clock and battery back-up.

*This will ensure that mechanical equipment is programmed to operate only during occupied periods and shut down during unoccupied periods. It also reduces operating and maintenance costs.*

### 9.3.6 Typical Ventilation Unit Control

A typical direct digital control system has been developed for ventilation unit control. The control strategy can be applied to many ventilation units, both small and large. Refer to Figure 9.1.

*A typical ventilation control strategy provides some consistency in operation and maintenance.*

Any DDC system approved must have a full front end as part of the package.

*Coding system changes is time consuming and requires a high level of skill and experience.*

Package must be the most current version available from vendor at time of project tender stage.

*Suppliers may offer upgrades after the design stage and after the tender award. Any upgrades which are available, or are potentially available, should be offered at the bidding stage as an alternate, complete with the price impact.*

### 9.3.7 Typical Direct Digital Control (DDC) Sequence of Operation

The ventilation system will start by pressing the system start push button PB-1, located in the general office, gymnasium, or area served. The ventilation unit will start and operate for the predetermined number of hours as preprogrammed in the DDC and will then shut down. (A gym ventilation unit would typically be set to operate for 4 hours). If additional time is required, the unit can be restarted by pushing the start button PB-1 again.

The DDC controller will start the supply fan with the HAND-OFF-AUTO switch in the AUTO position via digital output DO-1. The return fan, associated exhaust fans and heating coil circulating pumps will be hard wired to operate with the supply fan. Supply fan start-up will notify the DDC by digital input DI-2, wired to the auxiliary contact of the supply fan starter.

Upon confirmation of start up from DI-2, the ventilation unit will operate on 100% return air for a pre-set purge time to stabilize temperatures (this time might be 5 minutes). At the end of the pre-programmed purge time, the supply air control loop will assume control of the mixed air dampers, DA-1 2, and 3. The mixed air dampers will be ramped to the minimum or control position over a preset time (i.e., 10 minutes)

The supply air control loop, with inputs from supply air temperature sensor TS-1 and return air temperature sensor TS-2, will modulate the heating coil valve V-1 in sequence with the mixed air dampers DA-1, 2 and 3 to maintain the supply air temperature at the proper set point as determined by the return air reset loop. A supply air temperature reset potentiometer ADJ-1, located beside the DDC panel, will allow the operator to INCREASE or DECREASE the supply air temperature, within set limits, to suit specific building requirements.

A $CO_2$ sensor, $CO_2$ -1, located in the return air duct and sensing return air $CO_2$ levels from the building, will reset the minimum outdoor air position to increase the percentage of outdoor air to the building and maintain the maximum $CO_2$ at the desired level (i.e., 800 ppm). The minimum outdoor setpoint will be set in the DDC controller, based on the minimum building ventilation requirements outlined in the ASHRAE Standard 62 (latest edition).

Direct mount and readout analog thermometers TI-1, 2, 3 and 4 will show the operator outdoor, mixed, supply and return air temperatures. A magnehelic type of differential pressure gauge, FI-1, mounted on the unit, will provide indication of the differential pressure or loading of the vent unit filters. A differential pressure switch, DP-1, sensing filter loading, will input to the DDC controller a dirty filter condition.

A low-limit control loop with inputs from the supply air temperature sensor TS-1, located downstream of the supply fan, will shut down the ventilation unit upon sensing a low supply air temperature, after a 5 minute time delay.

The following user adjustable setpoint and control parameters will require password access:

- ventilation unit run time (2, 4, 10 hours, etc.)
- purge time at system start (10 minutes)
- mixed air dampers ramp time (10 minutes)
- minimum outdoor air position (15, 20, 30%, etc.)
- supply/return air temp reset schedule
- remote supply air temperature reset adjustment span (i.e., 31ºC)
- low limit supply air temperature setpoint adjustment (21ºC)

Provide continuous trending at 30 minute intervals for the following points:

- supply air temperature
- outdoor air temperature (one sensor per project)
- return air temperature
- $CO_2$ reading
- filter status (CLEAN/DIRTY)
- supply fan status (ON/OFF)

### 9.3.8 Typical DDC Sequence of Operation Diagram

Provide a modem module connection with remote dial-in capability on buildings where this is desired, to allow off-site monitoring of the system performance.

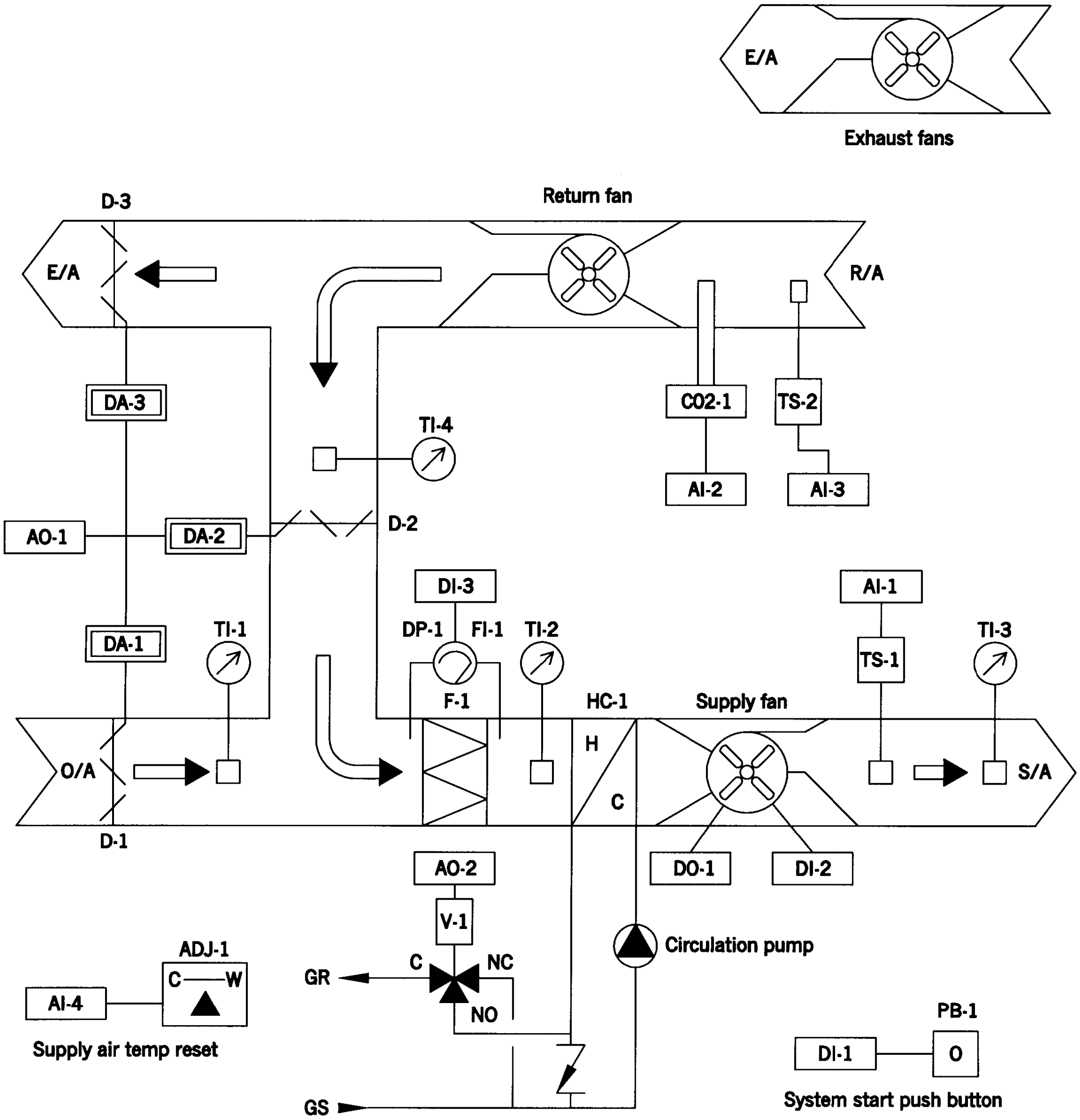
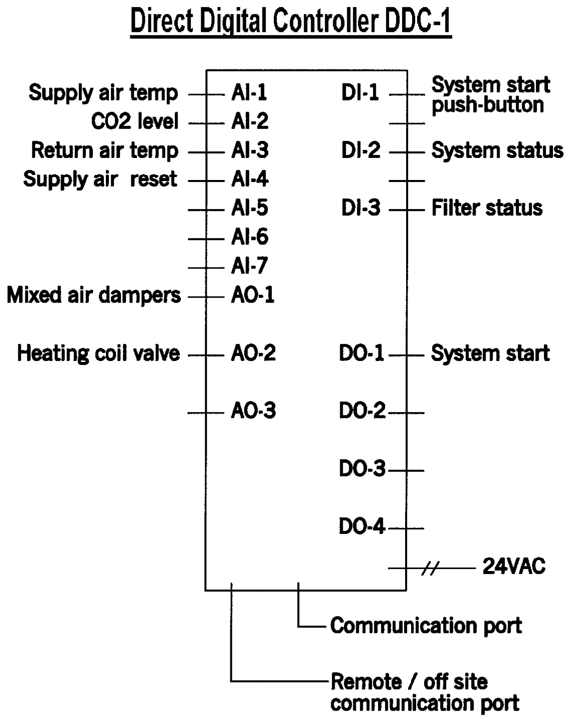
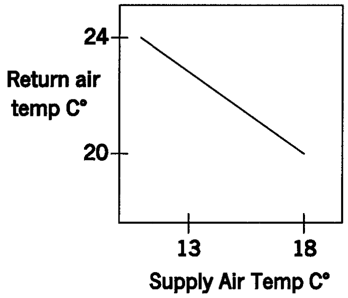


Figure 9-1: Ventilation System Control

### 9.3.8 Typical DDC Sequence of Operation Diagram



Supply Air Reset Loop



| Tag | Material Identification |
|---|---|
| ADJ-1 | Manual pot with scale "Cooler - Warmer" |
| CO2-1 | CO2 sensor and transmitter |
| DDC-1 | Direct digital controller |
| DA-1,2,3 | Damper actuators |
| DP-1 | Differential pressure switch |
| FI-1 | Filter gauge (magnehelic) and DP switch |
| PB-1 | System start push-button - momentary contact |
| TI-1,2,3,4 | Duct mounted thermometers (75 mm) |
| TS-1,2 | Duct mounted bulb temperature sensor |
| V-1 | 3 way control valve and actuator |
| AI | Analog input to DDC controller |
| AO | Analog output from DDC controller |
| D1 | Digital input to DDC controller |
| DO | Digital output from DDC controller |
| D-1,2,3 | Control dampers |
| F-1 | Filter section |
| HC-1 | Heating coil |

Figure 9-2: Direct Digital Controller Identification

## 9.4 HYDRONIC HEATING CONTROL

### 9.4.1 Radiation Control

Radiation zone is to be controlled by a low-voltage room thermostat controlling the normally open (NO) two-position control valve.

*This gives a cost effective radiation zone control.*

All heating loops, including those installed in washrooms and storage rooms, are to be provided with individual or zone control, and not allowed to ‘run wild.’

*The small additional initial cost of providing control is much less than the long term energy saving.*

### 9.4.2 Force Flow Control

Force flow units are to be controlled by line voltage, low-range, wall-mounted thermostats complete with locking metal guards. Provide control valves on units where overheating of the area may occur when the fan is off.

*This provides a cost effective control of force flow units.*

### 9.4.3 Unit Heater Control

Unit heaters are to be controlled by line voltage, low-range, wall-mounted thermostats complete with locking metal guards.

*This provides cost effective control of unit heaters.*

Provide control valves on units where overheating of the area may occur when the fan is off.

The room thermostat is to be located on the wall, but not directly in the air stream from the unit, and shall be provided with a locking guard.

### 9.4.4 Boiler Temperature Control

Provide indoor/outdoor controls for boilers with 2 or 3 step settings.

*Seasonal adjustments to boiler temperatures are made automatically (increased in cold weather, decreased in warmer weather), thereby increasing energy efficiency.*

*If existing domestic HW tanks are dependent on boilers do not use this method of control. However, dedicated HW tanks are to be used in new buildings.*

## 9.5 MECHANICAL ALARMS

Recommendation

*Rationale*

### 9.5.1 Mechanical Alarms

Mechanical alarms should be minimized and restricted to essential building conditions. Low building temperature is the only condition that is considered critical. A low building temperature alarm must activate the automatic dialer and/or the outdoor alarm light.

*Elaborate alarm systems, which are costly to install and maintain, have caused many nuisance call-outs and may become ignored. The probability of false alarms is reduced with only one (i.e., low building temperature) alarm designated as critical.*

## 9.6 OPERATION AND MAINTENANCE

Recommendation

*Rationale*

### 9.6.1 Spare Parts

The following spare parts are to be provided:

- Specialized wrenches, screwdrivers etc., required to access and adjust control equipment.

### 9.6.2 Regional Equipment Preferences

Use equipment preferred by local maintainers.

### 9.6.3 Code Requirements

Provide framed, glazed schematics for all systems to be mounted on wall adjacent to system.

### 9.6.4 Identification

When a DDC system is installed, all addressable components must be provided with a permanent lamacoid identification label.

END OF SECTION

# Table of Contents

## ELECTRICAL

# Table of Contents

# Table of Contents

# Table of Contents

# Table of Contents

# ELECTRICAL

## INTRODUCTION

Electrical energy in most of the isolated northern communities is provided mainly by isolated (non grid connected) diesel driven generators, with only a few communities being supplied by hydro electric plants. This has resulted in relatively high electrical energy costs in the North. At the same time, technology over the years has been providing many new and innovative energy saving electrical systems that in Southern Canada appear cost effective. However, the lack of reliable and clean electrical energy, the lack of qualified or experienced trades people, and the isolated nature of the North can quickly affect the life cycle costs of any installed system. Careful planning and design is needed to install electrical systems that are simple, reliable and robust enough for the northern operating environment. Seasonal changes in the North include harsh winter conditions, and a large variation in natural daylight, which require special design considerations. Guidelines and recommendations covered in this section include installations that have been found acceptable by PWS to date, balancing the sometimes conflicting demands for occupant satisfaction, energy conservation, simplicity and reliability.

## E1 CODES AND REGULATIONS

Documents referenced in this section include:

- National Building Code of Canada (NBC)
- Model National Energy Code of Canada (MNECB) [2]
- Canadian Electrical Code (CEC)
- Underwriters Laboratories Canada (ULC), various
- Underwriters Laboratories Incorporated (ULI Canada), various
- Canadian Standards Association (CSA), various
- Illuminating Engineering Society (IES) Lighting Handbook and various Recommended Practices
- Institute of Electrical and Electronics Engineers (IEEE) Color Book Series
- Telecommunications Industry Association (TIA) – TIA Standards
- GNWT Electrical / Mechanical Safety Section – Electrical Bulletins
- GNWT Office of the Fire Marshal (OFM) – Technical Bulletins
- American Society of Heating, Refrigeration and Air – Conditioning Engineers (ASHRAE) 90.1 “Energy Standard for Buildings Except Low Rise Residential”
- ASHRAE Guideline 4 “Preparation of Operating and Maintenance Documentation for Building Systems.” – Latest Edition

Related offices include:

- Electrical / Mechanical Safety Section Offices – Yellowknife, Hay River, and Inuvik
- NWT Power Corporation – Hay River (head office)
- Northland Utilities – Yellowknife
- NU (NWT) Limited – Hay River

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[2] This Design Protocol sets out requirements for building design for energy efficiency; the building must comply with all the mandatory provisions in the Model National Energy Code for Buildings (MNECB), and must be at least 25% more efficient than the MNECB reference, as shown by use of the EE4 software (or the EE Wizard, which is applicable to some types of building analysis). The design process for certain types of facilities listed below shall include an Energy Modeling analysis utilizing the EE4 program and, where called for by the Client, an Energy Modeling Workshop, to maximize the energy savings potential of the facility while maintaining the cost effectiveness of the relevant payback period. Funding applications to NRCan shall be made naming the Client Department as the “Owner” of the facility.

# E2 OPERATION AND MAINTENANCE

## 2.1 GENERAL

See General G1 “Local Resources” and G4 “Appropriate Technology”.

## 2.2 ACCESS

Electrical systems generally require relatively little maintenance. However, easy access to equipment that must be serviced is important. Adequate access hatches and working space needs to be provided for all electrical equipment as required by the Canadian Electrical Code (CEC) to ensure a safe working area for servicing or replacement of electrical equipment.

For example, access to lighting control systems is best provided at floor levels where a qualified maintainer can stand and work in front of, rather than from a ladder in difficult to approach or cramped ceiling spaces.

Locating of control systems and components for security, digital control system components, telephone terminations, data terminations, and sound reinforcement systems should also be designed for ease of access for maintenance purposes.

## 2.3 SPARES

The building owner in consultation with the design team should determine what spare parts should be provided. The following is a recommended list of regular and emergency spare parts that should be stored in each facility for communities that are not on the road system:

- 1 set of each type of manual starter heater
- 5 spare fuses of each type used (i.e., control fuses)
- 1 spare coil of each starter size
- 1 spare control transformer of each type used
- 5 spare pilot lights of each type used (i.e., fire alarm panels, MCCs, transfer switch), 10 of each if they are incandescent
- Spare incandescent lamps equal to 10% of the number used in the facility. Specify an integer number of lamps.
- Spare fluorescent lamps equal to 10% of the number used in the facility. Specify an integer number of lamps.
- Spare high intensity discharge lamps equal to 20% of the number used in the facility. Specify an integer number of lamps.
- 5 spare of each other type or size of lamps used (i.e., 2’, 3’ compact fluorescent, incandescent)
- 5 spare 2-lamp fluorescent ballasts
- 2 spare single lamp fluorescent ballasts of each type used (i.e., 2’, 3’, compact fluorescent)
- 2 spare High Intensity Discharge ballasts of each type used

If a generator is required, provide:

- 5 spare oil filters
- 5 spare fuel filters
- 5 spare air filters
- 2 spare fan belts of each type used

Rationale

*Spare parts are often difficult, if not impossible, to get within many communities, and there is often a long time lapse required to send in spare parts. As a minimum, an inventory of spare parts as listed, if maintained, should cover most of the regular and emergency maintenance required on electrical systems during a facility's life time. Spare parts used for repair during warranty period are to be replaced at the end of the warranty period.*

### 2.4 STANDARDIZATION

In the interest of maintenance and economy, it would be prudent to ensure that all distribution panels, starters and switches be of the same manufacturer throughout a specific facility.

### 2.5 CODE REQUIREMENTS

Some codes, such as CSA-282 or CSA-Z32 have specific requirements with regards to spare parts, special tools, log books for testing and maintaining of systems. These requirements are to be included in the project specifications for the Contractors information. Refer to subsequent sections for these requirements.

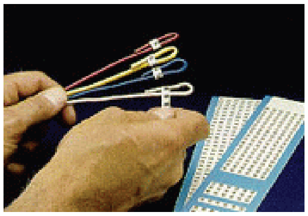
## E3 IDENTIFICATION

Clear identification of electrical equipment is particularly important for the electrical system. Local maintainers and trades people should be able to quickly understand and locate related system equipment. Consistent identification in all public sector buildings is recommended to ensure that maintainers and operators can easily become familiar with any public sector building in any community.

At a minimum the language should be English for identification of components and systems. Abbreviations and acronyms should be used in a consistent and clear manner.

Various levels of identification can be incorporated within a specific building. According to the Canadian Electrical Code, identification of main distribution panels, sub-panels, motor control centres and motor starters is required. Additional steps in identification are listed below for possible implementation.

### 3.1 CONDUCTOR IDENTIFICATION



Tape style identification

Heat shrink identification

Printable sleeves

| Recommendation | Rationale |
|---|---|
| Self-laminating conductor markers may be used to identify conductors at all panel boards, motor control centres, junction boxes, terminal cabinets and outlet boxes. The numbering system can include circuit numbers on power circuits located on the switch or receptacle conductors. In low voltage and control system wiring, the numbering should match the control diagrams. | *Circuit numbers are useful to identify wiring for trouble-shooting and to avoid accidents by preventing contact with energized conductors. Due to the increasing complexity of electrical systems, it has become important to identify wiring with control diagrams of the system, to be able to trace wiring when correcting operation and maintenance problems. The minimal cost of identifying the conductors is paid back during trouble-shooting, and during training of maintainers or when modifying the system.* |

### 3.1.1 Power Distribution Identification

| | |
|---|---|
| A copy of a single line diagram of the normal and emergency power distribution is practical to install beside the main electrical distribution system of a building where there is emergency power, or where there are greater than 2 branch circuit panels, or where the service is greater than 200 amps. | *This provision ensures the safety of maintenance and emergency response personnel (e.g., firefighters) to provide a clear understanding of the installed system and where to de-energize equipment when servicing.* |

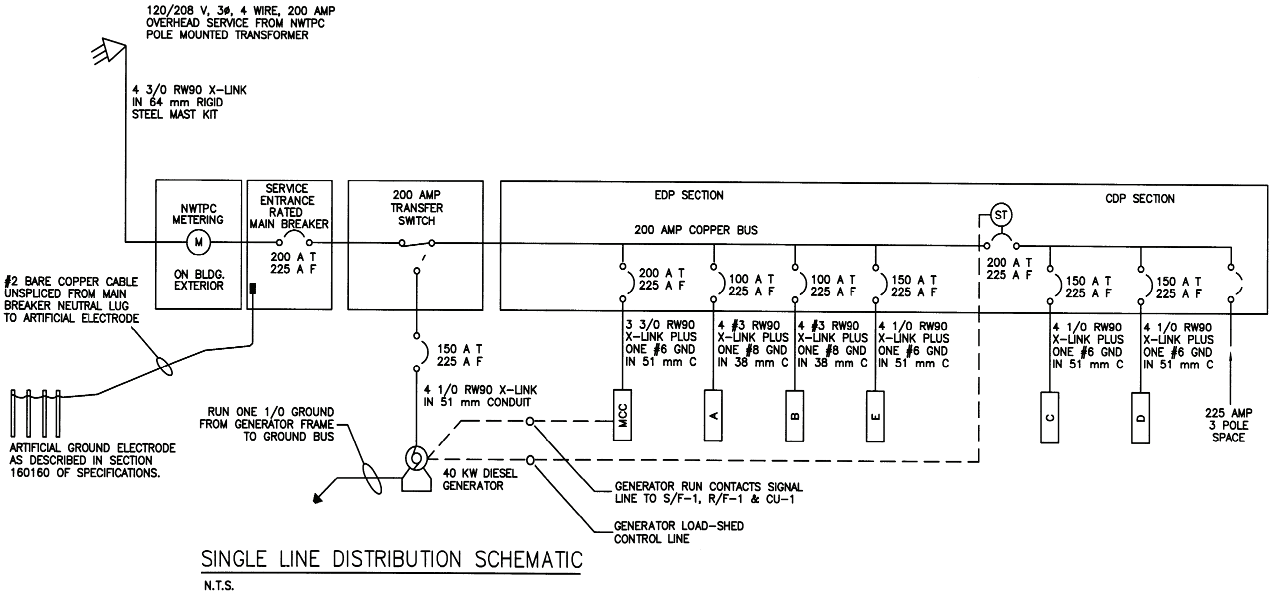


Figure 3-1: Sample Single Line Diagram

## 3.2 JUNCTION BOX IDENTIFICATION

### 3.2.1 Junction Boxes

| Recommendation | *Rationale* |
|---|---|
| Provide identification of the enclosed systems by painting the junction box cover plates. See Electrical System Identification Tables E-1 and E-2. | *This is useful when tracing system conduits, for locating devices and system components when troubleshooting or when making additions or deletions to the system.* |

## 3.3 EQUIPMENT IDENTIFICATION

See Electrical System Identification Tables E-1 and E-2.

### 3.3.1 Panel Directory

| Recommendation | *Rationale* |
|---|---|
| Computer generated or typewritten panel directories are required. | *Handwritten directories vary in legibility and durability.* |
| Room numbers used for circuit identification should be those that are identified on the contract documents. | *Maintainers should have access to the original and subsequent drawings for reference. The room numbers are required by other sections of the GBP.* |
| At times both a room name and number may be used. | *Common names of rooms that are unlikely to change may also be used for quick identification. Eg: Mechanical Room, Electrical Room, Janitorial etc.* |
| The directory should allow for the identification of any future loads added to the panel. A copy of the file should be included in the O&M manual. | *This provision would provide ease of future updating the directory when changes are made.* |

### 3.3.2 Terminal Cabinets

| | |
|---|---|
| In terminal cabinets for control wiring and low voltage wiring, identify terminal strips and wiring with appropriate labeling. Provide a computer generated or typewritten directory. | *This is done for operations and maintenance staff (maintainers or factory representatives) to be able to quickly understand the enclosed system, trouble shoot problems or to add and delete parts of the system.* |

### 3.3.3 Control Diagrams

Copies of the control diagrams of the enclosed system may be located within enclosures designed for such and an additional copy provided within the appropriate section of the O&M manual.

*Many simple or complex control systems are located in public sector buildings. No matter the complexity, control diagrams provide the electrical or maintenance staff with the information they need to understand the proper operation of the system. The minimal cost of providing control diagrams is paid back during future trouble-shooting, and during training of maintainers or when modifying/repairing the system.*

### 3.3.4 Labels and Lamacoids in Service Rooms

Fasten all lamacoids on equipment either by mechanical means or with adhesive backing. Ensure lamacoid is applied on clean level surface.

*Mounting labels on controllers ensures identification is not painted over during maintenance activities.*

Type D labels should be provided for relays in control cabinets.

*Relays in control cabinets must be identified for maintenance and trouble-shooting.*

## 3.4 RECEPTACLE IDENTIFICATION

Receptacles may be identified by circuit and panel only when it is important that a building user, unfamiliar with the electrical system, be able to quickly re-set breakers.

Recommendation

*Rationale*

### 3.4.1 See Electrical System Identification Tables E-1 and E-2

*This is typically required in basic health care areas of health centres, patient care areas of hospitals and industrial arts rooms of schools.*

### 3.4.2 Receptacle labels

Mount labels adjacent to, not on the cover plate of the receptacles.

*This practice ensures identification when all the cover plates in a room are removed (i.e., during painting).*

Use lamacoids.

*Printed labels may be easily painted over, whereas lamacoids are raised off the wall surface and even if painted over remain readable.*

## ELECTRICAL SYSTEM IDENTIFICATION TABLE E-1 LABELS AND LAMACOIDS

| Component | Type | Information |
|---|---|---|
| Main distribution centre | A | Year installed, name of facility, names of electrical engineer and electrical contractor |
| Main breaker | A | Voltage, phase, amps |
| Sub distribution panel | A | Name of panels it is feeding (i.e., Panel A, Panel B) |
| Panel boards | A | Panel designations (i.e., A,B,C or EA,EB,EC for panels fed from emergency power) |
| Terminal cabinets<br>i.e., telephone, low voltage | B | Indicate equipment controlled<br>(i.e., Telephone Rooms 1-12, Intercom Rooms 1-7) |
| Equipment<br>i.e., motors, fans, pumps, etc. | | SEE MECHANICAL IDENTIFICATION STANDARDS |
| Disconnect switches | B | Indicate equipment controlled and voltage |
| Starters / contactors | B | Indicate equipment controlled and voltage |
| Motor control centres | B | Indicate equipment controlled and voltage |
| Transformers | B | Circuit and panel designations |
| Relays | D | Circuit and panel designations |
| Junction boxes, pull boxes | D | Circuit and panel designation for power.<br>Contents for low voltage<br>(i.e., TV rooms 1-12 or security rooms 1,2 & 7) |
| On/Off switches | C | If it is not obvious, then indicate area being served<br>(i.e., service spaces or grouped switches) |
| Fire alarm devices (i.e., pull stations, bells, end of line) | C | Zone number and device number in that zone<br>(i.e., Zone 1-#3, Zone 10 - #7) |
| Receptacles: | | If required, then indicate: |
| • standard duplex | C | • panel / circuit designation |
| • GFCI | C | • panel / circuit designation |
| • surge suppression | C | • panel / circuit designation |
| • special receptacles | C | • panel / circuit designation and voltage, phase, amps |

| Label | Letter Height | Type | Colours |
|---|---|---|---|
| Type A | 9.5 mm | lamacoid | white lettering / black background |
| Type B | 6.0 mm | lamacoid | while lettering / black background |
| Type C | 3.0 mm | lamacoid | white lettering / black background |
| Type D | 3.0 mm | adhesive | no preference |

## ELECTRICAL SYSTEM IDENTIFICATION TABLE E-2

## COLOURS

| Component | Conductors or Cables | Junction Boxes[1] | Receptacles | Other |
|---|---|---|---|---|
| Normal power:<br>- 120/208, 240 volt<br>- 347/600 volt | <br>Code<br>Code | <br>Gray<br>Sand | <br>As specified by designer | |
| Emergency power:<br>- 120/208, 240 volt<br>- 347/600 volt | <br>Code<br>Code | <br>Orange<br>Sand | <br>Red[3]<br>n/a | |
| Low voltage:<br>- switching / controls<br>- emergency<br>- exit lighting<br>- security / panic<br>- mechanical alarms | See Note 2 | <br>Black<br>Orange<br>Orange<br>Blue<br>Amber | | <br><br><br>Exterior<br>Strobe (blue)<br>Strobe (amber) |
| Fire alarm: | Red | Red | | Exterior Strobe (red) |
| Communications:<br>- structured wiring<br>- telephone<br>- intercom and sound<br>- television and cable<br>- CCTV | See Note 2<br>Blue<br>Olive / Gray<br>Brown<br>Black<br>Beige | <br>White<br>White<br>White<br>Brown<br>Brown | | |

[1] All junction box covers of a particular system must be painted according to the colour coding schedule. Color coding is not necessary for visible surface mounted junction boxes as they can be easily traced.

[2] Low voltage cables can be purchased with various colors of the exterior jacket allowing quick identification for tracing of installed cabling for security, nurse call, intercom, data, video, telephone, television, CCTV, DDC cabling.

[3] Only receptacles that form part of an Essential Power Supply are required to be red.

## E4 POWER SUPPLY

Electricity is supplied in most NWT communities by diesel generators operated by the NWT Power Corporation. Fuel is re-supplied annually and power costs are very high. Hydro power is currently available in only a few communities. Voltage fluctuations are typical, as are power outages. As a result, sensitive electronic equipment requires special design considerations. Three phase power and 347/600 volt service is not available in all communities. Power is supplied to consumers primarily by overhead services, with larger buildings being supplied by underground conductors from pad mounted transformers.

### 4.1 PUBLIC UTILITIES

Power is supplied and generally distributed by NWT Power Corporation, except that it is distributed by Northland Utilities in some communities. Some communities will only provide 120/208V 3 phase and 120/240V single phase. Only in very rare cases will it be deemed acceptable to provide 347/600V in communities where it is not regularly supplied. This will require careful coordination with the local utility.

| Recommendation | *Rationale* |
|---|---|
| **4.1.1 Consumption Targets** | |
| See specific sections regarding energy consumption requirements (i.e., lighting, motors). | See *General G6.1 Model National Energy Code.* |
| **4.1.2 Underground Service** | |
| Overhead services are preferred. However, if an underground service is necessary for safety reasons, teck cable is preferred. In non-permafrost areas, the cable needs to be placed below the frost especially if the soil is frost susceptible. In permafrost, or if the cable must be placed in the active layer, it must be surrounded by non-frost susceptible soil. This can be accomplished by surrounding the screened sand on all sides by gravel, which will ensure drainage of water out of the sand. | *Overhead services are preferred as they are easy to repair and maintain. If the service is underground, teck cable is easier to install and less expensive compared to conduit, especially in cold weather. Teck cable is flexible enough to take the stress of frost heaving and installation over uneven or rocky ground. In permafrost areas, surrounding fill should be of a type that does not bond to the cables (because frozen soil tends to contract and crack, causing buried lines to pull apart when the line on each side of the crack is frozen tightly in the soil).* |
| Underground service conductors over 75 meters should be installed inside a PVC sleeve. | *By providing a PVC sleeve for long underground service runs, the increased potential of movement from frost heaving, will decrease the stress on the installed cable.* |

## 4.2 AUXILLIARY POWER

Reliability of power supply for equipment is more important in cold climates than in moderate climates because of the dire consequences of extended failure. Systems dependent on electricity include boilers, pumps, fire protection and heating controls. Power failures in northern communities are not uncommon due to extreme weather conditions or equipment failures, which can incapacitate the community generator. For this reason, generators are often required in public sector buildings where services must be maintained. Emergency generators, where required by NBCC, need to meet stringent requirements. Standby power supplies are optional and sized according to desired load requirements determined on a project by project basis.

The importance of reliability is mentioned, not so much for community functions, but because of the dependence on electricity for building systems.

| | Recommendation | *Rationale* |
|---|---|---|
| 4.2.1 | **Where Required** | |
| | Emergency power is only to be provided where required by the National Building Code of Canada. Provide standby power where the facility program drives the requirements for a generator. | *Emergency power has specific code requirements above and beyond those for standby power.* |
| 4.2.2 | **CSA C282** | |
| | This standard “Emergency Electrical Power Supplies for Buildings” is suitable as a guide for standby generation. Items such as fire resistance ratings that do not affect the general reliability of the system can be overlooked. For emergency generators, it is expected that CSA C282 will be followed. | *The CSA standard was developed to cover installations where power is required on an emergency basis. In most GNWT facilities, standby power is provided as a backup for convenience, not safety, and shutdowns can be scheduled, making a manual by-pass unnecessary. Installing a “standby” or “auxiliary” generator to C282 maintains reliability.* |
| 4.2.3 | **Components Required** | |
| | When generators are required, they should be: | |
| | • fuelled by the same fuel tank provided for the heating system | *This assures fuel supply.* |
| | • liquid-cooled with mounted radiator fan and water pump (integral radiator only) | *Remote radiators are problematic in harsh winter conditions.* |
| | • air-cooled with integral cooling fan and cooling ducting where conditions make an air-cooled generator practical | *For some smaller installations, an air-cooled generator may be practical. Example: park generators, or very small units in buildings.* |

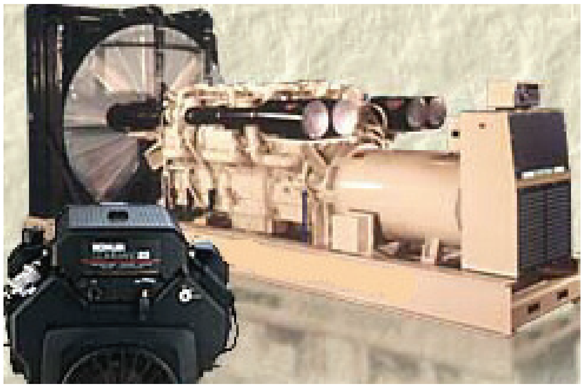
| | |
|---|---|
| • skid mounted and come complete with: | *Is easier to move if equipment needs to be repaired.* |
| • glow plug and timer | *This should be installed where required.* |
| • steel springs and/or rubber pads as recommended by the manufacturer | *This combats light and heavy vibrations*. |
| • remote annunciator package for critical functions | *This practice helps to identify generator problems.* |
| • thermostatically controlled recirculating block heater fed from boiler heat exchanger | *This practice ensures the generator is warm for easy starting and conserves energy.* |
| • integral radiator | *See above regarding remote radiators.* |
| • hospital or critical grade muffler | *This will assist in noise reduction.* |
| • flexible exhaust section | *To dampen generator vibration to the exhaust.* |
| • battery, automatic battery charger, cable and rack | *Starting system failures typically cause 85% of failures on emergency generators. Proper selection of battery and charger is particularly important.* |
| • 12 volt electric start | *Preferred over 24 volt systems for safety and maintenance.* |

### 4.2.4 Capacity

Where emergency generators are required by code, they must be sized to carry the following only:

- fire protection system (including fire pump and jockey pump)
- complete heating system including fuel pumps, controls, boilers and zone valves
- exit lighting
- domestic water pumps
- sanitary pumping
- selected lighting (including wash room lighting in buildings where there are young children, the aged or the infirm)
- power loads deemed necessary by the program requirements
- loads required by the National Building Code to be powered from an emergency power supply

*Besides code requirements, emergency generators allow buildings to continue operating with minimal disruption. In many instances the size of the fire pump dictates the size of the installation, and thus the entire electrical system can function on emergency power as there is little cost or operational advantage to reducing lighting and receptacle capacities. In many cases it is desirable to shunt trip building load from the generator in the event that the fire pump is required to start. Refer to the facility program to determine which lighting and power loads are essential. Subject to emergency lighting design of specific building.*



**Sample emergency generator**

### 4.2.5 Automatic Exercising

Automatic exercising of the emergency or standby generators is not required.

*In the past there was concern that maintenance staff were either non-existent or untrained for testing the generator regularly. Consequently, time clocks were installed to ensure the generator was cycled regularly to ensure proper operation. With qualified maintainers in all communities and the requirement of CSA C282 and the Maintenance Management System (MMS) to record and log all instrument readings during a weekly test, the time clock is redundant.*

### 4.2.6 Customer Metering

Provide digital customer meter where the generator size is in excess of 75 kVA that can provide consumption, demand, voltage and current information.

*Digital metering is an excellent tool for troubleshooting, generator loading and a variety of general maintenance activities.*

### 4.2.7 Location

Generators should be installed in a room separated from other oil-fired equipment and with connecting door large enough to allow for changing the generator.

*This ensures that generator operation does not consume boiler combustion air and provides a way to access for future maintenance requirements.*

### 4.2.8 Portable Generators

Portable generators are not recommended.

*Where a generator is required, it should be permanently installed to ensure reliability and regular maintenance. If it were portable, there would be a good possibility that it would not be readily available when needed. Portable units can also be hazardous if improperly installed, grounded or exhausted.*

### 4.2.9 Load Banks

Permanently connected, stepped load banks with customer metering to monitor generator loading is recommended for hospitals and correctional facilities.

*Permanently connected stepped load banks provide a means for maintenance staff to properly exercise generators on a weekly and yearly basis avoiding “wetstacking” from small building loads.*

Emergency, auxiliary or standby generators 300 Kw and over should also have permanently installed stepped load banks.

Where the building load is not adequate for the yearly testing of code required emergency generators, means to safely install a portable load bank should be provided.

*This provision will provide a safe way of connecting portable load banks on a yearly basis.*

## 4.3 RENEWABLE ENERGY (SUN, WIND)

The seasonal variation of solar in the North is often much higher than southern locations. Many renewable energy systems are designed for warmer climates and where technical staff is available for proper care and maintenance. Due to required maintenance, isolated or seasonal sites may increase the life cycle costs of these systems significantly. The trend of rising fuel prices and dropping costs for renewables, coupled with a desire to reduce greenhouse gas emissions make these systems more desirable. An analysis of whether or not to install these systems would be contingent on a life cycle cost analysis, as well as making considerations on the overall environmental impact or offset created.

| Recommendation | *Rationale* |
|---|---|
| **4.3.1 Unsuitable Applications** | |
| .1 Where buildings can be connected to a hydro powered grid, energy technologies that generate electricity should not be installed. | *The hydro system provides a reliable clean source of electricity. It is unlikely that life cycle costing will be favorable for alternative energy sources. Note that this is based on cost information at the time that this was written, current costs should considered when making a decision.* |
| .2 Systems that use solar photovoltaic energy primarily to provide lighting should not be used when natural daylight can be used to provide adequate lighting. | *In the summer months natural daylight is available. Solar panels are not effective in the winter due to short daylight hours.* |
| **4.3.2 Suitable Applications** | |
| .1 Solar energy technologies that generate electricity may be considered for remote and/or summer-use facilities such as: parks buildings, field research stations and fire towers. | *The cost of operating and fueling generators in remote locations in the North is usually very expensive. Alternative energy is also expensive, but may be viable because it has very low operational costs. Yearly setup costs also need to be considered as equipment left on site may be subject to theft or vandalism.* |
| .2 Renewable energy sources in locations with community diesel generators may be considered where life cycle costing shows it to be a viable alternative. | *Seasonal availability of sunlight, and issues such as hoar-frosting make the availability and maintenance costs different from southern climates.* |
| .3 All electrical loads need to be reduced to a minimum by using efficient installations, before considering renewable energy. | *The initial cost of buying a renewable energy system is normally the largest component of the life cycle costs. As the initial cost is proportional to the size of the loads imposed on the system, reducing the loads will help minimize the life cycle costs of the system.* |

| | |
|---|---|
| .4 Where wind turbines are installed, they will generally require a separate power source. | *Most wind turbines are induction generators and require excitation from a separate power source.* |
| .5 Batteries should not be provided where connected to a community power grid. | Capital and maintenance cost of batteries are not necessary. |

## 4.4 REMOTE SITES

| | |
|---|---|
| Remote sites are defined as those sites which must generate their own electricity on site, and do not have access to a local community power grid. | |
| Remote sites should consider a hybrid power system that incorporates a small generator, a battery bank, a solar array and associated equipment as the electrical supply. | *Electricity at remote sites is expensive to produce and most often relies on small, relatively inefficient diesel generators.* |
| Electrical systems for seasonal sites must be simple to install and remove. | *Seasonal sites are accessible year round and costs of equipment replacement can easily offset the yearly setup costs.* |
| All reasonable measures shall be taken to reduce electrical loads. | |
| Propane shall be used whenever possible for stoves, ovens, and clothes dryers. | *The cost of operating these propane appliances is roughly 1/3 that of operating electric models when electricity is diesel-generated.* |
| Special emphasis shall be placed on the use of natural lighting. | *Lighting can be easily accomplished during much of the day with ambient light. Sun tubes, skylights, and windows can significantly decrease electricity demand for lighting.* |

## 4.5 CONSUMER SERVICE AND DISTRIBUTION

### 4.5.1 Electrical Service Rooms

| Recommendation | *Rationale* |
|---|---|
| .1 Separate Room | |
| A separate electrical room is recommended for all facilities that have services of 600 V and larger and/or 400 A and larger. | *Services greater than 600 V and/or 600 A are of such a size that a separate room is desirable to consolidate electrical equipment. Separating it from the mechanical equipment generally ensures better access for maintenance operations, as well as provides a cleaner environment required for electrical equipment that often includes communications equipment, transformers, etc.* |
| Wherever auxiliary power is provided, electrical panels and equipment may be located in the generator room noted in Electrical E4.2.7 above, with the exception of motor control centres, which are ideally located within sight of equipment being served. | *As a separate room is already required for the generator, electrical equipment can be located there. Motor control centres are usually better placed in the mechanical room so the controls are within sight of many of the motors they control.* |
| A separate electrical room is recommended in facilities where the mechanical space is expected to reach temperatures that will be higher than 30°C. | *Electrical and electronic equipment and in particular breakers are temperature sensitive and should not be located in spaces where their performance will be compromised.* |
| Rooms that serve a dual function such as storage or corridor and electrical room should be avoided. | *Architectural designers assume that electrical equipment is static and wish to use this “empty” space for other purposes such as pathways to other rooms. This can easily create a dangerous situation such as a door being opened into an electrician working on an open electrical enclosure.* |
| .2 Working Space | |
| Adequate space around electrical equipment is to be provided. Minimum working space around electrical equipment is 1.0 metres. Coordination with the other disciplines (especially mechanical) is essential. | *Past experience with unacceptable clearances has resulted in need for on-site changes. The intention is to ensure that a safe working space is provided around electrical equipment (i.e., including space to stand beside panel boards while disconnecting breakers).* |
| Entrance to and exit from the working space around electrical equipment must be kept clear of all obstructions. | *Careful consideration during the design phase can help to anticipate and avoid the working space being used for storage space.* |

### 4.5.2 Service Size

Calculation of service shall be as per the CEC, with no oversizing of service, unless specific mention of future additions is made. Include calculation on drawings.

*Service size calculations from the CEC are generally very conservative, with best practice margin errors adding to the CEC numbers. If a major renovation takes place in the future, and there is no spare capacity, then the service will need to be upgraded at that point in time.*

Sizing and trip settings of the main service breaker must be considered carefully as the available fault current in many communities is very low, and as a result a fault may not clear within a reasonable time. Include available fault current at the service entrance on the single line diagram.

*A low available fault current means two things; most interrupt ratings will be sufficient and instantaneous trip settings need to be set so that they open the circuit. Many molded case circuit breakers have a instantaneous trip setting 10-12 times nominal, and this may be too high to actually open quickly. Local conditions need to be considered to ensure that protective devices function properly.*

### 4.5.3 Components

Standard of acceptance for power systems is Eaton Cutler Hammer, Schneider or Siemens.

*This reduces inventory and allows maintenance staff to become familiar with the products.*

Standard of acceptance for control equipment is Allen Bradley, Cutler Hammer, Schneider or Siemens.

### 4.5.4 Customer Metering

Provide a digital customer meter where service size is in excess of 200 kVA that can provide power quality metering, such as harmonic content, phase imbalance, transients, protection from phase reversal, overvoltage, undervoltage as well as Kwh consumption etc., capable of being tied into the building automation system.

*This meter provides invaluable O&M data. This can be used to verify utility invoices, provide a quick history for maintenance person and allow for O&M staff to realize problems by reading through the data on their prescribed PM programs and logged evidence of power quality problems originating off site.*

Provide digital customer meter where the service size is in excess of 75kVA that can provide consumption, demand, voltage and current information.

*Digital metering is an excellent tool for troubleshooting and other general maintenance activities.*

### 4.5.5 Power Quality

Ensure items prone to adding noise, such as a VFD are adequately isolated from the rest of the electrical system.

### 4.5.6 Uninterruptible Power Supplies (UPS)

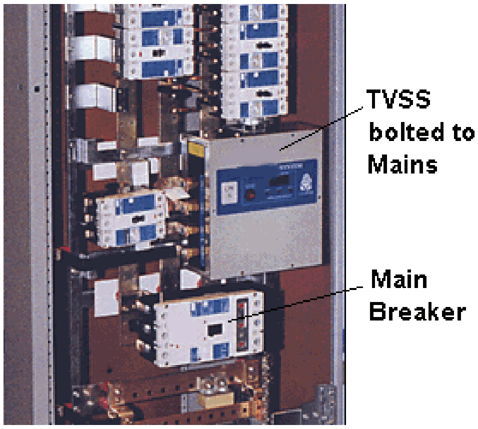
| | |
|---|---|
| Provide wall mounted shelves for UPS units that are supplying fixed wall mounted equipment. | *Wall mounting above the floor surface allows ease of area cleaning procedures, and a more protected location.* |
| When grouping computer or network equipment in a single room, consider consolidating all UPS power requirements into a centralized unit feeding a small panel. | *Regular servicing of a single larger unit can be more cost effective than servicing many smaller units. This also provides a higher level of protection from the electrical supply that may have variable quality.* |
| Where available, supply building systems such as telephone, public address, alarm systems, security systems, networking systems etc., from a UPS, but also from the generator. | *Providing electrical redundancy to systems that are needed for proper operation of the building during utility power failures provides a greater level of reliability.* |
| Where UPS is fed from a genset, provide a minimum of 15 minute back-up, where no genset is present, 30 minutes would be the minimum. | *Generators do not always start, and this provides sufficient time to shut equipment down. Because of the frequency of outages, the larger capacity batteries will also last longer before requiring replacement.* |

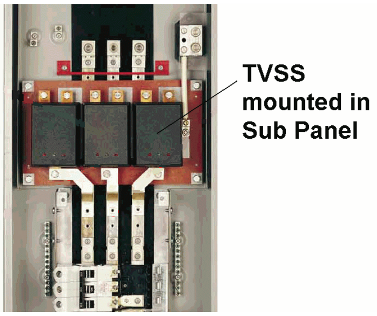
### 4.5.7 Surge Suppression

| | |
|---|---|
| Transient voltage surge suppression (TVSS) should be provided on buildings with electronic equipment; however, surge arrestors for lightning strikes are generally not required. | *The Northwest Territories has low incidence of lightning strikes, so surge arrestors would only be considered an asset on buildings where electrical reliability is critical. Power quality though is not generally high, so some form of TVSS at the service entrance will reduce the exposure of equipment inside the building to harmful surges.* |
| Sensitive electronic equipment should be protected from surges, both those generated from other equipment and those originating from the utility service. This can be accomplished at the service entrance, panel boards, and at receptacles. | *The rise in amount of sensitive electronics, and high powered switching devices such as VFD as well as the number of building systems that are sensitive to electrical noise (building automation systems, lighting controls) means that we have more harmonic content that can negatively affect the building systems. TVSS properly located will provides protection from internal sources of harmonics, voltage spikes, and transients.* |
| Evaluation of where to place TVSS will depend on the application. | *Cost of providing TVSS is minimal compared to the potential of equipment and/or data lost due to poor power quality issues.* |
| Computer room distribution panel boards should use surge protection bolted directly to the buss. | *Bolting TVSS directly to the buss bars locates the surge suppression devices in the most effective location and provides downstream protection to many devices.* |
| All units should indicate status in event of TVSS failure. | *Status of equipment ensures protection is provided.* |

Point of use devices at workstations or integral to the receptacle may also be incorporated.

*TVSS receptacles or within power bars is a relatively inexpensive method of providing good protection to single location equipment.*





### 4.5.8 Breakers

Wherever possible, use breakers rather than fuses.

*Tripped breakers can be reset; burned-out fuses must be replaced. Replacement fuses are not readily available in most communities, which can lead to the serious consequences associated with loss of power in cold climates. Fuses may be specified only where a large interrupting rating is required.*

### 4.5.9 Location of Receptacles

.1 Receptacles Facing Up

Receptacles must not be mounted facing up, either inside or on shelving units, work surfaces or counters. The only exception permitted is a floor box with a hinged cover.

*Dirt accumulation or spilled substances could create problems (e.g., in home economic rooms and science rooms).*

.2 Receptacles in Exterior Walls

Where possible, avoid locating outlets in exterior walls if the air-vapour barrier must be broken to accommodate the devices.

*It is not always possible in large rooms with exterior walls (i.e., gyms, assembly halls), but the intent is to reduce the number of penetrations. (Note: this is not a concern where walls are built or strapped on the warm side of the air-vapour barrier). Careful attention to maintaining the vapour seal is required to avoid air and moisture infiltration.*

### 4.5.10 Provision of Branch Circuits

.1 Counter Receptacles

At least one 3-wire branch circuit (split receptacle) or 20 amp T slot receptacle should be provided at counter work surfaces.

*This will prevent the overloading of a circuit and allow a variety of equipment to be used on work counters. These requirements border on adequacy provisions, but experience shows that if there is not a degree of adequacy in the electrical installation, they quickly become unsafe. Examples include classrooms, school lounges, office work counters etc.*

.2 Fridge, Microwave, Freezer

Each receptacle installed for a refrigerator, microwave oven or freezer is to be supplied by a separate branch circuit.

*Same as Electrical E4.5.10.1.*

.3 Circ Pump, Heat Trace

Each water circulation pump and heat trace outlet is to be supplied by a separate branch circuit.

*This prevents the freezing of the facility water supply due to a fault in other electrical equipment.*

.4 Circuits feeding receptacles in a classroom should not share a circuit with receptacles in other classrooms.

*If a circuit trips in one classroom, it should leave other classrooms unaffected.*

.5 Circuits feeding receptacles in common corridors for cleaning equipment should not share the circuit with receptacles in other areas. Install T slot receptacles.

*Modern cleaning equipment can overload circuits that are shared by other devices causing nuisance tripping. T slot receptacles can provide adequate power requirements for a variety of present or future labor saving cleaning equipment.*

.6 A minimum of one circuit should feed receptacles within an enclosed office space.

*Initial design of circuitry and receptacles, if not adequate for future needs within an office may result in poor power quality, extension cord usage, or additional circuits having to be added at a future date. Personal use photocopiers and laser printers may be future requirements.*

.7 Drinking Fountains

*See Mechanical M4.8.6.*

### 4.5.11 Electrical Boxes

.1 Sectional Boxes

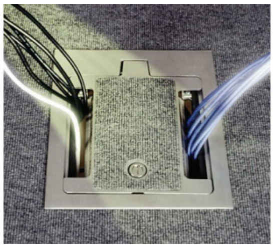
Avoid ganging together of sectional boxes.

*Joined sectional boxes can come apart during rough-in, which eliminates the grounding between boxes.*

.2 Floor Boxes

Use floor-mounted receptacles only if there is no alternative to providing power to equipment. Unless a raised floor system has been installed, whose purpose is to provide floor mount receptacles.

*Flush-mounted floor boxes with removable covers are undesirable because the covers are often misplaced, leaving the receptacle exposed (facing up), which is an electrical hazard.*



If construction allows, they should be flush-mounted type complete with hinged covers.

*Floor boxes that are flush-mounted are less obtrusive and less of a tripping hazard compared to surface-mounted floor boxes and are able to accommodate both line voltage and low voltage wiring.*

## E5 GROUNDING AND BONDING

Grounding by connecting to municipal water mains, as is typical in most of urban Canada, is seldom possible for buildings in the NWT. In areas supplied by municipal water mains the water lines are insulated and not in contact with the ground due to the cold winter conditions. Buildings within most isolated communities are provided by individually tanked water and sewage systems. Means of adequately grounding these facilities are covered by the CEC; the preferences stated reflect PWS experience with different situations encountered in Northern public sector buildings.

### 5.1 ORDER OF PREFERENCE

Recommendation

Order of preference is as follows:

1. Exothermic (cad) weld to a minimum of 4 steel pipe piles.
2. Minimum 9.5 mm ($^3/_8$") bolts (copper, bronze or brass) tapped and threaded to a minimum of 4 steel pipe piles.
3. A minimum of 3 rod electrodes.
4. Uffer ground.
5. Plate electrodes.
6. Municipal piped water system.

*Rationale*

*The large surface area of a steel foundation system that is contact with the ground and commonly used in the north can provide the best ground possible in northern areas. Cad welding provides a permanent connection.*

*The electrical resistance of the ground in arctic or subarctic areas is extremely variable (1 to 1000 ohms for a standard 19 mm by 3.0 m grounding rod). The resistivities of frozen ground are inadequate to meet the electrical code requirements. The choices given indicate the options in order of preference for providing the best possible ground system.*

*Consideration must be given at the design stage to pick the best possible system, avoiding dissimilar metals, and from galvanic action set up under certain soil conditions.*

| | |
|---|---|
| Where low ground resistance is critical or standard means will not obtain a reasonably low ground resistance consider use of additives. | *Additives will degrade over time, reducing the effectiveness of the grounding system, however they may be warranted in some situations.* |

### 5.2 CSA Z32 "ELECTRICAL SAFETY IN PATIENT CARE AREAS"

Assume procedures as noted in Electrical E6.3.7.

## E6 WIRING

### 6.1 USE OF CONDUIT

PW&S previously required all wiring to be run in conduit. This was viewed as a worthwhile investment as it simplified any unforeseen expansion or changes. In practice not all facilities make use of this feature over their lifetime. The need for conduit has now been reviewed and modified as noted below.

| Recommendation | *Rationale* |
|---|---|
| **6.1.1 Conduit Use** | |
| .1 Surface-mounted conduit<br>Is acceptable in service buildings (i.e., garages, firehalls), in recreational buildings (arenas, etc.) and in spaces concealed from the public or not accessible. | *This clarifies where surface conduit is acceptable.*<br>*Spaces such as service rooms and closets, plenums, crawlspaces etc., are not normally seen, so surface conduit use in these areas is acceptable.* |
| .2 Concealed conduit<br>Install conduit concealed wherever possible to provide clean wall and ceiling surfaces. | *Surface conduit should be avoided wherever possible to reduce wall and ceiling trim and painting requirements in new and renovated buildings and maintain visual appeal.* |
| .3 Wood Frame Construction<br>.1 Where a conduit is not required by the Code but is installed in a wood frame construction, the conduit may be terminated in junction boxes convenient to each room (i.e., above T-bar ceilings, in crawl spaces, etc.). NMD90 or armoured cable may then be used as wiring to the power outlets from this junction box. | *The intent is to reduce construction costs and yet allow some flexibility in wood frame construction by providing a "grid" system of conduit and junction boxes.*<br>*Facilities where future electrical requirements are most likely to change include maintenance shops, open offices, and modular classrooms in schools.* |

.2 Conduit is not required for long runs or where only a single circuit is used (i.e., exterior lights, exit lights, emergency battery pack remote heads).

*Conduit to allow for expansion of electrical power systems is typically not required for residential facilities such as student residences or group homes, arena support space areas, gymnasiums or community halls, garages, warehouses or fire halls.*

.4 In Slab Conduit

Ensure adequate depth in slab to avoid fasteners.

*Conduits need to be protected from mechanical fasteners.*

Coordinate with mechanical heating lines.

*Proximity to in slab heating lines can result in de-rating of conductors.*

### 6.1.2 Basket Tray

Basket tray is desirable where many structured wiring cables will be installed. Basket tray should also be installed where there is a strong potential for frequent changes to structured wiring, or where multiple systems (ie: security, CCTV) may be added at a later date.

*Basket tray allows for very fast installation and for ease of changes in the future. Data requirements are changing very quickly and the tray allows for a neat installation for retrofits.*

Basket tray should be designed for future additions.

A minimum of 21mm conduit from the basket tray location should be installed to the point of use.

*A 21 mm conduit provides ample room for a variety of cables that may be terminated at one point of use within a room.*

### 6.1.3 J Hooks

It is also acceptable to branch off a cable tray system at right angles using J-hooks for support in concealed spaces (above T bar ceilings).

*J-hooks provide an approved means of attachment for a variety of cables when few are required to a point of use. This cabling system also improves cabling organization above ceilings.*

Install 21mm conduit sleeve within wall to allow for cable installation.

*Conduit provision allows for ease of installation and future cabling upgrades.*

### 6.1.4 Surface Mount Raceway

Preference is to concealed raceways, although areas that are being renovated, or frequently renovated, where the wall finish is not being removed, surface mount raceway may be used, provided the appearance is matched to other architectural finishes in the space.

*In areas that experience frequent renovation the visual appearance of surface mount raceway can be offset by lower cost of the renovations and the flexibility of surface mounted raceways.*

Surface mount raceway would also be acceptable for short runs to feed non-permanent pieces of equipment such as intelligent whiteboards.

*These installations are often changed, frequently require different connections than previous generations and are often installed by non-electricians. Architecturally finished surface mount raceways provides a way to run cords in a tidy and inconspicuous manner.*

### 6.1.5 Telephones

Telephone cabling should be run in structured wiring type cable, and follow all applicable guidelines.

*This allows for greatest flexibility in ever changing cable requirements, as each client department is often responsible for all wire installation. Structured wiring also allows for future changes to telephone technology.*

Where twisted pair telephone lines are installed in a facility, cables should be installed in conduit where exposed to mechanical injury.

*The installation of conduit provides mechanical protection and for future changes within a building.*

### 6.1.6 Owner Equipment

Group wiring and cables for centrally controlled or networked equipment in a common conduit or raceway. Conduit should be sized to allow for some expansion.

*Examples of systems where this should be applied include computer LANs, intercom systems (independent of telephone), sound systems and television systems. Equipment and systems should be identified in facility programs.*

### 6.1.7 Air / Vapour Barrier

Conduit penetrations through air/vapour barriers need to be sealed inside and outside of the conduit.

*See Architectural A3.1, A3.3, A3.4, and A3.6. Sealing prevents air and moisture penetration that can detrimentally affect installed electrical systems and wiring.*

## 6.2 WIRE AND CABLE

### 6.2.1 Type and Size

.1 Copper wiring only, thermoset type insulation R90, RW90 (XLPE).

*Compared to TW or thermoplastic insulation, thermoset XLPE insulation provides a wider range of acceptable operational temperatures encountered in northern buildings. XLPE insulation is also more robust and thus not as susceptible to installation damage.*

Cable types NMD90, AC90 or Teck90. All wiring to be minimum #12 gauge with the exception of control wiring and low voltage wiring.

*#12 is specified to prevent voltage drop problems associated with #14. Heat ($I^2R$) losses are reduced.*

It is to be noted that NMD90 cabling is only FT1 rated. It cannot be installed in a return air plenum.

*This note is provided for information purposes to ensure where NMD is installed in a wood structured building that it is not installed in a return air plenum.*

.2 Control wiring and low voltage wiring (i.e., fire alarm) can be as per minimum code requirements.

*This confirms that minimum code requirements are acceptable for control and low voltage wiring.*

.3 FAS cable is acceptable for fire alarm systems in wood frame construction.

*This confirms that minimum code requirements are acceptable for control and low voltage wiring.*

.4 The use of aluminum wiring is not recommended.

*Connections require special procedures and application of antioxidant material. Also require annual inspections as they have a tendency to loosen.*

.5 Structured wiring that does not meet the flame spread rating the NBCC requires should be removed during renovations.

*Older Cat 3 cables or non plenum rated cables that have been installed in plenum spaces need to be removed to reduce fire load and smoke development.*

Capacity and rating of cable should be considered during schematic design.

*Rapid changes in industry mean that any specific preference for capcity of structured cabling (ie: Cat 6) could easily be outdated prior to new GBP's being issued.*

## 6.3 WIRING DEVICES

See Electrical E2.4 Standardization".

Recommendation

*Rationale*

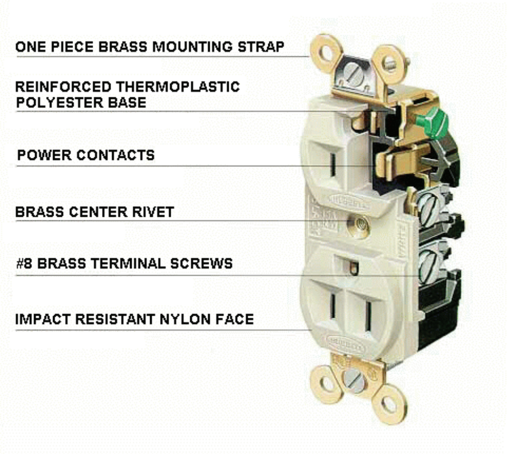
### 6.3.1 Grade

Wiring devices should be "Specification Grade" or better for all applications.

*Residential quality is not durable enough for public buildings.*

The following set the Standard of Acceptance:

- Standard receptacle: Cooper, Eagle 5252, Hubbell 5252 or Leviton 5252 Specification grade.
- Surge suppression receptacle: Hubbell 5252-S c/w blue nylon face (5261-SP).
- Ground fault receptacle: Bryant GFR 5252 FT, Hubbell GF 5252.
- Standard switch: Cooper, Hubbell or Leviton specification grade.
- Exterior light control: Hubbell 1381-T (spdt).



### 6.3.2 Colour

Wiring devices (receptacles and switches) should be of the same colour throughout the building. Preference is user defined. Exceptions:

*The intent is to standardize the colour for replacement and stocking purposes, yet allow some flexibility for the designer's choice (i.e., ivory, white, brown).*

| | |
|---|---|
| • Surge protection outlets | Blue |
| • Emergency outlets | Red |
| • Isolated ground | Orange |

### 6.3.3 GFCI Outlets

Interior ground fault receptacles may be the receptacle type that have "test" and "reset" on face of receptacle.

*GFCI receptacles are much less expensive than GFCI breakers, and also more likely to be tested regularly because the test is readily accessible.*

Exterior ground fault receptacles will need to be protected by a GFCI breaker, not from within the receptacles itself.

*GFCI receptacles do not function properly in cold temperatures, and exterior receptacles that require GFCI protection must have the GFCI protection in a warm location.*

### 6.3.4 Cover Plates

Stainless steel, enamel finish metal is the preference, however, nylon receptacle plates will be considered.

*Stainless steel plates are typically used in schools, health centres and detention facilities, as they are the least susceptible to damage. Enamel finish metal or nylon is acceptable for most other uses including student residences, offices, group homes and treatment centres.*

Bakelite is not recommended.

*Bakelite plates are not durable.*

Recess wall receptacles within gymnasiums approximately ½" from front wall surface.

*This reduces impact forces on receptacles resulting in broken receptacles and bent cover plates that can become a safety hazard.*

### 6.3.5 Crawl Space

Receptacles may be provided in all enclosed crawl spaces. Locate receptacles adjacent to all equipment or mount receptacles so that any point in the area is not more than 25 m horizontally from a receptacle.

*The NBCC does not clearly cover requirements for crawl spaces, which are a common feature in buildings. These receptacles may be required to provide power for "trouble lights," pumps and/or repair equipment.*

Regardless of enclosed crawlspace heights, do not install NMD cabling on bottom cord of floor joists. Provide protection by location of cabling or by mechanical means.

*Enclosed crawlspaces are typically used for maintenance activities or material storage. NMD cabling is much more prone to mechanical damage than armored cable or conduit.*

Install GFCI protection on crawl space receptacles.

*Moisture and standing water can be found in many crawlspaces during seasonal variations. GFCI protection provides increased safety to maintenance personnel.*

### 6.3.6 Outdoor Receptacles

Receptacles should be provided if they are a program requirement.

*Minimize the use of exterior electrical cables; keep outlets above snow level.*

Flush mount exterior electrical outlets on the building unless otherwise stipulated, and ensure that they are mounted above the level of winter snow accumulation.

*Flush mounting has been found to be less susceptible to vandalism. Mounting on buildings is also desirable because people tend to leave a walking space between the vehicle and the building in order to access the receptacle.*

Parking rails with receptacles are preferred. Posts may be used only where necessary or unavoidable.

*Install rails at or above vehicle grill height, as people will be a more cautious when approaching.*

Parking outlets should be split receptacles if they serve 2 parking stalls.

*Vehicles in the North generally have a block heater, and battery blanket. Some vehicles may also have an oil pan heater. To avoid nuisance tripping, a separate circuit is usually provided for each parking stall.*

Where only a few exterior receptacles are required for vehicles, use intelligent receptacles that are programmable with a delayed response to initial connected load, are temperature sensitive and are individually adjustable.

*Providing an intelligent receptacle can reduce energy costs due to unnecessary use.*

When more than 10 automobile stalls or spaces are required, consider installing a control system that provides power to the outlets in the following manner:

*This is required for energy conservation.*

- Above -20°C: No power.
- -20°C to -30°C: Cycle power
  (i.e., 20-30 min on, 20-30 min off).
- Below -30°C: Continuous power.

The controller can be either a centralized panel or an intelligent receptacle.

When 10 or more outlets are provided, at set point temperatures between -20°C and -30°C, the outlets could be cycled in such a manner that only one-half of the outlets are energized at any given time.

*This is required for energy conservation. It reduces demand charges.*

A separate set of car plug controls needs to be designed for propane and diesel driven vehicles where these types of vehicles will be plugged in.

*Propane and diesel driven vehicles require more heating.*

Mechanically protect exposed low temperature thermostat sensors so that they are exposed to the wind and isolated from sources of heat. (e.g., a wire mesh guard or similar device).

### 6.3.7 CSA Z32.2 “Electrical Safety in Patient Care Areas”

Receptacles need to conform to requirements as follows:

*Clarification of application of the Z32 Standard. Terms used here are as defined in the Standard*.

Hospital grade receptacles are identified by a green dot on the receptacle face. These receptacles should only be installed in patient care areas to differentiate from receptacles installed outside of these basic, intermediate or critical care areas.

*It is our intent to clearly identify receptacles that must be installed and tested to Z32 requirements, and thereafter tested on a regular basis by maintenance staff.*

*Hospital grade receptacles that have not been installed to Z32 requirements should either be replaced with specification grade, or the wiring upgraded to meet Z32 installation requirements. This ensures medical staff are properly informed of the nature of the installed system.*

Classification of care areas within a Community Health Care Center must be confirmed with the appropriate authority prior to finalizing design.

## E7 LIGHTING AND LIGHTING DESIGN

This section deals with lighting not only as it relates to building electrical systems, but also as it relates to architectural and interior design. Lighting Design is defined in the Illumination Engineers Society Handbook as,

*"Providing light for the visual tasks to be performed and creating a balanced, comfortable, and aesthetically appealing environment coordinated with the decorative and architectural theme."*

### 7.1 INTERIOR LIGHTING

Artificial lighting requirements are not much different in the NWT than anywhere else in North America, although the potential for day lighting is more limited during winter months. The use of "energy saving" lamps, fixtures, and switching devices which allow discreet control, is important because lighting accounts for a large portion of electrical costs. The use of new and innovative products, however, should be carefully considered in terms of cost, availability and maintenance on a Regional scale. The role played by lighting in enhancing the architectural setting, orientation and atmosphere is to be recognized.

| | Recommendation | *Rationale* |
|---|---|---|
| **7.1.1** | **Illumination Levels** | |
| | Lighting intensity and quality should be to the recommended minimum of the current edition of the Illuminating Engineering Society's (IES) Lighting Handbook and IES recommended practices for different facilities. | *This is recognized as the industry standard. Facilities such as schools or health facilities have recommended practice documents that detail many considerations that should be made when designing lighting layouts beyond the simple intensity at the workplane.* |
| **7.1.2** | **Energy Efficiency** | |
| | Designers are encouraged to meet or exceed the energy budgets for lighting as set out in ASHRAE/IES 90.1 or the Model National Energy Code. | *Costs for electrical energy in the northern environment are high. The goal is energy efficiency.* |
| **7.1.3** | **Daylight** | |
| | Where daylight can contribute to illumination for a significant portion of the annual occupied hours in any room, the artificial lighting levels should be adjustable to take advantage of day lighting. | *Minimum lighting levels have to be calculated based on northern winter conditions when day lighting is not possible in most NWT communities. Where daylight can provide adequate illumination to a room or a portion of a room, there must be the capacity to turn off redundant electrical lighting, (by automatic or manual control) if any energy savings are to be achieved. Large areas with rows of fixtures controlled by a single switch for example, do not normally allow the flexibility required.* |

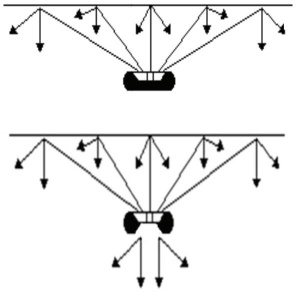
Lifecycle costing should be performed, as well as an attempt to outline the qualitative aspects of daylighting in justifications for daylighting.

*Low angle sunlight and snow accumulation are items that affect northern buildings, and differentiate this from southern applications. In general, understanding of daylighting in northern building is poor, although it is clear that there is a benefit well beyond the economic benefits, this would include benefits to circadian cycles, vitamin D.*

### 7.1.4 Indirect Lighting

Indirect lighting should only be considered where the quality of the lighting is the most important factor in the lighting design.

Fixtures that are a combination of direct and indirect lighting are preferred due to the high cost of energy in the north.



*For most public sector buildings, the life cycle cost is the most important factor. Typical applications such as school gyms and entrance foyers should not be considered for indirect lighting unless the additional life cycle cost is insignificant (i.e., <5%).*

Where indirect lighting is appropriate, reasonably uniform ceiling luminance is to be achieved.

*If this is achieved, occupants may face in any direction without being subject to excessive ceiling reflections on the tasks.*

### 7.1.5 Valence Lighting or Spot Lighting

Use only for task lighting, display cases and walls that are intended to be features or where dramatic lighting is important.

*Minimize this practice because of poor lumen/watt ratio obtainable and the tendency to pick up irregularities of wall surfaces such as painted drywall.*

### 7.1.6 Night Lights

Provide night lighting only where minimum lighting for safety or security is required at night and where light switches are not conveniently located.

*The high cost of electricity limits the use of night lighting. Appropriate uses are group home hallways (for safety) or arena lobbies (for security) where switches are normally located at a central panel or in a closed-off room.*

### 7.1.7 Fixtures

.1 Polycarbonate Fixtures

Are ideal for use in change rooms and ancillary washrooms.

*There is a high potential for vandalism in some washrooms and change rooms (i.e., arenas, schools).*

.2 Over-counter Lighting

Where required, provide separately switched task lighting over counters (i.e., fluorescent valance lighting under cupboards).

*Work at counter tops often requires good lighting for tasks (e.g., nursing stations - writing reports, kitchens - reading recipes) and helps in overcoming shadows cast by the body from general room lighting.*

.3 Task Lighting

Wherever possible, provide built-in task lighting to supplement the ambient lighting for critical seeing tasks, rather than providing high ambient lighting.

*This assists in energy conservation and accommodates the need for higher lighting levels due to task visual difficulty, glare, etc. Typical applications are desks in student or senior residences, as well as airport control towers.*

.4 Arena / Curling Fixtures

All luminaries in unventilated (less than 3 air changes / hour) arenas / curling rinks need to be suitable for use in wet locations.

*High humidity due to flooding of rinks and the lack of mechanical ventilation causes severe condensation and frost build-up.*

.5 Indirect T bar Fixtures

Provide improved optics over deep louvered parabolic fixtures.

*Reduced glare, no lens shrinkage, reduced cleaning and design provides improved operating temperature for T5HO lamps if required.*

### 7.1.8 Lamps

.1 Incandescent Lamps

Incandescent lamps, including halogens, are recommended for use only for special light-critical applications, or in locations where other types of lamps will not perform satisfactorily (i.e., cold temperature applications).

*This assists in energy efficiency and avoids re-lamping costs.*

*Special applications may include unheated crawlspace, hospital operating rooms and light sensitive display areas in museums.*

.2 Fluorescent Lamps

.1 T-8 lamps are recommended for most general lighting applications within heated spaces.

*These lamps are energy efficient, and have a proven high Colour Rendering Index (CRI). Intent is also to reduce inventory. Typical uses are for general lighting in office areas, classrooms, lobbies, health centres, maintenance garages, firehalls, community halls, gyms and kitchens.*

.2 T5HO lamps are recommended for high/low bay applications as well as for use in indirect fixtures within heated spaces.

*T5HO performance is generally superior to that of T8 and HID fixtures but because of the high intensity output, will give a bright “line” look to direct fixtures in lower ceilings unless designed as part of an indirect fixture.*

Exceptions: unheated spaces.

*These lamps require a higher operating temperature for efficiency which can restrict application.*

.3 Fluorescent lamps should have CRI >80, colour temperature should be 3500k for warm and 4100k for cool colour temperatures.

*T-8's have a high Colour Rendering Index (CRI between 80 and 85) and produce more light for the same wattage than other lamps; i.e., fewer fixtures are required resulting in lower capital and maintenance costs.*

*Lamp selection must be done to standard lamps, instead of careful specification. It is unlikely that local O&M staff will be able to procure proper replacement lamps if tightly specified lamps with lumen/CRI/power consumption levels are significantly beyond the norm.*

.4 U-shaped fluorescent lamps or tubes over 4 ft (1.2 m) in length are not recommended.

*Cost of U-shape is a major concern. (34 watt U- shaped are currently 20 times as expensive as standard 4 ft. 34 watt lamp). Lamps over 4 ft (1.2 m) require larger storage area and are more susceptible to breakage during shipping.*

.5 Compact Fluorescent

Practical wherever low level lighting is required to be on continuously or for extended periods of time.

*Although compact fluorescent lamps are more expensive than incandescent bulbs, low energy consumption means life-cycle costs are much lower when lights are used continuously. They are typically used for recessed decorative lighting.*

Compact fluorescent lamps are available in various wattages, i.e., 13W, 26W, 32W and 42W, twin, triple and quad tube formats.

Standardize wattage and formats on each project.

*The intent is to standardize maintenance and lower inventory requirements, especially important in remote communities.*

Advances have been made in electronic dimming of compact fluorescent lamps with appropriate controls.

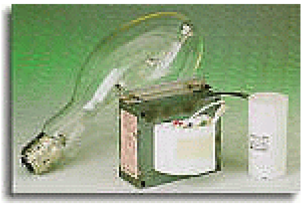
*Use of pin type compact fluorescent lamps instead of integral ballasted lamps within dimming fixtures ensures replacement with appropriate sized lamps.*

Recessed fixtures housings and trims should be designed for lamp type.

*This provides for increased efficiency.*

.4 High Intensity Discharge (HID) Lighting

.1 Metal halide (MH) lamps should be used for exterior applications where accurate colour rendering is of benefit.



*Metal halide lamps provide an acceptable colour rendition. They are typically used for large area flood lighting, indirect spotlighting, exterior lighting and where low operating temperatures are required. Use pulse start electronic ballasts, and compatible lamps.*

.2 High pressure sodium (HPS) sources are best suited for exterior lighting where color rendering is not a factor.

*HPS sources generally provide poor colour rendition, although they have a good lighting efficacy and can be high powered, making them ideal for outdoor applications. Note that MH lamps have similar qualities to HPS, but have superior CRI to HPS.*

### 7.1.9 Ballasts

.1 Ballast Factor

Ballasts are to be standard ballast factor type (i.e., approximately .88).

*High or low ballast factor ballasts may be difficult to procure for O&M purposes.*

.2 Total Harmonic Distortion (THD)

Ensure that harmonic distortion is <10%.

.3 Rapid Start Ballasts

Specify rapid start ballasts (RS), rather than instant start (IS) ballasts for fluorescent fixtures.

*Instant start ballasts shorten lamp life, especially when used with rapid start lamps and/or if the lamps experience short cycling times (i.e., less than a three hour burning cycle).*

.4 Low Temperature Ballasts

Provide low temperature ballasts for all exterior lighting and for lighting in unheated buildings (i.e., arenas, cold storage garages).

*Luminaries suitable for cold weather conditions are also required in unheated buildings.*

.5 Programmable Ballasts

Programmable or addressable ballasts should not be considered unless significant cost savings can be shown.

At this time, the GNWT is not encouraging the use of addressable ballasts as a form of lighting control. This is seen as a system that will introduce maintenance complications with minimal advantages over other low voltage lighting controls.

.6 Dimmable Ballasts

Ensure that low voltage wiring cannot be confused with line voltage wiring. Ensure that a full 100 hour burn-in time is done prior to using dimming capability. THD <10% at full power, with steps sizes <5%. Low voltage control should be 0-10VDC.

Cost of burn in time of the lamps for dimmable ballasts is substantial. When lamps need to be replaced, if not performed for the new lamps, the expected service life will be greatly reduced.

### 7.1.10 Plastic Luminous Panels

Use acrylic prismatic lenses with a minimum thickness of 0.125” (K12) mounted within a frame.

*This identifies the standard of acceptance. A framed lens is not prone to falling out of the fixture due to lens shrinkage or vibration.*

### 7.1.11 Lighting Controls

.1 Except as permitted in 7.1.12.2, all interior lighting systems shall be provided with manual, automatic, or programmable controls.

*This is an adoption of requirements outlined in the National Energy Code for Buildings published in 1997.*

*The goal is energy efficiency.*

.2 Controls are not required where:

- .1 continuous lighting is required for safety or security purposes, or
- .2 lighting is emergency or exit lighting.

.3 Each space enclosed by walls or ceiling height partitions shall be provided with controls that, together or singly, are capable of turning off all the hard-wired lights within the space.

.4 Where practical, subdivide spaces to allow greater flexibility and energy saving where possible.

*The goal is energy efficiency.*

### 7.1.12 Location of Controls

.1 Except as provided in 7.1.13.2 and 3, lighting controls shall be:

*This is an adoption of requirements outlined in the National Energy Code for Buildings published in 1997. The goal is energy efficiency.*

- .1 located next to the main entrance or entrances to the room or space whose lighting is controlled by those controls;

*Requiring controls to be located at the entrances to the spaces served will not only encourage the use of the controls, but will reduce the likelihood that circuit breakers will be used for that purpose.*

- .2 located in such a way that there is a clear line of sight from the control to the area lighted; and
- .3 readily accessible to persons occupying or using the space.

.2 Low voltage relay cabinets are ideally wall mounted near electrical panels supplying lighting circuits.

*This provides ease of access for maintenance and setting of controls.*

### 7.1.13 Type of Controls

.1 Low Voltage Switching (LVS)

Consider LVS wherever there are multiple circuits and the switching is desirable from multiple locations.

*This is not economical where there are few circuits. This is typically used in schools, health centres and correctional facilities.*

Install programmable controls to provide after hours sweep off capabilities.

*This provision ensures fixtures are not left on after normal operational hours. Flick warning allows after hours use.*

Install low voltage switching in all cases where 347 volt lighting fixtures are in use.

*This provision limits access to increased hazards when cover plates are removed for painting or electrical maintenance.*

Network panels in facilities with multiple low voltage control panels.

*This provision allows ease of trouble shooting, programming/setting changes for maintenance staff.*

.2 HID Switching

Install HID switching so that they are protected against accidentally being shut off. This can be done through:

*This prevents HID fixtures from being accidentally shut off. The restrike time creates a delay before light levels are back to normal and that delay is a safety concern. At best the delay is an inconvenience.*

.1 location (i.e., in an area not readily accessible to the public) or

.2 mounting height (i.e., install at 2.1 m) or

.3 protective covers.

.3 Motion Sensor Switches

Passive Infrared Sensors (PIR) or dual technology sensors should be used to control lighting in all rooms that may be left unoccupied for extended periods of time (i.e., classrooms, offices, gyms, boardrooms, garages, janitor rooms) except for crawlspaces and service spaces.

*They provide energy efficiency and security. Motion sensors should be used when the reduced energy consumption makes the increased capital cost worthwhile. The cost of electricity, type of fixture and space function will determine when motion sensors should be used. Motion sensors are not acceptable where lights going off unexpectedly may cause life safety issues.*

They should be installed where:

.1 The SIMPLE payback period is less than 5 years (assume the sensor will switch off the lights for 100 hours/year), or

*The length of time the lights will be shut off by the sensor is usually unknown; so to make the calculation and comparisons possible, the shut off period effected by the sensor has been standardized (based on 30 minutes/day x 200 days).*

.2 automatic lights are required for security reasons.

.3 The PIR sensors require an override option.

*In case of malfunction or inadequate coverage, the occupants must be able to override the lights.*

.4 Ceiling mounted sensors are preferred to cover larger areas.

*This is because they provide full 360° coverage and are less likely to be subject to tampering.*

.4 Key Operation

Keyed lighting switches are not recommended.

*Keys are easily lost, and lights are then left on unnecessarily resulting in wasteful energy consumption.*

.5 Service Space Lighting

Wherever lighting is provided in typically unoccupied spaces, (i.e., crawl spaces) a pilot light, indicating whether service lights are “on”, may be conveniently located at the entrance to the service space.

*Lights can be left on inadvertently for extended periods of time, and nobody would be aware, because that space is not normally used.*

.6 Daylight Harvesting

Perform life cycle costing analysis.

*Where daylight study justifies, install daylighting controls for energy efficiency.*

.7 Power Pack Installations

Where life cycle cost analysis recommends motion sensor or daylight sensors, relays may be mounted above T bar ceilings. Restrict to 120 volt lighting control. Low voltage wiring needs to be installed where not susceptible to mechanical damage from sharp edges and vibrations.

*Access difficulties to power packs can create unsafe working environments when troubleshooting 347 volt lighting circuits.*

### 7.1.14 Protection of Light Fixtures

.1 Wire Guards

Luminaries require wire guards if located in areas where they are subject to damage.

*Protection of luminaries in such locations is necessary to prevent lamps from being damaged by moving objects during games or during storage of equipment, and to prevent subsequent injury to persons. Guards may be required in gyms, service areas, storage areas, industrial arts classrooms, locker rooms and for exterior lights.*

.2 Safety Chains/Cables

Suspended fixtures in recreational / sports facilities must not rely on support directly from an outlet or box or fixture hanger; provide safety chains / cables.

*This is required to ensure that luminaries cannot fall when impacted by moving objects.*

## 7.2 EXTERIOR LIGHTING

Exterior lighting should be provided for safety and security reasons only (i.e., only install exterior lighting where they are required by code or by function as determined by the facility program). The high cost of electricity in the NWT makes the use of any decorative lighting undesirable.

Recommendation

*Rationale*

### 7.2.1 Fixtures

Polycarbonate fixtures are well suited for all exterior lights. For all facilities consider the use of vandal resistant fixtures.

*This reduces breakage due to high potential of vandalism. Some facilities experience very high rates of vandalism and it may be warranted to install fixtures and metal guards that will stand up to significant abuse.*

Fixtures IESNA dark sky compliant and layout to avoid light trespass.

*Reduces energy costs.*

### 7.2.2 Lamps

Ceramic Metal Halide lamps, with CRI >80, and luminous efficacy >85 lm/W (initial lumens), using a pulse start ballast with cycling detection are recommended for exterior lighting.

*Superior colour rendering of these fixtures offsets the slight difference in inefficiencies between HPS and MH. HPS will be acceptable only for some industrial type applications.*

Ceramic Metal Halide may provide improved CRI and energy efficiency for safety and security.

Efforts should be made to standardize lamp size to reduce inventories and lamp ballast mismatching.

### 7.2.3 Ballasts

See Electrical E7.1.10.4
“Low Temperature Ballasts.”

### 7.2.4 Controls

.1 Exterior Lighting Controls

Except as provided in E7.2.4.2, exterior lighting shall be controlled by:

*This is an adoption of requirements outlined in the Model National Energy Code for Buildings.*

- lighting schedule controllers;
- photo cells (PEC) located so that the PEC is not covered in snow during the winter or adversely affected by the lights it controls (on/off cycling); or
- a combination of lighting schedule controllers and photo cells.

*Controllers allow for user defined flexibility between providing security, safety and energy concerns which can vary depending upon location, operational hours and facility type.*

*The goal is energy efficiency.*

Locate PEC on north side of building.

If networked low voltage control systems are employed in a facility, integrate the exterior lighting controls.

*This provision will simplify operational and maintenance requirements.*

.2 Lighting Schedule Controllers

.1 Controllers required in 7.2.4.1 shall be of the electronic type capable of being programmed for 7 days and for seasonal schedule variations.

*The intent is to allow flexibility within various types of facilities.*

.2 Schedule controllers should be of a type that does not derive its time base from the AC power line frequency.

*The small isolated utility power systems in all NWT communities typically have poor frequency stability that is not suitable for clock time bases.*

.3 Back-up

All lighting schedule controllers shall be equipped with back-up provisions to keep time synchronization during a power outage of at least 4 hours.

*Power outages occur relatively frequently and maintaining the schedule is desirable for appropriate operation.*

.4 Daylight Savings Changes
Capable of automatic setting changes.

*This reduces maintenance costs.*

## 7.3 EMERGENCY LIGHTING

Recommendation

*Rationale*

### 7.3.1 Lamps

Emergency lighting should be installed in areas required by the NBCC, as well as, service spaces (i.e., generator rooms, mechanical rooms, usable crawl spaces) stairwells and washrooms.

*This will allow servicing in service areas when power supply fails; lighting for egress from service areas, crawl spaces and washrooms should be maintained as outlined in the NBCC. The provision of lighting in stairwells is for occupant safety during the time it takes for an emergency generator to provide power for lighting.*

Where Emergency generators provide lighting ensure that emergency battery powered lamps are provided in the generator room and stairwells.

### 7.3.2 Location of Battery Packs

Battery Packs should be installed in service spaces, corridors or other spaces easily accessible to O&M staff.

*Battery packs must be frequently tested and should not be located in areas where they may be subject to vandalism, such as a school washroom.*

### 7.3.3 Timers

In spaces that are illuminated only by high intensity discharge (HID) lighting (i.e., arenas), emergency lighting is to be timer controlled so that it stays on for 15 minutes after resumption of power.

*This will provide emergency lighting while HID lights “restrike”. HID lighting with quick restrike lamps and integral quartz lamps which provide instant illumination during the restrike cycle are an acceptable alternative.*

### 7.3.4 Auto-test

Automated self-diagnostic circuitry card (auto-test) should be provided for emergency lighting in facilities. with centralized battery pack unit(s).

*The auto-test system automatically tests a centralized battery pack unit monthly. Burned-out lamps are automatically sensed to indicate replacement required. The auto-test system is economical on central battery pack systems.*

### 7.3.5 Remote Heads

When located in gymnasiums provide securely mounted and adequate protection around remote heads.

*High impact sports require not only strong wire guards covering fragile devices, but these guards need adequate backing to prevent damage to wall finishes.*

## 7.4 EXIT SIGNS

| Recommendation | *Rationale* |
|---|---|
| **7.4.1 LED's** | |
| The exit sign should be illuminated with light emitting diodes (LED), with no external transformer required, a 25 year life expectancy, a 10 year warranty, a DC voltage option and a power consumption of 2 watts per face.<br>All exit signs are to meet the CAN/CSA C860 standard. | *This is acceptable because of its low energy consumption.* |
| **7.4.2 Guards** | |
| When located in gymnasiums provide securely mounted and adequate protection for fixture. | *High impact sports require not only strong wire guards covering fragile devices, but these guards need adequate backing to prevent damage to wall finishes.* |

# E8 OWNER / COMMUNICATION EQUIPMENT

Telephones and computers are typically anticipated during building design. Current and future equipment requiring cable or special wiring must be routinely considered during design. Basket or cabling tray may be suitable for projects to consolidate all low voltage cable requirements. Figure 8-1 is provided below to encourage consolidation of head end equipment within a single location to limit floor space, and mechanical ventilation requirements.

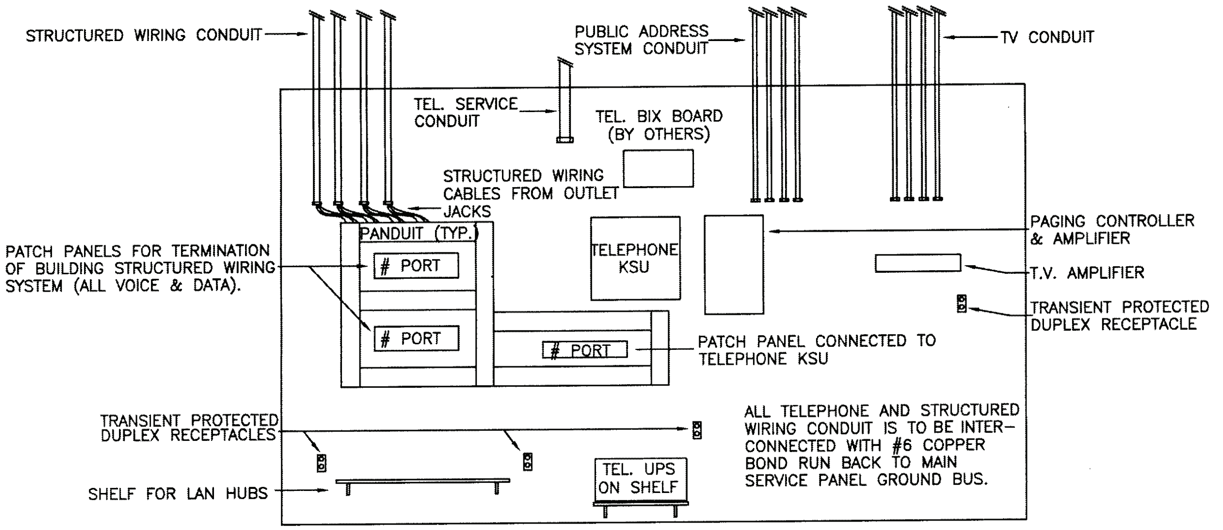


Figure 8-1 Typical Layout for Communication Equipment

## 8.1 TELEPHONES AND INTERCOMS

Northwestel provides telephone services across the NWT. The utility provider’s responsibility is generally to the demarcation point (lightning protection block) usually located within a building. This is the point of interconnection between the utility service wiring, and the property owner’s internal wiring and equipment. Communication systems vary from simple two or three line telephone distribution systems to multiple-phone use with teleconferencing and video capability. VoIP (Voice over Internet Protocol) use is also gaining popularity.

| Recommendation | *Rationale* |
|---|---|
| **8.1.1 Telephone Requirements** | |
| Supply and installation of cabling beyond the demarcation point located at the utility providers entrance to the building is the building owners or tenants responsibility. | |
| **8.1.2 Pathways** | |
| Pathways are to be provided as outlined in the Canadian Electrical Code, and TIA 568 and 569. Cabling is to terminate at a backboard in a service room with a dedicated duplex outlet. | *This is done to ensure that a telephone service and pathway system is installed within every building and that a consistent location is chosen for terminations.*<br>*The duplex outlet is for a UPS power supply. (A quad receptacle shared with the Cable TV is not acceptable as the size of plugs c/w transformers restricts plugging both power supplies into a quad outlet.)* |
| **8.1.3 Communication Rooms** | |
| Separate communications rooms should be provided only when the complexity of the communications systems warrants it. | *Health centres may require space for video conferencing and associated equipment for medical and educational support.* |
| The following are guidelines for space requirements:<br>.1 Buildings with 10 or fewer phone lines:<br>• minimum 600 mm x 600 mm wood backboard. It can be installed in a mechanical or electrical room. | *Modern telephone equipment can withstand a wide range of environmental conditions. Small and medium-sized key systems can operate in almost any interior environment.* |

.2 Buildings with more than 10 phone lines:

- min. 1200 x 2400 mm wood backboard. It can be installed in a mechanical or electrical room.

*Large systems, especially Private Branch Exchange (PBX) with many tie lines, require a more controlled operating environment.*

.3 Ensure adequate space is provided for future growth of network equipment, RF amplifiers, Security equipment, Sound amplification etc.

### 8.1.4 Installation

Use star topology for wiring layout.

*Simplest system to trouble shoot and administrate. Problems with wiring are isolated to specific outlet.*

Figure 8-2 is provided to illustrate a star topology, and suitable termination blocks for multi conductor and device applications. Type of terminations may vary for various systems.

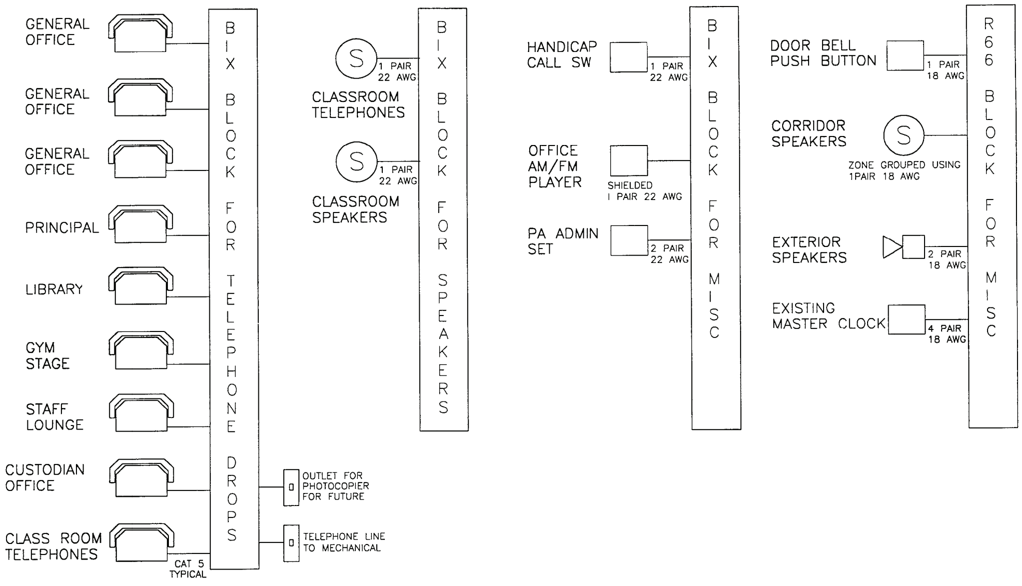


Figure 8-2: Typical Schematic for Analog School Communications Layout

### 8.1.5 Power Requirements for Telephone Systems

The community telephone distribution system has power backup for continued operation through utility power failures. This system provides the power needed for line connected handsets to continue to function.

Wireless handset head end equipment requires a UPS or emergency power to continue operation.

Building owned equipment that is operated and maintained by various departments requires carefully designed UPS for continued operation.

*Key service units (KSU) which provides onsite telephone exchange and an interface with utility service provider requires a UPS for power filtering and backup during power failures. VoIP networking equipment also requires its own power supply for continued operation.*

## 8.2 COMPUTERS

Computers require power, and/or networking cables and possibly telephone line connections to allow communication by modem. Electrical design should ensure the system can accommodate future expansion without significantly increasing construction costs.

Recommendation

*Rationale*

### 8.2.1 Networking

Wherever computers are identified as a current or future requirement in a facility program, allow for expansion using conduit or basket tray as outlined in E6.1.

*This allows for changes and future expansion.*

Where conduit is used, a minimum 19 mm conduit linking computer work stations to hub or cable tray locations.

*Conduit infrastructure allows for a wide variety of cable requirements i.e., from a basic single twisted pair of wires, a 4 pair cable, a coaxial cable, or a fiber optical cable from each workstation.*

A 19 mm conduit from the cross connect to the communication backboard is recommended.

## 8.3 TELEVISION AND CABLE

Recommendation

*Rationale*

### 8.3.1 Cable Installation

Where televisions or television monitors are identified as a current or potential future requirement in a facility program, assume cable connection may be required and allow for capacity in common conduit as outlined in Electrical E6.1.

*Typically used in classrooms, visitor centres and museums, group homes or detention facilities.*

Wherever cable television is identified as a current or future requirement, run individual cables to each TV outlet from a main television service backboard located in a service room, c/w a separate circuit duplex receptacle.

*The intent is to ensure that the required television service will be installed at a consistent location and to identify that a conduit system is not always required, but that cables are not to be looped to outlets (to prevent a cable malfunction affecting more than one outlet). The duplex receptacle is required for a plug-in transformer or RF (radio frequency) amplifier.*

Labeling of cabling is required at both ends of all cable runs.

*Cable labeling provides ease of cable management and troubleshooting.*

### 8.3.2 Television Distribution Diagram

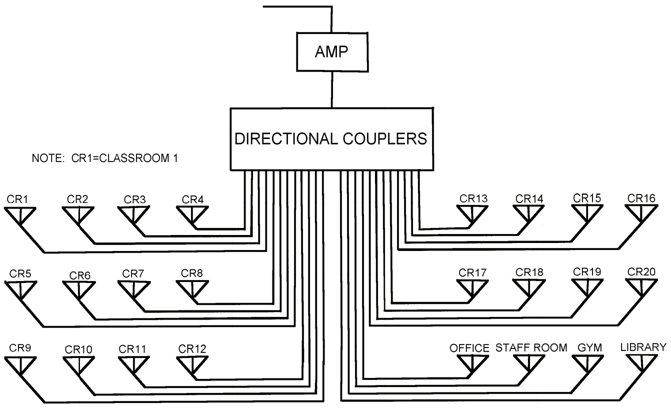


Figure 8-3: Typical School RFTV Distribution System

## 8.4 CLOCKS

Battery powered clocks are preferred. Class change signal clocks may be powered by an AC source, but should not derive the time base from the AC line frequency.

*Power outages and the frequency of fluctuations in cycles/second (Hertz) of diesel generated power adversely affect the accuracy of 120 volt clocks.*

# E9 ALARM SYSTEMS

The primary purpose of an alarm is to issue a warning, preferably before any major damage occurs. Although fire and security alarms are typical across Canada, mechanical system alarms are also commonly used in the NWT. Alarm systems must be suited to the community and its resources: in some communities resident maintainers may be able to respond quickly when alerted; in other communities residents are expected to notify the Hamlet or Band Office, who in turn can notify the area maintainer, who may have to fly or drive in.

## 9.1 FIRE ALARM SYSTEMS

See the references below to News Bulletins issued from the Office of the Fire Marshal. Where clarification is required on fire alarm systems, consult with the NWT Fire Marshal early in design. Systems should be as simple as possible (i.e., factory service technician should not be needed to program the fire alarm system).

| Recommendation | *Rationale* |
|---|---|
| **9.1.1 Supplier Qualifications** | |
| The system manufacturer must have an office established for a minimum of 5 years with full in-house technical service and maintenance capabilities. | *This is intended to clarify the qualifications required to supply a fire alarm system.* |
| **9.1.2 Product Manufacturers** | |
| Fire alarm systems should be supplied by one of the following suppliers:<br>• Simplex<br>• Notifier<br>• Edwards<br>Substitutions are not recommended. | *To ensure competitive bidding, yet limit the number of systems and replacement parts, the GNWT has specified 3 suppliers.* |
| **9.1.3 Types of Fire Alarm Systems** | |
| Fire alarm systems should not exceed the requirements of the NBC. | *This keeps the systems as simple as possible, and meets minimum Code requirements.* |
| Exception: Buildings designated as emergency shelters must have a fire alarm system, although not necessarily required by Code. | *People may be required to sleep overnight or longer in an emergency shelter, which necessitates a safe haven.* |
| If programming is required, it must be site programmable with a non-volatile memory (i.e., lithium battery back-up for programming). | *This maintains programming memory in the event of loss of normal and battery power.* |

Addressable systems may be capable of remote programming.

*This feature is useful for replacement of any devices without incurring the cost of air travel.*

### 9.1.4 Strobes / Sirens

See Electrical E9.6.

### 9.1.5 Manual Pull Station

To be installed in every floor area near every required exit, including crawl space exits.

*This is a clarification of the Code requirements*.

Manual pull stations in gymnasiums must be fully recessed.

*The intent is to prevent injury to people and damage to pull stations in gyms.*

### 9.1.6 Fire Alarm Notification Devices

Horn strobe devices should be used in place of bells. Devices need not be red.

*The intent is to ensure audibility and visibility where required. Red horn/strobes often take away from the architectural look.*

### 9.1.7 Fire Alarm Verification

Verification is to be carried out in accordance with Can/ULC-S537 and Office of the Fire Marshal.

*This will clarify verifying agent qualifications.*

### 9.1.8 Central Monitoring Stations

Use only where required by the National Building Code 3.2.4.7 and the NWT Fire Marshal.

*This is intended to clarify which projects require central monitoring with a DACT (Digital Alarm Communicator Transmitter). Consult the NWT Fire Marshal to determine which communities have local monitoring systems meeting this requirement of the building code.*

### 9.1.9 Auto Dialers

For local fire alarm notification, digital dialers described in E9.5 may be used to dial local fire phone systems. It is to be noted that these dialers do not meet Central Monitoring Station requirements.

*In emergency fire situations, local people need to be contacted immediately. Many OPX (Off Premise Exchanges) fire phone systems address this requirement for quick response.*

## 9.2 COMMUNITY FIRE SIRENS

| Recommendation | *Rationale* |
|---|---|
| **9.2.1 Standard of Acceptance** | |
| Federal Signal Corporation for items listed below: | *Most of the community fire alarm sirens in the NWT are now of this type and this manufacturer.* |
| • Sirens<br>• Model No. STH 10A (3ø) or STH10B (1ø) equivalent.<br>• Controls<br>• PGA (Predetermined General Alarm) timer or equivalent.<br>• Motor Starter<br>• Use RC5 Motor Starter (heavy duty relays, capable of handling the operating current) or equivalent. | |
| • Exercise Clock<br>• Model 75 or equivalent. | *The experience has been that this motor driven siren has given the fewest problems if exercised daily.* |

## 9.3 MECHANICAL SYSTEM ALARMS

Failures of mechanical systems can have serious consequences during the long, cold, winter months. The sooner maintainers can be alerted to a problem, the sooner they can make repairs or switch the building over to standby systems while effecting repairs.

| Recommendation | *Rationale* |
|---|---|
| **9.3.1 Mechanical Alarm Annunciators** | |
| Locate the primary annunciator panel in the mechanical room. | *The intent is to ensure that information is provided for building operators and maintainers.* |
| The secondary, remote panel is required to alert building users to mechanical problems. | *Typically required in schools, community halls, large residential facilities, and health centres where responsible users can notice and alert maintainers. Not required in firehalls, garages, or seasonal use facilities.* |
| **9.3.2 Nuisance Tripping** | |
| Ensure mechanical alarms are not initiated by a power interruption of less than 30 seconds, e.g., Edwards Panels. | *False alarm signals produced during a power interruption have created a nuisance both for local staff and personnel contacted by the auto dialler.* |
| **9.3.3 Auto Diallers** | |
| See Electrical E9.5. | |

### 9.3.4 Alarm Lights and Audible Alarms

See Electrical E9.6.

## 9.4 SECURITY SYSTEMS

| Recommendation | *Rationale* |
|---|---|
| **9.4.1 Intrusion Alarm Systems** | |
| Where a security system is a program requirement, monitor entrances, exits, corridors, and accessible openings. | *Intrusion alarms are installed for a variety of end purposes including when there is a danger of burglaries because of building contents, or as a means of reducing incidences of vandalism.* |
| Monitor rooms with high value or controlled contents. | *Computer labs, specialized equipment storage or pharmacies require controlled access.* |
| .1 Device Wiring | |
| Provide each device with individual conductors to main security panel. | *Separate wiring allows isolation of failed individual devices rather than total failure of the system. It also provides identification of individual device status for troubleshooting purposes.* |
| .2 Door contacts | |
| Mount within door frame during new construction. | *Mounting door contacts within frame provides excellent mechanical protection to door contact devices.* |
| Install door contacts for all exterior doors. | *Motion sensors do not confirm door position. Experience has shown that motion sensors can be repositioned and not noticed until after incidents. Door contacts are not as easily defeated.* |
| .3 Alarm Signal | |
| If there is a sound system within the facility, connect the alarm to the tone generator to sound a continuous tone upon receiving an intrusion alarm signal. | *The sound system tone generator, if available, is a desirable deterrent.* |
| .4 Partitionable | |
| Provide partitions to allow separation of areas within a building. This provides access to one area, while continuing to secure other areas. For example, schools with night use requirements (i.e., gyms). | *Many communities make good use of schools/gyms in the evening, and therefore, access to some areas is required at night without setting off the intrusion alarm.* |

.5 Enabling Systems

Time clocks or internal time settings may be used to automate the arm and disarm process for buildings that have regular schedules.

*This provision ensures the facility is secured through the normally unoccupied times.*

.6 Access Means

Access may be provided by a variety of means; key switch, keypads, key fobs, card access etc.

*Keys may be used to reduce the number of people in the community knowing the access codes.*

### 9.4.2 Video Monitoring

1. Privacy

   Before installing a CCTV system, check local laws regarding privacy and recording.

   *Never install video surveillance anywhere there is a reasonable expectation of privacy such as in bathrooms, locker rooms, changing rooms, medical examination rooms etc.*

2. Cameras

   *Each application requires a specific type of camera that will provide satisfactory image quality.*

   1. Outdoor cameras may require infrared illuminators to allow night vision. If the camera is a pan/tilt/zoom, a heated enclosure is needed to operate properly in our northern environment.
   2. Inside cameras that are exposed to brightly lit and dark areas will require a wide dynamic range and dual shutter speeds for picture clarity.
   3. Aisle cameras may require a long range lens, positioned to face away from light sources.
   4. Large open areas may require day/night cameras with wide angle lens.

3. Recording

   Digital Video Recorders (DVR) allow greater flexibility for recording space and network access from remote locations. Ensure equipment is located in a ventilated, secure environment suitable for continuous operation.

   *Operational environment will affect the durability of the installed equipment.*

### 9.4.3 Access Control Systems

Proximity type sensors are acceptable. Preference is given to door strike hardware. Magnetic door locks are to be avoided wherever possible.

*Access control systems simplify the process of ensuring secure access to various parts of a building. This can easily be done using the system's database. This has significant advantages over key and lock, but in small centers, it may become an encumbrance that is simply bypassed.*

Access control should not be used outside of the larger centers in the NWT.

*Maintenance of these systems requires a level of expertise not commonly found within isolated communities.*

Copies of the control diagrams should be located within enclosures designed for such and an additional copy provided within the appropriate section of the O&M manual.

*This provision is to assist future maintenance requirements.*

### 9.4.4 Patient Wandering Systems

Locate wiring diagrams and sequence of operation within front cover of main panel as well as O&M manuals.

*This provision is to assist future maintenance requirements.*

### 9.4.5 Panic Alarm Systems

Where panic alarm systems are a program requirement, they must be complete with a strategically placed audible alarm connected to the auto dialer. Call buttons should be of industrial quality.

*Typically, panic alarms are installed in health centres where a member of staff may be alone with clients and may require immediate assistance in case of emergency.*

Copies of the control diagrams should be located within enclosures designed for such and an additional copy provided within the appropriate section of the O&M manual.

*This provision is to assist future maintenance requirements.*

### 9.4.6 Auto Dialers

See Electrical E9.5.

### 9.4.7 Strobes/Sirens

See Electrical E9.6.

## 9.5 AUTO DIALERS

| Recommendation | *Rationale* |
|---|---|
| Where an auto dialer is not required by Code but is a program requirement, digital voice or digital dialer types are recommended as noted below: | *Auto dialers are the best method available to provide a signal of potential problems where there is a possibility of life or property loss (i.e., schools, health centres).* |
| Simplicity of programming is very desirable. | *To be able to talk an untrained person through programming over a phone connection to a remote community is very cost effective.* |
| A minimum 3 channel, digital voice, site programmable dialer is required. | *Three channels are currently required (fire/mech/security). The dialer must be simple to program on site providing messages in any language (i.e., English, Inuktitut, Dogrib).*<br>*Some dialers may have remote programming capabilities, which may be desirable in some Regions*. |
| All messages are to be cleared with appropriate authorities to ensure they meet their requirements. | |
| Do not include low domestic water or high sewage alarms on auto dialer. | *Low water or high sewage alarms do not signify conditions that warrant after-hours attention by maintainers.* |

## 9.6 ALARM LIGHTS AND AUDIBLE ALARMS

### 9.6.1 Exterior Alarm Lights

| Recommendation | *Rationale* |
|---|---|
| .1 Lights or strobes should be located on high point of buildings, clearly visible from the roadway. | *Lights can be used either to indicate a building condition, or to act as an alarm indicating a critical condition requiring immediate attention. Intended as a supplement to the auto dialer.* |
| Exception: Strobe alarm lights are not to be installed on arctic airports. | *The intent is to avoid confusion with landing lights, vehicle lights, etc.* |
| .2 Colour of lights<br>• Fire alarm: red<br>• Mechanical alarm: amber<br>• Security/panic: blue<br>• See 3.4.1 Table E-2 | *Colour coding is standardized on public sector buildings. Blue strobes are typically used for security systems and panic systems in health centres and correctional facilities, where staff may be alone with clients and could require immediate assistance.* |

### 9.6.2 Sirens/Horns

| | |
|---|---|
| Exterior audible alarms are required for fire alarm systems and security systems. | *Audible alarms can unnecessarily disturb the entire community. However, a fire condition is a critical condition that makes this disturbance necessary. Security system audible alarms are a deterrent as it draws attention to the building and the people nearby.* |
| A siren is not required for mechanical systems. | *With auto dialers and the strobe lights, the audible is not as necessary for mechanical systems (e.g., while air handling unit low temperature is a problem, it does not require disturbing the community).* |

### 9.6.3 "High Water" Light

| | |
|---|---|
| High water level in a holding tank is indicated by using an illuminated light mounted close to the water fill pipe. Water fill indicating lights should be LED type with 25 year life span and provide adequate illumination to be clearly visible. | *LED lights have low energy consumption and low maintenance requirements.* |
| Install a two lamp fixture. | *This provision ensures at least one lamp will illuminate in the event of a lamp failure.* |
| Locate in a visible location convenient to the operator. | *Water delivery pumps are controlled at the vehicle. The light indicates that the tank is full and that the driver should stop pumping.* |

# E10 MOTORS

## 10.1 CHARACTERISTICS

| Recommendation | *Rationale* |
|---|---|
| Motors must meet the specified minimum efficiencies in the Model National Energy Code for Buildings (MNECB) unless it can be shown that a lower efficiency motor will yield lower life cycle costs. | *This is done in the name of energy conservation.* |
| Installation of high efficiency motors should be installed where life cycle costs may be demonstrated. | |
| Match voltage rating of motor with supply voltages, i.e., use 200 V motors for 208 V services. | *Although 230V and 240V motors may function on 208 V, experience has shown that their life expectancy is greatly reduced compared to 200 V motors.* |

### 10.1.1 Motor Starters – 3 phase

| | |
|---|---|
| 1. Provide single phase protection for all motors 5 hp or larger with magnetic starters c/w solid state adjustable overload sections offering phase loss protection. | *This prevents costly motor replacement of large motors due to single phasing.* |
| 2. Provide “Hand” option and “Running” indicator to allow for ease of O&M. If DDC is present, use CT’s to indicate motor status in DDC. | *These functions may be used rarely but are invaluable for troubleshooting purposes.* |
| 3. Where number of 3 phase starters in a given location will exceed four, give strong consideration to installation of an MCC. | |
| 4. Where multiple 600 volt motors are installed, provide full sized motor starters within an MCC. | *This ensures that the failure of one starter does not detrimentally affect other starters in the same enclosure, and provides improved maintenance safety.* |
| 5. Copies of the control diagrams should be located within enclosures designed for such and an additional copy provided within the appropriate section of the O&M manual. | *This provision is to assist future maintenance requirements.* |
| 6. All motor starters to be combination c/w lockable disconnect. | *This provision provides increased safety during any future maintenance requirements.* |

### 10.1.2 Motor Starters – Fractional Horsepower

| | |
|---|---|
| 1. Provide thermal motor protection switches for fractional horsepower motor loads serving pumps. | *Although motors have built in motor protection, this provision assists in notifying maintenance staff of equipment status.* |
| 2. Provide a pilot light on all thermal motor protection switches. | *This provision provides a visible indication of power and state of thermal element.* |
| 3. Provide lockable toggle plates. | *This provision provides an increased measure of safety during maintenance requirements.* |
| 4. Use hinged lockable covers on suitably sized junction boxes to enclose control and motor relays and/or sensors. If mounting thermal motor protection switch in junction box cover, mount independent of switch cover. | *Secure mounting of the motor protection switch allows safe access to the thermal elements.* |

5. Do not use float switches to interrupt motor current where long distances from storage tanks to motors loads are required.

*Installation of a motor control relay may reduce voltage drop to motor loads during startup, providing them with the proper operating voltage.*

### 10.1.3 Motor Terminations

Stranded wire should be used where wiring to motors ends in a terminal strip.

*This is required because solid wiring to terminal strips in motors tend to become loose due to motor vibrations.*

### 10.1.4 Variable Frequency Drives (VFD)

Install in conjunction with Direct Digital Control systems for mechanical loads where variable control is determined beneficial by the designer, or where energy savings can be proven (e.g., heat circulation pumps).

*The intent is to allow for energy conservation.*

Provide line side reactors.

*This provision reduces harmonic distortion from feeding back into the power system.*

Ensure motor matches VFD and is suitable for inverter duty.

### 10.1.5 Soft Starters

Large motors with frequent start/stop should have soft starters, especially in smaller communities.

*Frequent start/stop can have a significant effect on the electrical supply in small communities, where a large motor starting can cause voltage fluctuations.*

### 10.1.6 Power Factor Correction

Power factor correction of motor loads should be considered and applied if the nature of the load is supportive of correction, and the designer can show an acceptable cost payback.

*Power factor correction can lower overall power and demand charges from the utility.*

## 10.2 DISCONNECTS

Recommendation

*Rationale*

A lockable manual disconnecting means to isolate a motor should be located within sight of and within 9m of the motor and the machinery driven thereby.

*The intent is to permit safe operation and maintenance.*

### 10.2.1 Motor Disconnects in Public Areas

Motor disconnect switches in public areas should be:

*This prevents young children from shutting off motors (e.g., cabinet unit heaters in vestibules) that must operate to prevent property damage (e.g., prevent sprinkler heads from freezing and busting).*

.1 installed at 2.1 m above the floor, or above ceiling tile close to equipment servicing.

.2 provided with a ventilated lockable cover or within manufacturers equipment where possible.

*Protecting the switches by location is preferred over lockable covers to avoid the cost and inconvenience of keyed covers.*

### 10.3 SPRINKLER PUMPS

| Recommendation | *Rationale* |
|---|---|
| Sprinkler jockey pump must be fed by the generator. | *Ensures operation of the jockey pump during utility power failures.* |

## E11 MISCELLANEOUS

Recommendation — *Rationale*

### 11.1 AUTOMATIC DOOR OPENERS

See Architectural A4.3.2 and A4.3.3.

### 11.2 HEAT TRACE

Where possible, hydronic heat trace should be installed instead of electrical heat trace.

*Where heat trace is required, hydronic provides the greatest energy efficiency.*

All electric heat trace is to be controlled by a temperature controller that limits its operation during high ambient conditions.

*Even self-limiting heat trace only regulates its temperature within a narrow range and, if allowed to run in a high-ambient environment, can cause overheating of the cable and possibly ignite adjacent materials. A temperature controller is a requirement of the NWT Electrical / Mechanical Safety Section.*

Where heat trace is required for water and sewer connections, it should be the self-limiting type.

*This is required for energy efficiency and premature failures of heat trace cable.*

If used on polyethylene pipe, the heat trace must be T-rated for such application.

*This applies to the typical heat trace system for standard GNWT water and sewer connections in permafrost areas to ensure “melt-down” does not occur.*

For water re-circulation lines, where heat trace is used as a back-up, the heat trace should be activated upon a loss of flow.

*This prevents freeze-up when the circulation pump fails. The heat trace should be sized to ensure that it will be of a sufficient size to thaw the pipe.*

A pilot light should be used to indicate the heat trace is on.

*The intent is to alert/confirm operation*.

END OF SECTION

# INDEX

## LEGEND

| | |
|---|---|
| **General** | **G** |
| **Sitework** | **L** |
| **Architectural** | **A** |
| **Structural** | **S** |
| **Mechanical** | **M** |
| **Electrical** | **E** |

# INDEX

# INDEX

# INDEX

# INDEX

# INDEX

# INDEX

# INDEX

# INDEX

# INDEX

# INDEX

# INDEX