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Government of Nunavut
Nunavut Kavamanga
Gouvernement du Nunavut

Good Building Practices Guideline

Second Edition
December 2005

FOREWORD

Building in the North is indeed different than building in more temperate climates. The *Good Building Practices Guideline* is intended to illustrate those differences. It is aimed at providing architects, engineers, building contractors, suppliers, facility administrators and operators with a comprehensive set of guidelines for building in the North.

The *Good Building Practices Guideline* assumes an advisory role, while renewing the challenge to builders to be innovative in applying the practices. Builders are encouraged to present alternatives to the suggestions detailed in the *Good Building Practices Guideline,* or to present new or innovative ways of resolving technical problems or of reducing building life-cycle costs.

The *Good Building Practices Guideline* incorporates years of experience in northern construction practices. The *Good Building Practices Guideline* was refined through input from architectural and engineering consultants, building contractors, suppliers, facility operators, Community and Government Services and client department staff, who worked together to achieve a consensus regarding northern building practices that are appropriate, economic and realistic. Simple, straightforward examples are used to illustrate and validate the practices.

The guidelines are not intended to replace mandatory codes or regulations, but to supplement the *National Building Code of Canada,* specifically where the GN believes that:

- More stringent practices should be applied relative to those of the *National Building Code of Canada* or the local municipality
- Code requirements should be clarified
- Its experience has demonstrated that conditions particular to remote northern communities require an approach different from typical Canadian building industry practice
- Its proven preferences for specific products, systems or methods should be employed

We are confident that all northern builders will find the *Good Building Practices Guideline* to be an indispensable guidebook, and challenge users to contribute towards its improvement in the next edition.

Tom Rich
Deputy Minister
Community and Government Services

ACKNOWLEDGEMENTS

In preparing the *Good Building Practices Guideline* (Second Edition), the Technical Services Division of the Department of Community and Government Services, Government of the Nunavut, 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. The *Good Building Practices Guideline* became a reality because of their participation.

We would like to express our appreciation to the many northern architectural and engineering firms, including AD Williams Engineering, Park Sanders Adam Vikse Architects, Ferguson Simek Clark Engineers and Architects, Pin-Matthews Architects, and Thorn Engineering for their important contributions to the production of this document. Our thanks also extends to the Arctic Energy Alliance and Envirovest Energy Ventures Inc. for providing beneficial information related to energy-saving initiatives for the Government of Nunavut.

Community and Government Services in-house technical and administrative staffs have played a key role in contributing to and coordinating the development of this guidebook. We also wish to recognize community and Government Services Regional staff for critiquing this guidebook.

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PREAMBLE

Introduction

The *Good Building Practices Guideline* (GBPG) 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 Nunavut. 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 Practices Guideline*

These technical guidelines do not replace any mandatory Codes or Regulations. Rather, they cover the following areas:

a) Where more stringent requirements should apply than the National Building Code of Canada or local municipal requirements

b) Where there is a need to augment or clarify a code requirement

c) Where conditions peculiar to a remote northern community require an approach different from typical Canadian building industry practice

d) Where specific products, systems or methods have been developed and have been found to be superior for northern conditions

Detailed studies or reference materials are provided in the Appendix or noted within GBPG for interest only, and unless otherwise stated, do not constitute a part of the GBPG.

Application of Guidelines

The GBPG has been prepared as suggested guidelines for obtaining good value and quality buildings. The GBPG may be applicable for renovations to existing buildings, tenant improvements in leased facilities, or utility buildings.

These guidelines come from studying buildings typical of the majority of buildings found in most communities in the Nunavut, that is small-scale low-rise structures designed to accommodate people. The GBPG may be less applicable to unusual or highly specialized buildings, or unusually large buildings.

Development of the *Good Building Practices Guideline*

The GBPG incorporates collected observations obtained from builders, designers, building operators and users. A substantial portion of the information was collected by staff of the Technical Services Division and Regional Project Management, in consultation with other stakeholders in the construction industry.

Revisions

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

Director, Technical Services, ***Technical Services Division,*** ***Community and Government Services,*** ***Government of Nunavut,*** ***P.O. Box* 1000 – Station 620** **Iqaluit, Nunavut – X0A 0H0** ***Phone:* (867) 975-5418** ***Fax:* (867) 975-5457 *(attach additional pages if necessary)***
Referenced section # and section name:
A brief description of your proposed change or addition:
Rationale (relate experiences that have led you to make this recommendation):
Name:
Occupation/Position:
Organization/Firm/Department:
Phone:
Fax:
E-mail:
Date:
Mailing Address:

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GENERAL BUILDING OBJECTIVES

The primary objective of this publication is to provide a technical reference handbook to help builders produce the best value in their respective buildings for the North. Buildings should be designed specifically for the northern climate and other physical parameters of the site, as well as for the minimum capital cost consistent with lowest life cycle costs. The objective is to encourage improvement over time based on proven methods and materials, while supporting improved building performance and new technology.

G1 LOCAL RESOURCES

Promoting and actively assisting communities to take on greater responsibility for their economic and social well being is an important objective of the GN. Construction projects provide important opportunities for communities to become involved in their own development.

1.1 BUILDING USERS

Residents of a community can provide valuable information related to site conditions such as snow drifting patterns, preferred orientations, anticipated use patterns and examples of successful materials or methods.

1.2 LABOUR

To facilitate maximum local involvement materials and methods used in building construction should be suitable for broad application that will permit training that will be applicable to future projects and avoid the use of specialized products or installations.

1.3 EQUIPMENT

The use of existing equipment benefits the community and can reduce construction costs, as bringing equipment into most communities is extremely expensive. Building design and construction methods should be suitable for available equipment.

1.4 SUPPLIERS

Specifications should not unduly restrict local or northern suppliers, and consideration should be given to incorporating any locally available products in new buildings.

1.5 OPERATIONS AND MAINTENANCE

Given the growing number of building projects and the limited numbers of experienced trades people in Nunavut, there is both a need and an opportunity to train and develop building maintainers in every community.

G2 LIFE CYCLE COSTS

Wherever alternative designs are considered, the alternative representing the lowest life cycle cost should be selected. Wherever alternatives are shown to have the same life cycle cost, the alternative with the lowest capital cost should be selected. The life cycle costing should be based on the expected design life of the building and its systems. For comparative purposes a 20-year design life should be used. In some circumstances other considerations may overrule: 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 these guidelines.

G3 ENERGY MANAGEMENT

Minimizing the energy consumption of public buildings is important in Nunavut where energy costs are extremely high: electricity is usually diesel generated and fuel must be transported annually to remote locations. Where practical and economically feasible, every attempt should be made to implement systems that reduce energy consumption.

See G6 for comments on the *National Energy Code*.

3.1 HEATING AND VENTILATION

Recommendations for energy efficiency have been integrated in the applicable sections of the GBPG.

3.2 LIGHTING

Recommendations for energy efficiency have been integrated in the applicable sections of the GBPG.

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 conditions in Nunavut.

4.1 SIMPLICITY AND EFFICIENCY

Available funding dictates "lean" buildings that minimize extraneous volumes and non-habitable space, apart from necessary building service spaces.

In terms of concepts all building design solutions should strive to:

- Produce the minimum gross area necessary to accommodate the stated net program
- Minimize the enclosed volume and building perimeter required to accommodate the program
- Facilitate expansion as simply as possible without major disruption to building use

In terms of detailed development, the building design solutions should:

- Be kept simple to improve the speed of erection in a limited construction season and to offer greater opportunity for employment of local skills
- Incorporate materials and methods that will permit quality construction under adverse environmental conditions in a limited construction season
- Limit the variety of materials to minimize the number of specialized trades required on the project
- Ensure O&M procedures can be easily understood and carried out using readily available 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 Nunavut. 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 desirable, though at times necessary.

4.3 STANDARDIZATION

The intent of the GBPG 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 Nunavut, 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.

G5 OTHER DESIGN CONSIDERATIONS

5.1 ARCHITECTURAL STYLE

It is not the intent of the GBPG to prescribe a 'style' of northern building. It is hoped that the rational application of basic design principles in response to program, climate and political imperatives will, in time, come to represent a practical style. Finding or creating a particular architectural style appropriate for public buildings in Nunavut today is an interesting challenge to designers. Generally, and understandably, many of the older, and indeed some of the newer vernacular buildings clearly exhibit a straightforward expediency. Directions may be found in building forms that respond demonstratively to all aspects of the environment and that are also enriched by culturally inclusive details.

Previous suggestions were that buildings should "fit into the immediate site unobtrusively, with the massing and finishes related to the context of the community". Although this can be a justifiable design approach, it is nearly impossible to achieve in many small communities in Nunavut when adding large new buildings. It should be recognized then, that other approaches are also valid, as long as the design successfully addresses the following:

- The design must communicate the function of the building
- The design should incorporate recognizable local symbols appropriate to the design
- Colours, materials and forms are selected to support and enhance other design decisions
- Massing is consistent with function and context
- Whether it blends in, contrasts with or dominates a site, the relationship of the building to the site should be consistent with its function and local traditions
- Whether it is private, public, friendly or decorous, the relationship of the building to the street should be consistent with the function and local traditions
- Whether they contrast with or are similar to adjacent buildings, the relationship between buildings should be clear and consistent with the building functions

Finally, the design of public sector buildings, while being stylistically appropriate in small communities, should satisfy the demand for buildings that are energy efficient, simple to build and to maintain.

5.2 OTHER RELATED DOCUMENTS

"Design" is a word that encompasses a number of activities within the fields of Architecture and Engineering. During the design phase of any project several documents are usually produced, each with a specific objective - the distinctions between them however can be confusing. The GBPG is meant to document performance criteria, preferred materials or methods and logistical considerations and should not be confused with other related documents such as functional programs, specifications or design documents. 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
GBPG	•recommends use of split receptacles wherever coffee making is anticipated
Specifications	•flooring to be 4.5 mm thick Mondoflex by Mondo Rubber
GBPG	•sports flooring may be either PVC or rubber
Submission requirements	•provide consumption estimates for heating and electricity
GBPG	•energy consumption targets

The interrelationship of all of these design considerations is as important to understand as the distinction between them: complete functional/program information is required before the correct technical requirement is applied, right material specified, adequate documentation submitted, and installation completed satisfactorily.

G6 CODES AND REGULATIONS

6.1 NATIONAL BUILDING CODE OF CANADA

The latest version of the "National Building Code of Canada" adopted in Nunavut as a regulation under the "Fire Prevention Act" by the Authority having Jurisduction must be used. The Authority having Jurisdiction is the Office of the Fire Marshal.

The Office of the Fire Marshal is a Division of the GN Department of Community and Government Services and is located in Iqaluit, Nunavut.

The Office of the Fire Marshal must be contacted for information regarding any bulletins released altering or amending the requirements of the latest version of the “National Building Code of Canada”.

The Model National Energy Code

The Model National Energy Code for Buildings was published in 1997, but has not been adopted by Nunavut. The Energy Code includes both prescriptive and performance requirements. The Energy Code with associated software, including a construction and energy cost database, is available to allow an evaluation of the performance of designs. Designers and Project Managers are therefore encouraged to become familiar with the Energy Code.

6.2 MUNICIPAL BYLAWS

All municipal bylaws and ordinances must be observed in the design and construction of facilities for the GN.

6.3 DESIGN PROFESSIONALS

Engineering

The practice of Engineering is regulated by the Association of Professional Engineers, Geologists and Geophysicists of the Northwest Territories, under the authority of the "Engineering, Geological and Geophysical Professions Act".

Architecture

The practice of Architecture in Nunavut is unregulated, No legislation exists to regulate the design of buildings other than the requirements outlined in the *National Building Code*.

6.4 SI METRIC REQUIREMENTS

All new construction for the GN must be designed in SI metric units: the actual materials may be designated in metric or imperial, 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 imperial measures: either metric or imperial may be used in this case. See notes in the Application of Guidelines section of the Preamble.

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

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SITEWORK

INTRODUCTION

Reasonable site development conditions include a site that:

- is well drained and not subject to periodic flooding
- Is not too steeply sloped
- Does not require excessive fill or levelling
- Has dimensional proportions suitable to accommodate the shape and size of the proposed building with ample setbacks
- Does not disrupt historical community use patterns

Site work includes all work required to:

- Prepare the site for building foundations
- Grade the site to promote drainage away from the foundation and to direct spring runoff to a suitable drainage course
- Provide access to the site and building for staff, visitors and services (pedestrian and vehicular traffic)
- Provide sufficient on-site parking
- Create outdoor activity areas such as playgrounds
- Create suitable settings for buildings through landscaping
- Remediation of any contaminated soil

L1 CODES AND REGULATIONS

- 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 1.
- Soil Contamination: See Guidelines for Site Remediation & Hazardous Waste Management.
- Asbestos: See Health & Safety Act, Worker's Compensation Board.

L2 INSTALLATION AND MAINTENANCE

2.1 INSTALLATION CONSIDERATIONS

2.1.1 Schedule

In communities above the tree line, there is a very limited period of time when site work can be done. Buildings are often completed in the late winter or spring before the site work can be finished, meaning that interim or temporary installations must be planned.

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 contractors. This benefits the local economy and minimizes the cost.

2.1.3 Local Equipment

Site work should be designed to ensure work can be completed using existing local equipment and operators.

2.2. MAINTENANCE CONSIDERATIONS

2.2.1 Snow Clearing

The presence of snow and the need to clear snow from a site is the norm in all communities in Nunavut. Any aspect of a site that does not function well when covered in snow is unacceptable.

Consider:

- How the snow must be removed (hand or machine)
- Where removed snow will be piled and the snow drifting patterns that may be affected by the snow pile
- Protection of building, vegetation and fixed site improvements from snow removal equipment

2.2.2 Spring Runoff

In most of the communities in Nunavut the spring melt occurs suddenly. This water must be directed away from the building and into acceptable drainage courses to avoid:

- Flooding of tank rooms
- Water or sewage holding tanks floating and connections breaking
- Granular pads being severely eroded by water seeping under or through the pad, resulting in structural damage

2.2.3 Planted Areas

Skills and interest in maintaining vegetation will vary depending on staff and location, and although it should be generally accepted that little effort will be put into maintaining planted areas, it is also a fact that once established, indigenous arctic plants and grasses only require some protection from concentrated traffic. Successful examples include timber framed raised beds defining walks or vehicular uses. Where appropriate, planting can play an important role in protecting slopes from erosion, as well as much needed relief from the ever-present gravel pad.

L3 ACCESS

3.1 PEDESTRIAN ACCESS

Public buildings should be easily identifiable, with prominent, clearly visible entrances. All pathways, ramps and stairs leading to entranceways should be easy to keep clear of snow and also be protected from vehicle traffic.

N.B.C. 3.8.1.2 may require more than one ramp depending on the number of exits from a building. Discuss this item with the Office of the Fire Marshal on an individual basis.

Recommendation	***Rationale***
3.1.1 Walkways	
Finished walkways should be provided; leading from the edge of the roadway and 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 public uses such as schools, health centres and community recreation facilities.*

Recommendation	***Rationale***
Concrete, paving or grating surfaces should be considered at entrances.	*Clean hard surfaces intercept dirt before it is tracked into the building.*
Avoid walkways that are immediately adjacent to walls of buildings.	*Traffic near the building face can increase the incidence of damage to building finishes.*

3.1.2 Ramps and Stairs

Whenever possible, eliminate the need for ramps and stairs by shaping the site. Grade elevation at the entrance should be as close to finished floor elevation as possible.	*Sloped grade often permits removal of snow with equipment rather than by hand, as is normally the case with stairs and ramps.*
One ramped path of travel to the building entrance is preferred to providing both stairs and a ramp. Wherever possible, a ramp with a straight run should be provided. Where space dictates that a ramp must be 'dog-legged', then stairs may 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 route can reduce costs, reduce snow-clearing requirements and reduce the perception that providing ramped access is wasteful.*
Note that NBC 3.8.1.2 requires that 50% of all pedestrian entrances to a barrier free building must have ramps. This should be negotiated with the Office of the Fire Marshal on an individual basis.	
Areas of fill leading to or from exits must be level and contained.	*This controls erosion from normal use.*
Open metal or fibreglass grating is the preferred surface material for exterior ramps, stairs and landings. Gratings should meet the requirements of NBC 3.8.1.3 and CSA B651 M90 "Barrier Free Design".	*This allows snow to pass through, diminishing accumulations at entranceways. CSA and NBC set a standard for the size of grate openings.*
Wood surfaces are acceptable only where traffic is light.	*Wood is easily damaged by snow clearing and promotes snow and ice build-up and slippery surfaces.*
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.*
Steel stairs. If steel pipe railings with wire mesh infill are used, ensure that the mesh is minimum 6 mm diameter in a maximum 50mm grid and held in place by spot welds at maximum 150mm o/c.	*Lighter wire and larger grid openings have not resisted abuse.*

Recommendation	***Rationale***

3.1.3 Snow Drifting

Locate entrances and major windows where snowdrifts will not normally form. If there are none, find another means of reducing the accumulated 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.*
Avoid locating entrances and exits at the inside corners of buildings.	*Inside corners are prone to snow accumulations.*

3.2 VEHICULAR ACCESS

In many small communities there are no municipal requirements for parking or service vehicle access to buildings. In general, requirements should be determined by:

- Vehicles commonly in use in the community; may include cars, trucks, snowmobiles or all-terrain vehicles
- The requirement for users of Nunavut buildings is to be provided, and where location of exterior electrical outlets may be required
- Type and size of service vehicles and personnel that must be able to approach connection points year-round with a minimum of difficulty, i.e., no obstruction by snow, standing water or steep slopes.

Recommendation	***Rationale***

3.2.1 Routes and Parking

Fire and regular vehicle 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.	*Use standard parking stall dimensions, especially in communities where no area requirements exist.*
Minimum dimensions for an ATV or snowmobile-parking stall are 2 metres x 2 meters. Consider drive-through parking spaces.	*ATVs 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 6 to 8 months of the year, it is important that building service points are easily accessed by trucks and personnel, and protected from snow and ice build-up. Most municipal services in Nunavut are delivered by vehicle. Water and sewer systems in any given community can range from honey buckets to more sophisticated means. Fuel (primarily heating oil) is delivered exclusively by truck. Power and telephone are generally provided by overhead services.

Recommendation	***Rationale***
3.3.1 Delivery Vehicles	
Provide adequate space for delivery vehicles to pull completely off main roadway when they are servicing a building.	*This keeps service vehicles from blocking traffic. (This is a municipal requirement in some communities.)*
It is preferable that roads are designed so that they are able to do so without reversing.	*Exhaust in winter blocks vision when reversing.*
3.3.2 Service Connection Access	
Provide stairs and platforms wherever people must access fill points or connect to services located more than 1.5 m above ground level. Ladders are not acceptable.	*This allows delivery people to connect to building service 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 Snow drifting	
Snow drifting around buildings should be managed through careful sitting and design so that problems can be minimized or avoided. Wind control devices, such as scoops or accelerators, should be avoided unless there is absolutely no alternative.	*Although such devices have proven effective, they are an expensive alternative to proper siting to take advantage of natural wind scouring. In certain communities, wind frequently shifts directions, making it difficult to rely on scouring by predominant winds.*

Notes and Recommendations

See Appendix A -"Resource Materials" for further information on snow drifting.

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 Government of Nunavut (Department of Community Government & Transportation)
- The Canadian Federal Government (Department of Indian Affairs and Northern Development)
- And in many cases ownership may have recently been transferred through the Nunavut Land Claims Agreement.

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 S3 "Foundations"	
4.1.2 Excavation	
Avoid cutting into existing soils where permafrost is present.	*This exposes frozen soil causing degradation of permafrost.*
See also S3 "Foundations".	

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:

- 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

Recommendation	***Rationale***
4.2.1 Finished Grades	
Finished grades should have a minimum 4% slope away from the building.	*This provides drainage away from the foundation without promoting erosion by runoff*
Finish the area under the building before construction begins	*To allow proper drainage and better working conditions. Rough surface conditions and puddling water make it difficult to work when installing plumbing, utilidettes, insulation and soffit under the building. Poor working conditions often lead to inferior quality when insulating and sealing the floor system, which can lead to cold floors and freezing pipes.*
4.2.2 Retaining Walls	
Where slopes of less than 1: 4 cannot accommodate grade differences, because of site constraints or limited fill materials. Heavy timber 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.*

Recommendation ***Rationale***

4.2.3 Drainage Channels

Drainage channels/paths 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 site work cannot be completed until mid to late summer.

L5 SITE REHABILITATION AND LANDSCAPING

A comprehensive landscaping plan must incorporate requirements noted in the sections above. Landscaping using lawns, flowerbeds, trees and shrubs, however, is not a practical consideration in the communities in Nunavut. Nonetheless, care needs to be taken in finishing sites around GN buildings for appearance, public safety and erosion control.

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.

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.

Also see Maintenance Considerations (2.2.3)

Growing conditions are too harsh for most southern plant species commonly used elsewhere in Canada. There is little or no tradition of 'gardening' in Inuit communities. Resources are currently unavailable for extensive maintenance programs.

5.3 Soil

If soil or topsoil is required, it must be available within the community, along with any necessary additives (sand, lime, etc.).

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.

Recommendation	***Rationale***
5.5 Landscaping	
Definition of landscape versus pedestrian and vehicular areas is important. Timbers and rocks have been successfully used for this but must be designed with large snow clearing equipment in mind. If concealed by snow, these elements will be damaged or relocated. (See 3.2.1)	*Counteracts the tendency for the site and the community in general to be a continuous gravel surface used universally by pedestrians and vehicular traffic*
Edge slopes of gravel pads can be stabilised and made more aesthetically pleasing by the addition of boulders 150 to 200mm diameter,(if economically available).	*Boulders discourage pedestrian traffic thus promoting the natural re-establishment of native arctic plants, either by transplanting or natural seed migration.*

END OF SECTION

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ARCHITECTURAL

A1 CODES AND REGULATIONS

See G6.

Documents referenced in this section, other than noted in G6, include the AWMAC (Architectural Woodwork Manufacturers of Canada) Standards.

A2 INSTALLATION AND MAINTENANCE

2.1 INSTALLATION CONSIDERATIONS

The minimum possible number of different trades should be involved in construction and maintenance, in order to reduce travel costs and coordination inefficiencies. Each sub trade on a job should have responsibility for a reasonably large portion of work. Small specialty contracts involve little financial incentive for the sub trades involved, and tend to result in poor workmanship and little attention to correction of post construction deficiencies

2.2 MAINTENANCE CONSIDERATIONS

Four primary O&M cost considerations are:

- Fuel and power consumption.

  Consumption is largely dependent on operating practices; however, the shape, layout, and the quality of the exterior envelope of a building can have a significant effect on fuel and power consumption.

- Operation and maintenance of equipment

  The planning and layout of a building must ensure adequate access to mechanical and electrical equipment.

- Maintenance of building finish materials

  Choose building materials and finishes that will reduce the effort required for maintenance, and that can be easily repaired.

- Janitorial services

  The choice of building finishes and floor layout, as well as convenience of janitorial supplies, will affect regular care taking operations.

2.3 MAINTENANCE MATERIALS

The Project Officer should determine, in consultation with Regional Maintainers 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
- Pre-finished wall covering materials such as plywood, plastic laminate or veneer-faced materials, sheet vinyl

- Custom-tinted paint to match installed paint
- Custom-coloured exterior wall cladding materials
- Replacement parts for door hardware
- Pre-cut replacement glass for exterior and interior windows
- Plastic laminates and cabinet hardware

A3 BUILDING ENVELOPE

The envelope of a building separates the interior environment from the exterior climate. In Nunavut temperatures can range from about -45° Celsius in the winter to +35° Celsius in the summer. Hourly wind pressures can range from 0.30 kilopascal to 0.80 kilopascal. The climate is generally very dry with precipitation mainly in the form of snow. Total annual rainfall in Iqaluit is 150 mm (as compared to 1,935 mm in Vancouver or 846 mm in Ottawa). Climatic variations within the Nunavut Territory must be recognized in building design and construction. Special attention should be given to major differences in climate from Kugluktuk in the west to Pangnirtung in the east and Grise Fiord in the north to Sanikiluaq in the south. These differences include snow drifting patterns, wind, seasonal temperatures and sunlight.

Careful design and construction are required to ensure airtight, energy efficient building envelopes. Suggested minimum standards in GBPG should be followed unless the designer can show that less demanding standards will provide savings over the life cycle of the building. The suggestions in this section are intended to augment the requirements of NBC Part 5, and NBC 9.25.

3.1 AIR MOVEMENT, WATER AND VAPOUR PROTECTION

Project managers, designers, and constructors of northern buildings need a clear understanding of air and vapour barriers. The requirements of the *National Building Code* are intended to apply to buildings in all parts of Canada. Northern application of the *National Building Code* requirements can be clarified with further reading and study. A suggested reading list is included in Appendix A.

Recommendation / ***Rationale***

3.1.1 Control of Rain and Snow Penetration

The requirements of the 1995 NBC 5.6.1 "Protection from Precipitation" applies.

3.1.2 Control of Moisture from Ground

The requirements of the 1995 NBC 5.8 *"Moisture in Ground"* apply.

3.1.3 Control of Condensation within the Building Envelope

The requirements of NBC 5.5 apply.

In addition, a means of venting and draining the envelope to the exterior is recommended.

Rationale: The objective is to ensure that any water vapour that does pass through the vapour barrier is not trapped in the envelope. Water vapour that migrates toward the exterior can be deposited in the envelope as frost over the winter months. The moisture must be able to drain or evaporate during the summer when the frost melts.

Recommendation | ***Rationale***

3.1.4 Air Leakage Rates

The maximum recommended air leakage rate is 1.5 ACH@50pa.

Although the NBC 5.4 *and* 9.25 *require all buildings to have an effective air barrier system, no measurement criteria are provided. Theoretically, this amount of air leakage will not introduce more vapour into an envelope assembly than can be 'managed' on an annual cycle. See Architectural A3.1.3.*

3.1.5 Rain screen Principle

Building envelopes are to be designed in accordance with the 'Rain screen Principle' (pressure equalization practice):

The objective of the Rain screen Principle is to ensure that wetted exterior surfaces of walls are not subjected to constant air pressures. Constant air pressure can force water on the exterior surface of the wall to move into the interior portions of the wall materials through construction joints or other fissures. Refer to CBD-40: "Rain Penetration and its Control. "

- A drained and ventilated air compartment is recommended between the exterior water shedding cladding and the sheathing of the wall.

The compartment behind the exterior wetted cladding is vented to allow the face and back of the cladding to be at the same air pressure. The venting allows air-drying of the compartment and of both faces of the cladding. The compartment is intended to keep the sheathing from being wetted.

Divide all cavities behind the exterior cladding into pressure equalization compartments (i.e., into zones of air pressure equal to exterior air pressure) no more than one storey in height. And no more than 6 m wide along building faces. At comers, 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 airflows developing, and therefore the likelihood of wetting the sheathing. Pressure equalization compartments must also incorporate openings to provide the drainage required by NBC 5.6.2.1.

3.1.6 Materials and Assembly

.1 Vapour Barriers

Materials or the assembly of materials making up the vapour barrier must be:

See GBPG A3.1. 3 *"Control of Condensation within the Building Envelope. " The purpose of* a *vapour barrier is to restrict diffusion (water vapour movement through the materials of the assembly).*

- Durable

To meet or exceed the service life of the building.

Recommendation	***Rationale***
• Impermeable	*To meet the requirements of the NBC and reference standard CAN/CGSB* 51.33 *or* 51.34.
• Compatible with other building components	*Differences in chemical composition, creep behaviour, elastic movement, thermal expansion, shrinkage, and moisture changes could result in reduced permeability or durability of the vapour barrier.* *To meet requirements described in Architectural A3.1.3 above. Materials with low vapour permeance, such as plywood sheathing or rigid foamed plastic insulation, can act as a barrier to vapour that is passing through the assembly. The vapour must be allowed to migrate to the exterior by open joints between sheets, or by perforating the material, or it will risk becoming trapped between water vapour tight layers.*
The building envelope must be designed so that multiple vapour barriers are avoided.	*Any material with a low permeance rating that is located on the low vapour pressure side of the insulation cavity, must be installed in such a way that vapour can migrate past it to the exterior.*
If the vapor barrier consists of poly installed inside the framing of the structure:	
Set staples fastening vapor barrier to structure at 2' centers.	*To minimize penetration.*
Ensure continuous solid backing behind joints in the vapor barrier so the joint will be trapped between the backing and drywall, effectively sealing it.	
Apply a thin bead of acoustic caulking to all studs and plates where they contact the vapor barrier.	*The caulking will seal any punctures made by staples, nails and drywall screws. This will also create separate dead air chambers in the wall. If there is a penetration, the air leak will be contained in a single stud bay, rather than traveling along the wall.*
Leave slack in the vapor barrier when installing it, especially in the corners.	*It is common for drywall screws to pull through the drywall, tearing the poly if it is so tight in a corner that it holds the drywall away from the framing. When this occurs, it is extremely rare that the drywall is removed to repair the poly.*
Don't allow the use of hammer staplers when fastening vapor barrier.	*These easily tear the poly*.
Use acoustic caulking in all joints and penetrations of the poly.	*Tape doesn't always bond well to dusty or cold poly, and wrinkles in poly or tape can cause air leakage.*

Recommendation	***Rationale***
If poly is inside framing, use 2"x 2" strapping or equivalent fastened horizontally to the studs and on top of the poly. A semi rigid insulation may be installed in this void.	*The insulation will increase the R-value of the wall. More importantly electrical boxes and wiring needn't penetrate the poly improving the seal, and drywall screws fastened to the 2"x 2"s won't "pop" as much due to wood shrinkage. If a drywall screw misses the framing, it won't puncture the poly. There is a great reduction in thermal bridging between the drywall and the wall studs.*
In 2 story structures, consider hanging the 2nd level floor joists instead of sitting on the top plate of the wall.	*The poly can be installed continuous behind the floor joists. This eliminates the practice of wrapping the box sill with poly, which puts the vapor barrier on the wrong side of the insulation causing condensation problems. Also thermal bridging through the floor system is decreased. Sometimes rigid foam insulation is fitted between the floor joists and caulked to create a seal and become part of the vapor barrier. This is very labor intensive and there are numerous joints to seal, decreasing the integrity of the building envelope*
.2 Air Barriers	
Materials, or the assembly of materials making up the air barrier system, must be:	*The purpose* of *an air barrier system is to restrict air movement.*
• **Durable**	*To meet or exceed the service life of the building.*
• **Impermeable** - Acceptable leakage rates for the complete air barrier system are noted in Architectural A3.1.4. The air leakage rates of Some common building materials and assemblies can be found in Appendix D.	*To minimize the movement of air through the barrier. An air barrier system, consisting of air leakage resisting 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 should therefore typically be greater than the air leakage resistance of the complete air barrier system.*
• Materials employed in the construction of the air barrier system should have air permeance values no more than 1110th of the air leakage rate allowable for the complete 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 noted in Architectural A3.1.4.*
• **Continuous** - Pay special attention to joints, corners and penetrations.	*To ensure that there are no leaks and that all parts* of *the building envelope restrict air leakage to a similar extent. An opening at anyone location is a failure* of *the entire system.*

Recommendation

- **Rigid and strong** - To withstand both positive and negative air pressures due to wind, mechanical equipment and stack effect in accordance with NBC 4.1.8. Air barriers must be designed to transfer such pressures to the structural framing while undergoing minimal deflection.

Rationale

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. The structural performance of many common materials and assemblies can be found in "Structural Requirements for Air Barriers" CMHC report No. 30133.0R1.

- **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 Location of Air Barriers and Vapour Barriers

- Coincident air/vapour (A V) barriers located on the outside of structural framing are recommended. Plywood sheathing located on the exterior of the structure with the joints sealed with torched on modified bitumen strips has been found to be an effective coincident A/V barrier.

By locating the A V barrier (and thus the insulation) on the exterior of structural framing, rather than on the interior, the following can be achieved:

- *The potential for damage to the structure due to condensation is virtually eliminated*
- *Interior finishes can be applied directly to structural framing (no need for additional strapping or protection for the A V barrier}*
- *Penetration of A V barrier by mechanical and electrical systems is reduced to those elements that must exit the building*
- *With fewer penetrations and use of rigid air barrier materials, a good quality installation is simpler to achieve.*

- Coincident A V barriers located on the inside of structural framing are acceptable. Except as noted under Architectural A3.6.3.2.

Common practice for smaller buildings, and although this assembly meets the requirements of the NBC for vapour protection, it requires that a number of precautions be taken including:

- *Plumping and electrical wiring routes in exterior floors, walls and roofs must be carefully detailed to minimize A V barrier penetrations*
- *Interior strapping or other means of attaching finish materials may be provided to accommodate electrical wiring and outlets without the need for air/vapour barrier penetration*

Recommendation ***Rationale***

.4 Sealants

Sealants used as part of the air barrier system of the exterior wall assembly must be:

- Serviceable to -50°C in their fully cured state
- Able to be installed under conditions to be encountered during their installation
- Strong enough to resist the anticipated loads without deforming or moving out of position.
- Elastic and compressible to accommodate movement of the joint
- Chemically compatible with adjacent materials
- Accessible for service
- Placed in primed joints of proper dimensions with backing rod or bond breakers

Silicone or one component elastomeric types that meet the above criteria are recommended. Acrylic and solvent curing types are not recommended.

The performance of sealants is dependent on choosing the correct sealant for the substrate as well as application under acceptable temperature and moisture service conditions.

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

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

3.2 THERMAL RESISTANCE

The thermal resistance of the building envelope serves two important functions: to minimize heat loss energy consumption, and to prevent moisture condensation on the interior skin of the building envelope. The National Energy Code for buildings is available from Resources, Wildlife and Economic Development as an advisory document on energy performance. It has not been adopted in Nunavut.

Recommendation ***Rationale***

3.2.1 Recommended Values

The **standard for** thermal resistance of exterior building envelope assemblies typically is recommended to be:

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 values provided are benchmark

Recommendation

- **Floors: RSI 7.0**
- **Walls: RSI 4.9**
- **Roofs: RSI 7.0**

However, 1995 ASHRAE Standards increased required ventilation rates. Heating the higher volume of cold outside air shifted the balance of heating load away from envelope losses. In buildings where ASHRAE standards apply, capital costs may be minimized by reducing envelope R-values in consultation with the Client Department and the Consulting Engineer.

In buildings or portions of buildings not intended for typical human comfort conditions. Thermal resistance values may be lower and still meet energy consumption standards.

3.2.2 Location of Insulation

All insulation should 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 or semi-rigid insulation should be used.

.2 Combustible insulation should be appropriately fire-stopped.

.3 Where the coincident AV barrier is located on the interior side of structural framing, compressible inorganic 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 Architectural A3.2.3).

.4 In small buildings, it may be advantageous to

Rationale

values. Thermal resistance of the building envelope is best determined by life-cycle cost-benefit analysis. Such analysis may determine lower or higher thermal resistance to be appropriate for a given building.

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 insulation specifically designed for the period of the year they are to be occupied.

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

The structural members reduce the overall thermal resistance of the assembly. Their thermal bridging effect should 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.

This allows an interior strapped and insulated

Recommendation / ***Rationale***

locate the vapour barrier 1/3rd of the way into the insulation from the inside.

space on the inside of the air/barrier and structural stud system.

*This method should be approved by the Authority's technical services Representative.

3.2.3 Continuity of 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 2 layers at right angles. The insulation may be secured with 2 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 building.

3.2.4 Localized Low Temperature

Layout of spaces and detailing of assemblies should avoid spaces or compartments that are not readily heated. Concealed spaces that are located on the warm side of the A V barrier may require transfer grilles to heat the space and keep the surfaces above dew point.

The location of furniture, fixtures and fittings can restrict the convection of heat within a space so that some surface temperatures on the warm side of the A V barrier may drop below the dew point.

Particular attention should be focused on corners that have large exposed exterior surface area relative to small interior surface area, and to spaces where supplies are stored against exterior walls.

3.2.5 Combustibility of Insulation

.1 The use of non-combustible types of insulation such as mineral wool in semi-rigid form is recommended.

This can be implemented as a measure to increase resistance to fire spread.

3.3 BUILDING ENVELOPE – FLOORS

Where northern buildings are elevated, floors assemblies have an exterior surface on the underside. Basements or concrete foundations are possible in only a few locations and for certain uses. On permafrost sites, foundation-bearing capacity can be maintained by artificial cooling of the ground. Induced draft cold air systems, powered refrigeration or thermosyphon refrigeration are techniques that have been used to keep permafrost intact beneath heated buildings.

Recommendation / ***Rationale***

Recommendation / **_Rationale_**

3.3.1 Air Movement, Water and Vapour Protection

All recommendations of Architectural Section A3.1 applies to building envelope floors.

Clarifies criteria to be used in evaluating floor assemblies with respect to NBC requirements.

All building envelope floors subject to differentials in temperature, water vapour pressure or air pressure require air barriers (AB) and vapour barriers (VB) meeting the recommendations outlined in Architectural A3. 1.3 and A3.1.4.

Floors above open crawl spaces are common in permafrost and discontinuous permafrost zones in the North. Suspended floors provide opportunities for air leakage, snow infiltration and water vapour diffusion, and not normally found in floors.

3.3.2 Thermal Resistance - See Architectural A3.2.

3.3.3 Materials and Assembly

.1 Air/Vapour Barrier

A false floor should be considered wherever insulation is located within the structural framing of a suspended floor and the comfort of users is a consideration, or where space is required to accommodate plumbing.

See Architectural A3.1.6.

A false floor will reduce heat loss due to thermal bridging through the floor joists. A false floor is suggested for residential and institutional facilities such as group homes, and elementary schools where children can be expected to be sitting on the floor. Drains and water supply pipes should not be placed within a suspended floor system, just as they should not be installed within exterior walls in northern buildings.

.2 Sealants - See Architectural A3.1.6.4.

.3 Insulation - See Architectural A3.2.

.4 Drainage and Ventilation

Architectural A3.1.1 and A3.1.3 address precipitation and water condensation management.

Joints of the exterior soffit finish should not be sealed in an effort to create an external air barrier. Plywood resists water vapour migration so as to create a vapour barrier if the joints are sealed, creating a second vapour barrier in the floor. See Architectural A3.1. 6.4.

.5 Exterior Finishes

.1 Exterior soffit materials for suspended floors shall be:

- Durable
- Light weight
- Easily installed

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 allow enough air movement to effectively ventilate a suspended floor.*

Recommendation	Rationale
• Easily removable and replaceable for repairs to contained services with locally available trades skill.	*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 is recommended where any risk of fire due to vandalism exists.*
• Installed with the minimum number of exposed 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

Thermal Break A thermal break should be provided between foundation units and bearing stratum, where highly conductive structural materials are used. See Structural S3.	*To minimize heat loss from building to frozen soils, and to prevent cold spots due to thermal bridging in the building envelope.*

3.3.5 Basements and Crawl Spaces

.1 Open Crawl Spaces

Open crawl spaces below buildings should be screened with durable metal mesh security.	*The objective is to prevent unauthorized and unsafe uses of the open crawl space under the building.*

.2 Heated or Semi-Heated 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 envelope.	*The different crawl space environment can result in air/vapour leakage, unwanted heat transfer, or condensation. Differences between interior environments are identified in NBC* 5.3, 5.4 *and* 5.5 *as requiring provisions to stop undesirable heat, air and water vapour movement.*

.3 Crawl Space Drainage

A graded slope of 2% or greater to sump points, or away from the building, is recommended for all crawl space ground surfaces. Any drainage connection or water collection device must not break the continuity of the ground moisture protection barrier in an enclosed crawl space.	*This conforms to NBC Section* 5.8, *to ensure that surface and ground water does not accumulate in crawl spaces. The objective is to dispose of surface water from spring runoff away from an open crawl space, and to collect and dispose of ground water that might enter an enclosed crawl space.*

Recommendation	***Rationale***
.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 building envelope.	*Using utilidettes to enclose grouped pipes and ducts in a floor system above an open crawl space can eliminate the need for an expensive continuous suspended utility space.*
It is mandatory that an absolute minimum of 300mm clearance be provided between grade and the underside of utilidettes or any other horizontal structure.	*Frost heave must be isolated from acting on the envelope or structure.*

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, and electrical conduits. Care must be taken to make the air barrier system in walls continuous at all openings and penetrations, and at joints with floors and roofs.

Recommendation	***Rationale***
3.4.1 Air Movement, Water and Vapour Protection	
All recommendations of A3.1, with The exception of A3.1.2, apply to building envelope wall assemblies.	*Clarifies criteria to be used in evaluating wall assemblies with respect to NBC requirements.*
All walls forming part of the building envelope require air leakage barriers and vapour diffusion barriers meeting all requirements outlined in Architectural A3. 1.3 and A3.1.4.	*Although this applies primarily to exterior walls forming the building envelope, internal walls that subdivide buildings may also be subject to differential temperature, air and water vapour effects. Examples include community arenas, or combined office/warehouse and office/fire hall buildings.*
3.4.2 Thermal Resistance	
Thermal Resistance See Architectural A3.2.1	
3.4.3 Materials and Assembly	
.1 Air/Vapour (A V) Barrier - See Architectural A3.1.6.3. , And 3.4.3.5 below.	Note that continuity of the A V barrier must be provided, including special detailing where roof or floor A V barriers are located on a different plane from that of the walls.
.2 Sealants - See Architectural A3.1.6.4.	
.3 Insulation - See Architectural A3.2.2 and A3.2.3.	
.4 Drainage and Ventilation - See Architectural	To meet NBC 5.6.2.1 requirements, including

Recommendation	***Rationale***
A3.1.5.	application of the Rain screen Principle.
.5 Heated Crawl Spaces with exposed grade	
Careful detailing is required to eliminate any transfer of freeze/thaw soil movement to the envelope and/or structure	Compressible 'void former' may be considered at interface of grade and insulating walls or grade beams. Note that the wall A/V barrier must be sealed to an interior protected grade A/V barrier. See also Structure 3.1.5.

3.5 EXTERIOR WALL FINISHES

"Good Building Practice" does not specify where particular materials are to be used: Materials are selected by the designer and should conform to the recommendations noted here. Maintenance needs, appearance, durability, ease of repair and availability of repair materials are all considerations made in selecting wall finishes.

Recommendation	***Rationale***
3.5.1 General	
All siding should be installed so that the requirements of Architectural A3. 1.5 "Rain screen" are met.	*Air pressure equalization compartments can be created using strapping applied to support the siding.*
Siding patterns and edge joints should allow easy replacement at areas susceptible to damage.	*Frequent damage occurs to the lower portion* of *exterior walls* of *schools and arenas, areas around stairs and landings, corners* of *garages, loading docks, etc.*
3.5.2 Wood	
Board and batten, lap joint, tongue and groove, channel or drop siding are acceptable.	*Although wood siding requires regular maintenance, it is easily applied and repaired, and a variety of colours and patterns can be used.*
Joints should be installed vertically to speed water draining from the cladding and promote rapid drying.	*Horizontal joints retain melt water and rain, wetting the wood for longer durations. Research has found increased early life cycle splitting, warping and staining when wood cladding stays wet.*
Spruce or cedar siding is acceptable, and siding may be air-dried or kiln-dried. A semi-transparent stain finish is preferred, and solid colour stains acceptable. Paint finishes for exterior wood may be limited to fascia and trim. Factory painted wood siding products with long term guarantees are acceptable.	*Commonly used because of acceptable performance experience. Paint seals wood and does not allow moisture from the concealed side of the rain screen to migrate freely outward.* As *a result, non-breathing paint can peel prematurely.*
Pre-finished plywood siding, such as "Ranch wall",	

Recommendation	***Rationale***
minimum 15.5 mm thick is an acceptable siding material.	
Glass fibre reinforced cement panels have proven to be an acceptable alternative to wood or corrugated metal as an exterior finish.	
3.5.3 Metal Siding	
Metal wall siding panels should be factory preformed steel sheet, minimum 0.6 mm (24 gauge) base metal thickness, zinc coated, pre-finished on weathering face.	*Typically used with prefabricated metal buildings such as recreational facilities or service buildings. Metal siding is susceptible to damage from impact, and because repairs are not easily undertaken by local maintainers. Often the damage does not get repaired. Wood siding should be considered* in *areas most susceptible to damage, such as entranceways.*
Profile: select from manufacturer's standard profiles Colours: should be selected from manufacturer's standard colours	*The extra cost of custom profiles or colours is generally not warranted for public buildings, and delivery time is often increased.*
Fasteners: concealed fasteners are preferred	
Aluminium siding is not recommended for northern buildings.	*Very susceptible to damage from impact, and subject to large thermal expansion and contraction. With large temperature ranges in the North, rippling and 'oil-canning' occur more readily.*
3.5.4 Vinyl Siding	
Not recommended for northern buildings.	*Expansion and contraction in varying temperatures causes warping, and vinyl also becomes very brittle in cold temperatures suffering impact damage easily.*
3.5.5 Stucco Finish	
Generally not recommended for use on northern buildings.	*Easily damaged on impact, and materials are generally unavailable for repairs.*

3.6 BUILDING ENVELOPE - ROOFS

Recommendation	***Rationale***
3.6.1 Air Movement, Water and Vapour Protection	
All requirements of Architectural A3.1, with the exception of A3.1.2, apply to roof assemblies.	*Clarifies criteria to be used in evaluating roof assemblies with respect to NBC requirements.*
All roofs are subject to differentials in temperature,	*Clarifies criteria to be used in evaluating A V*

Recommendation	***Rationale***
water vapour pressure and air pressure, and as such require air barriers and vapour barriers meeting all requirements outlined in Architectural A3. 1.3 and A3.1.4.	*barriers with respect to NBC requirements.*
3.6.2 Thermal Resistance - See Architectural A3.2.1	
3.6.3 Assembly and Materials	
.1 Air Vapour (A V) Barriers	
Coincident air/vapour (A V) barriers located on the outside of structural framing are recommended for all buildings located above the tree line.	*Condensation within the roof assembly has caused structural damage to a number of roofs across the Nunavut: locating the structural roof inside of the A V barrier is a reliable means of avoiding this problem. Venting roof assemblies above the tree line is problematic as vents allow snow infiltration.*
Protected, fully adhered coincident air/vapour (A V) barrier membranes are recommended.	*With the membrane fully adhered to a structural backing, the assembly can meet the A V barrier requirements, and any damage to the membrane will not allow moisture to travel laterally between the membrane and the backing.*
.2 The location of the A V barrier on the interior of roof framing is recommended only for small buildings located Below the tree line. Great care must be taken to ensure continuous A V barriers, and a means of venting the assembly that will minimize snow infiltration.	*The use of better performing insulation and membrane materials becomes necessary when the A V barriers are located on the exterior of the roof framing. These become cost effective on larger buildings. The additional cost may not always be justifiable for smaller buildings located below the tree line. Where a ventilated roof system can perform satisfactorily.*
.3 Sealants - See Architectural A3.1.6.4	
.4 Insulation - See Architectural A3.2.2, A3.2.3.	
.5 Ventilation and Drainage	
Wherever fibrous mineral insulation is used in a roof assembly. The requirements of NBC 5.4 and 5.5, or 5.6 must be met.	*It is important that adequate ventilation be provided where fibrous mineral insulation is used as its insulation value is adversely affected by condensation. Snow infiltration through required ventilation openings is difficult to avoid; wetting of*

Recommendation	***Rationale***
	the insulation and roof assembly occurs as soon as conditions allow infiltrated snow to melt.
Whenever possible, drainage should be provided from the interior membranes of the assembly to the exterior of the building envelope.	*Water that accumulates within the assembly due to snow infiltration, roof leaks or A* V *barrier leaks can drain to the exterior.*

.**6 Roof Coverings**

Shingles

Asphalt shingles are not recommended for use in *Nunavut.* If used, install with slope of 4 in 12 or greater, or 2.5 in 12 where fully tabbed shingles are used.	*Areas above the tree line are typically very windy. Shingles can be blown off and are difficult to replace. Asphalt shingles are readily available, generally less expensive, and represent a lower fire hazard than* *Wood shingles.*
Wood shingles are not recommended.	*Early deterioration of wood shingles occurs with excessive drying and long solar exposure common in the North. Combustibility of wood shingles increases fire loss risk compared to other water-shedding membranes.*

Modified Bitumen Membrane (MBM)

The 2-ply, torched-on MBM roof system is recommended for northern buildings.	*The 2-ply, torched-on MBM membrane has proven to be suitable for installation at subzero temperatures, and has performed well to date. Repairs are relatively simple to perform.*

EPDM or Rubber Roofing

Loose-laid membranes are not recommended for use on northern buildings.	*These loose-laid membranes can allow moisture to travel between the membrane and the backing, making it difficult to trace leaks.*

Metal Roofing

Metal roofing is acceptable; the standing seam type is recommended for low slope installation.	*This type of roofing has performed well* *On northern buildings provided it is installed properly.*

Metal roofs are prone to wind driven leakage at ridges and intersections with vertical surfaces where closures and caulking are poorly or not installed or break down due to the high degree of expansion/contraction movement of metal.

3.6.4 Flat Roofs

All roofs are recommended to have a minimum slope of 4% (1:25).	*To ensure positive drainage and avoid ponding.*

3.6.5 Stepped Roofs and Offsets

Recommendation	***Rationale***
Avoid stepped roofs. If two different roof levels are required, a continuous sloping roof section should connect them.	*To prevent the occurrence of extensive snow drifting, which may cause excessive roof loading and protracted wetting of wall segments and roof component joints.*
3.6.6 Parapet Walls	
Avoid the use of parapet walls.	*Parapets can create an obstruction where snowdrifts will form, adding to snow retention on the roof.*
3.6.7 Eaves	
.1 Eave Projections	
Eaves projections beyond the line of the AV barrier must not weaken the air tightness of the building envelope.	*While eaves provide one of the simplest ways to divert rain and melt water away from walls, windows, doors and the building perimeter, careful design is necessary to make sure the* A V *barrier joint is continuous and to avoid ice damming on eaves.*
Where the AV barrier is located outside of the structural framing, eave projections should be supported by structural members, which do not pass through the AV barrier.	*Depending on the roof assembly, the continuity of the* A V *barrier may be compromised if the structure is extended through the building envelope to provide eave projections.*
Minimal eave projections ranging from 100 to 200 mm are preferred in Nunavut	*Minimal eaves are considered adequate above the tree line, where rain and melt water runoff is less severe than below the tree line, and high winds cause large transient structural loading* of *eaves.*
.2 Eavestroughs	
Generally to be avoided	*Ice build-up renders them ineffective,* as *well* as *damaging them during spring melt.*
3.6.8 Access	
Where roof traffic is anticipated, the finish at access routes should be slip resistant.	*Access to the roof will be required for inspection, cleaning and maintenance of roof equipment and the roof itself* *Roof access is always required. Plumbing vents require clearing during the winter due to ice build-up*
3.6.9 Skylights	
Although past technology gave skylights a bad name, new roof and flashing systems and high quality insulating skylight materials now make their use more acceptable. Skylights are generally not recommended for use in Northern facilities.	*The extent of skylights would be inappropriate if the energy lost through the skylight increased the energy management budget unreasonably when compared to the environmental benefits and energy saved in lighting.*

Recommendation

When skylights are acceptable for northern buildings, several key design features must be included:

.1 A steep slope is required for drainage, i.e., 3:12 to 6:12.

.2 Skylight units should be placed on raised up stands above the roof plane a minimum of 200 mm to allow for drainage, expansion and contraction control, and flashing of joints.

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

.4 Adequate drip pan is to be provided, allowing condensation to evaporate and not overflow. Consideration should be given to force air movement over the surface, eliminating condensation.

.5 Framing members should be detailed with a secondary drainage plane leading to the exterior.

.6 If clear skylights are proposed, consider equipping them with blinds to reduce overly strong sunlight. The blinds must be easily operable by facility users.

Rationale

Skylights (especially translucent structural panels) have successfully provided a number of facilities with light in areas where windows were not possible.

The quality of overhead natural lighting is comparable to lighting from windows. Past problems experienced with skylights cannot be ignored. Poor detailing with resulting condensation has caused damage to interior furnishings and property. Inappropriate locations allowing direct penetration of sunlight causes discomfort to users who often complain of overheating and glare. Extensive roof damage has occurred as a result of poorly sealed skylight units.

The objective is to catch condensation and allow it to evaporate.

Accumulation of water cannot be totally eliminated on sloped surfaces. Joints exposed to standing water will eventually leak. Secondary drainage relieves the water that passes through the primary weather seal.

3.6.10 Clerestory Windows

Clerestory windows are reasonable alternatives to skylights, provided careful design allows them to remain clear of snow accumulation.

As for skylights, the use of clerestory windows requires extra care, attention and cost. The designer must deal effectively with potential climate and building envelope problems.

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 over the past 20 years, available products are often designed to meet performance requirements found in less severe cold weather conditions than are found throughout *Nunavut Territory*. 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. Direct heat loss is inevitable, as doors are not typically insulated to more than RSI1.8. Air leakage at door edges is also common, as weather seals lose flexibility in extreme cold. Excessive air leakage is also common in doors that are loose fitting or difficult to close properly, due to lack of alignment between the door and the frame. Door and frame misalignment can occur from higher than normal door use, or from structural strain on the walls, such as caused by impact damage or even foundation movement.

Recommendation	***Rationale***
4.1.1 Doors	
All exterior doors should be insulated metal, 16 gauge if steel, and minimum RSI 1.3. For energy conservation.	*Solid or hollow wood doors cannot achieve this minimal level* of *insulation, and warp easily in extreme dry cold.*
It is not practical to use a second storm door at entrances in public use buildings to keep warm air inside. Vestibules between outer and inner door sets are more practical and more durable.	*Warm interior air leaking past the inner doors can cause frost to form on the colder outer door edges, affecting weather seal operation.* *Residential grade storm doors wear out quickly from the heavy use encountered in public buildings, and are easily damaged.*
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, fire halls, 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, and can be selected from manufacturers' standard products.	*Insulated doors provide the best value in insulated walls. Thermal resistance ratings of RSI* 1.8 *is 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 do not accumulate.	*To ensure water and ice do not accumulate.*
4.1.3 Door Frames	
Metal frames are required for exterior doors in public buildings. Where steel, minimum 16 gauges, welded pressed metal frames are recommended for all exterior doors. Knock down frames are not acceptable.	*Added strength is required as doorframes can wear out early from high volume use in public buildings. Additional structural reinforcement connecting the doorframe to the wall and floor system is recommended.*

Recommendation	***Rationale***
All exterior doorframes require a thermal break. However, thermally broken frames need to be reinforced by the manufacturer when they are to be installed in high traffic public use facilities, or other facilities that are subject to break-ins. The available continuous polyvinyl chloride (PVC) interlocking thermal break system has been found to be the most effective protection in these locations.	*The thermal break, although needed because of the extreme cold experienced in the Nunaqvut Territory, can weaken the frame where strength is required by hinges and latching hardware. Doorframe failure arising from wear and tear and from forced entry has been an ongoing problem in schools and arenas.*
Wood frames may be used where security will not be compromised.	*Wood frames lose less heat than steel frames; however, they are not as strong as steel, and they should be used in 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.* *Consider the use of oversized exterior doors in the place of this system.*
A good air barrier seal to the doorframes is essential for energy conservation and to minimize corrosion from moisture.	*Air leakage out around doorframes 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 Architectural A3.1.3.*

4.1.4 Sealants - See Architectural A3.1.6.4.

4.1.5 Glazing in Doors and Sidelights

Sidelight frames should be independent of doorframes.	*The intent is to permit replacement of doorframes without replacement of the sidelights. The smaller independent frames are also easier to transport and handle on the site.*
Polycarbonate exterior sull sash protection for the sealed unit glazing is preferred solution to the exterior glazing in doors and sidelights at building entrances. Note that polycarbonate is not allowed as primary glazing at exits by NBC (3.4.1.10)	*See NBC A9.* 6.8.1. *Typically used for schools, community halls. Health centres, court facilities, libraries, airport terminals and other public access buildings.*

4.1.6 Vestibules

Recommendation	***Rationale***
Vestibules are recommended at all main entrances or other high traffic entrances. In schools the storage of boots as well as the space to put them on and off should be provided.	*Vestibules help keep warm interior air inside the building, conserving fuel energy. Larger vestibules are desirable.*

4.2 INTERIOR DOORS AND FRAMES

See AWMAC, Part 3 -"Wood Doors".

Recommendation	***Rationale***
4.2.1 Doors	
Solid core wood doors are preferred for all interior locations.	*Hollow core doors are too easily damaged in public access buildings, including residential buildings. The best life cycle value is found in more durable solid core doors.*
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 doors requiring a fire protection rating (label) may be wood or metal.	*Some solid core wood doors are available with laboratory-tested ratings, and may be appropriate for use in some areas of low traffic.*
4.2.2 Frames	
Interior doorframes may be wood or metal.	*Metal frames require less attention over their service life than wood and are generally less expensive installed.*
Fully welded metal frames are recommended over knockdown 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. Labelled wood frames should be considered only at areas of very light traffic.*
Interior doorframes requiring a fire protection rating (label) should be metal and have riveted metal labels.	
4.2.3 Bi-fold Doors	
Bi-fold doors are considered appropriate for use only in residential facilities, at door locations with very low use rates.	*Sliding mechanisms of bi-fold doors are too susceptible to damage from heavy use. Bi-fold doors are impractical for most locations And should be avoided whenever possible.*

Recommendation	***Rationale***
4.2.4 Glazing	
Restrict the use of glass in the lower portion of doors (closer than 600 mm to the finished floor) to well supervised locations. Where glass must be used in the lower section, it must be tempered.	*Although glass can be important for visibility, the lower portion of the door is vulnerable to damage.*

4.3 DOOR HARDWARE

After construction, Regional maintenance staff is often called on to correct or repair door hardware. As these repairs often require immediate attention, replacement parts are stocked in the Region. Heavy door usage in public access buildings requires reliable, durable and easily repaired hardware.

Recommendation	***Rationale***
4.3.1 Preferred Products	
Locksets	
Selection should be coordinated with maintenance staff so that Regional preferences and standard keying systems are accommodated.	*Maintainer preference where Regional keying system in place. Limiting hardware to preferred manufacturers reduces the stock of maintenance materials.*
Other Hardware	
No preferred products.	
4.3.2 Overhead Door Openers	
Manual operation by chain hoist is preferred. Automatic door openers are recommended only where they are essential to facility operation.	*Automatic overhead doors require more ongoing maintenance and are more susceptible to problems than manual doors. The additional cost is not usually justifiable.*
4.3.3 Power Door Operators	
The Office of the Fire Marshal should be approached to relax the requirement of NBC 3.8.3.3(5) in communities where repairs and maintenance is not available in the community.	*These are dealt with on an individual basis.*
4.3.4 Exterior Door Latching	
At least two point, and preferably three point latching, should be considered for all exterior doors. Surface bolts combined with a rim device are recommended.	*Although more expensive initially than single point latching, three-point latching provides higher security doors and a more airtight seal: forced entries are a recurring problem in public buildings where single point rim device latching is used.*
A properly sloped threshold plate is required where threshold recesses are used.	*Recesses tend to become blocked by ice.*
4.3.5 Keying	
Keying for all buildings to be maintained by PW&S is to be done according to the Regional or Area lock	*This allows buildings to be keyed separately for security reasons, but allows Regional Maintainers*

Recommendation	***Rationale***
keying system. Regional Maintainers can advise.	*to cut keys and provide sub-master keys where required.*
4.3.6 Hinges	
Full-length continuous hinges are recommended on exterior main entry doors subject to high traffic.	*This is to prevent ' jacking' of door or doorframe due to wind forces. Reduces O&M costs. Field evaluation data supports this requirement for schools and like buildings.*
4.3.7 Weather stripping	
Brush type is recommended for door bottoms.	*The rubber type wear rapidly with threshold friction.*

4.4 WINDOWS

The number and size of windows should be carefully designed in northern building envelopes, given the extreme climate and because of the potential for vandalism of public buildings. Views and natural light must be carefully considered when selecting and locating windows.

Recommendation	***Rationale***
4.4.1 Window Frame	
Insulated frame PVC, vinyl or pultruded fibre reinforced plastic frames are preferred.	*Easy maintenance as there is no need to refinish, and the potential for damage to windows by condensation is eliminated.*
Metal windows with thermal break frame, or protected wood windows are recommended for schools and heavily used public buildings.	*See 4.4.4*
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.	*Large single pane windows are not recommended as they are difficult to protect and expensive to replace.*
4.4.2 Sealants - See Architectural A3.1.6.4.	
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.	*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 window frame should straddle the plane of the AV barrier.	*The intent of such placement is to provide* A V *barrier continuity through the window frame without offset.*
4.4.4 Operation	
All operating windows in schools and public	*Crank handles are not acceptable in schools.*

Recommendation	***Rationale***
buildings should be casement or awning type with rugged hinges, *and rugged camlock handles*.	*Camlocks have been found to be the most maintenance free and to provide the best seal of all opening window types. Note that these handles require the rigidity of metal or pultruded fibre reinforced plastic frame materials.*
Windows must be designed so that they will not be blocked by accumulations of snow or ice on sill plates. Awning vents located in the top 1/3 of the window are preferred and awning vents in the lower 1/3 discouraged.	*Awning vents in lower 1/3 of frame are more likely to allow wind, dust and snow to blow in. Also, ventilators in lower portions of windows are less secure and ready intrusion points.*
Refer to M8. 1 when windows with an operable panel are provided.	

4.4.5 Glazing

All windows should have double- glazed sealed units with low "E" coating or triple-glazed sealed units.	*The objective is to obtain the best insulation value currently available and economically justifiable. Wherever recurring vandalism is identified as a potential problem, protection of glazing should be provided. See notes in NBC A9.* 6.8.1. *Typically used for schools where windows are subject to vandalism.*
A single-glazed removable sulsash of polycarbonate plastic on the exterior face is recommended to Protect double glazed sealed window glazing.	*Such protection should be considered for all seasonal use facilities where vandalism is a potential problem. This may also include schools because of shut down for the summer.*
Note that combustible glazing is not permitted as primary glazing in exit enclosures by NBC (3.4.1.10)	
Shutters or demountable panels may be used to protect windows.	

4.4.6 Window vents – snow and forced entry.

In high wind locations these have been successfully protected with full height hoods that discourage snow penetration and prevent forced entry. If wind is not a factor exterior metal louvers are recommended.	*Solid inward opening vents with insect screens have worked successfully with exterior hoods or louvers*

A5 INTERIOR CONSTRUCTION AND FINISHES

Durability and simplicity are desirable qualities in northern buildings. This applies similarly to interior construction and finishes. As it does to all buildings systems. Generally colour schemes and careful placement of building elements must be relied upon to create attractive and pleasing interiors: the range of appropriate materials and architectural details can be limited by cost. The occasional special use facility. Or high profile project may call for more elaborate treatment. In such cases. And when materials with very long service life are used. Trendy colour schemes that may become dated should be avoided. Increased concern about volatile organic gas from finish materials in recent years should encourage all building designers to investigate new products. And to ensure indoor air quality is not adversely influenced by 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 commonly used flooring materials, and indicates preferences for some specific applications.

Recommendation	***Rationale***
5.1.1 Resilient Flooring	
.1 Marbleized Linoleum	
This is the preferred flooring for most northern buildings.	*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 is too slippery for wet areas such as shower rooms. See 5.1.1.2*
Heavy traffic areas:	
Minimum 2.5 mm thickness with welded seams.	*Typical high traffic areas would include all public lobbies and corridors. And throughout health centres.*
Medium traffic areas:	
Minimum 1.8 mm lino with welded seams.	*Typical medium traffic areas would include seasonal use facilities, private offices and a few GN facilities where traffic would be deemed consistently light.*
Light traffic areas:	
Minimum 1.8 mm lino with welded seams.	*There are few northern public buildings considered to have light traffic.*
.2 Skid Resistant Sheet Vinyl 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.	*Typically used in vestibules, washrooms and change rooms where floors may remain wet for some time, or for residential uses where only small areas required. Welded seams are required to provide a durable, watertight joint. Products with surface colours and patterns should not be selected because they show wear too readily in*

Recommendation	***Rationale***
	public facilities with medium to heavy 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. Typically used in community or school gymnasiums.
Heavy-duty vinyl sports flooring with slip resistant surface, suitable for surface-painted lines, is acceptable.	
.3 Vinyl Composite Tiles (VCT)	
2.5 mm minimum thickness, colour and pattern detail throughout the thickness of the tile. Use marbleized or granite patterns.	*Because VCT is easily installed using local labour, they are especially appropriate where small quantities do not warrant the expense of bringing in a flooring subcontractor.*
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 fireballs, DSD field offices or summer use staff quarters. Tile shrinkage in cold temperatures makes them a poor choice for cold areas.*
Tiles should not be used in wet areas or areas subject to spills.	*Water and spilled materials can enter the joints and deteriorate the adhesive. Spilled fuel oil and antifreeze are particularly bad as they also penetrate the sub floor and make repairs difficult.*
.4 Rubber Flooring	
Rubber flooring is generally not recommended for general use in northern buildings.	*Rubber flooring used in public or residential buildings has been found to be difficult to clean, and expensive to install'. There is no inherent advantage that makes rubber flooring a better choice than linoleum or vinyl where resilient flooring is called for in GN facilities.*
Rubber sports flooring suitable for surface-painted lines is acceptable for use in community or school gymnasiums.	*Rubber flooring is suitable for sports activities, but also allows for community events without requiring people to remove footwear: unlike the more traditional wood sports floor, rubber flooring is resistant to damage from sand or mud tracked in by footwear.*
Vulcanised rubber skate flooring is acceptable for use in limited areas of community arenas.	*Typically installed only between ice surface and areas where skates are put on or removed.*
.5 Cork Flooring	
Generally not recommended in northern buildings.	*Difficult to maintain, and expensive to install. There is no inherent advantage that makes cork*

Recommendation	***Rationale***
	flooring a good choice for any particular use in a GN facility.

5.1.2 Wood Flooring

Generally not acceptable for use in northern buildings. Including gymnasiums, because of the typical dry service environment.	*Capital, installation and maintenance costs are high. Wood floors in gymnasiums require protective coverings when used for community events, which is inconvenient for users: where protective coverings are not used, floors are easily damaged.*
In high school gymnasiums wood flooring can be considered in consultation with the Technical Services on an individual basis.	*Evidence indicates an increased level of injuries at the senior sports levels due to the non-slip characteristics of man made versus wood floors.*

5.1.3 Ceramic Tiles

Generally not recommended for use in northern buildings, unless it can be shown that the advantages of durability outweigh the disadvantages of high initial cost.	*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 (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 the most stable substrate for ceramic tiles. Susceptibility to* cracking, de-bonding and grout repairs can lead to expensive maintenance. *Installation requires skilled trades persons, and repairs require special attention by maintainers.*
When tile is appropriate, neutral colours should be selected and accent colours avoided.	*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 stable substrates* *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.	*See notes re: "Carpet Tiles" below, and Appendix A "Tenant Improvement Standards (carpeting). " Carpet is typically used in classrooms, libraries, office areas, and courtrooms. Not suitably durable or soil resistant for use in such areas as kitchens,*

Recommendation

Rationale

.1 Properties

main entrances, stairs or bathrooms.

- Yarn: nylon preferred.

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

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

Hardwearing and easier to maintain than cut pile.

- Density: minimum 12.0 kilotex.

Density is the standard measure of carpet "wearability", 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.

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 suitable for use in most northern buildings.

.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.

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

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

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.

Using less durable carpeting will generally result in higher life cycle costs because of the high cost of shipping materials to Nunavut.

5.1.5 Carpet Tiles

Generally not acceptable for use in northern buildings.

The objective of carpet tiles is to extend the overall life of the carpet by rotating fast wearing tile areas with low use areas. In practice carpet tiles have been found to lift easily. Joints wear and become unattractive over time tiles are expensive to rotate as part of routine maintenance.

5.1.6 Epoxy Floor Finishes

Recommended for use only where continuously wet

Careful application is required, and it is difficult to

Recommendation	***Rationale***
conditions will be encountered in fairly large areas.	*keep maintenance materials in stock. Shower rooms in correctional centres are an example of where epoxy flooring may be considered.*

5.1.7 Concrete Toppings

As mechanical rooms and fan rooms are required to have a one hour fire separation (NU Fire Marshal), which often includes the floor, and have a finish that can contain water spills and leaks, concrete toppings sloped to drain are recommended in these rooms.

5.1.8 Floor Paint

Where suitable, should be non-skid finish, and applied to marine or exterior grade plywood or concrete.	*Suitable for low traffic, non-public areas where protection from water, dirt or spilled oil is required, such as mechanical or fan 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: .1 A liner should be installed below the ice surface. .2 A means of directing melt water away from the building should be provided.	*Floors under the ice surface in arenas have typically been left as compacted granular or sand fill. Allowing melt water to seep through the granular or sand floor can result in damage to the foundation system: degradation of permafrost by melt water changes the soil bearing capacity; increased moisture in the soil can increase frost heaving forces.*

5.1.10 Baseboards

Wood baseboards although costly, are preferred for high-use public areas.	
Integral base trim is recommended for wet areas. Resilient base trim may be used in supervised areas such as classrooms, offices or in passive use areas of a building, such as storage rooms. Carpet base may be considered in fully carpeted areas	*Resilient cove/baseboards detach easily from walls and require ongoing maintenance.*

5.1.11 Entrance Mats and Grilles

Avoid building in recesses for mats or grilles at entries.	*Difficult construction detail. Rely on frequent cleaning and surface track age mats instead.*

5.1.12 Local Materials

Where a suitable local 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.	*Can provide opportunities for local employment and skill development, as well as results in a more distinctive community building.*

5.2 WALLS

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 need to be reinforced where they are likely to be kicked, hit, bumped or carved. Surfaces should be washable, and easily repairable and refinishable by local trades people with materials that can be easily obtained and stored.

Recommendation	***Rationale***
5.2.1 Framing of Non-Load Bearing Walls	
Wood or steel studs are 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.*
5.2.2 Demountable Wall Systems	
Acceptable for use in office areas only.	*Demountable systems can allow flexibility; however, typically some acoustic separation is required, and built-in-place walls generally perform better at lower cost.*
5.2.3 Mechanical Room Walls	
.1 Heat Transfer	
The preferred means of reducing heat transfer from mechanical rooms to 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 public buildings such as schools or health centres.*
.2 Acoustic Isolation	
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 eliminate transmission by the structure.	*Equipment noise from mechanical rooms disturbs users of adjacent spaces in many existing buildings.* *STC (Sound Transmission Class) measures the acoustic separation capacity of a wall. The higher the STC rating, the better is the sound separation.* *Refer to A9.10.3.1 in the National Building Code for examples of STC ratings. See also Mechanical M8. 2.10 and Electrical E4.2.3 of the GBP.*
5.2.4 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.*

Recommendation	***Rationale***
5.2.5 Plywood Backing	
Gypsum board finishes should be backed by, or surfaced with, plywood in vestibules and washrooms. Consider plywood wainscoting in school corridors.	*These areas are subject to damage (i.e., from doors or impact damage from users) that gypsum board cannot withstand.*
5.2.6 Birch Plywood	
An acceptable wall finish where durability is important. Use select grade for clear finish, or paint grade for a painted finish.	*Provides a reasonably durable wall finish. Typically used in gymnasiums, change rooms, lobbies and foyers to enhance wall appearance.*
5.2.7 Wood Panelling	
Tongue and groove board finish is acceptable. Wood veneer panelling should be limited to communities where skilled trades people are available.	*Hardwood veneer panelling requires skilled finish carpenters to install and maintain it. Pre-finished vinyl veneer panelling should be avoided because it is difficult to repair if damaged, and difficult to match in replacement.*
5.2.8 Prefinished Wallboard	
Not recommended for use in northern public buildings.	*Appearance and durability concerns; any damage requires replacement of entire panels.*
5.2.9 Metal Wall Liner Panels	
Where metal panels are used as an interior wall finish, such panels should be factory preformed steel sheet, zinc coated, prefinished 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 the 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 damage.*

5.3 CEILINGS

Although generally inaccessible to occupants, ceilings do need to be able to withstand abuse in many circumstances (schools, gymnasiums, arenas, correctional facilities) and may be subject to periodic cleaning (health facilities, kitchens). The effects of ceiling heights, shapes and materials on acoustic and lighting design must also be considered.

Recommendation	***Rationale***
5.3.1 Drywall	
Seamless construction such as Gypsum board is sometimes preferred, however in teaching areas consideration must be given to reverberation time making hearing difficult.	*Industry standard but acoustics may prevent its use.*

Recommendation	***Rationale***
5.3.2 Exposed Roof Decks	
An acceptable ceiling finish where tongue and groove board deck is used.	*Typically used in gymnasiums and school classrooms, but may be considered wherever roof assembly allows decking to be exposed and such a finish is appropriate. Does provide an acceptable degree of sound absorption.*
5.3.3 T – Bar Suspension Grid	
Suspended ceiling system recommended only 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 boards in public use areas where the ceiling is less than 2.5 m high, or in areas that require frequent cleaning.	*Susceptible to impact damage and very difficult to clean.*
5.3.4 Textured Ceiling Finishes	
Not recommended for use in northern buildings.	*Easily damaged, and difficult to refinish.*
5.3.5 Metal Ceiling Liner Panels	
Where metal panels are used as an interior ceiling finish, panels should be factory preformed steel sheet, zinc coated, pre-finished on the exposed face.	*Typically used with pre-engineered metal buildings as an interior finish for garages and fireballs.*
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 the reach of occupants.	*Lighter gauge material is easily dented and should only be used where there is no exposure to damage.*

5.4 PAINTING AND WALL COVERINGS

Recommendation	***Rationale***
5.4.1 Acrylic/latex Paints	
Water-based acrylic latex paints are preferred for use in northern buildings.	*Environmental and health concerns have encouraged manufacturers to develop water-based paints that can now compete with oil-based paints for durability. Painting trades people are also beginning to stipulate the use of water-based products because of health concerns. Minimizing the availability of harmful products (including solvents) is also an important concern in many northern communities.*

Recommendation / ***Rationale***

5.4.2 Alkyd Paints

Oil-based paints are recommended for use in GN facilities where the risk of freezing is high because of a lack of heated storage area, or where there are limited shipping options.

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.

5.4.3 Special Coatings

Special coatings are to be used only where they will be applied to a reinforced drywall, plywood or concrete surface. As noted above, water-based products are preferred.

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

5.4.4 Vinyl Wall Coverings (VWC)

Vinyl wall coverings recommended are for:

- Visible public areas where 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. Although more difficult to clean, textured surfaces almost totally conceal tack marks.

Where used in high traffic areas, VWC could be installed so that the lower portion of the wall (up to about 1.2 m) can be replaced independently.

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.

5.4.5 Ceramic Tiles

Generally not recommended for use in northern buildings, unless it can be shown that the advantages of durability outweigh the disadvantages of high initial cost, cracking and debonding susceptibility, and problematic grout maintenance, in which case tiles may be proposed and considered.

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 (especially due to transportation costs). There is also a high risk of breakage in transit, and flexible wood structures typical of most GN facilities do not provide the most stable substrate for ceramic tiles. Installation requires skilled trades people, and repairs require special attention by maintainers.

When tiles are appropriate, neutral colours should be selected and accent colours avoided.

Examples of where ceramic tiles may be appropriate would include specialized facilities such as laboratories or hospital operating rooms where applied over stable substrates. It has also been successfully used for wall protection in limited areas such as at classroom sinks and at urinals.

Recommendation	Rationale
	The tile finishes will outlast adjacent finishes, so they must be able to work with changes of decor and changing colour trends.

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 usually 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 A WMAC Quality Standards for Architectural Woodwork, Part 2 "Casework", Part 1 "Quality Grades and Material Standards", Part 5 "Factory Finishing", and Part 6 "Installation",

Recommendation	Rationale
6.1.1 Casework	
Custom grade casework, including drawers, shelving, doors and edge banding as described in AWMAC Part 2. Cabinet Doors:	*AWMAC establishes only* two *grades: custom and premium. Premium would rarely be necessary or justifiable.*
Plywood doors are acceptable if they do not exceed 450 mm (w) x 1200 mm (h) in size. For larger doors: Hollow core doors or composite boards are both acceptable.	*Large plywood doors often warp.*
6.1.2 Clear Finish	
.1 Materials	
Where a clear finish is to be used, birch veneer hardwood plywood is preferred. To be Select White or Red, as described in AWMAC Part 1, Section 8.	
.2 Matching	*Reasonable appearance and cost.*
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 Part 1, Section 8, 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*

Recommendation	***Rationale***
Cabinet hinges: • Concealed 180 degree hinges preferred	*suited to public use buildings, where long life is expected.*
Drawer glides: • Ball bearing type preferred	
Cabinet door and drawer pulls: • Simple design preferred	

6.1.5 Shelving

The use of pre-manufactured 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.	*Pre-manufactured 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.	*To give users some flexibility.*
.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.	*Visible shelving is typically required in schools, community offices, health care centres and public reception areas.*
• Tempered glass shelving should be limited to display cabinets.	*Display shelving is used in a limited application in schools and community centres, but would more often be found in visitor centres, cultural centres or museums. Because glass needs to be kept very clean, and may be subject to breakage, its use may be minimized.*
• Factory painted metal shelves are preferable for storage rooms or low visibility locations. Melamine or painted wood shelves are acceptable.	*Less expensive alternatives to clear finished wood where appearances are not as important. Typically acceptable for storage rooms, garages or 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, Part 1, Section 11 and Part 2, Section 7.

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.	
Avoid the use of post-formed laminate counter tops with integral back or side splashes.	*Experience has shown that post-formed counter tops are often damaged in transit; and exposed edges at nosing/overhangs are easily chipped.*
6.2.2 Plastic Laminate	
General-purpose grade, complete with backing sheets, velour or suede finish. Texture patterns preferred in all high-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 DSD labs.*

6.3 MISCELLANEOUS FINISH CARPENTRY

Refer to AWMAC Part 1 "Quality Grades and Material Standards", Part 4 "Frames, Panelling and Specialties", and Part 6 "Installation".

Recommendation	***Rationale***
6.3.1 Grade	
Custom grade as described in Part 4, AWMAC standards.	*Birch and oak are hard enough to withstand scratching or denting, whereas pine is soft and susceptible to damage from everyday activities.*
Recommend clear birch or oak throughout. Avoid pine. Consider using American Poplar as an option for paint grade trim. It has very few knots, machines well, is a very stable and durable wood, and accepts paint very well with virtually no knots or sap bleeding through. It is generally less expensive than softwood, and as tough as hardwood. It must be painted as its natural color varies from yellow to green to a purplish color.	

Recommendation	***Rationale***
6.3.2 Coat Racks	
Ensure spacing and size of pegs are adequate for heavy winter parkas, coveralls etc. Pegs should be nominal 25mm diameter with rounded ends and mechanically anchored.	*Typically provided in schools, community offices and group homes.*
Parka hooks in school corridors should be installed with a protective 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	
Pre-manufactured metal radiation cabinets are preferred for most public buildings: wood cabinets/covers are acceptable only for special use public 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/covers are not recommended for use in high use facilities such as arenas and schools.	*Higher initial cost than standard metal cabinets. The design of wood 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

7.1 WASHROOM ACCESSORIES

Durability and damage resistance are important because washroom accessories are often subject to abuse. Including scratched or applied graffiti. Accessories should normally be surface- mounted or freestanding for ease of installation. However. Recessed accessories may be considered in small washrooms where reduced volumes are adequate.

Recommendation	***Rationale***
7.1.1 Shower Surrounds	
Glass fibre, reinforced acrylic moulded units, or PVC units are preferred. Integral grab-bar system or the ability to attach standard grab bars is recommended.	*Pre-moulded units are easily cleaned, easy to install, and provide a durable surface.*
The thresholds in handicapped access manufactured units exceed NBC allowable height. Unless the floor system allows the stall to be recessed, a ramp integrated with the non-slip vinyl floor finish is recommended. Avoid using ceramic tiles or prefinished panel materials requiring jointing on site.	*PVC is more difficult to clean than acrylic and typically has a shorter service life.*
7.1.3 Washroom Accessories	
Preferred washroom accessories manufactured by: .Bobrick . Twin Cee	*These brands have proven to be an acceptable standard for public buildings.*

Recommendation ***Rationale***

. Frost Metal
.Watrous Sales

7.1.4 Backing

Backing must be installed for all furniture. Equipment and hardware to be mounted on walls.

Secure, safe and vandal-resistant installation.

7.2 SIGNAGE

There have been no interior or exterior sign standards adopted for other northern buildings. A sign section was developed and added to the Visual Identity Guideline for the GN by Public Works and approved by the Department of Executive and Intergovernmental Affairs. It should be used where applicable. The following recommendations are based on the GN Visual Identity Guideline and best practice based on historical information.

Recommendation ***Rationale***

7.2.1 Language

Signs provided to help user and visitor orientation should be integrated signs in all Official Languages of Nunavut and international graphic symbols as appropriate

All languages should be displayed as described in section 4.0 (Official Languages) of the Visual Identity Guideline.

7.2.2 Exterior Signs

Sign material and installation method should be selected on a site-specific basis as per the Visual Identity Guideline. Signs must be visible, functional, durable and aesthetically pleasing

Exterior signs should conform to section 4.1 (Primary Identification Signs) of the GN Visual Identity Guideline for the purpose of consistency.

7.2.3 Interior Signs

.1 Name Plates

Material consistent with that used on directory boards should be used.

Colours can be coordinated with building interiors.

Name Plates should conform to section 4.2 (Directory Boards) of the GN Visual Identity Guideline for the purpose of consistency.

. 2 Directory Boards

Sign material and installation method should be consistent with the Visual Identity Guideline.

Directory Boards should conform to section 4.2 (Directory Boards) of the GN Visual Identity Guideline for the purpose of consistency.

7.2.4 Regulatory, Warning and Information Signs

Regulatory, Warning and Information Signs should be implemented as per CAN-CSA-Z321 (Signs and

All signs of this nature should be installed as required in the interest of safety.

Recommendation	Rationale
Symbols for Occupational Environments) and ISO7001 (Public Information Symbols).	
Evacuation Plans and Evacuation Layouts are required in all buildings.	*Standards for Evacuation Plans and Evacuation Layouts are available from the Government of Nunavut and should be included in specifications.*

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 18 to 24 hours of daylight for 4 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	
Should be machine washable.	*Dry cleaning is not available in most northern communities.*
7.3.2 Blinds	
Adjustable vertical blinds are preferred. Perforated plastic (non-toxic) or metal blinds are preferred.	*Note that vertical blinds may require stacking room beyond the window opening to access opening vents.*
Roll down blinds with operating chains and end tracks are also acceptable in supervised locations. Horizontal blinds are acceptable.	*Vertical blinds do not collect dust as readily as horizontal blinds.* *Plastic or metal are simple to clean compared to fabric blinds.*
Avoid using fabric blinds unless the fabric has an easily cleanable surface.	*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 APPLIANCES

Built-in appliances are commonly included in construction contracts rather than with furnishings.

Recommendation	Rationale
7.4.1 Kitchen Appliances	
Preferred manufacturer of stoves, fridges, freezers and other kitchen appliances should be confirmed with local building/asset management agencies.	*The objective is to simplify the number of parts stocked, so maintainers can become familiar with repairs.*

Recommendation ***Rationale***

Standard sizes and energy efficient models should be selected. Colour should be white.

7.4.2 Laundry Equipment

Preferred manufacturer of washing machines, dryers or other laundry equipment should be confirmed with local building/asset management agencies. Standard sizes and energy efficient models should be selected. Colour should be white.

The objective is to simplify the number of parts stocked, so maintainers can become familiar with repairs.

A8 COORDINATION

This section highlights structural, mechanical, electrical, or site considerations that are particularly affected by, or affect, architectural design.

8.1 MECHANICAL EQUIPMENT

Recommendation ***Rationale***

8.1.1 Space Requirements

Adequate space should be provided in mechanical rooms for plumbing, heating and ventilation equipment, including required clearances and access for maintenance. See notes in Mechanical Section.

Cramped mechanical rooms with minimal clearances and inadequate access for maintenance have been a common shortcoming of northern building designs.

Space in wall and floor assemblies is often required to accommodate plumbing and ducts. Great care must be taken that these spaces do not interrupt the continuity 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, grilles and louvers, and servicing points must consider effect on equipment performance and be coordinated. With structural systems and architectural finishes.

The location of equipment should satisfy both requirements: giving one consideration priority Over the other is unacceptable.

8.1.3 Access

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

Fairly frequent access is required, especially when building is newly occupied and operator is becoming familiar with system.

8.1.4 Windows

Heat gain and heat loss through windows must be taken into consideration by heating and ventilation system designers.

Changes to architectural design may not necessarily be passed on to mechanical consultants. When ventilation systems cannot manage heat gains, the facility can become very uncomfortable for occupants.

8.2 ELECTRICAL EQUIPMENT

Recommendation

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. See Electrical Section.

Rationale

Cramped electrical/mechanical rooms with minimal clearances and inadequate access for maintenance have been a common shortcoming of GN building designs.

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. Designers should observe electrical section of this publication and the Canadian Electrical Code requirements.

8.2.3 Electrical Outlets

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 envelope, or they must be efficiently sealed.

8.3 LIGHTING DESIGN

Recommendation

Fixture locations need to be coordinated with structural and mechanical elements.

Fixture styles should be coordinated with decorative or architectural themes.

Day lighting zones and electrical lighting zones should be coordinated.

Rationale

The objective is to avoid the need for on-site changes and to prevent lighting obstructions.

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

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

Recommendation

Where risk of injury to persons exists because fittings, hardware, or similar items are mounted within two metres of the floor level, such fittings on walls shall be recessed.

Rationale

The intent is to prevent bodily harm to persons and/or damage to equipment. Typical locations where this is important are school gymnasiums and other sport activity rooms.

END OF SECTION

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6.1 Floors

6.1.1 Slabs

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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 playa 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

National Building Code
NWT Engineering, Geological and Geophysical Professions Act

S2 LOGISTICS

2.1 TRANSPORTATION AND HAND

Equipment available to move materials is often limited in small 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 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 erection procedures, reducing erection time and complexity. Whenever possible. Simplify detailed design and minimize the number of operations required to install components. Simple details are likely to bring about a better building.

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 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". Geotechnical investigations should be undertaken as soon as a site is identified, and well in advance of design. Buildings are typically raised above grade to protect the permafrost from deterioration caused by building heat loss. Thermosiphons 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 "ad freeze" 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 Nunavut. 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 construction start in the summer or fall (particularly when materials arrive by sealift in July or August).

Recommendation	***Rationale***
3.1.1 Site Preparation	
Avoid cutting into existing slopes to accommodate building foundations where permafrost is present.	*Permafrost soils with 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 Piles 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	
Recommended where woodpiles have been used in the past, and local materials, expertise and equipment are available. Wood piles should be pressure treated with chemical preservatives, and installed in a reasonably dry or air free service environment, if they are intended to provide a long service life (greater than 20 years) in most northern service conditions.	*Untreated woodpiles have been used extensively in the Inuvik Region since the 1960's and are presently approaching 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, woodpiles are typically more expensive than steel piles when transportation and market factors are the same.*

Recommendation

It is essential that the grade adjacent to wood piles (particularly untreated wood piles) be well drained to Ensure the piles are not standing in water, and that there is not a high water content in the active layer surrounding the piles.

.3 Concrete Piles
Not recommended.

Rationale

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 ad freeze 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 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 decay of wooden piles.

3.1.4 Pile Caps

Adjustable pile caps are recommended for use wherever piles cannot be pinned to bedrock.

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

3.1.5 Grade Beams

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.

3.1.6 Monitoring Performance

The installation of monitoring equipment to investigate the performance of pile foundations of northern buildings should be considered wherever a research project could be identified, responsibility for monitoring is acceptable to the owner, and the results will be made available to the design community.

Research projects may be instigated by the building owner, by private consultants or educational institutions.

3.2 SHALLOW FOOTINGS

Shallow footings are generally used only in combination with built-up granular pads in the North. Seasonal movement is to be anticipated with this type of foundation, unless thermosiphons are installed to maintain the frozen soil beneath the footings. Granular fill work is often completed by local community contractors, as equipment and skilled operators are available for this type of work in most communities in Nunavut. 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 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	
Where granular pads are installed as a part of a foundation system on a sloping site, consider using an impermeable liner to divert surface water.	*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.*
3.2.3 Footings	
Pressure preservative treated wood pads are preferred. Concrete is acceptable where quality of concrete can be assured.	*Wood can be easily shipped and assembled, and can also be easily adjusted on site to line up with column grid lines.*
3.2.4 Adjustment	
Adjustable wedges or screw jacks allowing 100 mm to 150 mm of vertical adjustment are recommended. A minimum clear height of 600 mm must be available for maintenance.	*Annual height adjustment should be anticipated, and adequate clearance is essential for workers who may be under the building for several hours at a time.*
3.2.5 Thermosiphons	
Wherever thermosiphons are installed as part of the foundation system:	
• The cooling medium should be a material 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 thermosiphons from functioning units.*

Recommendation	***Rationale***
• Radiators must be protected from damage by vehicles, and be situated away from warm air exhaust vents	
• Thermistors 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 thermosiphons as outlined in the "Maintenance Management System (MMS) Manual. "*

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 so that it does not result in melting or softening 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* 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 S3.2.2 and L4.1.1 "Built-up Granular Pads”.	
3.3.3 Active Layer Bond Breakers	
Grease or polyethylene wrap should be provided as a bond breaker on all surfaces of piers that pass through the active layer.	*The objective is to minimize uplift forces on the pier that may be caused by seasonal freezing and expansion of the soil in the active layer.*
3.3.4 Footings	
Pressure preservative treated wood pads are preferred. Concrete is acceptable only where the quality of the concrete can be assured.	*Wood can be easily shipped and assembled, and can also be easily adjusted on site to line up with column grid lines.*
3.3.5 Adjustment	
Adjustable wedges or screw jacks allowing 100 mm to 150 mm of vertical adjustment are recommended. A minimum clear height of 600 mm must be available for maintenance.	*Annual height adjustment should be anticipated, and adequate clearance is essential for workers who may be under the building for several hours at a time.*
3.3.6 Thermosiphons	
Refer to Section S 3.2.5.	

3.4 STRUCTURAL SLABS

Concrete slabs would seem an ideal choice for many buildings such as garages, fire halls 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 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 are not recommended.	*Ventilation can easily fail if ventilators are blocked by snow or fill with water.*
.2 Mechanical Ventilation	
Mechanically ventilated slab foundations 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 Thermosiphons	
Refer to Section S 3.2.5.	

S4 WOOD STRUCTURES

Due to their versatility and general availability, 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.

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 structure with the building envelope and mechanical systems: floor assemblies must often accommodate thick thermal insulation, plumbing runs and ventilation ducts.

Recommendation	***Rationale***
4.1.1 Joists	
Consider using plywood web joists, 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.*

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. 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, and 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 Section A 3.6.

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, fire halls, arenas and warehouses -all buildings with fairly simple spatial requirements, 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 equipment is available in the community 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 resources. Bolted connections are preferable to extensive specialized field welding.

5.1 FLOORS

No special structural requirements. See recommendations of S4.

5.2 WALLS

No special structural requirements. See recommendations of S4.

5.3 ROOFS

No special structural requirements. See recommendations of S4.

S6 CONCRETE

The use of concrete is challenging in the Canadian North because granular materials, mixing equipment and testing facilities are not available in many communities. Unstable soil conditions and a limited construction season can also make using concrete problematic as a structural material. In communities where ready-mix concrete is available, or where very small quantities are required so as to make hand batching feasible, concrete may be considered for some structural elements. Typically this is limited to foundation elements, which are covered in Section S3 above.

6.1 FLOORS

6.1.1 Slabs - Refer to S 3.4 "Structural Slabs".

6.2 WALLS

Concrete walls are not recommended for use, 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.

6.3 ROOFS

Concrete roofs are not recommended, except where no other assembly can be used to meet NBC requirements, or where it can be shown that concrete would be most economical choice.

END OF SECTION

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. At the same time high energy costs have resulted in the need to make efficient use of energy. These two factors have led to the use of increasingly sophisticated mechanical systems, particularly with respect to heating and ventilation. However, in the Arctic, operation and maintenance of sophisticated mechanical systems can be difficult as qualified or experienced trades people are not always available in small communities, and response time can be slow if someone has to be brought in. For this reason, 'simple and reliable' mechanical systems are desired in all buildings. Of course, the demands made of a system limit just how simple it can be. There are no trouble free systems. Guidelines and recommendations covered in this section include installations that have been found to be acceptable by PW&S to date, balancing the sometimes-conflicting demands for comfort, energy conservation, simplicity and reliability.

M1 CODES AND REGULATIONS

National Building Code -1995
See G6 "Codes and Regulations"

Other Related Documents

Documents referenced by the NBC or this document include:

- ASHRAE Handbooks and Standards
- National Fire Code 1995
- National Plumbing Code 1995
- SMACNA (Sheet Metal and Air Conditioning National Association)
- CGSB-41-GP-22 Process Equipment: reinforced polyester. Chemical resistant, custom-contact moulded
- NWT Impact Review Board (NIRB)
- Installation Code for Oil Burning Equipment CAN/CSA-B139-M91
- CAN/CSA-B149.1-05 for Natural Gas and Propane Installations
-
- Department of Health Building Standards for Potable Water and Sewage Holding Tanks
- National Hydronic Design Standard
- American Society of Plumbing Engineers -Data Book
- ASHRAE 62 -1989 Ventilation for Acceptable Indoor Air Quality

M2 OPERATION AND MAINTENANCE

2.1 GENERAL

See G1 "Local Resources" and G4 "Appropriate Technology'

2.2 ACCESS

Along with the selection of equipment and systems, the design of mechanical systems must consider how location and access can affect the simplicity and reliability of mechanical systems. For example, the quality and frequency of servicing can be adversely affected if it has to be carried out in cramped and uncomfortable spaces, especially when heavy winter clothing is worn. Ducts or equipment concealed in ceiling or floors should be located in such a way that servicing is possible with ease. Mechanical rooms and crawl spaces should be designed to provide adequate space for servicing or replacement of all equipment.

2.3 MAINTENANCE PREVENTION

Design facilities and select equipment requiring minimal maintenance and ease of service when necessary, (In other words, build something that can be readily maintained).

2.4 PREDICTIVE MAINTENANCE

Determine the life expectancy of facility and equipment components in order to replace them at the optimum time. (If the building is going to outlast its major components. let's have this clearly stated up front so everyone knows where they stand).

2.5 SPARES

Regional Maintainers should determine, in consultation with designers, what spares should be provided. Replacement equipment and parts are often difficult to transport to small remote communities.

2.6 STANDARDIZATION

In the interest of maintenance the equipment for any particular function should be of one manufacturer and compatible with the existing O&M parts inventory currently used in the Region or community.

2.7 OPERATION & MAINTENANCE MANUALS

At present manuals are to be prepared in accordance with good engineering practice. Guidelines for the preparation of O&M manuals are currently in draft form only.

M3 IDENTIFICATION

Operating and maintaining mechanical systems require an understanding of their systems components, including movement of fluids, air and mechanical parts. Nameplates, tags and arrows can all be used to assist quick identification. Consistent identification in all publicly owned buildings is required so that maintainers and operators can orient and familiarize themselves easily with any building in any community across Nunavut.

3.1 PIPE PAINTING & IDENTIFICATION

Refer to Standard Colour and Identification Chart #15190.101-1, Issue #2, dated June 1988 (see Appendix F). The following points are in addition to the chart and are included to clarify requirements.

Recommendation	***Rationale***
3.1.1 Text	
Complete spellings of material names in English should be used.	*Not everyone will be familiar with abbreviations*
3.1.2 Locations	
Locate pipe markers and direction arrows on piping systems where they are visible from the floor of the usual operating areas or readily accessible points: • Beside each valve • Where pipes penetrate walls, floor and ceilings.	*This is done for the sake of convenience*
3.1.3 Extent of Colour	
Paint the piping its entire length in all mechanical rooms. Elsewhere, piping is to be identified by using bands of classification colour (either paint or tape) at selected points including: • Where pipes penetrate walls, floor and	*This allows for convenient and consistent identification.*

Recommendation	Rationale

ceilings

- Every 5 metres in concealed spaces
-

3.1.4 Labels

Labels are to be made from plastic- coated cloth with protective over coating and wrap-around tape or of the plastic 'snap-on' type.

Stick-on types are not to be used because they falloff after the adhesive dries.

3.2 EQUIPMENT IDENTIFICATION

Refer to Standard Colour and Identification Chart #15190.101-1, Issue #2, dated June 1988 (see Appendix F). The following points are in addition to the chart and are included to clarify requirements.

Recommendation	Rationale

3.2.1 Equipment

Use laminated plastic plates with a black face and white centre, minimum size 90 x 40 x 2.4 mm engraved with 12 mm high lettering for major equipment, 6 mm high for other equipment. All tags and identification labels are to be mechanically fastened to equipment by rivets, bolts or chains, not by adhesives.

These requirements result in high legibility and permanence.

3.3 VALVES AND CONTROLLER IDENTIFICATION

Refer to Standard Colour and Identification Chart #15190.101-1, Issue #2, dated June 1988 (see Appendix F). The following points are in addition to the chart and are included to clarify requirements.

Recommendation	Rationale

3.3.1 Valve Tags

Metal or plastic tags with 12 mm stamped code lettering and numbers filled with black paint are to be used.

These requirements result in high legibility and permanence.

Ensure that all concealed valves, instrumentation and controllers are identified with Avery coloured adhesive dots (i.e., above ceilings)

This provides a means of quickly identifying the precise location of these devices.

3.3.2 Instrumentation and Controllers

Use laminated plastic plates with a black face and white centre, minimum size 90 x 40 x 2.4 mm. engraved 6 mm high letters, mechanically fastened using pop rivets, screws or bolts (not adhesives).

These requirements result in high legibility and permanence.

3.3.3 Valve List

A typewritten valve list corresponding to 'as-built' plans. To be framed under clear acrylic sheet (such as plexi- glass) and mounted securely on wall with four screws. Is to be used.

This provides maintainers with a permanent reference assisting maintainers to become familiar with an installation, and eases trouble-shooting.

M4 PLUMBING AND DRAINAGE

The selection of the type of plumbing system has a significant impact on mechanical construction costs and building life cycle costs.

Some factors 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 is the size of the tank needed for fire suppression?
- If a tanked sewage system is selected, what is the size of the sewage tank and where in the building or outside the building will it be located?

These requirements generally apply to systems contained within the building. The documents "Water Distribution and Sewage Disposal Systems of the NWT", dated August, 1985 and "Water and Sewer Service Connections in Permafrost Areas of the NWT", Wilson & Cheema, 1987, should be referred to for a more complete discussion of municipal servicing requirements affecting building construction contracts.

4.1 DOMESTIC WATER - PIPED SERVICE

Less than 20% of all communities in Nunavut have piped service where water lines are either buried or carried in aboveground utilidors. Water treatment in all communities consists of the addition of chlorine and/or filtration and is the responsibility of the municipality. Even though Nunavut has abundant fresh water, capital and operating costs of delivering water are high, making conservation very important.

Recommendation	***Rationale***
4.1.1 Municipal Connection	
Connection to a municipal system is preferred, when available.	*While usually more costly, especially when a manhole is required, connection to the municipal system has the following advantages:* • *Lower cost than water truck delivery* • *The building will not run out of water*
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 meters the water and billings reflect consumption.*

4.2 DOMESTIC WATER SUPPLY - TANKS

Water delivery by truck for storage in holding tanks located within buildings is common in all communities in Nunavut. Deliveries are generally made once or twice a week following a regular schedule. Conservation is especially important where tanked water supplies are used. The space required to store adequate water for a building can be considerable. Coordinate with the structural designer for proper tank support.

Recommendation	***Rationale***
4.2.1 Environmental Health Standards	
For water storage tanks issued June 1992, are to be followed.	***Note:*** *these standards were developed in consultation with Housing Corporation, PW&S, and the Office of the Fire Marshal. They are currently guidelines for Environmental Health Officers, but will eventually be incorporated into regulations under the Public Health Act.*
4.2.2 Potable Water Supplies	
.1 Consumption Estimates	
In the case of additions to existing buildings, actual consumption during the preceding three years will form the basis for determining sufficiency of existing tank capacity.	*Actual water consumption may deviate significantly from the estimates used to determine the tank capacity for the existing facility and often is much lower than originally anticipated. The lower consumption is often due to changes in usage (of showers) and the substitution of low- consumption fixtures during earlier renovations. The project brief should provide appropriate guidance.*
The following are the recommended minimum acceptable amounts to be used in calculating the estimated total daily consumption of potable water for new buildings:	*Consumption estimates for new buildings are normally based on program information or engineering standards; however, such information is not always available or appropriate for conditions in Nunavut.*
.1 Residential Occupancies:	
90 litres/resident/day except that 25 litres/staff/day is sufficient for non-resident staff.	*This is the CGS standard for residential occupancies.*
.2 Non-residential Occupancies:	
25 litres/person/day.	*This is based on a review of actual consumption figures for existing buildings.*
.2 Supply	
.1 A **seven-day** supply should be provided where total daily consumption is estimated at less than 600 litres (calculated on normal building operation).	*This would apply to residences with up to six residents, or non-residential buildings with up to* 24 *occupants. The maximum tank size would be* 4,200 *litres (about* 1,000 *gallons). Previous PW&S direction was to size tanks for* a *minimum two-week supply; however, this was based on the need to provide adequate water for emergencies, which is not necessary for all facilities. Smaller tank sizes will help to ensure the tank will be replenished with fresh Water at least once a week, and that capital and O&M costs will be minimized.*
.2 A **three-day** supply should be provided in all buildings where total daily consumption is estimated at more than 600 litres (calculated on normal building operation).	*This would normally apply to residences with more than* 6 *residents or non-residential buildings with more than* 24 *occupants. Smaller tank sizes will help to ensure the tank will be*

Recommendation	Rationale
	replenished with fresh water at least once a week, and minimize capital and O&M costs.
4.2.3 Emergency Water Supplies	
Potable water storage capacity may be increased up to a maximum 10 day supply if:	*It is generally preferable to keep water supplies to a minimum in order to maintain a fresh water supply. Tanks are generally in a warm mechanical room or crawl space and water can stagnate in that time.*
.1 A building is designated as a community reception or evacuation centre under the "Civil Emergency Measure Act", or	*There are currently no regulations governing water supplies that must be provided in buildings designated as community reception or evacuation centres. The ten-day supply is suggested by PW&S, as interruption to water delivery service could occur during severe winter storms. Typically this would apply to schools (which are often considered as community evacuation or reception centres), but this could apply to other community buildings as well.* *See notes in Appendix B.*
.2 A prolonged shortage of water would require the relocation of residents.	*Typically this would apply to any long-term care or detention facilities, and student or staff residences.*
4.2.4 Fire Protection Sprinkler System Reserve	
See Section M5.2.	
.1 Separate Tanks	
Potable water Supplies must be stored in dedicated tanks, separate from any water Supplies reserved for fire protection.	*Complaints about the quality of potable water in schools where large reserves of water for fire protection have been combined in a single tank (or series of tanks) have been numerous. Combining large water supplies in one tank also makes cleaning operations cumbersome and expensive. Potable water storage tanks require frequent cleaning, while fire protection water supply tanks do not.*
4.2.5 Tank Construction	
All water storage tanks should be fibreglass or plastic and constructed to CGS8-41-GP-22 standards.	*The CGSB standard is a more suitable standard for water storage tanks, replacing the previous requirement for water storage tanks to meet AWWA C950. The rated test pressures of the AWWA standard far exceed those required for an atmospheric tank, and construction to CGSB ensures better longitudinal strength of pipe tanks.*

Recommendation	***Rationale***
To prevent over pressurization of the tank when the overfill pipes freeze, an interior vent line on water tanks is required.	*The CGSB standard does not state a working pressure. Tank manufacturers have stated they cannot build straight walled tanks to meet high-pressure requirements. Pressure requirements of tanks should be limited to the head in the tank, plus a slight margin of safety. Low profile tanks must meet CGSB standards.* *Newer water trucks in the community are capable of delivering water at very high volumes and pressure. This should be a consideration in tank selection, arrangement and placement.*
Galvanized steel, aluminium and concrete are not permitted.	*The Canadian Plumbing Code does not approve galvanized steel, aluminium and concrete.*
4.2.6 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 prevents tank contents from freezing or from becoming tepid.*
Avoid locating tanks in the same room as boilers or furnaces.	*If potable water supply is warm, it is objectionable to users and promotes bacteria and algae growth.*
Buried water storage tanks are not acceptable.	*They make access difficult for maintenance.*
Small Tanks (up to 4,200 litre capacity)	
.1 Locating small tanks enclosed within occupied building areas (may include a basement) are preferred.	*The tank needs to be small enough to be located in an occupied building area where it is easily accessible.*
.2 Locating small tanks in a heated crawl space are acceptable.	*Where a heated crawl space is available, the space may serve as a service space. It is preferable if the tank's location in the crawl space takes advantage of any natural slope on the building site. The objective is to limit the raising of the main floor level to accommodate tanks and access clearance, and reduce ramp and stair access requirements.*
.3 Locating small tanks in a suspended tank room are acceptable, but are to be avoided where possible.	*A suspended tank room is acceptable where the building footprint must be minimized and space cannot be made available within the occupied building area, and where a heated crawl space cannot be provided due to soil conditions. This generally results in the* *Main floor level being raised considerably above grade, and can result in the need for extensive ramp and stair construction.*

Recommendation	***Rationale***
.2 Large Tanks (over 4,200 litre capacity)	*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 access clearance (resulting in additional costs for stairs and ramps), this is generally Preferable to increasing the main floor area, building envelope size and structural capacity.*
.1Locating large tanks in a heated crawl space or basement is preferred.	*Where a heated crawl space or basement cannot be provided because of soil or site conditions, a suspended tank room is acceptable. This generally results in the main floor level being raised considerably above grade, and can result in the need for an extensive ramp and stair construction.* As *much as possible, suspended tank rooms should be located to take advantage of any natural slopes of the building site.*
.2 Locating large tanks in a suspended tank room are acceptable.	*The cost of providing the main floor area with adequate structural support and site limitations makes this alternative undesirable.*
.3 Locating large tanks in the occupied building area may be considered.	

4.2.7 Fill and Vent Piping

Fill and vent piping is to be Schedule 80 PVC within the building and change to copper pipe where it penetrates exterior walls or fire separations.	*Plastic pipe gets very brittle in cold outdoor temperatures and can easily crack or break. See NBC* 3.1.9.1 *and* 3.1.9.4 *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 hose from vehicle to fill pipe.	*This reduces the risk of the water hose being dragged through spilled sewage at pump-out location. Fill and pump-out service points are to be determined based on the access route, with water fill point being the first accessible to arriving vehicles.*
Fill and vent piping 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 may reduce the effective capacity of the tank; however, they are necessary to vent and protect the tank from damage.*
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 janitor sink).	*Frozen condensation from the tank can block the exterior vent through the Winter months and create the potential for the tank to rupture during filling.*

Recommendation	***Rationale***
Vents terminating outside the building may be screened where dual venting is provided. Otherwise terminate with an elbow to comply with Environmental Health Standards.	*Environmental Health Standards suggest both means of preventing dust, birds and insects from entering tank, but it should be noted that a screen fine enough to exclude insects during summer months will freeze over In the winter, and the second vent is required for relief.*

4.2.8 Access to Water Tanks

Water tanks must be accessible to maintainers for cleaning and repairs when necessary .The following access locations are preferred:

.1 Top access with a minimum of one metre 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.	*Access to the interior of tanks should be as simple 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.*
.2 End or side access to tanks is acceptable where service space height is restricted, and tank construction allows for removable ends.	*End or side access may in fact 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.*

4.3 DOMESTIC HOT WATER (HW) SUPPLY

Hot water use 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.

Recommendation	***Rationale***
4.3.1 Oil-Fired Domestic Hot Water Heaters	
Dedicated, oil-fired HW heaters should be used where:	*This type of heater has the lowest operating cost where large quantities of domestic hot water are required, and where it can be tied into the same fuel supply used for the building heating system. They are typically installed in schools and recreation facilities with showers, and in residential facilities including student hostels, long-term care facilities and group homes.*
Install Indirect domestic water heaters where the building heating is provided by hydronic heating. This can be utilized in areas where the boilers are not shut down on a seasonal basis.	*This would reduce the requirement for an additional chimney and fuel oil piping to the extra appliance. As the heating boiler is being operated throughout the year, the domestic hot water can be produced at a minimal cost.*
.1 Fuel oil is used for the building heating system.	*Fuel oil usually costs substantially less than electricity.*

Recommendation	Rationale
See "Electric HW Heaters" Mechanical M 4.3.2	*In some instances a combination of oil-fired and electric HW heaters should be considered for the same facility.*
On-demand oil fired heating systems should be considered in applications where the demand for hot water is minimal.	*This minimizes fuel consumption.*
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-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-fired domestic water heaters is to be the manual reset type.	*This provides safety protection shutdowns*

Refer to Section M 7.2.2 for chimney and vent requirements.

4.3.2 Electric HW Heaters

The use of Electric HW Heaters should be avoided when possible .	*These are typically selected for smaller buildings such as maintenance garages, fire halls, community offices and air terminal buildings with low **HW** use, in conjunction with forced air heating systems. The use of on-demand oil fired HW Heaters should be considered for these applications.* (See 4.3.1 Oil-Fired Domestic Hot Water Heaters)
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 complexed 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.*

4.3.3 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.	*Use is restricted to communities where propane/natural gas is available: Propane/Natural Gas are generally unavailable in Nunavut.*

4.3.4 Temperature

See National Energy Code for Buildings, "Measures for Energy Conservation in New 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	*Recommended by National Energy Code for Buildings Review* 2.0, *Reference* 6.2.5.1(1).

Recommendation	***Rationale***
temperature higher than 60°C.	
.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 system allows primary domestic HW heaters to be set at lower temperatures to save energy. This is typical for buildings such as air terminal buildings, schools, offices, libraries and service buildings where large volumes of hot water are not required. This is a more cost-effective method of providing tempered water than having two separate domestic storage and distribution systems.*

4.3.5 Provision for Monitoring Performance

.1 Provide thermometers in domestic hot water supply.	*Thermostats and gauges provide information for the building maintainers to monitor the system's performance.*
.2 Provide pressure gauge(s) at domestic hot water recirculation pumps.	

4.4 DOMESTIC WATER SYSTEM

Domestic water pressure is provided either by a municipal system, or by individual pressure pumps when buildings are equipped with holding tanks. Although freezing of water circulation lines was a common problem in older buildings, changes to standard design principles have decreased this risk. Increased insulation and air tightness of new buildings, concentration of plumbing fixtures locations, and keeping plumbing lines out of exterior walls are now accepted as common practice in cold climates.

Recommendation	***Rationale***
4.4.1 Insulation	
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 on cold water piping because water supplied from ambient temperature domestic water tanks will not be cold.*
Insulation is not required on small domestic hot water piping systems that do not have domestic hot water circulating pumps.	*Domestic hot water systems that do not have circulating pumps (i.e., a demand system) realize little benefit from insulation. This reduces the installed cost.*
4.4.2 Domestic HW Circulation	
Domestic hot water recirculating 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 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 recirculating systems is generally not warranted in the case of small buildings where only a minimal amount of hot water is used.*
When required, recirculating lines are to be controlled by a time clock and kept off during unoccupied hours. Pump is to be smallest KW possible.	*This reduces energy requirements.*
Extend the circulating line directly to the fixture or	*Running circulating lines down corridors still*

Recommendation	***Rationale***
group of fixtures to ensure hot water is readily available.	*requires wasting water before hot water is available at the fixture(s)*.
4.4.3 Drain Valves	
All water pipes must be pitched, and drain valves must be provided at all low points.	*The Canadian Plumbing Code allows pipes to be blown out with air or drained by valves at low points. PW&S prefers drains as this simplifies operation for maintainers.*
4.4.4 Location	
Avoid locating water piping in the exterior walls.	*This reduces the potential for pipes to freeze.*
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 tend to 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 -drill require special equipment that may not be available to maintainers.*
4.4.6 Access	
Easy access must be provided to all valves and faucets.	*This allows maintainers to respond to any problems or to repair equipment.*
4.4.7 Domestic Water Pressure Pump	
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.*
Typically use shallow well jet pump.	*These pumps are readily available.*
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.*
4.4.9 Provision for Monitoring Performance	
The standard pump-mounted pressure gauge on the discharge is acceptable in most instances.	*Provides indication of system operation parameters to the operator.*

4.5 SANITARY WASTE AND VENTING

The combination of the extremely cold climate and the need to use low volume fixtures in most public sector buildings can cause drainage problems. The goal is for the design to keep the drainage system operational with minimal use of supplementary heating such as heat traces, and to also ensure easy access to clean-outs, so that when problems occur (generally blockages), they can be quickly corrected.

Recommendation	***Rationale***

Recommendation	***Rationale***
4.5.1 Grade	
All waste lines 75 mm and smaller must be graded a minimum of 2%.	*Although this is the minimum allowed by the NBC within a building, actual grades achieved in construction have commonly been inadequate in this respect.*
4.5.2 Location of Drain Lines	
Do not locate drainage lines in exterior walls.	*This requirement reduces the potential for freezing of drain lines.*
4.5.3 Trap Seal Primers	
If a floor drain is provided for occasional use, a trap seal primer is required.	*Traps dry out and allow odours into the building. Typically this occurs in floor drains of mechanical rooms and change rooms.*
4.5.4 Clean-outs	
Clean-outs are required at all changes in direction greater than 45° on sanitary waste lines.	***Note:*** *This exceeds requirements of the Canadian Plumbing Code, but is considered necessary because there have been so many cases of blocked drains in public buildings.*
4.5.5 Roof Vents	
An Arctic Vent with heat provided from the building hydronic heating system or with an electric heat trace should be used.	*This type of vent will not block with ice. This eliminates the need to access the roof and inspect vents on a scheduled basis.*
4.5.6 Special Traps and Piping	
.1 Plaster Traps	
Plaster traps should be installed on sinks used for any biology, horticulture or art activities.	*Required because of potential for blockage by materials going into the sink. Typical locations include schools, colleges, adult education facilities, group homes; health care centres, workshops, young offender facilities and hospitals.*
.2 Grease Interceptors	
Interceptors must be installed wherever deep-frying equipment may be used.	*Typically required wherever commercial kitchen equipment is installed, such as in correctional facilities and hospitals, and in community kitchens located in community halls and gyms.*
.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 typically required in photo developing facilities and science rooms that may be included in schools or health centres.*

Recommendation	***Rationale***
All piping and fittings used in these applications must be resistant rated for the application, such as acid resistant and fuse sealed.	*The use of proper piping and fittings will extend the service life of the system.*

4.6 SEWAGE DISPOSAL - PIPED SERVICES

Less than 20% of all communities in Nunavut have piped sewer systems (either buried or in above-ground utilidors). Where they are in place, the owner is responsible for all costs associated with connecting a new building to existing mains. 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 are usually some 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***
Refer to the PW&S publication "Water Distribution and Sewage Disposal Systems of the NWT" August 1985, and "Water and Sewer Service Connections in Permafrost Areas of the NWT", Wilson & Cheema, 1987.	*Complete description and standard details are included in these manuals.*

4.7 SEWAGE DISPOSAL - HOLDING TANKS

Where piped services are not available, soil conditions make septic fields a viable option in very few locations in Nunavut. The majority of public sector buildings rely on holding tanks serviced by pump-out trucks operated by the municipality. Frequency of pump-out service varies with communities and may be dependent on equipment available. Tanks can be located either in an enclosed crawl space within the building, or sometimes buried outside the building. This system is dependent on regular servicing to function properly; sewage must be emptied as often as water is delivered. Coordinate with the structural designer for proper tank support.

Recommendation	***Rationale***
4.7.1 Health Standard	
Refer to Environmental Health "Building Standards -Sewage Holding Tanks" June, 1992 and included as Appendix B.	***Note:*** *This document was developed in consultation with PW&S and the Housing Corporation. It is currently issued as guidelines 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: • Large/complexed buildings: equal • Small/simple buildings: 1.5 times	*This is a clarification of 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 schools or complexed 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	*This specifies the type of device referred to in Environmental Health Standards.*

Recommendation	Rationale
capacity.	
4.7.4 Construction	
All sewage-holding tanks are recommended to be either fibreglass, polyethylene or CPVC.	*Concrete or metal tanks are unacceptable due to potential cracking or corrosion.*
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 by sewage pump-out vehicles. They are concerned over reports that sewage tanks have, on occasion, been cleaned out manually, and will be looking to see that tanks are designed to allow sludge to be effectively removed by the vacuum truck* - *whether by sloping the tanks or by having 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 be double walled, insulated and heat traced. The following preferences should serve as a guide:	*See Figures* 4-4 *and* 4-5.
.1 Tanks buried outside the building are acceptable wherever the soil conditions and water table permit.	*This installation allows sewage tanks to be located close to roads for servicing and does not require additional building space. When installed in this manner, tanks and connections should be placed away from all doors, widows and fresh air intakes.*
.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. Areas intended for tank storage require a containment under and around holding tanks to prevent damage to insulation and sheating in the event of a spill.	*This is typical of most public sector buildings in areas of 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 result in high electrical operating costs.*
.4 Tanks located on grade or partially buried are acceptable. These tanks must be double walled. Insulated and heat traced.	*The placement of the tank on grade is usually less costly overall than locating the tank in a tank space. When installed in this manner, tanks and connections should be placed away from all doors, widows and fresh air intakes.*
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.	*Movements of over* 100 mm *due to frost heaving are not uncommon.*

Recommendation	***Rationale***
Provide flexible piping to the tank to allow for differential movement between the tank and the building.	*If problems occur, repair of a tank under the building is very expensive.*
Tanks may be positioned under buildings	*Any take installed under a building must be fully accessible to allow for potential remoaval and replacement.*

4.7.7 Pump-out and Vent Piping

The sewage tank pump-out suction line is to be graded back to the sewage holding tank and securely anchored to the building.	*This prevents sewage spills on the ground around the pump out.*
Sewage tank pump-out suction line is to be located away from all doors, windows and fresh air intakes.	*This will prevent sewage odours and truck exhaust from entering the building during sewage tank 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 • Securely anchored to the building	*Plastic pipe is not to be used outside, as it is subject to cracking or breaking at very cold temperatures.*
Cap and chain are to be installed on the pump-out Suction line quick connect fitting.	*This is in addition to the requirements noted in Environmental Health Standards.*
A secondary vacuum relief vent is required on all sewage holding tanks. A spring loaded check valve set to 14 KPa must be used.	*In the event the tank vent is blocked. The check valve provides a relief to prevent the tank from collapsing while it is being pumped out.*

4.7.8 Utilidette Piping

All utilidette piping should be PVC	*Heat tracing Should be provided hydronically.*

4.8 FIXTURES AND BRASS

Fixtures are generally required to be low consumption type to conserve water used and waste water produced. This requirement is most important for buildings with water and sewage holding tanks.

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.	*General appearance and to make matching simple if replacement is necessary.*
4.8.2 Fittings and Trim	
Triple chromium-plated, exposed fitting and trim to be used	*Quality and durability are required for public use buildings.*

.1 Infrared Sensing Plumbing Trim

Recommendation	***Rationale***
This is acceptable where the higher cost can be justified.	*Infrared sensing trim has been tried in several installations and works satisfactorily. The benefits are a more cleaner public washroom, less odours, and lower water usage.*
.2 Spring-Loaded Faucets	
Spring-Loaded faucets are not acceptable.	*Spring-Loaded faucets discourage users from using them.*
4.8.3 Sinks	
Stainless steel sinks are preferred.	*Stainless steel sinks are required, because enamel finishes would be subject to damage in typical kitchens, health centres, correctional facilities and schools.*
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.*
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 public facilities.	*Stainless steel basins are typically required in schools, community recreation facilities, air terminal buildings, and in all corrections facilities. Fixtures must be durable enough to withstand the level of abuse they are often subject to in these types of buildings. Basins in schools and community recreation facilities are frequently damaged.*
Vitreous china or stainless steel basins are acceptable in all non- public use facilities.	*Non-public use facilities are less prone to vandalism.*
Enamel on steel and plastic or fibreglass basins are not acceptable.	*These components have an inadequate service life in public buildings.*
All faucets and showerheads are to have flow restrictors to ensure low water use.	*This reduces water consumption and waste.*
4.8.5 Toilets and Urinals	
All toilet fixtures should be low water use type (4 to 9 litres per flush). All urinals are to be low water use type.	*The objective is to reduce water use. Although there have been problems in the past with blockages. Designs have improved and most low flush fixtures are now as effective as conventional 20 litre toilets. Handicapped fixtures are also now available in 6-litre flush.*
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 public use buildings, although they may be acceptable for installation in facilities normally occupied by fewer than 6*

Recommendation	***Rationale***
	people.
Use of propane-fired incinerating toilets is not acceptable.	*Propane supply is generally difficult, and installation and maintenance costs are high.*
The toilet seats in schools and community recreation facilities should be extra heavy, open front, seat ring type only.	*Toilet seats in arenas and schools have been high 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.	*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

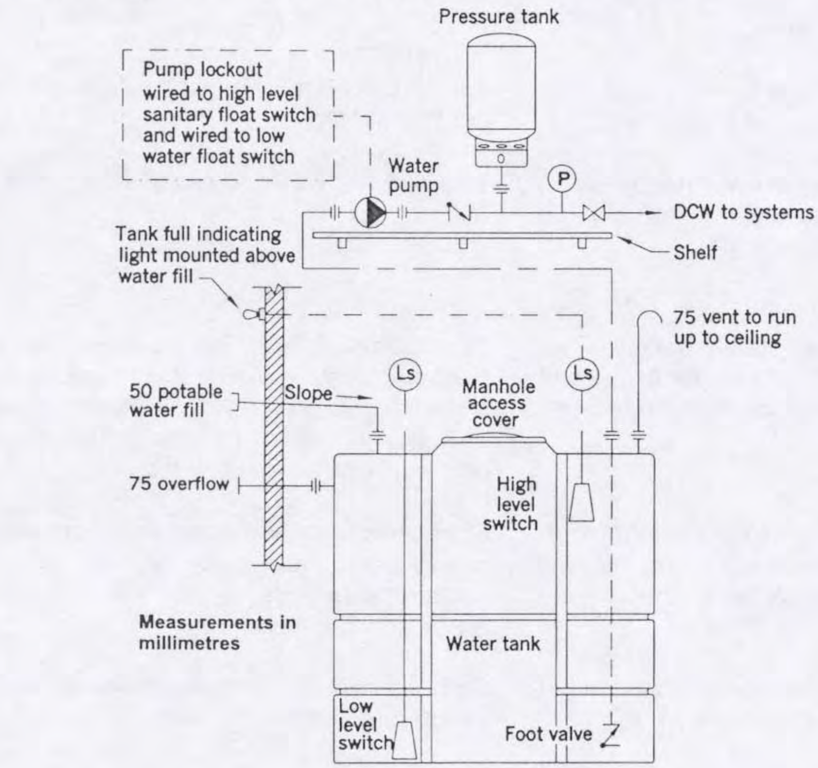


Figure 4-1: Typical Water Tank

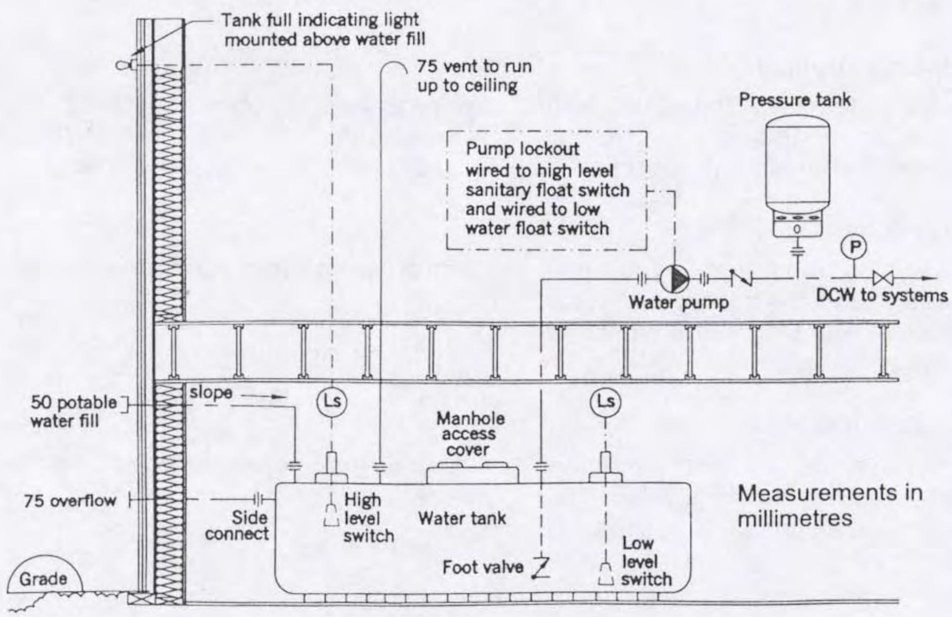


Figure 4-2: Water Tank in Crawl Space

4.9 WATER AND SEWAGE TANK CONFIGURATIONS

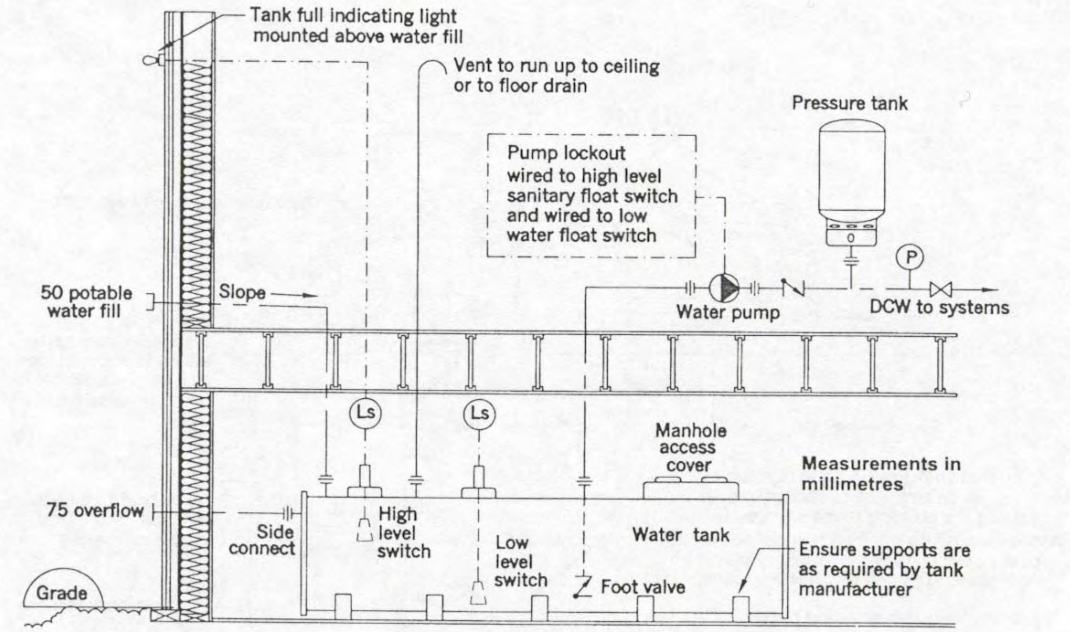


Figure 4-3: Tube Tank in Crawl Space

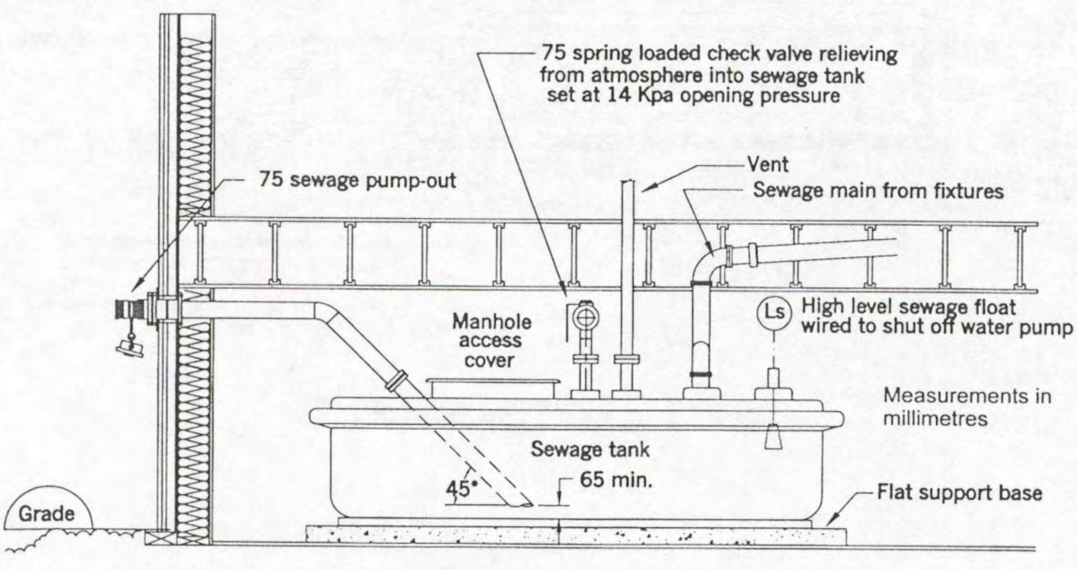


Figure 4-4: Sewage Tank in Heated Space

4.9 WATER AND SEWAGE TANK CONFIGURATIONS

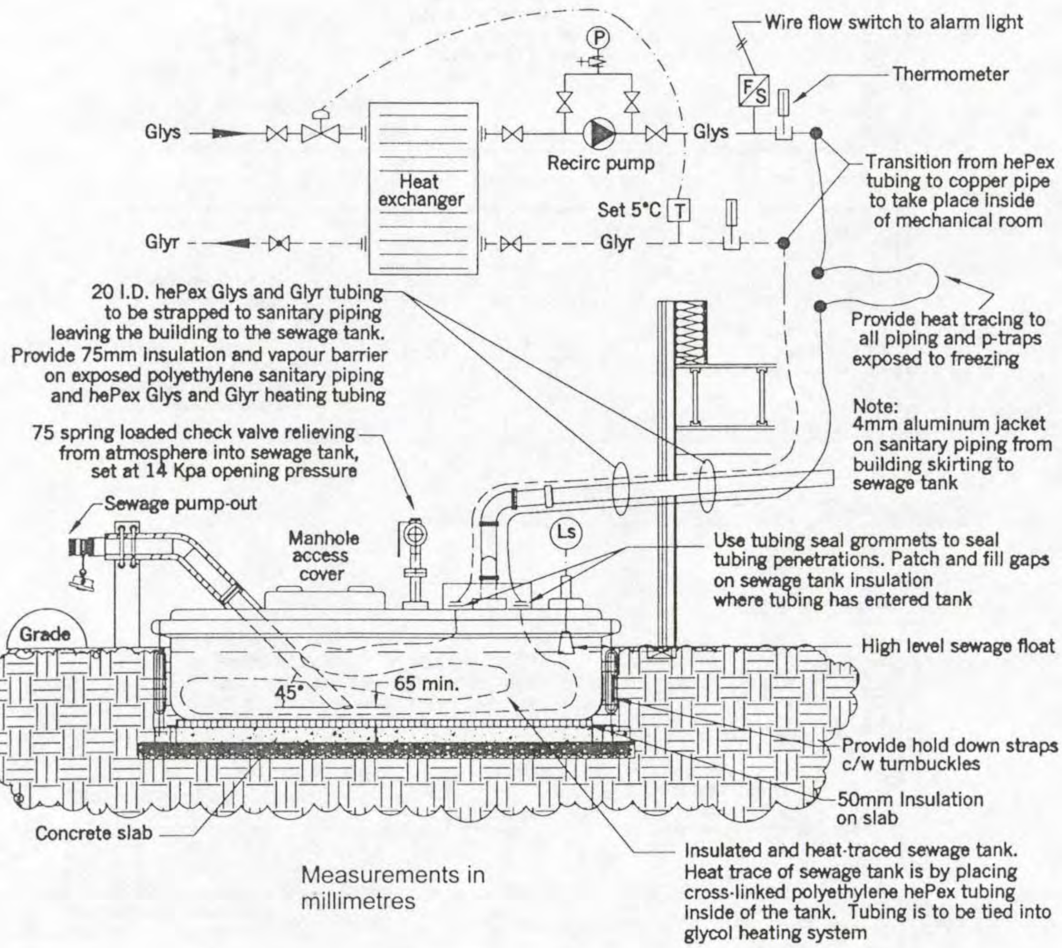


Figure 4-5: Sewage Tank Outside

M5 FIRE PROTECTION

Fire fighters and fire-fighting equipment available in most communities in Nunavut 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 public sector buildings and are intended for use by occupants to extinguish small fires immediately.

Recommendation | ***Rationale***

5.1.1 Room Temperature Operation

ULC approved, 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.

Please note PW&S previously required that all buildings be equipped with Ansul extinguishers rated for service to -40°C. High insulation levels and air tight construction have greatly reduced the risk of indoor temperatures, in any regularly occupied building, reaching extreme freezing temperatures.
ABC rated extinguishers require less maintenance than other types allowed by code, such as pressure water types.

5.1.2 Low Temperature Operation

Wherever there is a potential for the temperature where the fire extinguisher is kept to fall below freezing, extinguishers must be multiple purpose dry chemical extinguishers rated for -40°C.

Typical applications are maintenance garages, fire halls, 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.

5.2 FIRE PROTECTION SYSTEMS

Sprinkler systems have been installed in many new public sector buildings since the 1985, either as required by code or regulation, at the request of the Fire Marshal, or at the request of the GN funding department.

Recommendation | ***Rationale***

5.2.1 General Requirements

Pipe sizes and fire protection system layout must have been reviewed by the Fire Marshal, Nunavut. Systems are to be hydraulically designed, with as-built drawings and calculations signed by a professional engineer.

The Nunavut Fire Marshal is the authority having jurisdiction.

In schools, certain areas are to be designed to ordinary hazard Group 1 characteristics.

See Fire Marshal's ruling.

Dry systems are generally unacceptable for GN facilities.

If not serviced regularly, valve seats can stick and the system may malfunction.

5.2.2 Sprinkler Heads

Quick response heads rated to 74°C are required Except as noted below.

By responding quickly, 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 1OO°C are required in mechanical equipment rooms, such as generator and boiler rooms.

Temperatures can often be excessive in these areas, which could lead to premature activation of the sprinkler Head.

Dry pendant heads are required in entrance foyers.

There is a greater potential for freezing in entranceways where doors are opening to the outside.

Recommendation	***Rationale***
A glycol loop is required wherever sprinkler piping is installed in crawl spaces close to outdoor air vents, louvers or intakes.	*Pipes are subject to freezing.*

5.2.3 Pumps and Controllers

Fire pumps and controllers must be ULC listed.

5.2.4 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:	A *Bulletin dated July* 7, 1992 *issued by the Office of the Fire Marshal clarifies the size of water reserves required for sprinklered buildings. Previous practice was to conform to NFPA* 13 *regardless of building type or size. This recent ruling takes room size and building use into consideration and may result in significant cost savings by reducing size of tanked water reserve.*
.1 Buildings where NFPA 13D applies will require a minimum of 985 litres of water reserved for sprinkler system.	*This will apply to most residential uses, including student hostels and group homes with fewer than* 10 *residents.*
.2 Buildings where NFPA 13R applies will require a minimum of 5,910 litres of water reserved for the sprinkler system.	*Typically this will apply to small gymnasiums, community offices containing council chambers, courthouses, visitor centres and libraries where sprinkler systems are installed.*
.3 Buildings where NFPA 13 applies will require a minimum of 17,035 litres of water reserved for the sprinkler system.	*This will typically apply to buildings designated as community reception or evacuation centres under the "Civil Emergency Measures Act of the NWT" and all Group B occupancies as classified by the National Building Code, such as long term care facilities, detention centres and treatment centres. See Appendix E.*

5.2.5 Carbon Dioxide

(C02) Use is limited as to where it is required for commercial range hoods, unless approval is given to 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.*

5.2.6 Halon

Not permitted.	*Halon use is restricted because of environmental damage (destroys ozone) and transportation hazards.*

5.2.7 FM-200

FM-200 Systems are permitted for use in LAN rooms and other areas containing sensitive materials.	*FM-200 systems require specialized installation and maintenance. The economics of each installation should be reviewed before installing an FM-200 system.*

Recommendation	***Rationale***
5.2.8 Tees	
Use factory tees only. Do not use a T-drill.	*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 are not nortmally requiredin GN 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 not required by code.	*The addition of hose cabinets in large buildings may provide an improved initial attack ability to fight fires in a large building.*

M6 FUEL SUPPLY

6.1 GENERAL

Electrical power, which is generated by diesel power plants in Nunavut, is usually far too expensive a heating method to realistically serve the North.

A new method of heating buildings, using heat recovery from Nunavut Power Corporation power plants, is being used and should be considered where the proposed building is near an NPC power plant. However, even where heat recovery is available, diesel fuel would likely be used to provide a base amount of heat to the buildings. Refer to Section M-10.

Diesel fuel has been specially designed, to flow at temperatures as low as -50°C. Most northern communities receive an annual supply of this fuel by barge. It is stored in a collection of large tanks (a grouping of which is called a fuel storage facility), for distribution (via truck) to required facilities and buildings for the community's use.

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

The storage and handling of fuel oil for building heating systems generally falls into 4 types of installations:

6.2.1 Fuel Storage Tanks Less Than 2,500 Litres (550 Igal) Located Outside Building

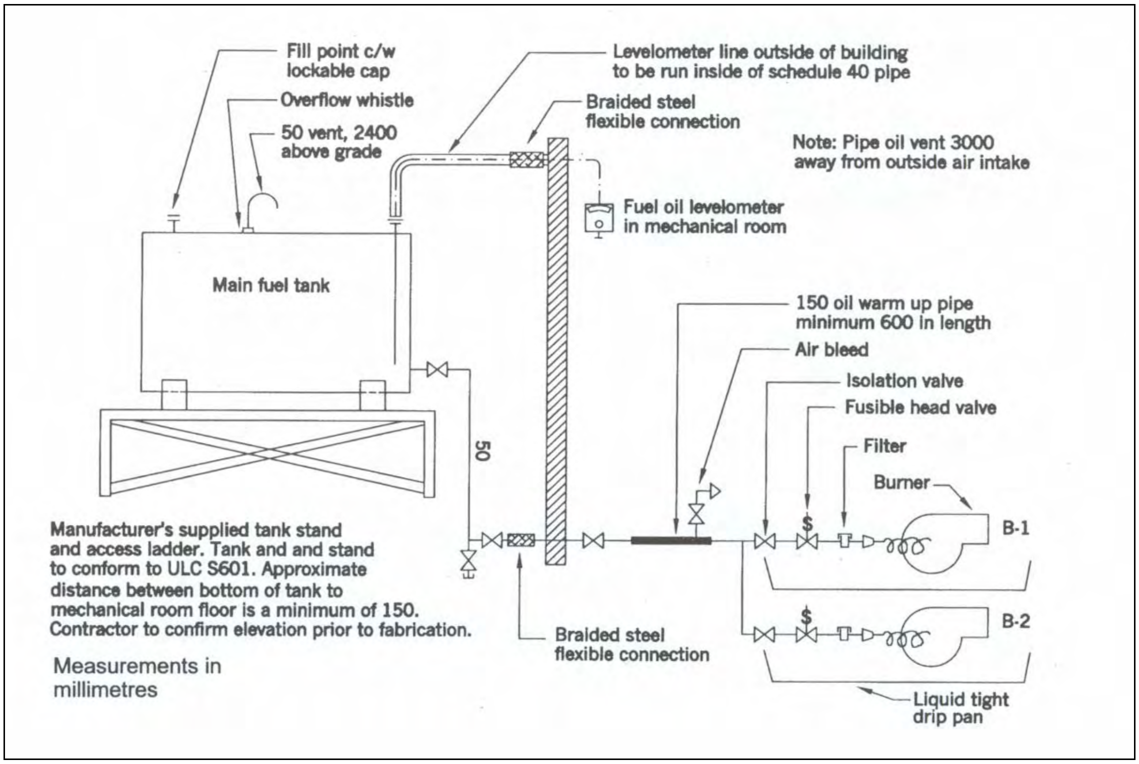
Fuel oil tanks located outside the building are usually mounted adjacent to the building on a tank stand located so that it is not near to a fire exit path from the building.

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 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.

Oil should be heated to an appropriate temperature to be ready for use in oil-burning appliances. Typically, fuel flows by gravity from the outside storage tank to the appliance. If the portion of pipe inside the heated building is short, a large diameter pipe or warming pipe is provided to allow the fuel oil time to warm up.

Figure 6-1: Fuel Tank Located Outside of Building

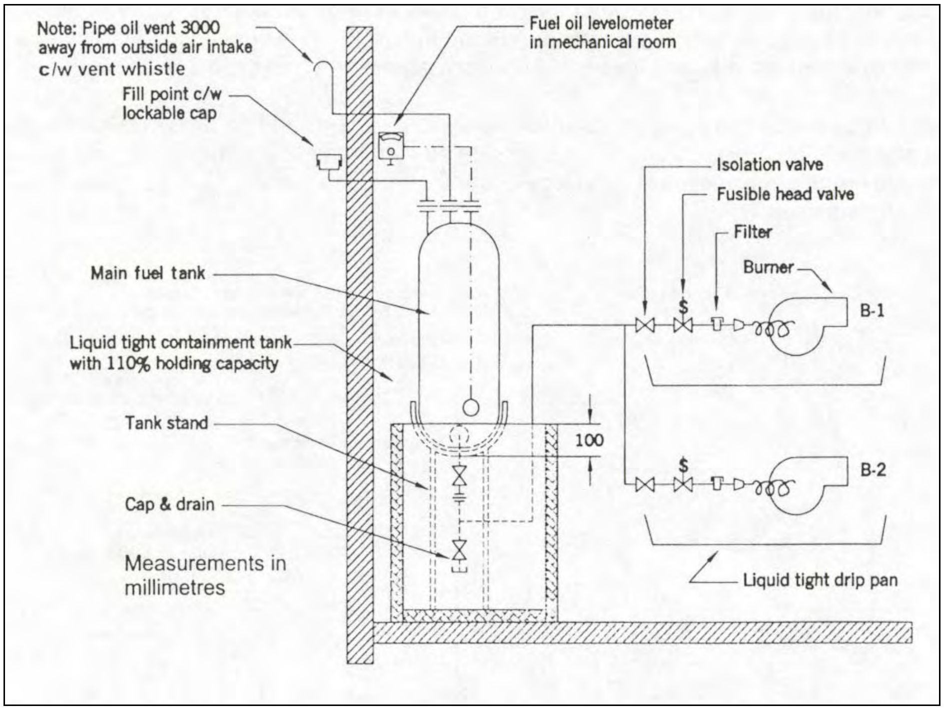


6.2.2 Fuel Storage Tanks Less Than 2,500 Litres (550 Igal) Located Inside Building

When total fuel storage is less than 2,500 litres (550 Igal), the fuel may be stored inside or outside of the building. Storing the fuel inside the building is not the best option. It is generally more expensive as adequate space is usually unavailable and adequate clearances of 1500 mm to burners needs to be maintained.

Fuel oil stored inside the building must be located on the lower floor. Location of the fuel tank in a crawl space is prohibited. 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 of the fuel truck operator and away from windows and fresh air intakes.

Figure 6-2: Fuel Tank Located Inside Building



6.2.3 Fuel Storage Tanks Over 2,500 litres (550 Igal) Located Outside Building

Fuel tanks over 2,500 litres (550 Igal) located outside the building must be contained by a double walled environmental tank, which must be located a minimum of 3000 mm from the building and 3000 mm from 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 guidelines are cost prohibitive.

The larger fuel tanks are usually mounted at grade (their large size makes mounting them on any acceptable stand impractical).

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 that should be chosen. 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).

6.2.4 Fuel Storage Tanks Over 2,500 Litres (550 Igal) 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 is rarely done and thus is not discussed in detail here.

6.2.5 Value Engineering

The most important consideration affecting the fuel system is the selection of the amount of storage capacity that the system should contain. If excessive amounts of fuel are stored, building construction costs will be significantly higher. If too little fuel is stored, then delivery cycles will be excessive and may begin to overload the local delivery service and possibly result in increased fuel costs.

Figure 6-3: Outside Tank With Transfer Pump

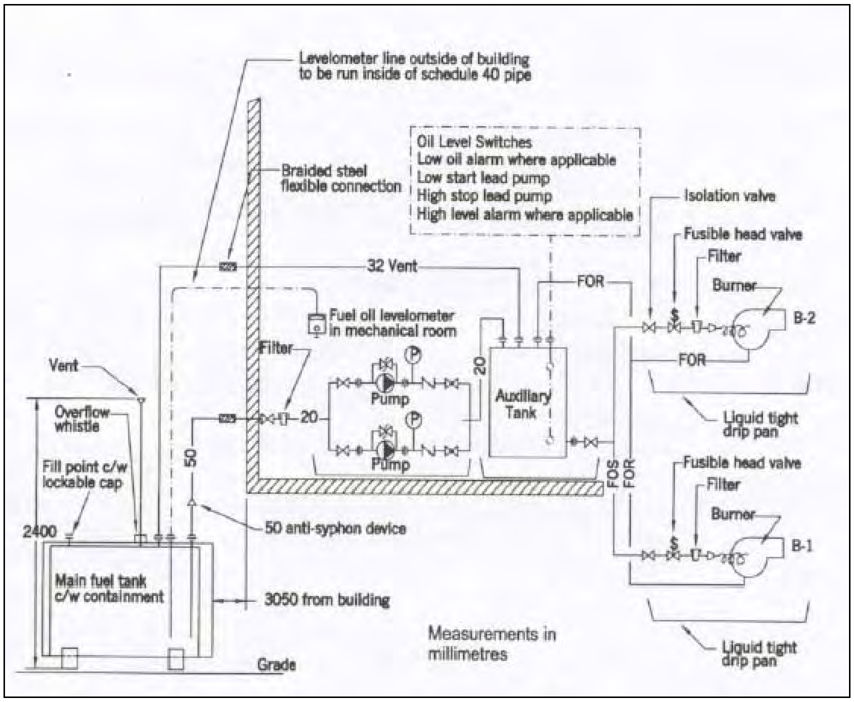
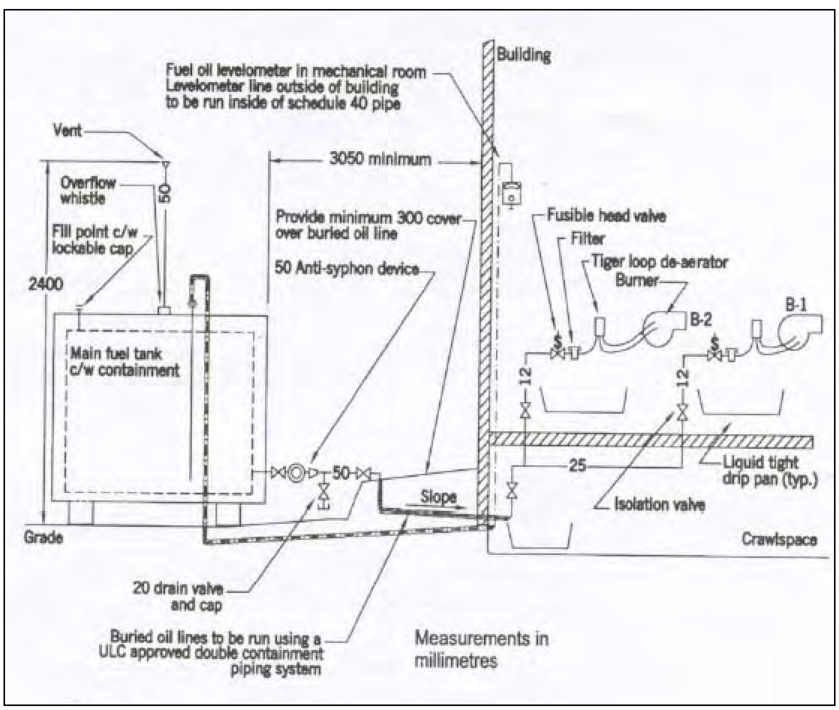


Figure 6-4: Outside Tank Over 2500 Litres (550 Igal)



6.3 FUEL OIL DELIVERY AND STORAGE

Fuel delivery is either by contract with the Petroleum Products Division of the Community and Government 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 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 2,500 litres, either a circular horizontal tank or up to two 1, 250 litre oval tanks may be used. If over 2,500 litres, double-walled, self-contained, self- bermed fuel storage tanks are required.

A dike is required by code for tanks over 2,500 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 1,250 litres (275 Igal) in size.

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. Timber stands are not acceptable.

Although required by code, this is sometimes overlooked.

Coordinate with the structural designer for proper tank support.

See Bulletin issued by the Office of the Fire Marshal in March 1992 waiving code requirement for 2-hour fire protection of steel stands. This is a waiver of CSA B 139 requirement in Nunavut.

.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.

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.

6.3.3 Fuel Tank Capacity

.1 Primary Tanks

Recommendation	***Rationale***
.1 A 2 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 a long disruption in heating would require relocation of residents, or could potentially damage essential equipment.	*Even with regular fuel delivery, blizzards or storms can make delivery difficult for periods up to 2 weeks.*
.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 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, actual fuel consumption over the preceding three years is to be ascertained to determine whether fuel storage capacity needs to be increased.	*Actual fuel consumption may be higher or lower than anticipated originally. Projected fuel consumption may or may not increase significantly, depending on whether previous envelope and/or ventilation upgrades were undertaken.*

6.3.4 Location and Access

.1 Primary Tanks

Suitable platforms with steps and handrails are to be provided for filling exterior tanks.	*This provides a safe condition for the fuel deliverer.*
Buried fuel tanks are unacceptable for public sector buildings.	*Soil conditions do not permit buried tanks in most arctic locations and environmental protection requirements make them costly.*
Tanks of up to 1, 800 litres capacity may be installed within the heated building envelope.	*Where space can be provided to allow the tanks to be concealed, the potential for spills makes this option undesirable.*
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. Where an auxiliary tank is used, a warming pipe is not required.	*Gravity feed from an auxiliary tank or oil-warming pipe to all oil-burning equipment, including standby generators, is cost-effective and still provides warm oil for improved combustion characteristics.*

6.3.5 Spill Protection

.1 Exterior Tanks

If a fuel tank is required to have spill protection	*The Environmental Protection Act specifies when*

Recommendation	***Rationale***
because of its size, the tank is to be of the horizontal type for above ground installation. 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 maintainers and to permit fuel delivery.	*spill protection must be provided; unprotected dikes are a safety hazard, as they can fill with water.* *Fencing will further discourage access and tampering by unauthorized persons.* *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. An equivalent approved double walled storage tank can be used as well	*Interior tanks are usually located in mechanical rooms. Such rooms normally 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.	*This eliminates the possibility of the tank level controls failing to stop the transfer pumps and overfilling the interior tank, such that the tank overt1ows out of the vent pipe onto grade. If this arrangement cannot be achieved, then 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 preheated before reaching the burners, by providing either an auxiliary tank, an oil warming pipe or an extended run of supply pipe in the mechanical room that is long enough to allow oil to warm to room temperature.	*Oil burners will operate at a 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.	*This is to transfer fuel from exterior primary tank to interior auxiliary tanks.* *One pump is operational, the other a standby pump that can be put into operation quickly and easily. Pressure gauges allow the monitoring of 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 a pump failure, a maintainer should be called to the facility to become aware that the primary pump has failed. The standby pump is permanently installed to ensure it is there when needed, and the system can be*

Recommendation / ***Rationale***

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 size, 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 an 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 locks, and returning the fuel to an interior tank maintains it at room temperature.

.4 Gravity Feed

If fuel is gravity fed to 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 produce condensation in the tank.

.5 Drip Leg

A valved 5Ox 5O mm nipple and cap is to be installed on all fuel tank piping with installation as follows: tank, valve, 90°elbow, tee (branch to building), valve, 5Ox 5O mm nipple and cap.

This will serve as a dirt pocket, and allows condensation to be drained from the tank to prevent water and ice build-up in the tank and piping.

6.4.4 Flex Connectors

Exterior fuel piping (supply and return) should have braided steel flex connectors installed prior to pipe entering building.

This prevents 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.

Movements of up to 100 mm are not uncommon.

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 easier. The use of braided steel connector is preferred, as the copper connector will kink over time.

Braided steel flexible connectors are required on the supply and return lines to the emergency generator.

Recommendation	*Rationale*
6.4.5 Isolating Valves	
Each piece of fuel-burning equipment must have isolating valves.	*This will allow equipment to be disconnected for maintenance or replacement.*
On a two-pipe system, the return line must not have an isolation valve.	*The code does not allow a valve on the return line.*
Fusible valves are to be used for all supply lines to all oil-burning equipment, including generating plants.	*The CSA B* 139 *code specifies only heating equipment as requiring fusible valves. As generating plants are common in larger public sector buildings, it is important to note that fusible valves are also a requirement on fuel lines to generators to stop flow of fuel in case of fire.*
6.4.6 Pressure Gauges	
Provide dial type pressure gauges with a 90 mm diameter dial scaled to the application intended and located at the discharge of each pump.	*Pressure gauges installed at appropriate locations assist the building operators in system operation and performance evaluation. Incremental cost of gauge installation can be offset by 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.*

6.5 PROPANE DELIVERY & STORAGE

All propane installations in public buildings are to be installed in accordance with the requirements of the authority having jurisdiction and the Propane Installation Code CAN/CSA -B 149.205.

M7 HEATING

Minimizing the energy consumption of public buildings is important in Nunavut where fuel costs are extremely high. Added to this, the severe climate means that heating must be provided over much of the year. The number of degree-days below 18°C can reach 12,594 in Resolute, as compared to an average of 3,000 in Vancouver or 5, 782 in Edmonton.

Recommendation	*Rationale*
The design objective for indoor space temperature in occupied areas during winter conditions is 21°C and during summer conditions is 24°C.	*It is intended that heating and cooling systems be properly sized for the actual requirements of the building.*
Whenever possible, implement temperature setback within buildings during unoccupied periods.	*This reduces energy consumption*

Recommendation

The outdoor air design temperature shall be according to the 2.5% January or July design temperature indicated in the most recent supplement to the National Building Code. Use similar data available from Environment Canada for specific communities that are not listed in the supplement.

Rationale

This advises the design industry of acceptable building design criteria in Nunavut.

7.1 FORCED HOT AIR SYSTEMS

Forced hot air heating systems are as common in Nunavut as elsewhere in the country. However. As few buildings in Nunavut have basements, counter-flow furnaces are generally required with ducts located in a raised floor. Although forced hot air systems are not suitable for all types and sizes of facilities, their relatively simple servicing requirements make them a good choice in many circumstances.

Recommendation	***Rationale***
7.1.1 Furnace Type	
Two speed fans are required where ventilation is provided by the furnace.	*This provides continuous air circulation and reduces the stratification of air.*
Where a separate ventilation system is installed, a one-speed fan is to be provided.	*Continuous use of the furnace fan is redundant and undesirable considering high electrical costs.*
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 13°C.	*Standard heat exchangers tend to 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.	*Past experience has shown that even equipment approved for use on a combustible base has burned into the floor.*
7.1.2 Combustion Air	
All fuel-burning appliances require a properly sized combustion air supply.	*This is a code requirement.*
7.1.3 Heating Capacity	
Forced air heating is suitable only for buildings where multiple heating zones are not required.	*Typically used for small buildings such as fire halls, garages, small office buildings, small health centres or residences. Not considered suitable for use in arenas or gyms, or where more than one furnace would be required to provide separate heating zones.*
7.1.4 Distribution	
Ducts located in a raised floor are preferred over those located in ceiling spaces.	*Better heat distribution when hot air is introduced at lower levels, and avoids penetration of building envelope assembly.*

Recommendation	***Rationale***
Where exposed ducts are acceptable, they may be located overhead.	*Generally results in poor heat distribution, but this may be acceptable in some situations where comfort levels are not critical.*

7.2 HYDRONIC HEATING SYSTEMS

This is the most commonly used heating system in public sector buildings because of its ability to heat large areas with multiple heating zones.

See Figures 7.1, 7.2 and 7.3.

Recommendation	***Rationale***
7.2.1 Boilers	
Two oil-fired, cast irons, 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. Exceptions sould be noted for facilities which may require heating capacities in excess of these amounts (example: health facilities)	*Sizing the two-boiler heating plant to no more than* 100% *of the building design heating load is intended to ensure that the heating plant capacity Will not exceed the actual building-heating load. The heating plant will operate more efficiently when not oversized.*
Multiple passes, 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.*
Only retention head type burners are to be used.	*They are the most efficient burners available.*
The high limit control on boilers is 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 shut down until the high limit is reset manually. If not reset promptly, considerable damage could result to the building from frozen piping and fixtures.*
Single stage firing arrangement (not high. low) is required on boilers.	*During extreme cold conditions, single stage firing reduces the danger of damaging boiler venting from condensing products of combustion.*
Consideration should be given to installing hour meters on each boiler.	*Provides runtime indication to operating personnel for lead/lag operation and maintenance.*
The use of Viessmann boilers should be considered to allow lower operating water temperatures.	*Water temperatures below 60°C are not possible in regular cast iron boilers due to condensation. Significant energy savings may occur when lower temperatures are used.*
7.2.2 Chimneys and Vent Connectors	
A separate chimney for each oil- burning appliance is preferred. ***Note:*** Although the terms 'stacks' for 'chimneys' and 'breechings' for 'vent connectors' are	*Although this may increase the number of penetrations through the building envelope, shared chimneys are always oversized.*

Recommendation	Rationale
commonly used, CSA Standard B139 no longer includes these terms in its definitions.	
Forced draft appliances require pressure rated chimneys. 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 result in condensation forming in the chimney due to moisture produced from combustion gases. The condensate freezes and builds up over the winter and can eventually block the chimney. Such condensate is also very corrosive and will lead to the premature failure of the chimney. Backpressure 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.	*Promotes more regular cleaning and inspection of vent connectors and chimneys.*
Vent connectors must be insulated	*Insulation is required on vent connectors 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 how many fuel- burning appliances are operating at a 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.	*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 Nunavut. Calculations are to be based on maximum heating loads, not including standby generators.	*Combustion air intakes are commonly oversized and colder air than necessary is brought into 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 is recommended to recognize the expansion* of *cold air to demand temperature.*

7.2.4 Heating Fluids

.1 Glycol

A glycol and water mix is the preferred fluid for use in hydronic heating systems.	*Based on past experience, systems using* 100% *water were prone to freezing resulting in high maintenance costs and disruption to users. Glycol can be tested regularly and inhibitors (di-potassium phosphate) added as required. The*

Recommendation	Rationale
	use of glycol is sometimes questioned because of its corrosive effects, which can damage equipment. It has been suggested that water may in fact not pose the same threat of frequent freeze-ups as it once did, given the improved quality of building insulation and air tightness. However, until this has been studied further, the GN is unwilling to change the practise of using glycol, which has generally proven to work well.
The heating fluid used in all hydronic-heating systems is to be a premixed 50% concentration by volume of Dowfrost HD propylene glycol. Ethylene glycol is toxic and cases of poisoning have occurred in the past in several communities in Nuavut. Alternatives to Dowfrost HD will not be considered until those products can be shown to be of equivalent and consistent quality.	*Dowfrost HD is currently the only product acceptable to the GN. The selection of Dowfrost as the only acceptable product allows for ease in training, fewer types of test kits and easier storage in the community.* A *premixed glycol solution will eliminate problems encountered with the on- site mixing of glycol utilizing 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 as part of the heating fluid. Water quality varies unpredictably between seasons and communities. A premixed glycol solution will ensure proper thermal and corrosion-inhibiting characteristics.*
.2 Glycol Fill	
Glycol fill provides a convenient and adequate means of charging hydronic heating systems by using either a motor driven pump or an automatic pressure controlled makeup system. The pressure relief valve on the boilers is to be piped back to a polyethylene glycol fill tank. A manual diaphragm type pump would be acceptable on hydronic heating systems sized at less than 117 kW. Manual vane pumps should not be used.	*Manual vane type pumps have proven to be unsatisfactory. 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 the glycol relief back to the glycol tank avoids wasting glycol whenever the pressure relief valve is activated.* *Manual diaphragm pumps work satisfactorily.*
7.2.5 Circulation	
.1 Piping	
Primary / secondary piping loops, which allow constant flow on both loops under varying load demands, are preferred for systems supplying over 117 kW. A single 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 loop avoids subjecting boilers to temperature shocks.*
	The use of variable flow pumps for the secondary pumping system will reduce energy use 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*

Recommendation	***Rationale***
	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 repairs. 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.*
.2 Equipment	
Pumps and other heating equipment must be selected while keeping the different properties of glycol vs. water in mind. For example. Expansion tanks must have an ED PM bladder that is 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 *glycol/water heating fluid is not common in other parts of the country, designers easily overlook this.*
Standby pumps are to be installed with each pump and sized to handle 100% of a full system load. Do not use automatic start I alternators, but rather a manual selector switch only.	*In case of pump failure.* A *maintainer must come out and is then made aware 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.*
Circulation pumps are to be sized to circulate water through all boilers in multiple boiler installation.	*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.	*Provides a reliable seal.*
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 for each hydronic heating system over 117 kW(4OO.OOOBtu). However. side stream filters are beneficial for all heating systems. Each side stream filter is to be provided with one case of replacement 1O-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.* *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. Insulation may be omitted from valves. Unions and strainers where	*Heat from uninsulated piping can cause overheating of the mechanical room, wasting energy and creating uncomfortable working*

Recommendation	Rationale
piping is 63 mm and smaller. Removable prefabricated insulation is to be used at all valves and unions on all piping over 63 mm.	*conditions for maintenance personnel.* *Periodic access to valves and unions requires 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

Recommendation	Rationale
Wall fin radiation is the preferred heat exchange system.	*It is the heating exchange system most frequently used, and most familiar to the 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. 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 airflow, 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 must be provided on the return line for each zone of radiation.	*Allows for proper balancing of the heating system.*
Isolation valves and unions are to be provided on both sides of zone valves and a piggyback drain valve is to be provided on the discharge side of the zone valve.	*This reduces the chance of systems becoming air locked and potential damage to carpeted areas.*
In low traffic vestibules and entrances/exits, wall fin radiation is preferred over a force flow unit. The wall fin radiation is to be controlled by a zone valve and a wall thermostat c/w tamper proof metal guard.	*This reduces both overheating in the area and installation costs.*

.2 Force Flow Units

Recommendation	Rationale
Force flow units are required for typical high traffic vestibules and entrances. Floor and wall mounted models should be recessed where structural conditions allow.	*Force flow heating units provide quick heat recovery in high traffic areas, such as entrances.*
Heating is controlled by cycling the fan and/or a control valve.	*The control valve is necessary to prevent overheating of the spaces.*

.3 Radiant Floor System

Recommendation	Rationale
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 body contact with the floor will be usual (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*

Recommendation | **_Rationale_**

premature system failure due to corrosion.

.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.

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 Thermometers

Provide thermometers scaled to the application intended in the following locations:

- 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 3-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.

Thermometers installed in appropriate locations assist the building operators in system operation and performance evaluation.

.3 Gauges

Provide dial type pressure gauges located to measure pump suction and discharge pressure of 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 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 air locks.

Recommendation	Rationale
Auto air vents are to be used in mechanical rooms only. All air vents must have isolation valves.	*Because propylene glycol quickly deteriorates the seat of auto vents, their use should be limited to the mechanical room where leaks will not damage carpeting.*

.2 Bibbs near Boilers

An 18 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 for the contamination of the potable water supply.*

.3 Access to Valves

Access doors to all control valves and isolation valves are required.	*Provides ease of maintenance.*

.4 Radiation Fins

Radiation cabinets should be secure, but easily removable by maintainers.	*Provides 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., where noise levels are not a consideration. Unit heaters are to be hung with appropriate vibration isolation. Balancing, isolation, drain valves, air vent 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, but 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.*

7.4 SCHEMATICS

The following schematics provide various boiler and heating loop configurations. Typically and preferably used in the North.

Figure 7-1: Single Boiler Double Pump

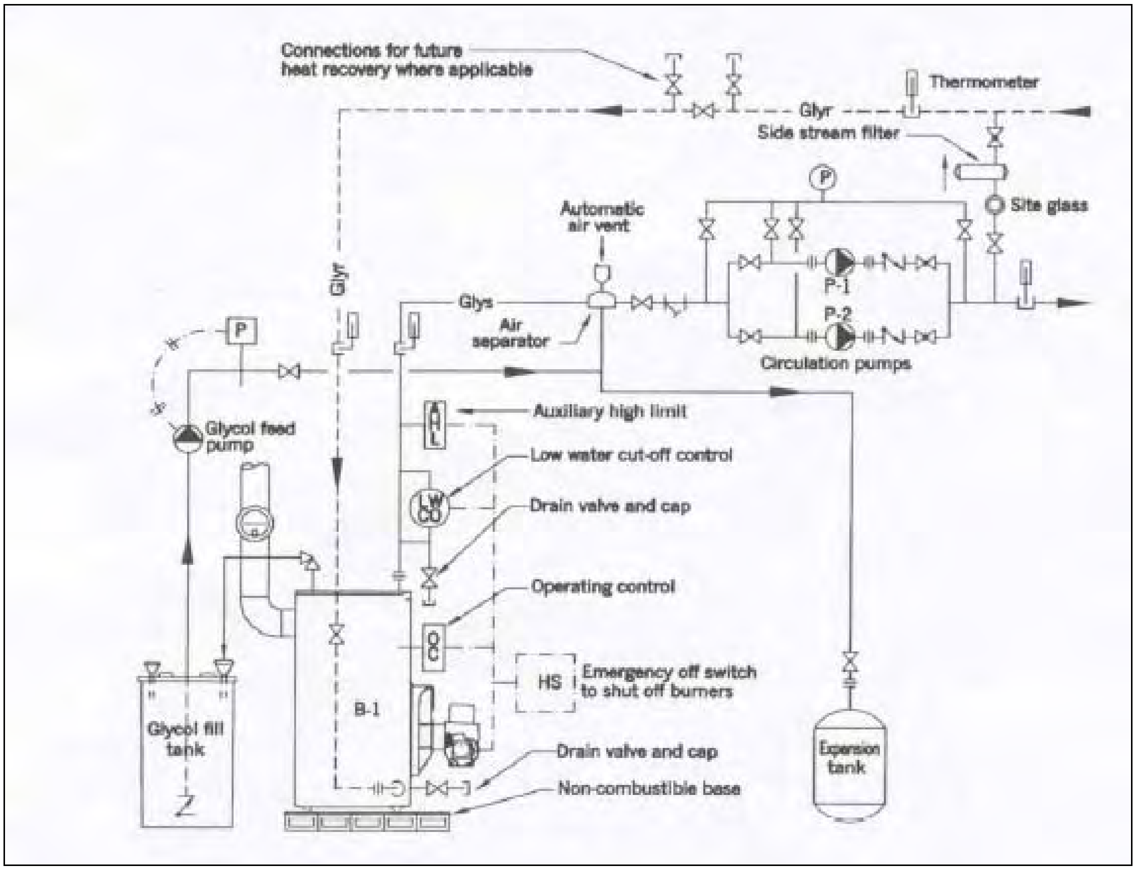


Figure 7-2: Double Boiler Double Pump

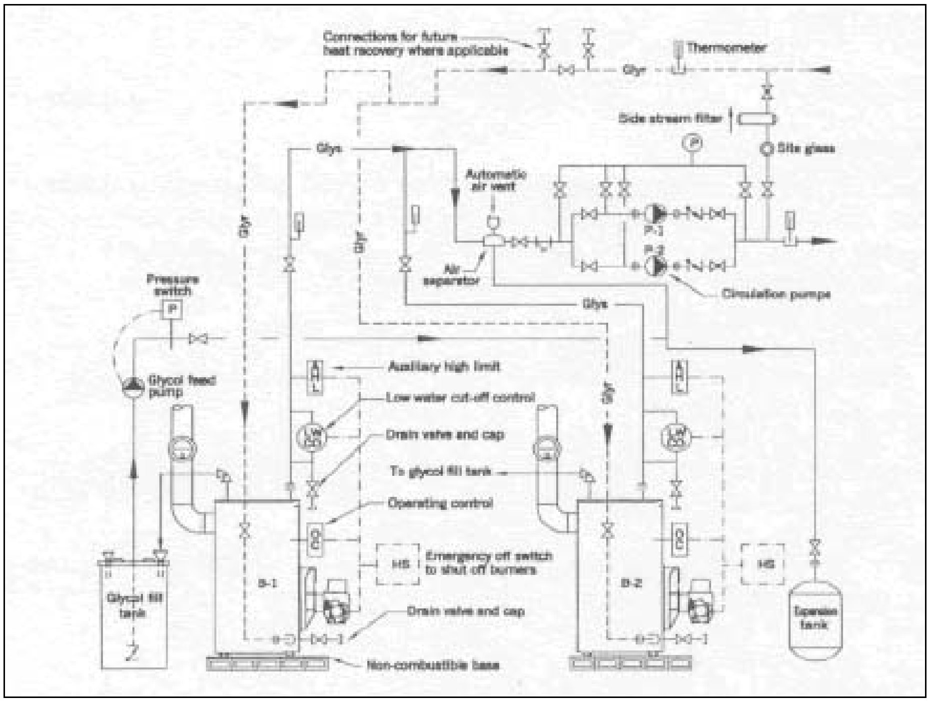
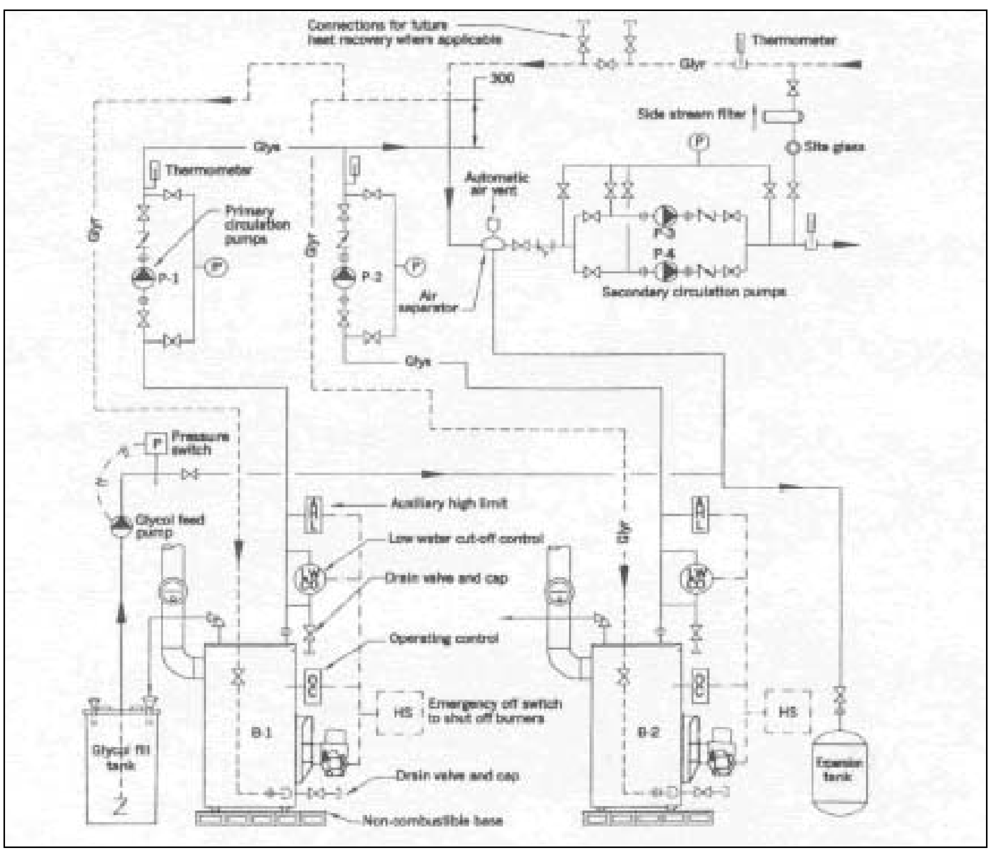


Figure 7-3: Primary-Secondary Boiler System



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, as has been experienced in some public sector buildings, users are not only uncomfortable, but may experience health problems. The extreme cold experienced during much of the year in Nunavut 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.

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 tolerated. 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 airflows 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 part of the mechanical ventilation system design have proven to be unsatisfactory.

Recommendation	***Rationale***
8.1.1 Supply	
Whatever the means of supply air. It must prevent entry of snow and dust. Any filters or screens required to do so must be easily accessible and easy to clean. Locate supply air source well away from oil tanks, sewage pump outs, parking lots and other source of odour and toxic gases.	*Ventilation hoods are often used in place of operable window sections. They are typically used for residential occupancies or small offices 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. Exhaust is to be located well away from the supply source, eliminating any possibility of cross-contamination	*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! As stipulated for natural air supply, users must be capable and willing to control exhaust.*

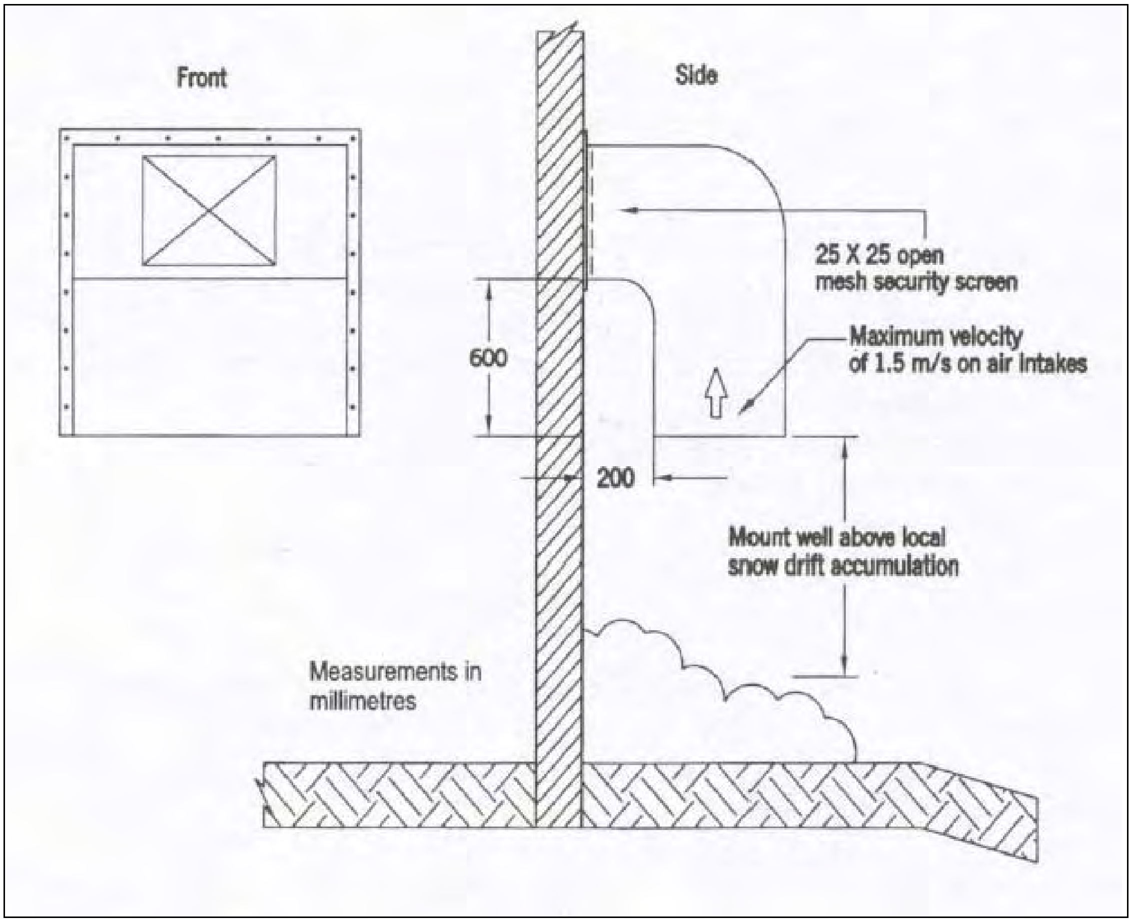
8.2 MECHANICAL VENTILATION

Most public use buildings are too large or configured in such a way that natural ventilation systems are not feasible. Consequently mechanical systems are needed to ensure that adequate ventilation is provided in most public sector buildings. The climate also makes mechanical means of ventilation preferable for much of the year. The quantity and temperature of outdoor air brought into a building needs to be adjusted frequently to suit changing outdoor conditions and indoor requirements. Automatic controls can perform this function for the building users, while keeping simplicity in mind as an O&M objective.

Recommendation	***Rationale***
8.2.1 Choice of Systems	
.1 Natural air supply and mechanical exhaust: Limited to use in residential or seasonal use buildings.	*The system relies on the users. It generally consists of opening windows for supply and turning on kitchen or bathroom fans for exhaust. It is considered unsuitable for buildings used by the public, or by groups of people who will not likely take on responsibility of controlling ventilation, or is concerned with energy conservation.*
.2 Mechanical air supply and natural exhaust: 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's not considered suitable for public use buildings, or for groups of people who will not likely take on responsibility of controlling ventilation, or be concerned with energy conservation. This approach has been used in several recent school projects with unsatisfactory results.*
.3 Mechanical air supply and mechanical exhaust: To be used in most buildings. A two-fan system is required.	*Both supply and exhaust can be automatically controlled using temperature sensors and time clocks and do not rely on users. Although improper maintenance, or operational difficulties (which may be design related) can lead to user complaints, this is not a problem exclusive to mechanical systems.*
8.2.2 Outdoor Air Supply	
.1 Supply	
A minimum of 7 litres per second (15 cfm) of outdoor air per person is required, based upon the 'normal' occupancy of the building. This applies to non- smoking occupancies as the norm.	*This is a requirement of ASHRAE* 62-1989. *Ventilation systems are to be sized to provide ventilation to the area served based upon the normal occupancy of that area. Ventilation systems sized for the occasional peak occupancy within gymnasiums or community/ assembly halls, result in oversized heating plants and ventilation equipment, which have higher capital costs, higher operating and maintenance costs, and are inefficient as well.*
.2 Free Cooling	
Air volumes and system arrangement must allow up to 100% outdoor air to be used for preventing overheating of occupied spaces. Do not preheat outdoor air	*Most new buildings are very energy efficient, and even at quite low temperatures (i.e., -10°C to -15°C), there maybe a need to cool the building during occupied hours in order to dissipate internal heat gains from lights, equipment and people.* *See Figure 8.1*

Recommendation	***Rationale***
.3 Outdoor Air Intakes	
Outdoor air intakes must be provided with downturn hoods designed to eliminate the potential for the system to draw snow in or to become blocked by snow.	*This is intended to 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, the location of outdoor air intakes is critical. Location of roadways, parking and service points and prevailing wind to the building must be considered at design.	*Many problems and even closure of buildings have recently occurred when vehicle exhaust, diesel fumes, sewage gases and products of combustion were drawn into the building through the outdoor air intakes.*
Considerations should include:	
.1Intake hoods to have sufficient vertical length (minimum 600 mm) and velocity (maximum 1.5 *mls).*	*To ensure contaminants including snow, wind and insects do not enter the ventilation system, these parameters should be considered.*
.2 Hoods 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 the potential for snow entry during windy conditions.*
.3 Hoods mounted high enough to avoid becoming blocked by snow accumulations expected in the selected location.	*A review of snow drifting patterns must be done when locating the air intake, as drifts may impede system operation for many months of the year. Setting the hood out from the wall reduces the potential for snow entry during windy conditions.*
.4 Outdoor air intakes 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.	*This reduces the chance of bringing in objectionable odours, vehicle exhaust or flue gases from chimneys, with the outdoor air.*
.5 Do not install insect screen on outdoor air intakes.	*Insect screening becomes blocked by snow and insects can be trapped in filters.*
.6 Outdoor air intakes should be separated to the greatest degree possible with a minimum distance of 10 meters from all trucked service points, including sewage pump-out, water fill and fuel delivery, and from chimneys and exhaust outlets.	

Figure 8-1: Outdoor Air Intake



Recommendation	***Rationale***
.4 Dampers	
Outside air dampers are to be low leakage type.	*This limits the infiltration of outdoor air.*
.5 Insulation	
Insulate outdoor air ducts using external duct insulation.	*The use of duct liner in an outside air intake duct contravenes current ASHRAE recommendations.*

8.2.3 Air Mixing

Packaged mixing boxes are not recommended.	*Conventional equipment is designed for conditions typical of the southern portion of Canada or the central U.S.A. In Nunavut, where outdoor air temperatures may be as low as -50°C, mixing of cold outdoor air with room temperature air is more difficult than standard equipment is designed to handle.*
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	*Supply air is a mix of fresh outdoor air and return air from within the building.* A *temperature sensor is provided to read the*

Recommendation	***Rationale***
unit. A variance of no more than about: t 2 degrees from one point to another should be achievable.	*mixed supply air temperature. The amount of outdoor air admitted is controlled by this sensor. If return and outdoor air is not thoroughly mixed when they arrive at this sensor, it will be reading 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. Refer to notes in Appendix* C.
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 physically above the warmer (return air) point of connection.	*This promotes the mixing of warm and cold air by taking advantage of the principles of convection.*
• Use opposed blade type dampers	*This promotes the mixing by directing streams of air towards each other.*
• Locate connection points at least 3 metres upstream from the heating coil with at least one duct elbow before the mixed air duct connects to the air handling apparatus.	*This practice gives air more distance in which to mix before reaching 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 mixing is important to enable air-handling systems to operate normally, without nuisance tripping from low temperature controls. Effective temperature control is difficult to achieve without good mixing.*
Exhaust, relief air, and outdoor air ducts are to be Insulated for a length of 3 metres from the connection to the louver.	*Insulation prevents the formation of Condensation on ductwork that is exposed to cold outdoor air when the system is operating or shutdown.*

8.2.4 Air Distribution

.1 Diffusers

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 supply registers located along the longest interior wall, blowing towards the perimeter wall, is an acceptable alternative.	*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 incorporate balancing dampers, which are easily adjusted, possibly resulting in avoidable air balance problems.*

Recommendation	***Rationale***
Air diffusers located in the floor and blowing through the baseboard radiation, are unacceptable.	*Air supply through the baseboard radiation does not permit proper air diffusion and temperature control.*
.2 Dampers	
Balancing dampers are required on all main branches at each branch duct takeoff. Dampers to be in-line mounted, and locking quadrant type. Splitter dampers are not acceptable for use as a balancing device. Volume control dampers at diffusers are not an acceptable means of controlling air volume.	*Line mounted dampers provide a reliable means of balancing. Results of adjustments made with splitter dampers are unpredictable, as the airflow in the main ducts as well as in the branch duct is changed. Dampers placed adjacent to supply outlets contribute to high noise levels because of the high velocity of air at that point.*
.3 Flexible Ductwork	
Flexible ductwork shall be limited to short lengths within one metre 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 excessive lengths of flexible ductwork create air delivery problems by increasing pressure drops in the ductwork, and in many instances when fastened with duct tape, the tape falls* off.
.4 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 lined up with the fan inlet or outlet and the flexible connection does not obstruct the airflow.	*Flexible connections reduce the noise and vibration from the fan equipment from being transmitted through the building structure to the occupied spaces. The fan performance is adversely affected if the ductwork connection is offset, or if the flexible connection projects into the air stream. This results in increased energy consumption* as *well* as *reduced fan performance.*
.5 Branch Take-off Ducts	
Branch take-off ducts to each air supply or exhaust outlet are to be a minimum 0.5 metre, located in an accessible location with a duct mounted balancing damper positioned near the take-off fitting.	*Supply or exhaust (return) air outlets that are mounted directly on the main branch ductwork tend to have uneven velocities, and are noisy and Uncontrollable. Balancing dampers located too close to the actual air outlets cause noise.*
.6 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 as it loses adhesive properties, particularly on cold ducts.*
.7 De-stratification Fans	
Consider use of de-stratification ceiling fans in applicable high ceiling areas (i.e., garages, theatres, etc.) Size for total area coverage. Provide protective guards over fans where they may be subject to damage.	*Allows for better-tempered air distribution during heating and cooling seasons. Reduces energy cost and improves space comfort.*

Recommendation	***Rationale***
8.2.5 Air Exhaust	
.1 Location	
Outdoor exhaust vents are to be located where they will not be susceptible to snow accumulation, or discharge directly into prevailing wind. Avoid locating in vicinity of the outdoor air intake (i.e., within 10 metres).	*Snow accumulation can hamper or eliminate exhaust capability. A review of snow drifting patterns must be done when locating exhaust, as drifts will impede system operation for many months of the year.*
.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 possibly closing off 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 tends to be ineffective.*
• Individual major exhaust fans are to be interlocked with the air handling system.	*Unless air is being brought in at the same time it is being exhausted from the building, a strong negative pressure can be created in the building.*
• Local exhaust fans must not discharge into boiler rooms.	*Unstable draft conditions will affect burner combustion efficiency.*
• Areas having manually controlled exhaust fans are to be provided with timed switches.	*This avoids the possibility of exhaust fans being left operating unintentionally for long periods of time.*
8.2.6 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.	
500 mm x 500 mm access doors are required for: • Exhaust air dampers • Return air dampers • Filters, coils • Balancing dampers • Mixing boxes • Reheat boxes • Turning vanes	
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 operating or not.	*It must be possible to operate the system manually if the three-way valve must be removed for maintenance or repairs.*

Recommendation	***Rationale***
8.2.7 Provisions for Monitoring Performance	
.1 Balancing	
Instrument test holes, drilled on site and sealed with duct plugs, are preferred to test ports for ventilation system balancing.	*Test ports are costly and not required frequently enough to warrant extra expense. Test holes can be drilled on site by the balancing contractor where and as required, eliminating the need for coordination with other subcontractors.*
.2 Adjusting Outdoor Air	
Instrumentation must be installed to allow operators to regularly monitor temperatures of outdoor air, mixed air and supply air. Dial type thermometers are preferred.	*By monitoring temperatures. The correct proportions of outdoor air and mixed air can be set to ensure suitable supply air temperature. When this is not possible, users may be subjected to uncomfortable conditions. Other types of thermometers can be difficult to read.*
Each air-handling unit is to have supply air, mixed air, return air and outdoor air.	*Provides indication to building operator* of *system performance.*
8.2.8 Heat Recovery Systems	
Heat recovery ventilators (HRVs) should be used with caution.	*Heat recovery ventilators have not proven to be effective in the past. Although the heating of outdoor air may be expensive, the necessary addition of defrost coils, preheat coils and associated controls reduces the effectiveness of the HRV, making the payback period unacceptable. There are new models of HRVs on the market today that may be effective; however, care must be taken to ensure they are specified correctly and installed correctly for them to work effectively.*
8.2.9 Filters	
All air shall be filtered before entering coils, equipment or occupied spaces, using throwaway, standard size filters.	*The intent is to prevent dust build-up and make it simple to replace filters regularly.*
Filtering shall be achieved by one set of filters, not by a summer-winterfilter arrangement.	*A summer-winter filter bank arrangement is unsatisfactory because it is based on allowing entry of snow into the air handling system. Where this has been tried, the maintainers sometimes may not be aware that they are to remove one set in each season.*
On recirculating 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 lower efficiency filters may not be needed to meet current codes, sufficient space in the ventilation system should be provided to accommodate higher efficiency filters.*
8.2.10 Acoustic Control	
.1 Duct Lining	
Acoustic lining should be provided in supply air,	*This is required to minimize noise transferred*

Recommendation	***Rationale***
return air and exhaust air ducts 5 metres downstream and 2 metres upstream of fans. Fasten using a pin spotter. Do not use self- adhesive clips.	*from fans to the occupied space.*
Adhesive must be applied to the entire adhering surface area of acoustic duct lining.	*Past experience has shown that self-adhesive clips often detach and allow duct liner to block ducts. For this reason, a more secure fastening method is required.* *There have been several cases where the duct liner has come loose because of inadequate adhesion. Loose duct insulation can totally block ductwork and is difficult to diagnose.*
.2 Acoustic Separations	
All components of the mechanical ventilation system must be designed so that sound level will be within noise criteria limits recommended by ASHRAE.	*Mechanical noise and vibration of fans and pumps can be objectionable to building occupants. NBC* 6.2.1.1 *requires HVAC systems to conform to good engineering practice such as described in the ASHRAE Handbooks and Standards.*
8.2.11 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.	*Mechanical and boiler rooms operating at continuous high temperatures will shorten the service life of mechanical and electrical components, and create uncomfortable working conditions for operation and maintenance personnel.*

8.3 AIR CONDITIONING

Although outdoor air temperatures can rise above comfortable indoor levels during the summer months, the additional cost of providing air conditioning is rarely justifiable for the short period of time it will be required. There are instances, however, where it may be justified because important normal operations would otherwise be disrupted.

Recommendation	***Rationale***
8.3.1 Cooling	
For most of the year, varying the amount of outdoor air introduced into the system, and adjusting the heat supplied to heating coils can control the supply air temperature. 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 M8.2.2 "Outdoor Air Supply" -reference to free cooling) will produce supply air above 18°C for an extended period of time, the need for cooling equipment should be reviewed.	

Recommendation	***Rationale***
Where air conditioning is installed, equipment must be designed in conformance with the ACNBC Canadian Heating, Ventilation and Air Conditioning Code.	*Provision must be made for the proper shutdown in fall and start-up in the spring.*

8.3.2 Humidification

Humidification is not typically required or recommended in public sector buildings.	*Humidification systems in the North have historically proven to be very difficult to operate and maintain because of poor water quality in many communities, and because of the continual attention required to ensure efficient and proper operation. During extremely cold outdoor temperatures, the humidification levels in a building must be kept low to prevent excessive condensation on windows and to prevent deterioration of the building envelope. This reduces the benefits 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 regularly malfunction due to calcium build-up.* A *proper water supply to the humidification system is required to ensure long-term system operation.*

8.4 ENERGY RECOVERY AND DEMAND CONTROL SYSTEMS

Higher energy cost coupled with growing concerns regarding Indoor Air Quality have placed increased demands on energy recovery and control system technologies. A method of maintaining good indoor air quality and conserving energy is to control the ventilation rate according to the needs and requirements 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.

Recommendation	***Rationale***

8.4.1 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. Consideration should be given when weighing possible marginally higher installation costs versus overall operational cost reductions, especially on smaller systems. Provide the client/user with a capital cost recovery summary as part of the system design and analysis.	*Reduces size* of *primary load equipment (i.e., boilers, chillers, burners, pumps, etc.), thereby reducing overall energy consumption. In many new buildings, the cost savings resulting from the reduction* of *cooling tonnage and/or heating equipment size, alone offsets the initial cost* of *thermal recovery units.*

8.4.2 Energy Recovery

Devices - General

Recommendation	***Rationale***
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.
Use counter-flow type energy recovery equipment only.	*Generally, counter-flow provides the greatest temperature difference and heat transfer rate across the recovery exchanger.*
Pending location and/or owner preference, the designer shall consider and weigh all advantages and disadvantages associated with the following three main types: Fixed Plate; Heat Pipe and Glycol Run Around Loop.	*When selecting, consider such factors as installation and operational costs, ease of operation, simplicity and maintenance, etc.*

8.4.3 Demand Control Systems

On large volume systems (i.e., greater than 4000 cfm), maximize usage of demand control ventilation (DCV) systems using sensory controls (i.e., CO2 sensors; time control and/or occupancy sensors). CO2 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 years.*

8.4.4 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. A VFD should be rated to match the electrical characteristics of the motor, the starter and the circuit protection.	*The use of a VFD to control mechanical equipment that has fluctuating patterns of use can result in energy savings. The Mechanical Designer will determine the need for a VFD, and it is the responsibility of the Electrical Designer to ensure that its installation is in accordance with electrical codes and standards.*

M9 AUTOMATIC TEMPERATURE CONTROLS

An automatic temperature control system properly designed, installed, maintained and operated 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, especially in more remote communities.*
Pneumatic control systems may be used where approved specifically in combination with electronic or direct digital control (DDC) systems. The sensing and logic is to be done electronically: the controlled devices are to be operated by pneumatic operators.	*Although pneumatic control systems are more complicated and prone to failure from lack of service, they have cost advantages for larger installations and can provide full modulation.*
Direct digital control systems with electronically	*The control industry is changing more and*

Recommendation	*Rationale*
operated control devices may be used where appropriate.	*more to DDC controls. The systems are now robust enough and easy enough to operate in remote communities. The ability to be diagnosed remotely over a modem has advantages in remote communities.*

9.2 CONTROL COMPONENTS

Recommendation	*Rationale*
9.2.1 Components -General	
All controls, regardless of type, are to be calibrated in degrees Celsius, whenever possible.	*The GN has standardized on the metric system. It is confusing to have mixed markings on controls.*
CSA approval is required for all control equipment, including alarm panels.	
Stand-offs are required for all duct- mounted controls and accessories mounted on externally insulated ducts.	*Stand-offs are intended to keep these items fully accessible for operation and servicing.*
9.2.2 Thermostats and Sensors	
Thermostats and/or sensors located in gymnasiums are to be located 2400 mm above the floor and be complete with a heavy-duty metal guard.	*Gym thermostats and sensors need to be protected against damage, and the students need to be protected from sharp comers. Gyms are used for public functions, which requires that they have tamper- proof covers.*
In cases where a space thermostat controls a heating control valve and a variable air volume or cooling control in sequence, there is to be a dead band of 2°C between the heating and cooling.	*The intent is to optimize energy consumption by avoiding simultaneous heating and mechanical cooling, or heating and free cooling.*
Thermostats located in public areas must have vandal-proof guards.	*This prevents intentional or unintentional tampering by building users.*
Locking type thermostats are to be used in public facilities where maintainers only should be able to adjust temperatures.	*Where there are a variety of users, it is often preferable to allow only maintenance staff to control temperature in public areas of facilities such as arenas, lobbies, public washrooms, public areas of air terminal buildings.*
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 many cases it is more appropriate to allow users to adjust room temperatures (rather than having them rely on maintainers for minimal adjustments). Examples include health Centres, staffed areas of schools (offices, classrooms), and community offices. Range limits would protect against overheating.*
Low voltage electric heating thermostats are to be SPST (single pole, single throw, i.e., similar to 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*

Recommendation	***Rationale***
	to be installed incorrectly.

9.2.3 Control Valves

Control valves (i.e., two and three way control valves for heating or cooling coils) are to be sized based on a Cv rating required to provide a pressure drop of 21 kPa or other rationale to ensure that there will be no 'hunting' at low flow rates.	*Incorrectly sized control valves result in poor controllability.*
Normally open, electrically operated heating zone valves are to be used. Do not use thermostatic valves.	*This allows for flow through heating system in the event of an actuator failure. Thermostatic valves are not recommended, as they require ongoing calibration.*

9.2.4 Flow Switches

Flow switches are to be vane type on piping 50 mm and smaller. Paddle type flow switches will be acceptable on larger piping.	*On smaller piping sizes, paddle type flow switches are difficult to install properly and do not function we". The sensitivity cannot be adjusted, resulting in nuisance alarms.*

9.2.5 Control Transformers

The number of control devices, i.e., low voltage electric zone control valve for heating radiation, is to be limited to 3 devices for each 40 V A transformer.	*Limiting the number of control devices on a circuit avoids excessive voltage drop for each controlled device and premature failure.*

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.	*Where a common damper actuator is used a long connecting rod is sometimes required, which is nearly impossible to set up, and the quality of control is reduced.*

9.3 VENTILATION UNIT CONTROL

Recommendation	***Rationale***

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 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.*

9.3.3 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 user areas and will therefore be at or above 20°C. If for any reason it 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)

Recommendation	***Rationale***
A supply air controller is required to control the temperature of the supply air to between 13 -16°C. For most of the year, varying the amount of outdoor air introduced into the system can control the supply air temperature. When the maximum amount of outdoor air will produce supply air above 18°C for extended periods of time, the need for cooling equipment should be reviewed. See Mechanical M8.3 "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 avoids inaccurate measurement by averaging colder or warmer air streams.*
An automatic reset type freeze stat located downstream of the heating coil must be provided and set at 2°C.	*The automatic reset type freeze stat is required to reduce the likelihood of air handling systems shutting down and remaining off during cold weather extremes.*

9.3.4 Heating Coils

The thermostat controlling the heating coil in each AHU (air handling unit) should be located a minimum of three metres downstream of the coil in the supply air duct and preferably downstream of the supply fan.	*The distance from the coil ensures the thermostat reads the actual supply air temperature (not the temperature immediately next to the heating coil).*
Fast response type controllers should control heating coil control valves.	*Without fast response controllers, the control valve hunts from full open to full closed position, never reaching a position of equilibrium, resulting in the overheating of occupied spaces.*
Electric, modulating controls are preferred for heating coils. And 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 preferred) when it is not required, and often the result is overheating.*

9.3.5 Time Clock

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 countdown 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 user-activated control, provide a 7 day programmable time clock c/w quartz control clock and battery back- up.	*This is intended to ensure that mechanical equipment is programmed to operate only during occupied periods and to 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	A typical ventilation control strategy for all vent

Recommendation	***Rationale***
developed for ventilation unit control. The control Strategy can be applied to many ventilation units, both small and large. Refer to Figure 9.1.	units across Nunavut will provide some *consistency in operation and maintenance.*

9.3.7 Typical Direct Digital Control (DDC) Sequence of Operation

The vent system will start by pressing the system start push button PB-1 located in the general office, gymnasium, or area served. The vent unit will start and operate for the predetermined number of hours as pre-programmed in the DDC and will then shut down (a gym vent unit would typically be set to operate 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 D1-2, wired to the auxiliary contact of the supply fan starter.

Upon confirmation of start up from D1-2, the vent unit will operate on 100% return air for a preset purge time to stabilize temperatures (i.e., 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, 2,3. 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, 2,3 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 limits (i.e., 3°C), to suit specific building requirements.

A CO2 sensor, CO2 -1, located in the return air duct and sensing return air CO2 levels from the building, will reset the minimum outdoor air position to increase the percentage of outdoor air to the building and maintain the CO2 at the desired level (i.e., 800 ppm). The minimum outdoor set point will be set in the DDC controller, based on the minimum building ventilation requirements outlined in the ASHRAE Standard 62-1989R.
Direct mount and readout analog thermometers TI-1, 2, 3, 4 will provide the operator with outdoor, mixed, supply and return air temperatures. A magnehelic type 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 vent unit upon sensing a low supply air temperature, after a 5 minute time delay.

The following user adjustable set point 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 (3°C)
- Low limit supply air temperature set point adjustment (2°C)

Provide continuous trending at 30-minute intervals for the following points:

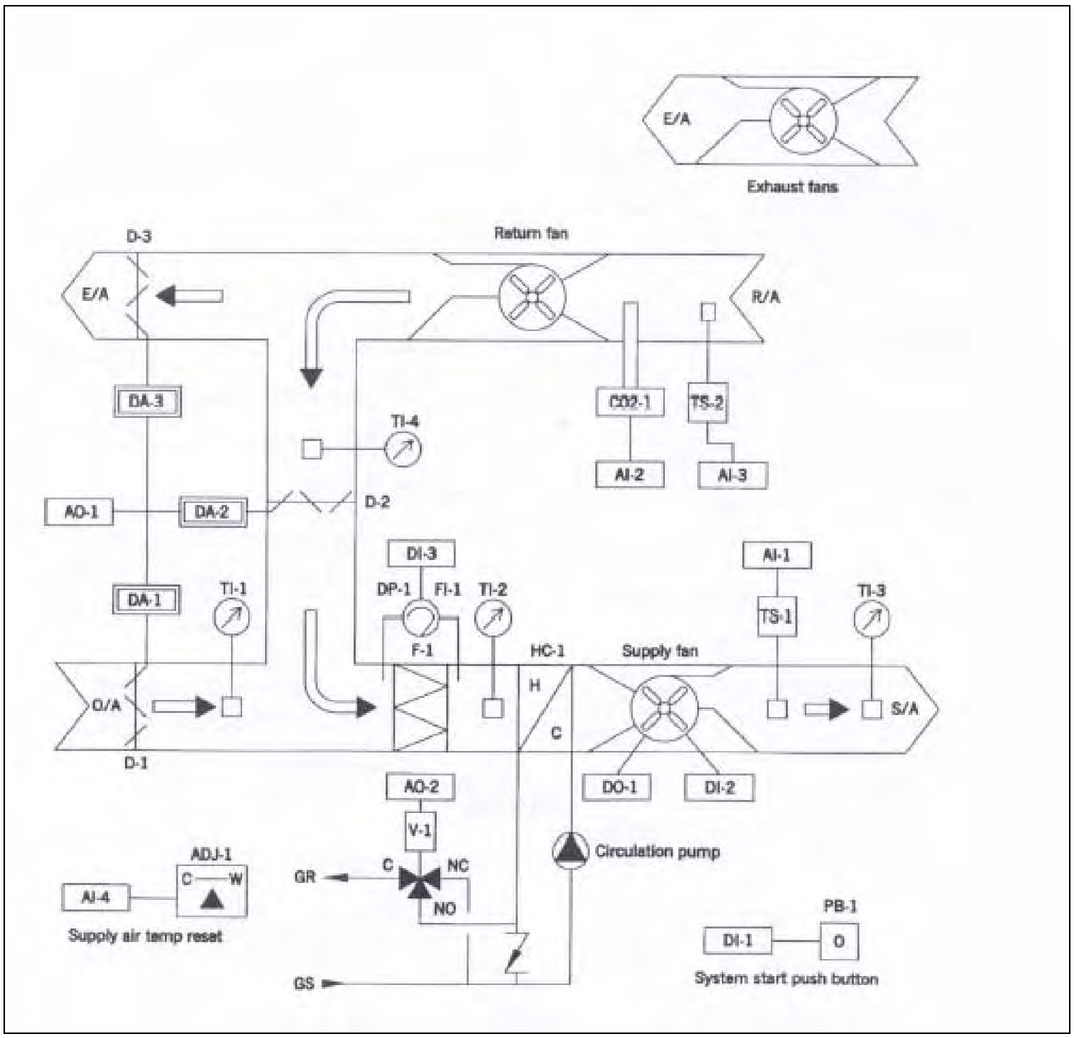
- Supply air temperature
- Outdoor air temperature (one sensor per project)
- Return air temperature
- CO2 reading

- Filter status (CLEAN/DIRTY)
- Supply fan status (ON/OFF)

9.3.8 Typical DDC Sequence of Operation Diagram

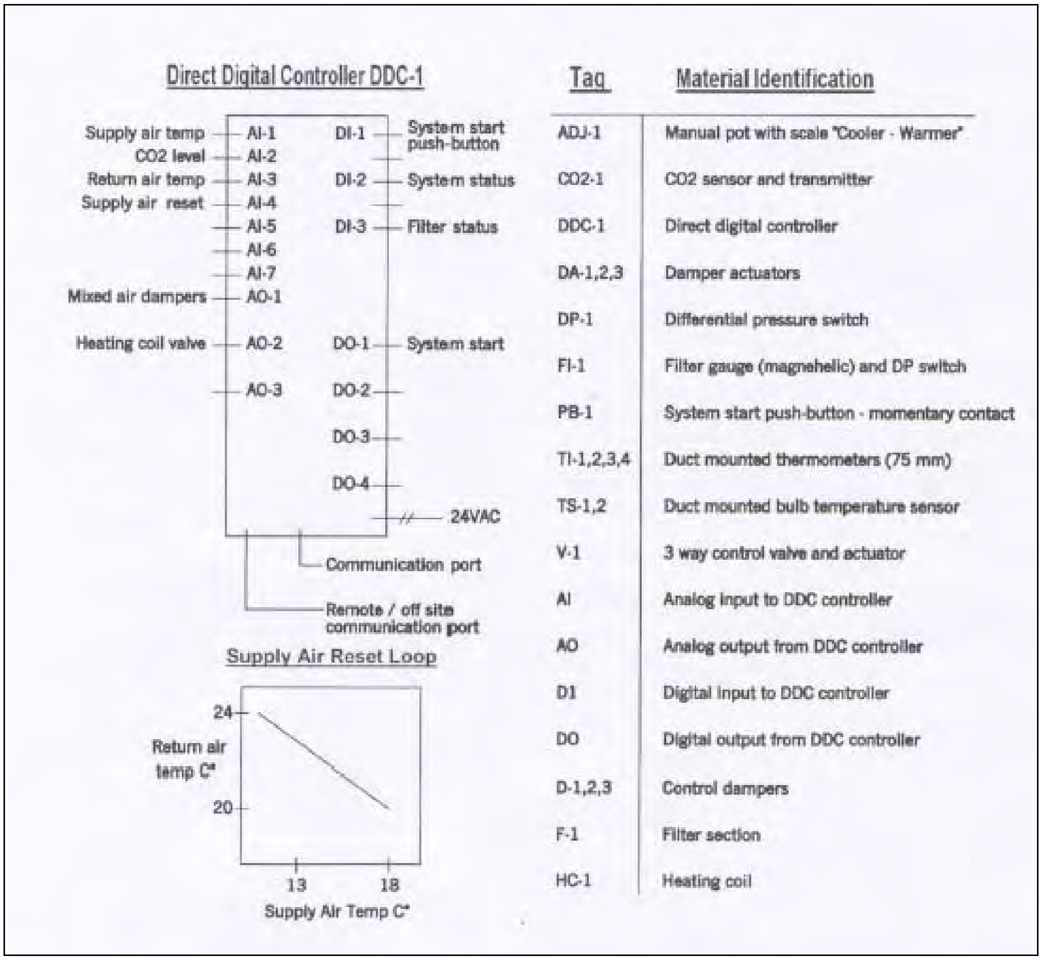
Provide a modem module connection on buildings where required to allow off-site monitoring of the system performance.

Figure 9-1: Ventilation System Control



9.3.8 Typical DDC Sequence of Operation Diagram

Figure 9-2: Direct Digital Controller Identification



9.4 HYDRONIC HEATING CONTROL

Recommendation	***Rationale***
9.4.1 Radiation Control	
The radiation zone is to be controlled by a low-voltage room thermostat controlling the normally open two-position control valve.	*This provides 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 'run wild.'	*The small additional initial cost* of *providing control is much less than the long-term energy savings, given the high cost* of *heating energy.*

Recommendation / ***Rationale***

9.4.2 Force Flow Control

The force flow unit is to be controlled by a line voltage, low-range, wall- mounted thermostat complete with locking metal guard. 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

The unit heater is to be controlled by a line voltage, low-range, wall- mounted thermostat complete with locking metal guard.

This provides a 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 can occur automatically (increased in cold weather, decreased in warmer weather), thereby increasing energy efficiency.

This could be problematic if domestic HW were dependent on boilers; however, dedicated HWtanks are now required (see M4.3).

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 to be 'critical' and that must activate the automatic dialler and/or 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.

M10 HEAT RECOVERY FROM NPC POWER PLANTS

10.1 GENERAL

The GN has Memorandum of Understanding (MOU) with Nunavut Power Corporation in regards to recovering heat from NPC power plants. This MOU provides for heat recovery systems to be provided by NPC, who will meter and charge the building owner for the heat provided. The charges for the system will result in an immediate 10 to 15% saving to the building that will remain until NPC recovers the cost of the system. Once the costs are recovered. The energy charge will be further reduced.

Some of the benefits of residual heat systems are:

10.1.1 Direct Cost Savings

Where the total costs of building and operating a residual heat distribution system allow the energy to be sold to the customer at a rate that is less than the customer's cost of equivalent heating fuel, a direct savings is realized in annual building operating costs. If a system can provide enough energy to significantly reduce operation of the customer boiler system, the customer may realize a savings in boiler maintenance and/or capital investment costs.

Once the capital costs of the system have been recovered, energy charges to the customer can be reduced, allowing greater savings to building operators.

There is often a direct benefit to NPC realized in lower station service requirements due to less frequent operation of radiator fans. This can result in an increase in net plant efficiency.

10.1.2 Long Term Community Infrastructure Cost Savings

A system providing thermal energy to buildings normally supplied by oil-fired heat can cause a significant deferral of fuel storage facility upgrades.

10.1.3 Local Economic Benefits

Local economy can undergo a boost during construction by hiring of local forces and increased business to the local hotel, etc.

All of the savings realized, and in some cases a portion of the energy revenue from the system, remain within the Region rather than being spent outside Nunavut on fuel re-supply.

10.1.4 Environmental Concerns

Production of greenhouse gas emissions and other pollutants is directly related to the amount of fossil fuel consumed by the community. A given percentage reduction in consumption of fossil fuels results in an identical decrease in emissions. There is no increase in electrical production fuel required by the power plant.

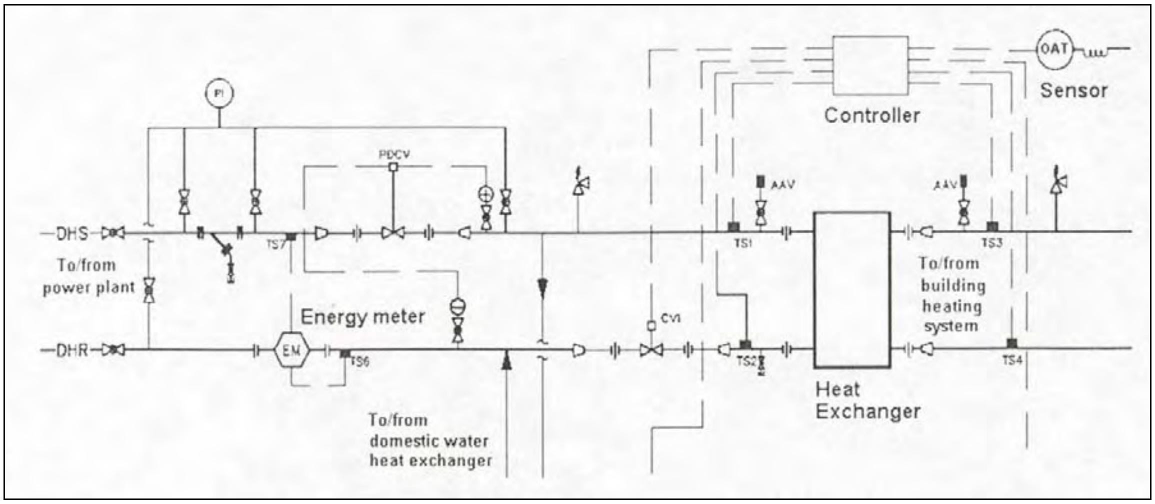
There is some reduction of transportation and handling hazard, especially where fuel is delivered to the community by truck.

Noise pollution caused by radiator fans is often reduced substantially, especially during the winter, when thermal demand on the system is greatest.

Figures 7.1, 7.2 and 7.3 show typical connection points for heat recovery from NPC. Figure 10-1 shows a schematic of a typical residual heating system.

When heat recovery is being considered, an agreement between the building owner and NPC must be signed. Copies of the MOU are available from Public Works and Services (867-975-5400).

Figure 10-1: Residual Heating System



END OF SECTION

TABLE OF CONTENTS

ELECTRICAL

INTRODUCTION

Since the late 1980s electricity has been available in every community in the Nunavut. Electric lighting, appliances, telecommunication and computer equipment are now typical in buildings across the territory. As well, the construction of increasingly airtight buildings, in the interest of reducing fuel costs, has resulted in an increased use of electricity to power mechanical systems and controls. Automatic controls balance the conflicting requirements for comfort, energy conservation, simplicity and reliability.

E1 CODES AND REGULATIONS

Documents referenced in this section include:

- National Building Code of Canada (NBC)
- Canadian Electrical Code (CEC)
- Underwriters Laboratories Canada (ULC)
- Underwriters Laboratories Incorporated (ULI Canada)
- Canadian Standards Association (CSA)
- Illuminating Engineering Society (IES)
- Institute of Electrical and Electronics Engineers (IEEE)
- GN Electrical Mechanical Safety Section -Electrical Bulletins

Related offices include:

- Protection Services Division – Community and Government Services
- Nunavut Power Corporation

E2 OPERATION AND MAINTENANCE

2.1 GENERAL

See G1 and G4 .

2.2 ACCESS

Electrical systems generally require relatively little maintenance. However, easy access to equipment that must be serviced is important. Access hatches and spaces to be provided for all electrical equipment are required to ensure a safe working area to service or replace electrical equipment.

2.3 SPARES

Regional Maintainers should determine, in consultation with the Project Officer and design consultants, what spare parts should be provided. The following is a recommended list of regular and emergency spare pacts 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 rounded to the nearest case.
- Spare fluorescent lamps equal to 10% of the number used in the facility. Specify an integer number of lamps rounded to the nearest case.
- Spare high intensity discharge lamps equal to 20% of the number used in the facility. Specify an integer number of lamps rounded to the nearest case.

- 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 lifetime.

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 each facility.

2.5 OPERATION AND MAINTENANCE MANUALS (O&M MANUALS)

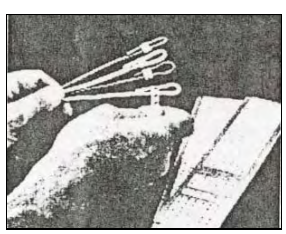
At present, manuals are to be prepared in accordance with good engineering practice. **"Guidelines for the Preparation of Operations and Maintenance Manuals for Electrical Systems" are currently in a draft form and will be distributed when completed.**

E3 IDENTIFICATION

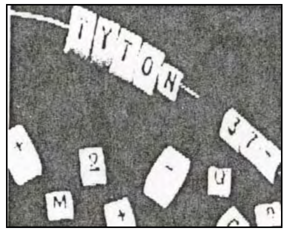
Clear identification of electrical equipment is particularly important for the electrical system. Local maintainers and trades people should be able to quickly understand and locate related system equipment. Consistent identification in all public sector buildings is recommended to ensure that maintainers and operators can easily become familiar with any public sector building in any community.

The language should be English. There are four official languages (including dialects) in the Nunavut. However, for operations and maintenance staff and trades people, an understanding of English is required, and therefore English is the language recommended for identification of components and systems.

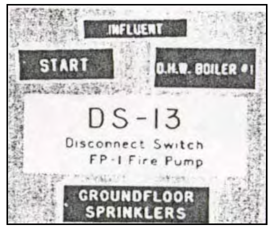
Various levels of identification can be incorporated within a specific building. According to the Canadian Electrical Code, annunciation of main distribution panels, sub-panels, motor control centers, and motor starters is required. Additional steps in identification are listed below for possible implementation.



Tape style identification



Heat shrink identification



Lamacoids

3.1 CONDUCTOR IDENTIFICATION

Recommendation

Self-laminating conductor markers may be used to identify conductors at all panel boards, motor control centers, junction boxes, terminal cabinets and outlet boxes. The numbering system can include circuit numbers on power circuits. In low voltage and control system wiring, the numbering should match the control diagrams.

Rationale

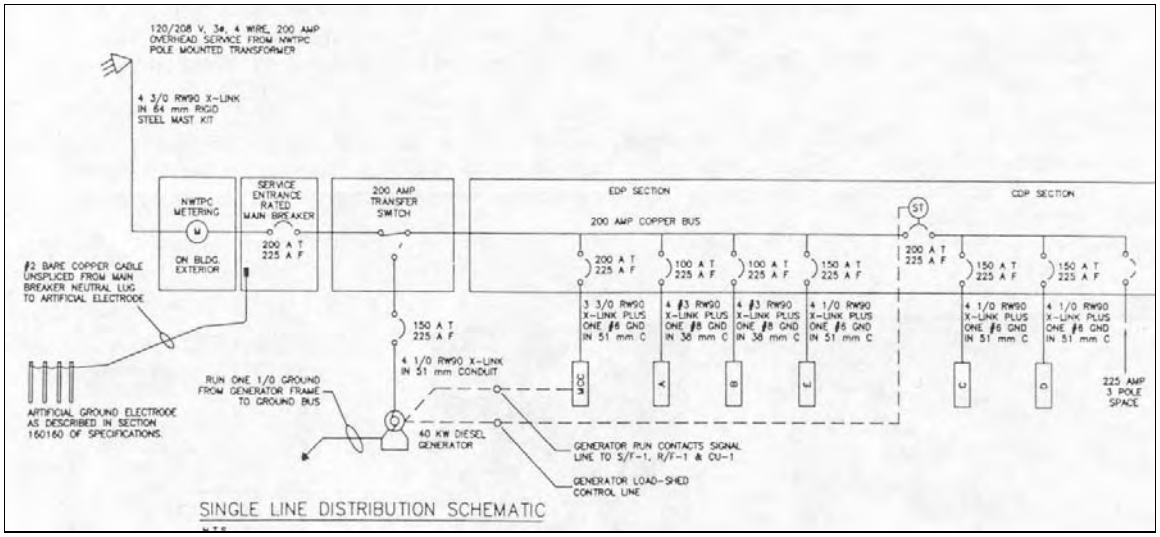
Circuit numbers are useful to identify wiring for trouble-shooting and to avoid accidents by preventing contact with energized conductors. Due to the increasing complexity of electrical systems, it has become important to identify wiring with control diagrams of the system, to be able to trace wiring 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 in buildings 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 will be useful for maintenance and emergency response personnel (e.g., fire-fighters).

Figure 3-1: Sample Single Line Diagram



3.2 RACEWAYS/JUNCTION BOX IDENTIFICATION

Recommendation	***Rationale***
3.2.1	
Provide identification of systems conduit wherever it is accessible. See Electrical System Identification Tables E-1 and E-2.	*This is useful when tracing system problems and for making additions or deletions to the system.*

3.3 EQUIPMENT IDENTIFICATION

See Electrical System Identification Tables E-1 and E-2

Recommendation	***Rationale***
3.3.1 Panel Directory	
Typewritten panel directories are required. Any room numbers used should be those that will be used by occupants, not room numbers used on contract documents.	*Users need to be able to identify the circuit quickly, by the name or number they commonly use.*
3.3.2 Terminal Cabinets	
In terminal cabinets for control wiring and low voltage wiring, identify terminal strips with a typewritten directory.	*This is done for operations and maintenance staff (maintainers to factory representatives) to be able to quickly trouble shoot problems and to add and delete parts of the system.*
3.3.3 Labels and Lamacoids in Service Rooms	
Mechanically fasten all lamacoids in service areas and mount adjacent to, not on, controllers.	*Mechanically fastened lamacoids are required so they will not fall off. Eespecially so in hot mechanical rooms where adhesive backed lamacoids do not remain attached. Mounting beside, rather than on, controllers ensures identification when* two *or more identical control covers are removed during maintenance, or when a defective controller is replaced.*

Recommendation	Rationale
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

Circuit and panel may identify receptacles 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 centers, patient care areas of hospitals and industrial arts rooms of schools.*
3.4.2 Mount labels Adjacent to, not on, receptacles.	*This practice ensures identification if the cover plates are removed (i.e., during painting).*

ELECTRICAL SYSTEM IDENTIFICATION TABLE E-1

LABELS AND LAMACOIDS

Component	Type	Information
Main distribution center	***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 I.e.. Telephone, low voltage	***B***	Indicate equipment controlled (I.e., Telephone Rooms 1-12 Intercom Rooms 1-7)
Equipment 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 centers	***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. Contents for low voltage (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 (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 (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	Colors
Type A	9.5mm	lemuroid	White lettering / black background
Type B	6.0mm	lamacoid	White lettering / black background
Type C	3.0mm	Lamacoid	White lettering / black background
Type D	3.0mm	Adhesive	No preference

ELECTRICAL SYSTEM IDENTIFICATION TABLE E-2

Component	Conductors	Raceways[1] and Junction Boxes[2]	Receptacles	Other
Normal power:				
-120/208, 240 volt	Code	Gray	As specified by designer	
-347/600 volt	Code	Sand		
Emergency power				
-120/208, 240 volt	Code	Gray *w/red* bands	Red	
-347/600 volt	Code	Sand *w/red* bands	N/a	
Low voltage:				
-Switching / controls		Black		
-Emergency / exit lighting		Black *wired* bands		
-Security		Black *w/blue* bands		Strobe (blue)
-Mechanical alarms		Black *w/yellow* bands		Strobe (amber)
Fire alarm		Red		Strobe (red)
Telephone/computer network:		White [3]		
-Telephone				
-Intercom and sound				
-Computer networks				
-Television and cable				
-Airport instrumentation and controls				

- Exposed raceways are to be color coded in mechanical and electrical rooms, above removable ceilings and where they enter and leave a room. The main color band must be a minimum of 130 mm x 30 mm with auxiliary color bands at each end (if required) being a minimum of 20 mm x 30 mm. Raceways (i.e., conduit) must be colored within 200 mm from each enclosure and at 5 m on center thereafter within an area.
- All junction boxes pull boxes and their covers must be painted according to the color-coding schedule.
- There should no longer be any distinction between voice system conduit and data conduit since the industry has moved towards TIA/EIA standards for structured wiring, wherein any structured wiring line can be used for either voice or data, as determined by the user.

E4 POWER SUPPLY

Nunavut Power Corporation supplies electricity in most communities In Nunavut by diesel generators operated. Fuel is re-supplied annually and power costs are very high. Voltage fluctuations are typical, as are power outages. Three-phase power is not available in all communities. Power is supplied to consumers primarily by overhead service.

4.1 PUBLIC UTILITIES

Power is supplied and distributed by Nunavut Power Corporation.

Recommendation	***Rationale***
4.1.1 Consumption Targets	
See specific sections regarding energy consumption requirements (i.e., lighting, motors).	*See General* G6.1 *National Energy Code.*
4.1.2 Underground Service	
Overhead services are preferred. However, if an underground service is necessary, 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 (i.e. pea gravel).	*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 wires (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).*

4.2 AUXILIARY POWER

Reliability of power supply for equipment is more important in cold climates than in moderate climates because of the dire consequences of failure. Systems depend on electricity for 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 essential services must be maintained. Emergency generators, where required by NBC, need to meet stringent requirements. "Standby" or "auxiliary" power supplies are optional and sized according to desired load requirements.

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 in buildings where required by the National Building Code or by the facility program.	*Capital and maintenance costs are high - generators must be exercised and checked weekly.*
4.2.2 CSA C282-M00	
This standard "Emergency Electrical Power Supplies for Buildings" is suitable for the design of gensets for most GN facilities (See Section 8.5 of the standard.)	*The CSA standard was developed to cover installations where power is required on an emergency basis.*
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.*

Recommendation	***Rationale***
• 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 with double wall sub base fuel tank complete with day tank feature, transfer pump system, leak detection and low fuel alarm.Must also include:	*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 electric block heater. In buildings with a hydronic heating system, a plate heat exchanger is to be used in place of the electric block heater.	*This practice ensures the generator is warm for easy starting.*
• Integral radiator	*See above regarding remote radiators.*
• Hospital or critical grade muffler	*This will assist in noise reduction.*
• Flexible exhaust section complete with guard to prevent accidental contact.	*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.*
Generator package should also include: • eye wash station • heavy duty acid resistant elbow length rubber gloves • heavy duty acid resistant apron • hydrometer	*Items required for personal protection when testing the specific gravity of the batteries.*

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 • Lighting (including bathroom lighting in	*Besides code requirements, emergency generators allow buildings to continue operating with minimal disruption. In many instances the entire electrical system can function on emergency power, as there is little cost or operational advantage to reducing lighting and receptacle capacities. Refer to the facility program to determine which lighting and power loads are essential. Subject to emergency lighting design of specific building.*

Recommendation	*Rationale*
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	

4.2.5 Automatic Exercising

Time clocks for automatically exercising the generators are 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 Timer

Provide a timer (holdover timer or "time delay, emergency to normal") with a minimum lag time of 10 minutes before retransfer from generator power to normal power after normal power restarts. This feature is a component of the automatic transfer switch settings.

This allows time for the normal power to stabilize. It is especially important when generators have a *'Warm- up" period of* 3-5 *minutes before accepting* a *load, as the effect of a second blackout would be a further delay for power to resume. (The generator cycles through a cool-down period, then a warm-up cycle starts again).*

4.2.7 Location

All generators must be installed in a separate room with a 2 hour fire rating. Access to allow potential removal or replacement of the generator must be provided.

This is a code requirement as per C282.00

4.2.8 Portable Generator

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 CSA Z32-04

This standard for "Electrical Safety and Essential Electrical Systems for Hospitals" has been adopted for health care facilities in Nunavut.

The intended use of a health care facility must be determined and designed to meet the chosen needs.

4.3 RENEWABLE ENERGY (SUN, WIND)

The seasonal availability of solar and wind energy in the North is often much higher than southern locations annually. However renewable energy systems should only be considered where life cycles costs could be shown to be lower than other alternatives.

Recommendation	***Rationale***
4.3.1 Unsuitable Applications	
.1 Where buildings can be connected to a grid, solar energy technologies that generate electricity should not be installed.	*Renewable energy equipment that is grid connected tends to be accompanied by high capital cost of synchronous inverters to perform the grid link, and by the refusal of utilities to pay fairly for energy supplied. Code requirements and enforcement also add to the cost and complexity.*
.2 Systems that use solar 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 expensive also, but may be viable because it has very low operational costs.*
.2 All electrical loads need to be reduced to an absolute minimum by using the most efficient hardware and appliances available, before renewable energy hardware should be considered.	*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.*
.3 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.*

4.4 CONSUMER SERVICE AND DISTRIBUTION

Recommendation	***Rationale***
4.4.1 Electrical Service Rooms	
.1 Separate Room A separate electrical room is recommended for all facilities that have services of 600 V and larger and/or 600 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.*

Recommendation	***Rationale***
.	*.*
.2 Working Space	
Adequate space around electrical equipment is to be provided. Minimum working space around electrical equipment is 1.0 meter. Coordination with the other disciplines (especially mechanical) is essential.	*Past experience with unacceptable clearances has resulted in need for on-site changes. We intend to ensure that 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.*
4.4.2 Components	
Standard of acceptance for power systems is Cutler Hammer, Federal Pioneer or Square D.	*This reduces inventory and allows maintenance staff to become familiar with the products.*
Standard of acceptance for control equipment is Allen Bradley, Cutler Hammer, Federal Pioneer or Square D.	
4.4.3 Spare Capacity	
Provide a minimum of 15% as empty spaces in panel boards (i.e., 6 spare spaces in a 40 circuit panel board).	*This provides circuits for future loads and avoids creating a hazardous condition caused by overloading the panel board. Additional capacity is required for additional loads expected over the lifetime of the building (e.g., computers).* ***Note:*** *These are minimum requirements (I. e., facilities planned for future expansion may require a larger capacity).*
Provide a minimum of four single poles. 15 amp spare breakers installed in each sub panel.	
4.4.4 Location of Disconnects & Panels	
Do not recess disconnects and panels INSIDE cold exterior walls.	*The thermal overloads and breakers trip based on a heat/time characteristic. If the equipment is below freezing, the time to trip is extended and no longer offers proper protection.*
4.4.5 Panel Boards -Spare Conduit	
For flush mounted panels, stub 3 spare 19 mm conduit out to the ceiling space and/or crawl space (whichever is accessible afterwards).	*The intent is to provide ready access to the panel boards for future circuitry requirements.*
4.4.6 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*

Recommendation | ***Rationale***

interrupting rating is required.

4.4.7 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- vapor 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- vapor barrier).

4.4.8 Provision of Branch Circuits

.1 Counter Receptacle

At least one 3-wire branch circuit (split receptacle) should be provided at counter work surfaces where coffee making is anticipated.

This will prevent the overloading of a circuit. These requirements border on adequacy provisions, but experience shows that if there isn't a degree of adequacy in the electrical installation, they quickly become unsafe. Examples include adult education classrooms, school lounges, and offices.

.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. 4.8.1.

.3 Circ Pump, Heat Trace

Each water circulation pump and heat trace outlet is to be supplied by a separate branch circuit. Heat trace circuits to be supplied by a GFI circuit breaker.

This prevents the freezing of the facility water supply due to a fault in other electrical equipment.

.4 Drinking Fountains

See Mechanical M4.8.6.

4.4.9 Electrical Boxes

Avoid ganging together of sectional boxes.

Joined sectional boxes can come apart during rough in, which eliminates the grounding between boxes.

Floor boxes

Use floor-mounted receptacles only if there is no alternative to providing power to equipment. If used, they should be flush-mounted type complete with hinged covers.

Boxes that are flush-mounted are less obtrusive and less of a "tripping" hazard compared to surface-mounted floor boxes. Flush-mounted floor boxes with removable covers are

Recommendation	Rationale
	undesirable because the covers are often misplaced, leaving the receptacle exposed (facing up), which is an Electrical hazard.

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 Nunavut. Means of adequately grounding facilities are covered by the CEC; the preferences stated reflect PW&S experience with different situations encountered in public sector buildings.

5.1 ORDER OF PREFERENCE

Recommendation	Rationale
Order of preference is as follows: 1. Municipal piped water system 2. Minimum 9.5 mm (3/8") bolts (copper, bronze or brass) tapped and threaded to a minimum of 3 steel piles. 3. Exothermic (cad) weld to a minimum of 3 steel piles 4. Uffer ground or rod electrodes 5. Plate electrodes	*The electrical resistance of the ground in arctic or sub arctic areas is extremely variable* (1 *to* 1000 *ohms for a standard* 19 *mm by* 3.0 *m grounding rod). The sensitivities 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 from galvanic action set up under certain soil conditions.*

5.2 CSA Z32-04 "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 a 20-year lifetime. The need for conduit has now been reviewed and modified as noted below.

Recommendation	Rationale
6.1.1 Conduit Use	
Surface-mounted conduit is acceptable in service buildings (i.e., garages, fire halls), in recreational buildings (arenas, etc.) and in spaces concealed	*This clarifies where surface conduit is acceptable. Spaces such as service rooms and closets, plenums, etc., are not normally seen, so*

Recommendation	Rationale
from the public or not accessible.	*surface conduit use in these areas is acceptable.*
Where a conduit is not required by the Code but is installed in a wood frame construction for the expansion, the conduit may be terminated in junction boxes convenient to each room (i.e., above T -bar ceilings, in crawl spaces, etc.). NMD90 or armored 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.* *Facilities where future electrical requirements are most likely to change include maintenance shops. Offices, schools, and health care buildings.*
Conduit is not required for long runs 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.*

6.1.2 Telephones

Ideally conduit should be provided as outlined in the Canadian Electrical Code, Part 1, and CAN/CSA-T529-M91 and CAN/CSA- T530-M90 standards.	*This allows for greatest flexibility in ever changing cable requirements, as each client department is often responsible for all wire installation.*

6.1.3 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. Equipment and systems should be identified in facility programs.*

6.1.4 Air I Vapor Barrier

See Architectural A3.1, A3.3, A3.4, and A3.6.

6.2 WIRE AND CABLE

Recommendation	Rationale
6.2.1 Type and Size	
.1 Copper wiring only, type R90, RW90 (X link) NMD90, or AC90. 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 (fR) losses are reduced.*
.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.*

Recommendation	***Rationale***
.4 The use of aluminum wiring is permitted.	*Connections require annual inspections as they have a tendency to loosen.*

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. The following set the Standard of Acceptance: • Standard receptacle: Arrow Hart 5252 series, Bryant 5252 series, Hubbell 5252 series. • Surge suppression receptacle: Hubbe1I5252-S c/w blue nylon face (5261-SP). • Ground fault receptacle: Bryant GFR 5252 FT, Hubbell GF 5252. • Standard switch: Arrow Hart 1891 series, Bryant 4801 series, Hubbell 1201 series, Leviton 53501/001 series. • Exterior light control: Hubbell 1381- T (spdt).	*Residential quality is not durable enough for public buildings.*
6.3.2 Color	
Wiring devices (receptacles and switches) should be of the same color throughout the building. Preference is user defined. Exceptions: • Surge protection outlets ***Blue*** • Emergency outlets ***Red*** • Isolated ground ***Orange*** •	*The intent is to standardize the color for replacement and stocking purposes, yet allow some flexibility for the designer's choice (i.e., ivory, white, brown).*
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.*
GFCI receptacles are not permitted for exterior use in cold climate applications due to a tendency to resist tripping.	*Regular duplex receptacles are to be installed and protected by a GFCI circuit breaker.*
6.3.4 Cover Plates	
Stainless steel, enamel finish metal, or nylon receptacle plates are preferred. Bakelite is not recommended.	*Stainless steel plates are typically used in schools, health centers 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 centers. Bakelite plates are not durable.

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 NBC 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" and repair equipment.

6.3.6 Outdoor Plug-ins (see also 6.3.3)

Plug-ins should be provided if they are a program requirement. Mount exterior electrical outlets on The building unless otherwise stipulated. Use underground Cable to rails or posts only where necessary or unavoidable.

Minimize the use of exterior electrical cables; keep outlets above snow level. 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. Install rails at or above vehicle grill height, as people will be a lot 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, oil pan heater, battery blanket, and may also have an in-car warmer. The loads require a separate circuit for each parking stall.

When more than 6 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.

When 12 or more outlets are provided, at 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 heaters to be energized about 10°C higher than gas engines.

Install low temperature thermostat sensors for plug-ins so they are mechanically protected and exposed to the wind (e.g., a wire mesh guard or similar device).

6.3.7 CSA Z32-04 "Electrical Safety and Essential Electrical Systems for Hospitals "

Receptacles need to conform to requirements as follows:

Clarification of application of the Standard. Terms used here are as defined in the Standard.

Assume casual contact only in basic care areas of community health care centers.

Assume casual contact, external connection and direct connection potential in basic care areas of hospitals.

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 Nunavut 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 should be to the recommended minimum of the current edition of the Illuminating Engineering Society's (IES) Lighting Handbook or the minimum as required by the Safety Act, whichever is the most stringent. Recommended IES illumination levels are shown in Appendix G.

This is recognized as the industry standard.

7.1.2 Energy Efficiency

Designers are encouraged to stay within the energy budgets for lighting as set out in ASHRAE/IES 90.1. For guidance, see the table in Appendix J, which includes excerpts from the Energy Code for Buildings Public Review 2.0 (Mar.95), which was based on Ashrae/IES 90.1.

The goal is energy efficiency. The National Energy Code for Buildings was published in 1997, but it has not been automatically adopted within Nunavut.

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 be able 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 communities in Nunavut. 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, 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.

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.

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

Recommendation	***Rationale***
	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 Video Display Terminal (VDT) Lighting

Where VDTs are used, lighting fixture lenses should be low-glare parabolic type.	*Visual comfort means little or no glare. Glare from reflective and convex screens can be annoying and even painful for the operator. It is often difficult to position the VDT to prevent reflections on the screen.*

7.1.7 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.*

7.1.8 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

Provide task lighting over separately switched 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 offices and residential buildings.*

.4 Arena / Curling Fixtures

Recommendation / ***Rationale***

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.

7.1.9 Lamps

.1 Incandescent Lamps

Incandescent lamps are recommended for use only in circumstances where other types of lamps will not perform satisfactorily (i.e., cold temperature applications), or where energy consumption will be negligible, or where certain other requirements exist.

This assists in energy efficiency and avoids re-lamping costs.

Special applications may include hospital operating rooms and light sensitive display areas in museums. Low use makes incandescent acceptable in janitor closets and storage rooms. Residential spaces for which incandescent is appropriate include living rooms and bedrooms.

.2 Fluorescent Lamps

.1 T-8 lamps are recommended for most general lighting applications within heated spaces. Exceptions: unheated spaces.

These lamps are energy efficient, and have a proven high Color Rendering Index (CRI). Intent is also to reduce inventory. Typical uses are for general lighting in office areas, classrooms, lobbies, health centers, maintenance garages, fire halls, community halls, gyms and kitchens and residential areas..

T8's have a high Color 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.*

T-5 High Output 4 foot lamps are recommended for large areas with high ceilings requiring an abundance of light.

T-5 lamps produce an abundance of light and consume less energy then Metal Halide lighting. Lamps do not require any warm up time so lighting is instantaneous.

.2 Standard of acceptance for T-8 lamps is:

For neutral "warm" light:
. General Electric SPX35
. Philips TL835
. OSRAM Octron 835

For "Cool" light:
. General Electric SPX41
. Philips TL841
. OSRAM Octron 841

T-8 lamps are inexpensive (1/4 *the cost) compared to full spectrum T 12 lamps, and the T –8 lamps come close to full spectrum lighting emissions throughout the visible spectrum.*

Standard T -12 full spectrum lamps are not recommended for use in new buildings.

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*

Recommendation	***Rationale***
	more susceptible to breakage during shipping.
.3 U-shaped fluorescent lamps or tubes over 4 ft (1.2 m) in length are not recommended.	*Imperial lamps are still more readily available, metric inventory is reduced (avoids double stocking as metric lamps are shorter), and costs of imperial lamps are about 2/3 of metric lamps.*
.4 Specify lamp lengths in Imperial measurement (i.e., 4 ft instead of 1.2 m).	
.3 Compact Fluorescent Practical wherever low-level lighting is required. Equivalent compact fluorescent light should be used in place of incandescent light whenever possible.	*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 lobby or corridor lighting in health centers, student residences and group homes.*
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.*
.4 High Intensity Discharge (HID) Lighting	
.1 Metal halide (MH) lamps are preferred in rooms or spaces with high ceilings. T5 High Output 4 foot fluorescent lamps should be considered in place of Metal Halide Lamps.	*Metal halide lamps provide acceptable color rendition. They are typically used in community gyms, airports, larger libraries and visitor entranceways.*
.2 Low Pressure Sodium (LPS) lamps are generally not acceptable for indoor use.	*They provide very poor color rendition. Typically they are used as exterior perimeter lighting to minimize operating costs.*
.3 Indoor use of high-pressure sodium (HPS) sources is discouraged except in specialty areas.	*They generally provide poor color rendition, although they can be used where interior finishes support the color shift or where color rendering is not important. **HPS** can be used effectively when combined with metal halide sources.*
7.1.10 Ballasts	
.1 Power Factor (pf)	
Ballasts are to be high power Factor type (i.e., minimum pf of 0.9).	*This reduces operating costs.*
.2 Electronic Ballasts	
In general, use electronic ballasts in all fluorescent fixtures. Standard of acceptance: Philips Mark V, General Electric G-RN- T8-1LL, EBT SSB1 or Orem System 32 GT2X32. *Exception*: Powerkut ballasts are acceptable where proven to be more economical with life cycle	*Electronic ballasts assist in energy conservation, the elimination of "light flicker", reduced ballast noise (hum) and have a reduced shipping weight. Ballasts must conform to "CAN/CSA-C654-M Fluorescent Lamp Ballast Efficacy Measurements" standard.*

Recommendation | ***Rationale***

costing.

.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 RFI Suppression Ballasts

Provide Radio Frequency Interference (RFI) suppressing ballasts in areas containing sensitive electronic equipment.

RFI suppressing ballasts are necessary to prevent interference where sensitive electronic equipment is present (e.g., typically required in flight service stations and community air radio stations).

7.1.11 Plastic Luminous Panels

Use acrylic prismatic lenses with a minimum thickness of 0.125" (K12).

This identifies the standard of acceptance.

7.1.12 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.

7.1.13 Location of Controls

.1 Except as provided in 7.1.13.2 and 3, lighting controls shall be:

.1 located next to the main entrance or entrances to the room or space whose lighting is controlled by those controls;

.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.

This is an adoption of requirements outlined in the National Energy Code for Buildings published in 1997.
The goal is energy efficiency.

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 Low voltage relay cabinets are ideally wall mounted near electrical panels supplying lighting circuits.

Recommendation | ***Rationale***

7.1.14 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 centers and correctional facilities.

.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 Passive Infrared Sensors (PIR)

PIR 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).

*They provide energy efficiency and security. **PIR** 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 **PIR** sensors should be used. Wherever night-lights are considered, use a **PIR** sensor instead.*

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.

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

Lights can be left on inadvertently for extended periods of time, and nobody would be aware,

Recommendation	***Rationale***
located at the entrance to the service space.	*because that space is not normally used.*

7.1.15 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, and 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 down 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 Nunavut makes the use of any decorative lighting undesirable.

Recommendation	***Rationale***
7.2.1 Fixtures	
Polycarbonate fixtures are well designed for all exterior lights.	*This reduces breakage due to high potential of vandalism.*
7.2.2 Lamps	
Exterior lighting in High Pressure Sodium requires an efficacy of not less than 50 Im/W.	*Energy conservation is necessary for lighting during long winter hours. HPS has poor color rendition, but it is better than LPS and is acceptable for outdoor use. Other disadvantages of LPS include slow delivery, higher initial cost, longer warm-up time, and lamp wattage decreasing over time and higher levels of sodium metal, which is a hazardous substance.*
7.2.3 Ballasts	
See Electrical El .1.10.4 "Low Temperature Ballasts.'	
7.2.4 Controls	
.1 Exterior Lighting Controls Except as provided in	*This is an adoption of requirements outlined in the National Energy Code for Buildings*

Recommendation

E7.2.4.2, exterior lighting shall be controlled by:

- 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 photocells.

Rationale

published in 1997.

The goal is *energy efficiency.*

.2 Lighting Schedule Controllers

.1 Controllers required in 7.2.4.1 shall be of the automatic type or otherwise capable of being programmed for 7 days and for seasonal daylight schedule variations.

The intent is to simplify the manual requirements for operating the controllers.

.2 Schedule controllers should be of a type that does not derive its time base from the AC power line frequency.

The closed power systems in all communities in Nunavut 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 during a power outage of at least 4 hours.

Power outages occur relatively frequently and maintenance of the schedule is desirable for appropriate operation.

7.3 EMERGENCY LIGHTING

Recommendation

Rationale

7.3.1 Battery Packs

Emergency battery-powered lamps should be installed in service spaces (i.e., generator rooms, mechanical rooms, usable crawl spaces) and washrooms, and all areas required by the National Building Code.

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 NBC.

7.3.2 Timers

In spaces that are illuminated only by HID lighting (i.e., arenas), emergency lighting is to be timer controlled so that it stays on for 15 minutes after resumption of power. (HID lighting with quick restrike lamps and integral quartz lamps, which provide instant illumination during the restrike cycle, are an acceptable alternative.)

*This will provide emergency lighting while **HID** lights "restrike".*

7.3.3 Auto-test

Automated self-diagnostic circuitry card (auto-test) should be provided for emergency lighting in facilities with one central battery pack unit. The auto-test is to be Lumacell Model/AT or equivalent.

The auto-test system automatically tests the central battery pack unit monthly. Bumed-out lamps are automatically sensed to indicate replacement required. The auto-test system is economical on central battery pack systems.

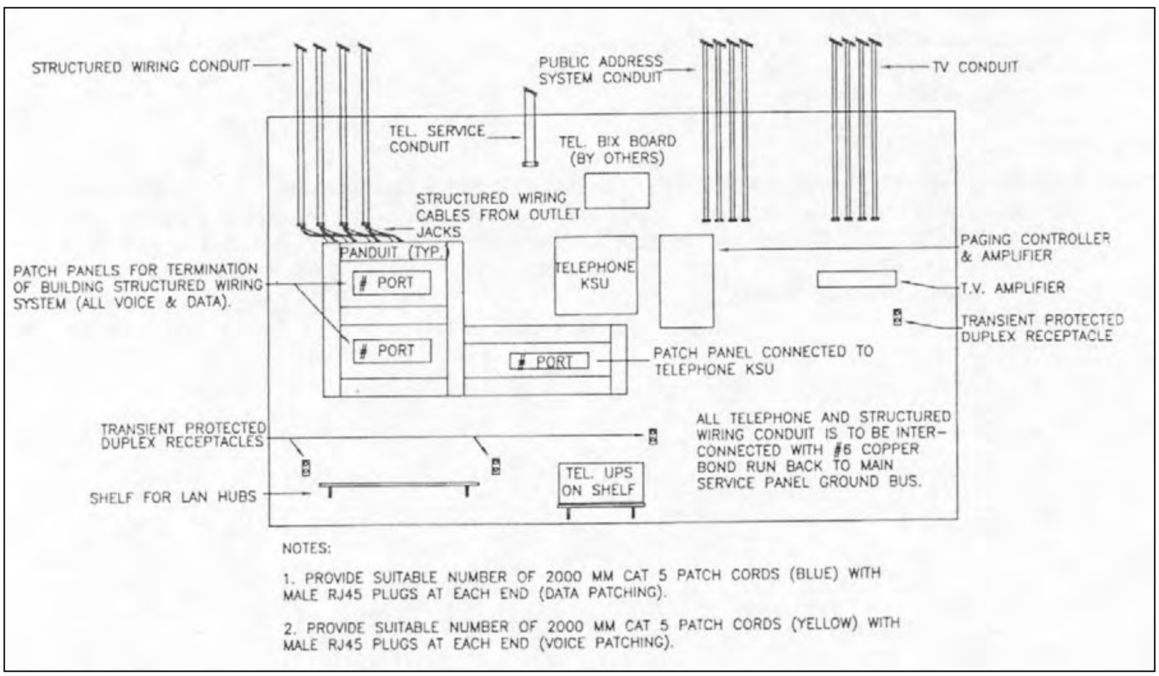
7.4 EXIT SIGNS

Recommendation	***Rationale***
7.4.1 LEDs	
The exit sign should be illuminated with LEDs, 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. Acceptable product: Lumacell model LER400 Series or Emergi-Lite LPEX50.	*This is acceptable because of its low energy consumption.*
All exit signs are to meet the CAN/CSA C860-96 standard.	*The CAN/CSA C860-97 standard is expected to be adopted in the next National Building Code.*

E 8 OWNER/COMMUNICATION EQUIPMENT

While standard equipment, such as telephones, is typically anticipated during building design, computers are now also common in many building types. Current and future equipment use requiring cable or special wiring must be routinely considered during design. Cable tray may be suitable for projects to consolidate all low voltage cable requirements.

Figure 8-1: Typical Layout for Communication Equipment

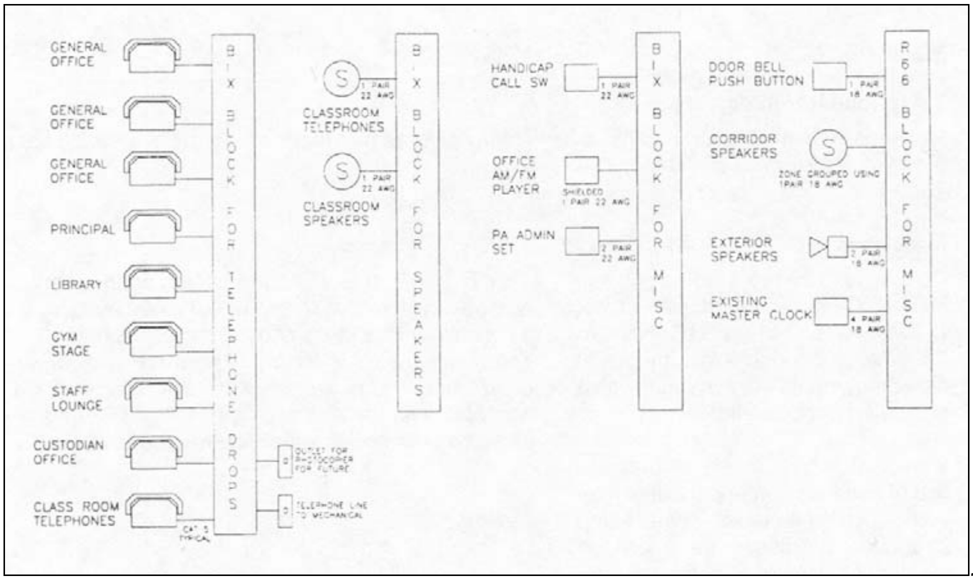


8.1 TELEPHONES AND INTERCOMS

Northwestel provides telephone services across Nunavut. Communication systems vary from simple two or three line telephone distribution systems to multiple-phone use with teleconferencing and video capability.

Recommendation	***Rationale***
8.1.1 Telephone Requirements	
Owner is responsible for installation of wire for system as per CAN/SCA- T529-M91.	*Northwestel is no longer responsible for the supply and installation of wire.*
8.1.2 Raceways	
Conduit is to be provided as outlined in the Canadian Electrical Code. CAN/CSA- T529-M91 and CAN/SCA- T530-M90. Conduit 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 raceway system is installed within every building and that a consistent location is chosen for terminations.* *The duplex outlet is for the Northwestel power filter. (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.)*
Multiconductor 3 or 4 pair cable in lieu of conduit for interior outlets may meet requirements for some wood structure buildings, i.e., college residences. Where structured wiring is employed, provide conduit to TIA/EIA standards.	
8.1.3 Telephone Rooms	
Separate communications rooms should be provided only when the complexity of the communications systems warrants it.	*Health centers may require space for video conferencing and associated equipment for medical and educational support.*
The following are guidelines for space requirements:	
.1 Buildings with 10 or fewer phone lines:	
• min. 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.*
8.1.4 Installation	
Use star topology for wiring layout.	*Simplest systems to trouble shoot and administrate. Problems with wiring are isolated to specific outlet.*

Figure 8-2: Typical Schematic for School Communications Layout



8.2 COMPUTERS

Computers require power, routes for networking cables and telephone line connections to allow communication by modem. Electrical design should ensure the system could 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 in conduit as outlined in E6.1.	*This allows for changes and future expansion.*
A minimum 19 mm conduit linking computer workstations to hub or cable tray locations and a 19 mm conduit from the cross connect to the telephone backboard is recommended.	*Conduit infrastructure allows for a wide variety of cable requirements i.e., from a basic single twisted pair of wires (basic modem, networking, communication link), or a 4 pair cable (Category 5 data cabling), or coaxial cable, or fiber optical cable from each workstation.*
8.2.2 Transient Voltage Surge Suppression (TVSS)	
Systems that are susceptible to lightning strikes and are in areas of high lightning incidence may have some form of transient protection on the main service.	*Dissipation of high-energy transients from lightning is typically provided at the main service point where the energy is first received from the utility power line in the event of a strike.*
Computer room distribution panel boards may use surge protection bolted directly to buss. All units should indicate status in event of TVSS failure.	*This provides protection from internal sources of harmonics, voltage spikes, and transients.*
Point of use devices at workstations may also be incorporated.	

8.3 TELEVISION AND CABLE

Recommendation

8.3.1 Conduit

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.

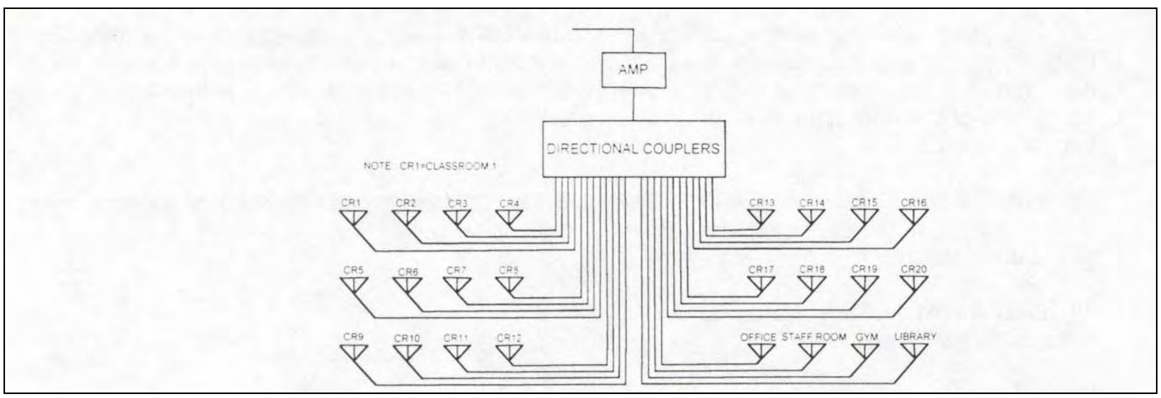
Rationale

Typically used in classrooms, visitor centers 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.*

Figure 8-3: Typical School RFTV Distribution System



8.4 CLOCKS

Recommendation

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.

Rationale

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 Nunavut. 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, 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 Bulletin issued from the Office of the Fire Marshal. Where clarification is required on fire alarm systems, consult with the Nunavut 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 supplier (i.e., manufacturer or the manufacturer's authorized agent) 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.*
Suppliers using third party in subcontracted maintenance services are not acceptable.	
9.1.2 Product Manufacturers	
Fire alarm systems should be supplied by one of the following suppliers: • Simplex • Notifier • Edwards Substitutions are not recommended.	*To ensure competitive bidding, yet limit the number of systems and replacement parts, the GN 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. Manual pull stations in gymnasiums must be fully recessed.	*This is a clarification of the Code requirements The intent is to prevent injury to people and damage to pull stations in gyms.*
9.1.6 Fire Alarm Bells	
Bells to be a minimum of 250 mm in diameter. Integrate fire flashers with fire alarm bells or horns where required for hearing impaired.	*The intent is to ensure audibility and visibility where required, and to keep stock requirements to a minimum.*
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.*

Recommendation

Technical Bulletin FM-OO2-86.

9.1.8 Central Monitoring Stations

Use only where required by the National Building Code 3.2.4.7 and the Nunavut Fire Marshal.

Rationale

This is intended to clarify which projects require central monitoring with a DACT (Digital Alarm Communicator Transmitter). Consult the Nunavut 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.

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

9.2.1 Standard of Acceptance

Federal Signal Corporation for items listed below:

Sirens

Model No. STH 10A (30) or STH10B (1Ø) equivalent.

Controls

PGA (Predetermined General Alarm) timer or equivalent.

Motor Starter

Use RC5 Motor Starter (heavy duty relays, capable of handling the operating current) or equivalent.

Exercise Clock

Model 75 or equivalent.

Rationale

Most of *the community fire alarm sirens in Nunavut are now* of *this type and this manufacturer.*

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 and especially heating systems can have serious consequences during 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

9.3.1 Mechanical Alarm Annunciators

Locate the primary annunciator panel in the mechanical room.

Rationale

The intent is to ensure that information is provided for building operators and maintainers.

Recommendation ***Rationale***

The secondary, remote panel is required to alert building users to mechanical problems.

Typically required in schools, community halls, large residential facilities, and health center where responsible users can notice and alert maintainers. Not required in fire halls, 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 dialer.

9.3.3 Auto Dialers - 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 typically installed when there is a danger of burglaries because of building contents, or where clients or residents should not leave a facility undetected (such as group homes).

.1 Standard of Acceptance

Radionics 7212 or equivalent.

.2 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.

.3 Partitionable

Schools with night use requirements (i.e., gyms) should include a key switch at the main entrance to disarm preselected zones, allowing use of these specific areas, while permitting the remainder of the system to function normally.

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. Keys may be used to reduce the number of people in the community knowing the access codes.

9.4.2 Panic Alarm Systems

Where panic alarm systems are a program requirement, they must be c/w a strategically placed audible alarm connected to the auto dialer. Call

Typically, panic alarms are installed in health centers where a member of staff may be alone with clients and may require immediate

Recommendation	Rationale
buttons should be of industrial quality.	*assistance in case of emergency.*

9.4.3. Auto Dialers - *See Electrical E9.5.*

9.4.4. 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 centers).*
In Iqaluit	
Auto dialers should be a 3-channel code reporting type that is compatible with the Town of Iqaluit's receiving system (Programming: Code 1 -Security, Code 2 -Fire, Code 3 -Mechanical alarm).	*Iqaluit has a code reporting system unique within GN buildings, which is monitored 24 hours/day.*
In all other communities	
A minimum 3 channels, digital voice, site programmable dialer is required. Suggested products: Delta Vox 4500, or for ease of use: Chatterbox by RACO, or Sensaphone.	*Three channels are currently required (fire/mechanical/security). The dialer must be simple to program on site providing messages in any language (I. e., English, Inuktitut, Innuinaqtun).* *Some dialers may have remote programming capabilities, which may be desirable in some Regions.*
All messages are to be cleared with municipal 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.*
Where an auto dialer is not required but a fire alarm is installed, conduit should be installed between the fire alarm panel and the telephone backboard.	*The intent is to allow for future installation of an auto dialer as fire departments develop in communities and allow for remote programming.*

9.6 ALARM LIGHTS AND AUDIBLE ALARMS

Recommendation	Rationale
9.6.1 Exterior Alarm Lights	
.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. The intent is to avoid confusion with landing lights, vehicle lights, etc.*

Recommendation	*Rationale*
Exception: Strobe alarm lights are not to be installed on arctic airports. .2 Color of lights • Fire alarm: red • Mechanical alarm: amber • Security/panic: blue • See 3.4.1 Table E-2	*Color-coding is standardized on public sector buildings. Blue strobes are typically used for security systems and panic systems in health centers 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 amber light mounted at the water fill pipe. Water fill indicating lights should be LED type with 25-year life. Standard of acceptance is Ledtronics, 120 V AC, Edison screw base.	*Water delivery pumps are controlled at the vehicle. The light indicates that the tank is full and that the driver should stop pumping.* *LED lights have low energy consumption and low maintenance requirements.*

E10 MOTORS

10.1 CHARACTERISTICS

Recommendation	*Rationale*
Motors must meet the specified minimum efficiencies in Appendix H, 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.*
Match voltage rating of motor with supply voltages, i.e., use 200 V motors for 208 V services.	*Although 240 V motors may function on 208 V, experience has shown that they burn out faster than 200 V motors.*

Recommendation	*Rationale*
10.1.1 Phase Protection	
Provide single-phase protection for all motors 5 hp or larger, i.e., magnetic starters with solid state adjustable overload sections offering phase loss	*This prevents costly motor replacement* of *large motors due to single phasing.*

Recommendation	*Rationale*
protection.	

10.1.2 Variable Frequency Drives

Install in conjunction with Direct Digital Control systems for fixed mechanical loads 5 horsepower and larger, or 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.*

10.1.3 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 disconnecting means to isolate a motor should be located within sight of and within 9 m of the motor and the machinery driven thereby.	*The intent is to permit safe operation and maintenance.*

Recommendation	*Rationale*

10.2.1 Motor Disconnects in Public Areas

Motor disconnect switches in public areas should be: .1 installed at 2.1 m above the floor, or .2 provided with a ventilated lockable cover.	*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).* *Protecting the switches by location is preferred over lockable covers to avoid the cost and inconvenience of keyed covers.*

10.2.2 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 (e.g., Grundfos) tend to become loose due to motor vibrations.*

10.3 SPRINKLER PUMPS

Recommendation	*Rationale*
A package fire pump system is required c/w with its own transfer switch.	*Past experience has shown that, when the jockey pump is not on auxiliary power, the fire pump cannot always operate properly.*

E11 MISCELLANEOUS

11.1 AUTOMATIC DOOR OPENERS

See Architectural A4.3.2 and A4.3.3.

11.2 HEAT TRACE

Recommendation

All electric heat trace is to be controlled by a temperature controller that limits its operation during high ambient conditions. In buildings with a a hydronic heating system all heat trace should be hydronic.

Rationale

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 Nunavut Electrical/ Mechanical Safety Section.

This is required for energy efficiency and premature failures of heat trace cable.

Where heat trace is required for water and sewer connections, it should be the self-limiting type.

Both ends of the heat trace should be terminated at the building.

This eliminates the problem associated with providing a CSA approved end seal in a potentially wet environment.

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 GN water and sewer connections in permafrost areas to ensure 'meltdown" 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 would 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

TABLE OF CONTENTS

ENERGY

INTRODUCTION

Energy efficiency issues are addressed throughout various sections of the GBPG. This document consolidates and supplements the energy information from the GBPG and outlines the various items which should be included or excluded in the design of a facility to make it more energy efficient. The recommendations in this document could be connected with financial incentives, and act as a guide for those involved in the construction process.

N1 CODES AND REGULATIONS

The Model National Energy Code

The National Energy Code for Buildings was published in 1997, but has not been adopted by Nunavut. The Energy Code includes both prescriptive and performance requirements. The Energy Code with associated software, including a construction and energy cost database, is available to allow an evaluation of the performance of designs. Designers and Project Managers are therefore encouraged to become familiar with the Energy Code.

Municipal Bylaws

All municipal bylaws and ordinances must be observed in the design and construction of facilities for the GN.

National Building Code: 1995

See G6.

Other Related Documents

Documents referenced by the NBC or this document include:

ASHRAE Handbooks and Standards
National Fire Code 1995
National Plumbing Code 1995
SMACNA (Sheet Metal and Air Conditioning National Association)
CGSB-41-GP-22 Process Equipment: reinforced polyester. chemical resistant, custom-contact moulded
NWT Impact Review Board (NIRB)
Installation Code for Oil Burning Equipment CAN/CSA-B139-M91
Propane Installation Code CAN/CSA B149.2-M95
Natural Gas Installation Code CAN/CGA-B149.1-M95
Department of Health Building Standards for Potable Water and Sewage Holding Tanks
National Hydronic Design Standard
American Society of Plumbing Engineers - Data Book
ASHRAE 62-1989 Ventilation for Acceptable Indoor Air Quality

N2 ENERGY CONSUMPTION

Consumption is largely dependent on operating practices; however, the shape, layout, and the quality of the exterior envelope of a building can have a significant effect on fuel and power consumption. Generating stations and distribution systems are located in 25 communities and serve approximately 11,000 residential and commercial customers.

N3 LIGHTING

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."*

3.1 INTERIOR LIGHTING

Artificial lighting requirements are not much different in Nunavut 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***
3.1.1 Illumination Levels	
Lighting intensity should be to the recommended minimum of the current edition of the Illuminating Engineering Society's (IES) Lighting Handbook or the minimum as required by the Safety Act, whichever is the most stringent. Recommended IES illumination levels are shown in Appendix F.	*This is recognized as the industry standard.*
3.1.2 Energy Efficiency	
Typically, lighting represents 30% of a buildings electrical load. Designers are encouraged to stay within the energy budgets for lighting as set out in ASHRAE/IES 90.1. For guidance, see the table in Appendix I, which includes excerpts from the Energy Code for Buildings Public Review 2.0 (Mar.95), which was based on Ashrae/IES 90.1.	*The goal is energy efficiency. The National Energy Code for Buildings was published in 1997, but it has not been automatically adopted within Nunavut.*
3.1.3 Daylighting	
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 be able 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 communities in Nunavut. 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, 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. The maximum number of fixtures controlled by a*

Recommendation ***Rationale***

switch should be determined. Where feasible, occupancy sensors should be considered.

3.1.4 Indirect Lighting

Indirect lighting should only be considered where the quality of the lighting is the most important factor in the lighting design. Where indirect lighting is appropriate, reasonably uniform ceiling luminance is to be achieved.

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%). If this is achieved, occupants may face in any direction without being subject to excessive ceiling reflections on the tasks.

3.1.5 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.

3.1.6 Video Display Terminal (VDT) Lighting

Where VDTs are used, lighting fixture lenses should be low-glare parabolic type.

Visual comfort means little or no glare. Glare from reflective and convex screens can be annoying and even painful for the operator. It is often difficult to position the VDT to prevent reflections on the screen.

3.1.7 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. Night lights can also be linked with occupancy sensors in low-use areas.

3.1.8 Fixtures

Polycarbonate Fixtures. These 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).

Over-counter Lighting. Provide task lighting over separately switched counters (i.e., fluorescent valance lighting under cupboards).

Work at counter tops often requires good lighting for tasks (e.g., at nursing stations for writing reports; in kitchens) and helps in overcoming shadows cast by the body from general room lighting.

Task Lighting. Wherever possible, provide built- in task lighting to supplement the ambient

This assists in energy conservation and accommodates the need for higher lighting

Recommendation	***Rationale***
lighting for critical seeing tasks, rather than providing high ambient lighting.	*levels due to task visual difficulty, glare, etc. Typical applications are offices and residential buildings.*
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.*
3.1.9 Lamps	
Incandescent Lamps. Incandescent lamps are recommended for use only in heated spaces for special light-critical applications, or in circumstances where other types of lamps will not perform satisfactorily (i.e., cold temperature applications), or where energy consumption will be negligible, or where certain residential requirements exist.	*Wherever possible, incandescent lamps should be replaced with compact fluorescent bulbs because of their improved efficiency and longer lifespan. This assists in energy efficiency and avoids re-lamping costs. Special applications may include hospital operating rooms and light sensitive display areas in museums. Low-use makes incandescent acceptable in janitor closets and storage rooms. Residential spaces for which incandescent is appropriate include living rooms and bedrooms.* *According to the CMHC, replacing one hundred 100 watt incandescent lamp with a compact fluorescent may save from $17 to $45 per year and have a payback period of six months to a year, depending on electricity rates.*
Fluorescent Lamps. a) T-8 lamps are recommended for most general lighting applications within heated spaces. Exceptions: unheated 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 and residential areas.*
Standard of acceptance for T-8 lamps is: For neutral "warm" light: General Electric SPX35 Philips TL835 OSRAM Octron 835 For "Cool" light: General Electric SPX41 Philips TL841 OSRAM Octron 841 Standard T-12 full spectrum lamps are not recommended for use in new buildings.	*T-8s 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.* *T-8 lamps are inexpensive (1/4 the cost) compared to full spectrum T-12 lamps, and the T-8 lamps come close to full spectrum lighting emissions throughout the visible spectrum.*

Recommendation	Rationale
c) 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.*
d) Specify lamp length in Imperial measurement (i.e., 4 ft instead of 1.2 m).	*Imperial lamps are still more readily available, metric inventory is reduced (avoids double stocking as metric lamps are shorter), and costs of imperial lamps are about 2/3 of metric lamps.*
Compact Fluorescent. Practical wherever low level lighting is required to be on continuously or for extended periods of time. 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.	*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 lobby or corridor lighting in health centres, student residences and group homes.*
High Intensity Discharge (HID) Lighting. a) Metal halide (MH) lamps are preferred in rooms or spaces with high ceilings.	The intent is to standardize maintenance and lower inventory requirements, especially important in remote communities. Metal halide lamps provide acceptable colour rendition. They are typically used in community gyms, airports, larger libraries and visitor entrance ways.
b) Low Pressure Sodium (LPS) lamps are generally not acceptable for indoor use.	*They provide very poor colour rendition. Typically they are used as exterior perimeter lighting to minimize operating costs.*
c) Indoor use of high pressure sodium (HPS) sources is discouraged except in specialty areas.	*They generally provide poor colour rendition, although they can be used where interior finishes support the colour shift or where colour rendering is not important. HPS can be used effectively when combined with metal halide sources.*

3.1.10 Ballasts

Recommendation	Rationale
Power Factor (pf). Ballasts are to be high power factor type (i.e., minimum pf of 0.9).	*This reduces operating costs.*
Electronic Ballasts. In general, use electronic ballasts in all fluorescent fixtures. Standard of acceptance: Philips Mark V, General Electric G-RN- T8-1LL, EBT SSB1 or Osram System 32 GT2X32. *Exception*: Powerkut ballasts are acceptable	*Electronic ballasts assist in energy conservation, the elimination of "light flicker", reduced ballast noise (hum) and have a reduced shipping weight. Ballasts must conform to "CAN/CSA-C654-M Fluorescent Lamp Ballast Efficacy Measurements"*

Recommendation	***Rationale***
where proven to be more economical with life-cycle costing.	*standard.*
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).*
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.*
RFI Suppression Ballasts. Provide Radio Frequency Interference (RFI) suppressing ballasts in areas containing sensitive electronic equipment.	*RFI suppressing ballasts are necessary to prevent interference where sensitive electronic equipment is present (e.g., typically required in flight service stations and community air radio stations).*
3.1.11 Plastic Luminous Panels	
Use acrylic prismatic lenses with a minimum thickness of 0.125" (K12).	*This identifies the standard of acceptance.*
3.1.12 Lighting Controls	
1. Except as permitted in 7.1.12.2, all interior lighting systems shall be provided with manual, automatic, or programmable controls. 2. Controls are not required where: a) continuous lighting is required for safety or security purposes, or b) 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.	*This is an adoption of requirements outlined in the National Energy Code for Buildings published in* 1997. *The goal is energy efficiency.*
3.1.13 Location of Controls	
1. Except as provided in 7.1.13.2 and 3, lighting controls shall be: located next to the main entrance or entrances to the room or space whose lighting is controlled by those controls; located in such a way that there is a clear line of sight from the control to the area lighted; and readily accessible to persons occupying or using the space.	This is an adoption of requirements outlined in the National Energy Code for Buildings published in 1997. The goal is energy efficiency. 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.

Recommendation	***Rationale***
2. Low voltage relay cabinets are ideally wall mounted near electrical panels supplying lighting circuits.	
3.1.14 Type of Controls	
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.*
HID Switching. Install HID switching so that they are protected against accidentally being shut off. This can be done through: location (i.e., in an area not readily accessible to the public) or mounting height (i.e., install at 2.1 m) or protective covers.	*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.*
Passive Infrared Sensors (PIR). PIR 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).	*They provide energy efficiency and security. PIR 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 PIR sensors should be used. Wherever night lights are considered, use a PIR sensor instead.*
They should be installed where:	
a) 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).*
b) Automatic lights are required for security reasons.	
c) The PIR sensors require an override option.	*In case of malfunction or inadequate coverage, the occupants must be able to override the lights.*
d) Ceiling mounted sensors are preferred.	*This is because they provide full 360° coverage and are less likely to be subject to tampering.*
Key Operation. Keyed lighting switches are not recommended.	*Keys are easily lost, and lights are then left on unnecessarily resulting in wasteful energy consumption.*
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	*Lights can be left on inadvertently for extended periods of time, and nobody would be aware, because that space is not normally used.*

Recommendation **_Rationale_**

located at the entrance to the service space.

3.1.15 Protection of Light Fixtures

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.

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 down when impacted by moving objects.

3.2 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 Nunavut makes the use of any decorative lighting undesirable.

Recommendation **_Rationale_**

3.2.1 Fixtures

Polycarbonate fixtures are well designed for all exterior lights.

This reduces breakage due to high potential of vandalism.

3.2.2 Lamps

Exterior lighting in High Pressure Sodium requires an efficacy of no less than 50 lm/W.

Energy conservation is necessary for lighting during long winter hours. HPS has poor colour rendition, but it is better than LPS and is acceptable for outdoor use. Other disadvantages of LPS include slow delivery, higher initial cost, longer warm-up time, lamp wattage decreasing over time and higher levels of sodium metal, which is a hazardous substance.

3.2.3 Ballasts

See GBP E7.1.10.4.'

3.2.4 Controls

a) Exterior Lighting Controls. Except as provided in GBP E7.2.4.2, exterior lighting shall be controlled by:

This is an adoption of requirements outlined in the National Energy Code for Buildings published in 1997.

lighting schedule controllers;

The goal is energy efficiency.

photo cells (PEC) located so that the PEC is

Recommendation ***Rationale***

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.

b) Lighting Schedule Controllers

Controllers required in GBP E7.2.4.1 shall be of the automatic type or otherwise capable of being programmed for 7 days and for seasonal daylight schedule variations.

The intent is to simplify the manual requirements for operating the controllers.

Schedule controllers should be of a type that does not derive its time base from the AC power line frequency.

The closed power systems in all communities in Nunavut typically have poor frequency stability that is not suitable for clock time bases.

Back-up. All lighting schedule controllers shall be equipped with back-up provisions to keep time during a power outage of at least 4 hours.

Power outages occur relatively frequently and maintenance of the schedule is desirable for appropriate operation.

3.3 EMERGENCY LIGHTING

Recommendation ***Rationale***

3.3.1 Battery Packs

Emergency battery-powered lamps should be installed in service spaces (i.e., generator rooms, mechanical rooms, usable crawl spaces) and washrooms, and all areas required by the National Building Code.

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 NBC.

3.3.2 Timers

In spaces that are illuminated only by HID lighting (i.e., arenas), emergency lighting is to be timer controlled so that it stays on for 15 minutes after resumption of power. (HID lighting with quick restrike lamps and integral quartz lamps which provide instant illumination during the restrike cycle are an acceptable alternative.)

This will provide emergency lighting while HID lights "restrike”.

3.3.3 Auto-test

Automated self-diagnostic circuitry card (auto-test) should be provided for emergency lighting in facilities with one central battery pack unit. The auto-test is to be Lumacell Model/AT or equivalent.

The auto-test system automatically tests the central battery pack unit monthly. Burnt-out lamps are automatically sensed to indicate replacement required. The auto-test system is economical on central battery pack systems.

Recommendation ***Rationale***

3.4 EXIT SIGNS

Recommendation	***Rationale***
Exit signs should be illuminated with LEDs, 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. Acceptable product: Lumacell model LER400 Series or Emergi-Lite LPEX50.	*This is acceptable because of its low energy consumption.*
All exit signs are to meet the CAN/CSA C860-96 standard.	*The CAN/CSA C860-97 standard is expected to be adopted in the next National Building Code.*

N4 HEATING AND COOLING

Minimizing the energy consumption of public buildings is important in Nunavut where fuel costs are extremely high. Added to this, the severe climate means that heating must be provided over much of the year. The number of degree-days below 18°C can reach 12,594 in Resolute, as compared to an average of 3,000 in Vancouver or 5, 782 in Edmonton.

4.1 TEMPERATURE

Recommendation ***Rationale***

4.1.1 Design

The design objective for indoor space temperature in occupied areas during winter conditions is 21°C and during summer conditions is 24°C.	*It is intended that heating and cooling systems be properly sized for the actual requirements of the building.*

4.1.2 Temperature Setback

Whenever possible, implement temperature setback within buildings during unoccupied periods.	*This reduces energy consumption*

4.1.3 Geographic Consideration

The outdoor air design temperature shall be according to the 2.5% January or July design temperature indicated in the most recent supplement to the National Building Code. Use similar data available from Environment Canada for specific communities that are not	*This advises the design industry of acceptable building design criteria in Nunavut.*

Recommendation	***Rationale***
listed in the supplement.	

4.2 FORCED AIR HEATING SYSTEMS

Forced air heating systems are as common in Nunavut as elsewhere in the country. However. as few buildings in Nunavut have basements, counter-flow furnaces are generally required with ducts located in a raised floor. Although forced hot air systems are not suitable for all types and sizes of facilities, their relatively simple servicing requirements make them a good choice in many circumstances.

Recommendation	***Rationale***
4.2.1 Furnace Type	
Two speed fans are required where ventilation is provided by the furnace.	*This provides continuous air circulation and reduces the stratification of air.*
Where a separate ventilation system is installed, a one speed fan is to be provided.	*Continuous use of the furnace fan is redundant and undesirable considering high electrical costs.*
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 13°C.	*Standard heat exchangers tend to 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.	*Past experience has shown that even equipment approved for use on a combustible base has burned into the floor.*
4.2.2 Combustion Air	
All fuel-burning appliances require a properly sized combustion air supply.	*This is a code requirement.*
4.2.3 Heating Capacity	
Forced air heating is suitable only for buildings where multiple heating zones are not required.	*Typically used for small buildings such as firehalls, garages, small office buildings, small health centres or residences. Not considered suitable for use in arenas or gyms, or where more than one furnace would be required to provide separate heating zones.*
4.2.4 Distribution	
Ducts located in a raised floor are preferred over those located in ceiling spaces.	*Better heat distribution when hot air is introduced at lower levels, and avoids penetration of building envelope assembly.*

Recommendation	***Rationale***
Where exposed ducts are acceptable, they may be located overhead.	*Generally results in poor heat distribution, but this may be acceptable in some situations where comfort levels are not critical.*

4.3 HYDRONIC HEATING SYSTEMS

This is the most commonly used heating system in public sector buildings because of its ability to heat large areas with multiple heating zones. Old boilers often convert less than 50% of their energy into heat compared to gas-condensing or power/fan assisted boilers which can obtain seasonal efficiencies ranging between 83% and 90%. "Low NOx" boilers also reduce emissions substantially.

Recommendation	***Rationale***
4.3.1 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 is intended to ensure that the heating plant capacity will not exceed the actual building-heating load. The heating plant will operate more efficiently when not oversized.*
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.*
Only retention head type burners are to be used.	*They are the most efficient burners available.*
The high limit control on boilers is 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 shut down until the high limit is reset manually. If not reset promptly, considerable damage could result to the building from frozen piping and fixtures.*
Single stage firing arrangement (not high. low) is required on boilers.	*During extreme cold conditions, single stage firing reduces the danger of damaging boiler venting from condensing products of combustion.*
Consideration should be given to installing hour meters on each boiler.	*Provides runtime indication to operating personnel for lead/lag operation and maintenance.*
The use of Viessmann boilers should be considered to allow lower operating water temperatures.	*Water temperatures below 60°C are not possible in regular cast iron boilers due to condensation. Significant energy savings may occur when lower temperatures are used.*

4.3.2 Combustion Air

Recommendation	***Rationale***
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.	*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 8139, considering that special engineering practice is necessary in the extremely cold climate of Nunavut. Calculations are to be based on maximum heating loads, not including standby generators.	*Combustion air intakes are commonly oversized and more cold air than necessary is brought into 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 is recommended to recognize the expansion* of *cold air to demand temperature.*

4.3.3 Circulation Piping

Insulation is required on all circulation piping located in mechanical rooms. 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 removal and replacement of insulation at these locations, in such a way that it does not damage adjacent pipe insulation.*

4.3.4 Distribution

Wall Fin Radiation. Wall fin radiation is the preferred heat exchange system.	*It is the heating exchange system most frequently used, and most familiar to the 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. 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.*
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.	*Force flow heating units provide quick heat recovery in high traffic areas, such as entrances.*
Heating is controlled by cycling the fan and/or a control valve.	*The control valve is necessary to prevent overheating of the spaces.*

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 body contact with the floor will be usual (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.

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.

4.3.5 Provisions for Monitoring Performance

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".

Thermometers. Provide thermometers scaled to the application intended in the following locations:
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 3-way control valves

Thermometers installed in appropriate locations assist the building operators in system operation and performance evaluation.

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.

Gauges. Provide dial type pressure gauges located to measure pump suction and discharge pressure of each pump.

4.4 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 tolerated. 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 airflows can provide adequate ventilation without adding to the mechanical and electrical complexity of a building. For occupied buildings that require ventilation, mechanical ventilation may be the only practical alternative during the heating season however; natural ventilation measures should be considered foremost. Systems that require the opening of windows or portholes as part of the mechanical ventilation system may be unsatisfactory due to the large temperature differential during the heating season.

Recommendation	***Rationale***
4.4.1 Supply	
Whatever the means of supply air. It must prevent entry of snow and dust. Any filters or screens required to do so must be easily accessible and easy to clean. Loacate supply air source well away from oil tanks, sewage pump outs, parking lots and other source of odour and toxic gases.	*Ventilation hoods are often used in place of operable window sections. They are typically used for residential occupancies or small offices where users are capable and willing to control ventilation. Operable windows are preferred for summer use buildings only.*
4.4.2 Exhaust	
Exhaust must be located to create an even flow of fresh air through rooms, without creating uncomfortable or disruptive drafts. Exhaust is to be located well away from the supply source, eliminating any possibility of cross-contamination	*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! As stipulated for natural air supply, users must be capable and willing to control exhaust.*

4.5 MECHANICAL VENTILATION

Most public use buildings are too large or configured in such a way that natural ventilation systems are not feasible. Consequently mechanical systems are needed to ensure that adequate ventilation is provided in most public sector buildings. The climate also makes mechanical means of ventilation preferable for much of the year. The quantity and temperature of outdoor air brought into a building needs to be adjusted frequently to suit changing outdoor conditions and indoor requirements. Automatic controls can perform this function for the building users, while keeping simplicity in mind as an O&M objective.

Recommendation	***Rationale***
4.5.1 Choice of Systems	
Natural air supply and mechanical exhaust: Limited to use in residential or seasonal use buildings.	*The system relies on the users. It generally consists of opening windows for supply and turning on kitchen or bathroom fans for exhaust. It is considered unsuitable for buildings used by the public, or by groups of people who will not likely take on responsibility of controlling ventilation, or be concerned with energy conservation.*
Mechanical air supply and natural exhaust: 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's not considered suitable for public use buildings, or for groups of people who will not likely take on responsibility of controlling ventilation, or be concerned with energy conservation. This approach has been*

Recommendation	***Rationale***
	used in several recent school projects with unsatisfactory results.
Mechanical air supply and mechanical exhaust: To be used in most buildings. A two-fan system is required.	*Both supply and exhaust can be automatically controlled using temperature sensors and time clocks and do not rely on users. Although improper maintenance, or operational difficulties (which may be design related) can lead to user complaints, this is not a problem exclusive to mechanical systems.*

4.5.2 Outdoor Air Supply

Supply. A minimum of 7 litres per second (15 cfm) of outdoor air per person is required, based upon the 'normal' occupancy of the building. This applies to non- smoking occupancies as the norm.	*This is a requirement of ASHRAE 62-1989. Ventilation systems are to be sized to provide ventilation to the area served based upon the normal occupancy of that area. Ventilation systems sized for the occasional peak occupancy within gymnasiums or community/ assembly halls, result in oversized heating plants and ventilation equipment, which have higher capital costs, higher operating and maintenance costs, and are inefficient as well.*
Free Cooling. Air volumes and system arrangement must allow up to 100% outdoor air to be used for preventing overheating of occupied spaces. Do not preheat outdoor air .	*Most new buildings are very energy efficient, and even at quite low temperatures (i.e., -10°C to -15°C), there maybe a need to cool the building during occupied hours in order to dissipate internal heat gains from lights, equipment and people.*
Outdoor Air Intakes. Outdoor air intakes must be provided with downturn hoods designed to eliminate the potential for the system to draw snow in or to become blocked by snow.	*This is intended to 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, the location of outdoor air intakes is critical. Location of roadways, parking and service points and prevailing wind to the building must be considered at design.	*Many problems and even closure of buildings have recently occurred when vehicle exhaust, diesel fumes, sewage gases and products of combustion were drawn into the building through the outdoor air intakes.*
Considerations should include:	
Intake hoods to have sufficient vertical length (minimum 600 mm) and velocity (maximum 1.5 *mls).*	*To ensure contaminants including snow, wind and insects do not enter the ventilation system, these parameters should be considered.*
Hoods 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 the potential for snow entry during windy conditions.*

Recommendation	***Rationale***
Hoods mounted high enough to avoid becoming blocked by snow accumulations expected in the selected location.	*A review of snowdrifting patterns must be done when locating the air intake, as drifts may impede system operation for many months of the year. Setting the hood out from the wall reduces the potential for snow entry during windy conditions.*
Outdoor air intakes 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.	*This reduces the chance of bringing in objectionable odours, vehicle exhaust or flue gases from chimneys, with the outdoor air.*
Dampers. Outside air dampers are to be low leakage type.	*This limits the infiltration of outdoor air.*
Insulation. Insulate outdoor air ducts using external duct insulation.	*The use of duct liner in an outside air intake duct contravenes current ASHRAE recommendations*

4.5.3 Air Mixing

Packaged mixing boxes are not recommended.	*Conventional equipment is designed for conditions typical of the southern portion of Canada or the central U.S.A. In Nunavut, where outdoor air temperatures may be as low as -50°C, mixing of cold outdoor air with room temperature air is more difficult than standard equipment is designed to handle.*
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°Cfrom one point to another should be achievable.	*Supply air is a mix of fresh outdoor air and return air from within 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 is not thoroughly mixed when they arrive at this sensor, it will be reading 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. Refer to notes in Appendix B*.
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 physically above the warmer (return air) point of connection.	*This promotes the mixing of warm and cold air by taking advantage of the principles of convection.*
use opposed blade type dampers	*This promotes the mixing by directing streams of air towards each other.*
locate connection points at least 3 metres upstream from the heating coil with at least one	*This practice gives air more distance in which to mix before reaching the heating coil.*

Recommendation	***Rationale***
duct elbow before the mixed air duct connects to the air handling apparatus.	
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 mixing is important to enable air handling systems to operate normally, without nuisance tripping from low temperature controls. Effective temperature control is difficult to achieve without good mixing.*
Exhaust, relief air, and outdoor air ducts are to be insulated for a length of 3 metres from the connection to the louver.	*Insulation prevents the formation of condensation on ductwork that is exposed to cold outdoor air when the system is operating or shutdown.*

4.5.4 Air Distribution

Diffusers. 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 supply registers located along the longest interior wall, blowing towards the perimeter wall, is an acceptable alternative.	*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 incorporate balancing dampers, which are easily adjusted, possibly resulting in avoidable air balance problems.*
Air diffusers located in the floor and blowing through the baseboard radiation, are unacceptable.	*Air supply through the baseboard radiation does not permit proper air diffusion and temperature control.*
Dampers. Balancing dampers are required on all main branches at each branch duct takeoff. Dampers to be in-line mounted, and locking quadrant type. Splitter dampers are not acceptable for use as a balancing device. Volume control dampers at diffusers are not an acceptable means of controlling air volume.	*Line mounted dampers provide a reliable means of balancing. 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 placed adjacent to supply outlets contribute to high noise levels because of the high velocity of air at that point.*
Flexible Ductwork. Flexible ductwork shall be limited to short lengths within one metre 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 excessive lengths of flexible ductwork create air delivery problems by increasing pressure drops in the ductwork, and in many instances when fastened with duct tape, the tape falls* off.

Recommendation	***Rationale***
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 lined up with the fan inlet or outlet and the flexible connection does not obstruct the air flow.	*Flexible connections reduce the noise and vibration from the fan equipment from being transmitted through the building structure to the occupied spaces. The fan performance is adversely affected if the ductwork connection is offset, or if the flexible connection projects into the air stream. This results in increased energy consumption* as *well* as *reduced fan performance.*
Branch Take-off Ducts. Branch take-off ducts to each air supply or exhaust outlet are to be a minimum 0.5 metre, located in an accessible location with a duct mounted balancing damper positioned near the take-off fitting.	*Supply or exhaust (return) air outlets that are mounted directly on the main branch duct work tend to have uneven velocities, and are noisy and uncontrollable. Balancing dampers located too close to the actual air outlets cause noise.*
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 as it loses adhesive properties, particularly on cold ducts.*
De-stratification Fans. Consider use of de-stratification ceiling fans inapplicable high ceiling areas (i.e., garages, theatres, etc.) Size for total area coverage. Provide protective guards over fans where they may be subject to damage.	*Allows for better tempered air distribution during heating and cooling seasons. Reduces energy cost and improves space comfort*
4.5.5 Air Exhaust	
Location. Outdoor exhaust vents are to be located where they will not be susceptible to snow accumulation, or discharge directly into prevailing wind. Avoid locating in vicinity of the outdoor air intake (i.e., within 10 metres).	*Snow accumulation can hamper or eliminate exhaust capability. A review of snow drifting patterns must be done when locating exhaust, as drifts will impede system operation for many months of the year.*
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 possibly closing off the exhaust opening.*
Local Exhausts. Local exhausts should be provided in all rooms and spaces where high levels of contaminants or odours are generated. Recirculating exhaust systems, such as rangehoods, are not acceptable.	*They are typically provided in industrial arts rooms, change rooms, washrooms and kitchens. If the recirculation air filters are not maintained, the system tends to be ineffective.*
Individual major exhaust fans are to be interlocked with the air handling system.	*Unless air is being brought in at the same time it is being exhausted from the building, a strong negative pressure can be created in the building.*

Recommendation	***Rationale***
Local exhaust fans must not discharge into boiler rooms.	*Unstable draft conditions will affect burner combustion efficiency.*
Areas having manually controlled exhaust fans are to be provided with timed switches.	*This avoids the possibility of exhaust fans being left operating unintentionally for long periods of time.*

4.5.6 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.	
500 mm x 500 mm access doors are required for: exhaust air dampers return air dampers filters, coils balancing dampers mixing boxes reheat boxes turning vanes	
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 operating or not.	*It must be possible to operate the system manually if the three-way valve must be removed for maintenance or repairs.*

4.5.7 Provisions for Monitoring Performance

Balancing. Instrument test holes, drilled on site and sealed with duct plugs, are preferred to test ports for ventilation system balancing.	*Test ports are costly and not required frequently enough to warrant extra expense. Test holes can be drilled on site by the balancing contractor where and as required, eliminating the need for coordination with other subcontractors.*
Adjusting Outdoor Air. Instrumentation must be installed to allow operators to regularly monitor temperatures of outdoor air, mixed air and supply air. Dial type thermometers are preferred.	*By monitoring temperatures. the correct proportions of outdoor air and mixed air can beset to ensure suitable supply air temperature. When this is not possible, users may be subjected to uncomfortable conditions. Other types of thermometers can be difficult to read.*
Each air handling unit is to have supply air, mixed air, return air and outdoor air.	*Provides indication to building operator* of *system performance.*

4.5.8 Heat Recovery Systems

Recommendation | ***Rationale***

Heat recovery ventilators (HRVs) should be used with caution.

Heat recovery ventilators have not proven to be effective in the past. Although the heating of outdoor air may be expensive, the necessary addition of defrost coils, preheat coils and associated controls reduces the effectiveness of the HRV, making the payback period unacceptable. There are new models of HRVs on the market today that may be effective; however, care must be taken to ensure they are specified correctly and installed correctly for them to work effectively.

4.5.9 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.

Mechanical and boiler rooms operating at continuous high temperatures will shorten the service life of mechanical and electrical components, and create uncomfortable working conditions for operation and maintenance personnel.

4.6 AIR CONDITIONING

Although outdoor air temperatures can rise above comfortable indoor levels during the summer months, the additional cost of providing air conditioning is rarely justifiable for the short period of time it will be required. There are instances, however, where it may be justified because important normal operations would otherwise be disrupted.

Recommendation | ***Rationale***

4.6.1 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 M8.2.2 "Outdoor Air Supply" reference to free cooling) will produce supply air above 18°C for an extended period of time, the need for cooling equipment should be reviewed.

Where air conditioning is installed, equipment must be designed in conformance with the ACNBC Canadian Heating, Ventilation and Air Conditioning Code.

Provision must be made for the proper shutdown in fall and startup in the spring.

4.6.2 Humidification

Humidification is not typically required or recommended in public sector buildings.

Humidification systems in the North have historically proven to be very difficult to operate *and maintain because of poor water quality in many communities, and because of the continual attention required to ensure efficient and proper operation. During extremely cold outdoor temperatures, the humidification levels in a building must be kept low to prevent excessive condensation on windows and to prevent deterioration of the building envelope. This reduces the benefits 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 regularly malfunction due to calcium build-up. A *proper water supply to the humidification system is required to ensure long term system operation.*

N5 BUILDING CONTROLS

Building automation systems (BAS) can reduce operating costs by automatically controlling the heating/cooling, ventilation, air quality, lighting and security systems. Systems vary – some are designed to respond to tenant requests for after-hours control of heating, ventilation and air conditioning (HVAC), and lighting for specific building areas (e.g. Tracer Summit®, Metasys®, BACnet etc.). Others consist of distributed controllers, transducers and sensors, combined in one local network which is managed from one computer centre so that it is possible to monitor, adjust equipment and control energy used just about anywhere in a building (e.g. Continuum). The cost of computerized controls has dropped significantly. The quantity and complexity of sub-systems however, must be great enough to warrant the cost which ranges from $50 to $300 per point, depending on the mix of included points. BAS can also be combined with the installation of electric demand controls on large electrical loads to prevent their operation during periods of high electrical demand Snow and ice-sensing controls installed on garage ramps operate ramp heaters only when they are required.

Higher energy cost coupled with growing concerns regarding Indoor Air Quality have placed increased demands on energy recovery and control system technologies. A method of maintaining good indoor air quality and conserving energy is to control the ventilation rate according to the needs and requirements 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.

5.1 GENERAL

Recommendation / ***Rationale***

5.1.1 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. Consideration should be given when weighing

Reduces size of *primary load equipment (i.e., boilers, chillers, burners, pumps, etc.), thereby reducing overall energy consumption. In many new buildings, the cost savings resulting from the reduction* of *cooling tonnage and/or heating*

Recommendation	*Rationale*
possible marginally higher installation costs versus overall operational cost reductions, especially on smaller systems. Provide the client/user with a capital cost recovery summary as part of the system design and analysis.	*equipment size, alone offsets the initial cost* of *thermal recovery units.*

5.1.2 Energy Recovery Devices

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*.
Use counter-flow type energy recovery equipment only.	*Generally, counter-flow provides the greatest temperature difference and heat transfer rate across the recovery exchanger.*
Pending location and/or owner preference, the designer shall consider and weigh all advantages and disadvantages associated with the following three main types: Fixed Plate; Heat Pipe and Glycol Run Around Loop.	*When selecting, consider such factors as installation and operational costs, ease of operation, simplicity and maintenance, etc.*

5.1.3 Demand Control Systems

On large volume systems (i.e., greater than 4000cfm), maximize usage of demand control ventilation (DCV) systems using 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 years.*

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. A VFD should be rated to match the electrical characteristics of the motor, the starter and the circuit protection.	*The use of a VFD to control mechanical equipment that has fluctuating patterns of use can result in energy savings. The Mechanical Designer will determine the need for a VFD, and it is the responsibility of the Electrical Designer to ensure that its installation is in accordance with electrical codes and standards.*

5.2 AUTOMATIC TEMPERATURE CONTROLS

An automatic temperature control system properly designed, installed, maintained and operated provides the best possible occupant comfort and the most efficient mechanical system operation.

Recommendation	***Rationale***
5.2.1 General	
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, especially in more remote communities.*
Pneumatic control systems may be used where approved specifically in combination with electronic or direct digital control (DDC) systems. The sensing and logic is to be done electronically: the controlled devices are to be operated by pneumatic operators.	*Although pneumatic control systems are more complicated and prone to failure from lack of service, they have cost advantages for larger installations and can provide full modulation.*
Direct digital control systems with electronically operated control devices may be used where appropriate.	*The control industry is changing more and more to DDC controls. The systems are now robust enough and easy enough to operate in remote communities. The ability to be diagnosed remotely over a modem has advantages in remote communities.*
5.2.2 Control Components	
General. All controls, regardless of type, are to be calibrated in degrees Celsius, whenever possible. CSA approval is required for all control equipment, including alarm panels.	*The GN has standardized on the metric system. It is confusing to have mixed markings on controls.*
Stand-offs are required for all duct- mounted controls and accessories mounted on externally insulated ducts.	*Stand-offs are intended to keep these items fully accessible for operation and servicing.*
Thermostats and Sensors. Thermostats and/or sensors located in gymnasiums are to be located 2400 mm above the floor and be complete with a heavy duty metal guard.	*Gym thermostats and sensors need to be protected against damage, and the students need to be protected from sharp comers. Gyms are used for public functions, which requires that they have tamper- proof covers.*
In cases where a space thermostat controls a heating control valve and a variable air volume or cooling control in sequence, there is to be a dead band of 2°C between the heating and cooling.	*The intent is to optimize energy consumption by avoiding simultaneous heating and mechanical cooling, or heating and free cooling.*
Thermostats located in public areas must have vandal-proof guards.	*This prevents intentional or unintentional tampering by building users.* *Where there are a variety of users, it is often preferable to allow only maintenance staff to control temperature in public areas of facilities*

Recommendation	***Rationale***
	such as arenas, lobbies, public washrooms, public areas of air terminal buildings.
Locking type thermostats are to be used in public facilities where maintainers only should be able to adjust temperatures. 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 many cases it is more appropriate to allow users to adjust room temperatures (rather than having them rely on maintainers for minimal adjustments). Examples include health centres, staffed areas of schools (offices, classrooms), and community offices. Range limits would protect against over heating.*
Low voltage electric heating thermostats are to be SPST (single pole, single throw, i.e., similar to 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.*
Control Valves. Control valves (i.e., two and three way control valves for heating or cooling coils) are to be sized based on a Cv rating required to provide a pressure drop of 21 kPa or other to ensure that there will be no 'hunting' at low flow rates.	*Incorrectly sized control valves result in poor controllability.*
Normally open, electrically operated heating zone valves are to be used. Do not use thermostatic valves.	*This allows for flow through heating system in the event of an actuator failure. Thermostatic valves are not recommended as they require ongoing calibration.*
Flow Switches. Flow switches are to be vane type on piping 50 mm and smaller. Paddle type flow switches will be acceptable on larger piping.	*On smaller piping sizes, paddle type flow switches are difficult to install properly and do not function we". The sensitivity cannot be adjusted, resulting in nuisance alarms.*
Control Transformers. The number of control devices, i.e., low voltage electric zone control valve for heating radiation, is to be limited to 3 devices for each 40 V A transformer.	*Limiting the number of control devices on a circuit avoids excessive voltage drop for each controlled device and premature failure.*
Damper Actuators. Independent damper actuators are to be appropriately sized and installed on each outdoor air, return air and relief air control damper.	*Where a common damper actuator is used a long connecting rod is sometimes required, which is nearly impossible to set up, and the quality of control is reduced.*

5.3 VENTILATION UNIT CONTROL

Recommendation	***Rationale***

5.3.1 Outdoor Air

The amount of outdoor air brought in to the system is to be controlled by a mixed air temperature sensor with minimum 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.

5.3.2 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 user areas and will therefore be at or above 20°C. If for any reason it 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.

5.3.3 Supply Air (Mixed Air)

A supply air controller is required to control the temperature of the supply air to between 13 - 16°C. 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 18°C for extended periods of time, the need for cooling equipment should be reviewed. See Mechanical M8.3 "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 avoids inaccurate measurement by averaging colder or warmer air streams.

An automatic reset type freezestat located downstream of the heating coil must be provided and set at 2°C.

The automatic reset type freezestat is required to reduce the likelihood of air handling systems shutting down and remaining off during cold weather extremes.

5.3.4 Heating Coils

The thermostat controlling the heating coil in each AHU (air handling unit) should be located a minimum of three metres downstream of the coil in the supply air duct and preferably downstream of the supply fan.

The distance from the coil ensures the thermostat 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, resulting in the overheating of occupied spaces.

Electric, modulating controls are preferred for heating coils. and 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 preferred) *when it is not required, and often the result is overheating.*

5.3.5 Time Clock

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 user-activated control, provide a 7 day programmable time clock c/w quartz control clock and battery back- up.

This is intended to ensure that mechanical equipment is programmed to operate only during occupied periods and to shut down during unoccupied periods. It also reduces operating and maintenance costs.

5.3.6 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.

A typical ventilation control strategy for all vent units across Nunavut will provide some consistency in operation and maintenance.

5.4 HYDRONIC HEATING CONTROL Hydronic Heating Control

Recommendation / ***Rationale***

5.4.1 Radiation Control

The radiation zone is to be controlled by a low-voltage room thermostat controlling the normally open two-position control valve.

This provides 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 'run wild.'

The small additional initial cost of *providing control is much less than the long-term energy savings, given the high cost* of *heating energy.*

5.4.2 Force Flow Control

The force flow unit is to be controlled by a line voltage, low-range, wall- mounted thermostat complete with locking metal guard. 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.

5.4.3 Unit Heater Control

Recommendation	***Rationale***
The unit heater is to be controlled by a line voltage, low-range, wall- mounted thermostat complete with locking metal guard.	*This provides a 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.	

5.4.4 Boiler Temperature Control

Provide indoor/outdoor controls for boilers with 2 or 3 step settings.	*Seasonal adjustments to boiler temperatures can occur automatically (increased in cold weather, decreased in warmer weather), thereby increasing energy efficiency.* *This could be problematic if domestic HW were dependent on boilers; however, dedicated HW tanks are now required (see GBP M4.3).*

5.5 HEAT RECOVERY FROM NPC POWER PLANTS

The GN has Memorandum of Understanding (MOU) with Nunavut Power Corporation in regards to recovering heat from NPC power plants. This MOU provides for heat recovery systems to be provided by NPC, who will meter and charge the building owner for the heat provided. The charges for the system will result in an immediate 10 to 15% saving to the building that will remain until NPC recovers the cost of the system. Once the costs are recovered. the energy charge will be further reduced.

Some of the benefits of residual heat systems are:

Direct Cost Savings. Where the total costs of building and operating a residual heat distribution system allow the energy to be sold to the customer at a rate that is less than the customer's cost of equivalent heating fuel, a direct savings is realized in annual building operating costs. If a system can provide enough energy to significantly reduce operation of the customer boiler system, the customer may realize a savings in boiler maintenance and/or capital investment costs.

Once the capital costs of the system have been recovered, energy charges to the customer can be reduced, allowing greater savings to building operators.

There is often a direct benefit to NPC realized in lower station service requirements due to less frequent operation of radiator fans. This can result in an increase in net plant efficiency.

Long Term Community Infrastructure Cost Savings. A system providing thermal energy to buildings normally supplied by oil-fired heat can cause a significant deferral of fuel storage facility upgrades.

Local Economic Benefits. Local economy can undergo a boost during construction by hiring of local forces and increased business to the local hotel, etc.
All of the savings realized, and in some cases a portion of the energy revenue from the system, remain within the Region rather than being spent outside Nunavut on fuel re-supply.

Environmental Concerns. Production of greenhouse gas emissions and other pollutants is directly related to the amount of fossil fuel consumed by the community. A given percentage reduction in consumption of fossil fuels results in an identical decrease in emissions.
There is no increase in electrical production fuel required by the power plant. There is some reduction of transportation and handling hazard, especially where fuel is delivered to the community by truck.

Noise pollution caused by radiator fans is often reduced substantially, especially during the winter, when thermal demand on the system is greatest.

N6 DOMESTIC HOT WATER (HW) SUPPLY

Hot water use 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.

6.1 OIL-FIRED DOMESTIC HOT WATER HEATERS

Recommendation	***Rationale***
6.1.1 Oil-Fired Domestic Hot Water Heaters	
Install Indirect domestic water heaters where the building heating is provided by hydronic heating. This can be utilized in areas where the boilers are not shut down on a seasonal basis.	*This would reduce the requirement for an additional chimney and fuel oil piping to the extra appliance. As the heating boiler is being operated throughout the year, the domestic hot water can be produced at a minimal cost*
Dedicated, oil-fired HW heaters should be used where:	*This type of heater has the lowest operating cost where large quantities of domestic hot water are required, and where it can be tied into the same fuel supply used for the building heating system. They are typically installed in schools and recreation facilities with showers, and in residential facilities including student hostels, long-term care facilities and group homes.*
Fuel oil is used for the building heating system.	*Fuel oil usually costs substantially less than electricity.*
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-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.*

Recommendation	*Rationale*
The high limit control on fuel oil-fired domestic water heaters is to be the manual reset type.	*This provides safety protection shutdowns*
On-demand oil fired heating systems should be considered in applications where the demand for hot water is minimal.	*This minimizes fuel consumption.*

6.2 ELECTRIC DOMESTIC HOT WATER HEATERS

Recommendation	*Rationale*
6.2.1 Electric Domestic Hot Water Heaters	
The use of Electric HW Heaters should be avoided when possible .	*These are typically selected for smaller buildings such as maintenance garages, firehalls, community offices and air terminal buildings with low HW use, in conjunction with forced air heating systems. The use of on-demand oil fired HW Heaters should be considered for these applications.*
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 complexed 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.*

6.3 PROPANE/NATURAL GAS-FIRED DOMESTIC HOT WATER HEATERS

Recommendation	*Rationale*
6.3.1 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.	*Use is restricted to communities where propane/natural gas is available: Propane/Natural Gas are generally unavailable in Nunavut.*

6.4 TEMPERATURE

Recommendation	*Rationale*
6.4.1 Temperature	
See National Energy Code for Buildings, "Measures for Energy Conservation in New	

Recommendation	*Rationale*
Buildings".	
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.	*Recommended by National Energy Code for Buildings Review 2.0, Reference 6.2.5.1(1).*
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 system allows primary domestic HW heaters to be set at lower temperatures to save energy. This is typical for buildings such as air terminal buildings, schools, offices, libraries and service buildings where large volumes of hot water are not required. This is a more cost-effective method of providing tempered water than having two separate domestic storage and distribution systems.*

6.5 PROVISION FOR MONITORING PERFORMANCE

Recommendation	*Rationale*
6.5.1 Provision for Monitoring Performance	
Provide thermometers in domestic hot water supply. Provide pressure gauge(s) at domestic hot water recirculation pumps.	*Thermostats and gauges provide information for the building maintainers to monitor the system's performance.*

N7 MOTORS

Efficient motors minimize energy consumption, eliminate the need for a separate motor starter, improve fan or pump control and extend equipment life.

7.1 CHARACTERISTICS

Recommendation	*Rationale*

Recommendation

Motors must meet the specified minimum efficiencies in Appendix G, unless it can be shown that a lower efficiency motor will yield lower life cycle costs.
Match voltage rating of motor with supply voltages, i.e., use 200 V motors for 208 V services.

Rationale

High Efficiency Motors (HEMs) are manufactured from higher quality materials than standard motors. More care is taken with the design and the geometry of the motor construction. Motor losses are thus minimised and energy consumption is, approximately, 3% less when compared with standard motors. Note that HEMs are also quieter than standard motors.
Although 240 V motors may function on 208 V, experience has shown that they burn out faster than 200 V motors.
HEMs can be justified as cost effective in applications where a motor, which is new or requires replacement, runs for long periods at high loads. Many manufacturers now offer "energy efficient" or "high efficiency" motors as their standard product for no extra cost.

7.2 VARIABLE FREQUENCY DRIVES

Recommendation

Install in conjunction with Direct Digital Control systems for fixed mechanical loads 5 horsepower and larger, or where variable control is determined beneficial by the designer, or where energy savings can be proven (e.g., heat circulation pumps).

Rationale

Variable speed drives can be used to provide a flow which exactly matches the system load. This can lead to a reduction in energy use.

7.3 POWER FACTOR CORRECTION

Recommendation

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.

Rationale

Power factor correction can lower overall power and demand charges from the utility.

N8 HEAT TRACE

Recommendation

All electric heat trace is to be controlled by a temperature controller that limits its operation during high ambient conditions.

Rationale

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 Protection Services Division of Community and Government Services.

Where heat trace is required for water and sewer connections, it should be the self-limiting

This is required for energy efficiency and premature failures of heat trace cable.

Recommendation	*Rationale*
type.	
Both ends of the heat trace should be terminated at the building.	*This eliminates the problem associated with providing a CSA approved end seal in a potentially wet environment.*
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 GN 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.*

N9 HEAT RECOVERY: COGENERATION

Cogeneration is the simultaneous production of heat energy and electrical or mechanical power from the same fuel in the same facility. Cogeneration greatly improves overall system efficiency by recovering “waste heat” from combustion processes that would otherwise be released to the environment. The recovered heat can be used for space heating through a district heating grid and thus offset the total amount of fuel oil required.

Recommendation	*Rationale*
Evaluate the effectiveness of recovering heat from diesel-powered electricity generation. Consider the application of a district heating grid and perform a cost-benefit analysis comparing the cost of implementing the new technology with the amount of fuel oil for heating which would be offset through cogeneration.	*The distribution pattern of buildings in the Nunavut community may constraint the effectiveness of a district heating grid. Buildings need to be in close proximity and the feed lines must be well insulated to avoid subsequent losses. Cogeneration may be better suited to larger (multi-residential, commercial, institutional and industrial) buildings.*

Recommendation	*Rationale*
Unsuitable Applications	
a) Where buildings can be connected to a grid, solar energy technologies that generate electricity should not be installed. b) Systems that use solar energy primarily to	*Renewable energy equipment that is grid connected tends to be accompanied by high capital cost of synchronous inverters to perform the grid link, and by the refusal of utilities to pay fairly for energy supplied. Code requirements and enforcement also add to the*

Recommendation	***Rationale***
provide lighting should not be used when natural daylight can be used to provide adequate lighting.	*cost and complexity.* *In the summer months natural daylight is available. Solar panels are not effective in the winter due to short daylight hours and interference due to snow.*

Suitable Applications

a) 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. b) All electrical loads need to be reduced to an absolute minimum by using the most efficient hardware and appliances available, before renewable energy hardware should be considered.	*The cost of operating and fueling generators in remote locations in the North is usually very expensive. Alternative energy is expensive also, but may be viable because it has very low operational costs.* *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.*
c) Renewable energy should be used to reduce the load on traditional energy sources.	*SolarWall technology preheats intake air and minimizes the fuel oil required to heat air to suitable temperatures.* *Geothermal systems are an effective and proven method of facilitating space heating, and for larger (multi-residential, commercial, institutional and industrial buildings) have very good payback periods.* *Direct combustion to generate energy from waste is an option which both manages solid waste as well as contributes to reducing heating fuel oil requirements. Costs and emissions from incineration need to be carefully considered.*
c) 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.*

N10 BUILDING ENVELOPE

Project managers, designers, and builders of northern buildings need a clear understanding of air and vapour barriers. The requirements of the *National Building Code* are intended to apply to buildings in all parts of Canada. Northern application of NBC requirements can be clarified with further reading and study.

10.1 AIR MOVEMENT, WATER AND VAPOUR PROTECTION

Recommendation	***Rationale***

10.1.1 Control of Rain and Snow Penetration.

Recommendation | ***Rationale***

The requirements of the 1995 NBC 5.6.1 "Protection from Precipitation" apply.

The objective is to ensure that any water vapour that does pass through the vapour barrier is not trapped in the envelope. Water vapour that migrates toward the exterior can be deposited in the envelope as frost over the winter months. The moisture must be able to drain or evaporate during the summer when the frost melts.

10.1.2 Control of Moisture from Ground.

The requirements of the 1995 NBC 5.8 *"Moisture in Ground"* apply.

10.1.3 Control of Condensation within the Building Envelope.

The requirements of NBC 5.5 apply. In addition, a means of venting and draining the envelope to the exterior is recommended.

10.1.4 Air Leakage Rates

The maximum recommended air leakage rate is 1.5 ACH@50pa.

Although the NBC 5.4 *and* 9.25 *require all buildings to have an effective air barrier system, no measurement criteria are provided. Theoretically, this amount of air leakage will not introduce more vapour into an envelope assembly than can be 'managed' on an annual cycle. (See GBPG A3.1.3.)*

10.1.5 Air Sealing

Tests carried out by the National Research Council of Canada on high-rise buildings have shown that 30-50% of heat loss could be attributed to air leakage. Proper air-sealing can save 15% in energy costs with an average payback of 5 years. Air-leakage affects thermal comfort, causes imbalance of mechanical systems and affects the building envelope through moisture migration. Many buildings can greatly reduce their air leakage by sealing following areas:
Conduct air-sealing of the top part of the building (i.e. the upper one third of the building and the mechanical penthouse).

Conduct air-sealing of the bottom part of the building (i.e. the lower one third of the building, the parking area and entrance doors).

Conduct air-sealing of the vertical shafts and elevators.

At the top of the building, isolate and compartmentalize mechanical rooms, weather-strip doors and fire-stop penetrations through rated walls, and reduce the size of cable holes in the elevator shafts and other electrical penetrations through the floor of the elevator rooms.
At the bottom of the building, parking, receiving dock and garbage compaction areas should be isolated. Penetrations into the underground parking areas such as unsealed cable conduit ducts, pipe penetrations and gaps between block infill and slabs should be sealed. Doors should be weather-stripped.
Other areas needing attention include fire cabinets, garbage disposal rooms, electrical rooms and other vertical service shafts. Sealing of vertical shafts decouples floor to floor and reduces stack pressures.

Recommendation	***Rationale***
10.1.6 Rainscreen Principle	
Building envelopes are to be designed in accordance with the 'Rainscreen Principle' (pressure equalization practice):	*The objective of the Rainscreen Principle is to ensure that wetted exterior surfaces of walls are not subjected to constant air pressures. Constant air pressure can force water on the exterior surface of the wall to move into the interior portions of the wall materials through construction joints or other fissures. Refer to CBD-40: "Rain Penetration and its Control.* "
a drained and ventilated air compartment is recommended between the exterior water shedding cladding and the sheathing of the wall.	*The compartment behind the exterior wetted cladding is vented to allow the face and back of the cladding to be at the same air pressure. The venting allows air-drying of the compartment and of both faces of the cladding. The compartment is intended to keep the sheathing from being wetted.*
divide all cavities behind the exterior cladding into pressure equalization compartments (i.e., into zones of air pressure equal to exterior air pressure) no more than one storey in height. and no more than 6 m wide along building faces. At comers, 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 airflows developing, and therefore the likelihood of wetting the sheathing. Pressure equalization compartments must also incorporate openings to provide the drainage required by NBC* 5.6.2.1.
10.1.7 Materials and Assembly	
.1 Vapour Barriers. Materials or the assembly of materials making up the vapour barrier must be:	*(See GBGP A3.1.3) "Control of Condensation within the Building Envelope.* " *The purpose of* a *vapour barrier is to restrict diffusion (water vapour movement through the materials of the assembly).*
durable	*To meet or exceed the service life of the building.*
impermeable	*To meet the requirements of the NBC and reference standard CAN/CGSB* 51.33 *or* 51.34.
compatible with other building components	*Differences in chemical composition, creep behaviour, elastic movement, thermal expansion, shrinkage, and moisture changes could result in reduced permeability or durability of the vapour barrier.* *To meet requirements described in GBP A3.1.3.) Materials with low vapour permeance, such as plywood sheathing or rigid foamed plastic insulation, can act as a barrier to vapour that is passing through the assembly. The*

	vapour must be allowed to migrate to the exterior by open joints between sheets, or by perforating the material, or it will risk becoming trapped between water vapour tight layers.
The building envelope must be designed so that multiple vapour barriers are avoided.	*Any material with a low permeance rating that is located on the low vapour pressure side of the insulation cavity, must be installed in such a way that vapour can migrate past it to the exterior.*
If the vapor barrier consists of poly installed inside the framing of the structure:	
Set staples fastening vapor barrier to structure at 2‘ centers.	*To minimize penetration.*
Ensure continuous solid backing behind joints in the vapor barrier so the joint will be trapped between the backing and drywall, effectively sealing it.	
Apply a thin bead of acoustic caulking to all studs and plates where they contact the vapor barrier.	*The caulking will seal any punctures made by staples, nails and drywall screws. This will also create separate dead air chambers in the wall. If there is a penetration, the air leak will be contained in a single stud bay, rather than traveling along the wall.*
Leave slack in the vapor barrier when installing it, especially in the corners.	*It is common for drywall screws to pull through the drywall, tearing the poly if it is so tight in a corner that it holds the drywall away from the framing. When this occurs, it is extremely rare that the drywall is removed to repair the poly.*
Do not allow the use of hammer staplers when fastening vapor barrier.	*These easily tear the poly*.
Use acoustic caulking in all joints and penetrations of the poly.	*Tape does not always bond well to dusty or cold poly, and wrinkles in poly or tape can cause air leakage.*
If poly is inside framing, use 2"x 2" strapping or equivalent fastened horizontally to the studs and on top of the poly. A semi rigid insulation may be installed in this void.	*The insulation will increase the R-value of the wall. More importantly electrical boxes and wiring needn't penetrate the poly improving the seal, and drywall screws fastened to the 2"x 2"s won't "pop" as much due to wood shrinkage. If a drywall screw misses the framing, it won't puncture the poly. There is a great reduction in thermal bridging between the drywall and the wall studs.*
In 2 story structures, consider hanging the 2 nd level floor joists instead of sitting on the top plate of the wall.	*The poly can be installed continuous behind the floor joists. This eliminates the practice of wrapping the box sill with poly, which puts the vapor barrier on the wrong side of the*

insulation causing condensation problems. Also thermal bridging through the floor system is decreased. Sometimes rigid foam insulation is fitted between the floor joists and caulked to create a seal and become part of the vapor barrier. This is very labor intensive and there are numerous joints to seal, decreasing the integrity of the building envelope.

The caulking will seal any punctures made by staples, nails and drywall screws. This will also create separate dead air chambers in the wall. If there is a penetration, the air leak will be contained in a single stud bay, rather than traveling along the wall.

.2 Air Barriers.

Materials, or the assembly of materials making up the air barrier system, must be:

The purpose of *an air barrier system is to restrict air movement.*

durable

To meet or exceed the service life of the building.

impermeable - Acceptable leakage rates for the complete air barrier system are noted in GBP A3.1.4. The air leakage rates of some common building materials and assemblies can be found in Appendix D.

To minimize the movement of air through the barrier. An air barrier system, consisting of air leakage resisting 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 should therefore typically be greater than the air leakage resistance of the complete air barrier system.

Materials employed in the construction of the air barrier system should have air permeance values no more than 1/10th of the air leakage rate allowable for the complete 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 noted in GBPG A3.1.4.*

Continuous - Pay special attention to joints, corners and penetrations.

To ensure that there are no leaks and that all parts of *the building envelope restrict air leakage to a similar extent. An opening at anyone location is a failure* of *the entire system.*

Rigid and Strong - To withstand both positive and negative air pressures due to wind, mechanical equipment and stack effect in accordance with NBC 4.1.8. Air barriers must be designed to transfer such pressures to the structural framing while undergoing 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. The structural performance of many common materials and assemblies can be found in "Structural Requirements for Air Barriers" CMHC report No. 30133.0R1.

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.

10.1.8 Location of Air Barriers and Vapour Barriers

Coincident air/vapour (A/V) barriers located on the outside of structural framing are recommended. Plywood sheathing located on the exterior of the structure with the joints sealed with torched on modified bitumen strips has been found to be an effective coincident A/V barrier.

By locating the A/V barrier (and thus the insulation) on the exterior of structural framing, rather than on the interior, the following can be achieved:
the potential for damage to the structure due to condensation is virtually eliminated
interior finishes can be applied directly to structural framing (no need for additional strapping or protection for the A/V barrier}
penetration of A/V barrier by mechanical and electrical systems is reduced to those elements that must exit the building
with fewer penetrations and use of rigid air barrier materials, a good quality installation is simpler to achieve.

Coincident A/V barriers located on the inside of structural framing are acceptable. except as noted under GBP A3.6.3.2.

Common practice for smaller buildings, and although this assembly meets the requirements of the NBC for vapour protection, it requires that a number of precautions be taken including:
plumping and electrical wiring routes in exterior floors, walls and roofs must be carefully detailed to minimize A/V barrier penetrations
interior strapping or other means of attaching finish materials may be provided to accommodate electrical wiring and outlets without the need for air/vapour barrier penetration

10.1.9 Sealants

Sealants used as part of the air barrier system of the exterior wall assembly must be:

The performance of sealants is dependent on choosing the correct sealant for the substrate as well as application under acceptable temperature and moisture service conditions.

serviceable to -50°C in their fully cured state
able to be installed under conditions to be encountered during their installation
strong enough to resist the anticipated loads without deforming or moving out of position.
elastic and compressible to accommodate movement of the joint
chemically compatible with adjacent materials
accessible for service
placed in primed joints of proper dimensions with backing rod or bond breakers

Construction typically occurs during cool or cold temperatures in Nunavut. Silicone and elastomeric sealants are available that can be applied at sub-zero temperatures and remain serviceable at temperatures down to -50 "C. Many other sealants cannot be properly applied at sub-zero temperatures and lose their ability to fulfill functional requirements at cold temperatures.
See also "Canadian Building Digest #155 Joint Movement and Sealant Selection."

Silicone or one component elastomeric types that meet the above criteria are recommended. Acrylic and solvent curing types are not recommended.

10.2 THERMAL RESISTANCE

The thermal resistance of the building envelope serves two important functions: to minimize heat loss energy consumption, and to prevent moisture condensation on the interior skin of the building envelope.

Recommendation / ***Rationale***

10.2.1 Recommended Values

The standard for thermal resistance of exterior building envelope assemblies typically is recommended to be:
Floors: RSI 7.0
Walls: RSI 4.9
Roofs: RSI 7.0

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 values provided are benchmark values. Thermal resistance of the building envelope is best determined by life-cycle cost-benefit analysis. Such analysis may determine lower or higher thermal resistance to be appropriate for a given building.

However, 1995 ASHRAE Standards increased required ventilation rates. Heating the higher volume of cold outside air shifted the balance of heating load away from envelope losses. In buildings where ASHRAE standards apply, capital costs may be minimized by reducing envelope R values in consultation with the Client Department and the Consulting Engineer.

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.

In buildings or portions of buildings not intended for typical human comfort conditions. Thermal resistance values may be lower and still meet energy consumption standards.

Seasonal use buildings may have reduced insulation specifically designed for the period of the year they are to be occupied.

Recommendation	***Rationale***
10.2.2 Location of Insulation	
All insulation should be located on the cold side of the coincident A/V barrier system.	
a) Where the coincident A/V barrier is located on the exterior side of the structural framing, rigid or semi-rigid insulation should be used.	*Insulation applied to the exterior of the building structure provides a uniform insulating value over the entire building envelope. Compressible inorganic insulation can also be used, provided it is protected, drained and vented to keep it dry as required by NBC* 5.3.1.3.
b) Combustible insulation should be appropriately fire-stopped.	
c) Where the coincident AV barrier is located on the interior side of structural framing, compressible inorganic 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 GBPG A3.2.3).	*The overall thermal resistance of the assembly is reduced by the structural members. Their thermal bridging effect should 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.*
d) In small buildings, it may be advantageous to locate the vapour barrier 1/3 rd of the way into the insulation from the inside.	*This allows an interior strapped and insulated space on the inside of the air/barrier and structural stud system.* **This method should be approved by the Authority's technical services Representative.*
10.2.3 Continuity of Insulation	
Thermal bridging by structural members needs to be recognized and minimized in the building envelope design.	
Where insulation is installed outside the structural framing, it should be installed in 2 layers at right angles. The insulation may be secured with 2 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.*
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 building*
10.2.4 Localized Low Temperature	
Layout of spaces and detailing of assemblies	*The location of furniture, fixtures and fittings*

Recommendation	***Rationale***
should avoid spaces or compartments that are not readily heated. Concealed spaces that are located on the warm side of the A/V barrier may require transfer grilles to heat the space and keep the surfaces above dew point.	*can restrict the convection of heat within a space so that some surface temperatures on the warm side of the A/V barrier may drop below the dew point.* *Particular attention should be focused on corners that have large exposed exterior surface area relative to small interior surface area, and to spaces where supplies are stored against exterior walls.*

10.3 BUILDING FLOORS

Where northern buildings are elevated, floors assemblies have an exterior surface on the underside.

Basements or concrete foundations are possible in only a few locations and for certain uses. On permafrost sites, foundation bearing capacity can be maintained by artificial cooling of the ground. Induced draft cold air systems, powered refrigeration or thermosyphon refrigeration are techniques that have been used to keep permafrost intact beneath heated buildings.

Recommendation	***Rationale***
10.3.1 Air Movement, Water and Vapour Protection	
All recommendations of GBP section A3.1 apply to building envelope floors.	*Clarifies criteria to be used in evaluating floor assemblies with respect to NBC requirements.*
All building envelope floors subject to differentials in temperature, water vapour pressure or air pressure require air barriers (AB) and vapour barriers (VB) meeting the recommendations outlined in GBPG A3.1.3 and A3.1.4.	*Floors above open crawl spaces are common in permafrost and discontinuous permafrost zones in the North. Suspended floors provide opportunities for air leakage, snow infiltration and water vapour diffusion, not normally found in floors.*
10.3.2 Thermal Resistance	*See GBPG A3.2.*
10.3.3 Materials and Assembly	
.1 Air/Vapour Barrier	
A false floor should be considered wherever insulation is located within the structural framing of a suspended floor and the comfort of users is a consideration, or where space is required to accommodate plumbing. See GBPG A3.1.6.	*A false floor will reduce heat loss due to thermal bridging through the floor joists. A false floor is suggested for residential and institutional facilities such as group homes, and elementary schools where children can be expected to be sitting on the floor. Drains and water supply pipes should not be placed within a suspended floor system, just as they should not be installed within exterior walls in northern buildings.*
.2 Sealants	*See GBPG A3.1.6.4.*

Recommendation | ***Rationale***

.3 Insulation

See GBPG A3.2.

10.3.4 Drainage and Ventilation

GBPG A3.1.1 and A3.1.3 address precipitation and water condensation management.

Joints of the exterior soffit finish should not be sealed in an effort to create an external air barrier. Plywood resists water vapour migration so as to create a vapour barrier if the joints are sealed, creating a second vapour barrier in the floor. See GBPG A3.1. 6.4.

10.3.5 Thermal Break

A thermal break should be provided between foundation units and bearing stratum, where highly conductive structural materials are used. See GBPG S3.

To minimize heat loss from building to frozen soils, and to prevent cold spots due to thermal bridging in the building envelope.

10.4 BUILDING 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, and electrical conduits. Care must be taken to make the air barrier system in walls continuous at all openings and penetrations, and at joints with floors and roofs.

Recommendation | ***Rationale***

10.4.1 Air Movement and Water and Vapour Protection

All recommendations of GBPG A3.1 with the exception of A3.1.2 apply to building envelope wall assemblies.

Clarifies criteria to be used in evaluating wall assemblies with respect to NBC requirements.

All walls forming part of the building envelope require air leakage barriers and vapour diffusion barriers meeting all requirements outlined in GBPG A3.1.3 and A3.1.4.

Although this applies primarily to exterior walls forming the building envelope internal walls that subdivide buildings may also be subject to differential temperature air and water vapour effects. Examples include community arenas or combined office/warehouse and office/firehall buildings.

10.4.2 Thermal Resistance

See GBPG A3.2.1.

10.4.3 Materials and Assembly

.1 Air/Vapour (A/V) Barrier - See GBPG A3.1.6.3. and A3.4.3.5.

Note that continuity of the A/V barrier must be provided, including special detailing where roof or floor A/V barriers are located on a different plane from that of the walls.

.2 Sealants

See GBPG A3.1.6.4.

Recommendation	***Rationale***
.3 Insulation	*See GBPG A3.2.2 and A3.2.3.*
.4 Drainage and Ventilation	*To meet NBC 5.6.2.1 requirements, including application of the Rainscreen Principle. See GBPG A3.1.5.*
10.4.4Heated Crawl Spaces with exposed grade	
Careful detailing is required to eliminate any transfer of freeze/thaw soil movement to the envelope and/or structure	*Compressible 'void former' may be considered at interface of grade and insulating walls or grade beams. Note that the wall A/V barrier must be sealed to an interior protected grade A/V barrier. See also GBPG S3.1.5.*
10.4.5 Mechanical Room Walls	
Heat Transfer. The preferred means of reducing heat transfer from mechanical rooms to 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 public buildings such as schools or health centres.*

10.5 BUILDING ROOFS

Recommendation	***Rationale***
10.5.1 Air Movement, Water and Vapour Protection	
All requirements of GBPG A3.1, with the exception of A3.1.2, apply to roof assemblies. All roofs are subject to differentials in temperature, water vapour pressure and air pressure, and as such require air barriers and vapour barriers meeting all requirements outlined in GBPG A3.1.3 and A3.1.4.	*Clarifies criteria to be used in evaluating roof assemblies with respect to NBC requirements. Clarifies criteria to be used in evaluating A/V barriers with respect to NBC requirements.*
10.5.2 Thermal Resistance	*See GBPG A3.2.1.*
10.5.3 Assembly and Materials	
.1 Air Vapour (A/V) Barriers	
Coincident air/vapour (A/V) barriers located on the outside of structural framing are recommended for all buildings located above the tree line.	*Condensation within the roof assembly has caused structural damage to a number of roofs across the Nunavut: locating the structural roof inside of the A/V barrier is a reliable means of avoiding this problem. Venting roof assemblies*

Recommendation	***Rationale***
	above the tree line is problematic as vents allow snow infiltration.
Protected, fully adhered coincident air/vapour (A/V) barrier membranes are recommended.	*With the membrane fully adhered to a structural backing, the assembly can meet the A/V barrier requirements, and any damage to the membrane will not allow moisture to travel laterally between the membrane and the backing.*
The location of the A/V barrier on the interior of roof framing is recommended only for small buildings located below the tree line. Great care must be taken to ensure continuous A/V barriers, and a means of venting the assembly that will minimize snow infiltration.	*The use of better performing insulation and membrane materials becomes necessary when the A/V barriers are located on the exterior of the roof framing. These become cost effective on larger buildings. The additional cost may not always be justifiable for smaller buildings located below the tree line. where a ventilated roof system can perform satisfactorily.*
.2 Sealants	*See GBPG A3.1.6.4.*
.3 Insulation	*See GBPG A3.2.2, A3.2.3.*

10.5.4 Ventilation and Drainage

Wherever fibrous mineral insulation is used in a roof assembly. The requirements of NBC 5.4 and 5.5, or 5.6 must be met.	*It is important that adequate ventilation be provided where fibrous mineral insulation is used as its insulation value is adversely affected by condensation. Snow infiltration through required ventilation openings is difficult to avoid; wetting of the insulation and roof assembly occurs as soon as conditions allow infiltrated snow to melt.*
Whenever possible, drainage should be provided from the interior membranes of the assembly to the exterior of the building envelope.	*Water that accumulates within the assembly due to snow infiltration, roof leaks or A/V barrier leaks can drain to the exterior.*

10.5.5 Flat Roofs

All roofs are recommended to have a minimum slope of 4% (1:25).	*To ensure positive drainage and avoid ponding.*

10.5.6 Stepped Roofs and Offsets

Avoid stepped roofs. If two different roof levels are required, they should be connected by a continuous sloping roof section.	*To prevent the occurrence of extensive snowdrifting, which may cause excessive roof loading and protracted wetting of wall segments and roof component joints.*

10.5.7 Parapet Walls

Avoid the use of parapet walls.	*Parapets can create an obstruction where*

snowdrifts will form, adding to snow retention on the roof.

10.5.8 Eaves

Eave Projections. Eaves projections beyond the line of the A/V barrier must not weaken the air tightness of the building envelope.

While eaves provide one of the simplest ways to divert rain and meltwater away from walls, windows, doors and the building perimeter, careful design is necessary to make sure the A/V barrier joint is continuous and to avoid ice damming on eaves.

Where the A/V barrier is located outside of the structural framing, eave projections should be supported by structural members which do not pass through the AV barrier.

Depending on the roof assembly, the continuity of the A/V barrier may be compromised if the structure is extended through the building envelope to provide eave projections.

Minimal eave projections ranging from 100 to 200 mm are preferred in Nunavut

Minimal eaves are considered adequate above the tree line, where rain and melt water runoff is less severe than below the tree line, and high winds cause large transient structural loading of *eaves.*

Eavestroughs. Generally to be avoided.

Ice build-up renders them ineffective, as *well* as *damaging them during spring melt.*

10.5.9 Skylights

Although past technology gave skylights a bad name, new roof and flashing systems and high quality insulating skylight materials now make their use more acceptable. Skylights are generally not recommended for use in Northern facilities.

The extent of skylights would be inappropriate if the energy lost through the skylight increased the energy management budget unreasonably when compared to the environmental benefits and energy saved in lighting.

When skylights are acceptable for northern buildings, several key design features must be included:

Skylights (especially translucent structural panels) have successfully provided a number of facilities with light in areas where windows were not possible.

A steep slope is required for drainage, i.e., 3:12 to 6:12.
Skylight units should be placed on raised upstands above the roof plane a minimum of 200 mm to allow for drainage, expansion and contraction control, and flashing of joints.
Adequate ventilation must be provided across the interior of the skylight to minimize condensation, and ample condensation gutters must be provided.

The quality of overhead natural lighting is comparable to lighting from windows. Past problems experienced with skylights cannot be ignored. Poor detailing with resulting condensation has caused damage to interior furnishings and property. Inappropriate locations allowing direct penetration of sunlight causes discomfort to users who often complain of overheating and glare. Extensive roof damage has occurred as a result of poorly sealed skylight units.

Adequate drip pan is to be provided, allowing condensation to evaporate and not overflow. Consideration should be given to force air movement over the surface, eliminating condensation.

The objective is to catch condensation and allow it to evaporate.

Framing members should be detailed with a secondary drainage plane leading to the exterior.

Accumulation of water cannot be totally eliminated on sloped surfaces. Joints exposed to standing water will eventually leak. Secondary drainage relieves the water that passes through the primary weather seal.

If ear skylights are proposed, consider equipping them with blinds to reduce overly strong sunlight. The blinds must be easily operable by facility users.

10.5.10 Clerestory Windows

Clerestory windows are reasonable alternatives to skylights, provided careful design allows them to remain clear of snow accumulation.

As for skylights, the use of clerestory windows requires extra care, attention and cost. The designer must deal effectively with potential climate and building envelope problems.

N11 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 over the past 20 years, available products are often designed to meet performance requirements found in less severe cold weather conditions than are found throughout *Nunavut Territor*y. Care should be taken to select doors and windows that will meet the extreme cold weather performance requirements of the North.

11.1 EXTERIOR DOORS AND FRAMES

Several problems are commonly experienced with exterior doors. Direct heat loss is inevitable, as doors are not typically insulated to more than RSI1.8. Air leakage at door edges is also common, as weather seals lose flexibility in extreme cold. Excessive air leakage is also common in doors that are loose fitting or difficult to close properly, due to lack of alignment between the door and the frame. Door and frame misalignment can occur from higher than normal door use, or from structural strain on the walls, such as caused by impact damage or even foundation movement.

Recommendation — ***Rationale***

11.1.1 Doors

All exterior doors should be insulated metal, 16 gauge if steel, minimum RSI 1.3. for energy conservation.

Solid or hollow wood doors cannot achieve this minimal level of *insulation, and warp easily in extreme dry cold.*

It is not practical to use a second storm door at entrances in public use buildings to keep warm air inside. Vestibules between outer and inner door sets are more practical and more durable.

Warm interior air leaking past the inner doors can cause frost to form on the colder outer door edges, affecting weather seal operation. Residential grade storm doors wear out quickly from the heavy use encountered in public buildings, and are easily damaged.

11.1.2 Overhead Doors

All overhead doors should be metal with replaceable panels. Manufacturer's standard metal gauge doors are adequate, unless there

Typical uses for overhead doors include arenas, fire halls, and garages. Damaged panels can be easily replaced in sections

Recommendation	***Rationale***
is a particular danger of impact damage. Where that is the case, use heavier16 gauge metal.	*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, and can be selected from manufacturers' 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 do not accumulate.	*To ensure water and ice do not accumulate.*

11.1.3 Door Frames

Metal frames are required for exterior doors in public buildings. Where steel, minimum 16 gauge, welded pressed metal frames are recommended for all exterior doors. Knock down frames are not acceptable. All exterior doorframes require a thermal break. However, thermally broken frames need to be reinforced by the manufacturer when they are to be installed in high traffic public use facilities, or other facilities that are subject to break-ins. The available continuous polyvinyl chloride (PVC) interlocking thermal break system has been found to be the most effective protection in these locations.	*Added strength is required as door frames can wear out early from high volume use in public buildings. Additional structural reinforcement connecting the doorframe to the wall and floor system is recommended.* *The thermal break, although needed because of the extreme cold experienced in the Nunavut Territory, can weaken the frame where strength is required by hinges and latching hardware. Doorframe failure arising from wear and tear and from forced entry has been an ongoing problem in schools and arenas.*
Wood frames may be used where security will not be compromised.	*Wood frames lose less heat than steel frames; however, they are not as strong as steel, and they should be used in 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.* *Consider the use of oversized exterior doors in the place of this system.*

Recommendation	***Rationale***
A good air barrier seal to the doorframes 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 GBPG A3.1.3.*
11.1.4 Sealants	*See GBPG A3.1.6.4.*
11.1.5 Vestibules	
Vestibules are recommended at all main entrances or other high traffic entrances. In schools the storage of boots as well as the space to put them on and off should be provided.	*Vestibules help keep warm interior air inside the building, conserving fuel energy. Larger vestibules are desirable.*
11.1.6 Weather stripping	
Brush type is recommended for door bottoms.	*The rubber type wear rapidly with threshold friction.*

11.2 WINDOWS

The number and size of windows should be carefully designed in northern building envelopes, given the extreme climate and because of the potential for vandalism of public buildings. Views and natural light must be carefully considered when selecting and locating windows.

Recommendation	***Rationale***
11.2.1 Window Frame	
Insulated frame PVC, vinyl or pultruded fibre reinforced plastic frames are preferred.	*Easy maintenance as there is no need to refinish, and the potential for damage to windows by condensation is eliminated.*
Metal windows with thermal break frame, or protected wood windows are recommended for schools and heavily used public buildings.	*See GBPG A4.4.4.*
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.	Large single pane windows are not recommended as they are difficult to protect and expensive to replace.
11.2.2 Sealants	*See GBPG A3.1.6.4.*
11.2.3 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.	*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*

Recommendation	***Rationale***
	of the window.
The window frame should straddle the plane of the AV barrier.	*The intent of such placement is to provide* A/V *barrier continuity through the window frame without offset.*

11.2.4 Operation

All operating windows in schools and public buildings should be casement or awning type with rugged hinges, *and rugged camlock handle*s.	*Crank handles are not acceptable in schools. Camlocks have been found to be the most maintenance free and to provide the best seal of all opening window types. Note that these handles require the rigidity of metal or pultruded fibre reinforced plastic frame materials.*
Windows must be designed so that they will not be blocked by accumulations of snow or ice on sill plates. Awning vents located in the top 1/3 of the window are preferred and awning vents in the lower 1/3 discouraged.	*Awning vents in lower 1/3 of frame are more likely to allow wind, dust and snow to blow in. Also, ventilators in lower portions of windows are less secure and ready intrusion points.*
Refer to M8.1 when windows with an operable panel are provided.	

11.2.5 Glazing

All windows should have double- glazed sealed units with low "E" coating or triple-glazed sealed units.	*The objective is to obtain the best insulation value currently available and economically justifiable. Wherever recurring vandalism is identified as a potential problem, protection of glazing should be provided. See notes in NBC A9. 6.8.1. Typically used for schools where windows are subject to vandalism.*
A single-glazed removable polycarbonate plastic on the exterior face is recommended to protect double glazed sealed window glazing.	*Such protection should be considered for all seasonal use facilities where vandalism is a potential problem. This may also include schools because of shut down for the summer.*
Note that combustible glazing is not permitted as primary glazing in exit enclosures by NBC (3.4.1.10)	
Shutters or demountable panels may be used to protect windows.	

11.2.6 Window vents: snow and forced entry

In high wind locations these have been successfully protected with full height hoods that discourage snow penetration and prevent forced entry. If wind is not a factor exterior metal louvers are recommended.	*Solid inward opening vents with insect screens have worked successfully with exterior hoods or louvers*

11.3 WINDOW COVERINGS (SHADES)

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 18 to 24 hours of daylight for 4 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***
11.3.1 Draperies	
Should be machine washable.	*Dry cleaning is not available in most northern communities.*
11.3.2 Blinds	
Adjustable vertical blinds are preferred. Perforated plastic (non-toxic) or metal blinds are preferred.	*Note that vertical blinds may require stacking room beyond the window opening to access opening vents.*
Roll down blinds with operating chains and end tracks are also acceptable in supervised locations.	*Vertical blinds do not collect dust as readily as horizontal blinds.*
Horizontal blinds are acceptable.	*Plastic or metal are simple to clean compared to fabric blinds.*
Avoid using fabric blinds unless the fabric has an easily cleanable surface.	*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.*

N12 APPLIANCES

Built-in appliances are commonly included in construction contracts rather than with furnishings.

Recommendation	***Rationale***
Kitchen Appliances	
Preferred manufacturer of stoves, fridges, freezers and other kitchen appliances should be confirmed with local building/asset management agencies. Standard sizes and energy efficient models should be selected. Colour should be white.	*The objective is to simplify the number of parts stocked, so maintainers can become familiar with repairs.*
Laundry Equipment	
Preferred manufacturer of washing machines, dryers or other laundry equipment should be	*The objective is to simplify the number of parts stocked, so maintainers can become familiar*

Recommendation	Rationale
confirmed with local building/asset management agencies. Standard sizes and energy efficient models should be selected. Colour should be white.	*with repairs.*

N13 ENERGY MANAGEMENT Energy Management

Energy management includes minimizing the environmental impact of energy usage, improving the energy security of individuals, organizations and communities, improving the comfort of homes and buildings and extending the life of equipment, systems and buildings. The management of purchased electrical power, heating fuel and water as well as the management of electrical power, heat and treated water produced internally at a facility or place of operations and the management of fuel used in the transportation of people, goods and materials, are fundamental to energy management.

Minimizing the energy consumption of public buildings is important in Nunavut where energy costs are extremely high: electricity is usually diesel generated and fuel must be transported annually to remote locations. Effective energy management involves establishing an energy policy, performing regular energy audits, targeting, monitoring and sub-metering energy consumption, making improvements to operations and maintenance procedures and training building staff and occupants in the energy efficiency features of the building.

13.1 ENERGY POLICY

An energy policy is a declaration of principles that guides planning operations with respect to energy management. An energy policy articulates a common purpose to all staff thereby helping to focus and coordinate efforts. It should express a commitment to establish targets, define responsibilities, monitor performance, and conduct an annual review and report. The policy should be signed by senior management.

13.2 ENERGY AUDIT

An energy audit should include costs, savings and payback period. It can be done for the entire building or for specific systems. An individual systems audit is best suited for instances where funding is limited, where energy savings are needed quickly or where management are aware of energy and performance problems with respect to a major energy-using system. A full building audit is recommended if a building is complex or is older and is scheduled for major renovation. It will make it possible to determine the combination of measures that provides the greatest return on investment. By accurately predicting the impact of measures, including their interaction with other building systems, this indicates what systems are in need of upgrading and what those upgrades should be.

A full energy audit of the building includes reviewing historical energy consumption data, the establishment of new consumption baselines and the identification of any anomalies. A full audit will outline baseline energy consumption levels at the outset of the program so that comparisons with future consumption levels can be used to measure the success of the program. Energy consumption data averaged for a two-year period is usually sufficient to establish baselines. Weather-dependent components of the energy consumption should be adjusted to reflect normal conditions and adjustments can also be made to reflect changes to the building, equipment or occupancy schedules that may have occurred during the baseline period.

13.3 ENERGY MONITORING AND TARGETING

Once the selected energy management opportunities have been implemented, it is important to follow up with ongoing monitoring of energy consumption to verify the effectiveness of the projects. Ongoing monitoring will also help to ensure that factors such as staff turnover, inadequate maintenance, improper operating procedures and faulty equipment do not negatively impact the results of the energy management program.

13.4 ENERGY TRAINING

Given the growing number of building projects and the limited numbers of experienced trades people in Nunavut, there is both a need and an opportunity to train and develop building maintainers in every community. When an energy management plan is established, a fully-trained committee should be created to verify, monitor and maintain the effectiveness of the program. Furthermore, as an organization and its functions evolve, new facilities, equipment and staff may be required. Also, new, more efficient technologies are constantly being introduced and manufacturers of energy-consuming equipment are constantly improving the efficiency of their products. Therefore, the committee must be continuously aware of new technologies and equipment and continue to look for new energy management opportunities. The committee should also be fully involved in any plans for building renovations or equipment acquisitions as it may be cost-effective to implement energy management opportunities in conjunction with these projects whereas it would not have been cost-effective to pursue the opportunities as stand-alone projects.

It is also important to keep employees apprised of the positive impact of their participation in the energy management program. Bulletin boards and newsletters are just a couple of ways that staff can be kept apprised of the progress of the program. Regular energy-management training sessions can be a catalyst for boosting morale and facilitating an ethic of continuous improvement.

13.5 SUB-METERING

Tenants have varying energy profiles, depending on the nature of the work, and the hours (e.g. shift work). Metering should be provided for every major tenant of the building, whether or not they are charged separately. Being aware of how much energy they consume encourages conservation and efficiency. It also enables management to factor in energy charges in a fair manner. The building should have sub-meters for monitoring major energy uses to establish building load profile and demand structure. To perform load profiling, specific measurements must be obtained within the facility to pinpoint the particular areas that are causing the peak loads. Sub-metering can also single out problem areas and facilitates making targeted repairs.

APPENDICES

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APPENDIX A

Building Standards - Potable Water Holding Tanks

Note: The following two pages are extracts from documents issued by Environmental Health, Department of Health and Social Services, in June 1992.

1. Water holding tanks shall be water tight and constructed of material that is not subject to decay or corrosion and has been approved for use for drinking water storage by an authority acceptable to the Health Officer.

2. Water holding tanks shall be designed to resist deformation or rupture due to induced hydrostatic pressure.

3. Water holding tanks must be provided with a drain or tap, situated in such a manner that the entire contents of the tank can be drained by gravity.

4. Water holding tanks shall be provided with a means of access for inspection and cleaning. Access holes shall have a minimum inside diameter of 450 mm, be provided with watertight, childproof cover and be easily accessible. On large tanks, the number of access holes shall be as required under the Safety Act and regulations.

5. To exclude dust, birds, insects and animals, water holding tank vents and overflows must either be screened, or must terminate with an elbow fitting located a minimum distance of three times the diameter of the pipe away from the opening of the pipe. Ground level vents/overflows must terminate in an inverted U position, the opening of which is a minimum of 600 mm above the ground surface.

6. Water holding tanks shall be provided with a fill pipe, which is accessible to the water delivery truck from the outside of the building, and which is equipped with a self-closing cover or enclosed in a box with a self-closing cover. The water tank filling point shall be separated from the sewage suction pipe by a minimum distance of 1.5 m measured horizontally, and shall be located one metre above the sewage tank suction pipe.

7. All piping associated with water holding tanks must conform to the requirements of the Canadian Plumbing Code.

8. The building's water distribution system shall be equipped with an automatic device so that it shuts down when the sewage tank is filled to a level as described in the Sewage Holding Tank Standards. This device should be designed and situated to discourage tampering.

9. Water holding tanks installed and buried below ground surface must be located not less than 15 m from the sewage holding tank.

10. When the capacity of a water holding tank is greater than 15 times the estimated normal daily water flow for the building, the building shall be provided with either:

    a) A separate holding tank for potable water storage, *or*
    b) An automatic device for disinfecting the water downstream of the storage tank,

or

    c) Some other suitable method, acceptable to the Health Officer that will ensure the water at the taps meets the requirements of the Guidelines for Canadian Drinking Water Quality.

Building Standards - Sewage Holding Tanks

Note: This is the second of two pages extracted from documents issued by Environmental Health, Department of Health and Social Services, in June 1992.

1. Sewage holding tanks shall be designed and constructed in accordance with the standards set by the Canadian Standards Association (CSA). The design and construction of tanks greater than 4500 L must be certified by a professional engineer.

2. Poured-in-place concrete holding tanks shall be designed, reinforced and constructed in accordance with CSA standards and the concrete design provisions of the National Building Code.

3. Prefabricated sewage holding tanks shall be designed and constructed in accordance with the standards set by the Canadian Standards Association, and bear the CSA seal of compliance.

4. Sewage holding tanks shall be equipped with a suction pipe ending with a quick connect fitting to allow the sanitary removal of the tanks contents. The size and type of the fitting shall be consistent with local conditions.

5. 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.

6. Sewage holding tanks must be provided with a means of access for inspection and repairs. Access holes shall have a minimum inside diameter of 450 mm and be provided with a watertight, secure cover.

7. All piping associated with the sewage holding tank must conform with the requirements of the Canadian Plumbing Code.

8. The building drainage system shall be adequately vented to prevent siphoning traps during removal of the tanks contents.

9. Sewage holding tanks shall be equipped with an apparatus or device that causes the building's water distribution system to shut down when the sewage tank is nearing capacity. This device shall be set to activate at a level where there is free remaining storage capacity for a volume of wastewater equalling the combined volume of all fixtures in the building.

10. Sewage holding tanks installed and buried below ground surface must be located not less than 15 m from any subsurface portion of the potable water system.

11. The working capacity of a sewage tank shall not be less than one and one-half the total volume of the water holding tank or tanks.

APPENDIX B

Ventilation Systems - Calculation of Optimum Quantities of Outdoor Air

The optimum amount of outdoor air to bring into a building is the amount (above the minimum set by ASHRAE) that can be allowed in without increasing associated heating costs. That amount is variable and depends on the outdoor air temperature: when it is very cold out, as little outdoor air as possible is brought into the building; when it is warm out, as much outdoor air as possible is brought into the building. With the extreme cold temperatures of the NWT, some heating of outdoor air is unavoidable. Bringing in more than the minimum air when it is very cold out should be avoided, as this results in higher energy costs. Unfortunately, building maintainers who operate the ventilation system do not monitor building energy costs, and there is currently no way to see the effect of operational practices on energy costs. To determine the percentage of outdoor air that should be brought into the ventilation system; use the following formula. Temperatures are indicated in Celsius.

Where:

RA = **return air**
MA = **mixed air**
OA = **outdoor air**

And

%OA = **[(RA temp - MA temp) / (RA temp - OA temp)]** x **100%**

Examples:

1. Typical winter conditions

RA = **20°**
MA = **13°**
OA = **- 30°**

Then, [(20-13) / **(20- (-30))]** x **100%** = **7150** x **100%** = **14%**

2. Typical spring or early summer conditions

RA = **25°**
MA = **13°**
OA = **10°**

Then, [(25-13) / **(25-10)]** x **100%** = **12/15** x **100%** = **80%**

3. Hot summer conditions

RA = **28°**
MA = **15°**
OA = **26°**

Then [(28-15) / (28- 26)] x 100% = 13/2 x 100% = 650%

Obviously, this is indicating you just can't bring in enough outdoor air to cool the mixed air down to 15°, the best you can do is bring in 100% outdoor air, which would result in an MA temperature of about 26°.

APPENDIX C

Air Permeability of Common Materials and Assemblies

Note: The following four pages are extracts from documents published by the National Research Council as included in DPW "Building Envelope Systems" seminar notes.

Materials of air barrier systems must exhibit low permeability to air. Design practitioners need to know how building materials and assemblies compare in air permeability along with how to evaluate the differences.

Accurate and reproducible testing procedures, developed a few years ago by IRC and private laboratories, are available to evaluate the air permeability of building materials and assemblies. Typically, the sample occupies one large face of an airtight box. The rate at which air flows through the sample is measured for various pressure differentials. The airflow rate at other pressure differentials can be calculated using a characteristic equation derived from the test results. For comparison, air permeability measured in litres per second per square metre of sample are reported at an air pressure differential of 75 Pascals (Pa).

CMHC sponsored the testing of building components by at least three agencies. IRC tested a dozen wood frame wall assemblies, Air-Ins Inc. tested 36 assorted building materials, and Ortech International evaluated elastomeric membranes applied to masonry walls.

The table presents the air permeability at 75 Pa of most materials and assemblies tested. Keep in mind that the data in the table represent the best performance possible. Tests were conducted in the protected environment of the laboratory with no outside weathering. The harsher conditions of <u>actual installations would likely cause an increase in air permeability</u>.

Selecting materials with low air permeability, however, is only one step in the process of designing an air barrier assembly. Here are several other important criteria for obtaining and maintaining assemblies that work:

- Rigidity and strength - to transfer sustained and gust wind loads (1000 Pa and greater), mechanical ventilation and stack effect to the structure with limited deflection. (IRC and Ortech International also examined this aspect of performance in their testing procedure.)
- Continuity of airtightness, rigidity and support. To obtain and maintain continuity of airtightness at interfaces, consider compatibility between materials, buildability of construction details, necessary level of execution, ease of inspection and need for temporary protection of substrates against weathering to ensure good adhesion of sealants and tapes.
- Durability - as a function of the quality of the materials used and of the conditions to which the materials are exposed. Durability of the air barrier depends on the overall design of the wall or roof (e.g., location of insulation, presence of a wind barrier, application of the rain screen principle), on the ease of inspection and maintenance, and on the chance of damage during service life.

Another important issue for the design of air barrier systems is the relationship between airflow and moisture damage. This relationship takes into account the amount of air flow per square metre and the indoor and outdoor temperature, humidity and pressure. A few models predicting moisture damage to the building envelope as a function of materials used, and indoor and outdoor environments have been developed, but their accuracy and limitations are not yet known since they have yet to be thoroughly validated in site conditions.

In 1986, IRC suggested that maximum airflow rates per unit area of air barrier assembly be established according to indoor humidity levels. Starting with the American industry guideline for the maximum allowable leakage for curtain walls (0.3 L's per m^2 at 75 Pa) and estimating a further 50% reduction achievable in Canadian construction, the levels were suggested as:

- 0.15L's per m^2 at 75 Pa for buildings operated at indoor humidity levels up to 27%.
- 0.1L's per m^2 at 75 Pa for indoor humidity levels between 27 and 55%.
- 0.05 L's per m^2 at 75 Pa for indoor humidity levels over 55%.

These values were proposed for discussion with building envelope specialists, designers and builders. Indeed, the figures are still open for discussion and feedback on their adequacy.

Most recently, Construction Specifications Canada in their document <u>Tek-Aid on Air Barriers</u> suggests using material and assemblies that do not leak more than 0.1 L's per m^2 at 75 Pa. Remember, though, obtaining this airflow rate via the air barrier assembly will not necessarily prevent all moisture damage in all types of buildings in the Canadian climate. Nevertheless, this target specification, published in March 1990, definitely demands improved design and construction practices.

(Continued on page 4)

Air Permeability of Common Materials and Assemblies

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Technical Enquiries: Air Barrier Systems (continued from page 3)

For more information, refer to Building Science Insight '86, "An Air Barrier for the Building Envelope," NRCC 29943. This publication can be purchased for $20 from IRC Publications Sales, Building M-19, Montreal Road, Ottawa Ontario, K1A 0R6, telephone (613) 993-2463. To obtain the three research reports by IRC, Air Ins Inc. and Ortech International, contact Jacques Rousseau, Canada Mortgage and Housing Corporation, 682 Montreal Road, Ottawa, Ontario, K1A 0P7 fax (613) 748-6192. Tek-Aid on Air Barriers is available from Construction Specifications Canada, telephone (416) 922-3159.

Information: M.Z. Rousseau

Air permeability of building materials and assemblies

Material or composite wall assembly	Air permeability Us per m² at 75Pa
9.5 mm plywood sheathing	<0.005
38 mm extruded polystyrene insulation	<0.005
*38 mm extruded polystyrene insulation compatible tape at joints (with or without tape at nail heads)	<0.005
25 mm foil-backed urethane insulation board	<0.005
24 and 42 mm phenolic foam insulation	<0.005
*28 mm phenolic foam insulation + compatible tape at joints and nail heads	<0.005
13 mm cement board	<0.005
13 mm foil-backed gypsum board aluminum foil on paper backing	<0.005
1.3 mm modified bituminous self-adhesive membrane	<0.005
2.7 mm modified bituminous torched-on membrane	<0.005
*synthetic stucco finish on 51 mm expanded polystyrene insulation on 13 mm exterior gypsum board	<0.005
*13 mm interior gypsum board painted with 2 coats of latex paint with joint of paper tape and joint compound	<0.005
*9.5 mm sheathing grade plywood on both sides of studs + subfloor adhesive at studs	<0.005
+ 64 mm glass fibre batt insulation in the cavity	<0.005
*9.5 mm sheathing grade plywood on both sides of studs (1 sheathing with two 51 mm holes) + subfloor adhesive at the studs + 64 mm glass fibre batt insulation in the cavity	<0.005
*0.15 mm (6 mu) polyethylene film sandwiched between 11 mm plain fibreboard and 13 mm interior gypsum board	<0.006
8 mm plywood sheathing	<0.007
16 mm waferboard	<0.007
13 mm moisture-resistant gypsum board	<0.009
11 mm waferboard	<0.011
13 mm particle board	<0.015
*13 mm exterior gypsum board + compatible tape at joint	<0.015
*28 mm phenolic foam insulation + compatible tape at joints	<0.018

Material or composite wall assembly	Air permeability Us per m² at 75Pa
reinforced non-perforated polyolefin geotextile	
*11 mm asphalt-impregnated fibreboard covered with 76 mm sprayed polyurethane foam on one side - joints taped	
13 mm gypsum board	
*11 mm asphalt-impregnated fibreboard covered with 76 mm sprayed polyurethane foam on one side - joints untaped	
16 mm particle board	
3.2 mm tempered hard board	
25 mm expanded polystyrene type 2	
30 lb roofing felt	
15 lb non-perforated asphalt felt	
*spunbonded olefin film on one face of a 25 mm glass fibre semi-rigid board + compatible tape at joints (with or without tape at nail heads)	
15 lb perforated asphalt felt	
spunbonded olefin film on one side of glass fibre semi-rigid board	
*Spunbonded olefin film sandwiched between 16 x 38 mm wood strapping @ 406 mm c/c and 11 mm asphalt-impregnated fibreboard	
11 mm plain fibreboard	
11 mm asphalt-impregnated fibreboard	
spunbonded polyolefin film	
3 mu perforated polyethylene (4.3-4.5 perforations/cm²)	
25 mm expanded polystyrene insulation type 1	
15 x 127 mm tongue-and-groove wood planks (8 joints)	
152 mm glass fibre insulation	
75 mm vermiculite insulation	
38 mm spray-on cellulose insulation	

*evaluated as composite assemblies

Air Permeability of Common Materials and Assemblies

List of Materials Tested for Air Leakage

Material		Air Leakage Rate @ 75 Pa (L/s - m^2)
2 mm	smooth-surface roofing membrane	no measurable leakage
2.7 mm	modified bituminous torch on grade membrane (glass fibre mat) aluminum-foil vapor barrier	no measurable leakage
1.3 mm	modified bituminous self-adhesive membrane	no measurable leakage
2.7 mm	modified bituminous torch on grade membrane (Polester reinforced mat)	no measurable leakage
9.5 mm	plywood sheathing	no measurable leakage
38 mm	extruded polystyrene	no measurable leakage
25.4 mm	foil-back urethane insulation	no measurable leakage
24 mm	phenolic insulation board	no measurable leakage
42 mm	phenolic insulation board	no measurable leakage
12.7 mm	cement board	no measurable leakage
12.7 mm	foil-back gypsum board	no measurable leakage
8 mm	plywood sheathing	0.0067
16 mm	wafer board	0.0069
12.7 mm	gypsum board (MIR)	0.0091
11 mm	waferboard	0.0108
12.7 mm	particle board	0.0155
	reinforced non-perforated polyolefin	0.0195
12.7 mm	gypsum board	0.0196
15.9 mm	particle board	0.0260
3.2 mm	tempered hardboard	0.0274
	expanded polystyrene type 2	0.1187
30 lb	roofing felt	0.1873

APPENDIX D

COMMUNITY EMERGENCY SHELTERS

Definition

Although commonly referred to as “community emergency shelters”, buildings intended for use by a community during a civil emergency should. In fact, be known as “reception” or “evacuation’ centres. For information about the *Civil Emergency Measures Act*, contact the Coordinator of Emergency Measures Organization, Department of Community and Government Services.

Building Designation

- There is no complete listing of designated buildings in communities in Nunavut; however, CGS is currently collecting this information. Regional Directors (CGS) should be contacted to confirm buildings are designated in each community.

- The local authority determines which buildings in a community should be designated.

- The Minister of CGS approves civil emergency plans submitted by the local authority (usually the municipal council).

Building Requirements

- The Department of Health and Social Services is responsible for operation of “reception” or “evacuation” centres.

- There are no written requirements for designated community shelters: it is recommended, however, that auxiliary power generators be capable of operating the entire building. There is no special requirement to increase water storage.

APPENDIX E

Standard Colour and Identification Schedule - Mechanical Systems

The following copy is provided for information.

Community and Government Services

STANDARD COLOUR AND IDENTIFICATION SCHEDULE

FIRE PROTECTION PIPING

Red	Fire Protection Water	→	Red
Red	Sprinkler	→	Red
Red	Fire Dry Standpipe	→	Red
Red	Carbon Dioxide	→	Red
Red	Halon	→	Red

MEDICAL GAS PIPING

Blue	Nitrogen	→	Blue
Blue	Medical Air	→	Blue
Yellow	Medical Vacuum	→	Yellow
Yellow	Nitrous Oxide	→	Yellow
Yellow	Oxygen	→	Yellow

FUEL AND GAS PIPING

Yellow	Propane Gas	→	Yellow
Yellow	Natural Gas	→	Yellow
Yellow	Fuel Oil Supply	→	Yellow
Yellow	Fuel Oil Return	→	Yellow
Yellow	Fuel Oil Overflow	←	Yellow
Yellow	Gasoline	→	Yellow
Yellow	Diesel Oil	→	Yellow
Yellow	Chlorine	→	Yellow

TANK FARM PIPING

Galway Green	Fuel Oil	→	Galway Green
Orange	Gasoline	→	Orange
Yellow	JP- 4	→	Yellow
Green	AVGAS 100/130	→	Green

HAZARDOUS PIPING

Yellow	Domestic Hot Water Supply	→	Yellow
Yellow	Domestic Hot Water Return	←	Yellow
Yellow	Glycol Supply	→	Yellow
Yellow	Glycol Return	←	Yellow
Yellow	Glycol Feed	←	Yellow
Yellow	Boiler Blow Down	→	Yellow
Yellow	Heating Water Supply	→	Yellow
Yellow	Heating Water Return	→	Yellow
Yellow	High Pressure Steam	→	Yellow
Yellow	Low Pressure Steam	→	Yellow

Yellow	High Pressure Condensate	←	Yellow
Yellow	Low Pressure Condensate	←	Yellow
Yellow	Cond. Pump Discharge	→	Yellow
Yellow	Waste Heat Recovery Supply	→	Yellow
Yellow	Waste Heat Recovery Return	←	Yellow

LOW HAZARD PIPING

Green	Cold Water	→	Green
Green	Raw Water	→	Green
Green	Treated Water	→	Green
Green	Circulating Water	→	Green
Green	Backwash Water	→	Green
Green	Make-up Water	→	Green
Green	Drain Water	→	Green
Green	Cooling Water	→	Green
Green	Chilled Water Supply	→	Green
Green	Chilled Water Return	←	Green
Green	Condenser Water Supply	→	Green
Green	Condenser Water Return	←	Green
Green	Refrigerant Liquid	→	Green
Green	Refrigerant Suction	→	Green
Green	Low Pressure Air	→	Green
Green	Plumbing Vent	→	Green
Green	Roof Drain	→	Green
Green	Sanitary Drain	→	Green

COLOUR CLASSIFICATION

Red	RED – 1 – GP – 12C – 509 – 102
Yellow	YELLOW – 1 – GP – 12 – 505 – 101
Green	GREEN – 1 – GP – 12C – 503 - 107
Blue	BLUE – 1 – GP – 12C202 - 101
Orange	ORANGE – 1 – GP – 12C – 508 - 101
Galway Green	GALWAY GREEN – 1 – GP – 12C – 503 - 111

VALVE AND DAMPER FINDERS

Red dot	FIRE PROTECTIVE VALVES FIRE/SMOKE DAMPERS
Yellow dot	HVAC VALVES
Green dot	PLUMBING VALVES
Blue dot	AIR VALVES PRESSURE REGULATORS
White dot	MODULATING DAMPERS VAV BOXES

APPENDIX F

Lighting Levels by Activity, Building Area or Task

The principal source of recommended lighting levels is the Illuminating Engineering Society (IES) Lighting Handbook. For tasks and activities not listed here, please refer to the IES Lighting Handbook.

Illuminance levels are given in lux and as such are intended as target values with minor deviations (+/- 15%) expected. These target values also represent maintained values. In all cases the recommendations in the following table are based on the assumption that the lighting will be properly designed to take into account the visual characteristics of the task.

Lighting Level Adjustment

The light levels in the following pages are based on the assumptions that the worker's average age is under 40, the speed and/or accuracy of the task is not critical, and the reflectance of the task background is above 30% (greater than 70% in health centre operation areas, examination and treatment rooms). The sum of the weighting factors (see the IES Handbook) is between -1 and 1, and therefore the lighting levels in this table are appropriate. If there is a change in these assumptions, see the IES Handbook for guidance.

Task Lighting

The table lists light levels for specific tasks as well as location. In the cases where this task lighting level is very high, it is often impracticable and wasteful to light the entire room to the recommended value. The general lighting level for areas where tasks are regularly performed may be reduced, but not below a minimum of 200 lux. Supplementary lighting should then be used in combination with the general lighting to achieve proper illumination of the given task.

Lighting Levels by Activity, Building Area or Task

Activity, Building Area or Task	Lighting Level (Lux)
Airports	
Hangar apron	10
Terminal building apron	
Parking area	5
Loading area (vertical illuminance)	20
Air terminal buildings	
Baggage checking	300
Boarding area	150
Concourse	75
Ticket counters	750
Waiting room and lounge	150
Auditoriums	
Assembly	300
Social activity	75
Badminton	
Tournament	300
Club	200
Recreational	100
Basketball	
College intramural and high school	300
Recreational (outdoor)	100
Building (construction)	
General construction	100
Excavation work	20
Building exteriors	
Building surrounds	10
Entrances	
Active (pedestrian and/or conveyance)	50
Inactive (locked, infrequent use)	10
Conference rooms	
Conferring (critical seeing, Refer to individual task)	300
Curling	
Tournament	
Tees	500
Rink	300
Curling (cont.)	
Recreational	
Tees	200
Rink	100
Dance halls	75
Educational facilities	
Classrooms	
General	750
Industrial arts shops	750
Science laboratories	750
Libraries	
Reading area	300
Stack	300
Office	750
Corridor	150
Offices	300
Mechanical rooms	300
Washrooms	150
Gymnasiums	300
Storage rooms	300
Stairwells	75
Computer rooms	300
Science labs	750
Firehalls	300
Garages	
Parking only	55
Service repairs	750
Health care facilities	
Corridors	
Nursing areas -day	150
Nursing areas -night	75
Dental suite	
General	300
Instrument tray	750
Exam and treatment rooms	
General	300
Local	750
Nursing stations	
General	300
Desk	750
Operating areas, delivery, recovery	750

Activity, Building Area or Task	Lighting Level (Lux)	Activity, Building Area or Task	Lighting Level (Lux)
Health care facilities (Contd)		**Reading**	
Patients' rooms (good to high		Copied tasks	
colour rendering capability		Micro-fiche reader	75
should be considered in		Xerograph	300
these areas)		Handwritten tasks	
General (variable switching		#2 pencil and softer leads	300
or dimming)	75	Ball point pen	300
Critical examination	750	Printed tasks	
Observation	30	8 and 10 point typeface	300
Reading	300	Telephone books	750
Toilets	300	Typed originals	300
Stairways	150	**Residences**	
Toilets	150	General, conversation and	75
Utility Room	300	relaxation	
Waiting areas		Passage areas	75
General	150	Dining	75
Local for reading	300	Ironing	150
		Kitchen work	
Hockey, ice (indoor)		Non-critical	300
Amateur hockey in NT (note:	300	Critical seeing	750
amateur hockey in IES is		Laundry	300
500 lux)		Reading	750
Recreational	200	Desk	
		Primary task plane, casual	300
Libraries		Primary task plane, study	750
Reading and carrels,			
individual study areas (See		**Schools** (See "Educ. Facilities")	
"Reading")			
Book stacks (vertical 760 mm		**Skating**	
above floor)		Ice rink, indoor	100
Active stacks	300	Ice rink, outdoor	50
Inactive stacks	75		
Card files	750	**Stairways**	150
Locker rooms	150	**Tennis, table**	
		Club	300
Offices		Recreational	200
General (see also "Reading")	300		
Lobbies, lounges and	150	**Volleyball**	
reception areas		Tournaments	200
Mail sorting	750	Recreational	100
Offset printing and duplicating	300		
area		**Warehouses**	
Video display terminals (may	75	Inactive	75
need to shield or reorient		Active	
task)		Rough, bulky items	150
		Small items	300
Parking			
(Depends on activity level)	5-20	**Washrooms**	150
Playgrounds	50		

APPENDIX G

Motor Efficiency Levels

Note: Motors must meet the specified minimum efficiencies indicated below, unless it can be shown that a lower efficiency motor will yield lower life cycle costs. The Table applies to T -frame (NEMA specifications), AC, three-phase motors in the 1-50 HP range. Motor efficiency shall be based on CSA C390-93.

Motor Size (HP)	3600 RPM (%)	1800 RPM (%)	1200 RPM (%)	900 RPM (%)
1	75.5	82.5	80.0	74.0
1.5	82.5	84.0	85.5	77.0
2	84.0	84.0	86.5	82.5
3	85.5	87.5	87.5	84.0
5	87,5	87.5	87.5	85.5
7.5	88.5	89.5	89.5	85.5
10	88.5	89.5	89.5	89.5
15	90.2	91.0	90.2	88.5
20	90.2	91.0	90.2	89.5
25	91.0	92.4	91.7	89.5
30	91.0	92.4	91.7	91.0
40	91.7	93.0	93.0	91.0
50	92.4	93.0	93.0	91.7

Section 4.0 – Signage – Official Languages

Official Languages Side By Side

When presenting the four official languages in a side by side format, care must be taken to achieve equivalence in both content and appearance. The following guidelines deal with the process of combining English, French, Inuktitut and Innuinaqtun.

<u>Equivalence</u>

To achieve equivalence in both content and number of lines, a revision of the original text may be required. This could include segmenting the text into main and secondary messages, or rephrasing.

<u>Choosing the Line Breaks</u>

Messages that are to be presented in more than one line should be broken into readable phrases. Articles and prepositions at the end of the line should be avoided. In addition, an attempt should be made to provide a visual balance between the four language columns. Although a visual balance is generally achieved by using the same number of lines for each language, compromises may have to be made to avoid one language column of three or more lines, each consisting of one line only.

Example:

ᓂᕈᐊᕐᓗᒋᓐᓂᒃ ᑎᑎᕋᖅᓯᒪᔪᐃᑦ ᐃᓱᓕᕐᕕᒋᓂᐊᖅᑕᖏᓐᓂ	Choosing the line breaks	Pukungnik titigakhimayut aviktungnit	Choix des fins ligne
ᓂᕈᐊᕐᓗᒋᓐᓂᒃ ᑎᑎᕋᖅᓯᒪᔪᐃᑦ ᐃᓱᓕᕐᕕᒋᓂᐊᖅᑕᖏᓐᓂ	Choosing the line breaks	Pukungnik titigakhimayut aviktungnit	Choix des fins ligne
ᓂᕈᐊᕐᓗᒋᓐᓂᒃ ᑎᑎᕋᖅᓯᒪᔪᐃᑦ ᐃᓱᓕᕐᕕᒋᓂᐊᖅᑕᖏᓐᓂ	Choosing the line breaks	Pukungnik titigakhimayut aviktungnit	Choix des fins ligne

<u>Message Elements Common to Both Languages</u>

Many messages include an element that is common to all official languages, e.g. a geographical name or street name that may not be translated, a street number, an expression of time, a distance or a directional arrow.

Depending on its context within the total sign message, a common element may be presented in several ways:

- Where a common element forms the main message (or an important part of the total message), it should be emphasized in relation to the remaining text. In such cases, a repeat of the common element in the right-hand column may be redundant. The examples show the effect of a different character sizes and how a common element should be emphasized.

- Where an element is common to all official languages but does not require emphasis in the context of the message, the common element should appear in each language column of the sign.

APPENDIX I

Interior Lighting Power Allowance (1)

TABLE I-1

Lighting Power Density by Building Type (W/m²)					
Building or Area Type	**Gross Lighted Area of Building or Area² m²)**				
	0 to 200	**201 to 1000**	**1001 to 2500**	**2501 to 5000**	**5001 to 25000**
Assembly					
Food Service Fast					
• Food/Cafeteria	**16.2**	**14.8**	**14.4**	**14.2**	**14.1**
Schools					
• Pre-School/Elementary	**19.4**	**19.4**	**18.5**	**17.8**	**16.9**
• Jr. High/High School	**20.4**	**20.4**	**20.2**	**19.7**	**18.9**
• Technical/Vocational	**25.8**	**25.1**	**23.4**	**21.6**	**19.8**
Business and Personal Services					
Offices	**20.4**	**19.5**	**18.5**	**17.8**	**16.9**
Industrial					
Storage Garages	**3.2**	**3.0**	**2.6**	**2.4**	**2.3**
Warehouse/Storage	**8.6**	**7.1**	**6.0**	**5.2**	**4.6**

Notes to Table I-1:

{1) This table is comprised of excerpts from the Model National Energy Code of Canada for Buildings 1997 and is based on the ASHRAE/IES 90.1 tables.

{2) The values in this table are not intended to represent the needs of all buildings within the types listed.

Lighting Power Densities for Space Functions (LPDSF) (1)

TABLE I-2

Space Function	LPDSF W/m²	Space Function	LPDSF W/m²
Assembly Spaces		**Care or Detention Spaces**	
Conference Centres		Hospitals, nursing homes	
• Banquet, multi-purpose rooms	25.8	• Corridor	14.0
• Conference, meeting rooms	19.4	• Dental suite	
Lecture Halls, classrooms	21.5	- Examination/treatment	24.8
Libraries		- General area	22.6
• Audio-visual	11.8	• Emergency	24.7
• Card file and cataloguing	17.2	• Laboratory	20.4
• Reading area	20.4	• Lounge/waiting room	9.7
• Stack area[2]		• Medical supplies	25.8
- Stock mounted lighting	16.2	• Nursery	21.5
- Ceiling space lighting	32.3	• Nurse station	22.6
Museums		• Occupational/physiotherapy	17.2
• General exhibition space	20.4	• Patient room	15.1
Passenger stations and depots		• Pharmacy	18.3
• Baggage area	10.8	• Radiology	22.6
• Concourse/main thruway	9.7	• Surgical and obstetrical suites	
• Ticket counter	26.9	- General area	22.6
• Waiting and lounge area	12.9	- Operating room	75.3
Sports venues		- Recovery	24.8
• Seating area, all sports	4.3	Jails, penitentiaries, police stations, prisons	
• Badminton		• Jail cells	8.6
- Club	5.4		
- Tournament	8.6		
• Basketball/volleyball		**Residential Spaces**	
- College	14.0		
- Intramural	8.6	Dormitories	
• Boxing and wrestling, amateur	25.8	• Bedroom	11.8
• Gymnasium	10.8	• Bedroom with study	15.1
- General exercising and recreation only		• Recreational, lounge	7.5
• Hockey, ice, amateur	14.0	• Study hall	19.4
• Skating rink, recreational	6.5		
• Swimming, recreational	9.6		
• Tennis, recreation (Class 111)	14.0		
• Tennis, table, club	10.8		

<u>Notes to Table I-2:</u>

(1) This table is comprised of excerpts from the Model National Energy Code of Canada for Buildings 1997 and is based on the ASHRAE / IES 90.1 tables.

(2) Appropriate light levels on vertical surfaces of library stacks would be difficult to meet with 16 W/m2 power level when lighting is ceiling mounted. An alternative level of 32.3 W/m2 is provided for ceiling mounted lighting.

Lighting Power Densities for Space Functions (LPD_{SF}) (1)

TABLE I-2 (Continued)

Space Function	LPD_{SF} W/m²	Space Function	LPD_{SF} W/m²
Business and personal Service Spaces		**Industrial Spaces**	
Office category 1		Service station/auto repair Shop	3.2
• Reading, typing and filing	19.4	• Carpentry	24.8
• Drafting	23.0	• Electrical/electronic	26.9
• Accounting	22.6	• Machinery	26.9
Office category 2		• Painting	17.2
• Reading, typing and filing	20.4	• Welding	12.9
• Drafting	31.2	Storage garage (3)	10.8
• Accounting	25.8	Storage and warehouse	
Office category 3		• Active storage, bulky, general	3.2
• Reading, typing and filing	23.7	• Active storage, fine, museum	7.5
• Drafting	36.7	Artifacts	
• Accounting	29.1	• Inactive storage general	3.2
		• Inactive storage, museum artefacts	6.5
General Spaces		• Material handling	10.8
Corridor	8.6		
Elec./mech.equipment room			
• General	7.5		
• Control rooms	16.2		
Lobby (general)			
• Elevator lobbies	8.6		
• Reception and waiting	10.8		
Locker room and shower	8.6		
Stair			
• Active Traffic	6.5		
• Emergency Exit	4.3		
Toilet and washroom	8.7		
Unlisted space	2.2		

Notes to Table I-2:

(1) This table is comprised of excerpts from the Model National Energy Code of Canada for Buildings 1997 and is based on the ASHRAE / IES 90.1 tables.

(2) Appropriate light levels on vertical surfaces of library stacks would be difficult to meet with 16 W/m2 power level when lighting is ceiling mounted. An alternative level of 32.3 W/m² is provided for ceiling mounted lighting.

(3) The LPDsf for storage garages includes lighting for parking, driving, and pedestrian walking areas.

APPENDIX J

Mechanical Equipment -Standard of Acceptance

The following equipment manufacturers are considered to be equivalent and acceptable for specification purposes, providing that they meet or exceed all capacity ratings, performances, efficiencies, etc., and that they are able to be integrated into the system design without exceeding space limitations, and providing that their substitution for the specified product does not result in changes to related equipment that would increase the cost or reduce the overall performance of the system.

Mechanical Equipment Type	**Standard of Acceptance**
Acoustic Sealant	Duro Dyne
Air Handling Units	Engineered Air, Haakon, Trane
Automatic Air Vents	Maid O'Mist, Amtrol
Automatic Temperature Controls	Honeywell, Johnson, Landis & Gyr
Boilers	Weil McLain, Burnham, Veissmann
Chimneys	Selkirk, Metalbestos
Circulating Pumps	Armstrong, Grundfos, B & G
Domestic Hot Water Heaters	Aero, Ruud, John Woods
Drinking Fountains	Haws, Elkay
Expansion Tanks	Amtrol, Hamlet & Garneau, Expandftex with EPDM bladder
Filters	Farr Air, Fram, American Air
Flexible Duct Connections	Duro Dyne
Fuel Oil Transfer Pumps	Viking, Ebara, Webster
Grilles and Diffusers	EH Price, Tuttle & Bailey
Heating Fluid	Dowfrost HD propylene glycol
Insulation	Fiberglas Canada, Johns Manville, Knauf, Manson, Owens Corning, PlastFab
Oil Burners	Riello, Carlin, Powerftame, Aero
Outdoor/Exhaust Air Dampers	Tamco, Westvent
Radiant Heating and Cooling Panels	Twa, Frenger
Side Stream Filters	Armteck
Sprinkler Equipment	Viking, Grinnel
Tanks	Clemmer, Maclin, Westeel, Back Bay Welding, Kingland

Mechanical Equipment Type	Standard of Acceptance
Time Switches	Paragon, Tork
Thermometers	Marsh, Taylor, Trerice, Weiss, Weksler
Valves	Crane, Kitz, Toyo, Red & White, Newman Hattersley, Grinnell

APPENDIX K

Seismic Design Requirements

The following table lists Za and Zv values for communities in the North. Additional information is available in the Reid Crowther and Partners Ltd., "Northwest Territories Seismic Review", dated December 1997 [Project #49496-00-(3)].

REGION	OFFICIAL NAME (FORMER)	ZA	ZV
Nunavut	Kugluktuk	0	1
	Cambridge Bay	0	0
	Taloyoak	2	1
	Arviat	0	0
	Cape Dorset	1	1
	Iqaluit	1	0
	Kimmirut	1	1
	Bathurst Inlet	0	0
	Gjoa Haven	2	1
	Resolute	2	1
	Baker Lake	0	0
	Rankin Inlet	0	0
	Whale Cove	0	0
	Grise Fiord	1	1
	Arctic Bay	1	1
	Nanisivik	1	1
	Pond Inlet	3	2
	Clyde River	5	3
	Pelly Bay	1	1
	Igloolik	1	1
	Hall Beach	1	1
	Qikiqtarjuaq	2	1
	Pangnirtung	1	1
	Repulse Bay	1	1
	Chesterfield Inlet	0	0
	Coral Harbour	1	0
	Sanikiluaq	0	0

END OF SECTION