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Measures for Energy-Efficient Northern Housing (Commentary)

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Canada

A Report Prepared For

The Director,

Technology Transfer and

Demonstration Programs Division

Energy, Mines and Resources Canada

Project Number 3-4889

March, 1985

MEASURES FOR
ENERGY EFFICIENT
NORTHERN HOUSING

(Commentary)

commentary

NORTHERN MEASURES

first edition 1985

COMMENTARY

SECTION 1: GENERAL

The need for an operating manual to describe the systems in the building is one which is becoming imperative for all housing, North or South. Mechanical, electrical and ventilation systems have become increasingly complex, and improper operation in dwellings which are essentially air-tight can lead to very inefficient operation and unsafe conditions. In the North, sewage and water systems are added to the list of systems which depend on intervention by the occupant for their proper operation; and the consequences of a malfunction in these areas are severe and long-lasting. A(7)

SECTION 2: DEFINITIONS

As a general rule, the Northern Measures uses definitions developed in the Residential Standards and the National Building Code. New definitions have been added only where required for specific Northern Measures applications. Otherwise, reference should be made to the comprehensive definitions contained in the NBC as has been past practice.

Active layer is the first of several new definitions which reflect the unique environmental conditions of the North.

Other new terms have been provided to deal with issues of air movement and the prevention of condensation, including air barrier, vapour barrier and air-vapour barrier. The useof these three terms also reflects the fact that, although most use is made of air-vapour barriers, only an air barrier is required to prevent the movement of air between a combustion equipment room and the rest of the dwelling. Another reason for providing separate terms is that an air-vapour barrier can be constructed by combining two adjacent layers, one performing the air barrier function and the other the vapour barrier function.

The term appliance is one which is taken from the NBC. It is not an ideal term, since it can easily be confused with the commonly used "kitchen appliance"'. In the NBC sense, however, the term only refers to systems and equipment that convert fuel into energy, thereby excluding, for example, electrically- operated stoves or furnaces. The principles followed in Sections 33 and 34 of the Northern Measures require that a distinction be made between equipment that uses air for combustion and equipment that does not. In view of this need, and the desire to maintain consistency with the NBC, the term has been adopted.

Another important new definition is building envelope. This term has been added to reflect the increasing need to differentiate between exterior walls which contain insulation and an air-vapour barrier, and those which do not.

The terms chimney, combustible and combustible construction have been added from the NBC for ease of reference. It was found that although the term chimney flue has been used in the RS 1980 and the NBC, it is not a defined term; a definition was therefore added.

The NBC and the RS 1980 contain a definition for service rooms, and reference is made in those standards to various special-purpose service rooms, such as furnace rooms, incinerator rooms, and equipment rooms. The Northern Measures places emphasis on special requirements for service rooms that contain appliances (fuel-fired combustion equipment). The term combustion equipment room was therefore defined to refer to this type of room, and utility room is used to refer to a service room that contains non-combustion equipment. The term service room has been kept intact, so that both combustion equipment rooms and utility rooms are now defined as special-purpose service rooms.

Flue pipe and grade are NBC terms added here for ease of reference.

Although the term heated space would appear to have an obvious meaning, it was felt necessary to define it to cover instances where heating of a space occurs indirectly, as in the case, for example, of radiant, losses from a hot-air duct passing through a space. The definition used is taken from the NRC Measures for Energy Conservation. The definition forpermafroat, has been adopted from "Permafrost" issued by the Associate Committee for Geotechnical Research.

Vent closure and weather barrier have been added since the terms have been introduced in Section 26. It should be noted that the vent closure defined here has no relationship to the term "closure" already defined in the RS 1980.

SECTION 3: MATERIALS, SYSTEMS AND EQUIPMENT

This Section contains few changes. The draft 1985 NBC suggested changes to Subsection B, which have been adopted. The only substantial changeis in Subsection C, dealing with the preservative treatment of lumber.

SECTION 4: STRUCTURAL REQUIREMENTS

This Section has been renamed in the 1985 draft NBC, and extensive changes have been proposed. All of the NBC changes have been included.

SECTION 5: ROOM AND SPACE DIMENSIONS

There has been little, if any, change in the space requirements of the Residential Standards for some forty years. This lack of change can be accounted for by two factors - first that their provisions have been acceptable to the majority of Canadians and second, and perhaps most significant, that they have been universally ignored by public and private developers who have exceeded the minimal space requirements as a matter of course. It is unlikely that most Canadians have seen, let alone lived in, houses built to minimum standards.

The Residential Standards were designed with asouthern and urban orientation and have never been thoroughly satisfactory for northern or rural areas. An attempt was made to develop a northern version, which was published but quickly withdrawn after key items were incorporated in the Residential Standards. Since that time, minor modifications of the space standards have been permitted in the field in response to well defined problems, but there have been no major changes.

In preparing the Northern Measures, many sources of information were considered, including those aspects of northern practice which, while not required by the Residential Standards, have been adopted as norms by northern designers. Reports on northern housing workshops and conferences have also been assessed for features in northern houses most frequently described as being inadequate or inconvenient.

The difficulties encountered by disabled people are amplified in the North where long winters make outside movement extremely difficult for much of the year. Movement within a house can be restricted by narrow corridors and doorways (as it is in the South) but bathrooms that are raised a few steps to accommodate a sewage holding tank provide a special problem for disabled residents in the North. A(8)

It is recognized that many houses cannot be designed to permit easy movement inside by the disabled who live there with their families or who are visiting. The Northern Measures does, however, require that "wherever possible" wheelchair, access should be provided between a sleeping area or bedroom, a bathroom and the living room or area. A(8)

Space standards for the main activity areas of the dwelling - the living, dining and kitchen spaces - reflect the tendency of people in the North to be more house-bound than southerners during the winter time, and the greater emphasis northerners place on visiting between families and friends. The minimum areaa of living and dining rooms and of kitchens have therefore been increased by 1 m^2 per bedroom for units that contain more than 2 bedrooms; a measure intended to reflect the additional demands placedon these facilities in dwellings with larger households. The Northern Measures retains the RS 1980 feature of permitting a reduction in the area of a living or dining room or kitchen where it is combined with another space. Subsections C, D & E

The small size specified for kitchens in RS 1980 appears to be especially inappropriate in the northern context, and the Northern Measures has therefore provided a substantial increase in its minimum size. The required counter space has also been increased and a requirement for the provision of shelving for the storage of bulk goods has been added. Subsection E

Table A provides a summary of the Northern Measures area requirements.

TABLE A MINIMUM AREAS REQUIRED IN IWELLING UNITS ACCORDING TO THE NORTHERN MEASURES, in m^2

	BACHELOR DWELLING	1 BEDROOM DWELLING	2 BEDROOM DWELLING	3 BEDROOM DWELLING	3 BDRM.+ DWELLING
LIVING ROOM	11.0	13.0	13.0	14.0	+1 .0/BDRM.
DINING ROOM	4.0	6.0	6.0	7.0	+1 .0/BDRM .
KITCHEN [1]	4.2	6.0	6.0	7.0	+1 .0/BDRM.
LIVING COMB.	11.0	11.0	11.0	12.0	+1 .0/BDRM.
DINING COMB.	3.0	5.0	5.0	6.0	+1 .0/BDRM.
KITCHEN COMB.[1]	4.2	4.2	4.2	5.2	+1.0/BDRM.

1. Gross area, including space occupied by base cabinets

Subsections C, D, E & F

Although both the RS 1980 and the Northern Measures specify minimum areas and dimensions for the major rooms within a dwelling, neither standard specifies areas for hall, bathrooms or service rooms. Table B provides a more meaningful comparison between the total areas that would result from application of the Northern Measures and the RS 1980. A stock CMHC plan was used to provided the basis for comparison, and the original CMHC room areas are also shown. The Table demonstrates that, while the Northern Measures results in a unit that is 11.8% larger than the minimum required by RS 1980, it is smaller than the CMHC stock unit, which exceeds the minimum by 23.22.

TABLE B: COMPARISON OF AREAS PROVIDED IN THE NORTHERN MEASURES, TEE **RS** 1980 STANDARDS AND **A STOCK CMHC** HOUSE

Type of Space	Minimum as per RS 1980	Areas in CMHC Plan, m²			Northern Measures, m²		
		Area	Diff.	% cliff.	Area	Dif f.	% cliff.
Living room	13.5	14.8	1.3	10%+	14.0	0.5	4%+
Dining/Kitchen	7.45	12.3	4.85	65%+	11.2	3.75	50%+
Bedroom 1	9.8	13.5	3.7	38%+	9.8	0.0	0%
Bedroom 2	7.0	9.8	2.8	40%+	7.0	0.0	0%
Bedroom 3	7.0	8.3	1.3	19%+	7.0	0.0	0%
Bathroom *	3.25	4.2	0.95	29%+	3.25	0.0	0%
Halls *	6.8	6.8	0.0	0%	6.8	0.0	0%
Clothes closets	1.65	2.9	1.25	76%+	1.65	0.0	0%
Linen closet *	0.16	0.3	0.14	88%+	0.16	0.0	0%
Coat closet	0.55	1.3	0.75	136%+	2(0.9)	1.25	227%+
Main vestibule	1.0	1.0	0.0	0%	2.25	1.25	125%+
Secondary vest. **	0.7	0.7	0.0	0%	2.25	1.55	221%+
Utility room * & general storage	stor. 5.7 total 5.7	10.9	see below		5.7 5.7	" 0.0	0%+
Combustion * Equipment Room	htg. 5.3 DHW 0.6 tank 0.0 total 5.9	included in utility room - total for both is 10.9, 0.7 or 6% less than RS total			5.3 0.6 0.0 5.9	0.0	0%+
TOTAL	70.46	86.8	16.34	23.2%+	78.78	8.12	11.8+%

* Indicates that, for the room indicated, there is no minimum area specified in the RS 1980 or the Northern Measures. In the case of the CMHC stock plan, the area provided was measured. For comparison purposes, areas used for the RS 1980 and the Northern Measures cases were built up from calculating the clearances which would be required around the necessary equipment or shelving area.

** There is no RS 1980 requirement for a secondary vestibule. The area used for the RS 1980 column is therefore based on the actual area provided in the CMHC stock house.

Note also that no provision has been made in any of the three units being compared for the internal location of oil, water or sewage tanks.

Subsection

A coat **closet** will now be required for each entry vestibule, and in many cases there will be two entry vestibules per dwelling (as in the example used for Table B, since the **gross** ground floor area exceeded 75 m^2). One of the required **closets** can be omitted, however, if the space is added to the vestibule and if heavy duty coat hooks are provided in addition to **those** now called for **in** each vestibule.

Subsection J

The only change **proposed** for the bathroom, apart from the new NBC requirement for a wider **door,** is in the provision of a lockable or child-proof cupboard for the storage of dangerous medicines or cleaning materials.

Subsection L

Unlike the **RS** 1980, which only contains specific requirements for exit doors, the Northern Measures also contains requirements for entrances. The approach taken in the Northern Measures reflects widespread observations that two entrances are necessary, located on different faces of the building so that at least one entrance remains free of snow blockage. In addition, it was clear that, in most cases, an entrance is a distinct liability in terms of energy conservation unless it **is** provided with an unheated vestibule large enough to contain a bench and adequate coat closet or hanging space. The provision of two vestibules in a small unit **imposes** a planning and cost problem, and so the requirement has been made **applicab**le only to units with a ground floor area of more than 75 m^2, thereby limiting its scope primarily to one storey units.

Subsection M

The term "'combustion equipment room" has been introduced to differentiate between a service room that contains fuel fired appliances and one that contains other types of mechanical or electrical equipment. The reason for the distinction is that the measures which have to be taken to assure safety and energy efficiency for combustion equipment require extra care and expenditures; and the common term of "service **room**" would have applied these measures even to a room containing only, for example, a water pump.

The Northern Measures requirements for combustion equipment rooms are consistent with the overall principle (expressed in Subsections 34C and 34D) of a complete separation between the air supplied to and emitted from the combustion equipment, and the air supplied to and exhausted from the dwelling spaces. Towards this end, an air barrier is required in the walls, floors and ceilings separating the combustion equipment room from other areas of the dwelling. Another area of concern is access to the room, since a door left open can negate other efforts to achieve a separation. It would therefore be ideal to completely isolate this type of service room from living areas and to allow access only from the outdoors or through an unheated vestibule, but practical considerations, especially in the case of basements, have led to the option of providing access by an interior air lock. It is recommended, however, that access be provided from an exterior vestibule wherever this is possible.

The supply of combustion air to a combustion equipment room is covered in Section 34, which allows air to be supplied to the room, as long as the ambient temperature does not fall below 10″C.

The only change made to Subsection P has been to clarify terms where reference is made to cubic metres.

SECTION 6: DOORS

The constructional requirement for doors with closers has been inserted to overcome the common tendency touse the same type of door for all applications. • A(4) Table 6A

The requirement for doors has been extended to include vestibulesand service rooms. Subsection

The change in C(1) is taken from the 1985 draft NBC. C(2) requires a door wide enough for access by a disabled occupant, and is consistent with the provisions of Subsection 5A. Subjection C

RS 1980 defined exterior doors in terms of their type of construction, leaving open the question of when an exterior door is required. In view of the Northern Measures requirements for unheated vestibules and the need to have E(1) both vestibule doors satisfy criteria for external doors, it was decided to clarify this question in E(l).

Several provisions are intended to achieve a reduction in air leakage and an improvement in thermal performance. The base requirement for a0.38 RSI thermal performance of exterior wood doors is modest and is easily achievable with stock units. Similarity, the RSI 1.23 requirement for metal doors is based on performance available in standard units. Requirements for weatherstripping, sloping sills, caulking and thermal breaks are all basic to good thermal performance and to trouble-free operation in the North. A performance standard is provided for air infiltration, at a level obtainable from several manufacturers. Finally, a cross-reference has been made to Subsection 28D for caulking. Subsection

Changes in permissible glass areas for doors are taken from the 1985 draft NBC. The Northern Measures has provided a new clause requiring a thermal resistance for glazing in doors or sidelights separating an unheated vestibule from a heated space. The level of performance required, RSI 0.29, is designed to be consistent with 7B(3) and 7B(4), which provide that glazing shall have a thermal resistance of RSI 0.45, except that an the glazing separating an unheated enclosure from the rest of the dwelling may be considered the equivalent of RSI 0.16. hence, (0.45 - 0.16) is equal to the RSI 0.29 requirement. Subsection

Garage door requirements have been modified to increase the height from 1.93 m to 2.44 m, to provide for the entry of 4x4 vehicles which are common in the North. Garage doors will also be required to achieve a thermal performance of RSI 0.38. Subsection G

Changes have been made to the Hardware Subsection include a requirement for lever handles to be used on both sides of all exterior swing doors. This measure reflects the difficulty of using a knob-type handle with heavy mitts or gloves. Exterior doors, doors to combustion equipment rooms and to an attached garage will require closers, located on the warmer side of the door, in order to reduce the possibility of malfunction. Appropriate closer standards have also been referenced. Subsection

SECTION 7: WINDOWS

A provision has been added to ensure that windows or vent closures can be upgraded with storm windows and/or screens. The need for screens on openable windows or vent closures is obvious. The ability to install storm windows on all windows, even fixed ones, is required so that thermal performance can be upgraded later by the owner, and so that temporary protect ion can be provided i f windows are broken. A(4)

The RS 1980 principle of imposing a minimum for glazed areas, to ensure adequate daylight, has been retained. The minima have, however, been reduced - for Kitchens from 10% to 5%, and for Living and Dining rooms from 10% to 8%. The change is a recognition that northern designers have for some time expressed the view that the existing minima are too high for the North. B(2)

The Measures requirement for triple glazing has been adopted, stated it in performance terms and permitting the alternative of double glazing plus a storm window. B(3)

An important change in this Section is the adoption, with modifications, of the approach taken in the NRC Measures for Energy Conservation for limiting the maximum area of glazing. The Measures uses an upper limit for glazing area of 15% of the floor area served; this has been reduced to 12% in the Northern Measures. The Northern Measures also limits the proportion of the exterior wall area that can be glazed, a measure which comes into play only with very large floor areas. B(5)

Another clause adopted from the Measures is one which recognizes the heat gain from South-facing windows. Its inclusion in the Northern Measures reflects the fact that, despite long and sunless winters in the North, Spring and Fall solar gain can be considerable. B(8)

Air infiltration standards have been set to a level whichcan be reached by several window manufacturers. B(9)

The limitation imposed on the use of non-vitreous glazing is meant to cover materials such as Lexan, which B(10) have been used to reduce the frequency of glass breakage. The use of these materials have led to a concern that occupant will face severe risks in cases of fire, since windows cannot then be broken for use as emergency exits or for the entry of firemen.

Window standards and glass standards have been revised in accordance with the 1985 draft NBC, and a Subsection for skylights has been added. Subsections C, D & I

SECTION 8: STAIRS, RAMPS, HANDRAILS AND GUARDS

Changes made in this Section are relatively minor. Several clauses have been added to minimize the problems of snow accumulation and clearance. B(3), D(5) & D(6)

The 1985 draft NBC proposes major changes to rise and run requirements for stairs, but it has been decided not to accept these until back-up justification is reviewed. Subsection C

Other changes result from the adoption of 1985 draft NBC proposals.

SECTION 9: MEANS OF EGRESS

The addition of the term "combustion equipment room'' has enabled exit requirements from service rooms tobe made more specific. It was also considered that the prohibition on door opening onto exit passageways is only necessary in buildings containing more than one dwelling unit. B(5)

Two clauses have been proposed in the 1985 draft NBC to deal with egress and access for the physically disabled, and they have been included here. B(9), B(10)

Many of the changes in this Section are based on the 1985 draft NBC. One exception is a clause designed to deal with the danger of snow accumulation outside an exit door. In this case it was decided that the disadvantage of having a step to a landing outside an exit door was less important than the risk of blockage because of snow accumulation. F(10)

Changes have been made in the provision of egress from dwelling units, to maintain consistency with the measures adopted in Subsection 5L. The RS 1980 provision for emergency exit through upper fleer windows has been made 1(1) I(2) more restrictive in recognition of the greater risk from fire in the North.

SECTION 10: FIRE PROTECTION

This Section has been substantially revised in the 1985 draft NBC, especially in Subsections D, H, I and O.

Other changes to this Section have been based on the assumption that the Northern Measures will (unlike the RS 1980) apply mainly to areas without a fire department or a mains water supply, and that greater protection is required to avoid the start and spread of fire, and to alert the occupants of danger as quickly as possible.

One clause dealing with the direction of door swings to service rooms has been removed [10M(12) in RS 1980], since it deals with non-residential occupancies.

Other specific changes put forward in the draft 1985 NBC inlude substantial reductions in permissible flame spread ratings. Although it is recognized that this will eliminate the useof some materials currently popular in the North (for example, factory-finished wall board), it does permit the use of common combinations such as drywall and paint. Subsection

Although the changes in alarm and detection systems originate in the proposed NBC changes, the Northern Measures has also stiffened requirements for smoke alarms, R(2)
both in number and in their type and method of installation. R(4), R(5)

Finally, the Northern Measures now requires the S(6)
installation of two field-rechargable fire extinguishers, a measure which is already accepted by many northern designers.

SECTION 11: SOUND CONTROL

No revisions have been proposed for this Section.

SECTION 12: EXCAVATION

Minor changes have been made to ensure the protection of permafrost during excavation, and to prevent thawing.

SECTION 13: WATERPROOFING AND DAMPPROOFING

Two minor changes have been adopted from the1985 draft NBC proposals. The requirement for dampproofing of slabs on ground has been modified, and Type S roll roofing has been removed as a permissible material for dampproofing. A(3) F(2)

SECTION 14: DRAINAGE

Only one minor change is proposed by NBC 1985, a reference to a new standard for corrugated pipes. The Northern Measures has added two minor changes to ensure adequate surface drainage. Clause F(2) deals with areas adjacent to the building and specifies that grading shall be by fill only, so that the existing surface is not disturbed. F(3), on the other hand, allows drainage channels to be cut into the existing soil under the building, to cover the case of sites which have an existing depression which might collect water. F(2) F(3)

SECTION 15: FOOTINGS AND FOUNDATIONS

Some rearrangement has been made of paragraphs between Subsections A and B, dictated by editorial logic. In general, the Section includes measures toprotect permafrost from thermal activity and to ensure that structures are not erected where permafrost activity is likely to create instability.

Since much development is occurring in this field, several clauses ensure that designers have options to explore innovative solutions which are not covered by the prescriptive clauses in the Northern Measures. A(4), B(1)

The most important principle followed is that of eliminating heat transfer to the permafrost. The Northern Measures takes the approach of permitting the use of granular pads, a ventilated foundation space, or insulation installed between the building and the ground surface, or any combination of these. Specific clause essentially flow out of this starting point. B(2)

Subsection now includes requirements for granular pads for surface foundations in permafrost areas, including dimensions, bearing pressures and construction techniques. Requirements for stepped footings have been adopted from the 1985 draft NBC and the Northern Measures includes clauses on foundations embedded in permafrost and the use of wood sills. Subsection C

The Subsection on joist and beam supports now omits reference to termites and includes a new provision to minimize beam deflection due to permafrost movement under footings. Subsection E

Subsection G was entitled "Foundations on Permafrost" in the RS 1980. These measures have now been redistributed throughout the previous Subsections. Subsection G now deals with pile foundations, and contains a new clause to cover the use of piles in permafrost. Subsection G

SECTION 16: SLABS-ON-GROUND

The 1985 draft NBC has proposed to reduce the number of Subsections, and this format has been followed in the Northern Measures, except for one new Subsection to deal with slabs on permafrost. All changes in Subsections A, B, C and D are taken from the NBC proposals.

Specific provisions for slabs on permafrost follow the principle used in Section 15, of permitting the designer to use one or a combination of options. The most novel feature of this Subsection is the specification of requirements for sub-floor venting, one of the options which may be used. E(8)

SECTION 17: COLUMNS

No revisions have been proposed for this Section.

SECTION 18: CRAWL SPACES

In the Residential Standards, crawl spaces were taken to mean enclosed spaces under a house. The Northern Measures has extended this to include the open space under many northern houses, leading to a renaming of Subsection B.

An attempt has been made to clarify the rules for the use or omission of skirtings in a functional manner, so that their use as decorative screen to hide the house supports is limited to those areas where this can do no harm. Specifically, performance requirements for rate of ventilation have been included, and, where it is desired to use skirting, requirements have been established for removable sections to be included. B(2), B(3) and B(4) B(6)

SECTION 19

There are two main mechanisms by which moisture maybe introduced into an attic space: moisture may be transported by air currents which leak from the conditioned spaces into the attic, and water vapour may diffuse through permeable materials because of differential water vapour pressures. For many years building codes have called for ventilationof attics and roof spaces so that condensation can be prevented bysweeping away water vapour that may have leaked intothem by one or both of these mechanisms, and of providing a means whereby any moisture that has condensed can be dried out under milder weather conditions.

This approach is, however, akin to a doctor treating a symptom rather than the underlying disease. If a well sealed and high quality air-vapour barrier is installed, there will be no air leakage into the attic or roof space and, since vapour diffusion through an air-vapour barrier is slight, the prime mechanism for moving water vapour into the attic will have been removed.

No air-vapour barrier imperfect, however, and therefore any water vapour which has entered the attic space must be allowed to leave it. Where the onward migration of water vapour by diffusion cannot be provided for because of the vapour resistance of the roof sheathingor covering, thenit must be removed either by ventilation or by draining it off the top side of the air-vapour barrier.

Clauses B(1) and B(2) contain the standard requirement for ventilation that has proved satisfactory in most cases in the South. B(l), B(2)

With flat or nearly flat roofs it is not possible to make any provision for draining water cut of the roof construction and such roofs must therefore be ventilated. The 75 mm clearance provides space for air to enter at one side of the roof and leave at the other. There is no requirement for the joist or rafter spaces to be cross connected. B(3)

If the joist or rafter spaces are cross connected, then any vapour that leaks into one space can dissipate, to some B(4) extent, into the adjacent ones. In addition there is the possibility of air flow in two directions to carry the vapour away. The clearance under the cross purlin in this case can be reduced to 25 mm giving a total clearance under the roof deck of 63 mm; (25 + 38 mm), between purlins.

In attics the clearance between the insulation and the roof deck can be reduced locally near the cave provided that the required ventilation area is maintained. B(5)

With steeper roof slopes it becomes possible to slope the air-vapour barrier and to drain condensed water to the outdoors. Under these conditions the designer has a choice of providing ventilation or of filling the roof cavity with insulation and providing the necessary drainage paths. Ifhe chooses to provide for drainage then each joist or rafter space must be blocked at the highest point to prevent wind induced flows in the insulation [See also 26 D(13)]. B(6)

In some locations very fine wind driven snow is carried into roof spaces through vents by currents of air. In such cases more moisture is added to the roof space by the ventilating air than is swept away by it. Where this situation prevails the designer has the option of sealing up the roof space in winter and providing large openings that can be used in summer to dry out any accumulated moisture. If this course is followed these summer ventilation openings must be closed tightly in winter to keep the blowing snow out. B(7)

Access hatchways from the conditioned space of the building into unheated attics frequently form a major leakage path through the air-vapour barrier. In extreme cases they may even be left open. Preferably, therefore, access should be from the outdoors. If this is not done then C(3) gives some requirements to ensure that the thermal and air tightness characteristics of the building envelope are maintained. Regardless of where it is located, the hatchway must have an airtight door or cover; to stop air leakage from the inside and to keep blowing snow out from the outdoors. With some designs it may be possible to provide access from a cold vestibule or similar unconditioned space to avoid the blowing snow problem. c(2), c(3)

SECTION 20: ABOVE-GRADE MASONRY

No revisions have been proposed for this Section.

SECTION 21: CHIMNEYS AND FLUES

Most changes made in this Section are due to proposals made in the 1985 draft NBC.

Other significant changes and additions have been made in response to the problems of flue condensation, icing-up and variable wind pressures. Specifically, the flue must be protected so that the warm, moist flue gases do not meet surfaces on which they will condense and freeze, which suggests short lengths of exposed chimney. Short chimneys may, however, exhaust at levels where wind turbulence caused by the roof may exist. The Northern Measures requirements attempt to strike a balance between these two conflicting requirements. B(9), B(10)

SECTION 22: FIREPLACES

This Section has been rewritten to be in accord with the principles established in the new Sections 33 and 34. The Section has also been shortened, since provisions for factory-built fireplaces have been moved to Section 34.

The main reason for concern about fireplaces is the highly variable rate of air utilization of a fireplace, which may span a range of about 150 or 200 L/s down to zero. In view of the relatively large impact which the fireplace combustion air system can have on the total air exchange in and out of an airtight dwelling, it is evident that great care must be takento reduce the safety hazards which would result from the interaction of the combustion air system of a fireplace and the ventilation air system of the dwelling.

Section 22 as now written will allow a fireplace only if it conforms to stringent requirements for air supply and isolation from the living areas. Currently available fireplaces will probably fail to meet these criteria, especially in the design of fireplace doors. This undoubtedly imposes a burden on designers building in areas where firewood is cheap, and it will be argued that fireplaces have shown themselves to be safe in the past. It must be considered, however, that the use of fireplaces in B(l), B(2) relatively airtight houses is a new situation, and that the provisions of this Section are a rational response to it.

Two of the clauses are adopted from a recent CSA Standard for Factory-built Fireplaces. The first fixes the proportion between intake and flue areas, thereby ensuring an adequate supply of outdoor combustion air. The second specifies that the air intake shall have a damper, and that it shall be interlocked with the flue damper, so that it becomes impossible cooperate the fireplace with the outdoor air intake in the closed position. B(3) G(2)

The new requirement for installing the fireplace within the building envelope has led toa simplification of certain previous RS 1980 clauses, which specified the thicknesses of fireplace walls and smoke chambers for fireplaces exposedto the outdoors, a situation which cannot now occur. B(4) D(l), H(2)

SECTION 23: WOOD-FRAME CONSTRUCTION

Relatively few changes have been proposed for this lengthy Section.

Two clauses in the Subsection on allowable spans have been modified according to 1985 draft NBC proposals. Minor modifications have been made to requirements for sill plates, in the interests of flexibility. A major additions a clause specifying deep section steel or wood members for beams supported by piers or footings on permafrost. This measure reflects severe problems which have been encountered in the North with differential movement of beams which are adequate to meet superimposed loads, but lack sufficient stiffness to reduce the effects of movement. Several other changes in the same Subsection are due to proposed NBC proposals. Finally, the Northern Measures has added a performance requirement for the prevention of overturning and lateral distortion of beams, again in response to northern experience with problems in this area. Subsection G(2) H(3) H(5) to H(8) H(n)

Almost all changes in subsequent clauses originate with NBC proposals, and are minor in their impact. One exception is the addition of 2 new Subsections, one of which permits some scope for the use of new types of framing and another which provides for the drainage of exterior walls (See also 26D(17). addition, several clauses throughout the Section that contain the term "sheathing paper", have been changed inthe Northern Measures to "sheathing membrane". Subsections S and T

SECTION 24: SOLID WOOD WALL CONSTRUCTION

This Section formerly covered post, beam and plank construction, but it was felt that all solid wood wall construction should be addressed, including log houses in particular.

The log-house Subsection (G) is however blank, since a CMHC/Log Builder's Association Task Force is working to develop a nationally acceptable standard, which will be included in the Northern Measures as soonas it is reviewed and available.

The few changes which have been made in this Section have been taken from proposals made for the 1985 draft NBC, except for two clauses in which the term "sheathing paper" have been replaced by '*sheathing membrane".

SECTION 25: SHEET STEEL STUD WALL FRAMING

Minor changes have been made in Subsection A, where cross-references are added. Changes proposed to the 1985 NBC have been adopted in the Subsection on installation of framing. Subsection

SECTION 26: THERMAL INSULATION AND THE PREVENTION OF CONCEALED CONDENSATION

This section has been completely revised from the corresponding section in Residential Standards 1980. The overall objectives of the new section are to ensure that sufficient insulation is provided to result in an economic level of energy conservation and that action is taken to control air leakage, both to promote energy conservation and to ensure the durability of the building.

Clauses B(2) and B(3) provides alternative ways of determining the overall thermal resistance of the above ground portion of a building based upon life cycle costing. B(2), B(3)

As insulation is added to a building assembly, the construction cost of that assembly is increased, but the heat lost through it, and thus the energy cost, is reduced. The construction cost is a one-time capital expenditure, usually paid for by means of a mortgage, and the ccst of heating is an continuing expenditure which will change, as the cost of fuel changes. These factors tend to make a comparison difficult, but the life cycle costing technique allows a valid comparison to be made, and can be used to show which level of thermal performance results in the lowest total expenditure, expressed in terms of present-day costs. The factors that must be considered are:

Temperature and time as expressed by degree days x the hours in a day	24D
An adjustment factor that relates degree days to the change in the amount of energy needed to heat the building that is caused by a change in thermal resistance of the building envelope	k
The cost of unit quantity of fuel	C
The energy content of unit quantity of fuel	F
The seasonal efficiency of the heating equipment	E
The cost of adding each increment of insulation	B
The rate of increase in the cost of fuel	e
The rate of interest on money	i
The economic life of the building	n

The last three factors can be combined to give the present worth factor (P) which is used to convert the cost of heating in future years to their equivalent present value so that they can be combined with the present day cost of constructing the building assembly. The formula used to do this is:

$$P = \frac{1+e}{i-e}\left[1 - \frac{1+e}{1+i}\right]^{n}$$

Then the thermal resistance that gives the minimum combined construction and heating cost is given by:

$$RSI_{opt} = \sqrt{\frac{24\ kDCP}{EFB}}$$

The following values have been chosen for several of these factors:

k = 0.83
F = 10450 W.h/L of heating oil
E = 70% = 0.7
e = 10% = 0.1
i = 13% = 0.13
n = 25 years

giving $P = 18$

and $$RSI_{opt} = 0.22\sqrt{\frac{DC}{B}}$$

The formula is given in clause 26B (3) and it is the responsibility of the authority having jurisdiction to select suitable values for the costs of adding insulation and the cost of heating oil in its region. The cost of heating oil must be used even though it may be intended to use an alternate fuel such as wood. This is necessary since oil is by far the most widely used fuel in the north and the building may be converted to oil heat at some future date.

The authority having jurisdiction may be a central authority that constructs buildings in many locations. In such a case, the authority may select some average values for B, C and D throughout its area, to standardize the type of construction used, or, alternatively, two or three value for different areas to standardize the types of construction.

The values in Table 26A were derived from the formula on the basis that at most locations in the North there is a rough relationship of 10 to 1 between the cost of adding insulation (B) and the cost of a litre of heating oil(C).

It will be noted that, unlike some energy conservation recommendations for the south, only one RSI value is given for the above ground portion of the building envelope. In southern construction the cost of adding insulation varies widely with the assembly that is being insulated. Large quantities of insulation can be added in attics relatively cheaply but it requires a modified type of construction to provide space for insulation in a wall. In the North, with the larger amounts of insulation that are used, it is probable that similar construction techniques will be used for floors, walls and roofs, i.e., a trussed system of some form. Thus the cost of adding insulation will be similar in all parts of the envelope and so only one RSI value is specified.

The economies of ins ulat ion applied to f oundat ion walls below ground is not so well established as for above ground assemblies. Thus the below ground insulation value has been set for all. locations as equivalent to 50 mm of extruded foamed polystyrene. Above ground, it is assumed that insulated wood construction can be used to cover the outside face of a concrete wall and so thermal resistances equal to half of those specified for above-ground building assemblies have been specified. The change over from one insulation value to the other is specified as being at 250 mm above ground to give some small margin above the 200 mm below which wood siding cannot be used (See 28 B(2)). B(4)

A special problem is presented by those concrete or masonry basement walls that have more than 50% of the face of any one wall exposed to the outside air. A reduced level of insulation on such a wall relative to the superstructure could lead to unacceptably high rates of heat ices and so the portion more than 250 mm above ground is required to be insulated as for the superstructure. Concrete and masonry should not be used for the above ground parts of such walls but rather a change should be made to timber or steel cons truction.

Finally, foundation walls other than those of concrete or masonry, i.e. wood or steel walls, are required to have their portions more than 250 mm above ground insulated as for the superstructure since they are really of the same type of construction. [See also D(6) and (7)].

In certain circumstances it may be desirable to deviate from the strict application of the thermal requirements of the Northern Measures. For example, in some particular types of construction it may be uneconomic to put the full amount of insulation in all assemblies, or a spectacular view may make a larger window desirable. B(5) gives the designer the option to reduce the thermal performance of some parts of B(5), B(6) the building provided that the thermal performance of other assemblies is increased to compensate. B(6), however, puts a lower limit on the thermal resistance of any above ground building assembly which means that the possible reduction in thermal resistance in milder locations is relatively small. This absolute minimum thermal resistance was considered to be essential to ensure that no assembly could be left more or less uninsulated no matter how much extra insulation was added elsewhere.

Once insulation has been built into the building envelope it is costly to add more, whereas mechanical systems can be changed relatively easily. Some devices, such as for heat recovery, are not essential for the operation of the building and could simply be switched off or not repaired if they failed. The efficiency of others may fall off because of poor maintenance. Should this happen, after the thermal performance of the building envelope had been reduced in anticipation of higher than normal performance of the mechanical system, the result would be an energy inefficient building. Such trade-offs are prohibited by B(7). B(7)

B(2) and (3) require only one R value for the whole envelope and so B(8) will be required only when attic insulation has been increased under the provisions of B(5). B(8)

Generally, it is bad practice to carry air ducts outside of the insulated envelope both because of the extra heat loss and because of potential air leakage passages at the points where the duct passes through the air barrier. It should never be necessary to do so with new buildings but may be unavoidable with the reconstruction of existing ones. Where the situation cannot be avoided the requirement that the duct be sealed against air leakage and insulated to the same level as the building envelope is a minimum requirement. Ducts carrying heated air have a greater temperature difference from the outside air than the building and so the thermal resistance must be increased proportionately. B(14)

Air leakage can redefined as theunwanted or unintended movement of air into or out of the conditioned space inside a building. In addition to increasing the energy consumption of the building and possibly causing cold draughts, such uncontrolled movement of air is frequently a prime cause of c(l), c(2) see also C(5), C(6) deterioration of the building envelope. An inward flow of cold air may cool the portions of the envelope that are inside the insulation and so cause condensation on the interior surfaces. An outward flow of air may carry considerable quantities of water vapour with it, leading to condensation within the building envelope and subsequent damage. A convective flow of air from the room into the envelope and back to the room can also deposit water in the envelope without there being a leak to the outside.

While air movement is usually the prime mechanism for moving water vapour to a point where it may condense the effects of vapour diffusion should not be ignored. Vapour diffusion takes place when there is a difference in the moisture content of the air producing a difference in vapour pressure. It should be noted that the moisture content of the air is not the same as relative humidity which for a fixed moisture content varies with temperature.

To stop the movement of air, an air barrier must be created and since large quantities of moisture can be swept through even relatively small holes this air barrier must be continuous. Similarly to stop moisture movement by diffusion a vapour barrier is needed. These two barriers should be combined in one air-vapour barrier.

Since the air barrier is the component in the building C(4)
envelope that stops the passage of air it seems almost superfluous to specify that it must be strong enough to carry the wind load. However, since it is located towards the inside surface of the building envelope, (see C(8)) the fact that wind pressure can act through holes that occur In the outer skin of the envelope to press against the air barrier is often overlooked. Holes in the outer skin can occur either by chance but frequently they are provided as part of an open rain screen design, for ventilation of the cladding or for drainage. [See D(17)].

As a separate, but related issue, it must be pointed out that while the wind pressure acting inside the thickness of the envelope is not harmful, a flow of cold outside air through the insulation destroys the effectiveness of the insulation. Such flows must be stopped by compartmentali zing the envelope especially at and near changes in direction. (See D(13))

Ducts should pass straight through the building envelope and in new construction should be restricted to intake and exhaust ducts. It is important that moist exhaust air should not be blown into the insulat ad envelope and that a flow of cold outside air should not be induced by a leaky intake. c(7)

When an air-vapour barrier is installed in the envelope it must be assumed that room air and humidity will come in contact with it. Thus, if condensation is not to occur on it, the air-vapour barrier must be kept above the dew point temperature of the room air. This is the underlying purpose of C(8). However just to specify it in that way could present some problems of interpretation as to what the dew point temperature might be and how to calculate the temperature gradient through the envelope. c(8)

By calculation it can be shown that when the outside temperature Is -35°C and when one-quarter of the total thermal resistance of the envelope is on the warm side, or when the outside temperature is -50°C and one-fifth of the total thermal resistance is on the warm side, the air-vapour barrier will remain above the dew point temperature of the room air until the relative humidity rises above about 39% with a room temperature of 22° C. Since, with a fixed inside temperature, the temperature at any point through the envelope will vary directly in proportion with changes in the outside temperature, the proportion of the total thermal resistance that can be positioned on the warm side of the air-vapour barrier can be obtained by interpolation between these values.

If the inside temperature or relative humidity is expected to vary significantly, from 39% at 22*C, the position of the dew point temperature relative to the air-vapour barrier in the proposed construction should be checked by calculation.

There is a wide variety of metal framing members that may increase the heat loss from the building. The requirement that the thermal resistance of the heat flow path through them be increased by their being covered with at least 25% of the thermal resistance required by B(2) or B(3)is a rule of thumb taken from the Measures for Energy Conservation in New Buildings issued by the Associate c(9)

Committee on the National Building Code. There is no requirement for this extra insulation to be applied on the outside. However if it is applied on the **inside** and the **air-vapour** barrier is in contact with the framing member, as is possible under the provisions of C(8), the **air-vapour** barrier could be very cold at the points of contact with an attendant risk of condensation.

Subsection 34D requires that the products of combustion be prevented from being drawn into the habitable part of the building either by the use of suitably designed equipment or by the appliance being installed In a separate service room. Subsection 5M requires that an **air** barrier be installed between a service room and the habitable spaces and that this installation be in accordance with subsection 26C. However, 26C only refers to **air-vapour** barriers and so this clause has been added to ensure that all the necessary steps are taken to seal the air barrier. **C(10)**

For the insulation to be effective it is essential that currents of air should be prevented from flowing through or around It. Preferably, therefore, it should be faced on all sides with an air impermeable **material.In** some instances, however, this may not be possible, as is usually the **casewith** insulation applied over a ceiling in an attic. But in all cases, the insulation must be in contact with the **air-vapour** barrier at least since this **is** theone layer that is called upon to be both air tight and continuous; all other layers could have holes in them through which **air** could circulate to bypass the insulation. D(l), D(2) **and** D(3)

Loose **fill** insulation almost invariably settles after installation. With a horizontal or nearly horizontal surface this will cause a slight reduction in insulating value over the whole area and **in** many cases a thicker layer of insulation can be installed initially to allow for this. With vertical faces, such as a wall stud space, settlement will leave an uninsulated space at the **top** and it is not **possible** to provide for this during construction (see **also D(12))**. D(5)

Heat **loss** through basement walls can be a major component of the total building heat loss. It has been found that even in southern locations adding insulation on the D(6) inside of a concrete wall does not reduce the heat loss as much as might be expected unless the insulation is carried down to the level of the basement floor because the heat is conducted up the wall to be lost from the exposed face above ground. Furthermore, insulation on the inside of the wall subjects the top portion of the wall to a greater range of temperatures thus increasing the risk of cracking because of expansion and contraction and of damage on freezing. Thus it is preferable to place all of the insulationon the outside but for practical reasons this may be difficult in some cases. Carrying at least the below ground insulation on the outside from basement floor level to the top of the wall gives the wall some protection and reduces the heat lost by conduction up the wall. Wood and steel foundation walls are exempted sinced they would have insulation within their thickness as for above ground construction.

If a large proportion of a concrete or masonry wall projects out of the ground the heat lest by conduction up the wall and dissipation to the air will be greatly increased relative to the wall with only a small amount above ground. Thus if more than half of the wall is exposed to the air all of the insulaton required for the upper portion must be applied on the outside. In other cases the designer has the option of putting it on the inaide. D(7)

As stated with respect to B(4) concrete or masonry should not be used for the above ground parts of such walls.

Wood and steel foundation walls are exempted since they would have insulation within their thickness as for above ground construction.

Clauses D(8) and D(9) deal with opposite conditions. D(8) relates to the condition of a building built on permafrost whose bearing strengthis reduced whenit thaws. In such a case, the ground must be kept frozen and insulation placed under a slab on ground, for example, to restrict the heat flow from the building into the ground. D(8), D(9)

D(9) on the other hand relates to a soil that is stable when not frozen but which will heave as it freezes. Silts and clays are examples of such frost susceptible soils whereas coarse sand and gravel are not. With one of the frost susceptible soils heat must be allowed to reach the soil to prevent it from freezing. D(9)

The vast majority of insulating materials derive their thermal resistance from the air that **is** trapped within them. The function of the matrix of **fibres** or foam is to prevent, or at least slow down, the movement of this air under the action of the convective forces that will inevitably be set up by the temperature difference between one side and the other. These forces are relatively small when compared to wind forces and fibrous or open cell foam **insulating** materials are quite incapable of stopping the wind from blowing through them. Closed cell foams or those that have an impervious skin applied to them will stop the wind but unless the joints are sealed perfectly the wind could still penetrate to what was meant to be the warm side of the insulation. If the joints are sealed perfectly then the insulation becomes an air barrier and must be capable of withstanding the wind **load.** On the **other** hand, if the insulation is in full contact with the air barrier (see D(l)) then there will not be a space on the warm side to allow passage of the wind and so the joints in the boards of insulation will not need to be sealed. **D(13)**

Fibrous emulations must be in contact with the air barrier to stop convective flow around them but evenso they have so little resistance to wind induced air flows that It is essential that their cuter faces be covered to stop the wind from blowing through them. In addition, this outer covering must keep rain and snow out of both the insulation and the fabric of the building envelope. Finally **it** must protect those materials (principally plastic) that are deteriorated by solar radiation. With all these functions to perform it should be refered to as a weather barrier.

In short a "weather barrier" can be defined as "'a covering provided to keep wind-induced air flow out of the insulation and to protect the building envelope from rain, snow and ultra violet radiation".

It should **also be** recognized that the weather barrieris not intended to prevent the wind from blowing straight through the envelope and into the building - that is the function of the **air barrier -** but it **is** intended to prevent the sideways flow of air within the insulated envelope itself.

There are, however, other requirements that may have to be met at the same time. Despite the efforts that will have been made to make aperfect air-vapour barrier (see C(l)) one cannot be certain that perfection will be achieved. Some vapour will still diffuse out and some air leaks will occur. It is important that any moisture that moves outward from the building is not trapped in the envelope by the weather barrier. As a minimum, the weather barrier should be sufficiently pervious to vapour diffusion that at least the water vapour that diffuses through the air-vapour barrier should continue to diffuse to the outside and not condense. That this condition has been met can be determined to some extent by calculating the vapour pressure gradient through the building envelope following generally accepted procedures such as are given in Chapter 21 of the ASHRAE Handbook of Fundamentals or Canadian Building Digest No.57. Such calculations are at best approximate because of the limited amount of data about the permeability of building materials and, in addition, they take no account of air movement.

It is virtually impossible to calculate the quantity of condensation that will take place because of air movement since, in most cases, one does not know where the hole is or how big it is. Because of the long periods of cold weather in the North it is prudent to assume that considerable quantities of water can be deposited on the inside of the weather barrier. This will probably be in the form of hoar frost or ice. As such, it is unlikely to be harmful to the fabric of the envelope until it melts when large quantities of water can be released at one time. In this event it is desirable to drain the water to the outside as quickly as possible and then to rely upon diffusion to dry out the remaining moisture. However, providing holes for drainage also provides a path for the wind to blow in.

The problem is that the designer is faced with an uncertainty as to whether his design, as constructed by the available labour force and under the conditions prevailing at the work site, will have a perfect air-vapour barrier, in which case there will be no condensed water to drain out, or whether there will be imperfections in the air-vapour barrier leading to an accummulation of water that will have to be drained out.

To reconcile the need to step the wind from blowing through or around the insulation with that of providing drainage holes to drain water out of the envelope, the envelope must be divided into compartments so that in moat of them the compartment is sealed against further movement of air within the envelope. The wind will then only pressurize the compartment and there will be no flow of air through It. If the air-vapour barrier is defective then the compartment will not be sealed against the inward movement of air and the wind will be able to blow through it and into the building. If this air flow is large the hole in the air barrier should be repaired. If it is small then the leak of air into the building will probably not be noticed. This is the situation with the outward flow of air when the wind is blowing in the opposite direction. Such an outward flow could carry large amounts of water into the envelope giving the condition when it needs to be drained out.

Lateral flow of air within the insulated cavity of the envelope can still occur even with no air flow into or out of the building because of the variation in wind pressure around the building. This can be particularly severe at changes in direction because the face on which the wind is blowing will have a positive pressure on it whereas round the corner it is probable that there will be a suction.

With ventilated attics or roof spaces there is a danger that the wind which enters through the vent will blow into the open end of the insulation. Also, because of turbulence, there is a danger that the wind will enter the top surface of the insulation near the vent. These two dangers are overcome by covering both the edges and the top surface with an sir impervious material. Further away from the vent it is thought that the air flow will stay out of the insulation, making a top cover unnecessary. D(14)

In the case of ventilated attics the air flow can be directed up the under side of the roof sheathing clear of the insulation by the use of suitable ventilation passages.

The vapourpermeanceof the weather barrier determines whether D(15) or D(16) will apply. D(15) embodies what was for many years the basic philosophy on the control of D(15), D(16) condensation In walls. That is that vapour diffusion is the main driving force that leads to condensation and if the permeance of the outer layers is much greater than that of the inner, then the small quantity of vapour that diffuses into the wall will be able to cent inue on to the outside. Now that air leakage is recognized as being the prime driving force, the principle of cent inuit y of vapour diffusion is recognized as being incomplete. However since the wall is required by C(1) to have an airtight and highly Impervious air-vapour barrier located near the warm side, the quantity of water vapour that penetrates into the wall should be small. Thus, if this small quantity of water can dry out by diffusion during the summer months, no serious damage should occur. Furthermore, with the added protection of an air tight outer layer, the possibility of serious air leakage is reduced and the resulting condensation should also be able to dry out.

If, on the other hand, the weather barrier is made from materials with a low permeance to water vapour, it is possible that any condensation in the wall will not be able to dry out by diffusion. In this case it becomes necessary to make provision for the water to drain out (See D(18)) and in doing so the weather barrier ceases to be air tight. Now it becomes necessary to stop the wind from blowing in at one drainage hole and out at another by dividing the wall cavit y into compartments.

The greatest wind pressure differences that would cause a lateral flow of air in the wall occur at changes in direct ion and so a compartment must not cent inue round such a change. Divisions are needed at the junction between a wall and a roof, between a wall and an elevated first floor where the wind can blow under the building and at each change in direction of plane walls. Since the wind pressure is not uniform even over the plane wall face additional divisions are called for at each floor level and the maximum dimension for any compartment is set at 12 m, which allows each wall in all but the larges t of houses to form one compartment. Naturally a greater number of divisions would give greater security. D(18), D(19) and D(20)

Since there is a positive pressure on the windward face and there may be a suction in the face around a corner, the wind pressures change rapidly near scorner and there maybe a suction even on the windward face near the corner. Thus additional divisions are called for near any corner with a change in direction of more than 45°.

Curved walls have no corners to give natural division points, but a change in direction of 30° around a cylindrical building gives a 10 fold drop in the wind pressure coefficient; a deviation of 15" gives a 20% drop. Thus divisions are required in a curved wall at each 15° change in direction. A minimum dimension of 1 m allows for short-radius curved walls or minor deviationa from a plane wall such as bay windows. Once again, the more frequent the divisions, the greater is the security against lateral air flow in the wall.

Cold floors may be caused in some cases by wind blowing through the insulation. Thus, floors that are exposed to the outside air must be protected with a weather barrier. Since it is unlikely that dwelling air will exfiltrate through a floor to cause condensation, no special requirements have been given for vapour permeance or drainage. D(21)

Considerable quantities of heat can be lost because of air movement into and out of a building. An uncontrolled movement of air can lead to deterioration of the building (see C(1) and (2) above) and rules out the possibility of recovering some of the heat in the outgoing air. The building envelope should therefore be made air tight and ventilation air supplied in a controlled manner. E(1)

The airtightness of a building can redetermined by the CGSB Fan Pressurization method and expressed as an equivalent leakage area. This is the size of opening needed to give the same air flowat the same pressure difference as takes place through all the various openings In the building envelope. The value specified as being the maximum permitted represents what can be called moderately tight construction. It is considerably larger than what haa been achieved in practice in many houses. On the other hand, it is much less than occurs with what, until relatively recently, could be called normal construction practice. It is specified per square metre of envelope to allow for different sizes of building.

Air-vapour barriers are not required to conform to CAN2-51.33-M80 "Vapour Barrier, Sheet, for Use in Building Construction"' since h s would limit them to thin sheet materials as specified in the standard. Rather they are required to be equivalent to such vapour barriers which allows vapour permeable materials to be coated with liquid applied coatings to reduce their vapour permeance to the required value. E(5)

SECTION 27: ROOFING

Only one small change has been made in this Section, in accordance with changes proposed to the 1985 NBC. G(6)

SECTION 28: SIDING

A cross reference has been added for the spatial separations between buildings. A(5) The introduction of the term "weather barrier" in Section 26 required that clarification be provided on the relationship between siding and weather barrier - the clause inserted here is a very general performance requirement, but this will leave the designer with maximum flexibility. B(6) A performance requirement has also been added for the use of caulkings, D(3) and a change in the attachment of sidings proposed for the 1985 NBC has been adopted. E(4) The Subsection on metal sidings haa been totally revised in the draft 1985 NBC, and has been adopted here. Subsection L

SECTION 29: STUCCO

No revisions have been made in this Section.

SECTION 30: INTERIOR WALL AND CEILING FINISHES

No revisions have been made in this Section.

SECTION 31: FLOORING

No revisions have been made in this Section.

SECTION 32: PLUMBING FACILITIES

The large numberof changes that have been made in this Section reflect the large differences in levels and typesof plumbing and sanitary services in the North. Most northern houses contain water and sewage tanks within the dwelling, and the filling and emptying of tanks is done by trucked service - these unique conditions require specific solutions. Another northern concern is the serious impact that system failure can have, and the difficulty and time required to make repairs. These factors have caused the NRS to err on the side of caution in specifying plumbing systems.

The reference to domestic hot water systems being used for space heating reflects the increasing use of this type of system. The system is still in a stage of early development, and the clause is therefore expressed in very general performance terms. C(2)

A minimum pressure has been specified for water distribution systems, since field comments indicate many cases of inadequate performance. C(3)

Most of the changes in the Subsection on water supply and distribution are concentrated on the design and performance of water storage tanks. The requirements have been expressed, insofar as practicable, in performance terms, and are in accord with current good practise. C(6) to C(8)

Two additions have been made in the "Required Facilities'' Subsection. The requirement for fl.oordrains now extends to service rooms containing a water tank and provisions for hose bibs have been somewhat strengthened. D(5) D(8)

In the Subsection on sewage disposal, changes will no longer permit ''other acceptable means" of wastedispoeal for buidings with no piped water - wastes must now be piped to the building sewer in all cases. The specification that sewage tanks shall have a capacity not less than 1.5 that of the water tank is intended to provide a safety margin against overflow of the sewage tank. Other changes for sewage holding tanks, are dealt with in a manner similar to that for water tanks- an emphasis on performance standards wherever possible. E(1) E(5) E(6)

Most of the changes in this Section are concentrated in a new Subsection, "Additional Requirements". A clause specifying vent pipe design has been added as a result of many cases of frosting up of conventional vent pipes. Clauses governing faucets and urinals have been provided to encourage the conservation of water, especially important where water and sewage may be trucked. The final clause in this Subsection is intended to prevent the serious problems which would result if leakage were to occur within the building - not only a mess, but also possible leakage of water into floor insulation and a consequent loss of thermal performance.

Subsection
G(1)
G(2), G(3)
G(4)

SECTION 33: VENTILATION AND HEAT RECOVERY

This Section, together with Section 34, deals with one of the most difficult, and even controversial, aspects of the Standard. Moreover, it is one that could, quite literally, be vital to the occupants of a building.

Ventilation is defined in both the ASHRAE Handbook of Fundamentals and in ASHRAE Standard 62-1981 "Ventilation for Acceptable Indoor Air Quality" as "the process of supplying and removing air by natural or mechanical means to and from any space. Such air may or may not be conditioned".

Standard 62-1981 makes it clear that recirculated air can be used for part of the ventilation air supplied to a space prwided it is of acceptable quality. In this section, however, since air change rates are specified all of the required air must be outdoor air.

Until recently, leaky building envelopes allowed so much air to pass through them that, under most conditions all the fresh air requirements were easily met. Now building envelopes are made much tighter in the interests of energy conservation, to reduce draughts and to prevent condensation within the envelope. Thus some form of controlled ventilation is needed.

A further, and possibly more serious problem is that ventilation equipment may be in competition for air with combustion equipment. This could lead to the products of combustion being drawn into the building instead of being vented safely to the outdoors. Thus the requirements of the ventilation system and the requirements of combustion equipment for air for combustion and dilution become inextricably entwined unless the combustion process la separated physically from the air in the habitable part of the building (See 34C and D).

Although ASHRAE Standard 62-1981 is not cited in this Standard the prudent designer should note that it requires that:

(i) "Where natural ventilation and infiltration are used, the ventilation rate shall be demonstrable"

(ii) "'Where infiltration supplies all or part of the combustion air, the supply rate of combustion air must be demonstrable"

The first of these requirements is particularly relevant to the requirements of Subsection E.

Other than for simple systems serving only one dwelling unit mechanical ventilation systems should be designed by a professional designer of such systems. They are, therefore, excluded from the Northern Measures and the designer is required to meet all the provisions of Part 6 of the National Building Code. A(l), A(2) and A(3)

This clause allows for the installation of a bathroom or kitchen exhaust fan which is not intended to form a full mechanical ventilation system. In such a case a natural ventilation system must be provided. B(3)

The requirements of clause B(4) could be met in most cases by the provision of a range hood or an exhaust fan drawing air from over or near the source of the contaminants. B(4)

Air will be restricted from entering a space if it cannot displace the air that is already there. The displaced air could leave via a return air system or through a louvered vent in the door or through a space under the door, in which case allowance should be made for the possible installation of a thick carpet. B(7)

The ventilation areas given in Table 33A are as given in the National Building Code with the addition of work rooms and service rmms which have been made the same as bathrooms. The requirement that ventilation shall not be **through** an unheated room or space has been added to avoid the possibility of warm humid **air** being discharged into an area that may not be insulated and which as a result would become **loaded** with **frost** and ice. c(1)

It has been shown on many occasions that openable windows are not a satisfactory means of providing ventilation. They usually lead to cold draughts and frequently cannot be **closed** again because of ice formation on the jambs. Specially designed ventilation **openings** are considered to be a better solution in that their size and location are not restricted by the requirements of a window. There is also some scope to design the vent **closure** so that it will not suffer from **frost** problems; something that is difficult to achieve with the relatively thin sash of a window. Improved designs of windows may, however, overcome these problems in which case C(2) allows them to be used. c(2), c(3)

While a mechanical ventilation system must be designed to be able to provide ventilation air at a rate of 1.0 ach and of **operating** continuously it is not intended that this rate should be maintained at all times. The system must be controllable to suit the needs of the occupants and capable of being switched off when the dwelling **is** unoccupied. D(1)

The requirement of D(2) will, in most cases, preclude the positioning of intakes and exhausts on walls. With elevated buildings air could be drawn from the open crawl space below the floor but should be located near the centre of the building to avoid eddy or venturi effects near the edge. Since elevated buildings are used in permafrost areas, warm exhaust **air** should not be discharged below the floor. Exhausts and also intakes could be taken through the roof, preferably near and some distance above the highest point so as to be in a location reasonably free of turbulence no matter which way the wind may be blowing.

The discharge from a laundry dryer is Inevitably humid and so may add excessive humidity to the **building.** In D(5) addition some laundry products such as fabric softeners may give off undesirable pollutants. To prevent the buildup of humidity or pollutants the dryer should be ducted to the outdoors.

The requirements of Subsection E apply to both natural and mechanical ventilation systems. Subsection E

Outdoor air introduced into the return air duct will remain as a separate stream for some considerable distance. If this separate stream of very cold air reaches the heating equipment it will produce local cold spots on the heat exchanger that could cause condensation of the flue gases leading to corrosion and premature failure of the heat exchanger. The outdoor air should be dispersed throughout the air stream in the duct or turbulence promoted to mix the two air streams. Extra turbulence in the air flow will cause additional resistance and so reduce the airflow. It has been suggested that sufficient mixing of the two flows will take place if they have to pass round two right angle bends in the duct before reaching the heat exchanger. E(4)

The whole purpose of providing a combustion equipment room is to separate the combustion and dilution air from the house air [See 34 C(1)]. If an intake duct that passes through such a room is not airtight then this separation will not be achieved. E(6)

The purpose of insulating an exhaust duct is to prevent condensation and corrosion within it and, in extreme cases, blockage by ice. E(7)

Devices that recover heat from the exhaust air, such as air-to-air heat exchangers, are sometimes referred to as ventilation systems, since the fans that provide the flow of ventilating air are often built in as part of the equipment. Such terminology is not correct since the ventilation system must operate with or without heat recovery. The purpose of clause F(1) is to ensure that ventilation is provided even though the heat recovery device may have failed or been disconnected for any reason. F(1)

SECTION 34: HEATING, COMBUSTION EQUIPMENT AND AIR CONDITIONING

This Section has been greatly revised from the 1980 Residential Standards mainly in conformance with the layout of the proposed revisions for the 1985 edition of the National Building Code. The dual underling objectives of the Section remain unchanged, however; First to ensure that buildings are heated adequately and secondly to achieve this ir a safe manner. The first objective is achieved quite simply by specifying the inside temperature to be maintained with agiven outside design temperature. The second requires that careful attention be given to the details of the installation to ensure that the products of combustion are discharged to the outdoors and that suitable clearances are maintained between the components of the system and combustible material.

Clauses B(1) to B(3) define the inside temperature conditions that the heating system must be able to maintain, give a reference as tohow the design outside temperature is to be established and give guidance as to how the design calculations are to be performed. B(l), B(2) and B(3)

Some combustion equipment is designed with an airtight casing that allows the combustion and dilution air to be ducted straight from the outdoors without contact with the air In the room or space in which the equipment is located. It is considered that the use of equipment of this type is the solution to the problem of ensuring that the products of combustion cannot be drawn into the habitable parts of the building. Unfortunately there is as yet only a limited number of such appliances but more are being developed. Clause C(1) is, therefore, given priority as being the way togo for the future. Clause C(2) recognizes that at present it is probable that conventional equipment that draws its air supply from the room within which it is located will have to be used in most cases. Such equipment must be located in a combustion equipment room [See D(l)] and the required resistance to the back drafting of the gases is provided by the walls, ceiling and floor of that room (See Subsection 5M). c(l), c(2) which remain completely closed except at the time of refueling. Combination stoves, that can be operated with the front open as an open fire, will therefore not be permissible under Subsection L.

SECTION 35: ELECTRICAL FACILITIES

The 1985 draft NBC has updated the reference to the CSA Code to the current 1982 edition. A(2)

A clause has been added to ensure that service panels have adequate capacity for modern requirements. A(5)

Clauses A(6) and A(7) are intended to protect the integrity of the **air-vapour** barrier. This is a very important part of the Northern Measures, since most projections of performance are based on the assumption that the **air-vapour** barrier is intact, and since punctures and tears are a very common consequence of electrical work. It is strongly suggested that the best way of avoiding the problem is to keep wiring out of the building envelope; if this is impossible, then the use of poly pans will reduce the possibility of problems. A(6), A(7)

Although the CSA Code is referenced In A(2), it was decided to add A(8) to draw attention to a specific new clause in the 1982 CSA Code dealing with wiring in insulated walls. A(8)

Clause A(9) is aimed at ensuring that penetrations of the building envelope are sealed, and that deterioration is not caused by incompatible materials. A(9)

This clause is intended to reduce the possibility of overheating of service panels which could occur in an insulated space. A(n)

The requirements for ground fault interrupters are covered in the CSA Standard, which is a required reference in this Section, but a specific reference has been added here to improve the chances of adherence. **A(13)**

The scope of B(2) has been expanded. The term "service room" now includes both utility rooms and combustion equipment rooms. B(2)

Requirements for receptacles have been augmented. "Service rooms'" has replaced '*utility rooms'" in C(l), and the requirement for two duplex receptacles in kitchens haa been increased to two split duplex receptacles. In C(4), a duplex receptacle is now also required in work rooms and in service rooms. C(6) extends the requirement for special purpose outlets from electric ranges to clothes dryers. c(l), c(3) C(4), c(6)

A duplex receptacle is now required for the parking space of each dwelling unit. it is anticipated that the added requirement for an interior switch will result In considerable energy savings, since block heaters will now be less likely to remain switched on for 24 hours per day. c(8)

Finally, a cross-reference has been provided to Section 10 for alarm wiring. D(2)

SECTION 36: GARAGES

No changes have been proposed for this Section.

SECTION 37: ELEVATORS

No changes have been proposed for this Section.

SECTION 38: PAINTING

Few changes have been made in this Section. A new clause has been added to ensure that wood surfaces are dry enough to provide adhesion for paint. Clause B(1) has been modified to clarify the point that staining is an acceptable alternative to painting. Finally, a new clause will ensure that moisture which emanates from areas behind siding will be able to escape through the paint surface. A(5) B(1) B(3)

SECTION 39: WALKWAYS, DRIVEWAYS AND PARKING AREAS

Only one clause has been modified in this Section, to provide a wider choice in the construct Ion of walkways. C(9)

SECTION 40: SITE IMPROVEMENT

This Sect ion has been extensively modif led, mainly through rearrangement and amplification.

A(2) and A(3) attempt to ensure that a survey and analysis of the site takes place before construction, and to enable some degree of control over site development in order to avoid damage to the relatively fragile sites of the North. A(2), A(3)

A(4) and A(6) are intended to protect the environment by protection and reutilization of natural drainage patterns, vegetative cover and scarce fertile soil. A(5) deals with siting, to protect buildings from the effects of wind, flood and excessive snow accummulations. The clause is written in general performance terms, in view of the widely varying conditions in the North. A(4), A(6) A(5)

All of the clauses of Subsection B have been amplified in order to meet special northern conditions. B(1) and B(2) are stated in very general terms, but offer leverage to prevent unnecessary damage. B(3) to B(7) are clauses from RS 1980 which have been modified. Subsection B B(l), B(2) B(3) to B(7)

Subsection C has been considerably enlarged to ensure proper treatment of grading and topsoil, both of which are of crucial importance in northern sites. Subsection C

Two new clauses have been added to Subsection D. D(4) requires protection of erodable slopes where grass cannot be used, by specifying the use of rip-rap or the creation of conditions f avourable to re-veget ation. D(5) extends this by specifying conditions which will facilitate re-vegetation. D(4) D(5)