Guide for the Application of Part 9 of the National Building Code to Existing Buildings

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NOTE: **DISPONIBLE AUSSI EN FRANÇAIS SOUS LE TITRE:**

GUIDE D'APPLICATION DE LA PARTIE 9 DU CODE NATIONAL DU BÂTIMENT AUX IMMEUBLES EXISTANTS

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Preface

In the early 1980's, the Associate Committee on the National Building Code (now the Canadian Commission on Building and Fire Codes, or CCBFC) considered the issue of renovation requirements for existing buildings. A special task force was created to develop a procedure to deal with this issue. As a result, it was agreed that each Standing Committee should develop appropriate guidelines for applying the National Building Code to existing buildings.

The merits of having a separate code for existing buildings was weighed against the alternative of having guidelines to explain how the existing code requirements could be applied to such cases. It was concluded at that time that the flexibility offered by guidelines was preferred over specific code requirements which allowed less flexibility and which had the effect of creating a double standard.

Technical committees working under the aegis of the CCBFC proceeded to work on the development of suitable guidelines. "Guidelines for the Application of Part 3 of the National Building Code to Existing Buildings" was published by the National Research Council in 1993. Work on Part 9 was delayed, pending the completion of the Guidelines for Part 3, although some preliminary work had been carried out.

The debate about guidelines versus a separate code requirements for existing buildings continued, however. Several jurisdictions opted for the latter approach and had already enacted specific regulations allowing less restrictive requirements for existing buildings.

The concern that requirements aimed specifically at existing buildings would imply different levels of safety is valid, however, and needs to be addressed. At the same time, it is appreciated that if the standards are not sufficiently specific, both the owner and the enforcement official can be placed in an awkward position. The owner does not know what has to be done to conform to the law, and may be subject to the whims of the enforcing official. The enforcing official, on the other hand, is at legal risk if he allows a deviation from requirements for new buildings without adequate justification, or waives a requirement that may result in future damage claims. This could result in unnecessary conservatism on the part of the enforcing official.

In the light of these on-going arguments on the merits of guidelines versus specific requirements, a background paper on renovation sponsored by Canada Mortgage and Housing Corporation was presented at the Canadian Renovation Council in Charlottetown in 1992. Diverse opinions were expressed in the merits of having specific alternative requirements or guidelines to regulate existing buildings. As a result of this meeting, CMHC agreed to sponsor the "Housing Renovation Code Forum", bringing together various concerned interests in renovation requirements. This was held in Ottawa towards the latter part of 1992.

One of the results of this Forum was a recommendation to the Provincial/Territorial Committee on Building Standards (PTCBS) that the "Administrative Requirements for Use with the National Building Code", published by NRC, be broadened to cover existing buildings as well as triggering mechanisms that bring existing buildings within the scope of building Code requirements. The Forum also recommended that deemed-to-satisfy requirements for the application of Part 9 to existing buildings be developed, as opposed to the guidelines currently proposed for Part 9 by the CCBFC. These recommendations were subsequently presented to the PTCBS by CMHC.

In the light of the CMHC presentation, it was proposed by the PTCBS that the guidelines "should be written in a form that could be codified".

This report is a result of that recommendation. It was commissioned by CMHC to address the concerns of those who wished to have more specific direction in the regulation of existing buildings, while at the same time taking into account the concerns expressed by the CCBFC on the desirability of flexibility and a common implied level of health and safety for the occupants in all buildings, new or old.

The report is presented in three chapters. The first discusses the principles by which code requirements should be applied to existing buildings. The second outlines the aims and objectives of each Article in Part 9. The third chapter is a compilation of 50 examples of typical problems that may arise in applying the National Building Code to existing buildings. Solutions to these problems are suggested, together with an explanation as to how the alternative design solutions were reached.

A new Section proposed for inclusion in Part 9 is presented in Appendix A. The purpose of this new Section is to provide specific requirements for the regulation of existing buildings to the extent that this is practicable. It is intended to provide a legal bridge between the requirements of the NBC and the information in this Guide. It is proposed that the new Section will be used in concert with this Guide to allow a flexible approach in regulating existing buildings, while at the same time providing code users more specific direction on the extent to which the NBC should be applied to existing buildings.

The opinions expressed in this draft Guide are those of the author, and do not necessarily reflect the views of Canada Mortgage and Housing Corporation who sponsored this work. This Guide has no official status, and is intended solely for presentation to the CCBFC for review by their Standing Committee on Part 9. as an approach that can be considered in the regulation of existing buildings.

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Chapter 1

Principles for Regulating Existing Buildings

Introduction

Each existing building that undergoes renovation, expansion or a change of occupancy presents a unique problem for code users to determine the extent to which the existing building must be brought into line with current building regulations. It is obvious that buildings constructed to earlier codes will not meet current requirements due to code revisions that have occurred over the years and the natural aging process of buildings. It is also obvious that it is impractical to require that buildings constructed to earlier editions conform to the current Code due to the economic burdens this would cause. The purpose of this Chapter, therefore, is to outline certain principles that should be followed in determining the degree to which existing buildings should conform to current requirements.

Chapter 2 of this Guide is a compilation of the objectives and reasons for each of the nearly 1000 Articles that constitute Part 9. This is considered to be the logical starting point in evaluating alternative design solutions that may be proposed when it is not practicable to follow a literal interpretation of code requirements.

Some of these explanations may appear obvious to many code users since many requirements are self-explanatory. Others may seem to lack specificity through the use of terms such as "reasonable", "adequate", "appropriate", "excessive", "sufficient", and "significant". Their use, however, is unavoidable, in that no specific performance limits have been established by code writers in framing such requirements. However, a prescriptive design solution specified by each Article implies an inherent level of safety or performance and provides a basis of comparison with alternative solutions. Part 2 therefore is proposed as an educational tool to focus code users' attention on the real purpose of the requirement. Knowing this, the user is in a better position to evaluate the merits of alternative proposals.

Chapter 3 presents a collection of fifty typical problems that may arise when a building is renovated or an occupancy is changed. These examples demonstrate how the National Building Code can be used as a guide in providing a safe and healthful environment for building occupants when it is not practical to follow a literal application of requirements designed for new buildings. It is intended that these examples provide a nucleus to which can be added other typical situations faced by those engaged in renovation work.

These examples do not pretend to be complete or even to be the only or best way to solve a particular problem. Rather, they are intended to encourage a logical approach in meeting the objectives of the Code where it is not practical to meet the letter of the law.

The code user is encouraged to focus on the principal objectives of the requirements and to justify alternative solutions on the basis of rational assessment. If the prime objective can be met by other means, then a departure from the literal application is relatively unimportant.

Triggering Mechanisms

The application of building regulations to an existing building can be initiated in a number of different ways. An owner may decide to refurbish or rehabilitate a building, change its use or increase its size. An application for a building permit to do any of this work, which is normally required by law, sets in motion a process by which the building and the proposed work are scrutinized by authorities under prevailing building regulations. In such cases, it is the owner or his agent who decides to initiate changes to the existing building.

In other cases, however, the owner may not be the initiator of change. An enforcement authority may decree that a building must be altered for the public good. This could result from provincial or municipal laws directed at buildings regulated by special acts. They might cover more critical occupancies such as hospitals, schools, hotels, motels and licensed drinking establishments. The triggering process for change may also result from a complaint or an inspection that reveals an unsafe condition that violated an act or ordinance such as a fire prevention act (i.e. fire code) or housing standards by-law. Under these situations changes are forced upon the owner who is required by law to carry out corrective action.

Some jurisdictions may cause the degree of code compliance or general up-grading to be related to the cost of the renovation work, usually expressed as a percent of the assessed value of the building. In such cases, cost of the proposed renovation can trigger various degrees of additional up-grading to be carried out. This can add further costs to the projects, and may have a "cascading" effect, leading to a much more extensive change than initially intended. This has in some cases been blamed for discouraging the normal process of building rehabilitation. This is not required by all jurisdictions, however. Some may merely require that the renovation work not lead to a condition that would cause increased risk to the occupants. Most allow alternative measures to the requirements specified for new construction, This inherently suggests that additional latitudes for code compliance should be given to existing buildings.

The triggering action for compliance may be the National Building Code itself. Article 1.1.2.1. states that the NBC "applies to the design, construction and occupancy of new buildings, and the alteration, reconstruction, demolition, removal, relocation and occupancy of existing buildings". Therefore, if renovation work involves new construction, or if there is a change of occupancy in an existing building, the NBC is intended to be applied to the affected parts of the building. The deficiency in the requirement, however, is that it does not specify the **extent** to which the Code applies. Proposed new Section 9.36. of the NBC in Appendix A is an elaboration on Article 1.1.2.1. as it affects buildings covered by Part 9, and describes in more specific terms how it is to be applied to renovation work.

Section 2.5., 'Equivalents", in the NBC is intended to provide users with some flexibility in code application by allowing alternative design solutions where it can be shown that the objective of the Code will be met. This Section on equivalents is intended to apply to existing buildings as well as to new construction. This Guide may be considered as an elaboration on Section 2.5. as it affects existing buildings. It attempts to set out principles by which equivalencies can be evaluated in existing buildings.

It is hoped that the adoption of the proposed new Section 9.36 along with this Guide will make it unnecessary to adopt special administrative requirements for existing buildings.

Principal Objectives

The major objective of building regulations is the protection of the lives of occupants in the event of fire. Property protection, while important, is not the prime objective, although requirements to this end often affect life safety as well.

Structural sufficiency is also a major concern in building codes, although life loss or injury from structural failures are relatively rare. This is due to the well developed state of knowledge in the structural design field.

The third major area of concern in building regulation is the health of building occupants. These requirements target areas related to ventilation, sanitation, and the control of contaminants such as radon.

When buildings are made air-tight to conserve energy, or new equipment is installed that affects internal air pressures or makes increased demands for combustion air, the effect of such changes on the health and well being of the occupants must be taken into consideration in applying the NBC requirements to ensure that a reasonable health standard is maintained. Similarly, plumbing systems may become over loaded as a result of occupancy change or increases in occupant loads, or may become defective as a result of corrosion, wear, or salt deposits, and may require renovation to ensure a reasonable level of sanitation.

Fire Safety

Although building codes are primarily concerned with life safety, the traditional basis for many requirements is property protection. It may be difficult in many cases to make a clear distinction between life safety and property protection requirements. Usually there is a component of both in most requirements. With some, such as those relating to egress, the target is obviously life safety. With others, such as those relating to spatial separations, property protection is the objective. Most, however, address both issues to some degree.

Life safety in the event of fire, however, must be considered to be the main objective in building regulations. This can be achieved by designing the building in such a way that the occupants can be safely protected within the building for the duration of the fire. This is relatively expensive to accomplish, however, and is usually reserved for tall buildings. The alternative is to design buildings to ensure the safe evacuation of their occupants. This is by far the most practical approach in buildings covered by Part 9. If this can be achieved by design alternatives not specifically described in the Code, it can be assumed that the major objective of the Code has in fact been met. Fire safety requirements for the purpose of minimizing fire damage are of secondary importance and the extent to which conformance to the Code is reasonable will to a large extent be tempered by economics. This will be discussed later under "Costs and Benefits".

Early Warning

Early warning is an essential ingredient for safe evacuation. It permits evacuation to start while the fire is relatively small and the escape route is still tenable. It is especially important in buildings in which the occupants may be sleeping.

Smoke alarms are provided in residential suites (including houses) to detect the presence of fire or smoke for the purpose of alerting the occupants of that suite. They do not usually sound an alarm beyond the suite. Smoke detectors, on the other hand, sense the presence of smoke in more critical areas such as public corridors and exit stairways, and sound an alarm throughout the building to warn all occupants to evacuate the building. Heat detectors usually are slower acting and are therefore permitted only in less critical areas such as storage rooms and furnace rooms.

A second factor to ensure safe evacuation is a protected egress route. If a fire occurs, the escape path must provide protection for the escaping occupants until the building is empty. In small buildings within the scope of Part 9, the time required will be relatively small and will depend to some extent on the nature of the occupancy.

Buildings in which the occupants are awake will require a relatively short period of time to escape if the exits are tenable. In buildings such as this, evacuation should be complete in from 5 to 10 minutes after occupants have been alerted. In residential occupancies, however, there is bound to be a delay in arousing occupants and having them prepare for evacuation. This can be further delayed if the occupants are frail or disabled. In such cases evacuation may take from 20 to 30 minutes to complete after the alarm has sounded.

Where the building is sprinklered, however, the fire would normally be controlled while it is relatively small, so that the magnitude of the rating is less important. The main function of the enclosing walls of the egress route in this case is to restrict the entry of smoke and to guide the occupants to safety.

Travel Distance to an Exit

The length of travel to reach a place of safety is also important. If the egress path becomes contaminated with smoke or fire, the shorter the path, the greater will be the chance of reaching safety. Although the length of travel is relatively unimportant as long as it remains tenable, once it becomes smoke-logged or no longer provides protection from fire, travel distance becomes critical. With adequate early warning, therefore, some latitude may be given to the maximum length of travel to reach an exit. Similarly if the building is sprinklered, the escape route can be safely extended since the magnitude of the fire will be kept small and should provide little threat to the escape route.

Alternative Escape Routes

To guard against the possibility of an untenable escape route, a general code principle has been to provide an alternative escape route wherever practicable. When a person leaves a suite, and enters a corridor, for example, a choice of direction is given to reach an exit. If the corridor is blocked at one end by fire or smoke, or if an exit stairway is untenable then an alternative exit is available to escape. When the travel distance is very small, this principle is allowed to be breached for practical design purposes to allow short dead-end corridors and single exit stairways but this is an assumed small additional risk.

When a building is sprinklered, the general level of fire risk is greatly reduced, and the use of dead-ends may therefore be extended.

Costs Versus Benefits

Code requirements to establish minimum acceptable levels of safety and health in buildings are developed with an awareness of the cost of the provisions and the constraints they impose on design. This is balanced by the perceived benefits in terms of health and safety. Although it may be easy in many instances to establish costs with reasonable accuracy, it is not as easy to establish benefits on a quantitative basis. Nevertheless, building code committees have relied on their collective experience and expertise to make such evaluations and judgments and it is largely on this basis that codes have evolved.

In new construction the cost of a particular provision may be entirely different from that for a building undergoing renovation work. It is much less expensive to dedicate a certain width to a corridor or stair during its initial construction than it is to change the width after the structure is built. Similarly it is less expensive to construct walls or ceilings with the required fire or sound resistance than it is to modify them after they are built. Perceived benefits therefore can be much more expensive to achieve in existing buildings than in new construction. Since code provisions are developed primarily for new construction, they may have to be modified to reflect the cost-benefit equations that apply to existing construction.

Benefits are difficult to evaluate quantitatively because statistics are not available to do this with any degree of accuracy. Suffice to say, however, there is an economic rationale for allowing a lower standard for existing buildings than for new construction, particularly where life safety is not an issue.

A relaxation in regard to many of the requirements does not necessarily mean a reduction in life safety unless the relaxations are carried to extremes. For example, if a slightly narrower corridor or stairway width is used than is required for new buildings, the effect on safety is not significant, although the day-to-day use of such facilities may be less convenient for the occupants. Of far more importance is to ensure that the egress pathway will be tenable until the building can be evacuated.

Beyond a certain magnitude of fire resistance required for public corridors or exit stairs to ensure safe evacuation, the requirements become more directed to property protection than life safety. The same may be said for other requirements that specify minimum fire resistance between suites or around known hazards such as furnace rooms or storage areas. Beyond the level of fire resistance necessary to ensure safe evacuation, the requirement is directed at containing or limiting the damage until fire fighters can extinguish the fire. Above the levels to ensure safe evacuation, therefore, a reduction in levels for existing buildings can be justified on the basis of a changed cost-benefit relationship.

It is important to remember, that these assumptions are valid only if the egress is unimpeded. If emergency rescue by fire fighters is necessary, a greater fire resistance rating will be required to allow for longer rescue time.

A reduction in the level of early warning capability, however, cannot be justified since this has such a direct impact on life safety. In fact, in older buildings, enhanced detection and alarm capability may be justified to offset other deficiencies that may exist in order to ensure safe evacuation.

Applying code requirements to heritage buildings can give rise to special problems. Removing or changing an essential historical feature represents a loss of value (or cost) that is difficult to assess. The concern for authenticity may be so strong that the feature must be preserved regardless of the cost for doing so. This limits the choice of design alternatives in many cases. Fire risk reduction through the use of sprinklers may be the logical design solution. Such risk reduction can justify relaxations in other areas as well where it may not be possible to meet certain code requirements because of their effect on authenticity.

Relative Importance of Code Requirements

All Code requirements do not contribute equally to life safety or property protection. The Guidelines for the Application of Part 3 of the National Building Code to Existing Buildings attempts to rank the relative importance of certain aspects of requirements. Such rankings however are highly subjective and to a large extent depend on the context of the requirements in relation to the building to which they apply. For example, what may be an important requirement in an unsprinklered building may be relatively unimportant in a sprinklered building because of the reduced fire risk.

The degree to which a requirement can be modified without changing significantly the risk to life or property varies. In evaluating alternative systems, or in modifying requirements for existing buildings, therefore, it is necessary for the code user to exercise good judgment. In this quest, assistance may be obtained by reviewing the compilation of objectives and reasons for individual Articles in Chapter 2, or relating the particular situation to one or more of the example problems listed in Chapter 3, or both.

Computer Modeling

In recent years various agencies have attempted to remove some of the subjectivity from the process of evaluating equivalencies in assessing alternate design solutions. Considerable progress has been made in analyzing the factors affecting the initiation and growth of fires and the movement of smoke, as well as in the development of mathematical models to evaluate various relevant factors in the growth of fires. Current research in the art of mathematical modeling, particularly at NRC's Institute of Research in Construction offers promise for a more rational assessment of alternate design solutions than has been possible in the past.

According to NRC's National Fire Laboratory, "the assessment model uses the stochastic approach which is a good compromise between the more scientific, deterministic approach and the non-scientific, opinionated approach. The comprehensive deterministic approach requires a complete understanding of the phenomenon which may take years to develop if it is at all possible. Even with a complete understanding, the calculations are so complex that they may require excessive computation time and enormous effort to develop the computer program. The stochastic approach, on the other hand, uses a simpler, probabilistic technique to perform the risk assessment with input information based on statistical data and experience. The accuracy of the assessment depends on the quality of the input data and experience, but can be refined as more knowledge is available. This approach is especially valuable for comparing alternative designs as is intended in the present use, since in such comparisons the absolute accuracy of each individual assessment is not critical".

This methodology, therefore, seems to have potential use in assessing design alternatives for existing buildings by using the current requirements as a basis for comparison for implied safety levels.

Structural Considerations

Although the need for alternative design solutions more commonly arise in the area of fire safety, they also occur in relation to structural sufficiency. Where new construction is part of the renovation work, applying requirements intended for new buildings is relatively straightforward. Design loads and design procedures are well established and provision is made for unusual structures that require special evaluation. In new building, it is possible not only to assign costs accurately, but benefits as well. For existing construction, however, the cost of increasing its strength may exceed potential benefits. As a result, some compromise may have to be sought, such as restrictions on future use to ensure that the structure will not be overloaded.

Where a building has been standing for many years, and its structural elements do not appear to have deteriorated as a result of decay, structural overloading or corrosion, the building can be considered to be field tested. If the building shows no signs of distress, it can be reasonably assumed that it will continue to provide adequate service, provided the loads are not significantly increased. If an occupancy change, however, is such as to increase anticipated floor loads, or if there are signs that significant deterioration of the structural elements has occurred, then remedial action should be taken to compensate for the increased loading or reduced strength. Such compensating measures are relatively straightforward and do not require as much subjective judgment as would be the case with many fire safety alternatives.

Earthquake resistance is a more difficult matter to deal with, both from the point of view of their irregular occurrences, and the cost required to provide such resistance. Predicting seismic forces is not an exact science, and considerable costs can be incurred in increasing the seismic resistance of buildings. Normally, wood frame buildings are sufficiently light and stiff enough to resist most earthquake forces in Canada. Unless the building is of such an unusual shape and lacks sufficient cross walls to provide reasonable lateral resistance, therefore, up-grading to provide earthquake resistance is not considered necessary.

Unreinforced masonry buildings, or buildings with concrete slab floors and roofs, are more prone to earthquake damage due to low tensile strength of masonry and heavy weight. For buildings within the scope of Part 9, seismic up-grading for existing buildings may not be economically justified, however, even in the more active seismic regions.

Extensions and Additions

Where a building is to be extended horizontally to increase its area, it is fairly obvious that all new construction in relation to the extension should conform to the requirements for new buildings.

If the extension places new demands on an existing building by virtue of its requirements for services, or increases significantly the number of occupants, this must be taken into consideration in evaluating the extent to which the Code requirements should be applied to the existing portion. If, for example, the occupant load is increased so that a fire alarm system is required, where it was not required previously, then it is obvious that a new alarm system must be provided throughout the entire building, and not only in the extension. If the occupant load is only marginally greater than the triggering occupant load in the Code (say within 10%), then the need for a new system may be ignored since the additional risk would be relatively small.

If the heating, ventilating, air conditioning, electrical or plumbing systems impose an additional service load on the existing system, it is also clear that each such system would have to be reviewed to ensure that the system is not overloaded as a normal design exercise. If, however, the system in the extension is self sufficient and places no additional demands on the existing portion, then it is only reasonable that a general up-grading of the services in the existing portion would not be required.

If an extension increases the area of the entire building so that it exceeds the scope limit of Part 9, then the entire renovation project would have to conform to Part 3 rather than Part 9, unless, of course, the extended portion is isolated by a firewall. The extended portion would then be considered as a separate building, provided it is served by its own fire access route.

If a building is extended in height, the structural adequacy of the supporting structure would have to be assessed to ensure it is capable of supporting the additional loading. Not only would the extended storeys have to be constructed to the requirements of the current Code, but any service load or occupant load due to the extension would have to be assessed to ensure that the existing building services will still be adequate. If the increased number of storeys cause certain relaxations permitted for the existing portion to no longer apply, such deficiencies would have to be corrected. Virtually the entire structure would have to be assessed as if it were a new building. The only portions that could be excused would be those that were completely unaffected by the extension and which were not dependent on storey height.

Hazardous Conditions

When in the course of a renovation work or a change in occupancy a condition is noted that constitutes a hazard to the public or to the occupant, such conditions must be rectified, regardless of whether or not the condition was created by the renovation or change of occupancy. Such conditions may be related to fire safety, structural sufficiency or health. This does not imply that all observed non-compliance situations must be corrected, however; only those that cause an obvious danger to life or property. This is a matter of common sense evaluation to remove obvious threats to the building occupants.

Chapter 2

A Compilation of the Objectives and Reasons for Requirements in Part 9 of the National Building Code

Introduction

This compilation of objectives and reasons for each of the Articles in Part 9 of the National Building Code, 1995 is the first attempt to explain the purpose or objective for each requirement. It is intended to provide the code user with additional insight into the purpose of each requirement, so that assessments can be made of alternative design solutions that may be proposed when requirements for new construction are impracticable to apply.

While some of the explanations may appear to cover the same ground as the "Commentary on Part 9", and the Appendix to the National Building Code, neither of these was designed for the same purpose as this document. The Commentary on Part 9 provides a general review of code requirements to assist users to understand the intent of the wording and an appreciation of the significance of the requirements. The Appendix to the National Building Code, on the other hand, covers only a limited number of specific requirements, and many are in response to user queries. They are also used to explain the reasons for introducing new requirements. Both sources, however, provide useful additional information and should also be consulted in assessing alternative design solutions.

Part 9 contains close to 1000 articles that cover virtually all aspects of building construction. Since the degree of importance of individual articles in contributing to the overall health and safety aspects varies widely, judgment is needed in knowing which should be emphasized in enforcement. Obviously, it would not be reasonable for an older building to be expected to meet all requirements intended for new construction. On the other hand, reasonable steps should be taken in renovation work to provide an adequate level of safety and health, taking into account the objectives of the various articles as described herein.

A COMPILATION OF THE OBJECTIVES AND REASONS FOR THE REQUIREMENTS IN PART 9 OF THE NATIONAL BUILDING CODE, 1995

Section 9.1 General

9.1.1.1. To indicate to the Code user that the scope of Part 9 is limited to buildings of limited size and occupancy classifications, and that requirements for other buildings are located in other parts of the Code.

Section 9.2 Definitions

9.2.1.1. Words shown in italics have special meanings for the purpose of the Code, and differ from common dictionary terms. These are defined in Part 2.

Section 9.3 Materials, Systems and Equipment

9.3.1.1. To ensure that concrete will have sufficient strength and durability to fulfill its intended function.

9.3.1.2. To ensure that Portland cements will have the necessary properties in meeting the objectives in 9.3.1.1.

9.3.1.3. To prevent premature deterioration of concrete in soils containing sulphate salts that attack ordinary concrete.

9.3.1.4. To prevent premature deterioration of concrete due to organic materials and alkali salts in the aggregate. Also to ensure reasonably durable and waterproof concrete without having to use excessive amounts of Portland cement by using well graded aggregate.

9.3.1.5. To provide concrete of reasonable durability and strength with normal amounts of aggregate and cement.

9.3.1.6. Minimum concrete strength is used as a measure of concrete quality. 15 MPa is the minimum strength needed to ensure reasonably durable concrete when exposure conditions are not severe. 25 MPa is needed, along with reasonable air entrainment to resist concrete deterioration in the presence of de-icing salts.

9.3.1.7. To prevent the use of excessive water which could lower concrete strength and cause aggregate to segregate. Maximum aggregate size is limited to allow concrete to flow around re-bars in thin wall sections and to control segregation of aggregate.

9.3.1.8. If too little air entrainment is used, it will not be effective in causing the concrete to be more fluid, and if too much is used, the concrete will be weakened. Similarly, other chemical admixtures can reduce concrete strength and durability and are therefore also controlled.

9.3.1.9. Part 9 does not have adequate controls for reinforced concrete. Such construction is therefore regulated under Part 4 to ensure proper design and construction practices will be followed.

9.3.1.10. Concrete can be seriously damaged if it freezes before it sets. If the temperature is too high, it may flash-set before it can be properly placed or finished. Frozen material in the mix can reduce the temperature of the concrete and make it more vulnerable to freezing.

9.3.2.1. Grade marks are required for visually verifying that certain defects such as knots, cross grain and decay that affect strength or usability will be within the limits assumed when the span tables were calculated, or when other rule-of-thumb limits for lumber in Part 9 were determined.

9.3.2.2. Minimum grades are specified to control the defects permitted in the various end uses of lumber that may adversely affect its strength or usability.

9.3.2.3. Machine stress rated lumber is intended to be used with structurally designed elements in building, such as roof trusses. Structural design for such lumber is not covered in Part 9 so that the design procedures in Section 4.3.1 must be followed.

9.3.2.4. Face marking of wood panel products is required for visually verifying that the material is appropriate for intended use, and for identifying the manufacturing source if the material is defective.

9.3.2.5. Moisture content greater than 19% may lead to decay and problems related to shrinkage.

9.3.2.6. Lumber span tables, and rule-of-thumb requirements for lumber are based on dimensions specified in CSA-0141.

9.3.2.7. If panels are thinner than specified, the panels may not be stiff or strong enough to withstand expected loads. Tolerance limits in standards also ensures relative uniformity in thickness at joints.

9.3.2.8. To permit undersize lumber to be used if the span is decreased to allow for the decreased strength and stiffness.

9.3.2.9. To ensure that wood used in termite infected areas will receive adequate treatment to resist termite attack if the wood does not have sufficient ground clearance. Also to ensure that structural wood elements subject to ground moisture will receive appropriate treatment to prevent wood decay.

9.3.3.1. To prevent negative manufacturing tolerances from reducing the metal thicknesses to below that assumed for the various uses specified.

9.3.3.2. To ensure that sheet metal exposed to the weather or dampness will have sufficient zinc thickness to resist corrosion for a reasonable period of time.

Section 9.4 Structural Requirements

9.4.1.1. The structural member sizes and connections in Part 9 have been calculated to support the anticipated loads or have been proven to be adequate, based on past experience. Members sizes and connections that are not given must be determined on the basis of structural calculations in Part 4.

9.4.1.2. Post, beam and plank construction does not have requirements based on past practice to determine member sizes, and are not sufficiently common to warrant the calculation of special tables. Such construction, therefore must be determined from structural calculations based on design standards listed in Part 4.

9.4.2.1. The snow load requirements in Part 9 are less restrictive than in Part 4 and are based on experience with residential structures where the span seldom exceeds 12.2 m and the members are almost always spaced 600mm or less apart. If these dimensions are exceeded, adequate roof strength may not be ensured, unless the more rigorous design assumptions in Part 4 are applied.

9.4.2.2. The design snow load is based on the assumption that there will be less snow accumulation on small span buildings than on larger span buildings, and that there is a risk of rain adding to this load. Since long span bow-string or arch type trusses are sensitive to unbalanced loads (not allowed for in Part 9), they are required to be designed to meet the more rigorous design requirements in Part 4 if they exceed a span of 6m.

9.4.2.3. Since exterior balconies can be subjected to snow loads as well as occupancy loads, both have to be considered in designing the balcony floor structure.

9.4.2.4. To ensure that if attics are not specifically designed for storage, they will have sufficient strength to support persons for occasional inspection or maintenance purposes.

9.4.3.1. Deflection limits are placed on members to reduce the springiness of floors to acceptable levels (1/360 of the span), to reduce ceiling damage (1/360), or to prevent noticeable sagging (1/240 for ceilings, 1/180 for rafters).

9.4.4.1. Soils have different capacities to support building loads without causing excessive settlement and subsequent building deformation. To reduce such damage the allowable load must be restricted, depending on soil types.

9.4.4.2. If a weaker soil underlies the soil supporting the foundation, the weaker soil could be overloaded unless the overlying soil is thick enough to spread the foundation load out over a sufficiently wide area to prevent this. Assuming the load spreads out at a 60° angle downward from the footing is a simplified assumption of what actually occurs.

9.4.4.3. Free water in granular soil provides lubrication between particles thus reducing its load carrying capacity. Since the foundation load per unit area on soil decreases with depth, this effect is reduced as the depth is increased, and at a depth equal to the footing width, can be ignored.

9.4.4.4. Clay soils will swell or shrink as the moisture content is increased or decreased. Some clays are affected much more than others and this can lead to serious foundation problems unless the effect of this soil movement on the building is minimized. Various methods are used to do this such as the use of piles, or foundation reinforcement.

9.4.4.5. Retaining walls will tip over if they are not designed to resist soil pressures.

9.4.4.6. Earth pressure against foundation walls is assumed to increase in direct proportion as the depth of the soil increases, in the same manner as a liquid. Foundations with footing drains are considered to support drained soil only. Surface loads from equipment or other structures close to the foundation wall (surcharge) can exert additional pressure against the foundation and have to be allowed for. These do not normally occur with houses, however.

Section 9.5 Design of Areas and Spaces

9.5.1.1. To clarify that measurements are made from the finished wall and ceiling surfaces, and not from the framing.

9.5.2.1. To provide facilities in buildings to facilitate wheelchair use (with certain exemptions in residential buildings).

9.5.2.2. To provide facilities in multi-level buildings to accommodate persons in wheelchairs in a fire emergency.

9.5.2.3. To allow certain walk-up apartments to be exempt from most of the requirements for wheelchair access, where the difference in elevation between the entry level and the floor level is too great to allow the practical use of ramps.

9.5.3.1. To provide sufficient headroom in residential buildings to avoid accidental head contact, as well as to provide an appropriate degree of spaciousness in certain rooms for livability.

9.5.3.2. To provide sufficient headroom below mezzanine floors to avoid accidental head contact as well as appropriate degree of spaciousness for the well being of the occupants.

9.5.3.3. To provide sufficient headroom in storage garages to avoid head contact.

9.5.4.1. To provide sufficient hallway width in dwellings for the convenient movement of people and furniture. A reduction in this width is permitted only where the building width makes it impracticable to have a standard hallway, and an additional exit is provided to serve the bedroom portion.

Section 9.6 Doors

9.6.1.1. To describe the scope of the requirements and to remind Code users that additional door requirements are located elsewhere in the Code.

9.6.2.1. To provide security for each dwelling unit as well as weather protection. Also to provide privacy and odour control for bathrooms.

9.6.3.1. To provide sufficient doorway width for normal pedestrian access and furniture movement in dwelling units, as well as sufficient headroom to avoid accidental head contact.

9.6.3.2. To provide sufficient width for wheelchair use of public washrooms, and sufficient headroom to prevent accidental head contact.

9.6.3.3. To provide sufficient doorway width in at least one bathroom of a dwelling to permit the entry of a wheelchair.

9.6.4.1. To prevent accidental falls from one level to another when the difference in elevation on either side of a doorway exceeds a normal riser height.

9.6.4.2. To ensure that exterior doors will be reasonably durable and free from excessive distortion when exposed to outdoor conditions, and normal usage. Labeling is for visually checking that the door is the proper type for exterior use, and to identify where the door was made, should it prove to be unsatisfactory.

9.6.4.3. To ensure that sliding glass doors will be reasonably durable, provide adequate protection from the weather, and not present a hazard to the occupants.

9.6.4.4. To ensure that insulated steel doors will be reasonably durable, provide adequate protection from the weather and prevent excessive heat loss.

9.6.5.1. To provide sufficient strength for glass panels in doors to resist accidental impact from normal use and to withstand anticipated wind forces.

9.6.5.2. To ensure that the quality of different types of glass meets accepted norms. Also to reduce possibility of serious injuries where glass is used in doors or sidelights, and is subject to accidental impact forces.

9.6.5.3. To prevent serious injuries from accidental impact by occupants, and to prevent confusion by occupants seeking access to exits.

9.6.5.4. To prevent injuries from accidental impact by occupants not knowing of the presence of the glass.

9.6.5.5. To prevent injuries from accidental impact by occupants either within or outside of a shower or bathtub enclosure.

9.6.5.6. To reduce the possibility of condensation on glass used in exterior doors. Such condensation can stain the door finish or cause deterioration at the base of the glass. Also to reduce heat loss.

9.6.6.1. To reduce the risk of condensation on metal frames for mounting exterior doors, or for glazing in doors or sidelights. Such condensation can cause the doors to freeze shut, or to damage the door finish or floor beneath the door.

9.6.7.1. To clarify the extent of coverage intended for the requirements to resist forced entry into buildings.

9.6.7.2. To ensure that entrance doors will be of sufficient strength to provide significant resistance to forced entry.

9.6.7.3. To provide a locking system that cannot be picked easily (i.e. at least 5 pins), and cannot be easily disengaged by typical burglary methods such as spreading the door jambs, or forcing the latch to disengage by the use of a device to push back the latch.

9.6.7.4. To make the inoperative entrance door of a twin door entry more resistant to forced entry from impact forces.

9.6.7.5. To provide resistance to forced entry from impact forces or prying devices that force the door away from the frame.

9.6.7.6. To provide resistance to forced entry from forces applied to the door handle or prying devices for forcing the door out from the opening.

9.6.7.7. To provide resistance to forced entry by preventing the removal of hinge pins to disconnect the hinge leafs.

9.6.7.8. To allow the occupant to view a visitor without having to open the door.

9.6.7.9. To provide resistance to forced entry by making it more difficult to spread the door jambs apart in an attempt to disengage the latch.

9.6.7.10. To allow for methods of door design to resist forced entry other than those specifically described.

Section 9.7 Windows and Skylights

9.7.1.1. To inform users of additional window requirements in other Sections.

9.7.1.2. To provide reasonable levels of natural lighting for the well-being of occupants in residential occupancies. (Also in sleeping rooms in other occupancies by virtue of cross reference from Part 3)

9.7.1.3. To provide a means for emergency escape of occupants from bedrooms should a fire prevent escape by normal egress routes.

9.7.1.4. To ensure that emergency escape through the window required in 9.7.1.3. will not be unduly impeded by a window-well adjacent to the window.

9.7.1.5. To reduce the risk of serious injuries to children falling from openable windows.

9.7.1.6. To reduce heat loss through windows and reduce the possibility of moisture condensation in winter. Such condensation can cause deterioration of the sash and frame, and the finish beneath the window. It can also enter the wall cavity and lead to decay and other moisture related problems.

9.7.2.1. To ensure that windows will be reasonably durable, with sufficient strength to withstand wind forces and provide adequate resistance to water and air leakage.

9.7.3.1. To ensure that different types of glass have appropriate characteristics for different intended uses.

9.7.3.2. To ensure that window glass will be strong enough to resist design wind pressures.

9.7.4.1. To prevent premature condensation between sealed double glazing by preventing an adverse chemical reaction between the material used for sealing the air space between the panes, and that used for sealing the units to the sash or frame. This reaction could cause a premature failure of the seal between the panes and allow the entry of moisture into the space.

9.7.4.2. To resist air and water leakage at the juncture between the window assembly and the exterior siding or masonry.

9.7.5.1. To prevent injury from accidental collision with a transparent panel whose existence may not be obvious.

9.7.5.2. To prevent injuries resulting from stairway crowding and accidental contact with windows in the stairway.

9.7.5.3. To allow sliding glass panels in public areas to be made with ordinary glass where the risk of accidental contact is reduced to acceptable levels (i.e. they are kept open during normal operations and obviously marked to show their existence).

9.7.5.4. To prevent serious injuries resulting from accidental contact with glazed windows, or as a result of accidental falls through open windows.

9.7.6.1. To reduce the risk of forced entry through windows near ground level.

9.7.7.1. To ensure reasonable durability and weather tightness of plastic skylights.

9.7.7.2. To ensure reasonable durability, strength and weather tightness of glass skylights.

Section 9.8 Stairs, Ramps, Handrails and Guards

9.8.1.1. To outline the subjects covered in this Section.

9.8.1.2. To remind users that additional requirements affecting stairs, ramps, handrails and guards also apply when the facility is used in an exit.

9.8.1.3. To refer users to Part 3 for the design and installation of elevators and moving walkways. These facilities are not used in Part 9 buildings to the extent that would justify repeating these requirements in Part 9.

9.8.2.1. Uniform stair rise and run is required to reduce missteps or tripping on stairs. Users anticipate such uniformity, and any significant deviation is unexpected.

9.8.2.2. A minimum of 3 risers is required primarily to make it obvious to the stair users that a stair is present. Persons with poor vision, or wearing bi-focal glasses may not perceive the presence of a one or two riser stair and may suffer an accidental fall. Exemption permitted in dwelling units is due to the familiarity that occupants have with their own unit.

9.8.3.1. Limit on <u>tread</u> size is to provide sufficient room to accommodate the length of a foot. Insufficient width requires a person to walk sideways to get sufficient foot support, and increases the risk of missteps. Limits on <u>run and rise</u> control the steepness of stairs with steeper stairs being more prone to accidents. <u>Minimum run</u> is required to provide sufficient tread width without excessive nosing projection. <u>Maximum run</u> is to allow a single stride between steps to facilitate a reasonable speed of travel on stairs. <u>Maximum rise</u> is to control the amount of effort required for each step and allow stair use without excessive exertion. <u>Minimum rise</u> is to permit a reasonable speed of travel; the smaller the rise the slower the speed.

Less restrictive requirements for service stairs anticipate infrequent use. Steeper stairs for dwellings acknowledge occupant familiarity with his/her unit.

9.8.3.2. Limits on curvature of nosing is to prevent missteps due to slipping at the leading edge. Also to ensure that there will be sufficient horizontal surface to support a person's foot.

9.8.3.3. Minimum width of public stairs is to allow ascending and descending users to pass one another without excessive difficulty. Minimum width in dwellings is to permit the movement of furniture, as well as use by occupants. Decreased width permitted since simultaneous use ascending and descending is not as frequent as with public stairs.

9.8.3.4. Headroom clearance is to prevent accidental head contact with ceiling or other object in using the stairs. It assumes a reasonably tall adult. Lesser clearance in dwelling units is rationalized on the basis of greater familiarity by the occupant.

9.8.4.1. Landings provide a stair user with a sufficient level area on which to pause, to change direction or to access the stairway.

9.8.4.2. Landings are provided to prevent door swing over stairs, causing accidental impact on stair users, or interference with traffic flow on stairs. Also to provide convenient access to and egress from stairways. Landings are not required on the door side at the tops of stairways, if the door swings away from the stair, because a landing is created when the door is opened. Exemptions for landings at the secondary entrances to dwelling units is rationalized on the basis of occupant familiarity.

9.8.4.3. Maximum distance limit between landings is to reduce apprehension of stair users during descent, thereby slowing traffic flow. Also to reduce excessive injuries from accidental falls.

9.8.4.4. See explanation for 9.8.3.4.

9.8.5.1. To provide appropriate stair dimensions and limitation on curvature to facilitate traffic flow across the full width of the stair (see also explanation for 9.8.3.1.).

9.8.5.2. To allow stairs of greater curvature than those used in exits. Rationalized on the basis that rate of traffic flow is not as critical for non-exit stairs.

9.8.5.3. To allow dwelling unit stairs to change direction without the use of landings. Although considered more prone to missteps than regular treads, their use is rationalized on the basis of occupant familiarity. Angular limit is to standardize the dimensions of treads that have been used traditionally. Limitations on the number of winders is to keep their use to a minimum to reduce missteps.

9.8.6.1. To provide a means for access or egress by persons in wheelchairs without undue effort or inconvenience.

9.8.6.2. To provide ramp access or egress for pedestrians that will not require excessive effort or cause undue risk of slipping.

9.8.6.3. To provide a sufficient level area on ramps adjacent to stairs and doorways to permit pedestrians to enter or leave the ramp without undue risk of missteps.

9.8.7.1. Handrail(s) are to reduce the risk of falling on stairs, and are located to be within reach of stair users regardless of their positions on the stair. Exception for short stair runs in dwelling units is justified on the basis of occupant familiarity and lower risk of serious injury when the difference in floor elevations is small.

9.8.7.2. Handrail continuity at landings is to provide directional cues for sight impaired persons. Also to reduce the risk of falls by persons with mobility impairment who rely on handrails for support.

9.8.7.3. To reduce the risk of injury to stair users, particularly for those with sight impairment, when a handrail projects into the path of travel. (Not intended as a special requirement for dwelling units due to occupant familiarity.)

9.8.7.4. Extension of handrails at the ends of a stair run is to provide temporary support to stair users with mobility problems to transfer their canes or crutches to one hand, and use the other to grasp the handrail, for ascending or descending the stairs.

9.8.7.5. Handrail height range is intended to facilitate grasping by most adult stair users.

9.8.7.6. Handrail clearance is to allow sufficient room for fingers to encircle handrail without touching the wall.

9.8.7.7. To control the size and shape of handrail profiles to facilitate grasping along their entire length.

9.8.7.8. To limit projections into the path of travel that will impede traffic flow. (Since shoulders are wider than hips, small projections at hip height or lower will not impede traffic flow.

9.8.7.9. To reduce the risk of falling due to missteps which are more likely to occur on steeper ramps.

9.8.7.10. To reduce the risk of handrails being dislodged by stair users relying on them for support. Also to reduce the flexing of handrails by limiting the maximum support spacing.

9.8.8.1. To reduce the risk of injury from accidental falls from one level to another when the difference in elevations between the two levels is sufficient to cause significant injury. More restrictive requirements for interior stair guards are based on the premise that there is less risk of injury in falling to a ground surface than to a finished floor surface.

9.8.8.2. Minimum guard height is to provide support for a reasonably tall adult to above hip level to prevent accidental falls over the guard due to jostling or pushing. Lower guard height is permitted on stairs because the body position above the supporting tread is back from the nosing from where the guard height is measured. Lower guard height in dwellings on level surfaces where the height of fall is limited is rationalized on the basis of occupant familiarity.

9.8.8.3. Curbs adjacent to vehicle ramps and at unenclosed walls of garages are to provide a positive stop for vehicles. Guards at such locations are to prevent accidental falls from one level to another by pedestrians.

9.8.8.4. Openings in guards are limited to prevent small children from crawling through the guard. Larger openings for industrial occupancies are rationalized on the basis of small children not likely to be present. Maximum dimension in industrial occupancies is to reduce the risk of an adult falling through the guard. Openings in <u>non-required</u> guards are limited in size range to prevent children from getting their head stuck in such openings.

9.8.8.5. Safety glass in guards reduces the risk of glass cuts from accidental breakage.

9.8.8.6. Foot holds in guards are restricted to reduce the risk of children climbing over guards and being injured.

9.8.9.1. Larger concrete steps are required to have adequate structural support to reduce the risk of uneven movement or settlement due to soil movement or frost action. Because of their weight, misalignment or settlement is more difficult to correct than with smaller concrete steps or wooden steps.

9.8.9.2. To reduce the risk of premature decay of wooden structural members in contact with soil.

9.8.9.3. To provide adequate structural strength for the support of loads on stairs, and to prevent excessive springiness of stair treads. Lower structural requirements are permitted in dwelling units because of lower loads and limited number of occupants.

9.8.9.4. Tread thickness is limited to provide for future wearing and to reduce excessive tread springiness.

9.8.9.5. To provide a reasonably durable wearing surface for treads. Exception for steps to unfinished basement allowed because such steps are not subject to as much use, and appearance is not as important as for stairs in finished areas. Also to reduce the risk of injuries from slips on treads in other than dwellings, or tripping on strips intended to provide slip resistance.

9.8.10.1. To require steps intended to be cantilevered to be structurally designed to carry the weight of the step and anticipated loads.

9.8.10.2. To ensure that a foundation wall will have sufficient strength to resist bending forces caused by the weight of the cantilevered step and the loads it is expected to carry.

9.8.10.3. Soil expands as it freezes. Well drained granular soil such as gravel or crushed rock is affected least while silts and clays expand much more and can damage the step or the foundation wall if insufficient clearance is allowed between the step and the ground.

Section 9.9 Means of Egress

9.9.1.1. To indicate to Code users that additional requirements affecting facilities in a means of egress are found in other Sections.

9.9.1.2. To indicate to Code users that additional requirements affecting fire safety are found in another Section.

9.9.1.3. Certain requirements are dependent on the size of the occupant load. This Article indicates how occupant load is determined.

9.9.2.1. To provide for a means to reach an exit from any location that may be occupied within, on or surrounded by the building, and for more than one means, where warranted by occupant load or the size of the area served.

9.9.2.2. To provide examples of the types of facilities that may constitute an exit or part of an exit.

9.9.2.3. To allow for the use of a non-conforming exit stairway in an existing building for escape from fire.

9.9.2.4. To provide examples of building facilities that do not constitute part of required escape route. These are considered to be unreliable in a fire emergency or potentially dangerous to use as an escape facility.

9.9.2.5. To prevent exit spaces from containing occupancies that may interfere with exiting or create a hazard within the exit. Also to prevent exit spaces from being designed as access routes to adjacent spaces that might constitute an unnecessary fire exposure hazard to the exit.

9.9.2.6. To reduce the risk of fire exposure to exits from adjacent rooms by requiring indirect access (such as through a corridor or vestibule).

9.9.2.7. To allow for the use of another building as an exit termination

9.9.3.1. To exempt dwelling units and their private exit facilities from the requirements in Subsection 9.9.3. because of their low occupant load and occupant familiarity.

9.9.3.2. To provide sufficient exit stair and ramp width to permit pedestrian traffic flow without contact with the enclosing wall surfaces, and with sufficient room to allow limited passing. Exemption for doorways is rationalized on the basis that limited obstructions from doorways do not seriously slow traffic flow. Corridors are also exempt from this requirement but for another reason. Corridors used by the public or shared by more than one suite are required to be wider to facilitate two way traffic flow in every day use.

9.9.3.3. To facilitate two way traffic flow in corridors.

9.9.3.4. To provide for sufficient room and corridor ceiling height to reduce the risk of accidental head contact by reasonably tall adults.

9.9.4.1. To exempt private dwelling unit exits from most of the requirements in Subsection 9.9.4. because of occupant familiarity and limited number of persons.

9.9.4.2. To protect exits from fire and smoke for a sufficient period to allow complete evacuation. Also to reduce the risk of fire spread from floor to floor via the exit stairs before the fire is contained by fire fighters. In the case of adjacent exits, additional measures are intended to prevent both exits from becoming untenable at the same time.

Exterior exit passageways open to the outside air are exempt on the basis that should a fire occur and block the passage, it will not become smoke logged, and people will be able to go away from the fire to another exit stair. Certain lobbies are also exempt. (See explanation 9.9.8.5.)

9.9.4.3. Glass area is restricted to reduce the risk of heat radiation from a fire on a floor area making an exit stairway unsafe or unusable for evacuation if the exit is not shielded by a fire resisting vestibule.

9.9.4.4. To reduce the risk of a fire breaking out through a window and interfering with evacuation from an exterior exit stairway as a result of excessive heat radiation.

9.9.4.5. To reduce the risk of a fire breaking out through a window in one fire compartment and exposing the window openings in an exit stairway to sufficient heat to break ordinary glass, and render the exit unusable or unsafe.

9.9.4.6. To reduce the risk of fire breaking out through a window and exposing an exit door to heat, making it unsafe or untenable as an exit.

9.9.4.7. To allow open stairways between certain bi-level suites by providing compensating restrictions to reduce the risk of not enclosing the stair.

9.9.5.1. To exempt dwelling units and their private means of egress from the requirements in Subsection 9.9.5. because of occupant familiarity and small number of occupants.

9.9.5.2. To prevent occupancies in corridors from encroaching on space intended to provide access to exit, thereby slowing the rate of evacuation.

9.9.5.3. To prevent obstructions in corridors that would normally not be detected by a visually impaired person using a cane.

9.9.5.4. To facilitate traffic flow in an exit by restricting obstructions in the path of travel.

9.9.5.5. To facilitate traffic flow to an exit by prohibiting obstructions in the normal path of travel used by the public unless compensating alternative routes are available in a fire emergency to circumvent such devices.

9.9.5.6. To facilitate traffic flow to an exit by prohibiting the use of furnishings that may cause pedestrians to be confused about the exit location or path of egress.

9.9.5.7. To prevent a potential fire hazard in a means of egress that could interfere with evacuation.

9.9.5.8. To prevent an exit being made inaccessible as a result of an explosion.

9.9.6.1. To exempt dwelling units from most of the requirements in Subsection 9.9.6. because of occupant familiarity and the small number of occupants.

9.9.6.2. Since small localized projections into the path of travel do not appear to significantly impede traffic flow, they are permitted within certain limits to allow for the thickness of the door jambs and the thickness of the door in the open position. When doors swing into exit corridors, they can cause accidents to if they swing into the path of travel. When swinging over a stair landing, sufficient space must be allowed to allow persons using the stair to be able to get around the opened door so that traffic flow will not be unduly restricted.

9.9.6.3. To prevent injuries from accidental head contact with a door closer or other device, (assuming a reasonably tall adult.)

9.9.6.4. To provide doors of sufficient size to facilitate pedestrian passage and furniture or equipment movement without accidental head contact with the top of the door frame, assuming reasonably tall pedestrians.

9.9.6.5. To facilitate traffic flow at critical points in a means of egress by requiring doors to swing away from potential crowd pressure caused by people trying to escape (when doors that subdivide a corridor have an exit on either side, the door must therefore swing in both directions). Exceptions for door swing for houses is based on familiarity of occupants and small number of people. Exceptions for garage doors and doors for storage buildings is because of the low number of occupants and the traditional design of such doors.

9.9.6.6. To prevent undue interference with traffic flow on stairs caused by doors that open into stairways, by allowing sufficient space for people to file past the door when it is opened. Also to facilitate exit flow by allowing exit doors to swing out over a single riser in locations where snow or ice may prevent opening the door.

9.9.6.7. To facilitate evacuation by requiring design features for revolving doors to prevent them from obstructing pedestrian traffic.

9.9.6.8. To prevent people being trapped in a fire if the key or opening device is mislaid, or if the mechanism is too complicated to allow it to be opened quickly under panic conditions. Exception for electromagnetic locking devices is permitted on the basis that compensating features are provided to reduce the potential hazard to an acceptable level.

9.9.6.9. To prevent people being accidentally locked out in an untenable corridor. Exception for hotels and motels is to reduce the risk of burglary when doors are left accidentally unlocked.

9.9.6.10. To facilitate pedestrian traffic flow by having doors that can be opened by most ambulatory people applying a reasonable force to the knob or handle side of the door.

9.9.7.1. To facilitate escape from a suite by having more than one path of travel from the suite egress door(s) to a place of safety should one path become untenable in fire (see 9.9.7.2. for exception).

9.9.7.2. Where a corridor does not provide a choice of direction from a suite to separate places of safety (i.e. a dead-end corridor), the additional risk to occupants served by the dead-end is considered to be acceptable if it is relatively short.

9.9.7.3. Fire risk and its life safety consequences depend on the activity in the space, and the number of people who may be at risk. For a particular occupancy the larger the space, the greater will be the potential occupant load; hence, the greater the risk. Beyond a certain size, therefore, rooms or suites are required to have a second means of egress (in the event that one becomes untenable) to reduce the potential risk. Similarly, the greater the fire risk, the more important is the need for rapid egress if only one egress is provided. If the path of travel to the egress is too long, then there is a greater possibility that a fire could block the egress, and a second egress is needed for an alternate escape route. For these reasons, therefore, the maximum path of travel, and the maximum area of a room or suite with a single egress are dependent on its occupancy.

9.9.7.4. To facilitate escape in a fire by providing escape routes that are not dependent on the activities or whims of the occupants of another suite, or do not lead through areas that may be unsafe.

9.9.7.5. To facilitate escape from a room or suite in the event of fire by limiting the distance (and hence the time) required to reach an egress door from that space.

9.9.8.1. A fire compartment provides temporary protection from fires occurring elsewhere if its enclosing fire separations have adequate fire resistance. If the building is sprinklered however, a fire is usually extinguished quickly, and the rating of the enclosure is unimportant as long as it provides a barrier to smoke. Because of this, the "maximum travel distances" can be measured from the egress door from such compartments to the nearest exit, rather than from the most remote point in a room or suite which would otherwise be the case.

An extension in travel distance is permitted for wide corridors (malls) if they are sufficiently high to allow for a reasonable volume of smoke storage above the heads of the pedestrians (if the building is sprinklered). It is considered that this will allow such mall corridors to be tenable for a longer period than ordinary corridors.

9.9.8.2. To facilitate escape in the event of fire by limiting the "travel distances" (and hence the time) to reach a place of safety. It is assumed that one exit may be untenable from fire or smoke, making an alternate escape route necessary. When a building is very small, however, and has a limited number of occupants, evacuation is rapid where the travel distance is short and an alternate exit escape is of marginal value.

9.9.8.3. To facilitate escape in the event of fire by ensuring that if any one exit is untenable, at least half of the total required exit capacity will still be available for escape.

9.9.8.4. To facilitate escape in the event of fire by providing sufficient distance between exits to make it unlikely that both exits be made inaccessible at the same time.

9.9.8.5. To facilitate escape in the event of fire in buildings where an exit route is through a lobby near grade level, by placing restrictions on its design and construction, and limiting the occupancies adjacent to the lobby.

9.9.8.6. To facilitate escape from a mezzanine in the event of fire by providing escape facilities to allow rapid evacuation.

9.9.9.1. To facilitate escape from a dwelling unit in the event of fire by limiting the vertical travel to reach an egress level. If a unit cannot be exposed to fire from a lower unit, the travel distance from a storey can be increased if temporary refuge is available on an outside balcony, or if it is possible to escape from a window from which the drop to the ground should not cause serious injury.

9.9.9.2. To facilitate escape from a dwelling unit with shared egress facilities by ensuring that should one exit be untenable, a second and separate means of egress will be available for escape. (See 9.9.7.2. for exception)

9.9.9.3. To facilitate escape from a dwelling unit with shared egress facilities by ensuring that should one exit be untenable, a second and separate means of egress will be available for escape.

9.9.10.1. To indicate that the requirements of Section 9.9.10. do not apply to individual dwelling units.

9.9.10.2. To facilitate egress in the event of fire by requiring signage to locate exits where these are not obvious to the occupants.

9.9.10.3. To facilitate escape in the event of fire by having signs over doors intended as escape routes. Since main entrances are obvious escape routes, signs at such locations serve no useful purpose. Similarly, in small buildings with a limited number of persons the exit locations are sufficiently obvious that exit signs over doors are not necessary.

9.9.10.4. To facilitate egress in the event of fire by having signs in corridors to show the direction of escape where this is not immediately obvious. This is intended to apply where the corridor layout does not follow a typical pattern and an unnecessary delay in reaching an exit could result without such signs.

9.9.10.5. To facilitate egress in the event of fire by having the escape doors clearly indicated from the normal approaches.

9.9.10.6. To facilitate egress in the event of fire by having standard signage that can be clearly recognized from a reasonable distance as designating an intended exit.

9.9.10.7. To facilitate egress in the event of fire by preventing the power to the circuit that illuminates the exit signs from being interrupted unnecessarily as a result of power demands or servicing unrelated to the exit illumination.

9.9.10.8. To facilitate egress in the event of fire by clearly indicating the intended escape route. In some building designs it may not be obvious that a stairway to a basement does not lead to an exit, and additional signage is necessary to avoid confusion.

9.9.10.9. To provide a means for blind or visually impaired persons to identify the storey they are at. Standardizing the location of such signage makes its location easier to find.

9.9.11.1. To indicate that the requirements of Subsection 9.9.11. do not apply to individual dwelling units.

9.9.11.2. To facilitate egress in the event of fire, and to avoid accidents in the everyday use of egress facilities, by providing reasonable levels of electric lighting for exit facilities.

9.9.11.3. To facilitate egress in the event of fire if the normal electrical supply is interrupted, by providing an alternate means for illuminating principal escape routes.

Section 9.10 Fire Protection

9.10.1.1. Non-combustible construction is usually much heavier than combustible construction, and certain types such as masonry can be seriously damaged if the supporting elements settle unevenly as a result of wood shrinkage, wood crushing or even decay. In the event of fire in the combustible portion, structural failure of a supporting element could cause major damage in the non-combustible portion, principally as a result of its weight.

9.10.1.2. The fire hazard caused when one building exposes another to heat radiation depends on the intensity of the radiation. This in turn depends on the angle that one surface makes with another, with the maximum radiation occurring when the surfaces are parallel. The steeper the roof, therefore, the greater the potential radiation to an opposing wall, with the maximum occurring when the roof surface approaches a vertical position. At an angle of 60° to the horizontal the potential radiation hazard is considered to be of sufficient magnitude for the roof surface to be considered as a wall for the purpose of establishing spatial separation, and in determining the construction of the roof assembly.

9.10.1.3. To prevent fires resulting from dispensing of fuel in buildings.

9.10.1.4. Commercial cooking equipment can generate large quantities of grease and smoke which must be ventilated to the exterior, usually by means of duct work. Such equipment can also be a source of accidental fires that can spread into the duct work to ignite grease deposits. Special provisions are therefore needed to reduce potential hazards by appropriate design procedures.

9.10.1.5. Certain equipment or building features present potential safety risks, but are not commonly used in small buildings regulated in Part 9. Requirements to provide a reasonable level of safety in relation to their design and installation therefore are found in Part 3.

9.10.1.6. To reduce the risk of vertical fire spread through floor openings that are not enclosed by walls.

9.10.1.7. Although Part 9 does not apply to assembly buildings, certain assembly rooms such as meeting rooms are sometimes found in buildings of other occupancies that are regulated under Part 9. Requirements to facilitate egress from such rooms in the event of a fire emergency are found in Part 3.

9.10.1.8. To reduce the possibility of rapid fire development or explosion in areas containing hazardous or explosive materials.

9.10.1.9. To reduce the risk of damage to the building or adjacent property as a result of fire or explosion in a roof top appliance.

9.10.1.10. To ensure that a fire fighting or suppression system will perform effectively whether or not it is required by the Code.

9.10.1.11. To reduce the risk of vertical fire spread through openings created to install service equipment.

9.10.1.12. To reduce the risk of structural collapse of basement components in the event of fire where basements are large or are multilevel.

9.10.2.1. The risk to life or property in a building is dependent on the activities of the occupants. An occupancy classification system is used in an attempt to group various activities together into similar risk groups for the purpose of simplifying the application of Code requirements.

9.10.2.2. By definition, children's custodial homes and convalescent homes are institutional occupancies. Where the number of occupants is very small, however, the activities within the home resemble the type of activities that would be carried out in a dwelling unit in a residential occupancy and the occupants would be subject to a similar risk as a family in a dwelling unit.

9.10.2.3. To provide sufficient structural stability under fire conditions to permit total evacuation, and to give fire fighters a chance to extinguish the fire before the building is destroyed. Since evacuation time and the difficulty in fire fighting increases with storey height, the fire resistance rating must take into account the total building height, and not the height of each major occupancy component.

9.10.2.4. In general, if more than one major occupancy are on the same storey, the fire resistance requirements for the most demanding one are necessary to resist failure in fire. Where the most demanding one occupies a very small portion, however, the added risk is considered to be small enough to be ignored for the purpose of classifying the building.

9.10.3.1. To provide a means for assigning a fire resistance rating to a building assembly to ensure that it will withstand the effects of fire for the rating period.

9.10.3.2. To provide a means for comparing the speed of fire spread on the surfaces of various building materials.

9.10.3.3. In fires, horizontal assemblies can be exposed to much hotter temperatures on their bottom surfaces than their top surfaces since hot gasses rise and are replaced at floor level by cooler air.

Exterior walls, can be exposed to much hotter temperature on the room side as a result of an internal fire than the outside surface caused by fire in another building.

Interior walls, on the other hand, can be exposed to equally severe fires from either direction and are therefore rated accordingly.

9.10.3.4. To prevent premature failure of a horizontal assembly as a result of fire. The buoyancy of hot gases can lift unsecured ceiling panels that are intended to shield the structural members, thereby reducing the time they can withstand fire.

9.10.4.1. Evacuation and fire fighting operations are hampered as the number of storeys increases (see 9.10.2.3.). This is due to the fire load on each floor level, and the fact that evacuation requires more time for vertical travel than horizontal travel. Also, the occupants on one level are not aware of the conditions on another level. For these reasons, safety provisions are generally more stringent as the number of storeys increase.

The additional fire and occupant loads for very small mezzanines are not large enough for such mezzanines to be considered as additional storeys. Similarly, if they are constructed so that it is possible to see what is happening above and below the mezzanine floors from outside the mezzanines, they can be somewhat larger without assuming they are storeys. Even when not considered as a storey, however, they do contribute to the overall floor area of the space containing the mezzanine.

9.10.4.2. If mezzanines occupy more than one level, the vertical travel distance of the upper level(s) is increased, thereby increasing the time for evacuation. This is considered to be sufficient justification to require the upper level(s) to be considered as an additional storey, regardless of its floor area.

9.10.4.3. It is possible to separate a basement parking garage from the building above it so that a complete burn-out of the garage portion will have no effect on the rest of the building. This allows the buildings on either side of the separation to be considered as separate buildings in much the same way as a firewall creates separate buildings. To prevent fire from traveling around the edge of the horizontal separation, the enclosing walls of the garage above ground level must be constructed with the same degree of separation as the slab ceiling above the garage.

9.10.4.4. Roof top enclosures for the protection of equipment to allow protected access to a roof have no building occupants except for occasional visits by service personnel. In addition, the areas protected by such enclosures usually have very little fire load that would have an affect on the remainder of the building should fire occur. Such structures, therefore, are not considered to add to the height of a building.

9.10.5.1. If a wall or floor depends on a membrane to achieve a certain fire rating, any opening through the membrane will allow hot gasses to enter the concealed space and cause a premature failure of the separation in the event of fire. If the assigned rating is not based on tests in which such openings were present, their size and distribution have to be limited to avoid reducing the assumed rating for the assembly.

9.10.6.1. Non-combustible construction is used to prevent structural elements in a building from igniting and being consumed in fire thereby leading to structural collapse of the building. Although certain combustible elements are permitted for practical reasons, they are limited in quantity and in many cases their rate of consumption in fire is controlled through restricting their flame spread rating. The objective is to reduce the extent of damage that can occur before fire fighting is able to be undertaken. (While generally limited to buildings beyond the scope of Part 9, it is required for critical elements such as firewalls, and exterior walls close to a lot line).

9.10.6.2. Heavy timber construction, although combustible is slow to ignite in most fires because of the large cross sectional areas of the members. Unlike ordinary light frame construction, it has few hidden cavities to encourage undetected fire spread. Because of member sizes, it is generally accepted as having a 3/4 hr. fire resistance rating. Such construction is more common in larger buildings and is not often used in buildings within the scope of Part 9.

9.10.7.1. Structural steel loses strength at higher temperatures. To maintain its strength in fire conditions it must be protected by other materials such as gypsum, concrete or masonry. There are certain situations, however, where the lack of such protection does not significantly weaken the structural integrity of a building on fire.

9.10.8.1. To provide sufficient time for occupants to escape in the event of fire, and permit fire fighting to commence before excessive fire damage occurs.

9.10.8.2. Where a building is sprinklered, a fire is usually extinguished at a very early stage, making it unnecessary to have roofs that will withstand the effects of fire over an extended period. (see also 9.10.8.1. for reason for fire resistance)

9.10.8.3. See 9.10.8.1. for reason for fire resistance ratings. Floors and roofs are rated, assuming fire exposure from below as the most critical condition. Unless the supporting structures have at least the same rating, the assembly may collapse before its required rating period is achieved.

9.10.8.4. Service rooms are constructed as fire compartments to contain fire hazards originating there, and are not intended to keep fire away from the service area. Therefore the fire resistance rating of the structure supporting the service room is not relevant to containment of the hazard.

9.10.8.5. See 9.10.8.1. for reason for fire resistance rating. Where mezzanines are relatively small they can be evacuated more quickly than the general floor area, and their collapse will not endanger the integrity of the building. For these reasons therefore their structural stability in fire is not considered to be significant unless the mezzanines are large enough to be counted as storeys,

9.10.8.6. Certain flat roofs are designed to support an occupancy and therefore must remain intact for a sufficient length of time to permit evacuation. Roofs with no occupancy, however, have no such need.

9.10.8.7. Exit passageways have to remain intact for a sufficient length of time to permit complete evacuation. In residential occupancies, fire may occur when people are sleeping and it may take some time for occupants to become aware of the fire and to arouse other occupants. Such evacuations therefore are generally slower than for other occupancies in which occupants are awake when the building is occupied. In very small buildings that do not have sleeping occupants, evacuation can be carried out so quickly that the fire resistances for the walkway is not considered to be important.

9.10.8.8. If a crawl space beneath a building is not used for any purpose that can cause a fire, there is no reason to require it to be isolated from the building above it with a rated fire separation. If, however, the space is high enough to encourage it to be used as an occupancy at some future time, or it contains a potential fire ignition source, a rated separation is necessary for the reasons given in 9.10.8.1.

9.10.8.9. Dwelling units whose collapse would not endanger the occupants in other dwelling units, do not need to have requirements to ensure their structural stability. The structural stability of conventional frame construction in fire is usually sufficient to allow evacuation of the unit regardless of type of finish used.

9.10.8.10. While the requirements in Part 9 are in general agreement with those in Part 3, certain simplifications have been made in Part 9 to make them easier to use. This creates certain differences between the two parts. If a user elects to use the fire safety requirements in Part 3, in spite of its added complexity, this is permitted, since the safety level established by the Part 3 requirements form the benchmark of those in Part 9.

9.10.9.1. The division of a building into fire compartments for the containment of hazards, or to protect egress routes in the event of fire, is not considered to be necessary within an individual dwelling unit due to the cost and inconvenience such measures would create.

9.10.9.2. Fire separations are generally installed to contain a hazard or to ensure that the escape routes will be tenable for a reasonable period of time. Since they are intended to restrict the passage of smoke and fire, they are constructed to provide continuous protection.

9.10.9.3. In order for a building to be useful, fire separations often have to be pierced to provide access for people or for the installation of services for the building. To maintain the continuity of the fire separation all such penetrations have to be protected with devices to close off any openings or to otherwise ensure the integrity of the separations.

9.10.9.4. To limit the potential size of a fire by isolating it to the storey of origin. Also to restrict the movement of smoke. This is intended to limit the amount of fire damage that occurs before fire fighting commences, and facilitates the evacuation of occupants from the unaffected storeys. Dwelling units are exempted for the reasons given in 9.10.9.1. Smaller mezzanines are exempted for the reasons given in 9.10.8.5. Most crawl spaces are exempted for the reasons given in 9.10.8.8.

9.10.9.5. In many building designs, the usefulness or the esthetic effect is enhanced by opening up the space between storeys, thereby creating "interconnected floor spaces". If this is done, however, compensating measures are required to maintain the appropriate levels of safety to achieve the objectives described in 9.10.9.4. Since interconnected floor spaces are more common in larger buildings such compensating measures are described in Part 3.

9.10.9.6. The effectiveness of a fire separation in resisting fire and smoke spread can be reduced if it is penetrated by openings for the installation of piping and electrical work. Unless the spaces around such services are sealed, fire can spread across the separation. If combustible piping or electrical services are used, fire can also spread by consuming the material and creating an opening. Limits are therefore placed on the size of such combustible elements or the conditions under which they can be used to reduce this risk, where no test evidence is available to justify otherwise.

9.10.9.7. Since drain, waste and vent (DWV) piping is open to the atmosphere at the top of the building, it can act as a chimney if it is penetrated by fire. Plastic DWV piping therefore presents a risk of spreading fire throughout its length and across any fire separation in its path. Such piping therefore is restricted to locations where it does not present risk of spreading fire from one fire compartment to another. (Proprietary systems to prevent fire spread across a fire separation can, however, be used to extend the use of DWV piping in buildings)

9.10.9.8. Wooden joists supported on a masonry wall can collapse in fire and pull down the wall if the connections are not properly designed. If the ends of joists are cut with a back slope, however, so that their top ends are flush with the wall surface, the joists can fall away freely without dislodging the masonry.

9.10.9.9. To maintain an adequate fire resistance rating at joist level between two fire compartments separated by a masonry wall.

9.10.9.10. If a fire separation terminates at the ceiling below a concealed space, a fire in one compartment may spread via the concealed space to the adjacent compartment unless the ceiling membrane keeps it from entering the space. Since fire must burn up through the ceiling membrane in one compartment and down through the ceiling in another, its fire resistance rating does not have to be as high as that of the vertical separation to give equivalent protection.

9.10.9.11. A residential suite in a building with other major occupancies is exposed to risks from the activities of those occupancies. A fire separation can isolate the residential portion from such risks. Since the fire load associated with mercantile or medium hazard industrial occupancies is higher than for other occupancies in Part 9, the fire separation required to isolate these is higher than for other occupancies. If only a small number of people are affected, however, the risk from a mercantile occupancy is considered to be sufficiently low to permit a reduced level of protection.

9.10.9.12. To ensure that only a limited number of people in residential suites will be exposed to the fire risks caused by medium hazard industrial occupancies.

9.10.9.13. Where a building is subdivided into suites (i.e. rental units) each presents a fire risk to other suites. These risks can be reduced by fire rated separations. Business and personal service occupancies, however, have such low fire risk that such separations are not needed to protect one from another. In a building served by wide (mall-type) corridors, the risk associated with mercantile occupancies to one another or to business and personal service occupancies can be reduced by the use of sprinklers to eliminate the need for such separations. (see 9.9.8.1.).

9.10.9.14. To isolate a fire that originates in one residential suite and reduce the risk to life or property in adjacent suites or rooms. Fire separations contain the fire to a portion of the building to allow the safe evacuation of the building and allow fire fighting to begin before the fire has a chance to spread. Storeys of multilevel suites are generally open to each other so that all levels can contribute to the fire load. A higher fire resistance therefore is necessary to isolate a fire in a multilevel suite than in a uni-level suite.

While individual sleeping rooms in boarding and lodging houses are defined as suites, those with a small number of boarders or lodgers are not considered to present a sufficient fire risk to require individual rooms to be isolated.

9.10.9.15. Since public corridors serve as routes of escape from suites to exit facilities, they have to be tenable in the event of fire for a sufficient period to allow all suites to be evacuated. The fire separation between a corridor and adjacent suites or rooms is primarily intended to protect the corridor; however, it also protects suite occupants until rescue can be carried out.

If a storey is sprinklered, fire is usually extinguished at an early stage so that the magnitude of the fire resistance rating is less important, particularly in occupancies where everyone is awake, and evacuation can be carried out quickly. Narrow corridors can be smoke logged very quickly, however, and these have to be able to resist the entry of smoke by being constructed as a fire separation.

9.10.9.16. Automobiles can initiate fires through faulty electrical connections, and provide a source of volatile fuel in addition to their combustible components. The risk of ignition, although low for individual cars, increases as the number of cars in a garage is increased. In the case of private garages that serve individual dwellings, the risk is insufficient to warrant the garage portion to be isolated by a rated fire separation, although measures are necessary to confine fumes and gasses to the garage. Where parking garages serve more than one dwelling or the public, the risk of fire is greater and a rated separation is necessary to isolate the potential fire hazard to protect adjacent occupancies. Since more than one automobile can be involved in the same fire, this separation is increased when six or more cars are parked.

9.10.9.17. Repair garages represent a greater potential fire hazard than parking garages by virtue of repair activities associated with them, and the amount and nature of products found there. A higher level of fire resistance is therefore needed for fire separations to isolate such hazards from other activities unrelated to the repair garage. This is intended to allow time to evacuate adjoining occupancies and restrict the spread of fire until fire fighting can start.

9.10.9.18. If more than one branch ducts have individual fans that exhaust air into a common duct in a shaft, the common duct will become pressurized, and any duct whose fan ceases to operate will have a reverse flow of air from the common duct. In the event of fire, this could cause smoke or hot gasses to circulate from duct to duct. By placing the exhaust fan near the top of the shaft, the entire common duct is put under negative pressure and the flow from all branch ducts will be into the shaft, thereby preventing the spread of smoke and fire from unit to unit.

9.10.10.1. To exempt dwelling units from the requirement for the isolation of service rooms due to the cost and inconvenience such requirements would have in relation to modest fire risk.

9.10.10.2. The reason that certain service rooms are required to be separated by fire resistive construction from the remainder of the building is to confine any fire originating there to the service room. It is not intended to protect the service room from the rest of the building. Since floor assemblies are only rated for fire originating below them, such ratings are not appropriate for service room floors.

9.10.10.3. Service rooms with equipment that creates a fire risk are isolated by appropriate fire separations to prevent fire spread before the building can be evacuated and fire fighting can start. On the other hand if there is no equipment to create a fire hazard, or if the storey is sprinklered, a fire separation is not justified because of the reduced risk of fire spread.

9.10.10.4. Fuel-fired appliances are a potential fire source and can expose a building to fire risk unless they are located in service rooms isolated from the remainder of the building by appropriate fire separations. These separations will permit the remainder of the building to be evacuated in the event of fire and allow fire fighting to start before it can spread to other parts of the building. Certain small capacity appliances, however, and appliances designed for use outside of a service room have a low fire risk, making fire separations unnecessary.

9.10.10.5. Incinerators present a fire risk to the remainder of the building because of the fire source and the fuel supply represented by the garbage. Although design and installation precautions can reduce this risk, it is still sufficiently high to justify separating this operation from the remainder of the building with a fire separation to confine the fire until the building is evacuated and fire fighting can start. Other fuel fired appliances not connected with the incineration operation can compound the fire risk by providing another ignition source and are therefore located elsewhere.

9.10.10.6. Experience has shown that rooms used for temporary garbage storage are high fire risks as a result of live cigarette butts or fireplace ashes in the garbage. Public storage areas are also notorious as a source of fire in residential buildings as a result of vandalism and the unpredictable nature of the materials stored there. Such areas therefore are isolated from the remainder of the building by fire separations to contain the fire until occupants are evacuated and fire fighting can start. If the storage area is sprinklered, however, the fire is usually extinguished at an early stage and the fire separation does not have to be as great to contain the fire.

9.10.11.1. A basic Code principle is that the events or activities on one property should not cause harm to another property. When a wall is built on a property line, therefore, it must be built in such a way that it will remain intact if a building on either side is completely destroyed.

9.10.11.2. Although the principle expressed in 9.10.11.1. also applies to houses when a wall is built on a property line, a relaxation in the degree of fire separation is rationalized on the basis that lighter fire loads in houses can be contained with a lower grade of fire separation. Cost is also an important consideration, since firewall construction can be much more expensive than typical construction used for houses. Finally, experience has shown that a lesser type of fire separation can provide an acceptable degree of fire separation between houses provided the protection extends to the full height of the adjacent structure.

9.10.11.3. As noted in 9.10.11.1., the objective of a firewall is to allow a building on one side to be completely destroyed by fire without affecting the building on the other side. The requirements to achieve this objective are located in Part 3 rather than Part 9 in order to keep Part 9 relatively simple.

9.10.12.1. Mercantile and medium hazard industrial occupancies have high fire loads compared to other occupancies. There is a greater tendency, therefore, for fire spread from storey to storey by flames issuing from windows. The risk is reduced if the windows are vertically separated or separated by a horizontal projection between the windows, provided the separating construction remains in place for a sufficient length of time. The objective is to restrict fire spread until the unaffected floors can be evacuated and fire fighting can commence.

9.10.12.2. To confine fires to the level of origin to permit safe evacuation of the mezzanine level, and to facilitate fire fighting by confining the fire to a single level. Where the mezzanine is very small, or if its occupants are able to see the conditions on the floor below, the mezzanine can be quickly evacuated before conditions become untenable.

9.10.12.3. Fires can easily break through skylights in a roof and expose the windows of the upper storeys to fire. Unless the skylights are kept away from these windows, there is a risk of fire spread from one floor level to another. The objective of this requirement is to restrict the fire to the level of origin to permit the safe evacuation of unaffected levels and facilitate fire fighting by confining the fire to a single level.

9.10.12.4. In a fire, a window in one wall can expose a window in another wall to heat radiation. If the windows are the same plane (i.e. 180° to one another), there is little or no exposure hazard. As they are tilted towards each other, the radiation hazard increases, and when the angle reaches 135°, there is sufficient radiation from one to another to cause a fire risk that could spread fire from one fire compartment to another. To reduce this risk, the windows are kept apart and the wall between them made sufficiently fire resistant to stay in place until the fire can be extinguished.

9.10.12.5. Fire issuing out of a window close to a soffit can enter the attic space through a soffit vent, or by burning through the soffit unless the soffit space is blocked off from the attic. If the attic space is common to a number of residential suites, an attic fire can involve all units simultaneously and render the separations between them useless. This risk is reduced by not locating soffit vents in the vicinity of windows and making the soffits more fire resistant. The objective is to delay the entry of fire into the attic space to permit the building to be safely evacuated and to facilitate fire fighting by keeping the fire confined to the suite of origin.

9.10.13.1. To prevent the passage of fire across an opening in an assembly required to act as a fire separation, for a period of time commensurate with the rating period required for the fire separation. A rating period for closures that is less than that required for the fire separation is based on economics. It is rationalized on the basis that the closure is non-load bearing and usually represents a small portion of the total area of the separation.

9.10.13.2. Objective is the same as in 9.10.13.1. Purpose of requirement is to enable the use of generic solid core wood doors as closures when they have not been tested and labeled.

9.10.13.3. Objective is the same as in 9.10.13.1. Purpose of requirement is to enable the use of generic wood door frames in closure assemblies when they have not been tested and rated.

9.10.13.4. To remind users that there are additional requirements for doors (e.g. dimensions, direction of swing, hardware) when they are used as a means of egress.

9.10.13.5. To ensure that when wired glass is used as a closure in a fire separation, it will remain in place for at least 45 minutes, even though it has not been rated in a fire test.

9.10.13.6. Objective is as described in 9.10.13.1. Purpose of additional requirements is to permit the use of generic steel door frames for doors required to have a 20 minute rating, even though the frames have not been tested and labeled.

9.10.13.7. To inform users that generic glass block used as a closure in a fire separation will remain in place for at least 45 minutes even though they have not been rated in a fire test.

9.10.13.8. The maximum dimension permitted for a closure in an unsprinklered location is based on the maximum size that can be tested by existing test furnaces. In sprinklered locations the cooling effect of sprinklers is considered to justify a larger maximum size closure based on tests on the smaller ones. The objective is to have a closure that will bar the spread of fire for its rated time.

9.10.13.9. Many doors subjected to fire on one side will warp, and if not restrained by a latch, may warp to the extent that flames will issue around the door. Also, significant draft pressures can be created that may cause the door to swing open. The objective is to provide a closure to bar the spread of fire for its rated time.

9.10.13.10. To prevent fire rated doors from being accidentally left open in the event of fire. Exception permitted for suite entrance doors in business and personal service occupancies is rationalized on the basis that the fire risk in such occupancies is less than in other occupancies, and since the occupants are awake, evacuation is fairly rapid. Where such doors are in dead-end corridors, however, the risk is increased and door closers are required to maintain the integrity of the corridor to allow escape of the occupants.

9.10.13.11. In certain occupancies fire doors are considered to be a nuisance especially in areas of frequent use, or where the doors are very large. These doors are sometimes held in the open position for convenience and are generally released on a signal from a smoke detector or the building alarm system. In some less critical occupancies, heat activated devices or sprinkler systems are also used to release the door. The objective of this requirement is to allow fire doors to be held in the open position for the sake of convenience, provided measures are taken to ensure that such doors will provide appropriate protection against smoke and fire spread.

9.10.13.12. There is a risk that doors to furnace rooms with fuel-fired equipment may be blown open in the event of a rapidly developing fire or an explosion. If the doors lead to a corridor or a room containing a large number of people, escape of the occupants may not be possible. To decrease this risk, such doors are required to swing inward so as to be able to provide greater resistance to explosion pressures. In other cases, however, the doors should be able to swing outward to facilitate a rapid escape from the service room.

9.10.13.13. Ducts that penetrate a fire separation provide a potential route for fire spread across the separation. To maintain the continuity of the separation, therefore, such ducts are normally equipped with a fire damper, held open by a fusible link at the separation. In the event of fire, the fusible link melts and the damper closes and latches. If the duct area is fairly small, however, and the duct work has a high melting point (e.g. steel), dampers may not be necessary.

9.10.13.14. If a membrane (e.g. gypsum wallboard) contributes to the required rating period, any openings through it can allow heat to enter the space and reduce the rating. Various measures can be used to reduce this possibility, one of which is the use of "fire stop flaps" at the openings. These, like fire dampers, are held open by fusible links that release the flaps in the event of fire to maintain the integrity of the membrane.

9.10.13.15. Although the fire risk from an attached garage is fairly small, there is a risk of exhaust fumes and gasoline vapours entering the habitable areas. To reduce this risk, any door from the garage to the house has to be weather-stripped and have an automatic door closer to prevent the door being accidentally left open. Since there is always some leakage past the weather stripping under wind conditions, doors from spaces where people sleep, should not have direct entrance to a garage.

9.10.13.16. Fire separations that depend on membranes such as gypsum wallboard to achieve the required rating can be damaged if a door is allowed to swing against the wall. A door stop prevents this damage and helps to maintain the effectiveness of the separation.

9.10.14.1. An important Code principle is that one person's property should not be allowed to damage another's. Therefore, buildings are set back from the property line to reduce the risk of fire spread if they have window or door openings that can expose adjacent buildings. The amount of heat radiation depends on the size of the exposing face and the area of the openings. Fire load also plays an important role. Those with higher fire loads (i.e. Groups E, F-2) radiate more heat and must have smaller openings than other occupancies for the same lot line distance. It is estimated that the specified distances should provide about 20 minutes before one building starts to ignite another, thereby allowing time for the firefighters to prevent the spread of fire.

9.10.14.2. Fire separations prevent the rapid spread of fire spread from one compartment to another. If the fire resistance rating is sufficiently high, the fire will be contained in the compartment until fire fighters are able to extinguish the fire. Therefore the area of the exterior wall of the fire compartment is used to determine the minimum distance permitted to a lot line (or to an assumed line between two buildings if they are on the same property). If there are no fire separations the entire building face is assumed to expose another building.

9.10.14.3. As noted in 9.10.14.1., the specified limiting distances are estimated to allow about 20 minutes before one building ignites another. If no fire department is available to help prevent fire spread, the minimum distances in table 9.10.14.1. will not be adequate to prevent fire spread. By doubling the distance, the radiation intensity is reduced to 1/4 (since it varies inversely as the square of the distance) which should permit a complete burn-out without affecting an adjacent building.

9.10.14.4. For lighter fire load occupancies (C, D, F-3) the spatial separation can be approximated as being equal to the square root of the window area. This rule-of-thumb provides about the same degree of safety as determined from the table and avoids the tedious process if interpolation for sizes or distances that fall between the listed values. Since the radiation intensity for the heavier fire load occupancies (E, F-2) is assumed to be about twice that for the other occupancies, the limiting distance is taken as the square root of twice the window area in the fire compartment. Again, the distance is doubled if there is no fire fighting service. (see 9.10.14.1. and 9.10.14.6. for objective)

9.10.14.5. Fire issuing from windows can extend a metre or so beyond the face of the building and might impinge on adjacent properties. Therefore, openings less than 1.2 m from the lot line are protected with fire rated closures. Wired glass or glass block are not used since these will permit heat to radiate even if they resist the passage of flames for the required time. (see 9.10.14.1. for objective)

9.10.14.6. Since wired glass or glass block prevent fire from issuing beyond the face of the building, there is much less heat radiation when openings are so protected, so that greater window areas are permitted for the same distance from the property line. Heat radiation is also substantially reduced if the building is sprinklered because the fire is usually extinguished early in its development. Since sprinklers and wired glass (or glass block) work in separate ways to reduce heat radiation, increased window areas are permitted for both sprinklers and wired glass (or glass block). (See 9.10.14.1. for objective)

9.10.14.7. Most heat radiation from one building to another is from window openings. If, however, any portion of the wall is consumed by fire, additional openings are created to add to those from the windows. The solid portion of wall therefore is required to meet certain fire resistance and combustibility requirements, to ensure that this will not occur. This is done by relating such requirements to the proximity of the building to the lot line in Table 9.10.14.A (or Article 9.10.14.4.). The lower the percentage of openings permitted, the closer the building is to the lot line, and the higher the level of construction is required in Table 9.10.14.A.

If the building face has an irregular shape, it can be difficult to use these tables, since the premise for them was a simple rectangular shape. A method for overcoming this problem is to assume a vertical plane between the building and the lot line, parallel to the latter, located so that it just touches the part of the building closest to the lot line. The building, including the openings and fire compartments are projected into this plane at right angles to it. This projection becomes the new location for the building for the purpose of determining the construction required for the exterior walls (see 9.10.14.1. for objective).

9.10.14.8. The location of the vertical plane in 9.10.14.7. for the purpose of establishing the construction requirements for the exterior wall will lead to overly conservative window area limits. To provide more realistic <u>window area limits</u>, the location of the plane can be moved back from the lot line so that <u>no unprotected opening</u> is between the vertical plane and the lot line (or line between buildings on the same property). (see 9.10.14.1. for objective)

9.10.14.9. An exposing face of a building that is at street level and faces the street is in an ideal location for fire fighting. Experience has also shown that such locations rarely lead to fires being spread across the street as a result of radiation, probably due to the ease of fire fighting, even if the entire face of the building is unprotected (i.e. glass display windows).

9.10.14.10. Open air parking garages can dissipate heat fairly quickly, so that even though they have large areas of unprotected openings the heat build-up is not sufficient for them to be a major exposure hazard to adjoining buildings. Typical car fires, even if occurring adjacent to an exterior wall, will not expose an adjacent building to a significant fire risk if the limiting distance is maintained at a fairly modest 3 m.

9.10.14.11. As explained in 9.10.14.7. the exterior wall construction is dependent on the percentage of the wall that is <u>allowed</u> to have openings. This is a way of relating its proximity to the lot line to the wall area and fire load (i.e. occupancy). The smaller the permitted area of wall openings, the greater the exposure hazard is assumed to be. Hence, the smaller the percentage of openings permitted, the greater the level of protection the wall is required to have. The level of fire resistance required is for the purpose of containing the fire to the building of fire origin. The requirement for non-combustibility is to prevent the wall from consuming itself in fire, thereby adding to the exposure risk. Non-combustible cladding is required principally to protect a building from the exposure hazard from another building.

9.10.14.12. Although the rationale for increasing the level of fire protection of exposing walls of houses in relation to their proximity to the lot line is the same as for other buildings (see 9.10.14.11.), a lower level of construction is permitted for dwellings provided such units are not stacked one above another. This relaxation is largely related to the cost of providing a higher level of fire protection. It is also rationalized, however, on the basis of tradition and past performance, and the fact that the life risk component of this requirement is very minor. (The objective is as described for 9.10.14.1.) (see also 9.10.14.5.)

9.10.14.13. Experience has shown that combustible elements attached to the face of a building can transmit fire to an adjacent building as a result of direct flame impingement if they are too close to a property line (or to another building). Such elements therefore are kept back from the lot line a sufficient distance to make flame impingement unlikely. An exception for one and two family houses is rationalized on the basis of past experience where such combustible elements have not been shown to be a serious problem. (Objective is described in 9.10.14.1.)

9.10.14.14. The rationale for increasing the fire protection level for the exposing walls of detached garages, carports or accessory buildings relative to their proximity to the property line is the same as described for other buildings (see 9.10.14.11.). A lower level of fire protection is permitted for these buildings, however. This is rationalized partly on the basis of cost, as well as on experience. Such structures are also generally very small, and their incidence of fires in relation to house fires is low. (see 9.10.14.1. for objective). There is insufficient risk, therefore, to spatially separate a house from its garage or carport.

9.10.14.15. Heavy timber and steel columns located outside of a building are protected from fire exposure in the same building by the exterior walls. They therefore do not have to have a fire resistance rating if they are far enough away from an exposing building to avoid the risk of flame impingement.

9.10.14.16. Buildings in which there is very little to burn offer little exposure risk to other buildings. The distance to the lot line can therefore be decreased accordingly. Although an occasional fire may generate some heat radiation, this is not considered to depend on the area of openings or the area of exposing building face. (see 9.10.14.1. for objective).

9.10.15.1. To reduce the extent of fire spread in buildings until evacuation can be safely carried out and allow fire fighting to commence before building damage is too extensive. Whenever an opportunity exists for air movement in hidden spaces there is a risk of undetected fire spread within such spaces if they contain sufficient combustible materials of a type that will allow flames to travel on their surface. Such spaces range in size from framing or furring spaces to crawl spaces and attics. Extent of fire spread is therefore controlled by blocking off such spaces at strategic locations, or in the case of larger spaces, dividing them into smaller compartments, if the flame spread rating of the enclosing construction is sufficient to allow flame propagation.

9.10.15.2. Same objective as in 9.10.15.1. Fire can travel up within concealed wall spaces only if the space is not filled with insulation and the materials in the space will allow fire propagation. Concealed spaces 25 mm or less in depth are considered to be too small to support the spread of fire and are therefore not required to be fire stopped.

9.10.15.3. Same objective as 9.10.15.1. Fire stopping must be able to resist the spread of fire within the concealed space for a sufficient length of time to permit the safe evacuation of the occupants and to allow fire fighting to commence before too much damage has occurred.

9.10.15.4. Same objective as 9.10.15.1. Since fire stopping is intended to provide a physical barrier to the spread of fire, any holes through it for the passage of services have to be sealed in such a way that fire will not pass through the fire stopping material for a reasonable period of time.

9.10.16.1. The flame spread characteristics of wall and ceiling surfaces affects the rate of fire spread in a building. It is limited in order to allow occupants sufficient time to be safely evacuated, and to allow fire fighting to start before damage is too extensive. Doors are permitted to have a higher flame spread rating because of the added costs of doors with low ratings. This is rationalized on the basis that doors usually make up a small proportion of a wall area and therefore do not affect significantly the overall rate of fire spread. (The scale of comparison uses a rating of zero for material such as asbestos cement, and 100 for red oak). Doors within dwelling units are exempted entirely as a result of past experience.

9.10.16.2. Since public corridors and exits are the escape routes when a building is evacuated, it is essential that they be kept tenable during that period. Since fires tend to propagate along the upper surfaces, the flame spread limit for ceilings must be kept low.

9.10.16.3. Objective is the same as 9.10.16.2. Exit wall surfaces can play an important role in flame spread, particularly in stairwells that connect two or more floors. Fire travels more quickly vertically than horizontally, and when doorways are opened, stairwells can act as conduits for fire from one level to another. Exit walls therefore are also required to have a low flame spread rating to prevent this. A slight relaxation is permitted in an exit lobby where only one storey is involved (principally to allow the use of a wainscoting as a decorative feature along the lower portion).

9.10.16.4. Experience has shown that fire can travel quickly along exterior passageways particularly in dry weather accompanied by high winds. Such passageways can be ignited by fire issuing from the window of an adjacent suite. If such passageways are the only escape routes they must be kept tenable until evacuation is complete. To this end, the flame spread rating of the various components is kept very low to prevent the propagation of flame.

9.10.16.5. Objective is the same as for 9.10.16.2. Since only one storey is involved the flame spread rating for the corridor walls is permitted to be higher than for exit walls. Since flames tend to spread faster along the upper surfaces of a corridor the lower part of such walls are permitted to have a higher flame spread rating (to permit the use of wainscoting) provided the rating for the upper half of the wall is reduced to compensate for this.

9.10.16.6. The purpose for allowing a small portion of a wall or ceiling surface to have a greater flame spread rating than the rest of the surface is to permit typical wood trim elements such as baseboards, window trim and door trim. Requirements for doors and plastic glazing or lighting elements are restricted by separate requirements intended to regulate only those items. These items therefore are not included in computing areas permitted to have the higher rating. (see 9.10.16.2. for objective).

9.10.16.7. To improve the usefulness or convenience in certain building designs, public corridors are sometimes enlarged at certain locations to permit their use for a purpose other than as an access to an exit. There is nothing to prevent this as long as the enlarged portion complies with all of the requirements for public corridors, including the flame spread limits. (see 9.10.16.2. for objective)

9.10.16.8. Many plastic light diffusers and lenses have flame spread ratings that exceed the limits set for ceiling surfaces. An increased flame spread is considered to be acceptable as long as such items will fall out of their frames before ignition and meet other test conditions to reduce potential hazards. Since public corridors and exits are of critical importance in evacuation, however, additional area and spacing restrictions are necessary to ensure reasonable safety during evacuation (see 9.10.16.1. and 9.10.16.2. for objective).

9.10.16.9. Most plastic skylights also exceed the flame spread rating for ceiling surfaces. These are not designed to fall out in the event of a fire and therefore can create a potential hazard if they are very large or are spaced too close together. When used in corridors that are required to be separated from the remainder of the floor area, therefore, the area and spacing has to be limited to reduce the chance of fire spread. (see 9.10.16.2. for objective).

9.10.16.10. Foamed plastic is very good insulator and is very light weight. When exposed to a room fire, therefore, the temperature on the surface rises very quickly, allowing combustible gasses to be released and contribute to a premature flash-over condition. To reduce this risk the surface of the foam is shielded from the room by a wall finish. This slows down the temperature rise rate at the surface of the foam and delays the flash-over event. (see 9.10.16.1. for objective). Exception for garage doors in private garages is rationalized on the basis of low incidence of such fires, and the fact that garage doors represent a relatively small portion of the total finish area.

9.10.16.11. The fire incidence rate in bathrooms is much lower than in most other parts of a residential suite. In addition bathrooms are usually very small and generally have little effect on the rate of fire spread within a suite. These areas therefore are permitted to have a slightly higher flame spread rating than other areas of the suite. The practical need for such an increased rating is that plastic used for bathroom fixtures and appliances does not generally meet the flame spread limits required for walls. (see 9.10.16.1. for objective).

9.10.16.12. Combustible linings and coverings used in heating and cooling ducts can contribute to fire spread throughout the area served by the duct if the flame spread is not kept sufficiently low. The objective for this requirement is to prevent the duct linings and coverings from contributing to fire spread via the duct system.

9.10.17.1. Although a firewall is constructed so that it makes a building on one side independent of the one on the other should a complete burn-out occur, when access is provided through the firewall, there is still a risk that smoke on one side could contaminate the other side. For this reason the alarms on both sides are interconnected. In the event of fire both sides are warned as a precaution against smoke contamination.

9.10.17.2. To warn occupants about the existence of a fire, so that occupants can be evacuated quickly. Fire alarms are necessary if it is unlikely that all occupants would be made aware of the existence of a fire within a short period of time. The need for alarms, therefore, is dependent on the state of alertness of the occupants (asleep or awake), the activities within the occupancy that may contribute to fire risk, the number of people, and the vertical separation of the occupants. The larger the occupant load, the greater the floor area to be evacuated, and the longer it will take to evacuate. Also the larger the occupant load, the greater the risk of life loss if warning is delayed. Exception for residential suites with direct access to the exterior is rationalized on the basis that the egress route will not become contaminated, so that there is more time to arouse the occupants and execute an escape.

9.10.17.3. To warn occupants in residential buildings of the presence of smoke and fire in time to permit evacuation while the escape routes are still tenable. Smoke detectors react more quickly to fire conditions than heat detectors, and are therefore used in the escape routes. Heat detectors are used where quick response is not essential for life safety such as in high fire risk areas in nonhabitable parts of the building. Dwelling units are exempted since these are provided with smoke alarms. Sprinklered buildings are also exempted since most fires are extinguished at an early stage in their development before they are a threat to life safety.

9.10.17.4. Smoke not only obscures vision and creates breathing discomfort, it can contain lethal concentrations of toxic gasses. This not only creates untenable conditions throughout the building but interferes with evacuation. Air ducts can facilitate the movement of smoke from suite to suite or from floor to floor unless the air moving fans are shut down when smoke enters the system. In dwelling units, floors are open to each other via stairwells, however, and smoke will move throughout the unit even if the system is shut down. In addition smoke alarms are provided to alert the occupants making detectors in the air handling system within a dwelling unit unnecessary.

9.10.17.5. Portions of buildings completely separated from adjoining parts, must have their own exit systems to the exterior if there is no access across the separation. If these separations have sufficient fire resistance, they will permit each portion so divided to be evacuated through an exit system that will not be contaminated by fire in another portion. Each is therefore considered to be a separate building when fire alarms are considered. (see 9.10.12.2. for objective).

9.10.17.6. To ensure that alarm and detection devices and their associated systems will operate effectively to fulfill the objective described in 9.10.17.2.

9.10.17.7. Central vacuum systems can contribute to spread of smoke and fire if they continue to operate in the event of fire. If fire should enter the vacuum system it can be drawn across separations and into the dust receptacle where a second fire could start. It is important therefore that such systems be shut down when a fire is detected in buildings that are of sufficient size or occupant load to require fire alarm systems. (see 9.10.17.2. for objective)

9.10.17.8. The amount of natural ventilation in an open air parking garage makes it unlikely that egress routes would become smoke-logged or that travel to an exit would be restricted in the event of fire. In addition the occupant load for such structures is very low and evacuation in the event of fire would be rapid. (see 9.10.17.2. for objective)

9.10.18.1. Smoke alarms are designed to detect smoke particles and/or ionized products of combustion, depending on the type used. In order for such alarms to have the proper sensitivity, audibility and dependability they must meet certain design and construction standards. This is to ensure that they will provide an adequate warning to the occupants of the room or suite of the presence of smoke so that appropriate action can be taken (i.e. escape or extinguishment)

9.10.18.2. Since the prime purpose of a smoke alarm is to awaken sleeping occupants in the suite of fire origin, they are installed in each bedroom or in the hallway that serves them. To avoid a delay in warning due to the time it takes for smoke to travel from storey to storey, and to allow for the fact that other habitable rooms can be used for sleeping, additional smoke detectors are installed on other storeys. (see 9.10.18.1. for objective)

9.10.18.3. One of the most common causes of failure of a battery operated smoke alarm is dead or missing batteries. In new construction, therefore, alarms are connected to the electrical supply (if available) to increase their dependability. To avoid inactivating the alarm, and making it ineffective, no switches are installed between the alarm and the electrical panel. (see 9.10.18.1. for objective)

9.10.18.4. A smoke alarm that sounds on one storey may not be sufficiently audible on another to awaken sleeping occupants. By interconnecting all alarms the alarms are audible on all levels, regardless of where the smoke is detected. (see 9.10.18.1. for objective)

9.10.18.5. Some fire alarms require periodic maintenance to ensure their dependability. Since such instructions can be easily misplaced over the years, it is posted in a permanent location for periodic reference. (see 9.10.18.1. for objective)

9.10.19.1. Unless a floor level is sprinklered, fire fighters must be able to access each floor level to fight fire effectively or to rescue occupants. To allow this, the access window or panel is made large enough to permit the entry of a fire fighter with a backpack, and situated within easy reach of the floor to facilitate entry or rescue. To avoid unnecessary delays in entry, the glass must be easily breakable if the window (or panel) is not openable. Since dwelling units that are not stacked one above the other have an access door at ground level, and various points of entry at other levels, access panels for such units are not necessary.

9.10.19.2. Basements have a reputation as a source of fire risk since they are usually the places used for storage purposes and the location for heating equipment. Access for fire fighting, therefore, has to be provided if it is of a size that all locations are not reachable by a hose stream from a perimeter opening. Such access is not necessary for basements that serve a single dwelling unit, since, fire fighting can normally be carried out using the basement stairway.

9.10.19.3. To facilitate the rescue of occupants who are unable to escape from a building, to prevent the spread of fire from one property to another, and to restrict the amount of fire damage. This is done by facilitating fire fighter's access to the building and enabling available fire fighting apparatus to be in sufficient proximity to the building to be used effectively in all seasons.

9.10.19.4. To reduce the amount of fire damage by enabling occupants to contain or extinguish fires before fire fighters arrive.

9.10.20.1. To provide a reasonable degree of fire safety for occupants of construction camps located in areas without organized fire fighting capabilities. Also to facilitate fire fighting by local personnel to reduce the amount of fire damage.

9.10.20.2. To protect sleeping occupants from fire outside of the sleeping room for a sufficient period of time to allow escape. Dwelling units are exempted on the basis that these are equipped with smoke alarms, and have a small occupant load, enabling rapid escape in the early stages of a fire. (see also 9.10.20.1.)

9.10.20.3. To protect occupants on the second storey from fire originating on the first storey, for a sufficient length of time to permit escape. Exemption for dwelling units is rationalized on the same basis as 9.10.20.2. (see also 9.10.20.1.)

9.10.20.4. To resist the spread of fire from one building to another in order to provide sufficient time to allow connected buildings to be evacuated. Also to give local personnel an opportunity to confine a fire to the building of origin to reduce the amount of potential damage. (see also 9.10.20.1.)

9.10.20.5. To prevent the spread of fire from one building to another thereby reducing the amount of fire damage. (see also 9.10.20.1.)

9.10.20.6. To slow the spread of fire in order to facilitate the escape of occupants. Dwelling units are exempted for the reasons given in 9.10.20.2.

9.10.20.7. To warn all building occupants of fire in its initial stage, so that the escape routes will be tenable until the building is evacuated. Buildings with 10 persons or less can be evacuated quickly, and since sleeping rooms are equipped with smoke alarms, a warning can be initiated when fire is in its initial stage.

9.10.20.8. To reduce the amount of fire damage by enabling occupants to contain or extinguish minor fires before additional fire fighting assistance arrives.

9.10.20.9. To provide additional fire fighting capability where hand-held extinguishers are not able to extinguish a fire. Objective is primarily to reduce the amount of fire damage.

Section 9.11 Sound Control

9.11.1.1. To provide a standard means for measuring and rating construction assemblies for their ability to resist sound transmission both under laboratory and field conditions.

9.11.2.1. To provide an environment in a dwelling unit in which sound originating as air born sound in an adjacent unit, or adjacent room or space will not be objectionable to the occupants.

Section 9.12 Excavation

9.12.1.1. To make the space beneath a building inhospitable to insect pests and vermin and to prevent it from generating objectionable odours that might migrate into the structure above.

9.12.1.2. To prevent the soil beneath the foundation from becoming saturated, thereby reducing its load carrying capacity, or making it subject to frost heaving.

9.12.1.3. As soil freezes, it expands. This expansion (or frost heaving) varies with the soil moisture content, the type of soil and the depth of freezing. Foundations constructed on such soils will therefore settle as the soil thaws. A significant amount of differential settlement may damage the foundation and the structure it supports.

9.12.2.1. Soils that are disturbed or loosened from digging may lose their natural compaction. A foundation constructed on such soils will therefore settle. If the settlement is uneven, damage to the foundations or the structure it supports could occur.

9.12.2.2. To reduce the possibility of damage to a foundation or the building it supports by extending it below the ground to a depth where the amount of potential movement is tolerable to the supported construction. Foundations enclosing heated space are not subject to frost heave if they are built so that the heat is not restricted from reaching the underlying soil. They may be subject to movement in clay soils however whose volume changes with seasonal moisture changes. This diminishes with depth. If foundations are unheated, however, they are subject to frost heave (except in well drained course granular soil). The exemption for small concrete steps is rationalized on the basis that any unevenness due to frost heave can be easily remedied. The exemption for mobile house type foundations is rationalized on the basis that the design of the undercarriage will allow considerable foundation movement without distressing the mobile home. The exemption for small accessory buildings is rationalized on the basis that these are unoccupied and do not constitute a threat to anyone.

9.12.3.1. To restrict the entry of ground moisture into the building. Also to maintain the structural integrity of the foundation.

9.12.3.2. To reduce the risk of surface water leaking into a building that could cause problems from excessive moisture.

9.12.3.3. To reduce the risk of future soil settlement adjacent to foundations which could lead to water leakage into the buildings and potential moisture problems as noted in 9.13.1.1.

9.12.4.1. To reduce the risk of soil settlement beneath footings at the service locations which could lead to pipe rupture and foundation damage.

Section 9.13 Dampproofing, Waterproofing and Soil Gas Control

9.13.1.1. In an enclosed building that is heated in winter, soil moisture can add to the moisture load and raise humidity levels to a point where a variety of problems may occur. These range from simple condensation on windows to decay of structural members. The objective of this requirement is to restrict the entry of soil moisture. Garage floors are exempt because garages are usually not heated to elevated levels in winter, and the air is not recirculated to the habitable areas where it could add to the total moisture load for the building. Floors on granular fill are also exempted since the fill provides a capillary break, preventing the soil moisture from wicking into the slab.

9.13.1.2. To reduce the possibility of ground water leaking into a basement or other space located below ground level and giving rise to moisture related problems leading to structural deterioration, property damage and health risks.

9.13.1.3. To reduce the entry of soil gasses into enclosed buildings to a level where they will not pose a significant health risk to occupants. (Garages are exempt since air from this area is not circulated to habitable areas).

9.13.1.4. To establish appropriate methods for the application of dampproofing and waterproofing to meet the objectives in 9.13.1.1. and 9.13.1.2.

9.13.2.1. To establish appropriate characteristics for waterproofing, dampproofing and soil gas-proofing materials to meet the objectives 9.13.1.1. and 9.13.1.3.

9.13.3.1. To provide an even base for the application of exterior dampproofing on foundation walls to meet the objectives of 9.13.1.1.

9.13.3.2. To describe the application method for dampproofing to meet the objectives in 9.13.1.1.

9.13.3.3. Moisture from drying concrete, or ground moisture that migrates past the exterior dampproofing or through foundation cracks, can be trapped between the foundation wall and the interior wall finish or vapour barrier. This can cause deterioration of the inside wall finish, and decay of wood support members. The interior dampproofing is a second line of defense against such moisture. Any moisture trapped between the exterior and interior vapour barriers is allowed to escape to the exterior by terminating the interior vapour barrier at ground level. (see also 9.13.1.2.)

9.13.4.1. To resist the movement of soil moisture into basements through concrete slabs to achieve the objective described in 9.13.1.1.

9.13.4.2. Same as 9.13.4.1., when dampproofing is installed below the slab.

9.13.4.3. Same as 9.13.4.1., when dampproofing is installed above the slab.

9.13.5.1. To provide an even base for the application of exterior waterproofing on foundation walls to meet the objectives in 9.13.1.2.

9.13.5.2. To provide a system of membrane protection for basement walls to resist the entry of ground water and soil moisture to achieve the objectives in 9.13.1.2.

9.13.6.1. To provide a system of membrane protection for basement floors to resist the entry of ground water and soil moisture to achieve the objectives in 9.13.1.2.

9.13.7.1. If the interior surface of a concrete block foundation wall is not dampproofed there is a possibility of soil gasses such as radon entering the building and causing a health risk. Gasses that enter at the base of the wall can travel up the voids in the block to the building above. The objective of this requirement is to reduce this risk by sealing off the voids in the block below the level of the concrete floor slab or crawl space ground cover (see 9.13.1.3. for objective)

9.13.8.1. To resist the entry of soil gasses through the floor of a basement or crawl space. (see 9.13.1.3. for objective)

9.13.8.2. To provide an alternative means for resisting the entry of soil gasses through the floor of a basement or crawl space in a detached single-family house. (see 9.13.1.3. for objective)

9.13.8.3. To resist the entry of soil gasses through the floor of a basement or crawl space through any discontinuities in the floor slab. (see 9.13.1.3. for objective)

Section 9.14 Drainage

9.14.1.1. To indicate the scope of this Section

9.14.1.2. To indicate that drainage requirements for crawl spaces are located elsewhere.

9.14.1.3. To indicate that drainage requirements under floors-on-ground are located elsewhere.

9.14.2.1. Rain water and snow melt that does not drain away from the foundation and into a drainage system will seep into the soil next to the foundation. If the water cannot percolate downward quickly through the soil to a level below the footings, the soil can become saturated and even create hydrostatic pressure against the foundation and beneath the floor. This can cause leakage into the basement or crawl space. In some cases, sufficient hydrostatic pressure is created to collapse the foundation wall or cause the floor to heave. The objective of this Article is to reduce this risk by providing foundation drainage at footing level to lead this water away from the building either in the form of drainage tile or a granular layer beneath the building below footing level. Material placed against the foundation to promote rapid vertical drainage (crushed rock, fiberglass) can also serve as a reservoir for water, and unless carried down to the foundation drainage system, can cause hydrostatic pressure against the foundation wall.

9.14.3.1. To establish characteristics for piping and tubing used for foundation drainage that will enable them to withstand the expected earth pressures due to backfilling, and to be durable for the expected life of the building. (see also 9.14.2.1.)

9.14.3.2. To provide sufficient capacity for water removal for foundation drainage to achieve the objective in 9.14.2.1.

9.14.3.3. To establish procedures to achieve the objective in 9.14.2.1. when drain tile or pipe is used for foundation drainage. The firm base reduces pipe settlement which could cause patches of soil saturation and consequent loss of load-bearing capacity of the soil. Spacing and cover over butted drain tile allow water to enter from the bottom while keeping soil from dropping in from the top. Granular fill over the drain tile or pipe extends their effective drainage influence, and keeps soil particles from clogging the tile or pipe.

9.14.4.1. To establish the characteristics needed for soil to allow rapid percolation of water, when it is used as a drainage layer beneath a foundation to achieve the objectives in 9.14.2.1.

9.14.4.2. To provide a sufficient drainage flow capacity through the granular drainage layer to meet the objectives in 9.14.1.2., when it is used as a foundation drainage system. The layer is extended beyond the footings to intercept drainage water before it reaches the foundation.

9.14.4.3. To lead water to a central collecting point (sump) for disposal to meet the objectives in 9.14.2.1.

9.14.4.4. To have sufficient drainage flow capacity through the upper portion of a granular drainage layer whose lower portion has been mixed with mud from the excavation and rendered less permeable. (see 9.14.2.1. for objective)

9.14.5.1. To remove drain water from the building site to achieve the objective in 9.14.2.1.

9.14.5.2. To provide a collecting reservoir for drain water with sufficient capacity to allow a sump pump to operate on an appropriate on-off cycle when gravity drainage from the collection point is not possible. Sump cover is provided to reduce the amount of moisture and soil gasses entering the building, and to prevent the sump from being a hazard to the occupants.

9.14.5.3. To provide for an alternative disposal site for foundation drainage water, away from the building site. See 9.14.2.1. for objective.

9.14.6.1. To facilitate the drainage of surface water away from the building, so that less will be able to percolate down through the soil adjacent to the building giving rise to problems described in 9.14.2.1.

9.14.6.2. Surface drainage water can be contaminated from a variety of sources such as animal and bird droppings, garbage and decaying animal matter. It can therefore pose a health risk if it drains into well water. Surface drainage can also saturate disposal fields of septic systems, causing effluent to rise to the surface and create a potential health risk.

9.14.6.3. To drain depressed areas in window wells down to the foundation drainage systems to reduce the risk of foundation wall leakage in the vicinity of the window well.

9.14.6.4. Driveways that slope downward from street level towards a house will allow surface drainage water to enter the garage unless it is intercepted by a catch basin to direct it into a drainage system. (see 9.14.2.1. for objective)

9.14.6.5. To remind Code users of additional drainage requirements for downspouts located elsewhere in the Code.

Section 9.15 Footings and Foundations

9.15.1.1. The requirements for foundations in Section 9.15 are based on a number of design assumptions including the type of soil, occupancy, type of superstructure, and the type of foundation materials. Where a building is constructed on soil with a lower load carrying capacity, an occupancy that imposes heavier design loads or a type of superstructure that imposes higher dead loads, the foundation has to be designed for the appropriate conditions in conformance with other Sections of the Code.

9.15.1.2. The load carrying capacity of permafrost soils can be seriously weakened when they are thawed, which may lead to foundation and superstructure damage. Foundations for such site conditions require special design procedures which are outside the scope of Part 9 but are covered in Part 4.

9.15.1.3. Preserved wood foundations are relatively new building innovations when compared to concrete or masonry. There are no rule-of-thumb requirements for such structures comparable to those in this Section for concrete and masonry. To ensure their ability to withstand anticipated loads, and their durability in contact with soil, they have to meet other design standards developed specifically for such structures.

9.15.1.4. A mobile home constructed on a chassis that provides sufficient rigidity for highway travel is considered to be sufficiently resistant to damage due to differential foundation movement to permit their support on surface foundations, regardless of soil conditions.

9.15.2.1. To ensure that the strength and durability of concrete will be adequate for use in foundations.

9.15.2.2. To ensure that the strength and durability of concrete block will be adequate for use in foundations.

9.15.2.3. To ensure that pier type foundations have adequate strength to support the superstructure, and to resist wind forces. The variable nature of pier type foundations, and their supported loads, makes rule-of-thumb requirements impractical except in the case of one-storey buildings where the superstructure loads and wind forces are relatively small.

9.15.3.1. Soils vary in their capacity to carry foundation loads. When the soil pressure beneath a foundation is too high, excessive foundation settlement and building damage may occur, particularly if the settlement is not uniform. Footings are therefore used beneath foundations to spread their load over a wider area, thereby reducing the bearing pressure, and reducing the risk of building damage.

9.15.3.2. To reduce the risk of excessive foundation settlement and consequent building damage. (see also 9.15.3.1.)

9.15.3.3. To ensure that the bearing pressure exerted by a foundation wall or column will not cause excessive soil settlement and consequent building damage. Table 9.15.3.A. is restricted to buildings of a size and occupancy (i.e. live load) that will not cause the design load assumptions on which the table is based to be exceeded.

9.15.3.4. In granular soils, the presence of groundwater serves to reduce the friction between soil particles thus reducing their capacity to support loads. Soil pressures caused by foundation loads, however, diminish as the soil depth increases, and at a depth equal to about half the footing width, the reduction in soil pressure compensates for the reduced load carrying capacity of the saturated soil.

9.15.3.5. To ensure that the soil bearing pressure beneath a non-loadbearing masonry wall will not cause excessive soil settlement and consequent wall damage. (see also 9.15.3.1.)

9.15.3.6. If concrete footings are too thin, they may dry out before the concrete has properly set, resulting in low strength concrete. In addition, such footings will have a limited capacity to even out soil irregularities and provide an even base for the foundation. (see also 9.15.3.1. for objective)

9.15.3.7. When a footing supports a foundation, the soil exerts a pressure beneath the footing. Where the footing is wider than the foundation wall (or column) the portion that projects beyond the wall (or column base) is bent upward. Such footings if unreinforced, tend to fail along shear lines that extend downward at an angle of about 45° from the face of the wall. To be within this shear line, therefore, the footing projection is limited to the footing thickness unless it is reinforced.

9.15.3.8. Steeply sloping sites can result in very high foundation walls if the footings are at the same level. Step footings are used to reduce this height. The maximum limit in vertical rise and the minimum limit on horizontal run are intended to limit the degree of soil disturbance.

9.15.4.1. To provide sufficient strength to resist horizontal soil pressures, and support for the superstructure loads, including the building contents.

(Soil exerts a pressure against foundation walls that increases with depth, much like a liquid. Foundations strong enough to resist such loads are usually strong enough to support the superstructure loads. Table 9.15.4.A. is based on the design assumptions in Article 9.4.4.6., modified by experience).

9.15.4.2. Foundation walls supported at the top act much like simple beams in resisting soil pressures. If unsupported at the top, their ability to resist earth pressures is dependent on the resistance to overturning provided by the weight of the superstructure and the weight of the foundation wall, Since walls supported at the top are able to withstand much more earth pressure than unsupported walls, it is necessary to establish what constitutes adequate support. Where openings are created for windows, the walls are weakened, since the portion under the window is unsupported. Limitations are therefore necessary on the extent of such openings in walls assumed to be supported at the top. (see 9.15.4.1. for objective)

9.15.4.3. To provide sufficient wall elevation above ground level to prevent the entry of rainwater run-off and snow melt.

9.15.4.4. See 9.15.4.1. for objective. When a foundation wall is reduced in thickness to achieve some design purpose, compensating measures are required to ensure that the wall will have adequate strength.

9.15.4.5. To ensure that a masonry superstructure will not become unstable when it extends over the edge of a supporting foundation.

9.15.4.6. To control the location of shrinkage cracks in foundation walls, so that such locations can be designed to resist the entry of soil drainage water.

9.15.4.7. To ensure that interior masonry walls that act as foundation walls will have adequate strength to support anticipated loads.

9.15.5.1. To ensure that the top of a hollow block foundation wall will have sufficient strength to support the superstructure loads, and to prevent the entry of termites into the wall cavity. Exception for wood frame construction supported on a sill plate is rationalized on the basis that the plate is capable of distributing joist loads to the foundation due to the lightness of such construction. (The siding is overlapped to prevent rain water entering the top of the foundation).

9.15.5.2. To ensure that the foundation wall will not be overstressed at beam support locations. Also to ensure that the ends of floor beams will be protected from rain, which could cause decay.

9.15.5.3. To ensure that the foundation wall will not be overstressed at beam support locations.

9.15.6.1. To provide an even base for the application of dampproofing or waterproofing to achieve the objectives in 9.13.1.1 and 9.13.1.2.

9.15.6.2. To resist the entry of rain through mortar joints in concrete block walls. (Tooling the joint brings the mortar into more intimate contact with the masonry, thus reducing leakage.)

9.15.6.3. To provide a suitable base for the application of dampproofing or water proofing on the exterior, and to reduce the risk of injury from accidental contact with ties on the inside.

Section 9.16 Floors-on-Ground

9.16.1.1. To indicate that this Section is intended to apply only to non-structural floors that rely on soil or granular fill for support. This includes concrete slabs and wood frame floors.

9.16.1.2. To indicate that the design requirements for structural floors are contained elsewhere in another part of the Code. This is intended to apply to structural concrete floors.

9.16.1.3. To indicate that each crawl space beneath a building that is provided with an opening for access must have a floor. The floor is intended to protect the ground cover from damage, and to assist in restricting the entry of soil moisture and soil gasses into the building. (See also 9.13.1.3. for objective)

9.16.2.1. To provide a reservoir (porous fill) for the collection of soil gasses, or to provide a capillary break between the soil and the floor to restrict the rise of soil moisture to the floor above. (The fill can be depressurized to prevent the entry of soil gasses into the building) (see objective in 9.13.1.3.)

Exemption for garages is rationalized on the basis that there is a gas seal between the garage and the remainder of the dwelling. Exemption for carports and certain types of industrial buildings is rationalized on the basis that these are open to the outside air, and for accessory buildings on the basis that these are unoccupied most of the time.

9.16.3.1. To intercept rainwater or snow-melt before it can migrate to the underside of the floor and eventually into the house. This could add to the moisture load in the house and create problems ranging from window condensation to structural deterioration.

9.16.3.2. When the groundwater level rises above the floor level, hydrostatic pressure is created on the underside of the floor, tending to push it upward. Such forces may be sufficient to cause concrete slabs to heave and break, or wooden floors to float. One method of counteracting this problem is to provide a structural concrete slab, designed to resist such forces.

9.16.3.3. To facilitate the disposal of water that spills or leaks onto a concrete floor slab that has been equipped with a floor drain.

9.16.4.1. To provide a floor surface, sufficiently smooth and even to facilitate cleaning, or to provide a surface suitable for the direct application of thin floor finishes. Also to provide a surface sufficiently hard and durable to withstand the effects of pedestrian traffic without undue deterioration, and to act as an effective adhesive base for certain floor finishes. Prohibition of dry cement when trowelling is to promote concrete hardness to resist surface crumbling (i.e. dusting) from pedestrian traffic.

9.16.4.2. To provide a floor surface sufficiently hard and durable to achieve the objectives in 9.16.4.1. If the concrete slabs are too thin they may dry out before the concrete has properly set, thus giving rise to low strength concrete.

9.16.4.3. When a load is applied to the top of a slab, it is distributed over a wider area beneath the slab. The thicker the slab, the greater will be the ground area over which the load is distributed, due to the increased slab stiffness. If the slab is too thin, the load may be large enough to deflect the ground beneath the slab, causing it to crack. The required slab thickness is intended to provide sufficient slab stiffness to prevent this for the loads normally encountered in buildings covered by Part 9.

9.16.4.4. To reduce the amount of cracking in concrete slabs caused by shrinkage, as the slab cures and dries. The bond break allows the slab perimeter to move inward as the slab shrinks, thereby relieving the slab of the tensile stresses that would have otherwise resulted.

9.16.5.1. To ensure that wood frame floors supported on the ground will be constructed in a manner that will resist decay for the expected life of the building. Also to ensure that such floors will resist the inward thrust from the walls caused by earth pressure. (Note CAN3-S406M does not cover floors on ground.)

Section 9.17 Columns

9.17.1.1. The column sizes described in this Section are based on experience in residential construction, where the loads are relatively small, partly due to the occupancy, and partly due to the type of construction and size of the buildings. When the limited application of the rule-of-thumb requirements are exceeded, the column is subjected to structural analysis to ensure that it will have sufficient strength to carry the anticipated loads.

9.17.2.1. If load-bearing columns are not located near the centers of their footings, the pressures beneath the footings will be greater near the positions closer to the column. This can cause an uneven settlement under the footing, and under severe conditions could cause foundation failure.

9.17.2.2. To ensure that columns will not be accidentally dislodged and cause supported members to fail.

9.17.3.1. To provide sufficient strength to carry the anticipated loads.

9.17.3.2. To spread the column load over a sufficient area to prevent crushing of the concrete at the bottom support, or crushing of wood at the top where the column supports a wooden beam. Exception is to permit the welding of a column directly to a supported steel beam.

9.17.3.3. To prevent rusting of the column before it is installed.

9.17.3.4. To ensure that adjustable steel columns will have sufficient strength to carry anticipated loads.

9.17.4.1. To ensure that wooden columns will have sufficient strength to support the anticipated loads. Also to ensure that each member in a built-up wood beam will be supported directly by the column, and that the column will have sufficient area to prevent undue crushing of the beam.

9.17.4.2. To describe various types of wooden columns. Also to indicate how the various members in built-up wooden columns are tied together in order to act as a unit to carry the anticipated loads. Glue-laminated columns require engineering analysis and manufacturing supervision beyond the scope of Part 9. These are designed in accordance with structural requirements found elsewhere in the Code.

9.17.4.3. To prevent moisture from the ground or as a result of surface condensation on the concrete in summer from entering the wood and initiating decay.

9.17.5.1. To ensure that concrete masonry will be a type capable of supporting the anticipated loads.

9.17.5.2. To ensure that concrete masonry columns will have sufficient strength to support anticipated loads.

9.17.6.1. To ensure that the strength of concrete used for columns will be capable of supporting anticipated loads.

9.17.6.2. To ensure that concrete columns will have sufficient strength to carry anticipated loads.

Section 9.18 Crawl Spaces

9.18.1.1. Most of the requirements in this Section relate to the control of moisture accumulation in crawl spaces. When crawl spaces have large portions of their exterior walls open to the outside air this danger no longer exists and the crawl spaces do not have to conform to this Section.

9.18.1.2. To remind users that when the enclosing walls of a crawl space support loads from the superstructure, they act as foundation walls whose requirements are located elsewhere in the Code.

9.18.1.3. To indicate the conditions for which a crawl space is considered to be heated space when applying the heating requirements located elsewhere in the Code, as well the requirements for insulation, vapour barriers and air leakage.

9.18.2.1. To provide a means for entering the crawl space for the purpose of inspection and servicing. Smaller openings for houses are rationalized on the basis of past experience. Access hatches or doors are required to reduce heat loss into unheated crawl spaces, or from heated crawl spaces to the exterior if they are located in exterior walls.

9.18.3.1. To prevent the build-up of moisture within a crawl space as a result of the evaporation of soil moisture. In severe cases moisture can increase to the point where wood decay is initiated. Vent distribution is to encourage cross ventilation and more rapid dissipation of moisture to the exterior. Moisture can also enter the vents as rain or snow if they are not shielded. Screening is also necessary to keep insects from entering the crawl space.

9.18.3.2. To indicate that heated crawl spaces are subjected to the same ventilation requirements as other heated spaces, and these are located elsewhere in the code.

9.18.4.1. To provide sufficient clearance within a crawl space to allow access to equipment that requires periodic servicing.

9.18.5.1. To restrict the entry of rain run-off and snow-melt from entering the crawl space where it may lead to conditions causing wood decay. Also to provide a means whereby any water that does enter the crawl space is led to a drain for disposal to prevent moisture related problems. See also the objectives 9.14.2.1., and 9.16.3.1.

9.18.6.1. To restrict the entry of ground moisture into unheated crawl spaces as a result of evaporation, where it could contribute to moisture related problems such as wood decay.

9.18.6.2. Same objective as in 9.18.6.1. for unheated crawl space. Also to restrict the amount of soil gasses escaping from a crawl space that could migrate to the living areas and create health problems.

9.18.7.1. When crawl spaces are used as warm air plenums, the warm air from the furnace plenum is blown into the crawl space which then becomes pressurized. Registers to allow warm air up into the living areas are not attached to any duct work, but rely on the crawl space air pressure to force the warm air up through the registers. Such systems are not able to regulate air distribution in buildings of more than one storey since there are no ducts to the upper storeys.

Crawl space fires can spread quickly if the enclosing material has a high flame spread rating. Since the register openings connect to the living areas, such fires can quickly spread upward. To reduce the likelihood of fire ignition, noncombustible receptacles are placed under register openings if the ground cover is combustible to catch items such as cigarette butts that might accidentally fall through the openings.

Section 9.19 Roof Spaces

9.19.1.1. To provide a means for allowing moisture that may have found its way into an attic or roof space to escape to the exterior. Excess moisture as a result of winter condensation can raise the moisture level in such spaces to the point where wood decay can start, or water leakage into the space below may occur when the winter build-up of frost and ice melts. Exception to this requirement is to allow certain factory-built structures that are designed with exceptionally air-tight ceiling construction to have no roof vents.

9.19.1.2. To provide sufficient vent area to transfer moisture that may collect in roof spaces to the exterior before it can create problems. Such vents not only reduce the amount of winter moisture accumulation, but allow the roof or attic space to dry out more quickly in the spring when the temperature rises to a level that allows wood decay. In low-sloped roofs, the roof sheathing is closer to the source of moisture leakage from the space below, and condensation and frost build-up can occur before the moisture escapes through the roof vents. Greater vent area is therefore required for such roofs both to reduce moisture build-up and to hasten subsequent spring drying.

Distribution of vents on opposite sides of the roof is to encourage cross ventilation while top and bottom distribution is intended to take advantage of convection currents to move heated air to the highest part of the roof to escape. If there is no common attic space (e.g. flat roofs, cathedral ceilings) and there is no interconnection between joist spaces, the only way the roof can be effectively vented is by venting each joist space. If the vents allow the entry of snow or rain, this will add to the moisture load and the risk of problems previously noted.

9.19.1.3. Unless air can flow freely between the insulation and roof deck to reach a vent to the exterior, venting will not be effective. As this space is reduced, the resistance to air flow increases. Therefore to achieve the objectives in 9.19.1.1. and 9.19.1.2. a sufficient clearance is required to reduce undue resistance to air flow.

9.19.1.4. Although gambrel style roofs are referred to as roofs, the lower portion with the steeper slope is in reality closer to a wall with the sheathing held out at the bottom. Experience has shown that unless the moisture load for the building is very high, wall spaces do not require venting to reduce potential moisture problems. The upper portion of a gambrel style roof, however, does perform as a roof and experience has shown that venting of this portion is indeed important to reduce the risk of moisture problems.

9.19.2.1. Where an attic space is high enough to permit a person to enter, an access opening is provided to permit periodic inspection. A hatch cover or doorway is also needed to resist heat loss and moisture leakage into the space.

Section 9.20 Above-Grade Masonry

9.20.1.1. To indicate that the rule-of-thumb requirements in this Section apply only to buildings of limited height that do not support concrete floors or roofs and which are unreinforced, except for nominal earthquake reinforcing. Masonry buildings beyond this scope are subject to the structural design requirements located elsewhere in the Code.

9.20.1.2. The heavy weight and brittle nature of unreinforced masonry makes it susceptible to earthquake damage. The risk of damage increases with the height of the building as well as the severity of the earthquake. Nominal reinforcing can decrease this risk, with the most restrictive measures needed in high risk areas, and the least restrictive in low risk areas. (e.g. no reinforcing is needed in low risk areas, reinforcing of 2 and 3-storey buildings is required in high risk areas, and reinforcing of 3-storey buildings is required in intermediate areas.)

9.20.2.1. To ensure that masonry units will possess the necessary characteristics to fulfill their intended purposes. These include dimensional stability, durability to resist freezing and thawing, structural strength and rain tightness.

9.20.2.2. To ensure that when used brick is used, it will have the necessary characteristics to achieve the objectives of 9.20.2.1.

9.20.2.3. To ensure that glass blocks will not be used in a location where they will create a fire hazard as a result of their inability to resist high temperatures or heat radiation, or where breakage could result in structural failure of a supported element.

9.20.2.4. Foamed concrete will deteriorate if directly exposed to certain soils. It also readily absorbs moisture and has relatively low resistance to damage from freezing and thawing.

9.20.2.5. See objectives in 9.20.2.1.

9.20.2.6. To ensure that non-loadbearing concrete block will provide reasonable resistance to rain and freeze-thaw cycles when exposed to the weather. Also to ensure that such units will have a reasonable degree of dimensional stability if provision for shrinkage has not been incorporated in the design.

9.20.2.7. To prevent the exposure of masonry units to weathering where they are not designed to withstand such effects. Also to ensure that masonry units will have sufficient strength to support anticipated loads and the type of handling to be expected on construction sites.

9.20.3.1. The essential properties of masonry mortar, including its workability, tensile and compressive strength, bonding strength and durability depend on the characteristics of its cementitious materials, mix water and aggregate. The objective of this requirement therefore is to define the necessary characteristics of the constituent materials to provide a mortar that will fulfill its intended purpose.

9.20.3.2. To ensure that the materials used to make mortar will be mixed in the proper proportions to achieve the objectives described in 9.20.3.1., commensurate with the exposure conditions and structural requirements of the intended application.

9.20.4.1. To ensure that the joint thickness in combination with masonry unit dimensions will be modular for the laid masonry units. Tolerance limits are to allow for normal variations.

9.20.4.2. To resist rain entry through joints between units. Also to ensure that the wall assembly will be able to resist the anticipated compressive and/or tensile stresses.

9.20.4.3. Same objectives as in 9.20.4.2.

9.20.5.1. The weight and friable nature of masonry construction requires that the supporting base be both strong and stable to avoid structural failure. Ordinarily, the only materials capable of providing such a base are concrete, steel and masonry. (In recent years, however, it has been shown that non-loadbearing masonry veneer can be satisfactorily supported on specially designed preserved wood foundations). If the base is narrower than the supported masonry, the masonry must be positioned so that excessive eccentricity will not occur to make it unstable, leading to structural collapse.

9.20.5.2. Since unreinforced masonry has little tensile strength, a means for supporting it has to be provided over the tops of doors and window openings. This can be done by the use of a steel or reinforced concrete lintel designed to carry the anticipated load. Alternatively the top of the opening can be arch shaped so that the units are all in compression. While rule-of-thumb requirements exist for steel lintels in non-load-bearing veneer, lintels (or other means of support) in other masonry walls have to be determined in conformance with structural design requirements located elsewhere in the Code to ensure structural stability.

9.20.6.1. To ensure that exterior masonry walls will have sufficient strength and stability to support the anticipated vertical loads including dead loads, live loads due to occupancy and snow loads, and to resist anticipated wind loads. (see also 9.20.1.1.)

9.20.6.2. Same objective as 9.20.6.1. Traditionally, cavity walls were intended to provide protection from rain leakage by virtue of the cavity, as well as thermal insulation. Modern cavity wall construction, however, may have the cavity filled with insulation for additional thermal resistance.

If the cavity is too narrow there will be insufficient space to prevent mortar squeezed from joints from bridging the cavity. If it is too wide the two wythes will act independently of each other, rather than in concert, to resist imposed loads and thus weaken the wall.

9.20.6.3. To ensure that interior masonry walls will have sufficient strength and stability to resist normal impact forces, and in the case of load bearing walls, sufficient strength and stability to support anticipated vertical loads.

9.20.6.4. Masonry veneer consists of two basic types; self supporting and individually supported. The latter type is more commonly used on larger buildings outside of the scope of Part 9. The requirements for such veneer therefore are located elsewhere in the Code. The objective of this Article is to ensure that the veneer will have sufficient stability to support its own weight and will resist anticipated wind forces. Since raking the joints reduces the width of bearing support, this practice is not allowed for thinner veneers because it could make the wall unstable.

9.20.6.5. To ensure that parapet walls will have sufficient strength and stability to withstand anticipated wind forces. Also to prevent rain leakage or snow-melt from running down any cavities in the parapet and into the rooms below. This could lead to deterioration of the parapet due to freezing and thawing, as well as damage to the wall and ceiling finishes in the rooms below.

9.20.6.6. Limestone slab facings are more commonly used in larger buildings beyond the scope of Part 9. Requirements for such facings therefore are located elsewhere in the Code.

9.20.7.1. Chases refer to long narrow channels in masonry walls to receive piping, ducts or wiring. Recesses, on the other hand are rectangular in shape and are usually made to receive electrical panels, standpipe and hose equipment or similar services. Since chases and recesses tend to weaken the masonry walls, their dimensions and locations are limited to prevent undue strength reduction.

9.20.7.2. The thicker the masonry wall, the greater the depth of chase or recess that can be permitted to allow the same percentage of strength reduction. In thin walls the amount of strength reduction to provide a chase or recess of a practical depth is considered to be too great to allow their use.

9.20.7.3. The strength of a masonry wall in resisting shear forces due to wind, and concentrated vertical loads, depends on its ability to act as a single unified system. When chases or recesses are provided, they create zones of weaknesses in the wall and tend to divide it into a number of partially connected units. To limit this effect, therefore, restrictions are placed on how close together such weakened zones are permitted to be. The effectiveness of cross walls, buttresses and pilasters intended to provide lateral support, can be reduced if chases and recesses are allowed to be too close to them.

9.20.7.4. In certain situations where it may be necessary to exceed the dimensional limits for recesses, it may be feasible to design the weakened sections as if it were an opening in the wall, and bridge across the top with a lintel designed to carry the weight of the masonry as well as any superimposed loads. In this way the structural integrity of the wall will not be compromised.

9.20.7.5. If chases or recesses are cut into hollow block after they have been laid, the face shell has to be removed as well as a portion of the web material. In effect the remaining portion is little more than a single face shell in thickness. This has a serious weakening effect on the wall and is therefore not allowed, unless that portion of the wall is designed as an opening.

9.20.8.1. To provide sufficient bearing area on top of a masonry wall to prevent crushing of supported wooden members or overstressing of masonry face shells beneath the loads.

9.20.8.2. Same objectives as 9.20.8.1. Also to tie the two wythes together at the top of the wall so that the supported roof loads are shared between the two wythes to reduce loading eccentricity and improve the stability of the wall. Floor joists do not extend into the cavity area in order to reduce the possibility of exposure to rain leakage which could lead to decay problems.

9.20.8.3. To provide sufficient bearing area beneath wooden members to prevent undue crushing of the wood.

9.20.8.4. Loads from beams and columns can be very high, and when supported on thin walls may cause them to be over stressed. To prevent this, a pilaster (which is really a thickened portion of the wall) is constructed to support such loads. The pilaster has to be bonded to the wall, however, if the thickened portion is to have maximum resistance to buckling.

9.20.8.5. If masonry projects too far over the supporting base, it will become unstable and structural collapse may result. Normally if the projection is not more than 1/3 the width of the unit it will be stable, although in the case of hollow masonry veneer units this may be somewhat less because of the decreased stability of these units.

9.20.9.1. Mortar joints are usually weaker in tension than the units they bond together. Head joints are much weaker than bed joints because the mortar is not pressed into intimate contact with the units from the weight of the masonry as it cures. If the head joints are not staggered they will form a plane of weakness where cracks will concentrate and such walls will have much less capacity to resist wind shear stresses or to support concentrated loads. If, however, a "stacked bond" is desired for aesthetic reasons, horizontal joint reinforcing can be used to compensate for the vertical planes of weakness, and reduce shrinkage cracking at the vertical joints. Reinforcing bars are lapped to transfer stress from one bar to another thus providing continuity in the reinforcing.

9.20.9.2. The strength of a wall that has 2 or more wythes of masonry can be greatly improved if the wythes are bonded or tied together to act as a single unit. Two wythes not bonded or tied together, will have twice the strength of a single wythe. If bonded together, however, the wall would have 4 times the strength of a single wythe in resisting bending forces. Bonding is therefore used to maximize the strength of such walls.

9.20.9.3. To maximize the load carrying capacity of masonry walls by bonding adjacent wythes together with masonry units. (see also 9.20.9.2.)

9.20.9.4. To maximize the load carrying capacity of masonry walls by tying adjacent wythes together with metal tie rods. (see also 9.20.9.2.). Filling the space between wythes with mortar prevents flexing of the reinforcing so that the wall will act as a single unit. Mortar cover over ties prevents corrosion. Metal ties are generally used to tie cavity walls rather than bonding bricks because they can be shaped to prevent rain leakage from reaching the inner wythe. Since they span across the cavity, however, they are not effective in making the two wythes act as a single unit. They do, however, increase the stability of the individual wythes under vertical loads, and increase the resistance to wind forces by providing lateral support from one wythe to another.

9.20.9.5. To increase the stability of veneer by providing intermediate lateral support. This increases its resistance to buckling due to its weight, and its resistance to horizontal wind forces. Also to remind the user that requirements for veneer that is not free standing are found elsewhere in the Code. The latter is more commonly found in larger buildings beyond the scope of Part 9.

9.20.9.6. Since glass blocks are not normally staggered from one course to another, the vertical joints line up to create zones of weakness and potential cracks (see also 9.20.9.1.). Horizontal joint reinforcing, therefore, is used to compensate for the weakened vertical planes and reduce the possibility of cracking.

9.20.10.1. Vertically loaded masonry walls behave somewhat like columns. As the slenderness ratio (i.e. the height divided by thickness) is increased, there is a greater tendency to buckle under a given load. If intermediate lateral support is provided by a floor or roof assembly, however, the column is made more stable and is able to carry greater loads. Cross walls and buttresses can also stiffen the wall against buckling in much the same way. Lateral supports not only enable the wall to carry higher vertical loads but also help in resisting wind forces. Limits are therefore placed on the maximum distance between such supports, depending on the thickness and location of the wall. Non-load bearing walls only have to support their own weight and the possibility of accidental impact. These are therefore permitted to have lateral supports further apart.

9.20.11.1. Where roofs or floors are intended to provide lateral support as described in 9.20.10.1. their points of attachment to the masonry must be sufficiently strong and at appropriate intervals to provide the necessary restraint to the masonry.

9.20.11.2. Where intersecting masonry walls are intended to provide lateral support for other masonry walls as described in 9.20.10.1., they must be fastened or attached to the adjoining masonry in a manner to provide the necessary restraint. Although this has traditionally been done by means of bonding alternate courses into the wall to be supported, metal ties can also be used.

9.20.11.3. Although wood frame walls do not provide sufficient support to masonry walls to be counted on as intermediate supports, they nevertheless do contribute to the stability of the masonry in resisting buckling forces. It is therefore considered good practice to increase the overall rigidity of the building by tying such wood frame walls to the masonry where they intersect.

9.20.11.4. To provide lateral support to the top of a masonry wall to resist wind forces. Also to anchor the roof system to the top of the wall against upward forces caused by wind action.

9.20.11.5. To ensure that masonry projecting beyond the wall face will be held firmly in position so that it will not create a hazard to persons below.

9.20.11.6. To provide adequate resistance to column uplift forces caused by wind action.

9.20.12.1. To ensure that when it is necessary to offset successive masonry courses the overhanging masonry will not cause the wall to be unstable.

9.20.12.2. To ensure that where the foundation is not as thick as the supported cavity wall, it will not be offset to the degree that the wall or the foundation will be unstable. Corbelling the interior of a masonry foundation wall to meet flush with the cavity wall is permitted, since the eccentricity of the cavity wall load tends to reduce the tensile stresses in the foundation caused by earth pressure.

9.20.12.3. (Should be deleted - see change to 9.20.8.5.)

9.20.13.1. To ensure that flashing materials used in a location where they will be exposed to air and sunlight will have reasonable resistance to deterioration from the effects of sunlight, moisture and air. Also to ensure that materials known to be chemically reactive with concrete or mortar will be protected from direct contact with them to avoid premature failure.

9.20.13.2. To ensure that flashing material that is not exposed to sunlight will have reasonable resistance to deterioration from the effects of moisture and air.

9.20.13.3. To prevent premature failure of the flashing as a result of a chemical reaction between the fasteners and the flashing.

9.20.13.4. To prevent the entry of rainwater into the building envelope where it could lead to masonry damage from freezing and thawing, wood decay, damage to the interior finish and other moisture related problems.

9.20.13.5. Same objective as 9.20.13.4. Extending the flashing upward behind sills or heads of openings prevents rain from leaking over the top of the flashing.

9.20.13.6. Same objective as 9.20.13.4. Embedment of flashing in the inner wythe secures it in position. Sloping it to the exterior ensures drainage out to the weep holes. Extending it beyond the face of the exterior wall is for the purpose of forming a drip edge so the water will not run underneath the flashing.

9.20.13.7. Same objective as 9.20.13.4.. See also 9.20.13.6.

9.20.13.8. Same objective as 9.20.13.4.

9.20.13.9. To provide a means for allowing any water that leaks through the outer wythe in cavity walls or through exposed masonry veneer to drain back to the exterior of the masonry in order to prevent damage due to moisture related problems.

9.20.13.10. Same objective as 9.20.13.4. Requirement for sheathing paper is to lead any rain leakage down to flashing where the water can be drained to the exterior. Exemption for cavity walls is rationalized on the basis that cavities are very effective in preventing leakage to the inner wythe. Exemption for walls with water repellent insulation is rationalized on the basis that the insulation will serve to protect the wall finish from any water leakage through the masonry.

9.20.13.11. Same objective as 9.20.13.4. Mortar that is squeezed out from the joints and mortar droppings, may bridge across the cavity and destroy the effectiveness of the cavity in keeping the inner wythe dry unless precautions are taken to prevent this. (e.g. a wooden slat suspended horizontally in the cavity is sometimes used, with the slat being moved upwards as work proceeds.)

9.20.13.12. To restrict the entry of air and rain water at the junction between door and window frames and masonry.

9.20.13.13. same objective as 9.20.13.4. The drip edge is used to prevent water from running back under the sill and into the building envelope.

9.20.14.1. Mortar cures slowly at temperatures below 5 °C. If the temperature drops much below freezing, mortar can lose much of its strength and freeze-thaw resistance. By providing heat, the temperature can be kept within a range to allow proper curing to take place.

9.20.14.2. Unexpected rain may occur before mortar has set sufficiently to resist water, and may wash out of the masonry. The joints near the top of the wall are the most vulnerable and have to be covered if the work is discontinued.

9.20.15.1. To provide sufficient reinforcing strength to meet the objectives of 9.20.1.2.

9.20.15.2. To ensure that masonry will be installed properly in order to meet the objectives of 9.20.1.2.

9.20.16.1. To ensure that metal ties, anchors, connectors and rods used in masonry construction for the purpose of providing structural stability will have a service life equal to the expected life of the building.

Section 9.21 Chimneys and Flues

9.21.1.1. To indicate the limited scope of the rule-of-thumb requirements in this Section. Beyond this scope, chimney and flue pipes require specialized design for the particular equipment served. This is specified in the installation standard applicable to the equipment.

9.21.1.2. To ensure that prefabricated chimneys will be made in a manner to withstand the expected flue gas temperature and resist corrosion due to flue gasses. Also to ensure that such chimneys will be installed in a manner that will not create a fire or health hazard.

9.21.1.3. To ensure that the products of combustion of fuel-fired equipment will be vented to the outdoors in a manner that will not create a fire or health hazard.

9.21.1.4. To prevent the escape of flue gasses from the chimney or flue pipe where they could create a health or fire hazard.

9.21.2.1. The draft demands from a fireplace or incinerator may be sufficiently great to interfere with the draft for other connected appliances. This could cause appliance to operate inefficiently, and even cause flue gas spillage into the building where it could create a health hazard.

9.21.2.2. See objective of 9.21.1.3. Requirement for appliances served by a common flue to be on the same storey appears to be a means to reduce the total number of appliances served. This prevents overloading the flue capacity which could lead to back drafts and spillage of flue gas into the building. The requirement for the flue connection for solid flue appliances to be at a lower level than for other appliances appears to be based on tradition.

9.21.2.3. See objectives for 9.21.1.3. To prevent excessive lengths of chimney flues in order to avoid excessive cooling of flue gasses and consequent condensation and loss of draft.

9.21.2.4. To provide sufficient flue gas capacity in a chimney flue to vent the products of combustion from the appliance served to the exterior to meet the objectives of 9.21.1.3.

9.21.2.5. To provide sufficient flue gas capacity in a chimney flue to vent the products of combustion from a fireplace to the exterior to meet the objectives of 9.21.1.3. As the height of a chimney flue is increased, its draft will also be increased, and hence its capacity to vent flue gas. The larger the fireplace opening, however, the greater the amount of air that flows into a fireplace and up the chimney. Fireplace flue vent area therefore depends on the area of the fireplace opening and the chimney height.

9.21.2.6. As the shape of an oval chimney becomes flatter, its cross sectional area decreases making it less efficient in transporting flue gasses. Ratio of length to width of oval flues, therefore, is limited to prevent excessive resistance to flue gas flow.

9.21.3.1. To ensure that the conduit for conveying flue gasses will resist the heat and the corrosive effects of flue gasses, and will provide a smooth surface that will not unduly restrict the flow of flue gasses to the exterior. See objectives in 9.21.1.3.

9.21.3.2. To provide a gas-tight conduit to meet the objectives of 9.21.1.3. Also to restrict the leakage of condensate in the flue gas into the surrounding masonry. Such condensate can be corrosive to concrete or mortar, and by keeping the masonry wet, will make it susceptible to damage from freezing and thawing.

9.21.3.3. To ensure that clay flue liners will be able to withstand the effects of flue gas temperatures and be able to meet the objectives in 9.21.1.3. and 9.21.3.1.

9.21.3.4. To ensure that fire brick flue liners will be able to resist the heat and corrosive effects of flue gasses to meet the objectives in 9.21.1.3. and 9.21.3.1.

9.21.3.5. To ensure that concrete flue liners will be able to resist the heat and corrosive effects of flue gasses to meet the objectives in 9.21.1.3. and 9.21.3.1.

9.21.3.6. To ensure that metal flue liners will be able to resist the heat and corrosive effects of flue gasses to meet the objectives in 9.21.1.3. and 9.21.3.1.

9.21.3.7. To enable the joints between flue liners to be constructed to resist the leakage of condensate into the surrounding masonry as required in 9.21.3.2., to meet the objectives in 9.21.1.3. and 9.21.3.1.

9.21.3.8. Double walled masonry chimneys are generally confined to higher capacity chimneys operating at higher temperatures than single walled chimneys, and tend to be used more for higher chimneys. If the liner were not able to move relative to the masonry, the resulting expansion of the liner could be great enough to cause tension cracks in the masonry or damage to the liner. The provision of the air space between the liner and the masonry reduces the temperature on the inside of the masonry and reduces the possibility of thermal cracks.

9.21.3.9. Chimneys for solid fuel appliances generally operate at a temperature high enough to cause refractory mortar to set properly. Chimneys for oil and gas appliances, however, operate at a temperature that is too low to ensure proper setting. Both refractory mortar and high strength Portland cement - sand mortar provide good resistance to the corrosive action of flue gasses, and are therefore used to meet the objectives in 9.21.3.7.

9.21.3.10. Chimney liners are designed to be enclosed by masonry and are not intended to be free standing above the chimney cap, except for a nominal amount to prevent rainwater flowing across the cap from running into the chimney flue. The maximum projection of the cap is based more on aesthetic than on structural considerations, however. Extending the flue liner below the lowest flue pipe is to ensure that the enclosing masonry will have adequate protection from conducted heat in this area.

9.21.4.1. To enable chimneys of masonry construction to be durable, and be able to provide adequate resistance to wind forces and rain penetration.

9.21.4.2. To enable chimneys of concrete construction to be durable, and be able to provide adequate resistance to wind forces and rain penetration. Also to provide footings of sufficient strength to carry superimposed loads.

9.21.4.3. To spread the weight of concrete and masonry chimneys over a sufficient area of soil to prevent excessive settlement of the chimney that could result in chimney damage.

9.21.4.4. To reduce the likelihood of downdrafts due to air currents close to the roof surface. This could cause backdrafting of the appliances served by the chimney.

9.21.4.5. To provide a chimney with sufficient structural stability to resist anticipated wind forces.

9.21.4.6. To prevent the entry of rain water into the top of the masonry through cracks between the masonry units and between the masonry and chimney liner. The drip edge for the cap is to prevent rain from leaking under the cap and into the masonry below. The bond break between chimney caps and liners is to allow vertical expansion of the liner without lifting the cap.

9.21.4.7. Over a period of time, the operation of a chimney will result in certain products of combustion such as soot and creosote being dislodged from the flue liner and collecting at the bottom of the flue, particularly during chimney cleaning. This material, being combustible, can create a fire hazard if ignited by a chimney fire. Provision is therefore made to clean out this residue by providing an access door near the bottom of the flue.

9.21.4.8. To provide chimneys of sufficient stability to resist anticipated wind forces. and to reduce the outside surface temperature of chimneys to the point where they will not ignite combustible material at the designated clearances specified elsewhere in the Code.

9.21.4.9. To prevent joints in chimney liners from opening up as a result of lateral instability. Such open joints allow the escape of flue gas and condensate into the masonry, and cause its deterioration from freezing and thawing action. Also to make flues independent from the action of an adjacent flue should one flue liner fail.

9.21.4.10. To prevent the entry of rain at the juncture between the chimney and the adjacent material where it may then leak into the building, giving rise to moisture related problems such as masonry deterioration, wood decay or damage to the interior finish.

9.21.5.1. To prevent the heat rise in combustible materials adjacent to a chimney from reaching a level where they could be ignited. Less clearance is needed for exterior chimneys since their exterior surfaces are cooler than interior chimneys. Wind and cooler temperatures dissipate the heat of exterior chimneys at a faster rate than interior chimneys. Since chimney fires can involve the residue at the base of a chimney, a clearance is necessary between the clean-out door and combustible material to prevent it from being a fire hazard.

9.21.5.2. To prevent the spread of fire from one level to another. Fire stopping is provided only at the top or bottom of a space adjacent to a chimney. If installed at both locations, air would be trapped in the space adjacent to the chimney and would increase in temperature to the point where adjacent combustible material could be ignited.

9.21.5.3. While it is generally not a safe practice to support wood on a masonry chimney, in some designs with large fireplaces, it is sometimes difficult to avoid supporting a beam on a fireplace wall that contains a chimney flue. To prevent the temperature of a wood beam from reaching a temperature where ignition may occur, a sufficient amount of masonry must be provided to separate the wood from the flue.

Section 9.22 Fireplaces

9.22.1.1. To indicate that the rule-of-thumb requirements in this Section apply only to site-built masonry fireplaces.

9.22.1.2. To ensure that masonry and concrete used to construct fireplaces, including their footings and hearths will have the necessary characteristics to provide a safe and durable fireplace. See also 9.21.4.1. and 9.21.4.2.

9.22.1.3. To spread the weight of concrete or masonry fireplaces over a sufficient area of soil to prevent excessive settlement and consequent damage to the fireplace.

9.22.1.4. In some fireplace designs, combustion air is ducted from the outdoors directly to the fireplace. If not done properly, however, the combustion air flow may reverse under certain wind conditions and cause the air duct to act as a chimney and create a fire hazard. Requirements are therefore provided to ensure that the supply air duct will not create a health or fire risk.

9.22.2.1. To ensure that the material used to line the fireplace fire box will have adequate durability to withstand the effects of heating, and the thermal shock associated with heating and cooling.

9.22.2.2. To ensure that mortar used with firebrick liners will have adequate resistance to the high temperatures associated with a fireplace fire chamber. Also to avoid through leakage paths in the masonry which could result in fire and health risks.

9.22.2.3. To prevent the leakage of products of combustion through the masonry surrounding the fire chamber, thereby reducing fire and health risks. Also to ensure that the material used for liners will be durable and stable when exposed to the anticipated temperature conditions.

9.22.3.1. To provide sufficient masonry thickness to ensure that fireplaces will not create a fire hazard to the surrounding combustible materials at the clearances specified elsewhere in the Code.

9.22.4.1. To provide structural support for masonry spanning across the fireplace opening.

9.22.5.1. To provide an area in front of the fireplace opening that will withstand the effect of heat radiation and burning embers from the fire chamber, without creating a fire hazard to surrounding combustible material. If the fire chamber is raised above the level of the adjoining floor, embers will be cast further out, making it necessary to have a larger hearth extension to catch them.

9.22.5.2. To provide support for the hearth extension in 9.22.5.1. that will withstand the effect of heat radiation and burning embers from the fire chamber without being a fire hazard to surrounding combustible material. Masonry arches to support hearth extensions are supported on the fireplace foundation near the fire chamber and by the floor framing out from the fire chamber. Such construction is now seldom used. A reinforced concrete apron is usually used instead. If the fire chamber is raised above the floor level, the heat intensity striking the hearth extension is decreased, allowing the use of a thin concrete slab laid directly on the subfloor without creating a fire hazard.

9.22.6.1. To provide a means for reducing the amount of room air passing up the fireplace flue when the furnace is not in operation in order to conserve energy.

9.22.7.1. To provide a shape to the fireplace fire chamber that will direct the products of combustion upwards to the flue without creating excessive air turbulence in the fire chamber that could lead to spillage of smoke into the living area.

9.22.7.2. To provide sufficient masonry to reduce the surface temperature of the exterior of the smoke chamber, so that it will not create a fire hazard to surrounding combustible material at the clearances listed elsewhere in the code.

9.22.8.1. To ensure that factory-built fireplaces will be designed and installed so as not to create a fire hazard to adjacent combustible material.

9.22.9.1. A fireplace can expose combustible material on its face to fire in two ways; the masonry facing can conduct heat directly, and combustible material that projects out from the face may be exposed to heat radiation from the fire chamber. Combustible materials, therefore, are not permitted close to the fire chamber, and large projections such as mantels must be even further away to avoid the risk of ignition from radiation.

9.22.9.2. The rate of heat conduction through steel is many times greater than that through masonry. Any metal therefore that extends from the fire chamber to the surface of the fireplace (such as damper controls) tends to be much hotter than the surrounding masonry and can ignite combustible materials if they are too close.

9.22.9.3. To prevent the ignition of combustible framing adjacent to the sides and back of a fireplace. Although the lining and back-up masonry reduce the temperature on the exterior masonry surface, this can still be sufficiently high to ignite combustible materials if they are too close to the masonry. The smoke chamber above the fire chamber is cooler than the fire chamber and does not require as much clearance to reduce the fire risk.

9.22.9.4. A fireplace liner that allows air to circulate behind it can produce air at the outlets that is hot enough to create a fire hazard to adjacent combustible materials. A sufficient clearance must therefore be provided above such openings to prevent the ignition of combustible materials. (It is not known, however, why the clearance is increased for larger projections since no heat radiation risk is present.)

9.22.10.1. To ensure that fireplace inserts and hearth mounted stoves will be designed and constructed in such a manner so that they will not create health or fire risks.

9.22.10.2. To ensure that fireplace inserts and hearth mounted stoves will be installed in a manner that will not create a health or fire risk.

Section 9.23 Wood-Frame Construction

9.23.1.1. The rule-of-thumb requirements in this Section are based to a large extent on successful past experience with trial and error practices, largely with smaller residential type structures. Other requirements are based on calculations with assumed loads, building sizes and occupancies. The objective of this Article is to inform the user of the limited application of the rule-of-thumb requirements, and to direct him/her to other parts of the Code when the requirements do not apply. This is to prevent the possibility of structural failure when the loads on which the requirements were based are exceeded.

9.23.1.2. The experiences on which the requirements in this Section are based do not include post and beam type buildings. Such buildings in the past have been individually designed on the basis of standard design practices using specified loads and allowable lumber stresses. The objective of this Article is to prevent the misapplication of the rule-of-thumb requirements in this Section which could lead to building failure.

9.23.2.1. To ensure that the building will have adequate strength to withstand the anticipated loads due to occupancy, as well as wind, rain and snow loads, without appreciable damage to the building.

9.23.2.2. To reduce the risk of decay of wooden members in a location where they are subject to high moisture levels. Exemption for wood beams from the use of wood preservatives is justified on the basis that air can circulate freely around the sides and ends of the member to carry off excess moisture.

9.23.2.3. Concrete in contact with the ground is generally cooler than the ambient air and is therefore subject to surface condensation in summer. There is also a risk that some soil moisture may migrate through the concrete to the surface. Wooden members in contact with such concrete (such as the sole plate in basement partitions, basement columns, or strapping on basement walls) can absorb such moisture, and are subject to decay if they are not treated with a preservative. The provision of dampproofing between the concrete and the wood is intended to prevent such surface moisture soaking into the wood thereby reducing the risk of decay. If the concrete is above the level where it is affected by ground moisture, however, such as the sill plate on top of a basement wall, such precautions are not considered necessary.

9.23.2.4. See objectives for 9.3.2.1. to 9.3.2.8.

9.23.3.1. To ensure that the shape, gauge and type of metal used in nails and screws will provide the fasteners with the appropriate characteristics to perform their intended functions.

9.23.3.2. Although the lengths of nails specified elsewhere in the Code should be sufficient to provide the required structural strength, it is still possible to use such fasteners in a manner that does not develop the appropriate fastener strength. For example, if toe-nailing a member to a second member is at too steep an angle, there may be insufficient penetration into the second member. If a thick member is nailed to a thin member, there will be insufficient penetrations if the nailing is done from the side of the thick member. This Article is intended to prevent such practices that can result in connections with inadequate strengths.

9.23.3.3. Where nails cause the wood to split, the strength of the resulting connection can be seriously reduced, and this may lead to structural failure. This risk can be reduced by locating the nails in such a way as to reduce the splitting.

9.23.3.4. To provide joints and connections between structural members that will develop sufficient strength to fulfill their function in the building (see objective for 9.23.2.1.). Alternate fastening of the sole plates to the floor joists (Sentence (2)) is intended to accommodate the use of factory-made closed wall panel sections, where direct nailing of the sole plates is not possible.

9.23.3.5. Sheathing and subflooring perform a number of functions in a building in concert with other elements. These may vary from building to building, depending on the combination of materials used. Sheathing and subflooring not only provide support for the roofing, siding and floor finish materials, but act in a structural capacity in resisting wind and snow loads or loads due to occupancy. Wall and roof sheathing therefore must be fastened to withstand anticipated wind forces or to act in concert with the framing to develop diaphragm action to transfer wind forces to transverse walls. Subfloors may also have to act as diaphragms to resist inward soil pressures or to transfer wind forces to transverse walls as well as provide solid support for the flooring. The object of the Article therefore is to provide attachments between the sheathing or subflooring and their supports with sufficient strength to carry out these functions.

9.23.4.1. To ensure that joists made from sawn lumber, or wooden beams (solid, laminated or built-up) will have sufficient strength and stiffness to support the anticipated loads without damage to any supported ceiling, or causing deformations that are aesthetically unpleasant; and in the case of floor joists, provide a floor system without objectionable springiness. See also 9.23.2.1.

9.23.4.2. To ensure that steel beams for the support of floor joists will have sufficient strength to support the anticipated loads, and sufficient stiffness to provide floors without objectionable springiness.

9.23.4.3. The joist and beam span tables in the Code are based on the assumption that all loads are distributed uniformly. Where a concentrated load (such as a crane load) is supported, stresses may be produced that are larger than those allowed, and could result in a failure of the member. Such members therefore are designed for the specific loading condition according to requirements located elsewhere in the Code.

9.23.4.4. When concrete topping is used with wood frame floors, (usually to increase their sound resistance), the weight of the supported floor is increased significantly. If span tables designed for the support of traditional light weight floors are used, the increased weight must be allowed for by reducing the spacing between the joists or decreasing their spans. Alternatively span tables designed specifically for floors with concrete topping have to be used to avoid over stressing the supporting joists.

9.23.4.5. The span tables for rafters and roof joists assume that the roofing will consist of lightweight asphalt-based roof coverings, wood shingles or shakes. When roofing tiles of clay or concrete are used, however, the resulting roof load is considerably greater and this has to be allowed for by decreasing the spacing between framing members or shortening the span to avoid over stressing the rafters or joists.

9.23.5.1. Where members carry bending loads (i.e. joists, rafters and beams) the areas of highest stress occur at the top and bottom edges, and decrease to zero at the center. Therefore, any holes drilled through such members should be located away from the edges, towards the center axis to reduce their effect on strength. The size of the holes is also restricted for the same reason.

9.23.5.2. Joists, rafters and beams simply supported at each end will have maximum bending stresses at the center of the span, decreasing to zero at each support. Notches cut into the member, therefore will have the least effect on bending strength if located near each support. Shear stresses, on the other hand will be zero at the center of the span, reaching their maximum at each support. For most members, however, bending stresses are the more critical. Therefore, to have the least effect on strength, the notches are allowed only near the supports. Notches, however, tend to concentrate stresses at their corners and cause the notch to initiate checking cracks that extend towards the center of the span as the wood dries and shrinks. Since checking is more severe for notches located at the bottom edge, these are not permitted. The depth of the notch is limited to prevent over stressing the member as a result of shear stresses near the support if the depth of the member is not increased to compensate for the notch.

9.23.5.3. Although exterior wall studs are subject to bending stresses caused by wind forces, the controlling stress is the compressive stress from the supported vertical loads. Interior studs, can be non-load bearing or load bearing. Studs as a rule have a great deal of reserve strength, and the weakening effect caused by drilling or notching can be tolerated in load bearing studs if the notching or drilling is kept within reasonable limits; otherwise, compensating measures have to be taken to strengthen the stud. Notching and drilling of non-load-bearing studs are permitted to exceed these limits provided sufficient wood remains to ensure reasonably solid support for the wall finish and prevent undue flexure of the studs under accidental impact loads.

9.23.5.4. Top plates help to hold the studs in position as well as provide ties to other intersecting walls, thereby providing overall rigidity to the building. Notching and drilling these members therefore must leave a sufficient cross section of the wood in order to carry out these functions unless compensating measures are taken to strengthen the plates.

9.23.5.5. Roof trusses are usually designed so that their members are stressed close to their maximum allowable limits at the anticipated loads. Any notching or drilling therefore could cause such members to fail under load and is therefore not allowed.

9.23.6.1. To attach a building to the top of a foundation wall in a manner that will prevent the superstructure from sliding or being lifted up due to wind action, and to prevent the tops of foundation walls from being pushed inward as a result of earth pressure.

9.23.6.2. To attach a building to the tops of piers in a manner that will prevent the superstructure from sliding or being lifted up due to wind action.

9.23.6.3. Narrow buildings such as mobile homes are particularly vulnerable to overturning forces due to wind action. The light weight of such buildings adds to this problem. Such buildings therefore require special anchorage provisions to meet the objectives described in 9.32.6.1 and 9.23.6.2.

9.23.7.1. Since sill plates transfer the anchorage resistance from the anchor bolts to the floor system it supports, it must have sufficient thickness to allow for reasonable nail penetration to attach the joists to the sill plate. This is necessary in order to transfer the anchorage resistance from the sill plates to the joists that they support. Sill plates must also have sufficient cross sectional area to provide adequate strength between anchorage points to resist upward as well as lateral forces. Sill plates must also be wide enough to support the ends of the joists without crushing the wood, and allow for nailing the joists to the sill plate.

9.23.7.2. To provide a firm, level base on which the floor framing can be supported. Also to restrict air leakage into the building at the juncture between the sill plate and the foundation.

9.23.8.1. To provide sufficient bearing area at the beam supports to prevent excessive crushing of the beam, (in the case of wood beams) or excessive stress in the supporting element. Also to provide sufficient length of bearing to prevent accidental dislodgment.

9.23.8.2. To prevent the rusting of steel beams as a result of weathering in outdoor storage. While such weathering might cause minor structural weakening of the beam, its main objective is aesthetic in nature.

9.23.8.3. To ensure that wood beams, built up from several separate pieces of lumber will be assembled in a manner that will allow the beam to support anticipated loads from the floor joists. This is provided for by locating the joints between butted pieces of lumber at the points of least bending stress, staggering the joints, and taking measures to develop continuity of the built-up beam over the column supports.

9.23.9.1. To provide sufficient bearing area under the individual joists to prevent undue crushing of the wood. Also to provide a sufficient joist length to allow nailing of the joist to its support. Exception for joists supported on ribbon boards is rationalized on the basis that the joists are also face-nailed to the studs. This helps to support the joists and makes it unnecessary to nail them to the ribbon boards.

9.23.9.2. To provide a means for supporting securely the ends of floor joists on steel or wooden beams in a manner that provides continuous support for the sub-flooring, and prevent the joist ends from twisting as the lumber dries. Also, to provide a means for accommodating the shrinkage of wood joists framing into the sides of steel beams without affecting the support for the subflooring in the vicinity of the beam.

9.23.9.3. To provide a means for preventing the ends of floor joists from twisting as the lumber dries. If joists twist out of their vertical position, they can create uneven floors, floor squeaks under foot traffic, and damage to ceiling finish supported by the joists.

9.23.9.4. To provide a floor system that will support the anticipated loads, and which will not seem to be excessively springy to the occupants.

Concentrated loads from foot traffic are distributed by the various elements in a floor system to adjacent joists. Subflooring, finish flooring, bridging, blocking, strapping and ceiling finish all help to distribute the load from one joist to another. The more effective the distribution, the stiffer the floor will appear to be and the more acceptable to the occupant. The efficiency of this load distribution is affected by many factors including the thickness of the subfloor, type of finish flooring, method of subfloor attachment, spacing of blocking, bridging or strapping and spacing of framing members.

9.23.9.5. To define the ceiling finish for use in combination with other elements that will provide floor systems that will support anticipated loads and provide an acceptable level of stiffness.

9.23.9.6. To ensure that the header joists at floor openings will have sufficient strength to carry the anticipated loads, including the loads from the supported tail joists, without excessive deflections.

9.23.9.7. To ensure that trimmer joists at floor openings will have sufficient strength to carry anticipated floor loads, including the loads caused by the header joists, without excessive deflection.

9.23.9.8. To ensure that the fasteners used to connect the tail joists to the header joists, as well as the header joists to the trimmer joists, will have sufficient strength to carry the anticipated floor loads.

9.23.9.9. To ensure loadbearing and non-loadbearing walls and partitions will be supported in a manner that will not cause the floor framing to be overloaded or the deflection of the floor joists or subfloor to be excessive.

9.23.9.10. To ensure that floor joists that are cantilevered out beyond their supports will not be overstressed or deflect excessively when the anticipated loads are applied, and will be attached at the opposite end in a manner that will ensure stability under the applied load.

9.23.10.1. To provide stud wall framing having sufficient strength to support anticipated vertical loads due to occupancy, snow, rain and the weight of the structure, and sufficient transverse strength to withstand forces due to wind action. Studs also provide support and a base for attachment of sheathing, siding, and wall finish.

9.23.10.2. To ensure that buildings will have sufficient rigidity to resist lateral forces due to anticipated wind forces. Also to prevent loadbearing studs in interior walls from buckling sideways under anticipated vertical loads to achieve the objective in 9.23.10.1.

9.23.10.3. To prevent loadbearing studs from being oriented in a wall in a way that would cause them to fail prematurely under anticipated vertical loading. Exceptions for gable-end walls are justified on the basis that such walls are short and are lightly loaded. Exception for loadbearing walls in bungalows is justified on the basis that additional loadbearing capacity is provided by structural sheathing, and the loads carried by such walls are relatively small.

9.23.10.4. To prevent the use of joints in studs that would significantly reduce their capacity to carry vertical or horizontal loads. Exception for glued finger joints is justified on the basis that such joints can provide studs equivalent in strength to full length studs.

9.23.10.5. To provide support for the edges of exterior sheathing and siding materials at the corners of buildings to allow them to be fastened to resist the negative pressure due to wind action. Also to support the edges of interior wall finishes so they can be securely fastened in place to increase the overall stiffness of the building in resisting horizontal wind loads. Such supports are also intended to reduce the risk of damage to finishes as a result of accidental impact.

9.23.10.6. To provide members of sufficient strength at the sides of openings in walls to support the loads transmitted by the lintel members. Doubling of members and their attachment together is done to increase their resistance to buckling. This is not necessary for non-loadbearing walls for structural reasons, however, but is necessary to develop sufficient fire resistance for closure assemblies in walls required to act as fire separations. Framing also provides a base for attachment of the interior and exterior cladding materials, and a base for securing the finish door and window frames.

9.23.11.1. Wall plates are used to align and anchor the studs, and tie them together to act as a unit. Since they support the top and bottom edges of the sheathing and wall finish, and provide a base for their attachment, they must be the same width as the studs. The plates also transfer supported loads to the studs, and from the studs to the floor joists below. They must therefore also have sufficient strength and stiffness to carry out this function without damage to the wall finish. Studs directly above joists, however, exert no bending load on the bottom plate, so that the bottom plate can be reduced in thickness.

9.23.11.2. Bottom wall plates are needed to anchor walls to the floor system on which they rest. Since such plates also transfer loads from the studs to the floor framing, they have to be located over a support in such a manner that the wall will not become unstable under anticipated loads. The amount that they are permitted to be cantilevered beyond their support is therefore limited. (see also 9.23.11.1.)

9.23.11.3. To provide sufficient strength and stiffness to transfer supported loads to the studs without damage to the interior finish. This is the principal reason for requiring a double plate when the supported members are not in close proximity to the studs, or when the top plate is supported by a lintel. If the supported members can be supported directly on a lintel, there is no reason to have a top plate, if other means are used to tie the top of the wall together across the lintel.

9.23.11.4. To tie the top ends of wall studs together so that they can act as a structural unit. Also to tie walls together at corners and intersections to provide additional overall stiffness and strength to the building in resisting forces due to wind action. See also 9.23.11.1.

9.23.12.1. To provide a means for securing the top of the finish door frame to the rough wall framing. Also to support the lower edge of the wall finish over the opening and provide a base for its attachment along with the top door trim piece. In the case of walls required to provide a fire separation, the framing above the opening also has to provide sufficient fire resistance above the opening to allow the closure to reach its required fire performance rating.

9.23.12.2. To transfer anticipated loads above openings in stud walls to stud members located on each side of the opening (jamb studs). Lintel members are fastened together to help share the superimposed load between the members. The separation of lintel members by filler pieces makes their overall thickness equal to the stud depth to facilitate the application of interior and exterior cladding materials.

9.23.12.3. To provide members of sufficient strength and stiffness to support anticipated vertical loads above wall openings, and transmit the loads to vertical framing members at the sides of the openings without damage to the cladding materials.

9.23.13.1. To ensure that rafters and joists will not be weakened by the presence of joints, so that they will be able to support anticipated roof loads.

9.23.13.2. When openings are framed into roofs so that it is necessary to cut through rafter or joist members, the cut members have to be supported on a header member, which in turn is fastened to the trimmer joists or rafters on each side of the opening. This imposes an extra load on the trimmer members, and to avoid over stressing them, they are doubled up on each side. If only one rafter or joist is cut, however, the additional load carried by the trimmer joists is considered to be tolerable and doubling is not necessary.

9.23.13.3. To provide a sufficient length of bearing to allow the ends of joists and rafters to be nailed to their supports without excessive wood splitting. Also to provide a sufficient area of wood to prevent excessive crushing of the fibers at the support.

9.23.13.4. Rafters have to be able to withstand uplift forces due to wind action as well as the weight of snow and rain. Rafters therefore have to be held together at the peak to resist wind action, and must be supported at the peak to carry the weight of snow and rain loads. If the rafters are directly opposite to each other, the horizontal rafter forces at the peak cancel each other. If the rafters are offset to an appreciable degree, however, and depend on a ridge board to transfer the horizontal thrust to opposing rafters, the ridge board may fail in bending if it is too flimsy. Thin ridge boards therefore are only permitted if the rafters are not offset significantly from one another.

9.23.13.5. To provide an even bearing surface at the lower ends of rafters to allow them to support the anticipated roof loads without excessive crushing of the wood.

9.23.13.6. Where two sloping roof surfaces intersect one another they form a hip if the intersection forms an outside corner, or a valley where the intersections forms an inside corner. In the former case the rafters are supported at their lower ends on the top wall plate and are supported by a sloping hip rafter at their upper ends. In the latter case, the rafters are supported at the ridge at the top ends, and by a sloping (valley) rafter at the lower ends. (The rafters supported by the hip or valley rafters are known as jack rafters). The objective of this requirement therefore is to ensure that hip and valley rafters have sufficient strength to carry the anticipated roof loads from the jack rafters.

9.23.13.7. Because of the relatively high roof loads in Canada, rafters of typical sizes are able to span a relatively short distance without over-stressing the wood. The objective of this Article is to describe the types of intermediate rafter support that will permit a reduction in the length of span so that smaller rafter sizes can be used.

9.23.13.8. Sloping rafters and roof joists loaded with snow will spread outward at their bottom ends unless the ridge of the roof is adequately supported. Therefore, if the ridge is unsupported, the ends of opposing rafters have to be tied together to resist such outward spreading. This is usually managed by nailing of the rafters to the ceiling joists and the ceiling joists to each other to complete the tie. At the lower slopes, however, the number of nails required becomes too great for this method to be practicable. The objective of this Article therefore is to describe how the ridge can be supported adequately to prevent rafter or joist spread, or how the lower ends of the rafters can be tied to prevent rafter spread.

9.23.13.9. Some roof joists have a tendency to twist as they dry out. Since they are restrained on the top edge by the roof sheathing, the major joist movement occurs at the lower edge, causing nails to pull through ceiling finishes such as gypsum board. The object of this Article is to prevent such damage by restraining the lower end near the support. Exception for plywood or waferboard ceilings is rationalized on the basis that such materials have sufficient strength to resist the twisting action.

9.23.13.10. When the intermediate support for rafters (such as dwarf walls) is supported by ceiling joists the ceiling joists may become overstressed as the rafters deflect under the snow load. Since the span tables for ceiling joists do not allow for this type of load, the ceiling joists have to be strengthened. The proportion of roof load transferred to the ceiling joists increases as the roof slope decreases, and appropriate compensating measures have to be taken to increase the strength of the ceiling joists for different roof slopes to avoid overstressing them.

9.23.13.11. To ensure that roof trusses will be capable of supporting anticipated roof and ceiling loads without excessive deflections that may damage the ceiling finish or create objectionable sagging.

9.23.14.1. If the finish flooring does not possess the required strength and stiffness to transfer the expected floor loads to the floor framing members, a subfloor must be provided. It must withstand exposure to the elements if it is constructed on site, and wetting from floor cleaning, accidental water spills or plumbing leaks that may happen during normal occupancy.

9.23.14.2. To provide a selection of materials with suitable characteristics to carry out the function in 9.23.14.1.

9.23.14.3. Finish flooring such as sheet vinyl or tile, ceramic tile and carpeting is not able to bridge across irregularities in the subfloor caused by differential deflection in adjoining sheets of subflooring. This happens when one sheet is loaded near its edge and the second is not, and can damage the finish flooring. To reduce this risk the subfloor edges are tongued-and-grooved, or blocking or framing is placed beneath the joint to support the edges of the subfloor.

9.23.14.4. Plywood is stronger and stiffer in the direction of the surface grain than across the grain. Strandboard fibers which are oriented along the length of the sheet are also stronger in this direction. It is for this reason that the sheets must be laid across the joists and not parallel to them in order to produce a floor of appropriate stiffness to support the finish flooring. Staggering the joints so that they do not occur in adjacent rows of panels along the length of any joist, also has an overall stiffening effect on the flooring and reduces the risk of cracks developing in the finish flooring above the joint in the subfloor if resilient flooring or ceramic tile is used.

9.23.14.5. The strength and stiffness needed for the subfloor depends on the other constituents of the assembly. Certain types of flooring such as adhesive applied ceramic flooring requires a very rigid base to avoid subsequent glue bond failures or damaged tiles. Wood strip flooring on the other hand can bridge surface irregularities and even contribute to the overall strength and stiffness of the floor. Panel type underlay can also contribute to strength and stiffness and is also able to mask surface irregularities in the subfloor. The objective of this Article therefore is to provide sufficient strength and stiffness in combination with other elements in the floor system to support the anticipated floor loads without causing excessive springiness, and to provide a base that will be compatible with the characteristics of the finish flooring.

9.23.14.6. When joists dry, their shrinkage tends to cause the subfloor nails to raise above the surface of the subfloor. The longer the fastener, the higher they will be raised. When thin flooring such as vinyl is used, the fasteners create little bumps in the flooring. Annular ring nails have better holding power than common nails, and therefore can be shorter. In addition, because of their shape, they tend to raise less than common nails of the same length. The objective of this requirement therefore is to reduce the problem of surface irregularities in flooring caused by fasteners.

9.23.14.7. Lumber subflooring is commonly laid in a diagonal pattern to permit wood strip flooring to be laid either parallel or at right angles to the joists. As the angle between the subflooring and the joists is decreased the effective span of each piece of lumber in the subfloor is increased, causing the floor to be springier. A limit is therefore placed on the minimum size of the angle between the joist and the subfloor. The ends of individual pieces are supported to reduce the springiness of the subfloor. As the width of the subfloor boards is increased, the total potential movement due to shrinkage is also increased and can cause gaps between the flooring strips. The limit on board width, therefore, is to reduce this problem.

9.23.15.1. Roof sheathing is used beneath roofing when the roofing does not have sufficient strength to support the expected roof loads. Such sheathing must not only be able to support the anticipated roof loads, but must also be able to resist deterioration due to exposure to the weather during construction, occasional wetting from roof leaks and cold weather condensation. The objective therefore, is to define the appropriate properties of different types of roof sheathing that will be able to meet these conditions.

9.23.15.2. Plywood is stronger and stiffer in the direction of the surface grain than across the grain. Strandboard fibers which are oriented along the length of the sheet are also stronger in this direction. It is for this reason that the sheets must be laid across the rafters or roof joists, and not parallel to them in order to provide a roof surface that will withstand the anticipated roof loads including the weight of workmen.

9.23.15.3. To avoid creating bulges in the roof sheathing should it become wet and expand.

9.23.15.4. As lumber roof sheathing shrinks, the nails or staples fastening asphalt shingles are shifted to new positions. Small shifts in position can be accommodated by the roofing without showing noticeable effects on the roofing. As the boards become very wide however the movement of the fasteners causes the asphalt shingles to bulge upward. Limiting the maximum width of roof boards is intended to reduce this problem which is essentially cosmetic. Supporting the ends of the boards is intended to prevent roofing damage resulting from differential deflection when a person steps on the ends of the boards.

9.23.15.5. When two sheets of roof sheathing butt together without underlying support, one sheet will deflect relative to the other if it is stepped on. If the deflection is large enough, the roofing will be damaged and the roof will leak. If the sheathing is not sufficiently thick to prevent excessive differential deflection, the edges have to be prevented from moving relative to each other to prevent the damage. This can be done by supporting the edges or providing H-clips between sheets.

9.23.15.6. To provide sufficient strength for the roof deck to support the anticipated loads, including those due to snow and rain as well as those from foot traffic. If the roofing itself contributes substantially to the strength of the roof, a somewhat weaker deck material can provide sufficient strength to support the anticipated loads. Where the surface is used as a walking deck, a stiffer surface than that provided for traditional roof decks is necessary to prevent excessive springiness.

9.23.16.1. To describe the conditions where sheathing is necessary. Whether or not it is needed depends on other wall components and how they are installed. Sheathing can add strength to resist wind loads and impact forces, and can be used as a nailing base to attach the siding. Many sidings can be attached directly to the sheathing (if it has adequate nail holding characteristics), or to furring or blocking at right angles to the studs. The siding thickness or the furring size can therefore depend on whether or not sheathing is used.

9.23.16.2. To describe the thickness and other characteristics of various wall sheathings needed to provide sufficient strength and durability to justify a reduced thickness for certain sidings, or a reduced furring size. Sheathing can be exposed to rain during construction or to condensation in winter. It must therefore have sufficient water resistance to prevent deterioration of its required strength from such exposure.

9.23.16.3. To describe certain sheathing materials that are not considered to have sufficient fastener anchorage strength to be used for the direct attachment of siding.

9.23.16.4. To enable lumber wall sheathing to have sufficient stiffness to be able to resist impact forces that might damage the siding as a result of differential deflection between abutting sheathing boards.

9.23.16.5. To avoid creating bulges in the wall sheathing should it expand as a result of increased moisture content.

9.23.16.6. When the lower portion of a gambrel roof is vented, the insulated part of the lower portion is subject to air leakage. Sheathing paper is therefore necessary to restrict air leakage, the same as for walls.

9.23.17.1. Sheathing paper acts as a second line of defense against the entry of rain water and provides resistance to air infiltration. Since there is a possibility that some moisture may condense in the wall space in winter, the sheathing paper must therefore be capable of allowing any trapped moisture to escape before wood decay is initiated. The object of this Article therefore is to describe the characteristics necessary for sheathing paper to fulfill its intended function.

9.23.17.2. When tar saturated felts come in contact with stucco, the tar will wick through the stucco, causing brown stains on its surface. The object of this requirement therefore is to prevent surface stains on stucco caused by the use of tar paper.

9.23.17.3. To provide a second line of defense against rain entry into the building walls, and to reduce the amount of air leakage into the building.

9.23.17.4. Certain "non-wood" sheathings can perform the same function as sheathing paper as described in 9.23.17.3. In such cases separate sheathing paper is not needed if the sheathing effectively limits the entry of wind and rain.

9.23.17.5. The sheathing component in a wall works in concert with the sheathing paper in providing a second line of defense against the entry of any rain or air leakage that bypasses exterior cladding. When sheathing is not used, the sheathing paper by itself is not as effective in doing this, so that a second layer of paper is required to compensate for the lack of sheathing. The paper, however, has to be attached with sufficient fasteners to keep it tight to the framing for air tightness. If the sheathing is not needed for structural reasons, it merely acts as a backup for the paper and its thickness is relatively unimportant.

9.23.17.6. If the siding material can be applied so that it is inherently wind tight and water tight, there is no reason to provide a separate sheathing paper to meet the objectives in 9.27.17.3. Panel type sidings for example, with suitably treated joints, and sheet type aluminum with locked-seam joints (common in mobile homes) can be made to meet this objective.

Section 9.24 Sheet Steel Stud Wall Framing

9.24.1.1. To indicate that this Section applies only to studs in non-load-bearing walls and partitions. Load-bearing sheet steel studs require structural calculations for proper usage. In addition, supervision is needed during construction to reduce the risk of structural collapse. Such studs have little strength unless their flanges are suitably stiffened by cladding materials and could collapse if they are loaded before being sheathed on both sides.

9.24.1.2. To define the characteristics of steel studs needed to fulfill their intended purpose.

9.24.1.3. To clarify that the steel thicknesses for studs in this Section do not include the thicknesses of the protective coatings which do not add to their strength. This reflects industry practice, and avoids the error of overestimating stud strength in structural calculations.

9.24.1.4. To define the characteristics of screws needed to attach gypsum wallboard to steel studs to enable the wall or partition assembly to fulfill its intended function.

9.24.1.5. Steel studs that are laterally unsupported have little strength in resisting transverse loads due to wind action or horizontal impact. Both edges have to be stiffened by the cladding materials for the wall or partition to have sufficient strength to resist such forces. Screws to attach cladding materials to the studs have to penetrate through the metal a sufficient distance to allow the large part of the screw shank to engage the metal to develop appropriate withdrawal resistance.

9.24.2.1. To provide framing for the support of interior wall finish materials. Also to provide walls with sufficient rigidity to withstand impact forces, including those resulting from the operation of doors, to prevent damage to the wall finish.

9.24.2.2. To provide studs with sufficient strength and stiffness to carry out the objectives of 9.24.2.1.

9.24.2.3. To provide a means for holding steel studs in alignment at the tops and bottoms of the studs, and a means for anchoring the wall assembly to the floor and ceiling.

9.24.2.4. When fire doors are subjected to fire on one side, they tend to warp. Since the doors are restrained by hinges and latch, this warping creates forces that are resisted by the door frame which is in turn supported by the steel studs. The objective of this requirement therefore is to provide wall framing with sufficient strength to resist such forces for the fire rating period. Since the first stud away from door opening in the framing assists in stiffening the frame near the door, its spacing from the opening is also limited. The framing must also provide sufficient strength and stiffness to resist impact forces from the normal operations of the door without damaging the wall finish.

9.24.2.5. To provide walls of sufficient strength and stiffness to resist horizontal forces due to anticipated wind loads.

9.24.3.1. To provide a means for keeping the top and bottom ends of studs in alignment and provide a means for anchoring the wall assembly to the floor and ceiling to resist wind loads or impact forces. Also to provide a means for supporting the studs beneath or above wall openings.

9.24.3.2. When a wall is subjected to fire, steel studs will expand in length. If they are prevented from expanding, the studs will tend to buckle and cause a premature failure of the protecting membranes.

The runners at the head of a door frame can warp and twist if subjected to heat transmitted through a steel door frame. This could also cause premature wall failure in the vicinity of the door. By insulating the door frame from the runners by a piece of gypsum, the stud frame can be made more stable.

9.24.3.3. Wall studs are much stronger and stiffer with their webs perpendicular to the wallboard than parallel to it. In addition if the webs are parallel to the wall, it would be impossible to attach the wallboard to the flange members. Finally, studs that are spliced will not be as stiff and as strong as those that are in one piece. The objective, therefore, is to develop the necessary strength in walls to resist horizontal forces due to wind and/or impact forces.

9.24.3.4. To provide support for the wallboard edges that meet at wall corners and intersecting walls to prevent damage to the wallboard as a result of impact or wind forces in these locations.

9.24.3.5. Wind forces on doors or windows are transferred to the jamb studs at the sides of the openings. If the opening for a door or window is more than a stud space in width, the jamb studs will be too flimsy unless they are reinforced with additional studs. As the opening width is increased, a greater magnitude of load is transferred to the side studs, and more than one additional stud will be necessary to provide adequate stiffness.

9.24.3.6. To keep the studs in proper alignment during construction, and to allow for the expansion of studs in walls required to act as fire separations.

9.24.3.7. To ensure that the wall framing around fire dampers will provide sufficient strength to support the dampers, and in the event of fire, provide sufficient strength to retain the dampers in their proper positions. Gypsum board between the wall framing and the fire damper protects the wall framing from excessive heat being transmitted from the fire damper casing to the wall framing. This is intended to reduce distortion of the framing that could cause the damper assembly to fail prematurely.

Section 9.25 Heat Transfer, Air Leakage and Condensation Control

9.25.1.1. To outline the scope of this Section and to remind users that additional requirements affecting duct work are located elsewhere.

9.25.1.2. To restrict the accumulation of moisture condensation in the building envelope during cold weather caused by the improper location of a vapour resisting material within the building envelope. Room moisture that enters a wall or roof cavity will condense on any vapour resisting surface below the dew point of the cavity air. The temperature gradient across the cavity depends on the outdoor and indoor temperatures as well as the thermal resistance of the various layers within the envelope. These factors therefore have to be considered in determining where the vapour resisting membrane can be located without risking condensation and its attendant moisture related problems. An exception for wood based panel products with a horizontal gap between adjacent panels is justified on the basis that the gap between sheets will allow moisture to travel to the exterior and not accumulate on the inside surface.

9.25.2.1. To provide sufficient thermal resistance in the building envelope to prevent moisture condensation on the inside surface in cold weather, and to increase the inside surface temperature of the envelope surfaces to a level where the occupants will not feel uncomfortable.

9.25.2.2. To define the characteristics of the thermal insulating materials necessary to perform their intended functions in the building envelope to meet the objectives in 9.25.2.1. The limits on flame spread specified in certain referenced standards are exempted on the grounds that these are specified where necessary in other Code requirements.

9.25.2.3. To install insulation in a manner to fulfill its intended purpose without creating building problems related to cold weather. Insulation that does not provide relatively uniform thermal resistance over the entire insulated surface may lead to surface condensation and mildew. If fibrous insulation is installed with an air space on each side, air can circulate around the insulation and reduce its effectiveness. Insulation in contact with a crawl space floor is subject to possible wetting and certain types can be damaged. If insulation prevents heat from reaching the foundation, frost heaving may occur with shallow foundations. Insulation that becomes damaged either as a result of weathering or mechanical contact will not be as effective in fulfilling the objective in 9.25.2.1.

9.25.2.4. To install loose fill insulation in a manner to permit it to fulfill its intended function without causing building problems to develop. If loose fill insulation does not fill the stud spaces it will cause cold spots that could result in surface condensation and mildew.

In the past, loose fill insulation has been successfully used in attics where it can be easily inspected and in cavity walls where it is installed as work proceeds. In existing buildings with the interior finish in place, it may be the only practical way to insulate, in spite of the fact that it cannot be inspected. In new construction, however, certain techniques have been developed to allow its successful application and inspection. If the insulation blocks the soffit vents, roof condensation problems may result that could lead to moisture related problems such as wood decay or ceiling damage.

9.25.2.5. To install spray applied polyurethane insulation in a manner to permit it to fulfill its intended function without causing other problems to develop.

9.25.3.1. Room moisture that diffuses through materials into concealed wall, roof and floor spaces can be effectively resisted by vapour barrier materials. Moisture carried by air leakage, however, is harder to control and accounts for most condensation problems in such spaces. One objective of this Article therefore is to prevent condensation in concealed spaces by means of an air barrier that restricts the leakage of room air into such spaces.

Cold air that enters the building envelope from outside can reduce the temperature of inside surfaces if it finds a path through the insulation. This can result in surface condensation and mildew problems. The second objective of this requirement, therefore, is to prevent interior surface condensation and mildew by restricting the flow of exterior air through the envelope.

9.25.3.2. To define the properties that are necessary for an air barrier to fulfill the objectives in 9.25.3.1.

9.25.3.3. Any air leakage through or around an air barrier reduces its effectiveness, and raises the possibility of moisture related problems. The objective of this Article, therefore, is to reduce the air leakage past an air barrier at points of possible discontinuity in order to achieve the objectives in 9.25.3.1.

9.25.4.1. To restrict the flow of moisture in room air from diffusing into the building envelope where it could condense during cold weather and lead to a variety of moisture related problems.

9.25.4.2. To define the characteristics that are necessary for a vapour barrier to fulfill the objectives in 9.25.4.1.

9.25.4.3. To describe where vapour barriers must be installed to meet the objectives in 9.25.4.1. without creating problems caused by condensation within the building envelope as described in 9.25.1.2.

Section 9.26 Roofing

9.26.1.1. To prevent rain, and water from snow melt from entering the roof space or attic. Since roofing is exposed to the weather, it must be able to resist deterioration caused by exposure to the sun, water, and air for a reasonable period of time, and be able to resist anticipated snow loads and uplift forces due to wind action.

9.26.1.2. To describe methods of installing asphalt shingles that differ from those described in this Section, but which are considered to meet the objectives of 9.26.1.1.

9.26.2.1. To define the characteristics of various types of roofing materials necessary to fulfill the objective of 9.26.1.1., through reference to various material standards.

9.26.2.2. To describe the characteristics of nails needed to resist the anticipated wind forces to meet the requirements in 9.26.1.1. Nails can be subject to periodic wetting, and therefore must have reasonable durability to prevent deterioration for a reasonable period of time.

9.26.2.3. To describe the characteristics of staples needed to resist anticipated wind forces to meet the requirements in 9.26.1.1. Staples can be subject to periodic wetting and therefore must be able to resist deterioration for a reasonable period of time.

9.26.3.1. To provide sufficient slopes for various roofing materials to effectively shed rain water in order to meet the objectives of 9.26.1.1.

Asphalt and coal tar products soften when heated and will tend to flow down the roof slope if it is too steep. Maximum slope limits are therefore necessary in some cases to prevent roof damage resulting from such flow. While build-up roofs are water tight in theory, leaks sometimes occur as a result of poor workmanship, thermal stresses or storm damage. A minimum slope for such roofs is to ensure that water will not pond on the roof to exacerbate any leak that might occur if drainage is not provided at the ponding locations.

9.26.4.1. To describe the characteristics of flashing materials used in conjunction with roofing that are necessary to meet the objectives of 9.26.1.1.

9.26.4.2. To prevent rain and water from snow-melt from reaching the roof deck in the vicinity of a valley between two intersecting roof surfaces, by the installation of appropriate flashing to shed the water. Closed valley flashing consists of short pieces of flashing interleaved with shingles. This type of flashing is not as able to protect the decking against the entry of water from ice damming as well as open valley flashing and is therefore used only on steeper slopes.

9.26.4.3. To prevent rain and snow-melt from reaching the roof deck or entering the building envelope at the juncture between a shingle roof and a masonry surface by the installation of appropriate flashing. Since differential vertical movement may occur between the masonry and roof surface, the flashing is counter flashed to accommodate this movement.

9.26.4.4. To prevent rain and snow-melt from reaching the roof deck or entering the building envelope at the juncture between a shingled roof surface and a wood frame wall (with other than a masonry veneer exterior) by the installation of appropriate flashing.

9.26.4.5. To prevent rain and snow-melt from reaching the roof deck or entering the building envelope at the juncture between a built-up roof and a masonry surface by the installation of appropriate flashing. Since differential vertical movement may occur between the masonry and built-up roof surface, counter flashing is used to accommodate such movement. The cant strip beneath the flashing at the juncture allows a gradual transition between the horizontal and vertical surfaces to facilitate mopping of the asphalt plies at the transition to obtain a watertight flashing.

9.26.4.6. To prevent rain and snow-melt from reaching the roof deck or entering the building envelope at the juncture between a built-up roof and a wood-frame wall (other than one clad with masonry veneer) by the installation of appropriate flashing. Cant strips at the junctures are to facilitate mopping of the asphalt plies at the transition to form a water tight flashing.

9.26.4.7. Chimney saddles are installed to intercept and drain rain water from a sloping roof surface before it reaches a masonry chimney. Chimney saddles also prevent the formation of ice dams between the chimney and the roof surfaces where water may enter the roof by running underneath the shingles. The object of this Article therefore is to prevent masonry work from becoming saturated (which could lead to damage from frost action) and to prevent the entry of water from snow-melt.

9.26.5.1. When the sun warms the roof surface, or sufficient heat from the attic escapes through the roof, the snow will melt and run down the roof, and refreeze at the edge. This causes an ice dam to form at the edge of the roof and the melt water to pond and run under the shingles to leak into the spaces below if the roofing does not form a continuous waterproof membrane. This phenomenon occurs in all but the mildest climate areas in Canada. The lower the slope, the further up the roof the leakage area extends. If the space below the roof is unheated, the severity of the ice damming will be less. If it is unfinished space, the occasional leak would probably not lead to serious problems. The objective of this Article therefore is to prevent snow-melt from leaking into the finished areas of a building where it could damage the ceiling and reduce the thermal resistance of insulation.

9.26.5.2. To define the characteristics of materials that can be used as eave protection to fulfill the objectives of 9.26.5.1.

9.26.6.1. Underlay has been used traditionally beneath shingles as a second line of defense against rain leakage if shingles are blown off. Experience has shown however, that with modern shingles such underlayment is not necessary. The objective of the requirement therefore is to describe the appropriate requirements for an underlay to fulfill its intended functions, if an underlay is to be used.

9.26.6.2. To install underlay in a manner that will allow it to shed water and protect the roof against the entry of water that may leak past the roofing.

9.26.7.1. To ensure that shingles have sufficient overlap to allow them to shed water effectively in order to meet the objectives on 9.26.1.1.

9.26.7.2. To prevent water leakage through the cut-outs between the shingle tabs in the bottom course of shingles.

9.26.7.3. To prevent water leakage above the cut-outs between shingle tabs.

9.26.7.4. To resist the uplift forces due to wind action. Over a period of time, roofing will shrink away from nail or staple shanks, and leakage will occur if the nails are exposed to rain. Fasteners are therefore located so that they are protected from such wetting.

9.26.7.5. To prevent damage to shingles by wind action that lifts and breaks the shingle tabs.

9.26.7.6. To protect the hips and ridges of a roof from water leakage, and to fasten the protection in a manner to resist uplift due to wind forces with fasteners located so they will be protected from wetting (see also 9.26.7.4.).

9.26.7.7. Same objective as in 9.26.5.1. and 9.26.5.2.

9.26.7.8. Same objectives as in 9.26.4.1. to 9.26.4.6.

9.26.8.1. To provide sufficient overlap between courses of shingles, so that, when cemented together with roofing cement, the roofing will form a continuous waterproofing membrane that prevents water from entering beneath each course of shingles into the space below.

9.26.8.2. To prevent water leakage through the cut-outs between the shingle tabs in the bottom course of shingles.

9.26.8.3. To prevent damage to shingles caused by the wind action that lifts and breaks the tabs.

9.26.8.4. To seal each course of shingles to the adjacent course in such a manner that the roofing will form a continuous waterproof membrane that prevents water from entering beneath each course into the space below.

9.26.8.5. To protect the hips and ridges of a roof from water leakage so that water will not be able to leak underneath the courses of the protecting shingles. Also to attach the protecting shingles to resist uplift forces due to wind action with fasteners located so they are protected from wetting (see also 9.26.7.4.).

9.26.8.6. Same objectives as in 9.26.4.1. to 9.26.4.4.

9.26.8.7. Same objective as in 9.26.7.4.

9.26.9.1. To provide structural support for anticipated snow loads and the weight of workmen. Also to provide a means for the attachment of the shingles to resist wind uplift.

9.26.9.2. To provide a means for controlling defects in shingles so that they will be able to shed rain water without leaking.

9.26.9.3. The minimum length of shingles permitted corresponds to the minimum length recognized in standards that define the defects permitted in each grade. The maximum width limit is to restrict the extent of random splitting that occurs when the shingles dry. The minimum width limit is to prevent the use of shingles that are too small to provide sufficient coverage over joints and natural defects in the undercourses.

9.26.9.4. Spacing between adjacent shingles is to allow for swelling when they get wet. If laid too tightly, the shingles may buckle upward when wet, which could cause the nails to lift. Offsetting of joints in adjacent courses is to ensure that there will be sufficient overlap of shingles in adjacent courses to prevent leakage through the roofing.

9.26.9.5. To attach shingles to the roof deck to resist uplift due to wind action. As the roofing weathers, the gap between the shingle and fastener shank will widen and allow leaking. Fasteners, therefore, are protected from the weather by locating them beneath the overlying shingle courses.

9.26.9.6. To provide sufficient overlapping of the shingles to enable them to shed water effectively without leakage occurring because of through leakage paths.

9.26.9.7. Same objective as 9.26.4.1. to 9.26.4.4.

9.26.9.8. Same objectives as 9.26.5.1. and 9.26.5.2.

9.26.10.1. Minimum length limit for shakes is the minimum length recognized for hand split shakes in standards that define the defects permitted in each grade. The maximum width limit is to restrict the extent of random splitting resulting from shrinkage. The minimum width limit is to prevent the use of shakes that are too small to provide sufficient coverage to protect joints and other defects in the undercourses. The minimum thickness limit is to provide sufficient wood to ensure reasonable durability from weathering. The maximum thickness limit is to prevent excessive unevenness in the decking, which could encourage the entry of windblown snow and rain.

9.26.10.2. To intercept windblown snow and rain that gains entry due to the unevenness between shakes, and re-direct any water to the exterior of the roof.

9.26.10.3. Spacing between adjacent shakes allows for swelling when they get wet. If laid too close, the shakes may buckle upward when wet, causing the nails to lift. Offsetting of joints in adjacent courses prevents through leakage paths through the roofing.

9.26.10.4. Same objective as in 9.26.9.5. for shingles.

9.26.10.5. Same objective as in 9.26.9.6. for shingles.

9.26.10.6. Same objective as in 9.26.4.1. to 9.26.4.4. for shingles.

9.26.10.7. Same objective as in 9.26.5.1 and 9.26.5.2.

9.26.11.1. To prevent the entry of rain water and snow melt through a built up roofing system to the deck below by providing sufficient bitumen between the plies of roofing felt and over the tops of the roofing felt to make the roofing perform as a continuous waterproof membrane.

9.26.11.2. Asphalt and coal tar products sometimes interact with one another to adversely affect the properties of both. This can lead to premature failure of a roofing system. The objective of this Article therefore is to prevent the premature failure of a roofing system by the use of incompatible materials.

9.26.11.3. Roofing felts serve as reinforcing for the bitumen layers in built-up roofs which provide the prime waterproofing components. Roofing felt is also used to prevent the bitumen from leaking through the roof deck into the roof space. The objective of this requirement therefore is to ensure that such roofing felts will be of sufficient weight to meet the objective in 9.26.11.1.

9.26.11.4. Aggregate on built-up roofs shields the bitumen from the detrimental effects of solar radiation, thereby helping to prolong its useful life. Such aggregate also helps to anchor the roofing in place against the uplift forces due to wind action. Aggregate particles must be large enough to resist being dislodged by the wind and yet not be of such a large size that would require an excessive weight of material to provide effective sun screening.

9.26.11.5. Same objective as in 9.26.4.1., 9.26.4.5. and 9.26.4.6.

9.26.11.6. The effective life of a built-up roofing system depends to some extent on the number of mopped-on layers of roofing felt that are provided for the roofing system. At least three layers are necessary to provide a roofing system with reasonable life expectancy.

9.26.11.7. To prevent water leaking through or past each ply of roofing felt in a built-up roof by providing a continuous layer of bitumen between each ply, and ensuring that there is complete adhesion between plies.

9.26.11.8. To prevent bitumen from leaking through the roof deck into the space below where it could cause stains.

9.26.11.9. To prevent the uplifting of roofing and roof insulation as a result of wind action.

9.26.11.10. To prevent aggregate on top of built-up roofing from falling off the edge of the roof. Since the gravel stop can interfere with the continuity of the built-up roofing, it is installed in a manner to prevent water penetration at this location. The provision of a drip edge at this location is to prevent wind-blown rain from leaking under the membrane at the edge of the roof.

9.26.12.1. To prevent water from leaking past the juncture between each sheet of selvage roofing to the roof deck. The double coverage allows the cementing area between layers to be sufficiently large to ensure a good water seal between sheets so that the roofing can be used on low slopes without the risk of leakage due to ice damming.

9.26.12.2. Same objective as in 9.26.12.1.

9.26.13.1. To ensure that metal roofing will have sufficient corrosion resistance to give the roofing a reasonable life expectancy. Also to provide the roofing with sufficient strength to support anticipated roof loads when it is installed over purlins or discontinuous roof decking.

9.26.14.1. To provide glass reinforced polyester roofing with sufficient strength to support anticipated roof loads when it is installed over purlins or discontinuous decking.

9.26.15.1. To install hot applied rubberized asphalt roofing in a manner that will provide a continuous waterproof membrane to meet the objectives in 9.26.1.1.

9.26.16.1. To install polyvinyl chloride sheet roofing in a manner to provide a continuous waterproof membrane that will meet the objective in 9.26.1.1.

9.26.17.1. To install concrete roofing tiles in a manner that will shed water effectively and prevent the entry of water caused by ice dams. Also to ensure that such roofing is attached to the roof in a manner that will resist uplift from wind action.

9.26.18.1. To direct roof drainage water away from the foundation so that it will not contribute to basement wall leakage, and in a manner that it will not cause soil erosion.

9.26.18.2. To lead roof drainage water to the building sewer in a manner that will not create building problems such as wet basements.

Section 9.27 Siding

9.27.1.1. To describe the various types of siding materials covered in this Section.

9.27.1.2. To inform Code users that requirements for stucco and masonry veneer are covered in other Sections.

9.27.1.3. To ensure that asphalt shingle siding will have a reasonable life expectancy, and will be installed in a manner that will shed water effectively, and be able to resist dislodgment due to wind action.

9.27.2.1. Siding protects exterior walls from the entry of rain and snow into the wall behind it. Such leakage can result in a variety of moisture related problems ranging from wood decay to paint pealing. Siding also must provide sufficient strength to resist wind action, and in some wall designs, acts as an air barrier in restricting air leakage. Since siding is exposed to the weather it has to resist degradation from cycles of wetting and drying as well as freezing and thawing.

9.27.2.2. To prevent the deterioration of wood based sidings as a result of backsplash from rain or being in contact with melting snow.

9.27.2.3. To prevent the deterioration of wood based sidings as a result of contact with rain water drainage from the roof, and contact with melting snow.

9.27.2.4. If applied directly to sheathing, insulated asphalt siding acts as an effective vapour barrier and traps moisture with the wall space. If there is no air space behind the sheathing to allow the moisture to escape, the moisture can accumulate during the winter and may be trapped between two vapour resisting membranes long enough to initiate wood decay and other moisture related problems.

9.27.3.1. Flashing materials may be exposed to the weather and therefore have to be able to resist degradation due to solar radiation as well as periodic wetting for a reasonable period of time. The purpose of this requirement, therefore, is to describe the types of materials that will fulfill those objectives.

9.27.3.2. To prevent the entry of rain water at the junctures of different siding materials or over the heads of openings where the siding is not shielded from rain by a sufficient roof overhang. Exception for flashing where the window or door is seated in mastic is in recognition of the successful experience with mobile home construction practices.

9.27.4.1. To resist the entry of water into the walls at the junctures between siding material and window and door trim, and between different siding materials where they are not lapped or flashed to shed water effectively.

9.27.4.2. Since caulking is exposed to the weather, it has to be able to resist degrading as a result of solar radiation and periodic wetting and drying cycles. Since the protected juncture may be subject to some movement caused by changes in temperature or moisture content of the cladding materials or building movement, the caulking has to remain pliable and retain its adhering qualities for a reasonable period of time, and be compatible with the protected surfaces. The objective of this Article therefore, is to define the characteristics of different types of caulking material necessary to fulfill their purpose through reference to various material standards.

9.27.5.1. To attach siding materials to the building in a manner that will support their weights and resist effectively the effects of wind action. Also to provide sufficient restraining force to resist warping of the siding when lumber siding is used.

9.27.5.2. To provide a means for the attachment of siding to meet the objectives in 9.27.5.1.

9.27.5.3. To provide a means for the attachment of siding to meet the objectives in 9.27.5.1.

9.27.5.4. To provide fasteners for the attachment of siding to meet the objectives in 9.27.5.1.

9.27.5.5. Fasteners for siding are subject to periodic exposure to moisture and therefore have to be able to resist the effect of corrosion to avoid creating rust stains on the siding. In addition, dissimilar metals such as steel and aluminum are subject to galvanic action in the presence of moisture when they are in proximity to each other. This can lead to premature failure of the fastener or the siding. The object of this Article, therefore, is to prevent the occurrence of such problems.

9.27.5.6. Siding materials expand and contract with changes in temperature. In wood based siding this movement is relatively small and can be accommodated by the nailing. In the case of aluminum and plastic sidings, however, the movement is greater, and unless allowance is made to permit such movement, the siding will tend to buckle and take on a wavy appearance in warmer weather.

9.27.5.7. To provide sufficient fastener withdrawal strength to resist the effects of wind action on siding materials, and sufficient length of bearing for the fastener to support the weight of the siding.

9.27.6.1. To provide a siding surface that will shed water effectively.

9.27.6.2. Lumber siding swells and shrinks with changes in moisture content. This can cause splits to occur over a period of time because of the shrinkage stresses created in the wood fibers. The wider the member, the greater the shrinkage, and the greater the risk of developing splits in the siding. Similarly, as the thickness of lumber is decreased, there is an increasing tendency for it to warp with changes in moisture content. The objective of this requirement, therefore, is to keep the risk of developing checks and splits to a reasonable level, and to provide a surface that is relatively free from warping.

9.27.6.3. To allow sufficient overlapping of the lumber siding to accommodate changes in its moisture content without creating cracks between siding members that would allow the entry of rain.

9.27.7.1. To control the defects permitted in shingles and shakes to ensure their surface will be able to shed rain effectively.

9.27.7.2. The maximum width limit is to reduce the risk of splitting as the shingles dry. The minimum size limit to prevent the use of shingles that are too small to provide sufficient lap over joints and other defects in the undercourses.

9.27.7.3. To attach shingles or shakes to the wall in a manner to resist the effects of wind action and to support their weight. Since fasteners provide an opportunity for rain water leakage, they are located so that they are not exposed to rain water.

9.27.7.4. To ensure that there will be sufficient lapping of shingles over the joints in the undercourses to prevent the entry of rain into the wall.

9.27.7.5. To provide a method of attachment for shingle and shake sidings that will resist the effects of wind action, and support the weight of the siding.

9.27.7.6. To provide sufficient overlapping of shingles to enable them to shed rain effectively and prevent the entry of rain into the wall. Also to provide a sufficient thickness of material to ensure a reasonable life expectancy as the shingle erodes from weathering.

9.27.8.1. To define the characteristics needed by asbestos-cement products to meet the objectives in 9.27.2.1.

9.27.8.2. To provide a sufficient thickness and density in asbestos-cement shingles to attain adequate strength to resist accidental impact forces and wind action.

9.27.8.3. To provide a method of attachment for asbestos-cement shingles that will resist the effects of wind action and support the weight of the shingles.

9.27.8.4. To offset the joints in successive courses of asbestos-cement shingles to allow them to shed water effectively and prevent it from entering the wall. Also to provide support behind each vertical joint to give the shingles more strength to resist impact forces.

9.27.8.5. To provide sufficient lapping or other rain shedding protection to prevent the entry of rain at the joints between sheets of asbestos-cement panels.

9.27.9.1. To define the characteristics needed for plywood siding to meet the objectives in 9.27.2.1., through reference to various standards.

9.27.9.2. To enable plywood siding to have adequate strength and stiffness to resist forces due to wind action as well as impact loads that may occur. Also to provide sufficient thickness to allow for the erosion of the plywood over time due to weathering.

9.27.9.3. To restrict the entry of water into edges of the plywood. This can lead to paint pealing and eventual delamination of the plies near the edges.

9.27.9.4. To provide adequate support at the edges of the plywood sheets to enable the siding to withstand wind and impact forces. Also to ensure that the plywood will be installed to shed effectively water and fulfill the objectives in 9.27.2.1. Gaps between adjacent sheets allow individual sheets to expand without buckling..

9.27.9.5. To provide adequate support at the edges of lapped strip plywood siding to withstand impact forces and to keep the edges in alignment where they butt together. Also to provide a sufficient overlap for the siding to shed water effectively and fulfill the objectives in 9.27.2.1. The butt joints are designed to allow the plywood to expand without buckling while still maintaining water tightness.

9.27.10.1. To define the characteristics needed for hardboard siding to meet the objectives in 9.27.2.1. through reference to standards for hardboard.

9.27.10.2. Same objectives as for plywood siding in 9.27.9.2.

9.27.10.3. Same objective as for plywood in 9.27.9.4.

9.27.10.4. Same objective as for plywood in 9.27.9.5.

9.27.10.5. To allow hardboard siding to expand at window and door openings without causing it to buckle.

9.27.11.1. To define the characteristics needed for waferboard and strandboard to meet the objectives in 9.27.2.1. through reference to a standard.

9.27.11.2. Same objective as for plywood in 9.27.9.2.

9.27.11.3. Same objectives as for plywood in 9.27.9.4. Also to restrict the entry of water into the edges of the board. This can lead to paint pealing and swelling of the board at the edges.

9.27.11.4. Same objective as for hardboard in 9.27.10.5.

9.27.12.1. To define the characteristics needed for metal siding to meet the objectives in 9.27.2.1. through reference to standards for metal siding.

9.27.13.1. To define the characteristics needed for vinyl to meet the objectives in 9.27.2.1. through reference to a standard for vinyl siding.

9.27.13.2. Same objectives as described in 9.27.5.1. to 9.27.5.7. for metal siding.

Section 9.28 Stucco

9.28.1.1. Sheathing is used behind stucco to provide a firm base over which an even coat of stucco can be applied with sufficient pressure to fully embed the lath or reinforcing. While there are a number of construction advantages in using sheathing, it is not necessary for the purpose of providing additional strength to the stucco in resisting horizontal forces. Reinforced stucco is much stiffer than common sheet type sheathings, and therefore takes most of such loads. Sheathing is permitted to be deleted if horizontal reinforcing wires are provided to support the stucco lath or reinforcing during the application of stucco so that the metal can be fully embedded. Paper backed welded wire lath also allows the metal to be fully embedded in the stucco, making sheathing unnecessary.

9.28.1.2. Stucco lath and reinforcing provides a means for securing the stucco to the building where the base cannot provide a good bond with the stucco to support its weight, and resist dislodgment as a result of wind action or freeze thaw cycles. It also adds strength to the stucco and reduces the size of shrinkage cracks, making them less obvious. Lath or reinforcing is provided for stucco applied to masonry chimneys to reduce the extent of cracking as a result of rapid thermal expansion.

9.28.1.3. Masonry units that have not been cured by the autoclave process (i.e. steam cured) shrink after manufacture due to continuing drying and curing that occurs. If stucco is applied over such units too soon after manufacture, shrinkage cracks may result.

9.28.1.4. Stucco applied over wood frame construction that is too close to the ground will expose the sheathing and framing to ground moisture and back splash from rain. This could lead to eventual deterioration or decay of the sheathing and framing.

9.28.1.5. Same objectives as for 9.27.3.1., 9.27.3.2., 9.27.4.1. and 9.27.4.2. Aluminum flashing will react with the alkali in stucco and will fail prematurely unless it is protected by a waterproof membrane or coating.

9.28.2.1. Since stucco performs the same function as siding, it has the same objectives as described for siding. The objective of this Article, therefore, is to ensure that Portland cement will have the necessary properties to produce stucco that will met the objectives in 9.27.2.1.

9.28.2.2. To ensure that stucco aggregate will have the necessary properties to produce stucco that will meet the objectives in 9.27.2.1. If aggregate is not well graded it will require an excessive amount of Portland cement to provide durable stucco that will resist rain and cycles of freezing and thawing.

9.28.2.3. To ensure that the mix water for stucco will provide stucco to meet the objectives in 9.27.2.1. Dirty water can cause stucco to deteriorate prematurely.

9.28.3.1. Since stucco fasteners are subject to wetting even though they are covered by stucco, they have to be corrosion resistant. Aluminum is not used since it reacts with Portland cement in the stucco which shortens the life expectancy of the fasteners.

9.28.3.2. To provide the appropriate shape of fasteners for the attachment of metal lath or reinforcing that will support the weight of the stucco and resist the effects of wind. Wall stucco is partly self-supporting so that the withdrawal resistance required for walls (i.e. fastener penetration) is less than for stucco applied to soffits or carport ceilings. (See 9.28.4.6.)

9.28.4.1. To ensure that stucco lath and reinforcing will have a reasonable life expectancy when embedded in stucco.

9.28.4.2. To provide alternate ways of supporting stucco lath and reinforcing when sheathing is not used.

9.28.4.3. To ensure that stucco lath and reinforcing will have sufficient strength to resist stucco cracking due to shrinkage, and to resist horizontal forces due to wind and impact loads. In the case of horizontal applications (i.e. soffits and ceilings) the stucco rib lath provides additional strength to support the weight of the stucco between fasteners.

9.28.4.4. To hold the stucco lath away from the base so that the stucco can flow around the mesh or reinforcing to completely imbed it. This helps to provide additional corrosion protection for the lath as well as strength for the stucco.

9.28.4.5. To reduce the possibility of stucco cracks developing over the joints between stucco lath.

9.28.4.6. To provide sufficient fasteners to attach stucco lath to the building to support the weight of the stucco and to resist wind forces. (See 9.28.3.2.)

9.28.5.1. To provide stucco with appropriate strength and durability characteristics to meet the objectives in 9.28.2.1.

9.28.5.2. To prevent the use of pigments that may adversely affect the strength or durability of the stucco. Also to prevent the use of pigments that will not be color fast.

9.28.6.1. The rate of curing of stucco slows as the temperature decreases and practically ceases at freezing temperatures. If stucco freezes before it sets, its strength and durability can be very seriously reduced. The objective of this requirement therefore is to prevent stucco from freezing, and to maintain a sufficient temperature over a time period that will allow enough curing to prevent future damage from freezing.

9.28.6.2. Stucco is applied in several coats to reduce the risk of shrinkage cracks extending from the surface to the base material, thereby reducing the risk of a variety of problems relating to moisture leakage. As one coat dries and shrinks some cracks will occur in the stucco. These are covered in succeeding coats. Any new cracks that occur would seldom coincide with those in the previous coat. The total minimum thickness in the case of reinforced stucco is to provide for sufficient material to imbed the lath and protect it from the weather to ensure a reasonable life expectancy. In the case of unreinforced stucco applied over masonry, the thickness is less important although if applied too thin stucco may dry out before it sets properly.

9.28.6.3. To completely embed the lath or reinforcing in stucco and to create a surface that will provide a sufficient bond so that both coats will act as one in resisting bending forces and impact loads.

9.28.6.4. To provide additional weather protection for the lath embedded in the first coat and to add to the strength of the first coat in resisting horizontal forces. Also to provide a surface that will bond with the finish coat so delamination will not occur as a result of freezing and thawing.

9.28.6.5. To provide a decorative and weathering surface for the stucco that will resist the entry of rain and the effects of freezing and thawing cycles.

Section 9.29 Interior Wall and Ceiling Finishes

9.29.1.1. Wall and ceiling finish provides wood frame structures with overall rigidity to resist the horizontal forces resulting from wind action. They are primarily intended however to provide a pleasing surface that will allow appropriate decoration and cleaning. They can also be an important element in an assembly required to provide fire or sound resistance. They are expected to be reasonably durable and be able to resist impact forces that might occur as a result of occupancy. Finally, interior finishes play an important role in the speed of fire propagation in a building, so that the flame spread ratings have to be within reasonable limits to allow occupants time to escape or to give fire fighters a chance to control the extent of damage.

9.29.2.1. To provide reasonably durable wall finish that will not deteriorate from frequent exposure to water splash in showers and around bath tubs.

9.29.2.2. To describe a number of wall finishes that will meet the objectives of 9.29.2.1.

9.29.3.1. Wood furring is often used over solid surfaces such as masonry or over existing wall surfaces to provide an even surface for the attachment of new wall finishes. It is also applied directly to framing to reduce the support spacing or to change the orientation of panels in applying wall and ceiling finishes. When used, its prime function is to provide an attachment base for the wall or ceiling finish and contribute to the objective in 9.29.1.1. It has to have sufficient thickness to give fasteners adequate withdrawal resistance to support the weight of the finish, and provide sufficient stiffness for the application of nails or staple. This is the main reason for increasing the size of strapping when the distance between supports is increased.

9.29.3.2. To fasten the furring to the framing so that it can support the weight of the finish and resist twisting of the furring as it dries.

9.29.4.1. To describe the applications of lath and plaster finishes that will meet the objectives in 9.29.1.1.

9.29.5.1. To explain the scope of this Section and to refer the reader to requirements for other applications of gypsum board finish that will meet the objectives in 9.29.1.1.

9.29.5.2. To describe the characteristics of gypsum board, through reference to a standard, that will provide a wall or ceiling finish to meet the objectives in 9.29.1.1.

9.29.5.3. Supports for the attachment of gypsum board are spaced sufficiently close together to prevent objectionable sagging of the ceiling finish between supports, and excessive flexing of the wall finish when subjected to impact forces. The fiber orientation in the paper facings make the board stiffer and stronger in its lengthwise direction, so that the spacing between supports can sometimes be greater if the board is applied perpendicular to them.

9.29.5.4. The minimum thickness for gypsum board ceiling finish that supports the weight of insulation is specified to prevent excessive sagging of the board between supports.

9.29.5.5. When exposed to fire, fasteners for wall and ceiling finishes will conduct heat into the support members, causing charring around the fasteners. This causes the fasteners to lose their withdrawal resistance. The longer the fasteners are subjected to fire, the greater will be the depth of char. Fastener length therefore is adjusted for the required duration of fire resistance required. Since walls are partially self-supporting, the depth of fastener penetration is not as important as it is with ceilings. The objective therefore is to provide a sufficient fastener length to prevent premature failure of a building assembly required to provide a specified fire resistance.

9.29.5.6. To define the characteristics of nails used for the attachment of gypsum board to contribute to the appropriate objectives in 9.29.1.1.

9.29.5.7. To define the characteristics of screws used for the attachment of gypsum board to contribute to the appropriate objectives in 9.29.1.1.

9.29.5.8. To provide a sufficient number of nails to support the weight of the finish and to contribute to the appropriate objectives in 9.29.1.1.

Using nails in pairs at greater spacing than single nails is a technique intended to reduce raised nail heads (nail popping). Omitting nails at perimeters of ceilings, is intended to reduce nail popping caused by the weight of the structure pushing the nail heads through the nail cover as the wood dries and shrinks. Nails too close to the edge of the board will split the gypsum, and make nailing much less effective. Driving nails below the surface of the board facilitates covering and hiding the nails with wallboard cement.

9.29.5.9. To provide a sufficient number of screws to support the weight of the finish and to contribute to the appropriate objectives in 9.29.1.1.

9.29.5.10. To provide sufficient heat to allow the gypsum wallboard cement to dry before subsequent freezing can occur. If the cement freezes before it dries, its adhesive characteristics may be adversely affected.

9.29.6.1. Supports for the attachment of plywood wall and ceiling finishes are spaced sufficiently close together to prevent objectionable sagging of the ceiling finishes, and excessive flexing of the wall finishes when subjected to impact forces. If blocking is provided at mid wall height, the wall panels are considerably stiffened, allowing the use of thinner wall finish. If applied to a continuous backing, the plywood serves only a decorative function and no minimum thickness is needed.

9.29.6.2. Thinner plywoods of the type used for wall finish can be seriously weakened if the decorative face grooves extend through the first ply. Such plywood can easily fail under modest impact forces if the grooves do not coincide with the supporting members. Since thinner plywoods are much stronger in their lengthwise direction, such deep grooves are permitted if the plywood is applied perpendicular to the supports and the plywood increased in thickness to compensate for the depth of the groove into the inner plys.

9.29.6.3. To provide a sufficient number of fasteners to support the weight of the plywood finish and contribute to the appropriate objectives in 9.29.1.1.

9.29.6.4. To prevent excessive flexing and damage to the interior wall finish as a result of impact forces.

9.29.7.1. To describe the characteristics of hardboard (through reference to a standard) that will provide a wall or ceiling finish that will meet the objectives in 9.29.1.1.

9.29.7.2. Same objective as for plywood in 9.29.6.1.

9.29.7.3. Same objective as for plywood in 9.29.6.3.

9.29.7.4. Same objective as for plywood in 9.29.6.4.

9.29.8.1. To describe the characteristics of insulating fiberboard (through reference to a standard) that will meet the objectives in 9.29.1.1.

9.29.8.2. To prevent excessive sagging of the fibreboard between supports when used as a ceiling finish and excessive flexing when used as a wall finish.

9.29.8.3. Same objective as for plywood in 9.29.6.3.

9.29.8.4. Same objective as for plywood in 9.29.6.4.

9.29.9.1. To describe the characteristics of particleboard, waferboard and strandboard (through reference to standards) that will provide a wall or ceiling finish that will meet the objectives in 9.29.1.1.

9.29.9.2. Same objective as for fiberboard in 9.29.8.2.

9.29.9.3. Same objective as for plywood in 9.29.6.3.

9.29.9.4. Same objective as for plywood in 9.29.6.4.

9.29.10.1. To describe how ceramic or plastic tile wall finish can be applied to meet the objectives of 9.29.2.1.

9.29.10.2. To describe how a mortar base can be used to adhere ceramic wall tile to meet the objectives in 9.29.2.1.

9.29.10.3. To describe how adhesive can be used to install plastic or ceramic wall tile to meet the objectives in 9.29.2.1.

9.29.10.4. When tiled walls are subjected to splash water there is a risk of some leakage through the tile joints and where the tile meets the bathtub or fixture. The base material therefore can be damaged over a period of time unless it is made of water resistant material or has been appropriately treated to repel water.

9.29.10.5. Experience has shown that the junction between the wall tiles and bathtub has been the source of numerous problems ranging from mildew to severe wall damage. The objective of this Article therefore is to prevent such damage by the use of appropriate caulking.

Section 9.30 Flooring

9.30.1.1. Finished flooring provides the wearing surface needed for the occupancy in which it is located. Its characteristics and functions therefore depends on the nature of the occupancy, and the design of the floor system. In the case of residential occupancies, the finish flooring has to lend itself to customary cleaning, depending on its location in the suite. It should not create a hazard to the occupants by virtue of its surface characteristics such as unevenness, excessive slipperiness, open defects and splinters; or emit harmful chemicals into the air. Since it will be exposed to water from time to time, and to solar radiation, it has to provide resistance to both for a reasonable period of time. Finish flooring may also contribute to structural support in the case of wood flooring, depending on the design of the floor.

9.30.1.2. To provide floors with a high resistance to deterioration from moisture and which facilitate cleaning in areas that are subject to water splash or food preparation.

9.30.1.3. To prevent the decay of wood sleepers supported on concrete resting on the ground. Such sleepers may be subjected to water from leaky basements, surface condensation on concrete during warm weather, moisture migration from the ground (if the slab has not been effectively dampproofed) and water from the drying of the concrete during construction.

9.30.1.4. To ensure that floor surfaces will not create a tripping hazard or lead to injuries resulting from splinters.

9.30.2.1. To provide an even, stable base, suitable for the type of floor finish to be applied. Panel type underlay evens out sub-floor irregularities, and bridges over sub-floor joints that are subject to differential deflection when one side of the joint is loaded. Since strip flooring is able to do this as well, such underlay is not necessary when strip flooring is used, unless the strip flooring is parallel to lumber subflooring. Unless a panel type underlay is used, any shrinkage of the lumber subfloor will cause cracks to open in the wood strip floor finish if they are laid parallel to one another.

9.30.2.2. To define the characteristics required for panel type underlay to fulfill the objectives of 9.30.2.1., through reference to different material standards. Ceramic tile flooring applied with an adhesive to the underlay requires an extra stiff base to prevent failure of the glue bond.

9.30.2.3. To describe how panel type underlayment is attached to the subfloor in order to meet the objectives in 9.30.2.1.

9.30.2.4. If joints in panel type underlay coincide with the joints in panel type subflooring, the underlay will not be able to prevent differential deflection if one side of the joint is loaded, and damage to the floor finish may result.

9.30.2.5. Open defects, such as holes, in the panel type underlay will cause finish flooring such as vinyl, linoleum, or adhesive applied ceramic tile to be damaged when a concentrated load is applied above the defect. Such defects therefore must be filled to prevent such damage.

9.30.3.1. To provide adequate strength and stiffness for the flooring system when wood strip flooring acts as a structural member. Also to provide sufficient wood thickness to allow for surface wear as a result of occupant use and subsequent re-sanding and refinishing .

9.30.3.2. To prevent cracks from opening between adjacent strips of flooring caused by shrinkage in the subflooring. Also to prevent differential movement between the butted ends of strips when a concentrated load is applied to one of the strips. Staggering the end joints, and making the strips continuous over two or more supports provides additional stiffness in the strip flooring.

9.30.3.3. To ensure that wood strip flooring is attached firmly to its base to resist warpage of the strips, or buckling of the floor due to seasonal increase in the moisture content of the wood. Since nail heads tend to rise as the wood shrinks, they are counter sunk to prevent them from creating a hazard, and the holes filled to improve their appearance.

9.30.3.4. Same objective as 9.30.3.3.

9.30.4.1. To ensure that parquet flooring is attached firmly to the supporting base by an adhesive that will be compatible with the surfaces to be joined, and will resist any upward movement of the parquet that may occur as a result of buckling caused by swelling of the parquet.

9.30.5.1. Resilient flooring used on concrete slabs resting on the ground are subject to exposure to moisture migrating from the soil, surface condensation, basement leakage, or drying of the concrete after placement. In addition concrete is highly alkaline and will attack certain adhesives. Resilient flooring (and its adhesive) used on slabs on ground therefore has to be of a type that will not mildew or decay, and be resistant to alkaline action.

9.30.6.1. To ensure that ceramic tile will be supported on a base that will provide adequate support for the tile and will not contribute to its premature failure.

9.30.6.2. Same objective as 9.23.14.3.

Section 9.31 Plumbing Facilities

9.31.1.1. To inform Code users of the limited scope of the plumbing requirements in this Section, and where other plumbing requirements are located elsewhere in the Code.

9.31.2.1. To ensure that plumbing fixtures, and the drain, waste and vent piping that service them, will be installed in a manner that will not create a health hazard or a nuisance to the occupants they serve.

9.31.2.2. To protect metal piping from coming in contact with potentially corrosive material that might reduce the service life of the piping.

9.31.2.3. Grab bars used in conjunction with plumbing fixtures are subject to both horizontal and vertical forces caused by the user of the fixtures. If grab bars are not anchored sufficiently well to resist such forces, they will not be able to provide the user with their intended assistance, and may in fact contribute to accidents.

9.31.3.1. To provide each dwelling unit with water that is fit to drink.

9.31.3.2. To ensure that each plumbing fixture can provide an appropriate level of sanitation where the dwelling unit has a piped water supply.

9.31.4.1. To attain a basic level of sanitation in dwelling units by providing essential plumbing facilities necessary for sanitary food preparation, dish washing, personal washing, and sewage disposal where a piped water supply is available.

9.31.4.2. To facilitate laundering by the occupants of dwelling units.

9.31.4.3. To facilitate attaining basic levels of sanitation in dwelling units by providing a supply of hot water to service the basic plumbing facilities used for washing, laundering or food preparation, where a piped water supply is available.

9.31.4.4. To facilitate the disposal of water in house basements that may result from ground water leakage, plumbing or equipment leakage where gravity drainage is possible. Also to facilitate water disposal in those areas that require periodic hosing down for sanitary reasons, or which are subject to periodic water release from equipment serving more than one dwelling unit.

9.31.5.1. To facilitate attaining a basic level of sanitation in dwelling units by disposing of the waste from every plumbing fixture to the building sewer.

9.31.5.2. To facilitate attaining a basic level of sanitation in dwelling units by providing for the sanitary disposal of waste from the building.

9.31.6.1. To ensure that the water supply will be hot enough and of sufficient quantity to meet the objectives of 9.31.4.3. but not hot enough to cause serious accidental burn injury.

9.31.6.2. To provide a choice of hot water supply systems to serve dwelling units in buildings with more than one unit.

9.31.6.3. To ensure that service water heaters are designed and installed so that they will not cause an undue risk of fire, explosion, or electric shock; or expose the occupants to a health risk from the products of combustion.

9.31.6.4. To prolong the service life of storage tanks for hot water heaters. The water in different communities can vary considerably in its corrosiveness and should be taken into account in selecting the type of protection. The water temperature is also an important factor and should be kept as low as practicable to prolong the life of water storage tanks.

9.31.6.5. To vent the products of combustion to the exterior so they will not create a health hazard to the occupants.

9.31.6.6. Hot water heating coils installed in a flue or a furnace combustion chamber can heat the water above its boiling point and create dangerous pressures in the water system. Such a practice can lead to scalding temperatures at the taps, rupture of the coils when solder melts, and even rupture of the hot water tank itself from excessive pressure.

Section 9.32 Ventilation

9.32.1.1. To inform the Code user of the limited scope of this Section, and where other ventilation requirements are found in other parts of the Code.

9.32.1.2. To provide a sufficient rate of air change in dwelling units to maintain healthful conditions for the occupants on a year-round basis, and to prevent the excessive build up of moisture, odours or other contaminants during the period when the heating system would normally be in operation with the windows closed.

9.32.2.1. To provide sufficient ventilation openings to the exterior to meet the objectives in 9.32.1.2. during the period when the heating system would not normally be in operation. Also to prevent an excessive build up of heat in dwelling units during this period due to lack of air change.

9.32.2.2. To provide sufficient ventilation area to the exterior for individual rooms and spaces within dwelling units to meet the objectives of 9.32.1.2. during periods when the heating system would not normally be in operation. Also to prevent the entry of insects or rain through such openings.

9.32.3.1. To provide a system of mechanical ventilation for rooms and spaces within dwelling units to meet the objective of 9.32.1.2. during periods when the heating system would normally be in operation with the windows closed.

9.32.3.2. To ensure that any system of mechanical ventilation will be installed in a manner to fulfill its intended purpose, and not create a fire, health or shock risk for the occupants.

9.32.3.3. To provide a sufficient volume of ventilation air during periods when the heating system would normally be in operation to meet the objectives in 9.32.1.2.

9.32.3.4. To provide a means for exhausting air from a dwelling unit by means of a mechanically powered exhaust system, coupled to the air intake system in such a manner as to avoid excessive depressurization within the unit to help achieve the objectives in 9.32.1.2.

9.32.3.5. To provide a means for exhausting, by mechanical means, moisture created by personal washing and bathing as well as odours from water closets and air contaminants from cooking to help achieve the objectives of 9.32.1.2. For greatest efficiency these are removed near their point of origin before they can mix with air from other rooms.

9.32.3.6. To provide a means for supplying outside air to a dwelling unit to help achieve the objectives of 9.32.1.2. by utilizing the furnace blower and warm air duct system. The blower operation is coupled with the exhaust fan required for general ventilation (as noted in 9.32.3.4.) to avoid excessive pressurization within the dwelling unit which might create moisture problems within the building envelope. The fresh air intake is connected to the blower in a manner that prevents excessively cold air from reaching the heat exchanger and creating corrosion problems due to condensation.

9.32.3.7. To provide a means for supplying outside air to a dwelling unit to help achieve the objectives of 9.32.1.2. by the use of a separate mechanical air distribution system. The intake fan is coupled with the exhaust fan (as noted in 9.32.3.4.)

to avoid excessive pressurization in the dwelling unit which might create moisture problems within the building envelope. The fresh air is heated before being distributed to avoid discomfort to the occupants.

9.32.3.8. To restrict soil gases, or the products of combustion intended to be vented to the exterior, from contaminating air within the dwelling unit caused by the operation of exhaust fans that are able to create a significant negative pressure due to their rate of air removal. Also to warn occupants of the presence of carbon monoxide where the nature of the appliance makes it impracticable to prevent the possibility of such contamination occurring under certain circumstances.

9.32.3.9. To provide a standard means for rating the air moving capacity of fans, blowers and other ventilating equipment. Also to restrict the level of noise generation of air moving equipment so that it does not cause undue annoyance to the occupants, and to ensure that the equipment will be installed in a manner to fulfill its intended function in contributing to the objectives of 9.32.1.2.

9.32.3.10. To ensure that ducts used for ventilation will be constructed of such materials and installed in such a manner that they will not create a fire hazard, or cause condensation problems. Since such ducts may be subject to periodic wetting, they have to be able to resist corrosion or other damage due to moisture. They also have to be sufficiently air tight to prevent the leakage of room moisture into concealed spaces which could lead to condensation problems within the building envelope.

9.32.3.11. To ensure that where heat recovery equipment is installed and forms part of the required ventilation system, it will provide an appropriate amount of fresh air in contributing to the objectives of 9.32.1.2. Also to ensure that the installation will not create a fire or health risk, or create significant problems related to moisture condensation.

9.32.3.12. To locate the fresh air intake opening for the ventilation system so as to reduce the risk of contamination from nearby sources of pollution, or recirculation of exhaust air. Also to locate intake and exhaust openings so they will not be blocked by snow or ice, and designed to prevent the entry of precipitation, vermin or insects.

9.32.3.13. To install ventilation equipment in a manner that will minimize noise generation that would create an annoyance to the occupants, and in a manner to facilitate inspection, adjustment, maintenance and repair. Also to install such equipment so that condensation will not occur within the equipment if it is not designed for such conditions.

Section 9.33 Heating and Air Conditioning

9.33.1.1. To describe the limited scope of this Section and to refer Code users to other parts of the Code for heating requirements beyond the scope of this Section.

9.33.2.1. To require all residential buildings to be equipped with heating systems for the comfort of the occupants if such buildings are to be occupied in the winter months on a continuing basis.

9.33.3.1. To provide a minimum temperature level in residential occupancies that will provide reasonable comfort for the occupants.

9.33.3.2. To describe the outdoor design temperatures that have to be used in determining the maximum heat loss from a building for the purpose of determining the necessary equipment heating capacity. This is the heating capacity needed to attain the temperature levels in 9.33.2.2. to provide a reasonable comfort level.

9.33.4.1. To ensure that heating and air conditioning systems are designed and installed in a manner to fulfill their intended functions without creating a significant fire, shock, explosion or health risk.

9.33.4.2. To facilitate the inspection, maintenance and repair of all components of a heating or air conditioning system where this is practicable.

9.33.4.3. To prevent heating and ventilation equipment from being damaged when exposed to freezing temperatures.

9.33.4.4. To prevent heating and cooling systems from being damaged by excessive pressures created by the heat transfer fluid when it expands or becomes over heated.

9.33.4.5. To prevent damage to heating and cooling equipment, including duct work and piping, as a result of movement of the building structure.

9.33.4.6. To prevent particles of asbestos from entering the air supply or return systems where they would create a health threat to the building occupants.

9.33.5.1. To ensure that the capacity of heating equipment that serves a single dwelling unit will be sufficient to meet the objectives in 9.33.3.1.

9.33.5.2. To ensure that heating and air conditioning equipment will be installed in a manner to fulfill their intended functions without creating a fire, shock or explosion hazard, or lead to conditions that will have a detrimental effect on the health of the building occupants.

9.33.5.3. To ensure that solid fuel appliances will be designed and installed in a manner to fulfill their intended functions without creating a fire or health hazard to the occupants.

9.33.5.4. Same objective as in 9.33.5.3.

9.33.6.1. To inform Code users of the limited scope of Subsection 9.33.6. and that other parts of the Code apply for air duct systems beyond this scope.

9.33.6.2. To ensure that ducts for air handling systems including duct connectors and associated fittings will have the necessary properties to fulfill their intended function without creating a fire hazard or conditions detrimental to the health of the occupants.

9.33.6.3. To ensure that tape used for sealing duct joints will not create a fire hazard by facilitating the spread of fire along its surface.

9.33.6.4. To ensure that air ducts (including plenums) and their components, such coverings, linings, insulation and adhesives will not facilitate the spread of fire along the ducts, and will not generate excessive amounts of smoke in the event of fire. Also to prevent ignition of these materials near sources of high temperatures as well as to preserve the integrity of any fire separation through which the ducts pass. Lining materials can interfere with the operation of dampers or fire stop flaps and this has to be considered during installation to maintain their effectiveness.

9.33.6.5. To ensure that metal ducts will have adequate strength to resist being damaged and have sufficient metal thickness to provide a reasonable degree of durability. Also to ensure that the associated duct fittings will provide reasonable strength to resist disengagement at the joints, provide reasonable air tightness, and facilitate the smooth flow of air at changes of direction of the ducts. The latter is important to reduce pressure losses due to air turbulence in the ducts as well as to reduce the noise level.

9.33.6.6. If larger ducts are not stiffened by creases they tend to move abruptly inward or outward with changes in air pressure or temperature, and reverberate to cause noise in the duct system.

Spaces between the duct work and the surrounding construction can create pathways for fire spread unless the spaces are fire stopped. Ducts have to be securely supported to prevent sagging and to keep them in alignment. To achieve reasonable efficiency in air distribution, ductwork, including joints have to be substantially air tight with no unnecessary openings cut into the ducts. The use of S-and-drive cleats not only reduce air leakage but make the joints resistant to dislodgment as a result of accidental impact forces.

9.33.6.7. Ducts serving a garage can allow dangerous exhaust gases and gasoline fumes to enter the living areas if both areas are served by a common system. Trunk supply ducts are not nailed directly to wooden members since such connections do not provide sufficient support strength for the ducts nor allow for their expansion. Unless ductwork that passes through unheated space is made air tight, substantial quantities of moisture may be carried into such spaces and lead to moisture related problems. Combustible underground ducts are kept away from furnace plenums to prevent ignition. Since underground ducts are subjected to ground moisture, they have to be able to resist the deteriorating effects of a damp environment to avoid premature failure, and be made watertight to prevent the entry of ground water into the heating system and consequent problems related to excessive humidity. Direct drainage of underground ducts to a sewage system could allow sewer gases to enter the living areas and is therefore not allowed.

9.33.6.8. To prevent ducts from exposing adjacent combustible materials to temperatures that could eventually cause ignition.

9.33.6.9. To distribute warm air from the furnace to the perimeter of the slab so that heating outlets can be installed to heat the perimeter walls. This arrangement is to enhance the comfort of the occupants by ensuring that the coldest portions of the building will be heated.

9.33.6.10. To facilitate the adjustment of the warm air supply to each heating outlet, so that the comfort level throughout the dwelling unit can be maximized.

9.33.6.11. To prevent large foreign objects from being dropped into the ductwork which could restrict the flow of air or create a potential fire hazard. Also to prevent the use of grill work that could create a fire hazard by facilitating flame spread travel.

9.33.6.12. To ensure that the warm air from a furnace is distributed throughout a dwelling unit in a manner that will provide a reasonable level of comfort in all parts of the unit. Also to ensure that the warm air temperature will be kept sufficiently low to prevent accidental burns from contact with the registers.

9.33.6.13. To ensure a reasonable recirculation of air from each story and from each room in a dwelling unit. This facilitates the introduction of heated air in sufficient quantities to provide an adequate comfort level in each room. If return air inlets are located in the same enclosed room or crawl space that provides furnace combustion air, the burner may be starved for oxygen and produce carbon monoxide. This, along with other products of combustion could find its way into the air system through the return air inlet and create a serious threat to the occupants.

9.33.6.14. To ensure that the return air system will not be installed in a manner that will cause a risk of ignition, facilitate the spread of fire, or create a health risk by drawing the products of combustion into the return air system. Also to ensure that the return air system has sufficient capacity to handle the entire air supply. If undersized, the furnace will not operate at full capacity or top efficiency. If a common return duct has outlets on more than one floor, it will be difficult to balance the system to ensure an adequate comfort level in all rooms.

9.33.7.1. To prevent ignition of the wall surface adjacent to a radiator after long-term exposure to its heat.

9.33.7.2. To prevent accidental skin burns from contact with the radiator.

9.33.8.1. To prevent the rupture of steam and hot water piping resulting from excessive temperature or pressure of the heating medium. Also to prevent excessive stress in the piping and its supporting structure as a result of thermal expansion of the piping.

9.33.8.2. To ensure that insulation and coverings on steam and hot water piping will be serviceable at the operating temperature of the system; and will not create a fire or smoke hazard as a result of ignition, facilitate the spread of fire along their surfaces, or deteriorate in the presence of moisture. Also to prevent skin burns from accidental contact with the piping.

9.33.8.3. To prevent the ignition of combustible material adjacent to steam and hot water piping as a result of long term exposure to heat.

9.33.8.4. Same objective as 9.33.8.3.

9.33.9.1. To ensure that where heating and cooling systems share a common duct network, the systems will be installed so that the operating temperatures of one system will not cause adverse effects on the equipment in the other system.

9.33.10.1. To ensure that the products of combustion from fuel fired heating equipment will be vented to the exterior in a manner that will not create a fire or health risk to the occupants.

9.33.10.2. To remind Code users that if masonry or concrete chimneys are used to vent the products of combustion from fuel fired equipment, the requirements for such chimneys are located elsewhere in the Code.

Section 9.34 Electrical Facilities

9.34.1.1. To ensure that electrical systems will be designed and installed so that they will not create a fire or shock hazard and will provide a reasonable level of convenience for the occupant.

9.34.1.2. To require that if electrical services are available, the building must be electrified as required in this Section.

9.34.1.3. To reduce the risk of unauthorized tampering or interference with the operation of electrical services or equipment in public areas.

9.34.1.4. To reduce the risk of ignition of combustible material adjacent to recessed lighting fixtures as a result of overheating of the fixture.

9.34.1.5. To reduce the risk of fire propagation along electrical wiring.

9.34.2.1. To reduce the risk of accidental falls and missteps at the entrance to a building. Also to reduce the risk of forced entry, and to provide a reasonable level of convenience for the occupant.

9.34.2.2. To reduce the risk of accidents in dwelling units by providing a light switch at the entrance to a room. Also to provide a reasonable level of convenience for the occupant.

9.34.2.3. To reduce the risk of accidental falls and missteps on stairs by requiring stairways to be lit, and having control switches at the top and bottom of the stairway (except for short stairway runs). Exception to omit stairway switch at the foot of stairs serving an unfinished basement with a second egress, is rationalized on the basis that basement egress is possible without the need to use the stairs.

9.34.2.4. To reduce the risk of accidents due to bumping into or tripping over objects in basements by having at least one basement light closest to the stair to be controlled by the switch at the head of the stair, and providing sufficient additional lighting to illuminate the entire basement.

9.34.2.5. To reduce the risk of accidental falls due to bumping into or tripping over objects in storage rooms. Also to provide a reasonable level of convenience for the occupant.

9.34.2.6. To reduce the risk of accidental falls or missteps in a garage or carport area.

9.34.2.7. To provide a sufficient level of electric lighting in public areas to prevent accidental falls or missteps, facilitate the speed of egress and reduce the risk of vandalism.

9.34.3.1. To remind Code users that requirements for emergency lighting (to facilitate egress in the event of power failure) are located elsewhere in the Code.

Section 9.35 Garages and Carports

9.35.1.1. To describe the limited scope of this Section.

9.35.1.2. To remind Code users that other parts of the Code also apply, and that the requirements in this Section are additional to, or exceptions to, the requirements in other parts of the Code.

9.35.2.1. To differentiate between a garage and a carport, based on the degree of enclosure. This affects the application of certain requirements such as 9.10.14.14., 9.10.13.15 and 9.10.13.16.

9.35.2.2. To provide drainage to the exterior of snow-melt from parked vehicles, and to discourage the entry of drainage water from outside. Also to encourage the flow of gasoline fumes and exhaust fumes towards the exterior.

9.35.3.1. To provide a solid support for garages and carports and prevent excessive movement of the superstructure that might cause structural damage, or hinder the operation of the garage door.

9.35.3.2. To prevent structural damage to the superstructure from differential vertical movement between a house and a carport or garage attached to it by a breezeway. Also to control cracking in a slab-on-grade that joins the house and garage or carport, and prevent heaving due to frost penetration that might damage the superstructure.

9.35.3.3. To permit small detached garages to be exempt from the foundation requirements for other buildings if they are of light weight construction. This is rationalized on the basis that such buildings can withstand considerable movement without causing damage to the superstructure, and pose no threat of injury since they are unoccupied.

9.35.3.4. To prevent the lower ends of columns from being subjected to wetting from drainage water and snow-melt. This can lead to decay in the case of wood columns and corrosion in the case of metal. Also to provide sufficient area at the base of the pier to prevent excessive vertical deflection when the columns support a roof load.

9.35.4.1. To exempt garages from the requirements for interior finish. This is rationalized on the basis that the space is unoccupied, and that such finish is not necessary for aesthetic reasons.

9.35.4.2. To allow wooden carport columns to be smaller than those used in basements to support the basement beam. This is rationalized on the basis of successful past experience and the fact that such columns usually support lesser loads.

9.35.4.3. To prevent garages or carports being moved as a result of wind action.

Chapter 3

Typical Problems in Renovation Work and Occupancy Change, with Suggested Solutions

Introduction

This Chapter is a collection of typical problems that may arise when a building is renovated or its occupancy changed. These examples demonstrate how a building code can be used as a guide in meeting its prime objectives of providing for a safe and healthful environment for building occupants, when it is not practical to follow its literal application.

It is intended that these examples will provide a nucleus to which can be added other typical situations that are faced by those engaged in the renovation of buildings, or in changing the occupancy of a building.

These examples, therefore, do not pretend to be complete, or even to be the only or best way that a particular problem may be solved. Rather, they are intended to encourage a logical approach in meeting the objectives of the Code where it is not practical to meet the letter of the law. The Code user is encouraged to focus on the principal objectives of the requirements, and to justify alternative solutions on the basis of rational assessment. If the prime objectives can be met by other means, then a departure from the literal application is relatively unimportant.

It will be obvious to Code users that requirements do not have equal impact on health or safety. The contribution of individual articles to these ends varies widely. Some have relatively little impact, while others are of fundamental importance. The majority fall between these extremes. In developing alternative solutions, therefore, the objective and purpose of the requirements have to be appreciated to avoid significant errors.

As codes are revised from time to time, buildings constructed to earlier editions will be less in conformance with each new edition. This does not mean that the buildings are becoming more dangerous simply because codes have been revised, however.

Code changes are initiated for a variety of reasons including changing economic and social conditions, experience, problems in usage, or new committee memberships that bring fresh experience to the committee deliberations. While it may generally be taken for granted that all code changes are improvements over previous requirements, it does not necessarily mean that a building constructed to an earlier code is unsafe because it does not meet all requirements in the current edition. This should be recognized in applying the current Code to buildings constructed to previous editions.

Typical Renovation Problems and Solutions

Example No. 1

Subject: Exterior Wall Near a Property Line

Problem: A wood frame wall with 13 mm plaster over 9.5 mm gypsum board lath on the inside and wood siding over wood sheathing on the outside is 1.2 m from the property line. The building was originally a single-family house but is being renovated to have a separate suite on the second storey. The Code requires that the wall be of one hour non-combustible construction since Article 9.10.14.12. no longer applies.

Solution: Gypsum plaster (13 mm) over gypsum lath (9.5 mm) should provide at least one hour of fire resistance if it is insulated with mineral wool insulation. This should provide sufficient fire resistance to contain a fire until fire fighters arrive to prevent the spread of fire to an adjacent building even though the wall is combustible construction. Protection of the wood siding from external exposure can be achieved by painting the exterior siding with external grade intumescent paint and would help compensate for the combustible siding.

Rationale: The exposure hazard created by a duplex house to an adjoining property should not be any greater than that of a single family house. Although the Code would require non-combustible construction for the duplex but would permit combustible construction in the latter case, this may be hard to justify. The existing exterior wall therefore should satisfy the objectives of the Code requirements (see "Compilation of Objectives and Reasons", 9.10.14.7. and 9.10.14.11.).

Example No. 2

Subject: Windows Near Lot Line

Problem: A house wall is 0.75 m from the property line, but contains openable windows with ordinary glass. Windows are needed for light and ventilation but are not permitted under the current Code.

Solution: Replace existing windows with fixed wired glass in steel frames. Provide mechanical ventilation in affected rooms to replace natural ventilation as required in 9.32.2.2. Alternatively, protect window openings with heat activated fire closures or install sprinklers.

Rationale: Most heat radiation from a burning building emanates from window openings. Maximum radiation occurs when a flame front extends beyond the face of the building where there is abundant oxygen to support the burning gasses. Wired glass not only prevents the flame front from extending beyond the building face, but it helps to restrict oxygen reaching the fire. This greatly reduces the amount of heat radiation and the fire risk to adjacent property. Sprinklers can also be used to reduce radiation by extinguishing fires before they can become very large.

Example No. 3

Subject: Combustible Siding Near Lot Lines

Problem: A wall with wood siding adjacent to the lot line is required to have non-combustible cladding. Replacing or covering the siding is considered to be too expensive.

Solution: The requirement for non-combustible cladding is to reduce the risk of a building exterior igniting as a result of exposure from another building. (see 'Compilation of Objectives and Reasons", 9.10.14.11.)

Therefore, unless siding is to be replaced with conforming siding, exterior surfaces should be coated with fire retardant intumescent paint formulated for exterior use.

Rationale: Since the objective is for self-protection from ignition from external sources, the use of intumescent paint is considered to provide an acceptable level of protection for existing buildings. Life safety is not a significant issue.

Example No. 4

Subject: Excessive Openings in Exterior Walls

Problem: A wall located more than 1.2 m from a property line contains a greater percentage of openings than is permitted by 9.10.14.1.

Solution: The objective is to reduce the exposure hazard to an adjacent building so that fire fighting can commence before the fire ignites the adjacent building. (see 'Compilation of Objectives and Reasons", 9.10.14.1.)

Calculations to determine area limits of window openings in Part 9 are based on a number of rough approximations. The limits therefore imply more precision than they warrant. A tolerance of 10 to 15% above the area limits therefore are considered justified for existing buildings. Beyond this, however, steps should be taken to reduce the exposure hazard. This can be done by the use of fixed wired glass in steel frames to replace some or all of the ordinary windows. Alternatively, sprinklers can be used to reduce the risk of heat radiation, or heat activated closures can be used.

In existing houses, the risk of fire spread is considered acceptable if the limiting distance exceeds 1.2 m. Life risk is not an issue.

Rationale: See rationale for Problem No.2.

Example No. 5

Subject: 20 Minute Fire Doors

Problem: Existing doors required by the Code to provide a 20 minute fire protection rating consist of different types. Some are hollow core, some solid core and some are stile and rail type with panels.

Solution: The objective is to ensure that the doors will provide effective barriers to fire for a period of at least 20 minutes (see "Compilation of Objectives and Reasons", 9.10.13.1., 9.10.13.2.). Doors therefore should be modified to meet this rating if the building is not sprinklered.

Existing solid core doors need no modification if they are at least 45 mm thick and are fitted with a self-closing device and positive latching mechanism.

Hollow-core doors provide little resistance to fire. They should be replaced or modified to improve their rating. This can be achieved by protecting one side with gypsum wall board (9.5 mm) and the other side and edges with sheet steel (0.41 mm). Certified kits for upgrading doors to 20 minutes can also be used. Closers and latches are required.

Stile-and-rail doors also provide little resistance to fire and also should be replaced or upgraded. Upgrading can be accomplished by a layer of 12.5 mm gypsum board or plywood nailed to the stiles and rails. Certified kits for upgrading doors to 20 minutes can also be used. Closers and latches are required.

Rationale: While the modified doors may or may not reach a 20 minute rating, they are considered to be sufficiently close to it to warrant their acceptance in existing buildings where 20 minute closures are required. If the building is sprinklered, fire is extinguished while still fairly small, and the main function of the door is to control smoke. In this case the existing doors would probably be adequate.

Example No. 6

Subject: Horizontal Fire Separation Between Dwellings

Problem: A house is being renovated into apartments; one on the ground floor, one on the second floor. Ceiling consists of wood lath and plaster (13 mm) on framing spaced 400 mm o.c. in all rooms except the living room. This has been previously renovated with fiberboard ceiling tile over furring (plaster removed).

Solution: Object is to contain fire in the suite of origin to permit time to evacuate the building, and allow fire fighting to commence before damage becomes too extensive. (see "Compilation of Objectives and Reasons", 9.10.9.14.)

If lath and plaster is in good shape (i.e. not badly cracked or sagging away from the lath), it should provide a fire resistance of about 30 minutes or so. This would probably be adequate if the lower unit were sprinklered. If not, an additional layer of protection such as 12.7 mm gypsum wallboard should be added. If a new layer is added, it would be advisable to increase the sound resistance by using resilient channels to attach the wallboard.

In the case of fiberboard tile, this provides very little fire resistance, and if the first floor is not sprinklered, it should have a more substantial protection, such as 15.9 mm type X gypsum board. If sprinklered, a less substantial protection such as 12.7 mm gypsum board should be adequate. Such protection should also be attached with resilient channels to increase the sound resistance as well.

Rationale: When sprinklers are used, most fires are extinguished at a fairly early stage so that a lower fire resistance rating is necessary to contain the fire.

When sprinklers are not installed, the additional fire protection is necessary to contain the fire to the suite of origin to satisfy the objective of 9.10.9.14.

Example No. 7

Subject: Fire Dampers in Ducts

Problem: A suite is being constructed in the basement of an existing house. It is to be heated by a warm air trunk duct extending from a furnace room to the suite (the furnace room contains two furnaces). Since the suite is separated from the furnace room by a fire separation, the Code requires a fire damper where the duct crosses the separation. The need for the fire damper is questioned.

Solution: The object is to prevent fire that originates in the furnace room, or in the suite, from crossing the separation via the duct work. (see 'Compilation of Objectives and Reasons", 9.10.13.13.)

If the basement is sprinklered with fast acting sprinklers, fire dampers would probably not be needed. If the basement is not sprinklered, however, there is a danger that fire could cross the separation unless certain compensating precautions are taken. Both the supply and return ducts should be of galvanized steel. The size of duct penetrations at the separation should be limited to ,say, 1000 cm^2. The trunk duct should be enclosed with at least 12.7 mm thick gypsum drywall within the suite, mechanically fastened to the duct.

Rationale: If the basement were sprinklered, fires would be extinguished at such an early stage that dampers would probably not be activated.

If galvanized steel ducts are used, they would probably remain intact for a reasonable period of time in a fire. The greater danger would be from heat conduction across the separation. Insulating the trunk duct with gypsum board would reduce this risk, particularly if the size of the duct is reasonably small.

Example No. 8

Subject: Plastic Drain, Waste and Vent Pipes

Problem: In the suite renovation in Problem No. 7, the existing house is equipped with a plastic DWV system that penetrates the first floor and runs through the ceiling of the suite below. This is not permitted by the Code.

Solution: Objective is to prevent fire from entering the plastic pipe on one side of the separation, and passing through the separation to the other side (see 'Compilation of Objectives and Reasons", 9.10.9.7.).

The plastic drain piping passing through the basement suite should be protected from fire exposure by wrapping the pipe with a layer of slag or rock fiber insulation protected with at least 15.9 mm type X gypsum board. Since the drain piping in the lower suite would be down under the slab, this could also be of plastic. Vent piping that connects to existing plastic vent pipes in the lower suite, however, would have to be non-combustible.

Rationale: Since the plastic DWV piping is insulated and shielded from fire in the lower suite, its use would pose only a limited fire risk. Since fire could penetrate vent pipes from the lower suite and be transmitted to the upper suite, any exposed runs from the lower suite should be non-combustible to prevent the entry of fire from below.

Example No. 9

Subject: Dead-end Corridors

Problem: A hotel is undergoing renovation but is not able to conform to the limits specified for dead-end corridors unless very expensive measures are taken to add additional exit stairways.

Solution: The limit on dead-end corridors is due to the potential risk of having only one escape route. This could become blocked in a fire (see 'Compilation of Objectives and Reasons", 9.9.7.2.). If the corridors are increased in length, the potential risk to safety also increases and compensating measures have to be taken to reduce the risk.

One means to do this would be to install a fast response sprinkler system. This would probably justify allowing about twice the distance specified in 9.9.7.2. in an existing building. Smoke detectors would also have to be installed in the corridor, however, to reduce the danger of it becoming untenable before evacuation is complete. These should be tied into the alarm system for the building, and would not be typical smoke alarms designed for use within suites.

Rationale: The fire risk factor should be greatly reduced if fast response sprinklers are installed. This plus the fact that the corridors would have early warning devices should allow evacuation of the building before the corridors become untenable.

Example No. 10

Subject: Unenclosed Exit Stairs

Problem: An older apartment building is being refurbished to upgrade its fire safety. The design is such, however, as to make it impracticable to enclose the two exit stairways that serve the suites, due to their design.

Solution: The principle of having an alternative escape route can be achieved by constructing a fire separation across the corridor on each floor including the exit floor. This should have the same rating required for exit stairways. Occupants can pass through the separation to an alternate escape route should one side become blocked by smoke. For convenience, doors in such separations can be held open, and released by a signal from a smoke alarm in the corridor.

Rationale: The principle of having alternative escape routes from each suite has been maintained by providing a fire separation across the corridor. (see "Compilation of Objectives and Reasons", 9.9.9.2.)

Example No. 11

Subject: Inadequate Number of Exits

Problem: A building is being converted from an office building to an apartment building. It is served by a single stairway that provides access to each floor level.

Solution: In order to provide an alternate escape route on each floor, an additional escape stairway must be constructed. This can be either an enclosed or an exterior exit stairway built to the same standard as stairs for new construction, or it can be built as a fire escape as determined by 9.9.2.3. (and 3.4.7.).

Dead-end corridors should be handled as described in Problem No. 9.

Rationale: The creation of an additional exit stairway is necessary to maintain the principle of providing alternative escape routes. While a fire escapes are considered to be inferior to exit stairways, they are nevertheless permitted in an existing building where escape facilities are inadequate.

Example No. 12

Subject: Inadequate Corridor Width

Problem: An apartment building is being renovated to upgrade the level of fire safety. The corridor width was found to be 150 mm less than the minimum specified for new construction (1100 mm).

Solution: The main reason for providing a minimum width of public corridor of 1100 mm is to facilitate two-way traffic (see "Compilation of Objectives and Reasons", 9.9.3.3.). In buildings within the scope of Part 9, the occupant load is usually not considered as a determining factor in establishing such widths. The width, therefore is more for the sake of convenience than for ensuring an adequate rate of traffic flow.

It would therefore not be considered justified to require the corridor to be enlarged an additional 150 mm, since such renovation work is too expensive in terms of the additional safety attained. By the same token, however, if a corridor is being newly constructed in an existing building, a 1100 mm width would have to be provided, since no financial hardship would result by requiring the same standard as for new buildings.

Rationale: The costs of providing Code compliance must be weighed against the safety benefits. If existing construction has to be dismantled and rebuilt, the benefits should justify the additional cost. If new construction is being undertaken, however, the standards that apply must be the same as for new construction.

Example No. 13

Subject: Reclassification of Storey Heights

Problem: A residential building constructed under the 1975 edition of the Building Code is undergoing general repairs and upgrading for fire safety. Originally, the building was classified as being three-storey (with "grade" based on the average ground elevation). Under the current Code, the building is now classified as four-storey (with "grade" based on the <u>lowest</u> of the average grounds around the building). This means the building would now have to conform to Part 3. This would require the building to be sprinklered.

Solution: A building classified under an earlier edition of the Code as a three-storey should continue to be classified as such. To do otherwise would in effect be tantamount to passing retroactive building codes, and would be unfair to the current owner. Building codes change from one edition to another to reflect the current status of opinions of the technical committees responsible for them. This may or may not be based on better knowledge. Any effort to force compliance with a new edition should only be done on the basis of a demonstrated safety problem and in the spirit of fair play.

Rationale: It would not be practical to require all existing buildings to conform to each new edition of a code. This would make the cost of property ownership prohibitively expensive. Unless it can be proven that an unsafe condition exists, buildings should continue to be classified in accordance with the code that was in effect during construction.

Example No. 14

Subject: Inadequate Egress from Dwelling

Problem: A two-storey house is being renovated to provide an apartment on the upper level. An open stairway connects the first and second storeys, and terminates within the living room on the first floor.

Solution: Since there is only one means of egress from the upper suite, this must be constructed as a private egress facility, separated from the lower suite by at least 0.75 hour. fire separation. In effect, the private egress stairway becomes part of the second floor apartment unit. The egress from the upper unit must also be protected by a fire separation from the stairway to the exterior door. (see "Compilation of Objectives and Reasons", 9.9.9.3.)

Rationale: If the egress is shared, there is a danger that the only egress could be blocked by fire as a result of the actions of the tenant in the bottom storey. Therefore the egress must not be shared and must be completely separated from the lower suite unless a second egress is provided, or other measures taken to ensure safe evacuation of the upper unit in the event of fire.

Example No. 15

Subject: Egress from a Dwelling Unit

Problem: The top storey of a two-storey dwelling is to be converted to a separate dwelling unit. The main stairway is unenclosed and is 900 mm wide. A secondary stairway is only 750 mm wide.

Solution: Both stairways have to be enclosed by a 0.75 hour fire separation to isolate them from the lower dwelling unit. This protection must continue from the foot of each stair to the exterior of the building. The enclosed egress route from the main stair can be a shared egress to serve both units since an alternate escape route is provided from the upper unit. The secondary stairway, although narrower than required for new construction, should be acceptable as a second egress in an existing building. It must also be enclosed to provide a protected egress to the exterior.

Rationale: The minimum width required for stairways serving dwelling units is intended primarily to allow one-way traffic. It is also for the purpose of allowing the movement of furniture (see 'Compilation of Objectives and Reasons", 9.8.3.3.). Since one full width stairway serves the second storey, the secondary stair will only have to serve as a one-way escape route in the event that the main route is blocked. The 750 mm width should be adequate to permit this.

Example No. 16

Subject: Sliding Door for a House Exit

Problem: A two-storey house has a balcony off of the master bedroom with access via a sliding glass door. It is intended to convert the second floor to a separate suite in which the master bedroom would be converted to a living room, and access to the suite would be by means of an exterior stairway from the balcony.

Solution: The existing interior stairway would have to be enclosed with a 0.75 hour fire separation. The separation would also have to provide protection from the foot of the stair to the exterior as well, similar to Problem 15. This egress route could also be shared with the lower unit since the upper unit has a separate route of escape via the sliding glass door.

Rationale: The sliding glass patio door is in an alternate escape route. In an existing building it would not be reasonable to require the owner to replace it with an ordinary swing type door as would be required in 9.9.6.5. even though it is a "required" egress. If, however, the protected escape route via the interior stairs was not shared, exterior stairs from the balcony would not be required.

Example No. 17

Subject: Suite Entrance Doors

Problem: A three-storey hotel is being renovated and the fire safety provisions are to be upgraded. The suite entrance doors consist of 45 mm thick solid wood doors mounted in wood frames, 900 mm wide, with a glazed transom over the door to improve natural ventilation.

Solution: The solid wood doors would probably provide adequate fire resistance, even if they do not conform to current standards. They would be required to be fitted with appropriate self-closing devices. The movable transoms, however, would not be permitted since they would negate the separation between the suites and the public corridor. The transoms should be removed and replaced with appropriate infill such as gypsum wallboard over wood or steel studs to provide the necessary separation.

Rationale: The relatively light fire load in individual suites would probably be contained by most solid wood doors of this thickness. The door closers would be an important addition to control the risk of leaving a door open in the event of a suite fire. Filling in the transom openings would also reduce the risk of suite fires involving the corridor escape route.

Example No. 18

Subject: Egress from Dwelling Unit

Problem: A two-storey mercantile building is being renovated, and is to have an apartment on the upper level. The interior stairway is to be removed to provide additional space. An exterior landing with an unenclosed stairway is to be constructed as the sole exit from the upper storey.

Solution: Since the means of egress from the apartment suite is not shared, this can be the sole means of egress from the top storey if there is no fire exposure hazard from windows in the lower storey mercantile portion. This means that any window in the mercantile portion would have to be protected with wired glass in steel frames if they are within 3 m horizontal distance of the stair (9.9.4.4.). Alternatively, the window could be blocked to eliminate this hazard.

Rationale: Since the stairway is not shared, another tenant cannot render the escape route untenable. The only risk is due to potential exposure from window openings in the mercantile portion below the suite. If this risk is removed, the escape route should be safe. While winter conditions in most parts of the country make exterior stairways a less pleasant option, they nevertheless can be made fire safe.

Example No. 19

Subject: Floor Strength

Problem: A two-storey office building will be converted to a mercantile use. This will change the design live load from 2.4 kPa. (50 PSF) on the second floor to 4.8 kPa. The design load for the first floor is unchanged. The second floor consists of wood joists spanning from the outside walls to a center bearing wall.

Solution: Actual loads in mercantile occupancies can vary widely depending on the merchandise. On the basis of the loads specified in Part 4, however, the second floor would have to be made twice as strong. This can be achieved by removing the ceiling and doubling the joists. Alternatively the joist spans can be reduced by providing additional bearing walls or columns and beams.

The strength of uniformly loaded joists, simply supported at each end, will vary inversely proportional to the square of the span. That is, at half of the span the joists will be 4 times as strong. This provides some latitude in locating the intermediate support if only twice the strength is needed.

Rationale: Solution based on simple engineering principles.

Example No. 20

Subject: Roof Strength

Problem: A building is undergoing general repairs and refurbishing. The roof rafters are over-spanned and there is insufficient nailing between the joists and the rafters to tie the ends together. The roof is noted to have a slight sag along the ridge but in general shows few signs of distress. The building is over forty years old.

Solution: The fact that the roof is over 40 years old probably means that it is strong enough to maintain expected snow loads for some time. Snow loads are quite variable, depending on local sheltering effects, wind currents and surrounding countryside, as well as snowfall for that area. In view of the slight sag along the ridge, it would be advisable to support the ridge at intervals with 38 mm x 89 mm struts, taking the struts down to solid bearing, close to a bearing wall. These should be located 1.2 to 1.8 m apart.

Rationale: One of the best indications of structural adequacy is successful performance over an extended period of time. Unless the structure clearly shows distress, drastic corrective action is not warranted. The inclusion of occasional ridge supports can add considerable strength and costs very little. (see 'Compilation of Objectives and Reasons", 9.23.2.1.).

Example No. 21

Subject: Non-conforming Firewall

Problem: One unit in a semi-detached house is to be converted into an office. The wall separating the units extends from the foundation to the underside of the roof sheathing. It consists of a one hour wood frame fire separation. The Code requires a two hour non-combustible firewall extending from the ground up to the roof to form a 150 mm parapet.

Solution: Install a sprinkler system in the office portion <u>or</u> add a 15.9 mm layer of type X gypsum board to the existing fire separation.

Rationale: Firewalls are intended primarily to limit damage to the property of fire origin. (For life safety purposes, ordinary fire separations would suffice). See 'Compilation of Objectives and Reasons", 9.10.11.1. and 9.10.11.2. (This focuses on one of the Code inconsistencies. Whereas a 1 h combustible separation is permitted between properties in semi-detached and row houses, a two or four hour non-combustible firewall is required in all other cases, regardless of the size of the property). In this case, the existing one hour fire separations should be able to contain a dwelling unit fire to that unit, and would pose little threat to the office portion. The office occupancy has a relatively low fire risk and would pose relatively little risk to the dwelling unit. Any slight risk would be due to the possibility of a slightly higher fire load. This risk can be overcome with the installation of sprinklers. Alternatively, an additional 15.9 mm layer of type X board would add about 40 minutes or so of additional fire resistance which should be adequate to contain a fire in this size of building. The fact that the separation is of wood frame should have little consequence on the fire risk in this instance.

Example No. 22

Subject: Horizontal Addition to Existing Building

Problem: A building constructed under an earlier edition of the Code is deemed to have a number of deficiencies when compared to the current edition. It is proposed to construct an addition to the building (same occupancy class), but there are insufficient funds available to undertake a complete renovation of the entire building. There are no obvious unsafe conditions that need to be addressed.

Solution: Construct the addition so that it does not interfere with the functions of the existing building. That is, it should have self-contained means of egress to the exterior, self-contained services that do not impose a demand on existing services (e.g. heating load, cooling load, electrical load and ventilation). In this case only the extension would have to conform to the current requirements. Otherwise, where, the extension imposes any load on the existing services (including occupant load) the system subject to the additional loads would have to be checked against current Code requirements for adequacy.

Rationale: If the extension is essentially self-contained, it imposes no demands on existing services. If there are no obvious unsafe conditions therefore in the existing building, a general upgrading cannot be justified. Whenever the extension interfaces with the existing building to create an additional load on it, the effect of the new load (including service loads) would have to be evaluated and appropriate remedial actions taken. If the extension causes the total building area to exceed 600 m², however, the extension and the effect on the existing building would fall within the scope of other parts of the Code unless the extension was separated by means of a firewall.

Example No. 23

Subject: Vertical Addition to an Existing Building

Problem: An additional storey is to be added to a two-storey building, having the same occupancy classification as the existing building. The existing two-storey portion was constructed under an earlier edition of the Code and therefore certain aspects do not conform to current requirements. A structural analysis has shown that this additional storey can be safely supported by the existing framing.

Solution: All significant deficiencies in the existing building should be brought into conformance with current Code requirements, with particular emphasis on those aspects involving life safety. In effect the entire building would have to conform to the current requirements for a three-storey building. Minor deficiencies affecting property protection may be forgiven as well as those items having a negligible effect on safety or which are completely unaffected by the new storey. (e.g. existing services that are unaffected and are not used by the addition) Certain existing deficiencies having a direct effect on life safety (such as those affecting the means of egress, compartmentation; flame spread limits) may be acceptable if a sprinkler system is installed throughout the building. The third storey however, would have to meet all of the requirements of the current Code.

Rationale: When an additional storey is added many aspects of the existing building can be affected including the means of egress and existing services used by the addition. In addition, some requirements are based on the number of storeys within the building (e.g. alarm and detection systems, structural, fire protection), and when the number of storeys is changed, the existing building may have major deficiencies in these areas. For these reasons therefore the building should be assumed as a new three-storey building.

Example No. 24

Subject: Horizontal Extension to an Existing Building

Problem: A new wing is being planned for an apartment building originally constructed under an older version of Part 9. A new addition is planned that will increase the building area from 500 m² to 700 m².

Solution: If the addition is not separated by a firewall, the entire building would have to be assessed in relation to Parts 1 to 7 of the Code. The "Guidelines for the Application of Part 3 of the National Building Code of Canada to Existing Buildings" would therefore apply, and the renovation work would not be undertaken in conformance to the Guidelines for Part 9. If, however, a two hour non-combustible firewall is erected between the extension and the existing portion, the extension can be considered to be a separate building and would be within the scope of Part 9. The new construction would therefore have to conform to the current requirements in Part 9. The interface with the existing building would also have to be considered in the case of services or egress facilities (see Example No. 22), and fire fighting access would have to be provided, the same as for a separate building.

Rationale: A firewall, by virtue of its construction makes the extension independent from the existing building so that it can be considered as a separate building in its own right.

Example No. 25

Subject: Inadequate Windows in Basement Suite

Problem: An unfinished house basement is to be converted into a two-bedroom suite. The glass areas in the bedroom portions are 5% of the floor area in one bedroom but only 4% in the other. The glass area in the living room portion is about 4% of the floor area. Neither bedroom window is large enough to permit emergency escape. Basement egress is via a single egress stair leading to an exit shared with the unit above.

Solution: Enlarge the living room window to provide the required 10% glass area. Allow the slightly undersized glass area in bedrooms. Compensate for the lack of adequate sized escape windows by installing wired-in interconnected smoke alarms in each of the bedrooms and in the egress vestibule, and change the shared egress vestibule to a private vestibule for the basement unit.

Rationale: The reduced window glass area in one bedroom, while not desirable, is not considered to be serious enough to require the additional expense of enlarging the bedroom window. Since bedrooms generally do not depend on natural lighting for usability, this is not considered to be a serious deficiency in an existing building. In the case of the living room window, the window has less than half of the required glass area, and would probably not provide a very satisfactory environment for the occupants. This is not primarily a health or safety issue, however, and some latitude for judgment can be exercised.

Lack of emergency escape facilities in the bedrooms, and the fact that part of the single escape route is shared, however, is more serious and has to be addressed. Providing a smoke alarm in the bedrooms and vestibule should provide adequate warning to allow escape while the route is still tenable. Restricting the vestibule to the use of the lower unit should reduce the threat of fire from the upper unit cutting off the only means of escape.

Example No. 26

Subject: Shared Heating System

Problem: An older house is being renovated for general refurbishing, and will have most of its basement converted to a separate suite. The house currently has a gravity warm air oil heating system. It is intended to install a modern heating system to heat both units.

Solution: While a warm air heating system could be used, it is not permitted to circulate air from one dwelling to another (6.2.3.11(2)). Each unit, therefore, would require a separate furnace to serve it. It would probably be more practical to use either a hydronic or baseboard electrical system that could serve both units. This would also avoid the need for fire dampers where ducts penetrate fire separations. If fuel fired units are used, separate the furnace room from the rest of the building by a one hour fire separation (9.10.10.3.(1))

Rationale: Using a common warm air system would not only allow odours and other contaminants to circulate from one unit to another, but would also allow smoke contamination in the event of fire. If a warm air system is used, therefore, each unit should be served by a separate furnace. When a furnace room serves more than one unit the unit is no longer part of one dwelling and 9.10.10.1. does not apply. Therefore it must be separated from the rest of the building unless the floor area is sprinklered.

Example No. 27

Subject: Foundation Wall Cracks

Problem: An office building is undergoing general renovations and repairs. One foundation wall (unreinforeced) has a horizontal crack extending about 1/3 the length of the wall near its mid-height and is about 5 mm wide at its widest part. Another wall has diagonal hairline cracks running diagonally from a window opening extending about one metre down the wall. All walls appear to support excessive heights of back fill in relation to current Code requirements.

Solution: Diagonal hairline foundation cracks are fairly common and are usually related to drying shrinkage. These can usually be ignored. Horizontal cracks usually indicate over-stressed foundations and are potentially much more serious. These can be caused by excessive horizontal pressure, due to an excessive height of backfill, poorly drained soil or hydrostatic pressure. These walls should therefore be strengthened to prevent eventual collapse. There are a number of ways that this can be done, including the installation of vertical structural members, or even the construction of an adequately anchored wood frame wall adjacent to the existing wall. The actual reinforcing details, however, should be determined by a designer competent in this field.

Rationale: An older foundation wall that has withstood backfill pressures for a number of years without distress can be expected to continue to be satisfactory even though the backfill exceeds the height limits specified in the current Code. In such cases corrective action does not appear to be warranted.

Where symptoms suggest a progressive structural failure, however, corrective action is necessary to prevent eventual collapse. Since horizontal soil pressures are difficult to predict with accuracy, the advice of a designer competent in this field should be sought.

Example No. 28

Subject: Multiple Deficiencies Affecting Fire Safety

Problem: An office building is undergoing extensive refurbishing and remodeling. A number of deficiencies have been noted regarding fire safety and means of egress. Some of these can be addressed without to much expensive renovation. Others however involve a significant expenditure that may make the entire project uneconomical. These deficiencies include: (a) inadequate fire separation for public corridor, (b) inadequate fire separation around exit stairs, (c) lack of rated fire doors on suite entrances, (d) open stairway on the first floor, and (f) substandard structural fire protection built into the floor assemblies.

Solution: Install a sprinkler system:

Rationale: In many cases where multiple fire safety deficiencies occur, the most economical corrective measure may well be to install a sprinkler system. A fast response sprinkler system can suppress most fires before they become large enough to pose a serious risk to the occupants. Since office occupancies are relatively low risk to begin with, and do not pose a serious safety risk, the addition of a sprinkler system can more than compensate for many fire safety provisions that do not conform to the Code.

Example No. 29

Subject: Change of Occupancy

Problem: A two-storey office building is undergoing conversion to an apartment building. The building was originally designed as a group 'D" occupancy with office suites on both the first and second storeys. It is not clear to what extent the converted building must conform to current Code requirements.

Solution: If the building is constructed under an earlier edition of the Code, and shows no obvious signs of structural distress, it is probable that it will be satisfactory for a residential occupancy which has a lighter design load requirement and no further structural upgrading would seem to be warranted.

Residential occupancies tend to be more critical than office occupancies from a fire safety point of view. They not only provide sleeping accommodation, but they also generate a variety of activities that create fire risks, such as children playing with matches, smoking and cooking activities.

Primary attention must be given to matters having a direct impact on life safety such as early warning and safe evacuation. Smoke alarms in suites and building alarm and detection systems required by the current Code should be installed. Fire separation of the corridors and exits as well as between suites and around hazardous areas such as storage rooms and furnace rooms should also be brought up to current requirements or other compensating measures taken to reduce fire risk such as installing a fast response sprinkler system. Attention should also be given to upgrading the sound resistance between units where this is shown to be needed.

Since the services required for residential occupancies can be quite different than for group D occupancies, these also should be evaluated in the light of current requirements.

Electrical loads and plumbing requirements, for example, are quite different for residential occupancies. Warm air cannot be circulated from one unit to another so that such heating systems may have to be completely revamped or changed to hydronics or electrical systems. Natural and mechanical ventilation provisions would also have to be evaluated to determine the extent of up-grading required.

It is impossible to give a complete listing of all items that need to be upgraded since this will vary from building to building. A significant element of judgment and common sense is needed to be fair to the owner as well as to ensure the safety of future tenants. Each such case requires a separate evaluation with input from the owner to arrive as reasonable solutions based on compromise.

Rationale: The cost versus benefit equations for new construction are quite different from existing buildings so that it is not reasonable to expect all deficiencies to be corrected to meet current requirements. However, life safety should not be seriously compromised, and particular attention should be paid to matters that have a direct impact on life safety such as early warning and safe escape routes.

Example No. 30

Subject: Change of Occupancy

Problem: A local one-storey general store (with basement) has changed ownership, and is to be converted into an automobile display area for a new car dealer. The building was constructed as a mercantile occupancy under an earlier Code and therefore does not meet all of the requirements in the current Code. The building shows no signs of distress although some maintenance work would be necessary to maintain a good appearance. It is not known to what extent the building should be required to be made to conform to current Code requirements.

Solution: Although the building is structurally sound, the new loading due to a change in occupancy should be assessed by an appropriate designer. Mercantile areas, are generally required to be designed for a higher uniform design load than areas used for parking passenger cars. However, the latter areas have to be designed for a concentrated load as well (4.1.6.10.). This may or may not require the floor to be strengthened to support the expected automobile loads.

With regard to fire safety, since an automobile sales area is usually not subject to as high an occupant load as a mercantile area, exit facilities should be adequate and additional precautions affecting life safety would not normally have to be upgraded unless there is an obvious unsafe condition. General upgrading therefore would not seem to be warranted. Aesthetic appearance is not the concern of a building code, unless this indicates a condition that might affect the health, safety or well being of the occupants or customers. For example, a leaky roof would adversely affect the roof deck and the supporting structure and could eventually lead to structural failure.

Existing services may or may not have to be upgraded, depending on utilization of the space. There would appear to be no special requirements for the proposed occupancy, however, that would warrant a general upgrading.

Rationale: As noted in other examples, it is not reasonable to expect existing buildings built to earlier Code editions to conform to all provisions in the latest edition. In this case, the change of occupancy has been from a higher risk occupancy (due to fire load and higher occupant load) to a lower risk F-3 occupancy. Any existing fire safety provisions deemed acceptable before the change of occupancy should therefore be adequate after the change.

Example No. 31

Subject: Change of Occupancy

Problem: An older house is to be converted into a rooming house. The second storey contains 5 bedrooms and a den to provide accommodation for 6 persons. There are 3 additional rooms on the first floor that will be converted to provide accommodation for 4 additional people. All finish is wood lath and plaster, doors are stile-and-rail construction. One stairway serves the upper floor. The basement is used for a common laundry and storage area, also served by a single stair. The building is generally of sound construction and has a modern forced air heating system in the basement. Since the building was not constructed under current requirements it has a number of deficiencies. It is not known to what extent the building should be upgraded to meet current requirements.

Solution: Even though the building will remain in the same occupancy classification, conversion from a single family house to a rooming house represents a change in occupancy or use, and with this change a number of risks are created due to the addition of 10 boarders. Obviously, however, the building cannot be expected to conform to all new Code provisions since the cost of making all such changes would be prohibitive. However, the roomers are entitled to a safe and healthful environment, and renovation work should concentrate on those aspects which will have the greatest impact in these areas.

Priority therefore must be given to early warning and safe evacuation, and where safe evacuation cannot be assured because of design constraints, compensating measures have to be taken to reduce fire risks.

One means to substantially reduce fire risk to compensate existing deficiencies such as sub-standard door separations, open stairway, dead-end corridor, lack of exit facilities, (all of which have a direct bearing on life safety), would be to install a fast response sprinkler system. In addition, wired-in smoke alarms should be installed in each sleeping room and the hallways that serve them. These should be wired together to sound simultaneously. Also if the basement is unfinished, the undersides of the floor joists should be protected with type X gypsum board to increase its fire resistance. The lath and plaster finish used throughout other parts of the house, however, should provide reasonable fire resistance.

Rationale: While the installation of a sprinkler system is an expensive compensating measure, it is considered justified in this case because of the major deficiencies that could affect the safe egress of the occupants. While lath and plaster does provide reasonable fire resistance, in many older houses, fire stopping may be quite inadequate and there is a possibility of rapid fire spread because of this. Sprinklering would help compensate for this problem.

The sprinkler system while very effective in reducing the severity of fires may not give adequate early warning particularly in the case of smoldering type fires. For this reason, an effective smoke alarm system should be installed.

Alternatively, each deficiency can be evaluated separately and a variety of compensating measures taken to reduce the fire risk and improve the means of egress.

Example No. 32

Subject: Change of Occupancy

Problem: A two-storey building (200 m^2) originally constructed as a bakery is to be converted into a convenience store (first storey), with two apartment suites on the second storey. There are two enclosed interior stairways which are intended to serve the apartments (one per apartment). These have exit doors to the exterior, as well as access to the lower level. The building has loadbearing masonry exterior walls, with post, beam and plank interior construction. It is not known to what extent the building must be brought into conformance with current requirements.

Solution: In this case a building is being converted from one that has a relatively low life risk occupancy (F-2) to one that has a greater life risk (E and C). This additional risk is due to the fact that the top storey will provide sleeping accommodation and will be subject to the normal fire risk activities in most dwellings (e.g. playing with matches, smoking, cooking, repair work, etc.). The mercantile portion also can be higher risk occupancy than the bakery due to a higher occupant load. While the dwellings can cause a property risk to the occupancy below, the principal risk is for the occupants on the second floor, both from their own activities as well as the threat of fire from the mercantile floor. If it is assumed that a sprinkler system is too expensive to install, then the principal concern should be in relation to early warning of fire, and safe means of egress. Containment of fire is also of importance, especially where a sprinkler system is not installed in order to limit the extent of fire damage.

Since the top storey is to be remodeled into two new suites, the construction of such suites should be in conformance with current Code requirements to the extent that new construction is undertaken. This includes wired-in smoke alarms, fire and sound separation between units, and electrical, plumbing, and heating and ventilation services. Structural adequacy should not be a problem in view of the fact that the previous occupancy was a bakery.

Since apartment exits are shared with the mercantile occupancy, either a second means of egress should be provided for each apartment, or the access to the mercantile portion closed off so that each stairway is private to the apartment it serves. This will mean creating new exits for the mercantile portion if these do not exist as separate exits.

The fire separation between the mercantile and residential portion should also be increased to one hour (9.10.9.11.). This would include both exit stairways as well (9.9.4.2.(1)). Supporting elements would also have to have the required rating.

Rationale: As in previous examples, when a change in occupancy results in increased risks, the primary concern is for the safe evacuation of those affected. This is why the exit stairways were made private to the apartments they served. This is to prevent the fire risk from the mercantile portion affecting the sole means of egress for the apartment units. Had the building been sprinklered, there may have been a justification for reducing the level of fire separation between the mercantile and residential occupancies, and possibly allowing shared egress.

Example No. 33

Subject: Basement Leaks

Problem: A suite is to be constructed in the unfinished basement of an older house. Evidence indicates that the foundation wall has been subject to occasional leaking (water stains, efflorescence in a number of areas). Floors also indicate the presence of moisture resulting in efflorescence (i.e. salt crystals) near cracks and dampness underneath rubber mats. The cause of the moisture leakage is unknown.

Solution: Construction of suites should not proceed until source of the moisture problem is known. Most likely causes include improper grade slope away from the foundations, absence of drainage tile, clogged or broken drainage tile, high water table and ineffective dampproofing. One or more causes may be present, and such problems can be exacerbated by the absence of gutters and downspouts to lead roof drainage away from the foundation.

A test hole should be dug near the foundation to confirm the presence of drainage tile and dampproofing and to determine whether or not the tile is filled with silt. A garden hose can be used to see if the tiles are able to handle a flow of water. The test hole can also be used to see if the ground water level is near the footing level. The necessary corrective action will depend on what the site investigation is able to find. This may result in re-grading around the foundation, replacing the drain tile, installing a sump pump, or applying a new dampproofing. (The latter, however, is usually not effective in correcting a serious moisture problem).

If the moisture problem is not serious and does not result in water running down to the floor, it may be possible to correct it from the inside with the use of polyethylene film next to the foundation. If the problem is due to a fluctuating ground water level, it may be possible to control it with the use of a sump pump.

No single solution exists, however, to answer all problem conditions. The most economical solutions will depend on the nature of the problem. Once the problem has been identified, and corrective action taken, construction of the suite can then proceed in conformance with current Code requirements.

Rationale: It would not be prudent to proceed with construction before determining the nature of the moisture problem. If this is not done, it may be found out too late that the solution may not be possible without incurring exceptional expenses. If this is known in advance, the owner may decide to abandon the project before having invested a significant amount of money that would in effect be wasted.

Example No. 34

Subject: Garage Extension to a House

Problem: An attached garage is to be added to an existing detached house so that the garage entry is at the same level as the basement floor. This requires excavating down to the footing level for the garage. The footing tile from the house will then continue around the garage at the same level as the house footing. The garage will be unheated so that the footings must conform to the level specified in Article 9.12.2.2. for foundation walls not enclosing heated space. The wall between the basement and garage is insulated on the house side. The garage footings are below the level of frost penetration from the exterior, but are just below the garage floor. An argument has arisen about the required depth of footings. The soil is not granular and is subject to frost action.

Solution: Since the garage is unheated, frost can penetrate to the footing level from the inside. The house foundation is relatively safe from frost damage because of heat loss from the house. The garage foundation, however, is vulnerable to damage from frost heaving. Since the garage foundation walls are unheated, and since concrete is a relatively good conductor of heat there is a good possibility that foundation damage may result unless measures are taken to prevent it. The garage footings can either be extended downward so that they will be below the level of frost penetration (measured from the garage floor level), or they can be protected by the use of insulation. The simplest solution, would be to protect the garage footings by a horizontal layer of foamed plastic insulation. This should be placed above the tops of the footing at least 300 mm below the slab to prevent crushing from the weight of the car. Heat loss from the driveway adjacent to the garage door can also pose a threat to the foundation. The insulation therefore should also extend outward from the door for a distance of a metre or more, depending on the climate.

The amount of insulation will also depend on climate severity. One rule-of-thumb used is that the thermal resistance should be about one RSI unit for each 800 degree days of freezing. (This would amount to about 50 mm of foamed plastic insulation in the Montreal-Ottawa area, 90 mm in Saskatoon and about 20 mm in the Halifax area). A map of freezing indices is provided in the commentary on Part 9 (P. 96).

Rationale: Even though a foundation may be below the accepted level of frost penetration when measured from the outside, it should be appreciated that when an enclosed space such as a garage or crawl space is unheated, the frost penetration can be from within the space as well. This has resulted in many cracked foundations. In an existing building, a practical method to prevent it is through a judicious installation of insulation.

Example No. 35

Subject: Dormer in a Trussed Roof

Problem: A house is being renovated to give it a more interesting appearance. One alteration is the addition of a dormer to provide a vaulted effect over the entry vestibule. It will require the cutting of three trusses to frame the dormer. The owner wishes to cause as little disturbance as possible to the existing roof frame.

Solution: The portion of the roof where the trusses are cut must be re-framed to compensate for the loss of strength of the three cut trusses. This can be most easily accomplished by re-framing the weakened portion with traditional joist and rafter construction. Conventional joists and rafters should therefore be installed adjacent to the cut truss chord members, (on both sides of the roof), and nailed to them. Where intermediate supports are provided to reduce the span of the rafters, these should be carried down to solid bearing. Trimmer rafters and joists at the sides of the dormer opening should be doubled to carry the load from the cut members, and the ends of the cut joists and rafters supported on doubled headers, securely fastened to the trimmer joists and rafters. In view of the difficulty of nailing the joists and rafters together in a confined space at the lower ends, the ridge in the weakened section should be supported with struts to prevent the spread of rafters under load.

Rationale: Cutting any truss member seriously reduces the strength of the entire truss. When a section of the top or bottom chord members are removed, the damaged trusses will have very little residual strength. Conventional rafter and joist members therefore have to be installed in the portion with the cut joists on both sides of the ridge to compensate for the lost truss strength. These are constructed in the traditional manner as described in Section 9.22.13., and provide the necessary support for roof and ceiling loads.

Example No. 36

Subject: Beam to Support Rafters

Problem: An 'L" shaped addition to a house is to be built to create an open dining area next to the living room. The wall to be removed to create the dining area supports roof rafters and ceiling joists. This must be replaced by a beam to support these loads.

Solution: If the framing in the extension is oriented so that the ceiling joists are not carried on the beam between the house and the addition, the span tables for lintels (9.23.12.A.) in the category 'Roof with or without attic storage" can be used. Although this is no longer an exterior wall, the same loads would be carried as if it were.

If the framing is oriented so that the beam carries additional ceiling loads from the extension, the beam could be overloaded if these tables were used, and the size of the beam would then be determined from calculations.

Rationale: The allowable lintel spans for exterior walls are based on experience rather than theoretical calculation. When the loading condition varies from the traditional practice and imposes an additional load, the beam size must be calculated for the new loading condition.

Example No. 37

Subject: Daycare Dwelling Renovation

Problem: A single family house is being converted so that the owner can provide day care for about ten children in the basement. The upper floors will continue to provide accommodation for the owners.

The basement is served by a single stairway leading to an exterior door, which is the secondary entrance for the house. The basement also contains a furnace and laundry facilities as well as a washroom which will be part of the day care facility.

By definition, the day care facility is an institutional occupancy (B-2) since the children will be quite young. It would require considerable upgrading to conform to requirements for a B-2 occupancy, and would make the conversion impracticable.

Solution: This situation is not clearly dealt with in the Code. While the day care center would be a B-2 occupancy, and therefore not within the scope of Part 9, for practical purposes the risk level is not much different than in a single family dwelling. It would therefore seem to be more realistic to regulate the day care portion as a separate dwelling unit under Part 9.

The prime objective in this case is to ensure that the children can be safely evacuated in the event of fire. This can be achieved by ensuring that staff will be on hand to assist in the evacuation and that the egress path to outdoors will be kept safe during the evacuation period. Staffing of such facilities is regulated either in fire codes or in special laws or acts for such establishments.

The dwelling unit above the day care area does not pose a significant fire threat except where the egress stairway may be affected. The stairway should be isolated from the dwelling unit as well as the laundry and furnace area by a fire separation that will act as a smoke barrier as well. This will also have the advantage of keeping children away from such areas. Typical gypsum board partitions should provide sufficient fire resistance to allow safe evacuation, and doorways should be protected with self closing solid-core doors.

Wired-in smoke alarms should also be installed in the egress stairway as well as the laundry-furnace area and should be interconnected to the dwelling unit alarm so all will sound simultaneously.

Rationale: The early warning system will allow the care givers to evacuate the day care centre while the evacuation route is still tenable. The fire separation should protect the evacuation route until the evacuation is completed.

When a dwelling unit is being renovated to allow an additional usage, the small size of the building and the fact that the establishment is under the operation and control of the owner should be taken into account in specifying which requirements should apply. In many cases, codes have given relatively little special consideration to such situations and a literal interpretation of requirements would cause unnecessary economic hardship and make potentially useful renovations too expensive to carry out.

Example No. 38

Subject: Wheelchair Accessibility

Problem: A zoning change allows a single family house to be converted into a barber shop. The entrance to the barber shop is at the top of a three riser stair. The doorway swings inward, allowing a clear passage width of 780 mm . The washroom is a typical four piece residential type with 710 mm door. To require full conformance with code requirements for accessibility would render the renovation project uneconomical.

Solution: The principal objective in this case is to provide a means whereby a person in a wheelchair can make use of the services of the establishment. It is not unreasonable however to require that the entrance stairway be replaced by a ramp. If there is insufficient space to install a 1:12 ramp, a slightly steeper slope could be permitted (say 1:10). The entrance doorway, although providing slightly less than the required 800 mm clear width, is nevertheless still navigable by a wheelchair. In view of the additional cost of increasing the door width, such a change may not be justified.

The inaccessible bathroom, however, is a more difficult judgment call. This would require not only enlarging the bathroom door, but redesigning the bathroom layout as well. Nevertheless, in spite of the fact that accessible facilities can be relatively expensive to provide in an existing bathroom, an attempt should be made to accommodate wheelchair users. Compromises may be possible to reduce this cost provided the added inconvenience is tolerable to the wheelchair user.

It may be possible to re-hang the bathroom door so that it swings outward and swing 180° so that almost the entire clear opening approaches the 710 mm width of the door. While not as convenient as the 800 mm clear width, it can be navigated by a wheelchair if it has a direct approach with no turns. It is also possible that the nature of the renovations required may make it impractical to provide an accessible bathroom. Each house design is different, however, and may require different compromises to provide an accessible washroom.

Rationale: While wheelchair access to a service such as a barber shop is not a matter of life safety, it is a matter of extreme importance to those who depend on wheelchairs for mobility. It must also be appreciated, however, that modification to an older structure for accessibility can be more expensive and difficult to provide than in a new building. That being the case, compromises between what is desirable and what is manageable have to be made. In some cases accessibility may be ruled out entirely due to the extreme design of the building. In most cases, however, access into the building should be provided, as well as access to sanitary facilities even if the standard of convenience may be slightly lower than the requirements specified in Section 3.7.

Example No. 39

Subject: Heritage Building Renovation

Problem: An old mansion, built before building regulations were enacted is to be conserved as a heritage property. Permission to use the building as a university residence for 12 students has been granted provided that adequate measures are taken to ensure the safety of the occupants. The other condition of use is that appropriate measures will be taken to prevent further deterioration and reduce fire risk.

Solution: The prime objectives in this case are to reduce the level of fire risk, and to ensure that in the event of fire the occupants can be safely evacuated. The secondary, but still important objective is to preserve the architectural integrity of the building, whether due to fire or to structural deterioration. These objectives are usually not easily achieved at low cost, especially where the potential fire risk due to occupancy has been increased, or if the building is in a poor state of repair.

Apart from occupant activity, the principal fire sources are due to heating and electrical systems. These have to be brought up to current safety requirements.

The major fire risk sources, however, are occupant activities such as smoking, cooking and the operation of electrical appliances. These are very difficult to control so that the only effective way of reducing such fire risk is by the installation of a fast response sprinkler system. This should also help compensate for other deficiencies in the structure such as high surface flame spread ratings, lack of adequate fire stopping, and inadequate fire separations between rooms or around exit stairways.

While sprinklers can be of considerable help in reducing fire risk, they cannot be relied upon entirely for this. Provision for early warning of fires that do not set off sprinkler-systems also have to be made. This requires the installation of smoke alarms in all sleeping rooms as well as in the corridor serving such rooms and on each level in the house that does not have bedrooms. These should be interconnected and wired into the electrical system.

Since building preservation is also important, all potential sources of moisture into the structure should be investigated and corrective action taken to prevent such entry. Any telltale moisture signs on the interior surfaces should also be investigated as well such as surface stains, spongy or deteriorating wall finish and efflorescence on masonry and concrete surfaces, as well as signs of wood decay, particularly in basement crawl space and attic areas. Necessary repairs should be made and corrective action undertaken to prevent future moisture problems.

Roof and floor structures should be examined for signs of distress and corrective strengthening carried out where sagging is noted. Foundation walls should be inspected for signs of cracking (horizontal cracks) that indicate progressive structural failures and structural supports added to resist further inward movement where structural distress is noted.

Rationale: The corrective action needed to create an acceptable level of safety in heritage buildings should acknowledge the need for building preservation when selecting a course of action needed to provide a reasonable level of occupant safety. Sprinklers not only compensate for a large number of safety deficiencies in a building, but they are also one of the most effective means to ensure the building will not be destroyed by fire. Ensuring that electrical and heating services needed to meet current standards for safety also reduces the risk of fires and add to the safety factor.

Since life safety must always be the prime objective in building regulation, early warning devices are also necessary to ensure that the occupants are alerted at an early stage of the fire so they can be evacuated while the escape routes are still tenable.

Finally it may be noted that moisture is the main ingredient in the deterioration of a building over a period of time. If moisture entry points are sealed to prevent rain from entering, and room air leakage into the building envelope is controlled, deterioration of most traditional building materials can be significantly slowed or stopped.

As with most cases of renovation, however, the solutions should be tailored to the conditions found in the building since no two buildings are exactly the same.

Example No. 40

Subject: Substandard Exit Stairs

Problem: A suite is to be constructed in the basement of a two-storey office building. There is only one access stairway to the basement and this is to serve as an egress stairway from the suite as well as a service stairway for the remainder of the basement which is used as a furnace room and for general storage. The stairway has a minimum headroom of 1930 mm at the bottom of the stair, and a width of 860 mm. The stair has a riser height of 215 mm and a run of 230 mm . The stair has a 25 mm nosing, giving a tread width of 255 mm . The stair is constructed out of cast concrete and cannot be rebuilt without considerable cost and inconvenience.

Solution: Since the stairway serves the general storage area as well as the suite, it cannot be regarded as a private suite stairway. In a new building it would have to conform to the requirements for public stairs. Since the stair is so difficult to change, however, some compromise would seem to be in order.

One of the most serious deficiencies is the headroom clearance which is 75 mm too low (see "Compilation of Reasons and Objectives" 9.8.3.4.). There is a possibility that persons using the stair will suffer injuries because of the low headroom and this should be remedied. One possible solution would be to chamfer the corner of the ceiling at the stairway soffit to provide 50 to 75 mm flat surface to reduce the sharpness of the corner and reduce the risk of injury. This chamfer could also be covered with padding and a sign posted near the low point to indicate low headroom.

While the width of the stairway is 40 mm too narrow (9.8.3.3.), this does not present a life risk since it is adequate to handle the suite occupant load during evacuation. Although it would be less convenient for every day use, and for the movement of furniture, the narrower width is considered acceptable in view of the high cost of enlarging it in this case.

Although riser height is slightly higher than permitted, this is not too serious. The run and tread width are slightly larger than required so that the stair steepness is about the same. Again, in view of the cost of changing the existing stair, no change would seem to be warranted.

Rationale: The cost of making a proposed change has to be considered in weighing the need to up-grade to increase safety. Where a significant hazard exists as in the case of the headroom, it has to be dealt with. However, where the change involves convenience rather than life safety in the case of the stair width, some relaxation can be considered. Riser height, while important for those with walking difficulties, was not sufficiently higher than permitted for new construction.

Example No. 41

Subject: Fire Alarm Systems

Problem: A two-storey warehouse is to be converted into a factory outlet clothing store. The proposed store will house a retail area of about 500 m² on each floor, including the basement. As a warehouse, an alarm system was not required. The change of occupancy, however, would increase the occupant load to about 400 persons so that an alarm system would be required (9.10.17.2.).

Solution: The purpose of the alarm system is to provide a warning for the building occupants of the presence of fire so that the building can be safely evacuated before the egress routes become untenable (see 'Compilation of Objectives and Reasons", 9.10.17.2.). In this case the building occupant load is 33% above the threshold limit for an alarm system. In this conversion the owner would be required to install the alarm system, or to reduce the occupant load to 300 persons (e.g.. close off one floor level). If the occupant load had only been slightly above the 300 value (say within 10%) this violation could probably have been tolerated provided all other aspects to ensure safe evacuation were conforming.

Rationale: The provision of a warning system in a building with a relatively high occupant load is considered to be an important life safety feature. There is, therefore, little justification to omit this feature just because the building is an older building. The cost of installing such systems is not appreciably greater in an existing building than it would be in a new building. Therefore the tolerance level above the triggering occupant load should be relatively low.

Example No. 42

Subject: Inadequate Exits

Problem: An older house is being converted into offices. The top and bottom floors will be rented as separate suites, and both suites will share a common reception space on the ground floor near the main entrance.

The second floor office has a single egress stairway, open on one side to the reception area, and enclosed on the other by a wall. Egress from both suites is through the common reception area. The lower suite also has a second egress door.

Solution: Office occupancies are considered to be relatively low risk and individual suites do not have to be separated from one another (9.10.9.13.). Furthermore, open stairways are permitted in buildings up to 2-storeys in height for such occupancies (9.10.1.6., 3.2.8.2.(b)). While having an enclosed exit stairway from the upper suite would be desirable, an open stairway in this case would be acceptable.

Rationale: When office conversions are made in small residential buildings such as this, the risk presented by the new occupancy is actually less than for the original occupancy because the sleeping accommodation is no longer necessary. Therefore, few if any additional safety features have to be provided to ensure a reasonable level of safety.

Example No. 43

Subject: Ventilation

Problem: An apartment building constructed under an earlier code is undergoing renovation for energy conservation purposes. The building is heated by a perimeter hot water system. Each unit has a bathroom exhaust fan but no kitchen exhaust. It is planned to replace existing windows with modern air tight windows and to re-caulk the entire building to reduce air leakage. Walls and ceiling will be re-insulated. The expense of providing a new ventilation system to conform to current Code requirements would make the renovation project uneconomical.

Solution: The addition of new windows and caulking will reduce natural ventilation due to leakage which has to be corrected by additional mechanical ventilation during the heating season when the windows are closed.

The new ventilation requirements specify a ducted ventilation system with both intake and exhaust fans interlocked to operate simultaneously to prevent excessive pressurization or depressurization. Incoming air would also have to be re-heated before distribution to prevent uncomfortable drafts.

The new ventilation requirements cannot be met without significant additional costs when applied to an existing building that does not have a warm air duct system. To avoid excessive costs, therefore, considerable latitude should be allowed in renovations to the ventilation system. Since a duct distribution system for ventilation as required in 9.32.3.7. is fairly expensive, a less elaborate system therefore should be considered.

Installing an additional kitchen exhaust fan to supplement the existing bathroom exhaust fan, for example, would help to compensate for the additional air tightness due to the renovation work. A dampered opening to the exterior to provide make-up air for the exhaust fans should ensure a reasonable supply of fresh air for the occupants. This should preferably be in a location where uncomfortable drafts would not be created if the air is not to be preheated. The total rate of ventilation should conform to Article 9.32.3.3.

Rationale: Restraint should be exercised in applying requirements designed for new construction to existing buildings, particularly where new requirements represent a departure from previous Code requirements. The principal objective of the requirement should be kept in mind, however. As long as a sufficient supply of fresh air is provided to attain a healthful environment, the principal objective of the Code has been satisfied.

Example No. 44

Subject: Conversion to an Old Age Home

Problem: A two-storey walk-up hotel is being converted to an old age home. No nursing care is provided and most tenants will be ambulatory. The hotel had been equipped with heat detectors in each suite and in the corridor. A fire alarm system had been installed under an earlier Code when the hotel was built. There is some question regarding the degree of upgrading that may be required under the current Code.

Solution: Since no special nursing care is being provided, the major occupancy classification has not been changed. It is still group C, residential. However, the use of the building has been altered and this fact justifies a review of the safety aspects of the building as well as its accessibility. One of the most important considerations is the provision of early warning to enable evacuation while the escape routes are still tenable. While heat detectors are reliable, they may not be sufficiently fast acting to achieve this objective (see 'Compilation of Objectives and Reasons", 9.10.17.2. and 9.10.17.3.). In this instance the need for smoke alarms in the escape route are especially critical since older people can be expected to be slower both in response to alarms and evacuation. Heat detectors within the suites, while considered to be acceptable in some earlier Codes, are no longer considered to provide sufficient early warning of fire within a suite. Wired-in smoke alarms should be provided in each suite. (see 'Compilation of Objectives and Reasons", 9.10.18.1. and 9.10.18.2.)

To protect the occupants during the evacuation period, the escape route should be fire separated from adjacent rooms for the required period, and the travel distance should not exceed that specified in the current Code unless other safety measures are provided to compensate for the added risk (e.g. provision of sprinklers).

Since some tenants will be wheelchair users or need other walking aids, accessibility is also an important need for the altered occupancy. This will entail accessibility for wheelchairs from the parking lot to an entrance, and from the building entrance to each suite on the ground floor. The bathroom door in each suite should also be made wide enough to allow the entry of a wheelchair.

Rationale: Even though a change in major occupancy classification has not occurred, the difference in actual use has to be considered in reviewing the need for upgrading safety facilities. In this case although no special care is given to the occupants, the fact that they are of an older age has to be taken into consideration in the building evaluation in order to make changes to maintain a reasonable standard of safety. Accessibility is also a priority to an occupancy such as this to ensure that the building occupants can make use of the available facilities.

Example No. 45

Subject: Roof-ceiling Repair

Problem: Tenant complaints in an apartment building have led to an order to repair a problem resulting from water damage to a ceiling.

Several tenants on the top storey experienced extensive staining and water damage to the ceiling during the spring, after a rain. A roof inspection revealed a very springy roof deck over much of the roof indicating possible deterioration of the roof deck. Ponding of water was also noted in several places. The roof is flat, with insulation between the joists and ventilation above the insulation.

Solution: It is sometimes difficult to differentiate between problems resulting from a build-up of winter condensation, and those resulting from roof leaks. In this case either one or both may be occurring. A fairly extensive pattern of ceiling stains or leakage that occurs only in the spring would indicate a condensation problem. A problem that occurs throughout the year would indicate a failure of the roofing.

Since the roof deck has apparently deteriorated and in all probability will continue to do so, it must be replaced as well as the roofing. This will provide an opportunity to inspect the framing as well; and allow any significantly decayed members to be reinforced with new joists. In addition, the adequacy of the venting above the joists can be inspected for conformance with current requirements and corrective action taken. Since ponding is occurring on the roof (which could also be a factor in the problem), the new roof surface should be provided with the appropriate slope (or the low points provided with roof drains). Rafters can be sloped by nailing tapered members to the tops of the roof joists. Cross purlins may also have to be added to improve ventilation if there is insufficient space above the insulation. Roof vents would also have to be checked against current requirements.

Whether or not the ceiling would have to be replaced in whole or in part would depend upon signs of significant deterioration. The presence of stains alone however would not necessarily indicate this.

As an alternative solution, the insulation could be removed and foamed plastic insulation applied above the roof deck. In this case, the vent openings into the space have to be sealed with caulking. This sealing has to be effective to prevent cold outside air from bypassing the insulation. In any event the roof surface would also have to be sloped or provided with drains to prevent ponding of water.

Rationale: The stains and ceiling deterioration are merely indicators of other problems relating to condensation or roof leakage or both. It would be of little purpose to treat these symptoms cosmetically without getting at the root of the problem. Since the roof deck has to be replaced, this gives the opportunity to inspect the interior of the roof and ensure that requirements affecting vapour barriers, air leakage paths, ventilation and roof drainage can be brought up to current requirements. (It should be noted that areas of springiness in the roof deck can be spot checked to confirm deterioration by removing portions for inspection before the entire roof is removed).

Example No. 46

Subject: Winder Stairs in Exits

Problem: The top floor of a two-storey house is being renovated to provide a separate suite. The only egress from the suite is an enclosed stairway leading to a foyer shared by the lower suite. The stairway in a typical house stair with three 30° binders at the bottom. Although winders are not permitted in an exit stair, it would be very difficult to change the stairway to eliminate them. The foyer is of questionable safety as well since a fire in the lower suite could make the only escape path untenable.

Solution: Although the exit stair is non-conforming in that it contains risers, the main concern is that it provides the only escape path for the upper unit. One solution would be to completely separate the foyer and stairway from the lower unit with the required fire separation and to eliminate the lower unit egress through it. In effect the foyer and stairway would be considered as being part of the upper unit and would be permitted under the Code, even with the risers.

A reasonable alternative solution would be to provide an early warning system that would allow the upper unit to be evacuated while the egress route is still tenable. A wired-in alarm in the vestibule, interconnected with an alarm in the upper unit would provide this. In addition a proper fire separation for the stairway and vestibule would also be required, including a self-closing solid core door from the lower unit into the vestibule.

Rationale: The current Code permits a single exit from a dwelling when it is an exterior door located near ground level. If the vestibule is not shared it can be considered as being part of the upper unit provided the stairway and vestibule are fire separated from the lower unit. In this case the exterior door is the exit facility and not the stairway. If this is not a practical solution, the alternative would be to provide sufficient warning to allow safe evacuation and to provide a sufficient fire separation to protect the exit during this period. The stairway in this case would be a non-conforming exit due to the risers, but since it serves only one unit, this is not considered to be any different in risk than any other stair in a dwelling.

Example No. 47

Subject: Exit Doors into Stairwells

Problem: The third floor of a mercantile building is being renovated to create four office suites intended for rental. These are served by an unrated corridor that leads to a stairway at each end of the corridor. The building was constructed under an earlier municipal code that permitted exit doors without latches for ease of operation. Although the doors are self- closing and metal clad, they are glazed with ordinary glass panes with an area of 0.90 m^2, the same as the exit doors on all other floors. The exit doors are deficient on three counts. They do not provide the required fire resistance, the glass area is excessive and the doors have no latches. The inspection has shown that not only are the exit doors deficient on the floor being renovated, but on all other floors as well.

Solution: Even though the change in occupancy is to one of reduced risk, an unsafe condition (use of plain glass in exit doors) has been noted on floors that are not renovated. This should be corrected on all floors unless there is a mitigating factor such as a sprinkler system. The degree of hazard would then be deemed to be within tolerable limits for a building constructed under an earlier Code. With no sprinkler system however, all doors should be upgraded. All doors should be fitted with latch hardware, and the ordinary glass panes replaced with wired glass. Although the glass area would be slightly larger than permitted (i.e. 0.9 m^2 rather than 0.8 m^2) this is not considered to be of critical importance. The exit way would be subjected to slightly more radiation in a fire, but the glass should stay intact a sufficient length of time to allow escape and confine the fire to the storey of origin until fire fighting can start.

Rationale: Even though only one floor was directly affected by the renovation work, any flagrant unsafe condition should be corrected during any renovation work. Exit doorways that would not confine a fire to the storey of origin long enough to permit a safe evacuation would fall in this category. Although minor infractions such as a slightly larger glass area could be tolerated, the use of ordinary glass in an exit door in an unsprinklered building or the absence of latches would not. (see 'Compilation of Objectives and Reasons", 9.9.4.3., 9.10.13.9.)

Example No. 48

Subject: Sound Transmission

Problem: A 1-storey motel built over a crawl space is being converted to a senior citizens residence. No special nursing care will be provided. Each unit is to be self contained although a central dining room is also available. The units are served by a central corridor. Construction consists of wood framing, 400 mm o.c., with 15.9 mm gypsum board finish. The sound transmission class (STC) rating is estimated at 32 between units and in the corridor walls. This is considerably below the STC 50 required in Article 9.11.2.1.

Solution: Lay carpeting in the corridors if it is not already installed. Fill the walls between the units with mineral wool insulation. Apply a layer of 15.9 mm gypsum wallboard to one side of each wall over resilient channels.

Rationale: Improving sound resistance in an existing building is considerably more expensive than in new construction. Considering that sound resistance does not affect life safety, and that senior citizens' housing generally generates less noise than housing for younger people, a compromise solution would seem to be justified.

There would seem to be little to be gained by increasing the sound resistance of corridor walls since the presence of the suite doors and the cracks around them generally determine the general level of sound resistance. Carpeting the corridors, however, reduces considerably the footstep noise generated there and should increase the level of acceptability.

Adding insulation to the walls between units should increase the STC level from 32 to about 36. This would be barely perceptible. If, in addition, however, a layer of wallboard is added to one side of each partition over resilient channels, the STC rating would probably increase to about 45 to 50. This would seem to be a reasonable level for most people.

Example No. 49

Subject: Alarm Systems

Problem: A two-storey office building is being converted into a college dormitory with 6 suites on each of two storeys. The suites are served by a corridor with 2 exit stairways. Under the previous occupancy, no alarm system was required, but is required under the new occupancy (Group C). Smoke alarms will be provided in each sleeping room. In view of the anticipated problems with false alarms, it is proposed not to install an alarm system as required in 9.10.17.2. Egress (i.e. exit stairs and corridors) has been judged to be satisfactory in terms of fire separation and travel distance.

Solution: Install smoke detectors in each hallway and stairway, and heat detectors in the service room and storage room, all connected to a building alarm system.

Rationale: The Code requires an alarm system where more than four residential suites share an exit facility. In this case six suites share a public corridor and twelve suites share the stairs, making a building alarm system necessary.

The objective of the alarm system is to warn all the occupants at an early stage of fire so that evacuation can take place before the major egress paths are made untenable. (see 'Compilation of Objectives and Reasons", 9.10.17.2.) If false alarms occur with any frequency, the objective of the alarm system is defeated, and it will be ignored by the occupants as a signal for evacuation. In this case, reliance on the alarm system activated by the smoke and heat detectors appears to be a reasonable decision, particularly in a building of this size, and permission to dispense with the manual alarm stations would be in order.

Example No. 50

Subject: Relocation of a House

Problem: An owner has relocated a house from another community on a new foundation constructed under current requirements. Although the house is generally sound, it was constructed under a much earlier Code and therefore does not conform to current requirements in a number of areas.

Solution: There are obvious areas where the relocated building must conform to current requirements such as the new foundation, basement columns and any new heating system. However, it would be unrealistic to require all aspects of the house to conform to new requirements. As a generalization, only those structural elements that show signs of distress need be strengthened. Obviously, a general inspection should be made if those elements that can be easily seen, such as the roof rafters and roof sheathing and the first floor joists. Those showing significant decay or structural damage should of course be reinforced. Since the interior finish has structural functions in a building, it should be repaired as necessary to perform its functions (see 'Compilation of the Objectives and Reasons", 9.29.1.1.).

When a building has been able to withstand snow, wind and occupancy loads for a significant period of time without distress, there is little reason to suspect they will not continue to do so and can be considered to meet the structural requirements of the Code under the general provisions in 2.5.1.3. Where structural distress is indicated, the appropriate parts have to be reinforced.

The building should also be inspected for signs of water entry into the structure, either as a result of condensation or rain leakage. Telltale signs such as water stains, decay, or softening or sagging of the interior finish should be investigated further to determine reasonable corrective action. Visual examination of the condition of the roofing, flashing and siding, including caulking should be carried out as well and corrective action taken as necessary.

The obvious sources of potential fire such as the electrical system, fireplace, chimney, cooking range and heating system also should be inspected for general safety including required clearances, and appropriate corrective action taken when indicated.

Rationale: It is obvious that an older house cannot be made to conform to each code article that may have been changed since the house was first built. The house must be evaluated in terms of its experience in adequately resisting occupancy loads and loads due to wind and snow.

Of particular importance, however, are potential sources of fire such as the electrical, heating and cooking facilities including venting and clearances. Probably the most significant factor in the deterioration of a building is the presence of moisture in the structure either as a result of rain leakage or from condensation. If these are prevented, buildings in most cases will last indefinitely if they are structurally adequate to begin with.

Appendix A

Requirements for the Regulation of Existing Buildings under Part 9 of the National Building Code

Introduction

This proposed new Section 9.36. "Existing Buildings" is intended to elaborate on how the scope of the NBC is intended to be applied to existing buildings that fall within the scope of Part 9.

This proposed new Section 36 is intended to be used in concert with Chapters 1 to 3 of this Guide. Chapter 1 describes the principles by which the NBC should be applied to existing buildings. Chapter 2 describes the objectives of each Article in Part 9, and Chapter 3 is a compilation of typical problems that arise in applying the NBC to existing buildings along with suggested solutions.

Section 2.5 of the Code gives general direction on allowing equivalents, and applies to existing buildings as well as new construction. This "Guide" may be considered to be an elaboration of NBC Section 2.5. as it applies to existing buildings in Part 9.

This proposed Section 9.36. makes reference to the Guide for determining the objectives of Part 9 and for alternative measures to meet the intent of the NBC. It, therefore, provides a link between the NBC and the Guide.

The overall objective of this proposed new Section is to facilitate the recycling of existing buildings. Its purpose is to permit alternative solutions to be used when it is impracticable to apply the requirements for new construction to existing buildings. The overriding concern however, is for the health and safety of the occupants, and these are not intended to be significantly compromised by alternative design solutions. Requirements affecting property protection, while important, are permitted to be less restrictive in existing buildings if this can be justified on the basis of costs and benefits. This is to permit the renovation of existing buildings without causing undue economic hardships. Excessive costs can in fact discourage rehabilitation, and may prove in the long run to be counter productive in the maintenance of reasonable standards of health and safety.

Each existing building has its own unique characteristics which must be evaluated in the light of any proposed change of occupancy or renovation. This requires that the application of Code requirements be flexible to allow alternative solutions.

Proposed Requirements for Part 9 of the National Building Code

Section 9.36. Existing Buildings

9.36.1. Application

9.36.1.1. Scope. This Section applies to existing *buildings* undergoing renovations, or a change of *occupancy*.

9.36.1.2. Renovation. In this Section, the term "renovation" shall include repair, refurbishing, alteration, additions, and rehabilitation.

9.36.1.3. Building Size. Where a *building* is extended in height so that the *building height* exceeds three *storeys*, or extended in area so that the total *building area* exceeds 600 m^2, the *building*, including the renovation shall conform to Parts 1 to 8 of this Code.

9.36.2. General

9.36.2.1. New Work. All new construction in renovation work, including electrical, mechanical and plumbing services shall conform to the appropriate requirements in Sections 9.1 to 9.35. in this Part for new *buildings*.

9.36.2.2. Replacement. Except as provided in Article 9.36.2.3., materials, systems or equipment to replace existing materials, systems or equipment shall conform to the same requirements as for new construction.

9.36.2.3. Heritage Buildings. Where a *building* has been declared by the municipal or provincial authority as a heritage *building*, renovation work may be carried out to match existing work, provided such work does not create a safety or health risk.

9.36.2.4. Old Regulations. Except as otherwise specifically required in this Section, where it can be shown that a *building* undergoing renovation conforms to *building* regulations in effect during its construction, the existing portions shall not be required to be made to conform to current requirements for new *buildings*.

9.36.2.5. Non-Conforming New Work. The provisions of this Section for existing *buildings* shall not be used to justify non-conformance with the requirements in Sections 9.1. to 9.35. for new construction.

9.36.2.6. Increasing Non-Conformance A portion of an existing *building* that does not conform to the requirements of Sections 9.3. to 9.35. shall not be modified in a manner as to cause further deviation from such requirements.

9.36.2.7. Barrier-Free Path. When a *building* is undergoing renovation or a change of *occupancy*, the requirements for a *barrier free* path of travel in Section 9.9 shall apply to the extent that this is practicable and reasonable.

9.36.3. Health and Safety Assessment

9.36.3.1. Maintaining Health and Safety. No renovation work or change of *occupancy* shall be carried out that will cause the existing level of health and safety to be decreased, or the fire risk to adjacent property to be increased.

9.36.3.2. Change of Occupancy. Except as provided in Article 9.36.3.6. when the *occupancy* of a *building* or part of a *building* is changed, all reasonable measures shall be taken to ensure that the *building* will meet the performance objectives of this Part in those portions affected by the change of *occupancy*.

9.36.3.3. Renovation. Except as provided in Article 9.36.3.6. when a *building* is renovated, all reasonable measures shall be taken to ensure that those portions affected by the renovation, either directly or indirectly, meet the performance objectives of this Part.

9.36.3.4. Performance Objectives. In determining the performance objectives as required in Articles 9.36.3.2. and 9.36.3.3., Chapter 2 of the "Guide for the Application of Part 9 of the National Building Code to Existing Buildings" shall be used as a reference.

9.36.3.5. Alternative Solutions. **(1)** In determining the measures needed to ensure that a *building* undergoing renovation or a change in *occupancy* will meet the performance objectives of this Part, Chapter 1 and 3 of the "Guide for the Application of Part 9 of the National Building Code" shall be used as a guide.

9.36.3.6. Compensatory Measures. When it is not practical to meet one or more of the performance objectives of this Part, appropriate compensatory measures shall be taken to maintain reasonable levels of safety and healthful conditions for the occupants.

9.36.3.7. Rationale. When it is necessary to take compensatory measures to maintain reasonable levels of safety and healthful conditions as permitted in Article 9.36.3.6., the rationale for selecting such measures shall be provided in sufficient detail to permit a reasonable evaluation of the alternative measure to be made.

9.36.3.8. Unsafe Conditions. When a *building* is undergoing renovation or a change of *occupancy* and an *unsafe condition* is discovered, corrective action shall be taken to remove the *unsafe condition,* regardless of whether or not it is due to the renovation or change of *occupancy.*

9.36.4. Emergency Evacuation

9.36.4.1. Existing Deficiencies. Where compensatory measures are necessary because of *building* deficiencies affecting fire safety or *means of egress,* appropriate measures shall be taken to ensure that all occupants can be evacuated safely in a fire emergency.

9.36.4.2. Safe Evacuations.

(1) Measures to ensure safe evacuation in Article 9.36.4.1. shall include one or more of the following measures, as appropriate for the *building* undergoing renovation work or a change of *occupancy*:

(a) automatic *smoke detector* and alarm systems to provide early warning of smoke contamination of the evacuation route,

(b) wired-in *smoke alarm* systems within *suites* where occupants may be sleeping,

(c) alternate escape routes,

(d) isolation of escape routes by *fire separations* to provide fire and smoke protection for the occupants for the time estimated to ensure complete evacuation of the *building,*

(e) isolation of *suites* of *residential occupancy* from one another by *fire separations* that will provide fire and smoke protection for the occupants for the time estimated to be needed for the complete evacuation of the *building,*

(f) isolation of hazardous areas such as communal storage areas and furnace rooms by *fire separations* that will contain a fire hazard until the *building* is completely evacuated,

(g) automatic fire extinguishing systems to reduce the potential size of a fire and lower the overall fire risk.

9.36.5. Estimating Fire Resistance

9.36.5.1. Ratings.

(1) Where an existing *building* assembly is required to have a *fire resistance rating* which cannot be determined in conformance with Section 9.10., the rating may be

determined from one of the following publications:

(a) "Fire Endurance of Protected Steel Columns and Beams", National Research Council of Canada, NRC 8379, Ottawa, April 1965.

(b) "Fire Endurance of Unit Masonry Walls", National Research Council of Canada, NRC 8740, Ottawa, October 1965.

(c) "Fire Endurance of Light-Framed and Miscellaneous Assemblies", National Research Council of Canada, NRC 9085, June 1966.

(d) "Fire Endurance of Concrete Assemblies (a compilation of published information on fire endurance of a variety of concrete walls, floors, roofs, columns and beams)", National Research Council of Canada, NRC 9279, Ottawa, November 1966.

(e) "Fire Endurance of Door Assemblies", National Research Council of Canada, NRC 9736, Ottawa, September 1967.

(f) "Guidelines on Fire Ratings of Archaic Materials and Assemblies, Rehabilitation Guideline No. 8., U.S. Department of Housing and Urban Development.

9.36.6. Structural Adequacy

9.36.6.1. Support Strength. Where a *building* is increased in height, evidence shall be provided to show that the supporting structure has sufficient strength to support safely the additional *storey* or *storeys* and their associated *live loads*.

9.36.6.2. Horizontal Additions. Where a *building* is extended horizontally by an addition, structural members at the interface between the addition and the existing *building* shall be designed to support safely any additional loads caused by the addition.

9.36.6.3. Increased Floor Load.

(1) Where a change in *occupancy* causes an increase in the design floor load, a structural analysis shall be provided to determine

(a) whether the floor and its supporting structure need to be strengthened, and

(b) the measures that must be taken to ensure that the members will not be overloaded.

9.36.6.4. Strength Reduction.

(1) If, during renovation, a *building* is altered so that the strength of any structural member or assembly is reduced, a structural analysis shall be provided to determine

(a) whether the affected construction has sufficient strength to sustain the anticipated loads, and

(b) the measures to be taken to ensure the member or assembly will not be overloaded.

9.36.7. Correction of Damage

9.36.7.1. Decayed Members.

(1) Where a structural element in a *building* undergoing renovation or a change of *occupancy* shows signs of significant decay as a result of rain leakage, excessive humidity levels, ground moisture or other cause, corrective action shall be taken to

(a) strengthen or replace the damaged members, and

(b) prevent a recurrence of the problem.

9.36.7.2. Overload Damage. Where a roof or floor system in a *building* undergoing renovation or a change of *occupancy* shows signs of previous serious overloading such as the presence of damaged structural members or significant sagging, the system shall be strengthened to carry the anticipated design loads.

9.36.7.3. Damaged Foundation. Where a foundation wall in a *building* undergoing renovation or a change in *occupancy* shows signs of being subjected to excessive horizontal earth pressure, such as the presence of extensive open horizontal cracks, the foundation wall shall be strengthened to prevent continued inward movement by the use of cross walls, buttresses or other suitably designed structural members.

9.36.7.4. Wet Basements. Where a habitable *basement* in a *building* undergoing renovation or a change in *occupancy* shows signs of water leakage or excessive ground moisture penetration as a result of improper surface water drainage, wet soil conditions or lack of adequate subsurface drainage, corrective action shall be taken to prevent a recurrence of such problems.

9.36.7.5. Damaged Finish. Where the interior finish in a *building* undergoing renovation or a change in *occupancy* has been significantly damaged as a result of impact forces, water leakage or excessive humidity levels, the damaged finish shall be repaired or replaced, and corrective action shall be taken to prevent a recurrence of such problems.

9.36.7.6. Damaged Masonry. Where above-grade *masonry* in *buildings* undergoing renovation or a change in *occupancy* shows signs of significant structural deterioration such as from cycles of freezing and thawing in the presence of excessive moisture, corrective action shall be taken to repair the damage, and to prevent a recurrence of the problem.

9.36.8. Additions

9.36.8.1. Shared Exits. Where vertical or horizontal additions to a *building* relies on the *exit* facilities of the existing *building* for part or all of its *exit* facilities, the portion of the *exit* system serving the addition shall conform to the current requirements for new construction.

9.36.8.2. Shared Services. Where one or more building services in an extension to an existing *building* share the services of the existing *building*, the entire shared service shall conform to the current requirements for new construction.

9.36.8.3. Shared Construction. Where one or more elements in an existing *building* rely upon, or are directly affected by an extension to an existing *building*, such elements shall conform to the current requirements for new construction.

9.36.8.4. Existing Alarms. Where the existing *building* is served by a *building* alarm system, any addition to the *building* shall also be served by the alarm system.

9.36.8.5. Existing Sprinklers. Where an existing *building* is *sprinklered*, any additions to the *building* shall also be *sprinklered*.