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Best Practice Guide on Fire Stops and Fire Blocks and their Impact on Sound Transmission

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June 2007

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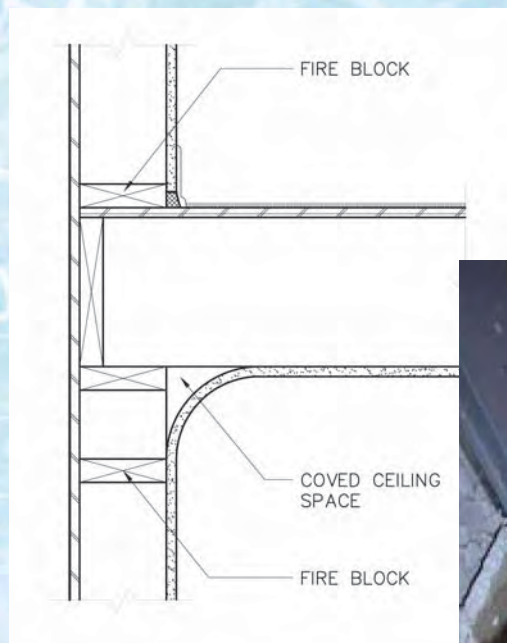
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J.K. Richardson, J.D. Quirt, R. Hlady

**BEST PRACTICE GUIDE ON FIRE STOPS AND FIRE BLOCKS
AND THEIR IMPACT ON SOUND TRANSMISSION**

Prepared For

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Fire Stop Technologies

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June 2007

DISCLAIMER

The analysis, interpretations, and recommendations in this Guide are those of the authors and do not necessarily reflect the views of the Special Interest Group on Suitable Acoustic and Fire Stop Technologies or those organizations that assisted in the preparation, review and publication of the document.

Care has been taken to review the literature summarized in this Guide. Neither the authors nor the Special Interest Group warrant or assume any liability for the accuracy or completeness of the text or drawings, or their fitness for any particular purpose. It is the responsibility of the user to apply professional knowledge in the use of the information contained in the drawings and text, to consult original sources, or when appropriate, to consult a qualified design professional.

BEST PRACTICE GUIDE ON FIRE STOPS AND FIRE BLOCKS AND THEIR IMPACT ON SOUND TRANSMISSION

**(A Publication of the Special Interest Group on Suitable
Acoustic and Fire Stop Technologies)**

PREFACE

The production of the Best Practice Guide was organised by the National Research Council of Canada (NRCC) and Ken Richardson Fire Technologies Inc. (KRFT). Unless otherwise indicated, all drawings have been provided by Affinity Fire Stop Consultants Inc.

This Best Practice Guide is based extensively on a document from The City of Calgary entitled “Fire Stopping Service Penetrations in Buildings”, and the authors extend their appreciation to the City for making the document available and for assistance in development of this Guide.

Critical review of the content of the Best Practice Guide was the primary focus of the Special Interest Group on Suitable Acoustic and Fire Stop Technologies (SIG-SAFT). This Special Interest Group (SIG) was made up of stakeholders, who provided financial and in-kind support for the project, as well as regulators and standards developers. The SIG provided review and comment on draft documents to NRCC and KRFT throughout the production process. A formal ballot of SIG members confirmed acceptance of the final content.

The organizations and individuals comprising SIG-SAFT are:

<u>Organizations</u>	<u>Individual</u>
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A/D Fire Protection Systems	Don Falconer
Affinity Fire Stop Consultants Inc.	Rob Hlady
Bibby Ste. Croix	William Monaghan
Canada Mortgage and Housing Corporation	Barry Craig
Canadian Copper and Brass Development Association	Stephen Knapp Arnold Knapp
Canadian Wood Council	Ineke Van Zeeland
City of Kitchener	Scott Dougall
Cobri Technologies Inc.	Walter Milani Larry Whitty
Gypsum Association	Robert Wessel

<u>Organizations</u>	<u>Individual</u>
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International Firestop Council	Anthony Crimi
IPEX Inc.	Allan Baker
Ken Richardson Fire Technologies Inc.	Ken Richardson
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NUCO Inc.	Keith Brebner
Ontario Ministry of Municipal Affairs & Housing	John Gryffyn Cengiz Kahramanoglu
The City of Calgary	Bernardine van der Meer
Tremco Inc.	Rick Reuss
Underwriters' Laboratories of Canada	Emmanuel Sopeju

The draft document was also circulated to external reviewers to obtain input from potential users who were not involved in the development of the Guide. The following individuals reviewed the draft and provided comment to the SIG and the authors.

<u>Organization</u>	<u>Individual</u>
NRCC – IRC – Canadian Codes Centre	Igor Oleszkiewicz
Senez, Reed, Calder Fire Engineering Inc.	Peter Senez
Gibbs Gage Architects	Ed Sych
Thermo Fire Systems Inc	Mike McClure

Participation of organizations and individuals from both Canada and the U.S.A. helped to ensure that the input encompassed the codes, standards and regulatory environments in both countries.

This Best Practice Guide primarily addresses fire stops and fire blocks installed in Canada, which must meet Canadian codes and standards. The requirements for fire stops and fire blocks in the National Building Code of Canada (NBCC) are similar, in concept, to those contained in the International Building Code (IBC) and NFPA 5000 in the U.S.A. Specific significant differences between Canadian and American codes are identified. The current requirements for CAN/ULC-S115 also contain a number of differences from the American Society of Testing and Materials (ASTM) and Underwriters Laboratories Inc. (UL) documents in the U.S.A; these are also identified in the Guide.

The Guide also identifies differences from the NBCC that have been approved in some provincial building codes. These are included to ensure that users of the Guide are aware of the minor provincial variations that may impact on fire stops and fire blocks.

The Guide has been developed to assist in the design, installation and inspection of suitable fire stop and fire block systems. It is intended to identify technical solutions relating to the fire resistance and sound transmission aspects of fire stops and fire blocks by those who manufacture, design, specify, install and inspect these systems.

The Best Practice Guide is not intended for use as a code document. Some of the solutions described in the Guide may not conform specifically to current Canadian codes. The authority having jurisdiction must be consulted on the acceptance of such solutions. The Guide, however, may be used as a background reference by those in the building regulatory community as a means of identifying suitable fire and acoustic solutions for fire stops and fire blocks. In the future, others may re-work the Best Practice Guide, or portions of it, into a form that may be suitable for use with codes and standards. That is not the intent of this current document, however. While the Guide makes extensive reference to the NBCC as being the source of the requirements for fire stops and fire blocks in Canada, there are occasions in the Guide where Best Practice may dictate the need for features beyond the NBCC requirements. The authors have tried to identify those situations in Chapters 7 through 13.

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1.0 INTRODUCTION

1.1 Background

While the past decade has produced valuable research information and technical solutions on suitable fire and acoustic components for fire-resistant wall and floor assemblies tested in a laboratory, the design and construction process also demands proven approaches to ensure satisfactory performance of installed fire-rated assemblies in buildings. This means addressing potential openings in or adjacent to these floors and walls. As well, recent research conducted at the National Research Council of Canada has shown that construction solutions that provide adequate fire resistance may not resolve (or may worsen) sound transmission shortcomings. Finding suitable fire and acoustic solutions and balancing fire resistance and sound transmission issues are growing problems for all in the construction industry as both are mandated by Codes for certain building occupancies.

For designers, plan reviewers, installers and inspectors, the lack of recognized solutions to provide both appropriate sound and fire control with fire stops and fire blocks is a frequently-encountered problem. As a result of the absence of reliable authoritative documents, accepted practice for fire stop and fire block solutions in one jurisdiction may be unacceptable in neighbouring ones. Those who design and install fire stop systems do not wish to face the problem of having met the fire requirements but not meet the requirements for sound isolation, especially when this is discovered at the commissioning stage. The manufacturers of fire stop and fire block systems, who provide technical information to designers, installers and regulators, also wish to assure themselves that they have addressed both the fire and sound transmission aspects of their systems to avoid problems that may only be identified at the commissioning stage or during the occupancy of the building.

There is currently no reliable reference document that addresses both fire and sound transmission issues related to fire stops and fire blocks. As well, there is currently no document that provides the design, regulatory, manufacturing and installation communities with reliable information that can be used with assurance across the many jurisdictions in the country. Much of the technical knowledge needed to produce such a document is presently available in a variety of references. This "Best Practice Guide" aspires to serve as a first reliable reference document.

Best Practice - For the purposes of this Guide, "best practice" is defined as:

Best Practice – Based on current knowledge, recommendations in this Guide representing the best judgement of individuals from all aspects of the industry involved in the preparation of the Guide.

It should be noted that there may be acceptable solutions other than those presented in this Guide and that new technology may provide improved solutions in the future. The concept of "best practice" in this Guide relates, therefore, to the state of the art at a particular point in time.

City of Calgary Experience – In the late 1990s, the City of Calgary was experiencing a building boom which included a large increase in the construction of multi-family housing units. During the same period, the City entered into a partnership agreement with the Calgary Region Home Builders' Association to, among other goals, raise standards and to achieve a higher level of consistency in construction of multi-family housing. The City's Building Regulations Division had identified multi-family buildings as their greatest area of concern and had noted a pattern of deficiencies in fire separations and fire stops. The City and its partners from the building industry, architects, engineers, contractors and fire stop manufacturers agreed that, to reduce deficiencies in the field and obtain a higher standard of consistency, a guideline on fire stops needed to be prepared.

The City of Calgary also noted that numerous new fire stop products were being introduced to the Canadian market and installed in buildings in Calgary. The City had concerns about the selection of appropriate products and their suitable installation in buildings, in particular, multi-unit residential units. Following a two-year development and review process, the guideline "Fire Stopping Service Penetrations in Buildings" [1-1] became a reality in 2003. Subsequently, the City expressed an interest in extending the document to address fire blocks and other fire stops not previously addressed, as well as sound transmission issues, which are often inseparable from fire separation issues in residential buildings. The City's document and request became the catalyst for the development of this Best Practice Guide.

1.2 Objective

With the numerous reference sources available, this Best Practice Guide will build on existing knowledge and then add value through the integration of the data on fire and sound transmission in such a manner that the user has a useful, authoritative document. With these thoughts in mind, the Objective of the document is:

"To describe, using a synthesis of available data, the technical solutions necessary to obtain, with fire stop systems and fire blocks, appropriate fire and sound control in buildings."

1.3 Basic Terminology

A number of words and phrases are currently used to describe what is generically known as "fire stopping". In common usage, the terms "fire stop", "fire block" and "draft stop" are often used interchangeably; others attribute specific meanings to each term. For example, in the 2005 edition of the National Building Code of Canada (NBCC) [1-2], while there is no definition of the term "fire stop", the terms "fire stop" or "fire stop system" are used to encompass all such materials and systems, including those commonly called "fire blocks" or "draft stops" in other documents. There are, however, differences, often not subtle, that call for unique terminology for each different technology. For this reason, in this Best Practice Guide, specific terminology will be

adopted in an attempt to enable the user to better understand what is being discussed, to reduce confusion and to achieve consistency with other North American documents.

Fire Stop – a material, component or system, and its means of support, used to fill gaps between fire separations, between fire separations and other construction assemblies, or used around items which wholly or partially penetrate fire separations, to restrict the spread of fire and often smoke thus maintaining the integrity of a fire separation.

Fire Block – a material, component or system installed in a concealed space in a building to restrict the spread of fire and often smoke in that concealed space, or from that concealed space to an adjacent space.

In this Guide, fire block is intended to encompass the term “draft stop” which is sometimes used in American codes when speaking of some fire blocks in larger concealed spaces. Draft stops are intended to stop air movement as well as fire spread. In the 2005 NBCC, fire blocks, as defined in this Guide, are called “fire stops”.

The basis for the “fire stop” and “fire block” terminology can be found in the Fire Protection Handbook [1-3], NFPA 5000 – Building Construction and Safety Code [1-4] and the International Building Code [1-5]. The Fire Protection Handbook is one of the most widely-used reference documents in the fire protection profession; its use of the above terminology (fire stop and fire block) in its 19th edition indicates a wide acceptance internationally of this terminology.

Throughout this Guide, reference is made to “listed fire stop systems”. These are systems which have been tested to CAN/ULC-S115 – Standard Method of Fire Tests of Firestop Systems [1-6] by a recognized testing agency and proof of that testing and subsequent follow-up service is provided by an independent certification agency. The definition for a “listed fire stop system” is adapted from CAN/ULC-S115 as follows: In this Guide, “listed fire stop systems” will be used to indicate fire stops which conform to CAN/ULC-S115.

Listed Fire Stop System – a specific construction consisting of materials, any penetrating items and their means of support, that has met the requirements for an F, FT, FH and/or FTH rating when tested in a fire-resistance rated assembly in accordance with CAN/ULC-S115 – Standard Method of Fire Tests of Firestop Systems.

It should be noted that under the NBCC [1-2], Part 3 requires that fire stops comply with CAN/ULC-S115, which may be accomplished by using a listed fire stop system, or be cast in place. Part 9 permits generic materials to be used for fire stops, however, listed fire stop systems may also be used.

1.4 Historical Requirements for Fire Stops and Fire Blocks

1.4.1 Introduction

The need for fire stops to ensure the continued integrity of fire compartments, and the need for fire blocks to restrict the size of concealed spaces has been known in the fire protection profession since fire compartmentation began to be used as a means of fire control. Historically, fire losses were much greater when fire stops and fire blocks were not installed or were installed with deficiencies. Fire departments frequently reported that fire suppression operations were made more difficult by the spread of fire to an adjacent compartment or to a concealed space as a result of no or poorly-installed fire stops and fire blocks. High profile fires, such as at the Brown's Ferry Nuclear Power Plant, the Inn on the Park and the MGM Grand Hotel, raised the awareness of all fire safety professionals to the need for appropriate fire stops and fire blocks and to the materials used for their construction. It is these and other events, related to sound isolation of residential units, that illustrated the need for this Guide.

1.4.2 Canadian Code Context

In Canadian Codes, until the latter half of the 20th century, fire stops and fire blocks generally consisted of generic materials, such as batt insulation, solid wood, gypsum board and even foamed plastic. The exact time duration for which these generic materials were expected to restrict fire spread and their efficacy at doing so was not quantified. Fire stops were generally mandated through the use of phrases such as "fire stopped with *noncombustible* material ..." as shown below from Article 3.2.2.5 of NBCC 1965] [1-7].

"3.2.2.5.(1) Where *heavy timber construction* is permitted as an alternate to 3/4 hr. *fire separation*, such heavy timber shall be constructed as a smoke-proof barrier with doors, shafts, and firestopping as necessary to prevent the passage of smoke and flame from one side of the separation to the other. Every duct passing through such construction shall have dampers fitted with temperature rise releases and every duct, pipe or wire which pierces the *fire separation* shall be tightly fitted or fire stopped with *noncombustible* material unless contained within a shaft." [Ref: 3.2.2.5.(1) of NBCC 1965]

In the NBCC 1965, fire blocks (called "fire stops") in "wood construction" were required at most locations indicated in the current NBCC [Ref: 3.2.2.9 of NBCC 1965]. These fire blocks were not permitted to be covered or concealed " ... until inspected and *approved by the authority having jurisdiction*".

In the 1970 edition of the NBCC [1-8], a separate subsection [Ref: 3.1.9 of NBCC 1970] was added to address most fire stop needs. It gathered together much of the information on fire stops spread throughout Part 3 in the 1965 Code. A "fire stop" was defined in the NBCC 1970 as:

"*Fire stop* – means a draft-tight barrier within or between construction assemblies that acts to retard the passage of smoke and flames" [Ref: 2.1.1 of NBCC 1970].

This 1970 NBCC definition again notes the need to retard the passage of both flames and smoke, however, no quantification of specific performance in that regard is mentioned. There were also requirements in the NBCC 1970 to install fire stops around such penetrations as noncombustible pipes and ducts [Ref: 3.1.7.6 of NBCC 1970 as example].

"3.1.7.6.(1) Openings for *noncombustible* pipes are permitted in *fire separations* provided such pipes

- (a) are enclosed in shafts conforming to Section 3.5, or
- (b) are tightly fitted or fire stopped to prevent the passage of smoke and flame.

(2) Openings for *noncombustible* ducts are permitted through *fire separations* provided such ducts

- (a) are enclosed in shafts conforming to Section 3.5, or
- (b) conform to Subsection 3.5.1. for unenclosed ducts and they are tightly fitted or fire stopped to prevent the passage of smoke and flame." [Ref: 3.1.7.6. of NBCC 1970].

In the 1970 edition, some performance criteria for fire stops and fire blocks can be surmised from the prescriptive terms used to describe their construction as shown below. For example, it is assumed that batt insulation used for fire stops in this edition of the Code would have had to meet the "noncombustible material having a melting point above 1200°F (649°C)" to be acceptable as a fire stop.

"3.1.9.1.(7) Every *fire stop* shall

- (a) be constructed of:
 - (i) asbestos cement board, gypsum board or other *noncombustible* material having a melting point above 1200°F (649°C) , such as sheet steel,
 - (ii) solid lumber not less than 2 in (51 mm) nominal thickness, or
 - (iii) ½-in.-thick (13 mm) plywood with joints backed with like material or two thicknesses of lumber not less than 1 in. (25 mm) nominal in thickness with joints staggered, where the width or height of the opening or space to be *fire stopped* is such that more than one piece of 2-in.-thick (51 mm) lumber is necessary." [Ref: 3.1.9.1(7) of NBCC 1970].

It can be easily seen that the actual performance, under fire exposure, of these diverse fire stop and fire block materials would vary considerably from the perspective of temperature rise on the unexposed surface and penetration by smoke and flames. The 1970 NBCC did, however, provide greater clarification and quantification of fire stop and fire block performance through this requirement.

Later editions of the NBCC better defined the performance expectations of fire stops. In the 1985 NBCC [1-9], fire stops around service penetrations were required to: "remain in place and prevent the passage of flame when subjected to the standard fire exposure ... for a period of time equal to the *fire protection rating* for the grade of *fire separation*" [Ref: 3.1.7.1.(2) of NBCC 1985]. In other words, a fire stop had to match the performance standard of a fire door or a fire damper in terms of resisting fire spread. In the 1985 NBCC, fire blocks were required to: "remain in place and prevent the passage of flames for a period of 15 min when subjected to the standard fire exposure"

[Ref: 3.1.9.4.(1) of NBCC 1985]. Generic materials such as gypsum board, sheet steel and plywood were still permitted in that edition of the NBCC without explicit reference to their expected fire performance. While the first edition of ULC-S115 was available in 1985, after the completion of the work on the 1985 NBCC, the policy of the NBCC of not including standards as references until they are published meant that ULC-S115 was not referenced in the NBCC until the 1990 edition.

It was only in the 1990 edition [1-10] of the NBCC that the present requirements for fire stops appeared. In that edition, fire stops around service penetrations were required to meet CAN/ULC-S115 "Standard Method of Fire Tests for Firestop Systems" [1-6], the reference standard still in use today. Fire blocks, on the other hand, had to resist the standard fire exposure for 15 min, as was required in the previous edition, or they had to consist of specified generic materials. It is clear that, from 1990 onwards, there was an intentional distinction between the fire performance expectations of fire stops and fire blocks, while still using the term "fire stop" for both.

While the code in Canada was undergoing these changes, events in the U.S.A. were leading to better-defined fire stops and fire blocks in both Canada and the U.S.A. Two major fires, in particular, played material roles: the Brown's Ferry Nuclear Power Plant fire in 1975 and the MGM Grand Hotel fire in 1981. The former indicated a weakness in the selection and testing of fire stop materials for cable penetrations and the latter a weakness in the fire and smoke performance of building construction joints, in particular, seismic joints. As well, a study by the U.S. National Bureau of Standards provided evidence of the need for fire stops and fire blocks to prevent unrestricted fire spread in concealed spaces in multi-family residences.

1.4.3 Brown's Ferry Nuclear Power Plant Fire

The fire at the Brown's Ferry Nuclear Power Plant [1-11, 1-12, 1-13] in 1975 originated with an electrician using a candle to check the airtightness of "seals" in major fire separations between a Control Room and a Cable Spreading Room. The wall was approximately 0.7 m thick and was penetrated by openings for cables. The space between the cables and the wall opening had been filled with resilient polyurethane foam. The foam was going to be covered eventually with a protective material. As the result of a pressure difference between the two rooms, the flame from the candle was drawn into the opening, igniting the polyurethane foam. The resulting fire caused property damage of approximately \$10M (U.S.) with business interruption losses many times that. Some plant employees believed that the polyurethane foam "would not sustain a fire" [1-13] so the foam was considered an appropriate material to seal cable penetrations. While the complete seal, with the protective material, had been tested under fire conditions, the tests had been conducted without a pressure differential. After the fire, the plant removed the existing seals and replaced them with silicon seals [1-12].

As a result of this fire, two significant changes related to fire stops occurred. The first was the development of an appropriate standard fire test to specifically evaluate the ability of through-penetration fire stops to remain in place and resist fire spread. This standards development activity, which occurred at the American Society for Testing and Materials (ASTM), was paralleled by research sponsored by the U.S. Nuclear Regulatory Commission on Fire Stops for Nuclear Plants [1-3]. The second change as a result of

that fire was to recognize the need for pressure differentials when testing fire stops, as these differentials tend to adversely affect the performance of some fire stops.

1.4.4 MGM Grand Hotel Fire

The extent of fire spread at the MGM Grand Hotel fire in Las Vegas in 1980 [1-14, 1-15] was the result of numerous deficiencies in construction and fire protection. The 26-storey high-rise hotel was built in the form of a "T" in plan which sat above a large single storey and basement structure housing the casino and other services. The space between the Ground Floor and the hotel room towers was a deep, essentially undivided, return-air plenum. Seismic joints, approximately 300 mm wide, were located in all floors of the hotel to isolate two of the wings of the "T"; the bottoms of the shafts adjacent to these joints communicated directly with the large plenum over the Ground Floor. At each floor level in the hotel, non fire-rated panels separated the seismic joint from the corridor [1-14].

The fire began in a room adjacent to the casino and rapidly spread to the casino and other spaces on the Ground Floor. Smoke and fire moved into the return air plenum above the Ground Floor and, from there, smoke spread up the shaft adjacent to the seismic joints in the high-rise tower [1-15]. Of the 84 casualties in this fire, 64 were in the hotel high-rise towers.

Among the many factors contributing to this tragedy, the inquiries identified that construction and seismic joints, if not appropriately fire stopped to prevent fire and smoke spread, can be a significant hazard. The inquiries also reinforced the findings from the Brown's Ferry fire on the detrimental affects of pressure differentials across fire-stopped openings on smoke spread to other spaces in a building.

1.4.5 U.S.A. Study on Fire Causes

In 1977, the Center for Fire Research of the National Bureau of Standards (now the National Institute of Standards and Technology) published the results of a study on fire spread in multi-family residences in which fires spread beyond the area of origin [1-3; 1-16]. That study focussed on fires in low-rise residential buildings located in parts of Maryland and Virginia; most of the buildings were of wood frame or ordinary (load-bearing masonry walls and wood frame) construction. The study identified the lack of fire stops and fire blocks as the single greatest cause of extensive fire spread in these buildings.

Many of the deficiencies identified with fire stops and fire blocks had been previously identified and addressed by code writers, and had been incorporated in the applicable Codes. The study was instrumental, however, in identifying the magnitude of the problem of horizontal and vertical fire spread through buildings as a result of fire stop and fire block deficiencies. Some of those deficiencies include:

- Penetration of fire separations by plumbing, mechanical and electrical services without fire stops.
- Partitions stacked one on top of the other without fire blocks at floor or ceiling levels.

- Omission of fire blocks in furred-out exterior walls.
- Lack of fire blocks between mansard roofs and attic spaces above these roofs. This was similarly observed at a fire in Winnipeg at the Fairland Meadows Complex in 1974.
- Roof and floor cavities formed by wood trusses without appropriate fire blocks.

This NBS study, combined with the results of the Brown's Ferry Nuclear Plant and MGM Grand Hotel fires, provided fire protection professionals and code developers with a clear indication of the critical need for appropriate, well-defined fire stop and fire block techniques and materials. As well, these fires indicated the need for a greater focus on the expected installed performance of fire stop and fire block systems. The recommendations from the NBS study included specific changes for the model codes in the U.S.A.; many of these changes are included in all North American building codes today.

1.5 The Effects of Fire Stops and Fire Blocks on Acoustic Separation of Spaces

In some circumstances where fire stops or fire blocks are installed, the fire-rated construction must also provide acoustical separation. One obvious example is that for multifamily residential buildings; some aspects of sound transmission are regulated via provisions of the National Building Code, or comparable codes in specific jurisdictions. But in addition, acoustical design requirements for a given building may apply to situations not addressed by the Building Code, or be more stringent than the minimum requirements of the Building Code.

- One example is spaces in office or public buildings where speech privacy is essential; such as meeting rooms for client/lawyer discussion in courthouses. There is no Building Code provision to address such concerns, but performance requirements for acoustical separation may be specified.
- Another example is luxury residential condominiums, where design objectives or performance requirements may be more stringent than minimum sound control requirements in the Building Code.

To address such concerns, this document also includes complementary information addressing acoustical performance requirements beyond the minimum design objectives of the Building Code:

- In Chapter 2, sections on acoustics outline basics of noise control, and the specific standards and requirements that apply to fire stops and fire blocks.
- Chapter 5 deals with acoustics in the current National Building Code of Canada.
- For each example in Chapters 8 through 13 where there may be significant acoustical issues, guidance is given in a sidebar. In some cases, minimum requirements in the context of building codes are given. In other cases, additional requirements for good practice are given; in the latter cases, the non-regulatory context is identified both by headings and the use of non-mandatory language.

Chapter 1 References

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2.0 BASICS OF FIRE COMPARTMENTATION AND SOUND TRANSMISSION

For the purposes of this Guide, fire compartmentation is defined as:

Fire Compartmentation – the use of fire-rated, vertical and horizontal, structural and non-structural assemblies to contain fire to a specified area in a building for a specific period of time.

2.1 Fire Compartmentation History

Fire compartmentation has been one of the fundamental means of fire control for hundreds of years. The developers of building and fire codes instinctively knew the value of fire compartmentation and mandated it in early codes. In 1189, Henry Fitz-Allwyne, the first Lord Mayor of London, issued a building regulation that included the need for stone party walls 0.9 m thick and 4.9 m high [2-1]. The objective of that regulation was to establish a fire compartment no larger than the building on one side of the party wall. Over the centuries, that London regulation ceased to be enforced. The need for fire compartmentation in London was further emphasized following the Great Fire of London in 1666 when a new building regulation required stone and brick houses to have fire-resisting party walls [2-1].

As time went on, those involved in construction attempted to better quantify the fire resistance performance of the wall, floor and roof assemblies that created fire compartments. As early as 1790, architects in London were conducting tests to determine the relative merits of different fire barriers for periods of 1 to 2 hours [2-1]. It wasn't until the late 19th century that standardized fire tests were developed both in the United Kingdom and the U.S.A. [2-1]. While those techniques and measurements were crude by today's standards, the basic fire exposure and minimum required fire barrier response from those 19th century tests are similar to those used today. This early fire research and testing led to the "fire resistance ratings" for wall, roof and floor assemblies commonly used in the 21st century. Assemblies with fire resistance ratings provide fire compartmentation in today's buildings.

2.2 Elements of Fire Compartmentation

Note: It should be noted that the discussion of Code concepts in this Chapter is limited to Part 3 of the National Building Code of Canada (NBCC). Similar concepts are applicable to Part 9 – Housing and Small Buildings; these are described in Chapter 5 – Code Requirements for Fire Stop Installations and Sound Isolation and Chapter 6 – Code Requirements for Fire Block Installations and Sound Isolation.

2.2.1 Continuity of Fire Compartmentation

Fire compartmentation is achieved through the use of fire-rated assemblies commonly referred to in building codes as "fire separations". In the 2005 edition of the NBCC [2-2], a fire separation is defined as:

Fire Separation means a construction assembly that acts as a barrier against the spread of fire [Division A: 1.4.1.2 of NBCC 2005].

An Appendix Note to that definition indicates that "A fire separation may or may not have a fire resistance rating" [Ref: A-1.4.1.2 of NBCC 2005]. A fire resistance rating is essentially the time that an assembly will resist fire spread in a standard fire test. Technically, a fire compartment would, when exposed to fire, have a minimal capacity to resist fire spread if the wall and floor assemblies were constructed of non-robust materials or with robust materials assembled incorrectly. In these cases, the fire resistance rating of the assemblies would be only a few minutes. On the other hand, if wall and floor assemblies comprised of robust materials (assembled correctly) were exposed to fire, the fire resistance rating of those assemblies could be a few hours and the fire compartment would fulfil its purpose for a longer period of time.

The importance of fire stops in achieving the needed continuity of fire separations to create fire compartments is stated, in principle, in the following requirement and Appendix Note:

"3.1.8.3

4) The continuity of a *fire separation* shall be maintained where it abuts another *fire separation*, a floor, a ceiling, a roof, or an exterior wall assembly. (See Appendix A.)" [Ref: 3.1.8.3.(4) of NBCC 2005]

"A-3.1.8.3.(4) **Fire Separation Continuity.** The continuity of a fire separation where it abuts against another fire separation, a floor, a ceiling or an exterior wall assembly is maintained by filling all openings at the juncture of the assemblies with a material that will ensure the integrity of the fire separation at that location. [Ref: A-3.1.8.3(4) of NBCC 2005]

While not specifically stated as such, a material which will fill "...all openings at the juncture of the assemblies ..." is clearly a fire stop which will restrict the movement of fire, and sometimes smoke, to adjacent fire compartments. While no mention is made in this requirement about penetrations, it can easily be concluded that fire separation continuity is equally important when an item penetrates the fire separation and thus fire stops are needed.

From the perspective of fire stops, it is important to understand the relationship between fire resistance ratings and fire separations since, the higher the fire resistance rating desired, the more robust a fire stop used in those fire separations must be; i.e., the greater the hourly rating. The NBCC formally defines "fire resistance rating" as:

"*Fire resistance rating* means the time in minutes or hours that a material or assembly of materials will withstand the passage of flame and the transmission of heat when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived therefrom as prescribed in this Code." [Ref: Division A: 1.4.1.2 of NBCC 2005]

So, to achieve fire compartmentation in a meaningful way, a defined area in a building must be surrounded by fire separations which can resist fire spread, when subjected to a standard fire test. In the NBCC, the standard test by which wall, roof and floor assemblies must be evaluated (and which defines the standard fire exposure that must be employed) is CAN/ULC-S101-M "Standard Methods of Fire Endurance Test of Building Construction and Materials" [2-3]. More information on this test standard is provided in Chapter 6 – Code Requirements for Fire Block Installations and Sound Isolation.

For fire stops, the most important aspect of the requirements for fire compartmentation are the words in Article 3.1.8.1 of the NBCC 2005 (see below) which state that a fire separation "... be constructed as a continuous element ..." and that openings in a fire separation "... be protected with *closures*, shafts or other means ..." [Ref: Article 3.1.8.1 of NBCC 2005]. Fire stops would be considered "other means" in this requirement.

3.1.8.1 General Requirements

- 1) Any wall, *partition* or floor assembly required to be a *fire separation* shall
 - a) except as permitted by Sentence (2), be constructed as a continuous element, and
 - b) as required in this Part, have a *fire-resistance rating* as specified (see Appendix A).
- 2) Openings in a *fire separation* shall be protected with *closures*, shafts or other means in conformance with Articles 3.1.8.4 to 3.1.8.17. and Subsections 3.1.9. and 3.2.98. (See Appendix A.) [Ref: 3.1.8.1 of NBCC 2005]

These requirements provide the basis for fire stops in the context of Canadian building codes: they provide a prescribed means to ensure the continuity of fire separations to achieve fire compartmentation. Further details on this concept are included in Chapter 5 – Code Requirements for Fire Stop Installations and Sound Isolation.

2.2.2 Types of Fire Separations

Fire separations can be made up of a single construction material (e.g., masonry walls) or of a number of materials that form an assembly (e.g., gypsum board, studs, insulation). As well, under the NBCC, fire separations may or may not have a prescribed fire resistance rating. An examination of these four variables (single/multiple components and fire-rated/non-fire-rated) provides a shopping list of the various types of fire separations that can be encountered in buildings. Some roof assemblies and mezzanine floor assemblies are required to have fire resistance ratings under the NBCC, however, they do not need to be fire separations. This means that through-openings in these assemblies, such as for skylights, do not require additional protection to ensure continuity. The solid (unpenetrated) portions of these assemblies must, however, possess the specified fire resistance rating.

Table 2-1 provides a list of the types of fire separations (and fire resistance ratings) in which fire stops may be installed within the context of the NBCC.

Table 2-1
Types of Fire Separations

Construction Type	Examples	Fire Separation		Fire Resistance Rating Required		Fire Stops/Fire Blocks Required	
		Yes	No	Yes	No	Yes	No
Solid homogenous wall, floor or roof ⁽¹⁾	Concrete floor or wall	X		X		X	
		X			X	X	
			X	X		(3)	
			X		X		X
Solid membrane wall, floor, ceiling or roof ⁽¹⁾	Gypsum board ceiling ⁽²⁾	X		X		X	
			X		X		X
Multi-component wall, floor or roof ⁽¹⁾ assembly	Wood or steel stud wall with gypsum board	X		X		X	
		X			X	X	
			X	X		(3)	
			X		X		X

Notes:

(1) Roof assemblies are required by the NBCC to have a fire resistance rating but are not required to be fire separations. This means that the solid portions of a roof must remain in place for the required time but that any openings in the roof assembly (e.g., skylights) are not required to be equipped with closures. Typically fire stops would not be required for openings in roof assemblies, such as where a plumbing vent pipe penetrates a roof deck. There are cases, such as where roofs expose exterior walls of adjacent buildings, that openings in roof assemblies may be required to be protected with fire stops.

(2) This applies to assemblies in which all of the required fire resistance rating for the assembly is provided by the membrane alone (see 2.2.3).

(3) Fire stops would be required if an opening could result in a decrease in the fire resistance rating of the structural assembly. An opening which does not impact negatively on fire resistance is assumed to not require fire stops.

2.2.3 Membrane Ratings

From Table 2-1, the entry "Solid Membrane Wall, Floor, Ceiling or Roof" describes a type of fire separation that is frequently used in construction. Codes permit two arrangements to achieve fire resistance ratings for assemblies made up of multiple components. The first, which is more common, is an assembly where all components collectively combine to provide the prescribed rating. An example is a typical wall comprised of gypsum board on both faces attached to studs, with insulation between the studs. All three components may be required to achieve a particular fire resistance rating, for example of 1 h.

For the purposes of this Guide and as a suggestion to users, another arrangement can be used to provide fire resistance in structural systems with multiple components. In a framed apartment building, for example, to achieve appropriate fire compartmentation, the fire separations around each apartment must be continuous so vertical fire separations would normally have to penetrate a gypsum board ceiling and abut the floor or roof deck above. With structural members and electrical, plumbing and HVAC services being installed above many such ceilings, it is often impractical to have these vertical fire separations penetrate the truss or joist space above.

One suggested solution to that problem is to terminate the walls at the ceiling membrane— which now must possess the required fire resistance rating for the entire assembly to ensure fire compartment continuity. This method of placing all of the fire resistance in the ceiling membrane alone (and its supports above the membrane to hold it in place) leads to fire stops at openings in such a ceiling having to be more robust than for an assembly in which multiple components contribute to the fire resistance. At this time, there do not appear to be any listed fire stop systems specifically designed to address penetrations through this type of membrane-only rated assemblies.

The concept of a membrane alone providing all of the fire resistance for the assembly is articulated in the NBCC for horizontal service spaces as shown below. The Appendix Note differentiates between the fire resistance of a membrane evaluated as part of an assembly and of a membrane evaluated on its own.

"3.6.4.2.(2) If a *horizontal service space* or other concealed space is located above a required vertical *fire separation*, other than a vertical shaft, this space need not be divided at the *fire separation* as required by Article 3.1.8.3. provided the construction between this space and the space below is a *fire separation* with a *fire-resistance rating* equivalent to that required for the vertical *fire separation*, except that the *fire-resistance rating* is permitted to be not less than 30 min if the vertical *fire separation* is not required to have a *fire-resistance rating* more than 45 min. (See Appendix A.)" [Ref: 3.6.4.2.(2) of NBCC 2005]

"A-3.6.4.2.(2) **Ceiling Membrane Rating.** In construction assemblies that utilize membrane ceiling protection and have been assigned a fire-resistance rating on the basis of a fire test, the membrane is only one of the elements contributing to the performance of the assembly and does not in itself provide the protection implied by the rating. For the fire-resistance rating of membrane materials used in this form of construction, reference should be made to the results of fire tests which have been conducted to specifically evaluate the performance of this element." [Ref: A-3.6.4.2.(2) of NBCC 2005]

The fire tests to which the Appendix Note refers would need to be those which provide information on membranes which stay in place and keep the non-fire side of the fire-exposed gypsum board below an average of 140°C or a maximum of 180°C, for the required time. These are the requirements for a rated fire separation.

Certification (Listing) agencies often list "finish ratings" for gypsum membranes in multi-component systems. A finish rating could, in fact, serve as a "membrane rating" if it were sufficiently high to provide the needed fire resistance rating for the entire assembly. Further information on finish ratings to obtain a 1 h or 2 h fire resistance rated membrane can be found in Reference 2-4.

Appendix D to the NBCC 2005 – Fire-Performance Ratings [2-5] also contains information on ceiling membrane ratings as shown below. These provisions are targeted at meeting the intent of the NBCC for membrane-only fire resistance ratings. As can be seen in requirement D-2.3.12. (below), this rating can be used "... provided no openings are located within the ceiling membrane". This provision would seem to imply that this ceiling membrane cannot be penetrated. Assuming that to be the case, fire stops would not be required if this method is used to provide a ceiling membrane rating.

"D-2.3.12. Ceiling Membrane Rating. Where the fire-resistance rating of a ceiling assembly is to be determined on the basis of the membrane only and not of the complete assembly, the ratings may be determined from Table D-2.3.12., provided no openings are located within the ceiling membrane.

Table D-2.3.12.
Fire-Resistance Rating for Ceiling Membranes

Description of Membrane	Fire-Resistance Rating, min
15.9 mm Type X gypsum wallboard with ≥ 75 mm mineral wool batt insulation above wallboard	30
19 mm gypsum-sand plaster on metal lath	30
Double 14.0 mm Douglas Fir plywood phenolic bonded	30
Double 12.7 mm Type X gypsum wallboard	45
25 mm gypsum-sand plaster on metal lath	45
Double 15.9 mm Type X gypsum wallboard	60
32 mm gypsum-sand plaster on metal lath	60

[Ref: D-2.3.12. of NBCC 2005]

Membrane-only fire resistance ratings then are available from certification agencies as "finish ratings", from individual fire test reports or research papers or from Appendix D to the NBCC 2005. As explained above, the manufacturers of listed fire stop systems do not yet provide listed solutions to protect openings in these membrane fire separations. The performance of these fire stops would have to meet the performance of the membrane to prevent the fire from entering the concealed space (i.e., an FT rating for the same duration as the fire resistance rating). To provide the intended level of safety, assurance of fire stop performance to prevent ignition in the concealed space is needed.

As indicated above, it is also not certain that membranes assigned ratings on the basis of Appendix D to the NBCC would be permitted to have penetrations. While the intent of the NBCC related to membrane-only ratings is clear and the application for membrane-only fire-rated ceilings widespread, there is an absence of listed fire stop systems for this application. An engineered judgement (see Chapter 7 – Basic Issues Related to Best Practice for Fire Stops and Fire Blocks) would be required to develop a technical solution for fire stops for penetrations of these membranes.

2.2.4 Smoke Separations

Table 2-1 also shows entries where fire separations are not required to have prescribed fire resistance ratings. In the NBCC, such fire separations are intended to restrict the spread of smoke for a period of time. That intent is stated in an Appendix Note:

"A-3.1.8.1.(1)(b) **Barrier to Control Smoke Spread.** Although a fire separation is not always required to have a fire resistance rating, the fire separation should act as a barrier to the spread of smoke and fire until some response is initiated. If the fire resistance rating of a fire separation is waived on the basis of the presence of an automatic sprinkler system, it is intended that the fire separation will be constructed so that it will remain in place and act as a barrier against the spread of smoke for a period of time until the sprinklers have actuated and controlled the fire." [Ref: A-3.1.8.1.(1)(b) of NBCC 2005]

For the fire separation to act as a barrier against the spread of smoke, some form of fire stop may be required to protect openings in that fire separation. Technically, the fire stops in a smoke separation should meet the performance criteria of a fire separation without a fire resistance rating – which may be for only a few minutes. Such listed fire stop systems should be non-permeable for as long as the fire separation withstands the spread of smoke. Insulation batts alone may not be suitable for this application. Acoustic caulking may be a solution that would meet both fire and acoustic needs of these separations. Another option that may be used is to employ a fire stop with an "L" rating – meaning it has been tested for air leakage, however, an "L" rating is not currently a requirement of the NBCC. The time duration for which this smoke spread must be restricted by this protection is not articulated by the NBCC but it can be estimated to be a few minutes; i.e., "the time until sprinklers have actuated and controlled the fire".

From the NBCC references above, it can be surmised that any non-permeable fire stop in a smoke separation should resist smoke spread for a few minutes. Where a caulk or similar less permeable product may achieve this performance, insulation batts may not. The ability of insulation batts to resist smoke spread will depend on such factors as the insulation density and the percentage of compression within the opening. Best practice would dictate using a product which can be expected to resist smoke spread for a few minutes.

2.2.5 How to Achieve Fire Resistance Ratings

The NBCC provides three methods that can be used to establish a fire resistance rated assembly:

- Testing and certification by an agency qualified to undertake such work. This is the most commonly used approach especially when proprietary materials are used.
- The methods described in Appendix D of the NBCC [2-5]. These provide ratings for some assemblies using generic materials. These ratings can be applied to buildings built under both Parts 3 (large buildings) and 9 (small buildings). For framed assemblies, the maximum fire resistance rating using Appendix D is limited to 90 min.
- The deemed-to-comply Tables in Appendix A of the NBCC [Ref: A-9.10.3.1 of NBCC 2005]. These tables contain extensive descriptions of assemblies that have been assigned fire resistance ratings by the Code Committees, based primarily on published research. These assemblies are made up of generic materials and are accepted for buildings constructed under Part 9 of the NBCC.

Whichever method is used to determine the fire resistance rating, the assembly must still be continuous to be a fire separation. As such, openings in that assembly must be protected with closures or fire stops. With respect to these three methods, from the fire stop perspective, it is important to note that Parts 3 and 9 of the NBCC treat fire resistance ratings differently and also treat fire stop materials differently. This is explained in detail in Chapter 5 – Code Requirements for Fire Stop Installations and Sound Isolation.

2.3 Protection of Openings In and Between Fire Separations

To maintain the continuity of fire compartmentation, building codes in North America require that openings in and between fire separations be protected by some means to prevent fire and smoke spread from the fire compartment. The NBCC states this requirement as:

"3.1.8.1.(2) Openings in a *fire separation* shall be protected with *closures*, shafts or other means in conformance with Articles 3.1.8.4. to 3.1.8.17. and Subsections 3.1.9. and 3.2.8...." [Ref: *Sentence 3.1.8.1.(2) of NBCC 2005*]

As indicated in 2.2.1 of this Guide, fire stops would qualify as the "other means". Shafts are fire rated in the same manner as walls. Closures, however, need to be discussed since the method of rating them is different from rating walls or floors. See Table 2-2 as an example of how fire stops and other closures are treated differently by the NBCC for both fire separations and fire walls. The NBCC defines a "closure" as:

"*Closure* means a device or assembly for closing an opening through a *fire separation* or an exterior wall, such as a door, a shutter, wired glass or glass block, and includes all components such as hardware, closing devices, frames and anchors." [Ref: *Division A: 1.4.1.2 of NBCC 2005*]

Prior to that, it is important to understand that the NBCC treats a firewall differently from a fire separation – primarily in the fact that a firewall creates a separate "building" for purposes of application of the Code. The NBCC defines "firewall" as:

"*Firewall* means a type of *fire separation* of *noncombustible construction* that subdivides a *building* or separates adjoining *buildings* to resist the spread of fire and that has a *fire-resistance rating* as prescribed in this Code and has structural stability to remain intact under fire conditions for the required fire-rated time." [Ref: *Division A: 1.4.1.2 of NBCC 2005*]

Table 2-2**Example of Protection for Continuity of Fire Barriers**

Fire Barrier	Protection	
	Closures (e.g., doors)	Fire Stops
Fire Separation 2 h FRR ⁽¹⁾	1 ½ h FPR ⁽²⁾	1 ½ h F Rating
Firewall ⁽¹⁾ 2 h FRR	1 ½ FPR ⁽³⁾	2 h FT Rating

Notes:

(1) FRR – Fire Resistance Rating – prevent flame transfer and high temperatures (FT Rating).

(2) FPR – Fire Protection Rating – prevent flame transfer only (F Rating).

(3) Temperature rise limit of 250°C after 30 min also required.

In principle, a fire stop is a type of "closure" given the words of the definition. However, the NBCC later clarifies that while fire stops have to achieve ratings not less than "the *fire protection rating* for closures in the *fire separation* [Ref: *Sentence 3.1.9.1.(1) of the NBCC 2005*], higher ratings are required for fire stops than fire doors for protecting openings in firewalls and similar major fire separations as shown in Table 2-2. Details of this are provided in Chapter 5 – Code Requirements for Fire Stop Installations and Sound Isolation.

There are a number of standards referenced for the rating of closures such as for fire doors, fire windows and fire dampers. The exact details of these standards for rating closures are not essential to an understanding of rating of fire stops and fire blocks, however, the underlying concept of a "fire protection rating" for a closure is important. The NBCC defines "fire protection rating" as:

"Fire protection rating means the time in hours or fraction thereof that a closure will withstand the passage of flame when exposed to fire under specified conditions of test and performance criteria, or as otherwise prescribed in this Code. [Ref: Division A: 1.4.1.2 of NBCC 2005]"

To obtain a fire protection rating, the closure has to withstand only the passage of flame, in most cases, whereas a fire separation has to withstand the passage of flame and the transmission of heat to obtain a fire resistance rating. Some fire separations are also required to demonstrate a level of residual integrity following the fire endurance period as evidenced by having to then pass the hose stream test described in CAN/ULC-S101 [2-3]. The first two measures become an issue when discussing the rating of fire stops and fire blocks in Chapter 5 – Code Requirements for Fire Stop Installations and Sound Isolation and Chapter 6 – Code Requirements for Fire Block Installations and Sound Isolation. Some fire stops and fire blocks can withstand both temperatures and flame while others can withstand only flame – and their specific uses are assigned accordingly.

2.4 Concealed Spaces in Construction

The MGM Grand Hotel fire described in Chapter 1 – Introduction provides an example of fire and smoke spread through a concealed space in a building, even if the building is of non-combustible construction. As well, as indicated in Chapter 1 – Introduction, there are numerous examples of fire spread through concealed spaces (floors, attics, mansard roofs) where combustible materials are used. This is not restricted to combustible construction but applies where combustible materials are used in construction. To prevent fire spread beyond the occupied fire compartments located below or above concealed spaces, codes typically require that fire separations below a concealed space be continued through the space to the floor or roof deck above. (See discussion of alternative means in 2.2.3 above.)

The NBCC contains an extensive list of spaces that must be provided with fire blocks (the NBCC uses the term "fire stops") to maintain fire compartmentation, or to prevent extensive fire spread in a space in which locating a fire source may be difficult and fire fighting may be ineffective. The basic requirement for fire blocks in the NBCC is:

"3.1.11.1. Separation of Concealed Spaces

1) Concealed spaces in interior wall, ceiling and crawl spaces shall be separated from concealed spaces in exterior walls and *attic or roof spaces* by fire stops conforming to Article 3.1.11.7." [Ref: 3.1.11.1.(1) of NBCC 2005]

While not stated specifically in the NBCC, best practice in restricting fire spread in a building would dictate that fire blocks should also be installed to separate concealed spaces in floor assemblies from other concealed spaces. As well, fire stops are needed between a floor assembly and an exterior wall to prevent vertical fire spread from floor to floor through that space. These perimeter fire stops will be discussed in Chapter 3 – Types of Fire Stops and Fire Stop Materials.

As well as the fire blocks between concealed spaces, the NBCC also requires fire blocks to reduce the area of a concealed space to a manageable size (e.g., a ceiling space or crawl space). [Ref: 3.1.11.6 of NBCC 2005 as an example shown below.] Typically, the fire blocks to reduce the area of a concealed space are waived if the space is sprinklered; this waiver does not, however, apply to other fire blocks between the attic, roof space or crawl space and other concealed spaces.

"3.1.11.6. Fire Stopping of Crawl Spaces

1) A crawl space that is not considered as a *basement* by Article 3.2.2.9. and in which sprinklers are not installed, shall be separated by construction conforming to Article 3.1.11.7. into compartments not more than 600 m² in area with no dimension more than 30 m." [Ref: 3.1.11.6.(1) of NBCC 2005]

2.5 Effect of Fire Stops and Fire Blocks on Acoustical Separation

In some cases, the separations where fire stops or fire blocks are required must also provide acoustical isolation between adjacent spaces. For multifamily residential buildings, some aspects of the sound transmission are regulated via the provisions of the National Building Code (or comparable codes in specific jurisdictions). Additional design requirements may be added, especially for expensive multi-family residential buildings (where more stringent design criteria than the minimum requirements of the Building Code are commonly required), or in office or public buildings where speech privacy is needed.

With this in mind, discussion here identifies the issues specifically addressed by Codes, but also presents some other aspects contributing to good noise control that arise in dealing with fire stop systems or fire blocks.

For sound transmission testing in a laboratory, sound is transmitted from one room to another only through the separating wall or floor specimen under test. In a building, however, there are many paths for transmission of sound and associated structure-borne vibration, as indicated in Figure 2.A. As a result, sound isolation between adjacent rooms in a building is often much less than would be expected from rated sound transmission performance of the separating wall or floor assembly.

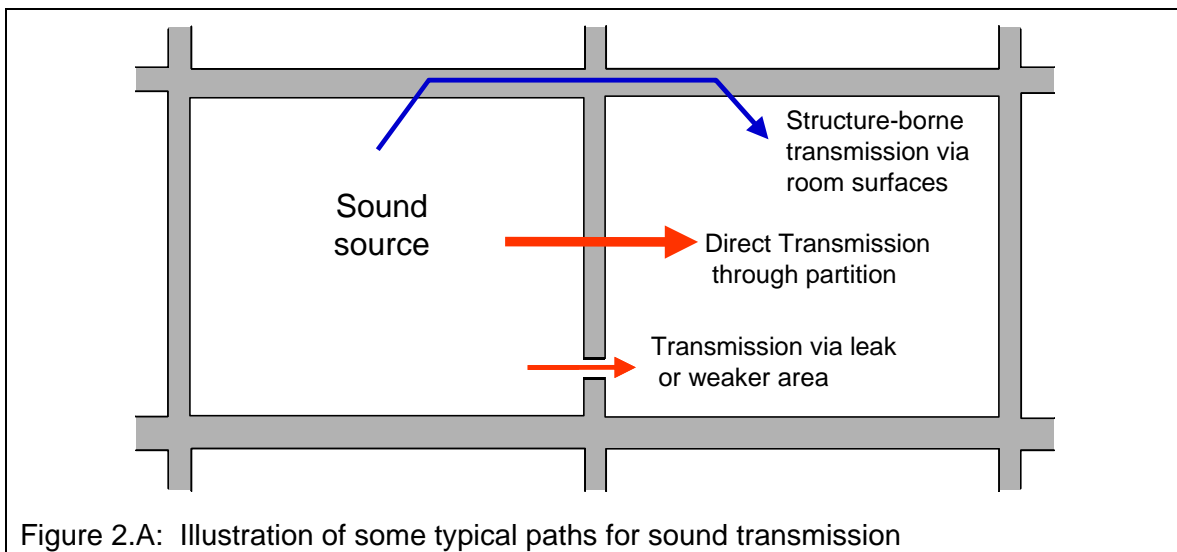


Figure 2.A: Illustration of some typical paths for sound transmission

This happens because, in addition to direct transmission through the nominal separating construction (wall or floor), sound penetrates via any leaks or weak spots, and also causes structure-borne vibration in all surfaces of the source room. Some of this structure-borne vibration is transmitted across the surfaces (walls, floors or ceiling) and through junctions where these surfaces connect, and is radiated as sound into the receiving room.

All of these transmission paths are relevant in assessing the acoustic performance in a building in the context of requirements for fire stops and fire blocks. From the occupants' perspective, what matters is the overall sound isolation between the adjacent spaces, including the combined effect of all transmission paths.

Key issues of concern include:

- Direct sound transmission through the nominal partition – the wall or floor assembly that separates a space from the adjacent one – is the primary focus of all North American building codes. Basic requirements for attenuation of airborne sound by an assembly are presented in conjunction with the fire resistance requirements in all North American Codes, in terms of standard ASTM test methods and ratings.
- Leaks and weak spots may transmit additional sound energy, compromising the effective sound isolation provided by the main surface of the partition. Gaps at the junctions of wall and floor assemblies, or at penetrations where building services pass through a wall or floor, may transmit sound from one side to the other that can significantly degrade the sound isolation. Fire stops are used to provide continuity of fire separation at such spots – they should also attenuate sound, or the separating partition will not provide its rated acoustical performance.
- Many wall and floor assemblies achieve their rated sound insulation by having a “vibration break” suppressing the transmission of structure-borne vibration (and hence sound) from one face of the partition to the other. Common examples are double stud wall assemblies with two parallel sets of framing having only minimal connections at room boundaries, or assemblies using resilient metal channels of lightweight steel to attach gypsum board to studs or joists. Similar concepts are used to suppress structure borne sound in general. Fire blocks are used to control spread of fire via hidden spaces, but fire blocks can short circuit vibration breaks – this can significantly compromise the overall sound isolation.

2.6 Rating Sound Transmission Through Fire Stops

2.6.1 Technical Standards for Sound Control

Measurement and rating of sound transmission between adjoining spaces is addressed in a set of ASTM standards. As discussed in Chapter 5, these ASTM standards are referenced in the National Building Code of Canada, all the provincial and municipal codes based on the NBCC, and corresponding codes in the USA. They define methods for measuring the transmission of airborne sound through an assembly (wall or floor), or the overall sound isolation between rooms in a complete building, and provide single-number ratings based on such measurement results.

- ASTM Standard E90 [2-6] is the standard laboratory test method for measuring airborne sound transmission through separating assemblies such as walls, floor-ceiling assemblies, and other space-dividing elements. This method determines airborne sound transmission loss in a specified set of frequency bands.
- ASTM Standard E336 [2-7] is the test method for determining the sound insulation between two rooms in a building - the field test counterpart of ASTM E90. The evaluation may be made including all paths by which sound is transmitted, or attention may be focused only on the wall or floor assembly

separating the two rooms. When it is required to demonstrate that a specific wall or floor assembly in a finished building complies with specifications, a test satisfying specific requirements that include eliminating “flanking” transmission (leaks or structure-borne transmission along paths other than that through the common partition) will be required; such results are designated “field transmission loss”. Measurements may also be made without taking any steps to eliminate flanking transmission, in which case results are designated “apparent transmission loss”. The latter indicates the overall airborne sound isolation that would be perceived by occupants.

- ASTM Standard E413 [2-8] gives single-number acoustical ratings from E90 and E336 results. The rating increases with better sound attenuation. The name given to the single-number rating depends on the test method used. If the test method is ASTM E90, the rating is called **sound transmission class (STC)**. If ASTM E336 is used with precautions that ensure negligible transmission except via the partition separating the rooms (i.e. – no flanking transmission) the rating is called **field sound transmission class (FSTC)**. If ASTM E336 is used without steps to make flanking transmission negligible, the rating is called **apparent sound transmission class (ASTC)**. The ASTC rating was introduced in the 2005 version of ASTM E336, and is recommended as the most suitable criterion for specifying sound isolation between occupancies in a building. Corresponding ISO standards have included “apparent sound reduction” terminology for many years, and such ratings are used in building code requirements in most developed countries other than Canada and the USA.

2.6.2 A Framework for Acoustical Rating of Fire Stops:

The requirements for acoustical separations in a building are expressed as the STC rating for performance of the entire separating construction, including any fire stop component(s), as discussed earlier. This rating is normalized to the area of the separating wall or floor assembly. Obviously, acoustical testing of a fire stop should provide a rating that is easily related to these STC limits.

At present, there is no established industry practice for acoustical testing or rating of fire stop systems, and reporting of acoustical performance is far from uniform. This could be addressed by establishing an industry test method based on the standards referenced in the Building Code (see Chapter 5). This could take the form of a manufacturers’ test method or a consensus standard, but should provide a framework for at least two key aspects:

- A protocol for installing test specimens for various types of fire stop systems at penetrations through wall or floor assemblies, or at junctions of such assemblies, and details of how to use the standard test method to evaluate them and calculate the values to be reported.
- A protocol for reporting results that can easily be used to compare products or to assess whether a product is acoustically suitable for a specific application.

With standardized test results, designers could readily assess expected sound transmission through a given fire stop relative to an acoustical objective.

2.6.3 Testing Protocol:

Laboratory testing by ASTM E90, with fire stop specimens installed in a wall or floor assembly, would give results obviously related to Building Code requirements. But getting results truly representative of sound transmission through the fire stop imposes additional requirements:

- The supporting assembly should have suitable sound transmission characteristics (preferably STC 60 or better, with a dependence on frequency similar to the STC contour).
- For different types of fire stop systems, different installation rules would be appropriate, but in general, multiple samples of the fire stop should be installed, and their combined surface area should be as large as possible (up to ~10% of the assembly's surface area).

This approach gives a lower STC for the test specimen (the fire stops and supporting assembly together) but the transmission due to the fire stop alone can then be obtained, and the result can be normalized to allow for the specific case of interest (see section on reporting results below). This approach avoids the systematic underestimate of the performance of the fire stop, due to including sound transmission through the supporting assembly.

2.6.4 Reporting Results

One obvious approach would be to establish the limiting case for which sound transmission through a given type of fire stop gives STC 50 or 55 (the minimum requirements in the Building Code). This could be expressed differently depending on the type of fire stop. For example:

- For fire stop systems with well-defined dimensions, the number of such units giving STC of 50 or 55 can be calculated from a test result for any known number of units, using the obvious rule that N identical treated openings will transmit N times the sound power passing through one.
- For fire stop systems sealing slits such as the crack at the bottom of a wall, or the joint where a wall meets the floor above, the total length of such fire stop giving STC of 50 or 55 can be calculated from a test result for a known length, using the rule that transmitted sound power will scale with total length.

Product ratings in these forms could be readily compared with one another, and assessed for suitability relative to the design requirement in a specific case. Given a well-defined reporting scheme, consultants could adapt the results to assess suitability in cases such as condominiums where good sound insulation is required.

2.7 **Cases where Sound Ratings are not Required for Fire Stops**

Requirements for sound control generally apply to separations between occupied spaces – the provisions of the NBCC apply between dwellings, and additional design objectives for offices or better dwellings typically apply to sound isolation between adjacent rooms. Whether the criteria are in terms of the sound transmission class of the separating assembly or the ASTC of the complete construction, they are concerned with sound reaching the space where a person may hear it.

But in many cases, there is no justification for requiring an STC rating for the subassembly penetrated by a fire stop system. These fit in three overlapping categories:

2.7.1 Separation between Service Spaces:

In many cases, fire stop systems are required to maintain continuity of a fire separation between (hidden) service spaces. This could include equipment rooms, or other service spaces, such as the space above a gypsum board ceiling where pipes, ducts, or electrical services might be installed. In such cases, additional constructions such as the gypsum board ceiling contribute to sound attenuation, and the sound attenuation provided between the occupied spaces (the rooms below the ceiling) by the complete built system may be significantly greater than that for the specific wall segment above the ceiling and any fire stops it may include. In such situations, although requirements for fire performance may apply, there is no basis for specifying a STC requirement for the fire stop or the hidden part of the separating assembly in which it is installed.

2.7.2 Penetration or Joint Covered by Other Elements:

A fire stop system at a joint or service penetration may be covered by other elements – for example, see Figures 8.E and 8.F where a water closet is installed above a penetration through a floor assembly. In such cases, at least part of the sound reduction at the penetration will be provided by the covering element. Any STC criterion should apply to the complete separating assembly.

2.7.3 Penetration through One Surface of Cavity Construction:

Similarly, no specific acoustic requirement can be specified for a fire stop at a penetration through just one surface of a cavity construction – such as a penetration of just the gypsum board ceiling of a floor/ceiling assembly. In such cases, the acoustical requirement should apply to the complete separating assembly. In practice, small penetrations through one surface of a joist floor or stud wall have little effect on the acoustical separation, if there is acoustical insulation in the cavity.

Chapters 8 to 13 present both specific examples of cases where STC ratings of fire stops should not be required, and examples of good practice for fire stops maintaining the acoustical performance of constructions separating occupied spaces where a rating would be useful.

2.8 Other Noise Control Objectives

Ratings for fire stop systems at penetrations through an assembly are not the only aspect of noise control that needs to be considered. Some other concerns that are addressed in this Guide are:

- In addition to the problem of limiting transmission of airborne sound from neighbours' voices and other such sources, good noise control requires suppressing the sound from building services (such as plumbing and ventilation systems) hidden within wall or floor assemblies. Frequently the pipes or ducts are enclosed in a service chase. Specific proprietary products can be used to reduce vibration at source or reduce vibration transfer to the supporting

construction, but generic construction details to control the resulting structure-borne vibration can also significantly reduce such noise. These issues are addressed for specific examples in Chapters 8 to 12.

- The effect of fire stop or fire block systems on transmission of structure-borne sound may compromise the ASTC in some cases. Some examples of good practice are given for specific examples in Chapter 13.

Of course, many aspects of noise control have been ignored here. For example, impact sound from footsteps can also be a significant concern, and is regulated by some Codes (although not by the NBCC), but is ignored here because it adds no additional considerations for fire stop systems or fire blocks.

Chapter 2 References

- 2-1. Richardson, J.K. (ed.), *History of Fire Protection Engineering*, National Fire Protection Association, Quincy, MA, 2003, Chapter 1 – Historical Evaluation of Fire Protection Engineering, Chapter 2 – Fire Severity and Fire Resistance.
- 2-2. *National Building Code of Canada*, Canadian Commission on Building and Fire Codes, National Research Council of Canada, Ottawa, ON, 2005.
- 2-3. *CAN/ULC-S101-M, Standard Methods of Fire Endurance Tests of Building Construction and Materials*, Underwriters' Laboratories of Canada, Scarborough, ON, 1989.
- 2-4. *GA-610, Fire Resistance Provided by Gypsum Board Membrane Protection*, Gypsum Association, Washington, DC, 2002.
- 2-5. *Appendix D to the National Building Code of Canada*, National Research Council of Canada, Ottawa, ON, 2005.
- 2-6. *ASTM E 90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements*, ASTM International, West Conshohocken, PA, 2004
- 2-7. *ASTM E 336-05, Standard Test Method for Measurement of Airborne Sound Insulation in Buildings*, ASTM International, West Conshohocken, PA, 2005
- 2-8. *ASTM E 413-04, Classification for Rating Sound Insulation*, ASTM International, West Conshohocken, PA, 2004

3.0 TYPES OF FIRE STOPS AND FIRE STOP MATERIALS

3.1 Introduction

Fire stops have been designed for the numerous arrangements needed to maintain the continuity of fire compartmentation. While there are many ways of categorizing these products and systems, this Best Practice Guide will use the definitions of "fire stop" and "fire block", provided in Chapter 1 – Introduction, and the test standards by which they are rated as the basis for classification. Recall from Chapter 1 – Introduction that fire stops are used to fill gaps around fire separations, or around items that wholly or partially penetrate fire separations.

- Fire Stops include through-penetration fire stops, membrane-penetration fire stops, blank opening fire stops, construction joint systems and building perimeter protection. In all cases for fire stops, the fire stop system is ensuring the integrity of a fire compartment and, in most cases, it is rated by CAN/ULC-S115 "Standard Method of Fire Tests of Firestop Systems" [3-1].

It could be argued that construction joint and building perimeter fire stop systems may be better classified as fire blocks than fire stops since they are often located in a concealed space. While this is true as far as location is concerned, the deciding factor in classifying them as fire stops is the manner in which they are tested. The 2005 edition of CAN/ULC-S115 [3-1] includes joint firestop systems as part of that standard. (See definition below.) Since these linear systems are being tested and certified using the same standard as through-penetration fire stops, they will be classified as "fire stops". While some building perimeter fire stops are still not addressed by CAN/ULC-S115, it is expected that they will be in the future.

Joint Firestop System – Material(s) and construction intended for use in linear openings between adjacent fire resistive structures" [Ref: 1.7C of CAN/ULC-S115].

In this Best Practice Guide, fire stops will be divided into the following groupings as explained in the following sections. Fire blocks will be addressed in Chapter 4 – Types of Fire Blocks and Fire Block Materials.

- Through-penetration fire stops
- Membrane-penetration fire stops
- Construction joint fire stops
- Building perimeter fire stops

3.2 Fire Stop Materials

Numerous proprietary and generic products are available to serve as fire stops. Chapter 3 – Types of Fire Stops and Fire Stop Materials is not intended to delve into the precise details of each such product but to provide the user with an introduction to the myriad of products available to perform the fire stop functions. Many of these products (and systems) are proprietary and are listed by one or more certification agencies. The unique chemical/physical attributes of most of these products or systems are protected by patents so that descriptions of their specific fire stop properties are not possible.

However, some generic products, permitted to be used as fire stops by codes, possess attributes that are well documented in the literature.

Users should note that the term "fire stop", as defined for use in this Guide, refers to the type of material or component used. A "listed fire stop system" refers to a tested and certified design which may be comprised of a number of fire stop products described in this chapter. In many cases, a listed fire stop system will be needed to meet the code requirements as described in Chapter 5 – Code Requirements for Fire Stop Installations and Sound Isolation.

For the purposes of this Guide, fire stop products (and systems) will be assembled into "groupings" and basic information provided about each grouping. These high level descriptions will enable a user to select a product or system with a basic knowledge of its construction and attributes. In this Best Practice Guide, fire stop materials and products have been divided into the following groupings which are listed in random order:

- Caulks and sealants
- Putties
- Mortars and grouts
- Foams
- Coatings and sprays
- Wraps
- Blocks, pillows and bags
- Composite sheets and boards
- Fire stop devices
- Generic materials

Properties of Fire Stops– Fire stops perform their required functions as a result of the fire resisting properties of the materials used in their construction, in combination with their appropriate installation. These fire-resisting properties result in the blocking of flame transmission, resisting high temperature transmission, or both, and sometimes resist smoke or water transmission. These properties thus enable the material or system to perform its required function. Each product possesses one or more of the following properties [3-2]:

- Intumescence – is the property of a material to increase in volume upon exposure to heat. This action causes the fire stop to fill the opening thus creating a seal in a fire separation. A typical intumescent product begins to swell at approximately 121°C, and reaches full expansion at levels of 540°C or above before it hardens into a rigid material. The rigid char layer, formed when the product intumesces, insulates and prevents fire penetration through the opening.
- Endothermic reaction – is the property in which a material absorbs the heat of the exposing fire by using that heat to decompose the material. A typical example is gypsum, which contains water bound in crystalline form. These crystals require a large quantity of heat to break down and release and evaporate the water. By absorbing heat on the fire-exposed side, the material retards heat transfer to the unexposed side.

- Ablative reaction – is the property in which a material resists heat transfer by using the heat of the exposing fire to erode the material. The material, by sacrificing itself, protects the unexposed side from rapid temperature rise until it is spent. A typical example is a silicon-based fire stop material.
- Insulation – is the property by which a material resists heat transfer as the result of its low thermal conductivity. Insulating materials used in fire stops must be stable at high temperatures to preserve their properties when exposed to fire. A typical example is a mineral wool made from fibres with a melting point well above the expected fire temperatures.

A particular fire stop system achieves its various ratings (F, T, H, L, FT, FH, FTH) (See Chapter 5 – Code Requirements for Fire Stop Installations and Sound Isolation) on the basis of which of these properties or combinations of properties it possesses. In Canada, fire stop systems achieving these ratings are certified by Underwriters' Laboratories of Canada, Underwriters Laboratories Inc. (through their cUL labelling) and Intertek Testing Services (formerly Warnock Hersey). Each of these certifies systems conforming to CAN/ULC S115. In the U.S.A., there are a number of nationally-recognized certification agencies which also certify these systems.

Limitations – Each fire stop system or material has its advantages and disadvantages depending on the specific application. The user should consult the manufacturers' product literature and the product listing to determine the limitations of each listed fire stop system for specific purposes. Some issues that a user should consider in making decisions on a fire stop material or system include:

- Ease of application at low temperatures
- Chemical compatibility
- Material safety restrictions
- Resistance to water and moisture penetration
- Resistance to smoke penetration
- Volatile organic compounds emitted
- Resistance to ultraviolet light and radiation
- Ease of re-penetration
- Potential to be dislodged by shrinkage or settlement of construction materials
- Adaptability to complex openings or congested locations
- Ease of clean-up
- Paintability
- Ability to adapt to some movement (flexibility)
- Ability to be poured into an opening and the need for damming material
- Speed and ease of installation
- Resistance to cutting, tearing and impact
- Ability to be used in large openings
- Ease of removal and re-installation
- Potential for vandalism or damage to installed system
- Need for skilled labour for installation
- Quality control of installation
- Adaptability to field adjustments for installation
- Timing of installation during construction process

3.3 Through-Penetration Fire Stops

Through-penetration fire stops are those that are employed when a penetrating item passes entirely through a fire separation. Such an opening creates the opportunity for fire and smoke to spread directly from one fire compartment to another. A through-penetration fire stop system "consists of a fire-rated wall or floor, a penetrating item (pipe, cable, conduit, etc.) and the firestop material" [3-3]. When testing through-penetration fire stops, the complete system (fire separation, penetrating item and fire stop material) is tested and not just the fire stop material alone [3-3].

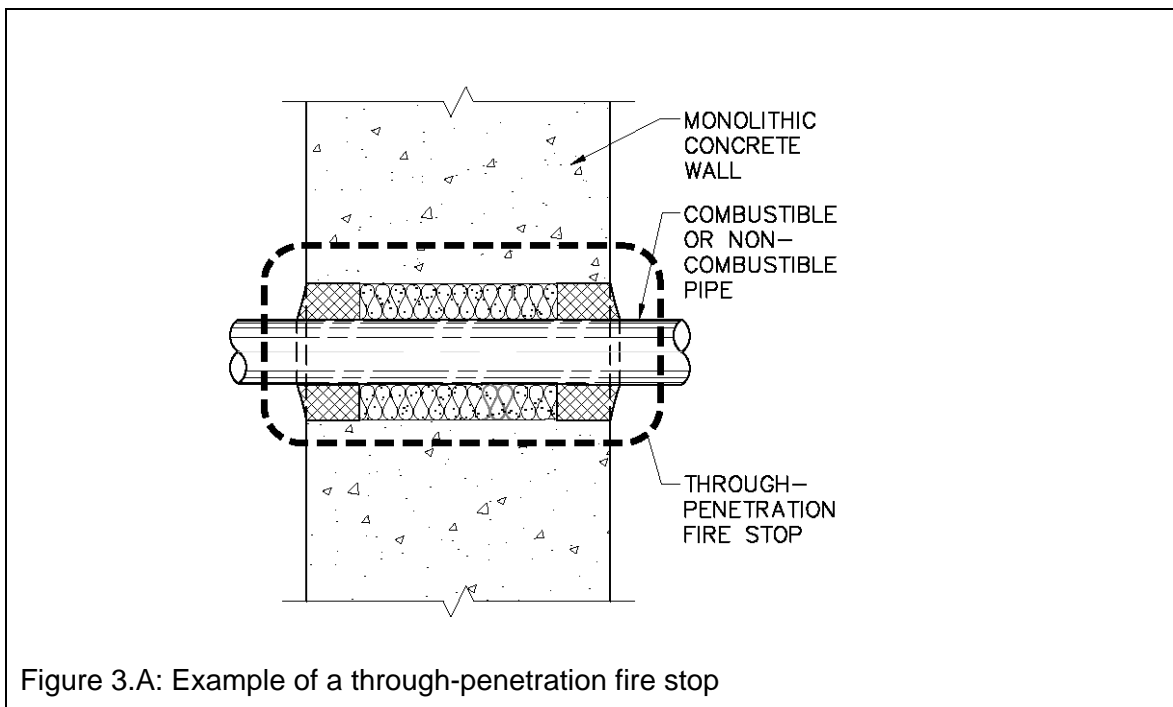


Figure 3.A: Example of a through-penetration fire stop

Through-penetration fire stop systems may be used to protect openings in wall or floor assemblies consisting of monolithic construction (e.g., concrete slab) or of multiple materials (e.g., gypsum board, insulation, studs) (see Figure 3.A). What is important to note is that the penetrating item passes through the entire assembly. Penetrating items may include piping, conduit, raceways, cable trays, bus ducts, cables, tubing, HVAC ducts or structural members. Penetrating items may be made of combustible or noncombustible materials; different fire stop systems are used for each type of penetrating item.

For assemblies where the entire fire resistance is provided by the protecting membrane (see Subsection 2.2.3 of this Guide), the selected through-penetration fire stop system must be able to maintain the entire rating at the back surface of the membrane and not just at the non-fire side of the complete assembly. This means that, in a standard fire test, fire cannot penetrate the membrane for the fire resistance time period.

There are some situations where an opening is created in a fire separation but the penetrating item has not yet been installed or has been removed. This can exist where cables penetrate a wall or floor assembly and changes to the cable arrangement

are frequently made. These are sometimes referred to as "blank opening fire stops" and they are rated in the same manner as for through-penetration fire stops using CAN/ULC-S115, but without a penetrating item.

3.4 Membrane-Penetration Fire Stops

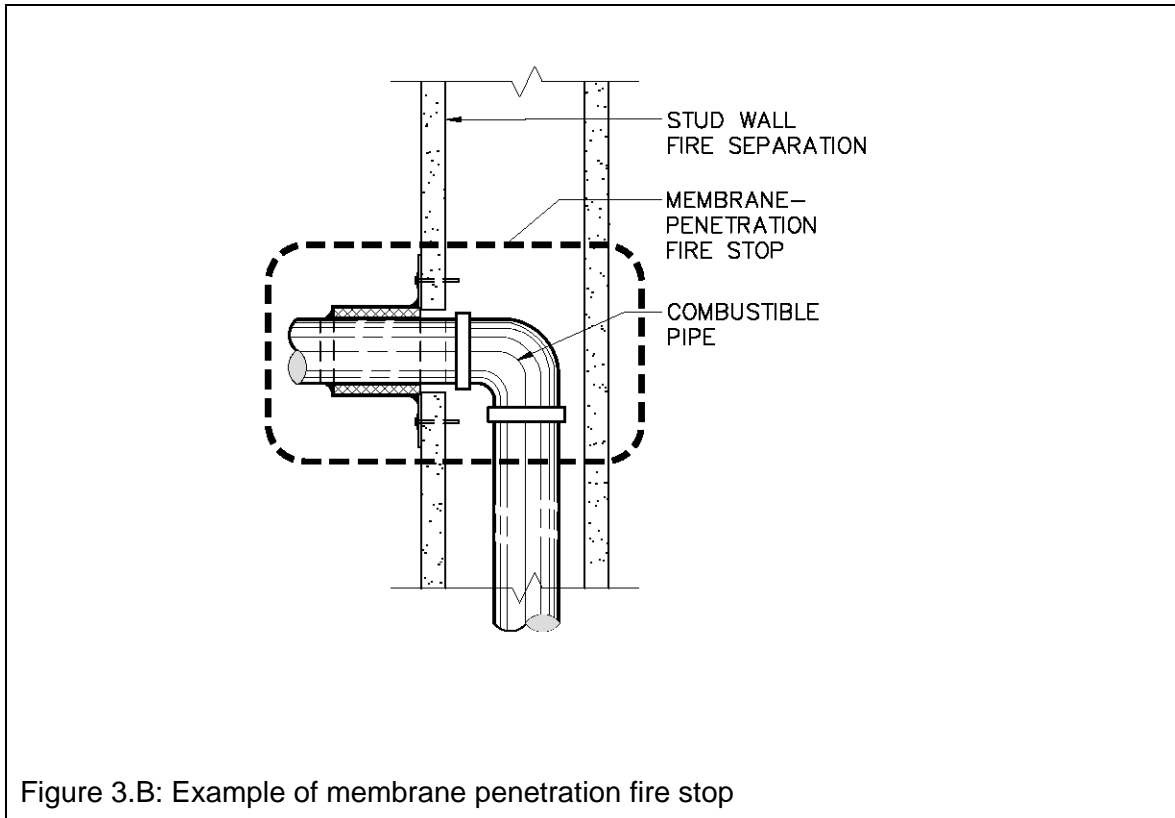
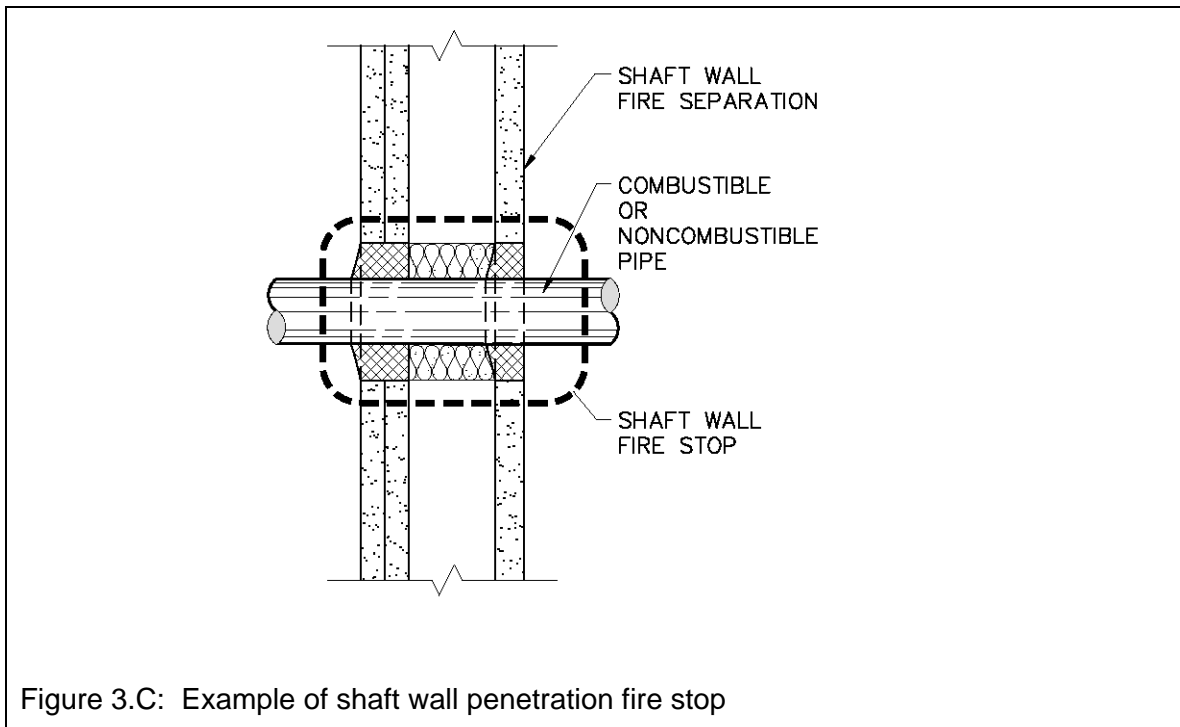


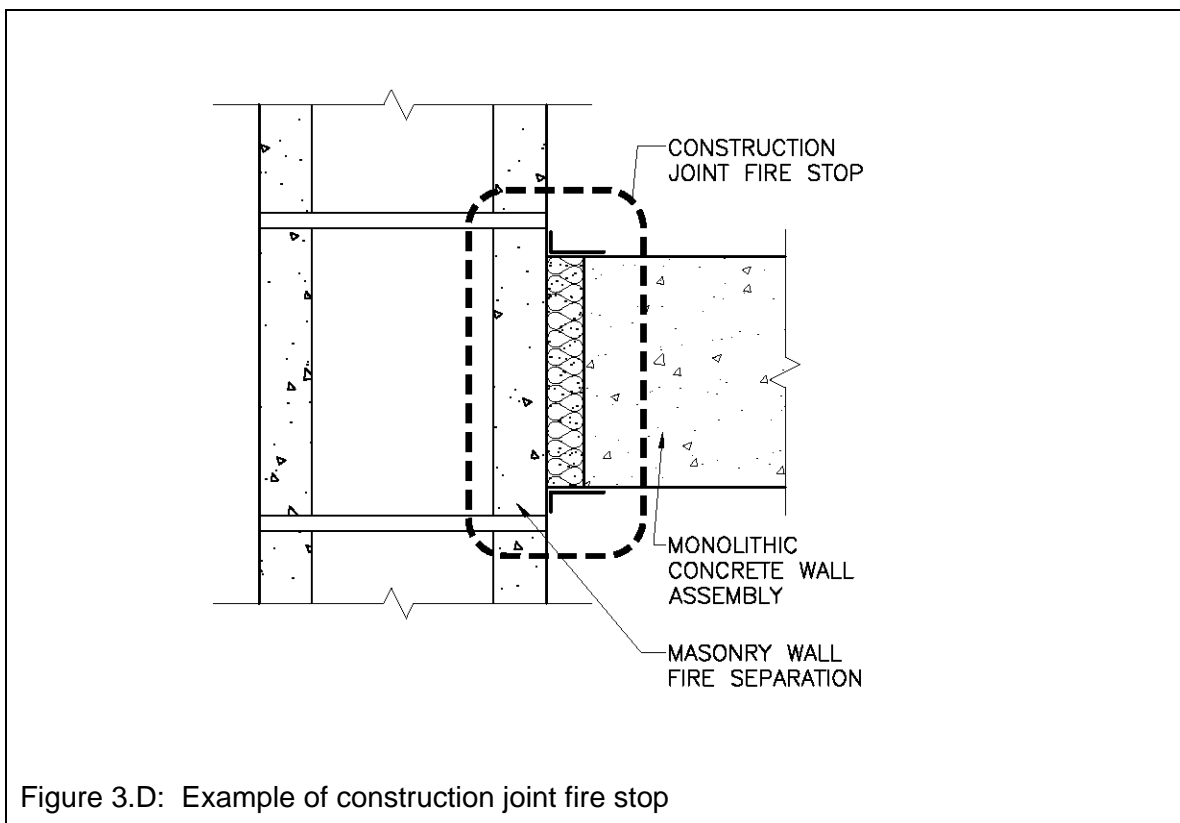
Figure 3.B: Example of membrane penetration fire stop

Membrane-penetration fire stops are those that are employed when a penetrating item passes through only one membrane of a fire-rated assembly (made up of multiple materials) but does not pass through the entire assembly (see Figure 3.B). Examples include an electrical box on one face of a wall with wiring or conduit inside the wall, or piping from a sink on one side of a wall. The failure of a membrane-penetration fire stop will allow fire to enter the assembly itself but not necessarily to immediately reach the non-fire side of the assembly. A membrane-penetration fire stop system consists of "a material, device or construction installed to resist ... the passage of flame and heat through openings in a protective membrane in order to accommodate cables, cable trays, conduit, tubing, pipes or similar items" [3-3]. Penetrating items may include piping, conduit, raceways, cable trays, ducts, cables, tubing, HVAC ducts or structural members. Penetrating items may be made of combustible or non combustible materials; different fire stops are used for each type of penetrating item.

"Shaft wall" construction – Shaft walls are typically proprietary assemblies which have been certified as meeting the fire resistance requirements of the NBCC. Fire stop systems for shaft walls should be treated as through-penetration fire stops described in 3.3 of this Guide rather than as membrane-penetration fire stops addressed in this Section (see Figure 3.C).



3.5 Construction Joint Fire Stops



Construction joint fire stops are those which are installed where two adjacent fire separations or components of fire separations meet (see Figure 3.D). These locations include all ceiling/wall and roof/wall joints, wall/wall joints either at a corner or in the same plane, wall/floor joints, floor/floor joints and ceiling/ceiling joints. Typically, these joints are linear and are either in the horizontal or vertical planes. CANULC-S115 refers to these as "joint firestop systems" [3-1].

Construction joints in which fire stops are usually required include seismic joints, vertical control joints, expansion joints and joints which occur at the tops and bottoms of fire separation walls. Listings for construction joint fire stops include information about whether or not the joint is capable of accommodating a defined amount of movement (called dynamic joints) or if the fire stop has been tested as a static joint.

Where a top-of-wall joint abuts a corrugated steel roof deck or floor assembly, the shape of those fire stops will be somewhat irregular to follow the contours of the deck and thus maintain the continuity of the fire compartment. There are occasions where a fire-rated wall abuts the underside of a non-fire-rated roof deck, a situation not addressed currently in CAN/ULC-S115. Since CAN/ULC-S115 addresses only joints between two fire-rated assemblies, there are no listed fire stop systems for this type of construction. In this instance, an engineering judgement (see Chapter 7 – Basic Issues Related to Best Practice for Fire Stops and Fire Blocks) may be necessary to ensure that appropriate protection is provided.

3.6 Building Perimeter Fire Stops

The space between a fire-rated floor assembly and a curtain wall is one where unchecked fire and smoke spread can impact numerous floors simultaneously unless properly protected. This, while being a linear joint, is treated by CAN/ULC-S115 as an entity separate from the construction joints discussed in Section 3.5. The space between a curtain wall and a floor assembly is often called a "safing slot" and the fire stop used in it is often called a "perimeter fire barrier system" [3-4]. In this Guide, they will, however, be referred generically to as "building perimeter fire stops".

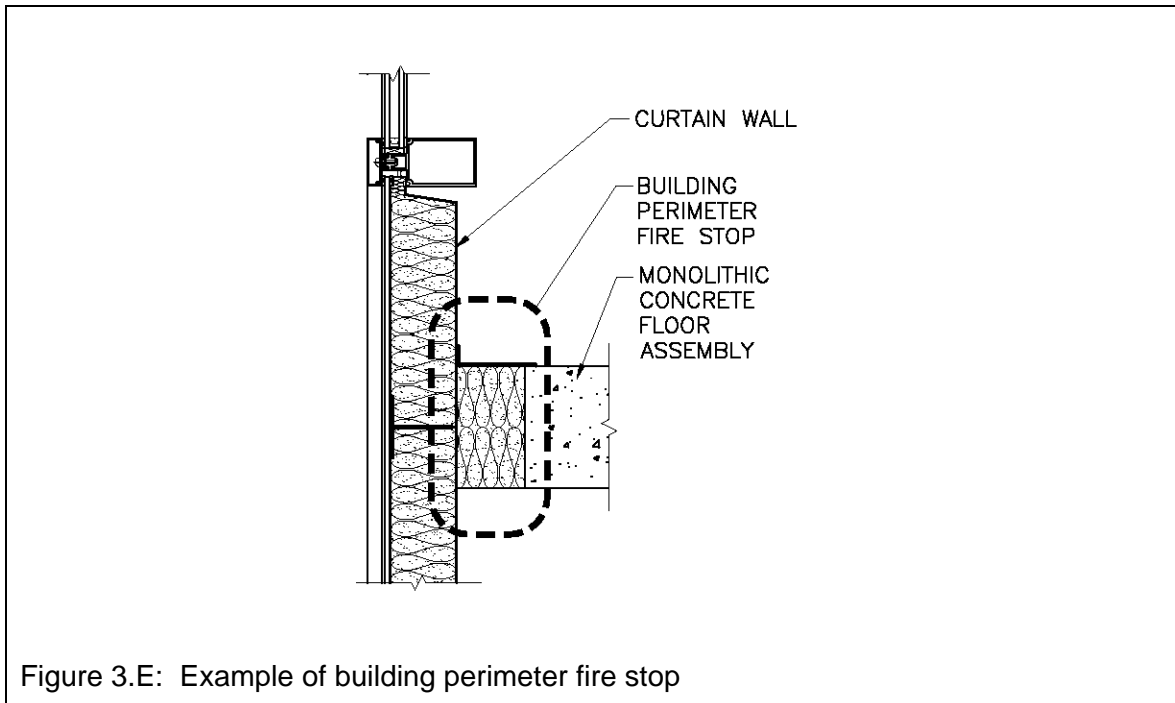


Figure 3.E: Example of building perimeter fire stop

Building perimeter fire stops (see Figure 3.E) are particularly important in high-rise buildings where differential pressures, caused by stack effect, exacerbate the movement of smoke – and the safing slot can be an ideal avenue for vertical fire and smoke spread. The NBCC does not specifically address building perimeter fire stops. The method of addressing the fire performance of most building perimeter fire stops is to consider the joint system as the means of providing continuity of the fire-rated floor assembly. Since the building perimeter fire stop is essentially an extension of the fire-rated floor assembly, its rating may typically be equal to the rating of the floor in which it is installed.

CAN/ULC-S115 (see below) states that CAN/ULC-S115 should not be used to evaluate building perimeter fire stops where a non-rated curtain wall is to be installed. It is expected that building perimeter fire stops will be addressed in a Canadian standard in the future. For fire-rated exterior walls, however, building perimeter fire stops conforming to CAN/ULC-S115 may be used.

1.8: The testing of a *joint firestop system* placed into a *perimeter joint* located between a fire rated floor and a non fire rated exterior wall is not intended to be tested using this test method. [Ref: 1.8 of CAN/ULC-S115, 2005].

In the U.S.A., a specific test method has been developed to evaluate building perimeter protection with non-rated curtain walls – the Intermediate Scale Multi-Story Apparatus [3-5]. This test method is intended to evaluate the protection of the safing slot where a curtain wall is not required to be fire-rated (see also Chapter 5 – Code Requirements for Fire Stop Installations and Sound Isolation). With a non-rated curtain wall, appropriate fire stops in the safing slot will force the fire through the exterior wall, if it is trying to spread upward; the fire stop prevents smoke and fire spread through the cavity to the floor above. For building perimeter systems located between a fire-rated exterior wall and a fire-rated floor assembly, CAN/ULC-S115 can be used.

3.7 Caulks and Sealants

Caulks and sealants are often used for single and multiple penetrations in an opening because they are adaptable to more complex and unusual penetrations and openings (see Figures 3.F, 3.G and 3.H). Caulks are normally applied around a penetrating item in an opening with a caulking gun to form a seal. A sealant is a similar material to a caulk that is applied with a trowel or putty knife, or is spray-applied. Caulks and sealants can possess intumescent or endothermic properties, depending on the specific material used. Caulks are used to seal the annular space around a penetration (e.g., pipe, cable, duct), or to cover a mineral fibre or similar material used in a construction joint [3-2]. Caulks and sealants can be of the latex, solvent-based or silicon types [3-6].

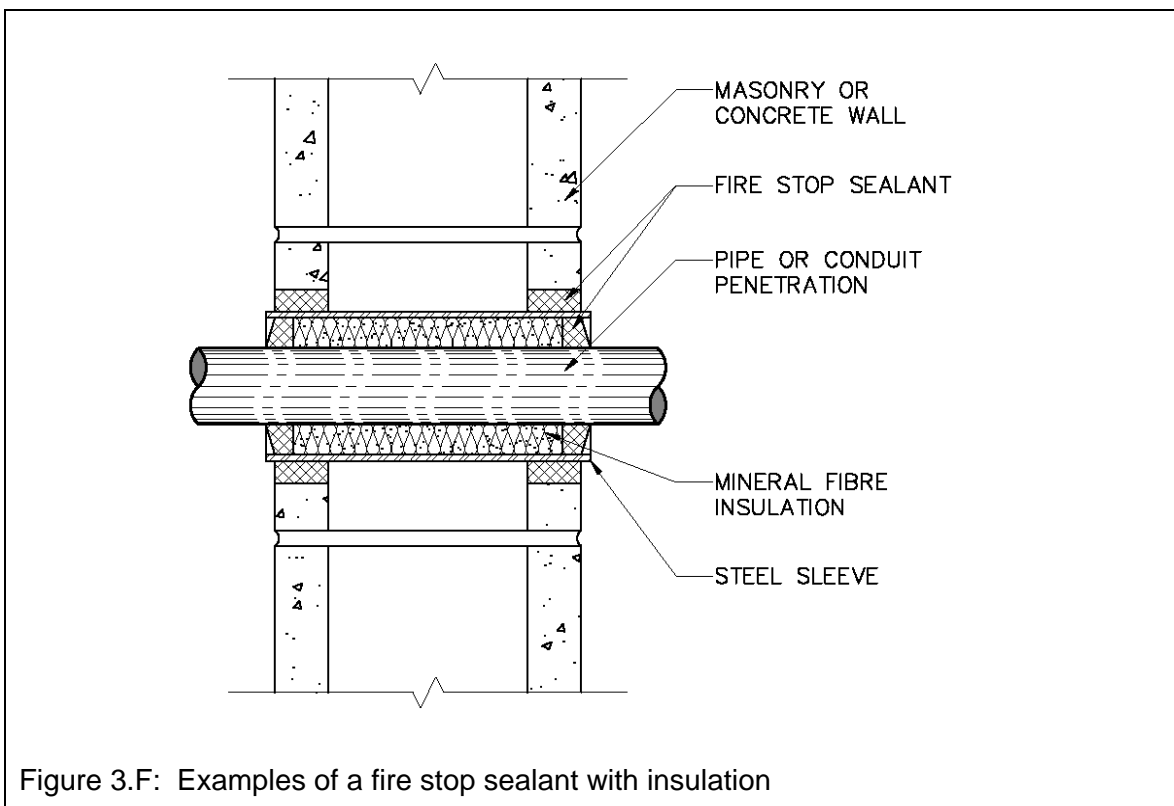
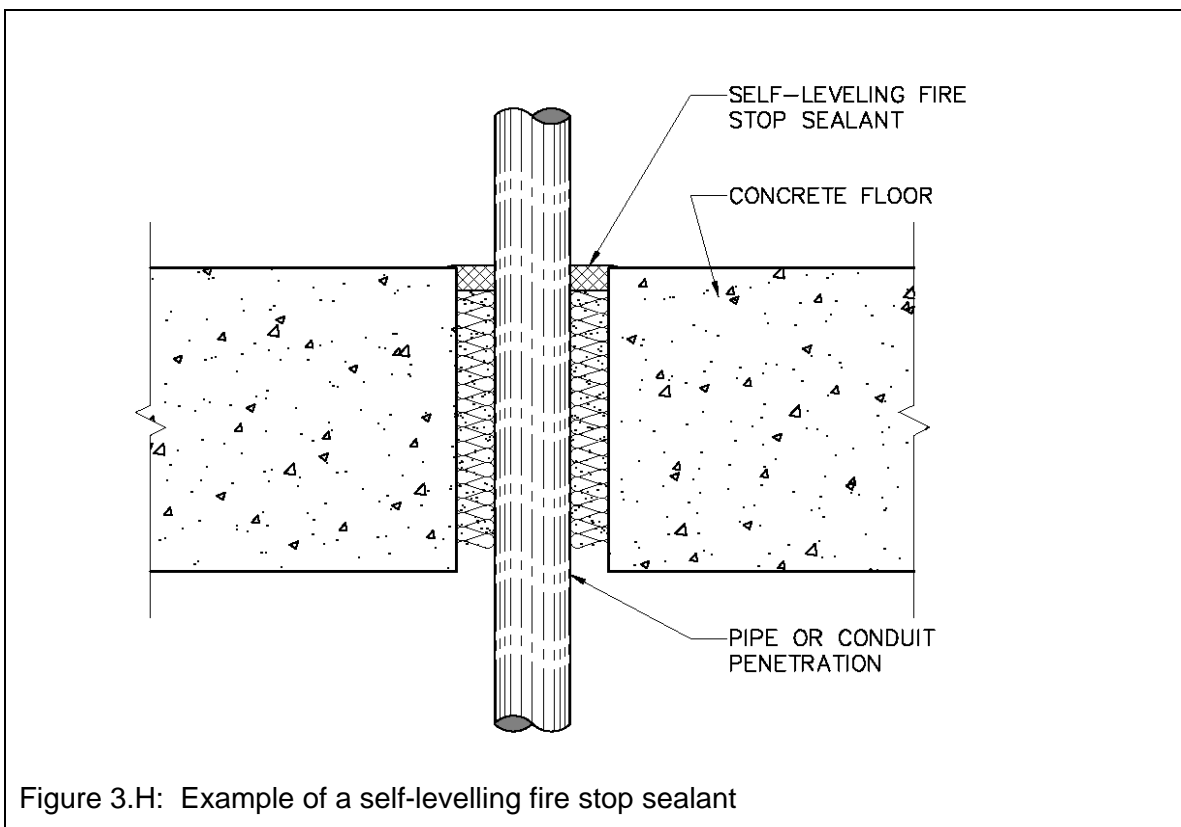
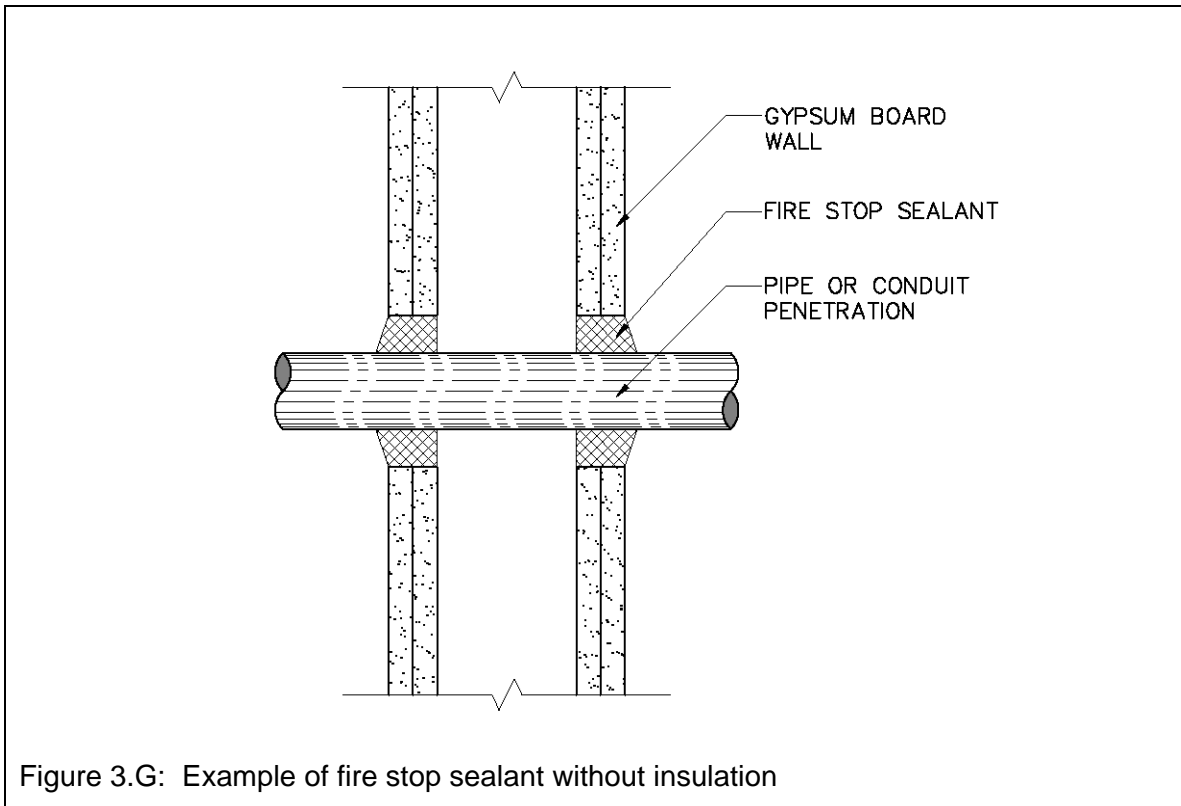


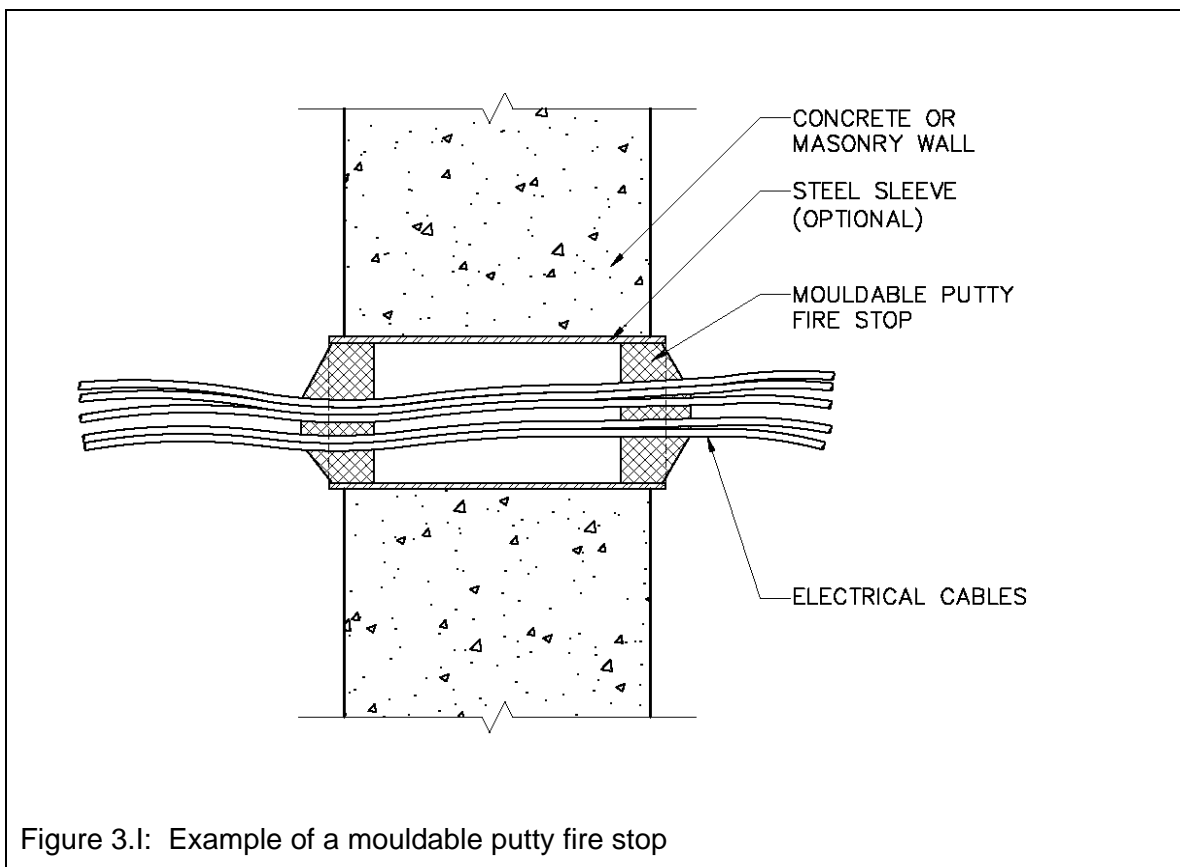
Figure 3.F: Examples of a fire stop sealant with insulation



3.8 Putties

Putties are normally installed as fire stops in similar situations as caulks and sealants. Putties are fire stop materials that are mouldable and can be pressed manually into an opening in a fire-rated assembly (see Figure 3.I). They may possess either intumescent or endothermic reaction properties. Putties are sometimes used to create a fire stop envelope over electrical boxes embedded in stud walls (see Figure 3.J). Putties are mouldable and thus provide ease of entry as they remain pliable and reusable for years.

Users should be aware that putty pads for electrical boxes (See Figure 3.J) are not yet listed to CAN/ULC-S115 but to a comparable UL protocol involving CAN/ULC-S101. Systems using mouldable putty are listed by ULC to CAN/ULC-S115.



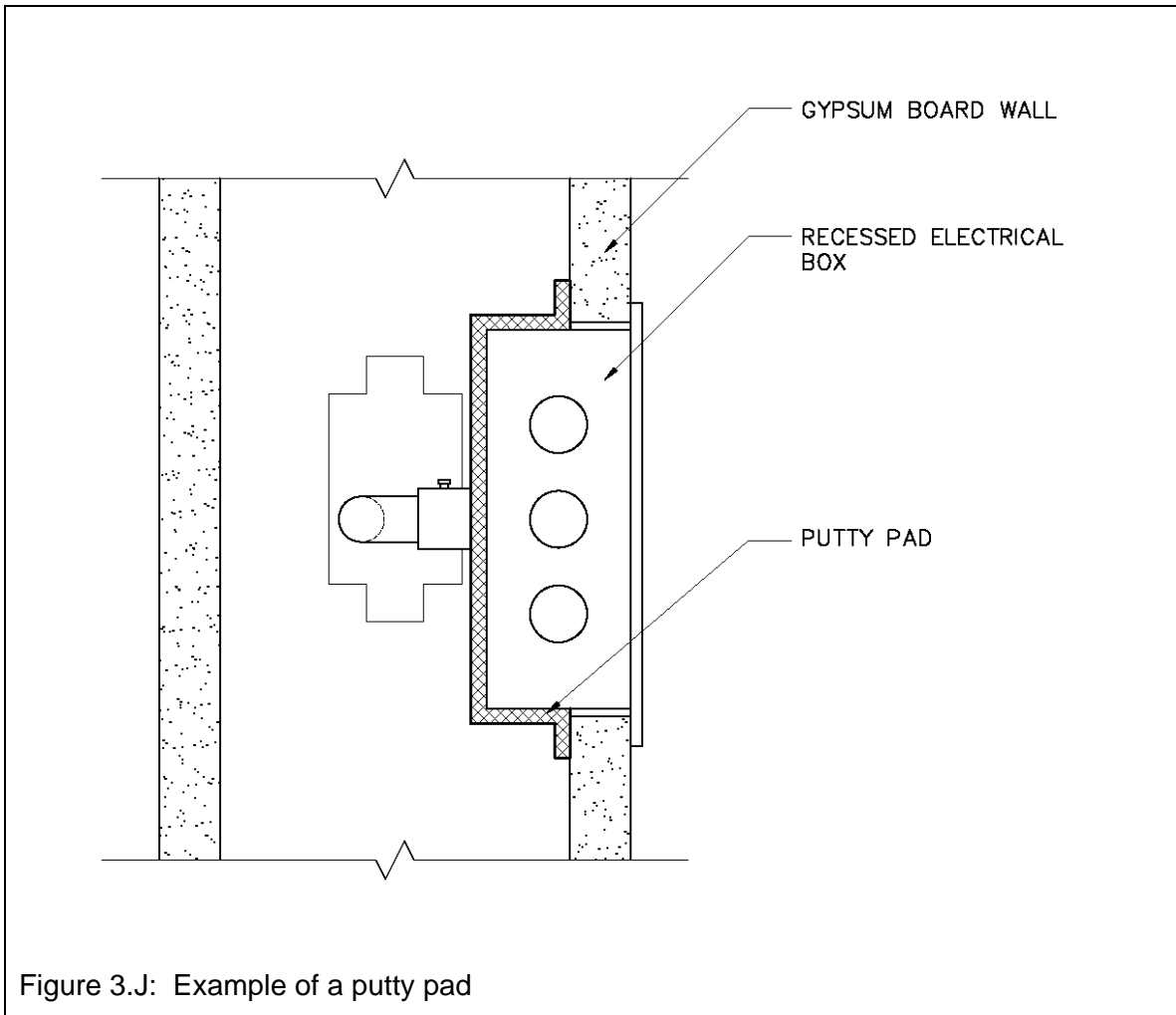


Figure 3.J: Example of a putty pad

3.9 Mortars and Grouts

Mortars and grouts are materials that are troweled, poured or pumped to fill large openings around pipes, ducts, cable trays and similar openings. These are specific mortars and grouts listed as part of a fire stop system and not general construction products. These materials use bonding or wedging of the material into the opening for support and harden to form a barrier that does not shrink under fire exposure (see Figure 3.K). Typically, a "damming" material is needed to support the mortar or grout during installation and curing although some mortar products are self-supporting. Mortars and grouts are often used in combination with wraps or sealants and are often listed for use on large vertical or horizontal openings. They are also commonly used for multiple penetration openings or situations where one side of a penetration is inaccessible. They can usually be drilled and filled to facilitate the addition or removal of a penetrating item. If the penetrating item is expected to move during the life of the building (e.g., thermal expansion, shrinkage), provision must be made with mortar and grout fire stop systems to accommodate that movement so that the fire stop is not compromised. An expansion joint or similar provision is often provided to allow the penetrating item to move without compromising the fire stop (not shown in Figure 3.K).

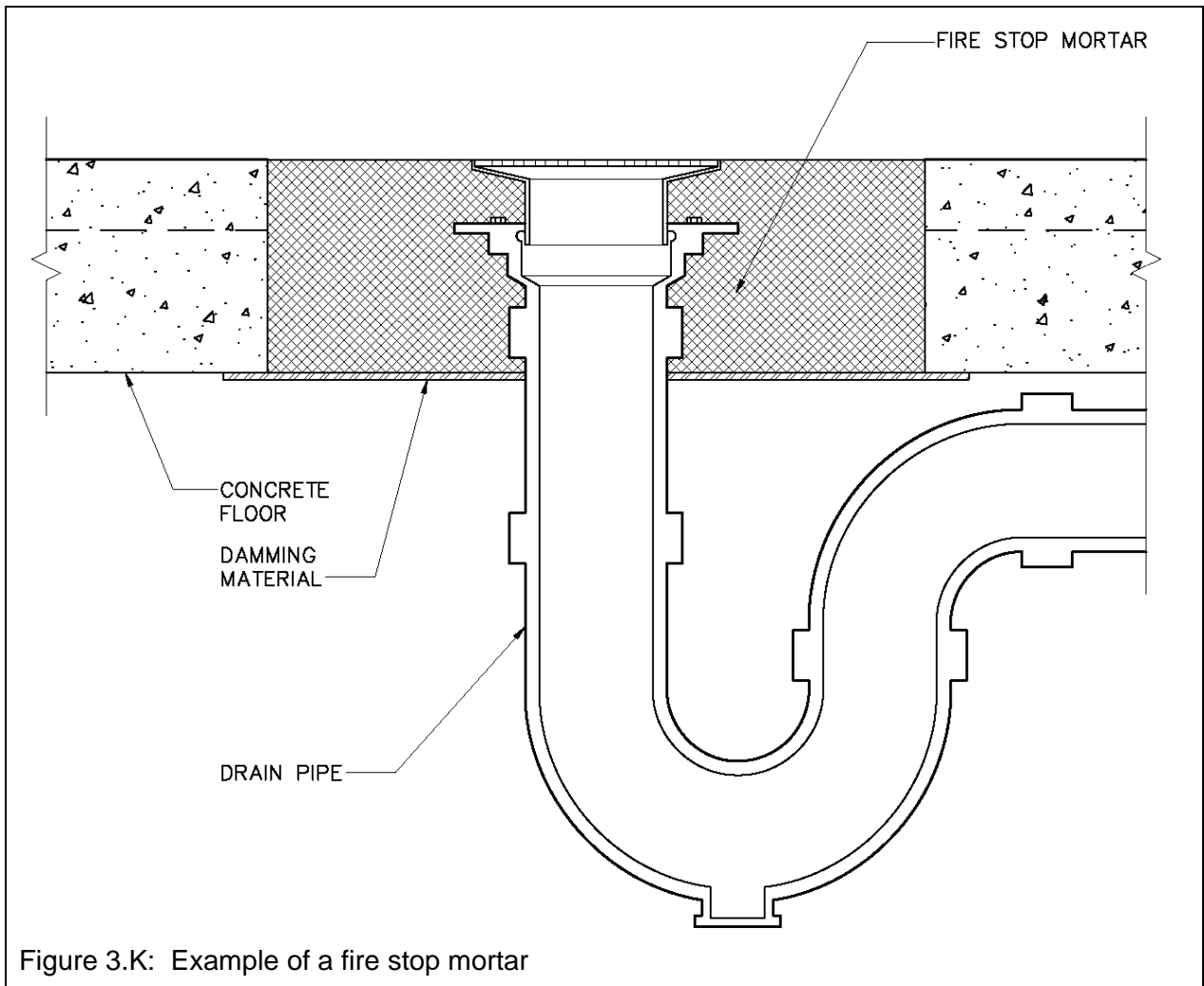


Figure 3.K: Example of a fire stop mortar

3.10 Foams

Fire stop foams are products, similar to caulks, but which expand during installation to fill openings in fire-rated assemblies (see Figure 3.L). Foam fire stop systems, typically used for small/medium sized openings, are often utilized where an opening is difficult to reach. Some foam products are used with a packing or damming material. Users of foams should check the manufacturer's technical literature as some foams remain liquid for several minutes before foaming occurs. In this situation, damming or packing is necessary.

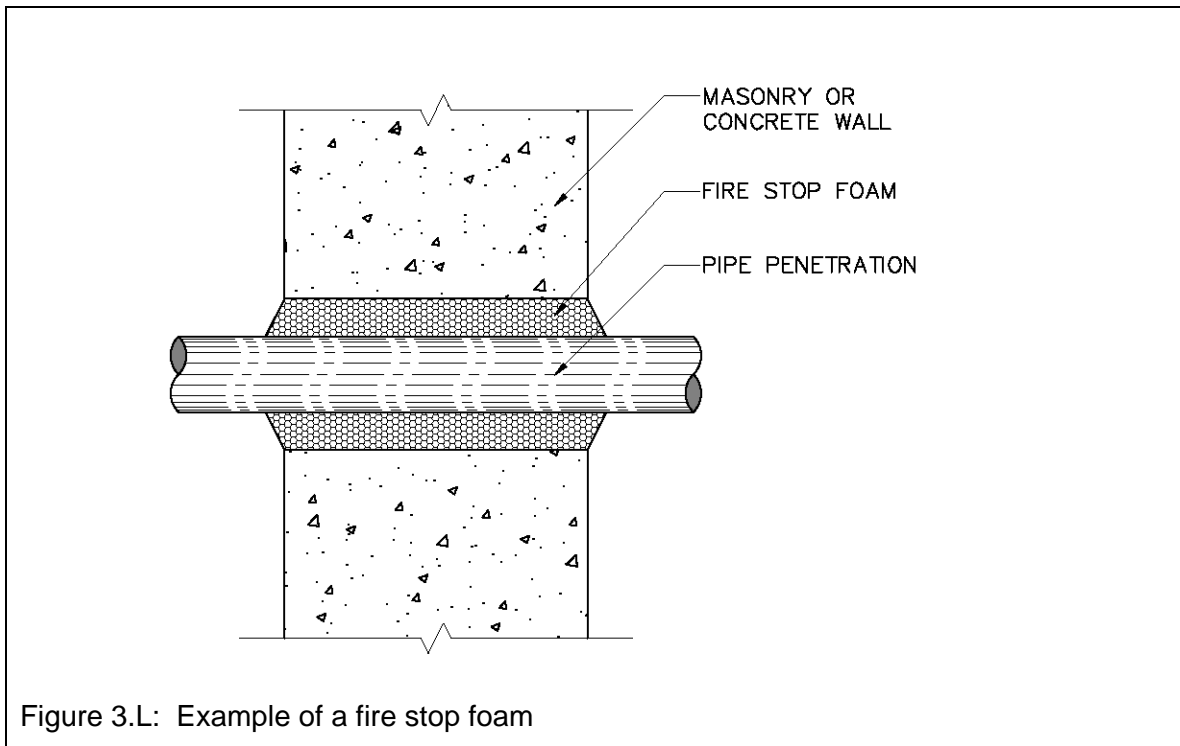


Figure 3.L: Example of a fire stop foam

3.11 Coatings and Sprays

Coatings and sprays are typically intumescent or ablative reaction materials that are sprayed or brushed into place, usually over a substrate of tightly-compressed mineral wool insulation (see Figure 3.M). The mineral wool acts as a damming material for the spray and provides resistance to heat transmission. Coatings and sprays are often used to cover construction joint fire stop systems where caulks would be time-consuming to install. Most coatings or sprays dry to form a flexible seal which can withstand a certain amount of movement [3-2] and withstand a degree of water penetration.

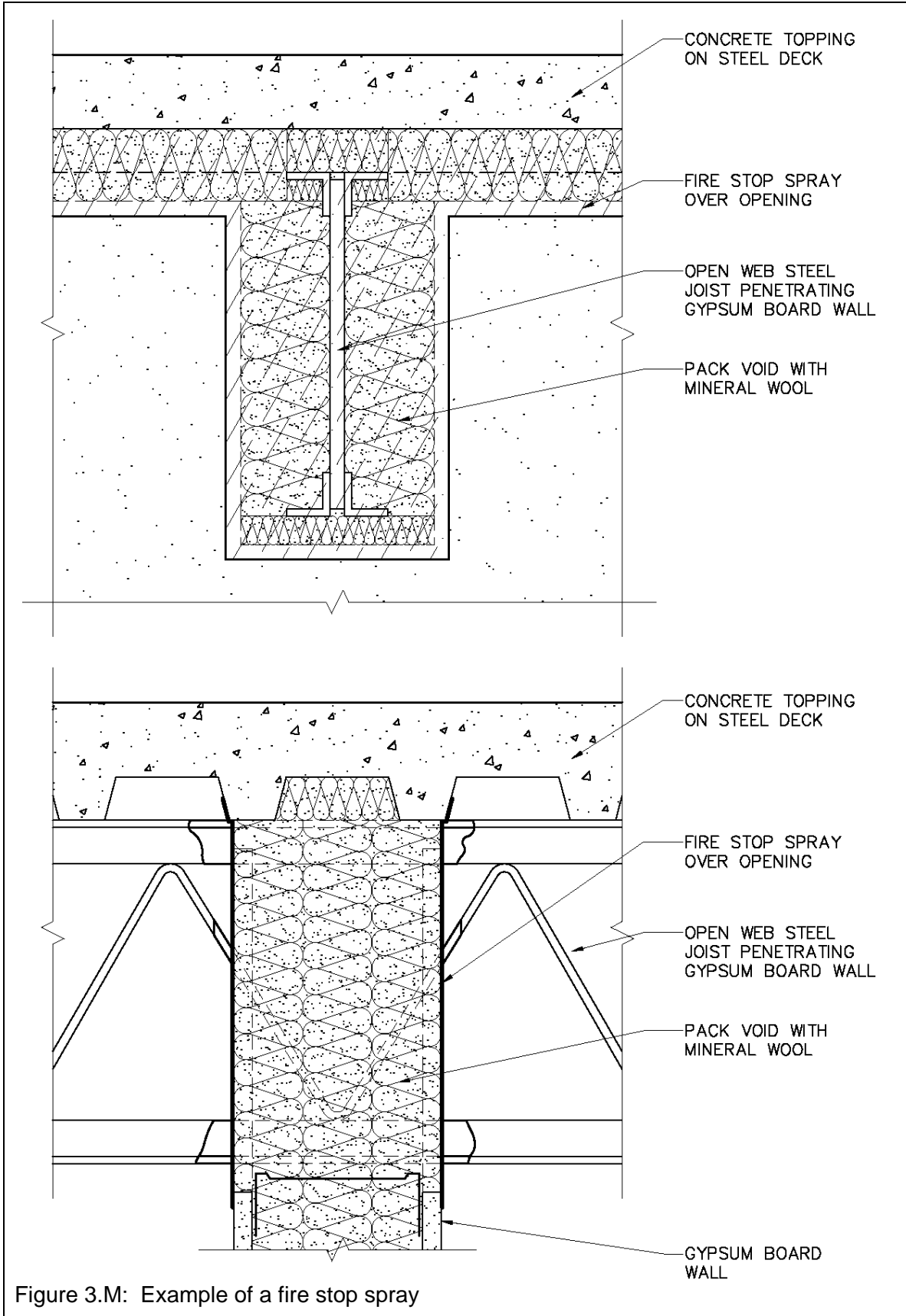
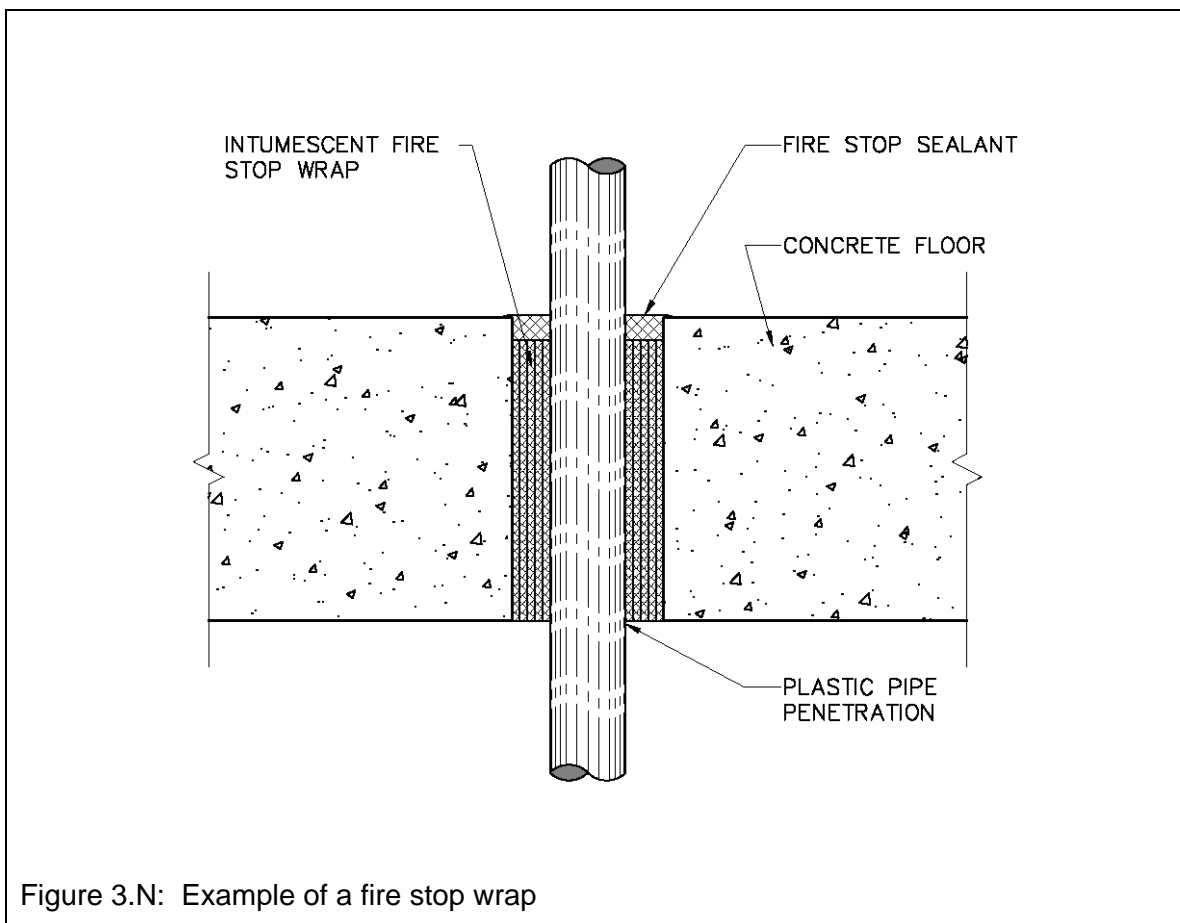


Figure 3.M: Example of a fire stop spray

3.12 Wraps

Wraps, used as fire stops, are intumescent tapes or strips (often in roll form) that are wrapped around a penetrating item to seal the opening (see Figure 3.N). Wraps are commonly used as fire stops for vented non-metallic (plastic) pipes in which the wrap intumesces under fire conditions, as the pipe softens or burns away, thus filling the resulting gap. They are also used around insulated metallic pipes. Wraps are often applied in multiple layers (The number of layers is specified by the listing requirements) around the penetrating item to fill the gap between the penetrating item and the fire-rated assembly, and to fill the space made by the collapsing plastic pipe [3-7]. Intumescent wraps may be used with metal collars adjacent to an assembly where there is insufficient space for the wrap inside the opening in the assembly. Pre-measured sections of intumescent wrap material are sometimes used for electrical box protection.



3.13 Blocks, Pillows and Bags

Blocks, pillows and bags are used for fire stops to fill large openings around pipes, ducts or cable trays (see Figure 3.O). Blocks are essentially fire stops formed as rectangular blocks and built up to fill an opening. These fire stops combine intumescence with insulation to perform their intended function. They are removable and replaceable so are frequently used for fire stops where reconfiguration of penetrating items is expected at a later date, such as with cable penetrations. In some cases, a wire mesh may be needed to protect the pillows from removal if the fire stop is not located in a controlled location.

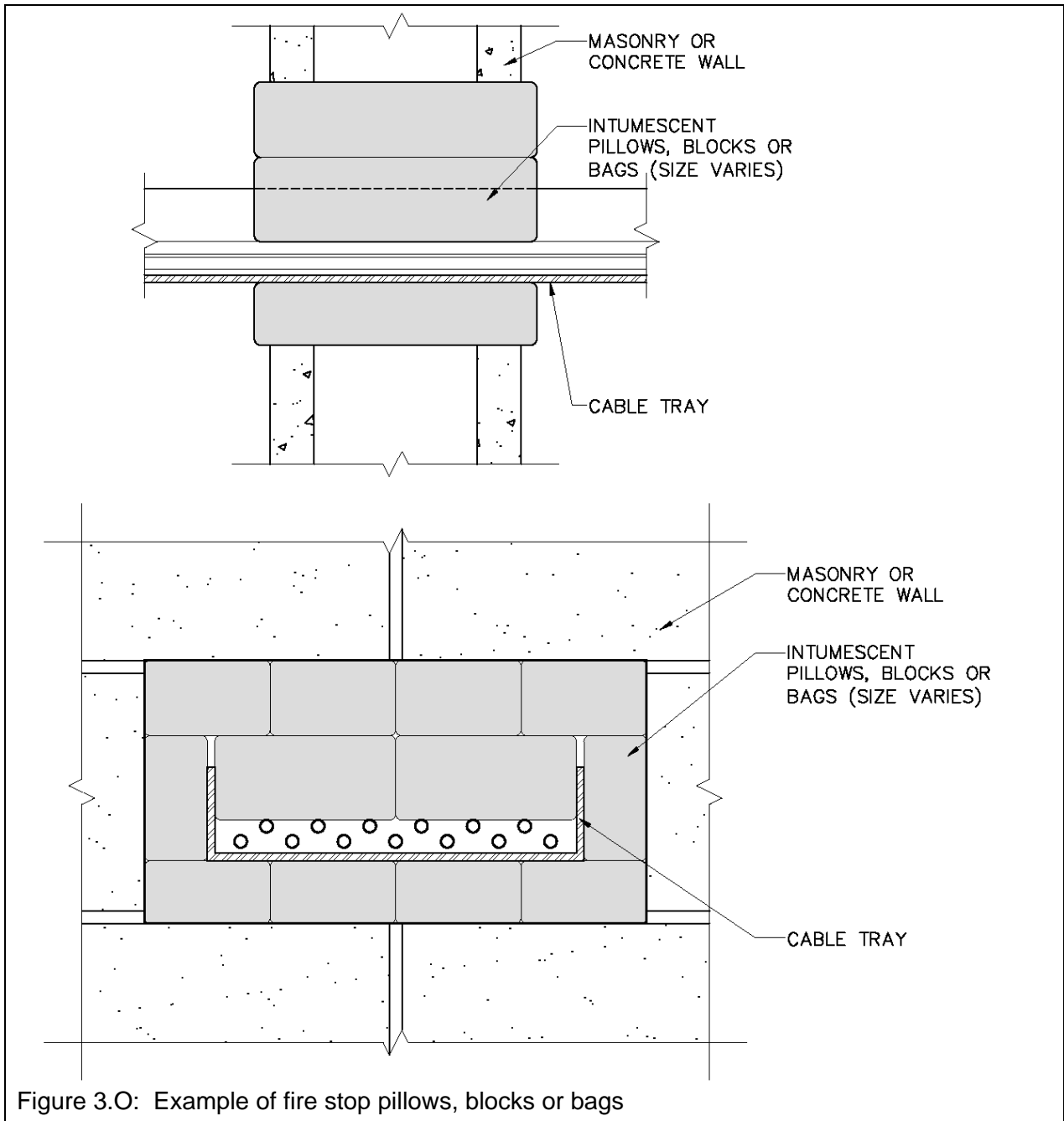
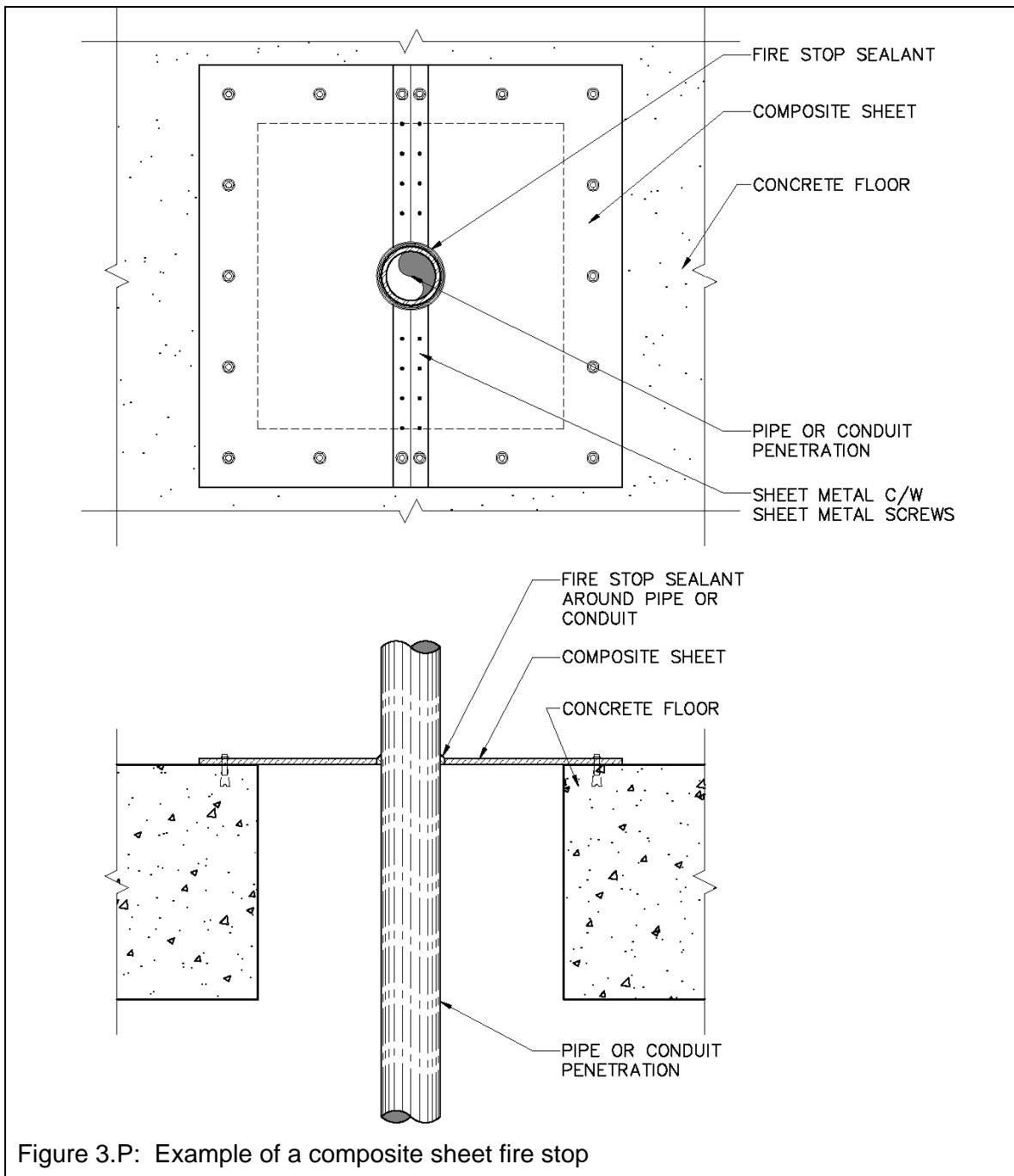


Figure 3.O: Example of fire stop pillows, blocks or bags

3.14 Composite Sheets and Boards

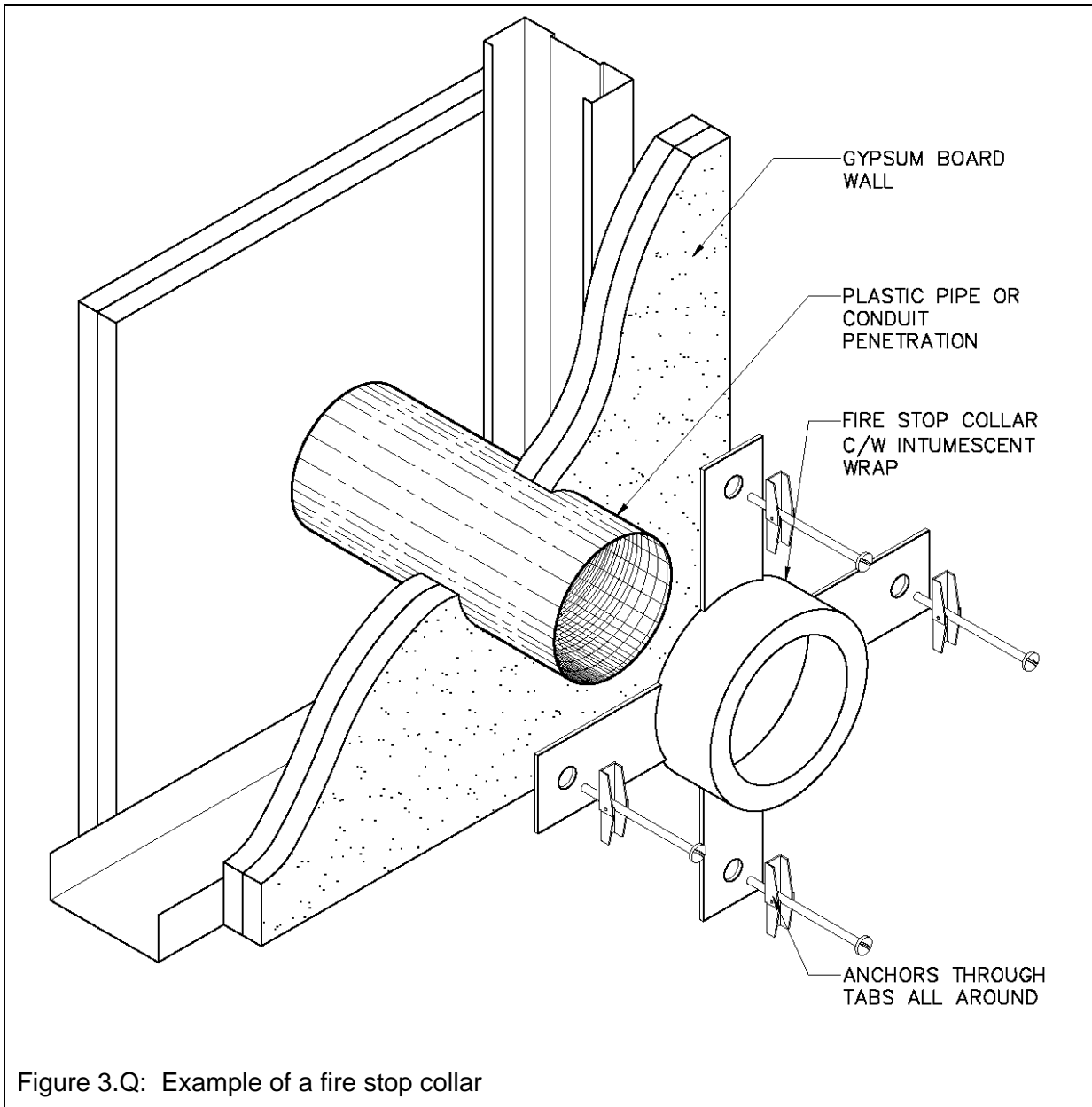
Composite sheets and boards consist of panels sandwiched around an intumescent material (see Figure 3.P). These are examples of fire stop products often used for large openings and openings requiring re-penetration. They are typically cut to fit closely around penetrating items, fastened to the fire separation and caulk or putty provided to seal around the penetrating item. They are commonly used for openings that are too large to be sealed by caulks or putties on their own [3-2].

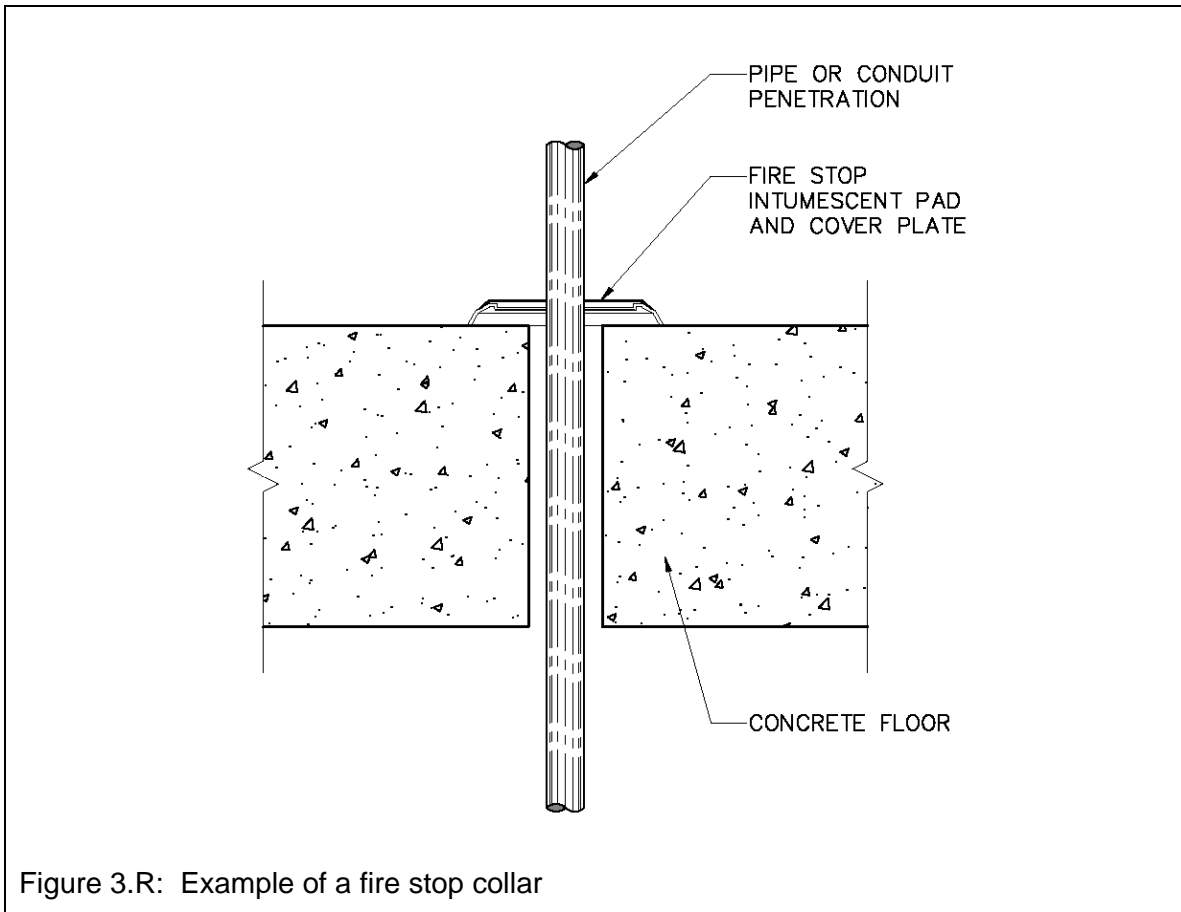


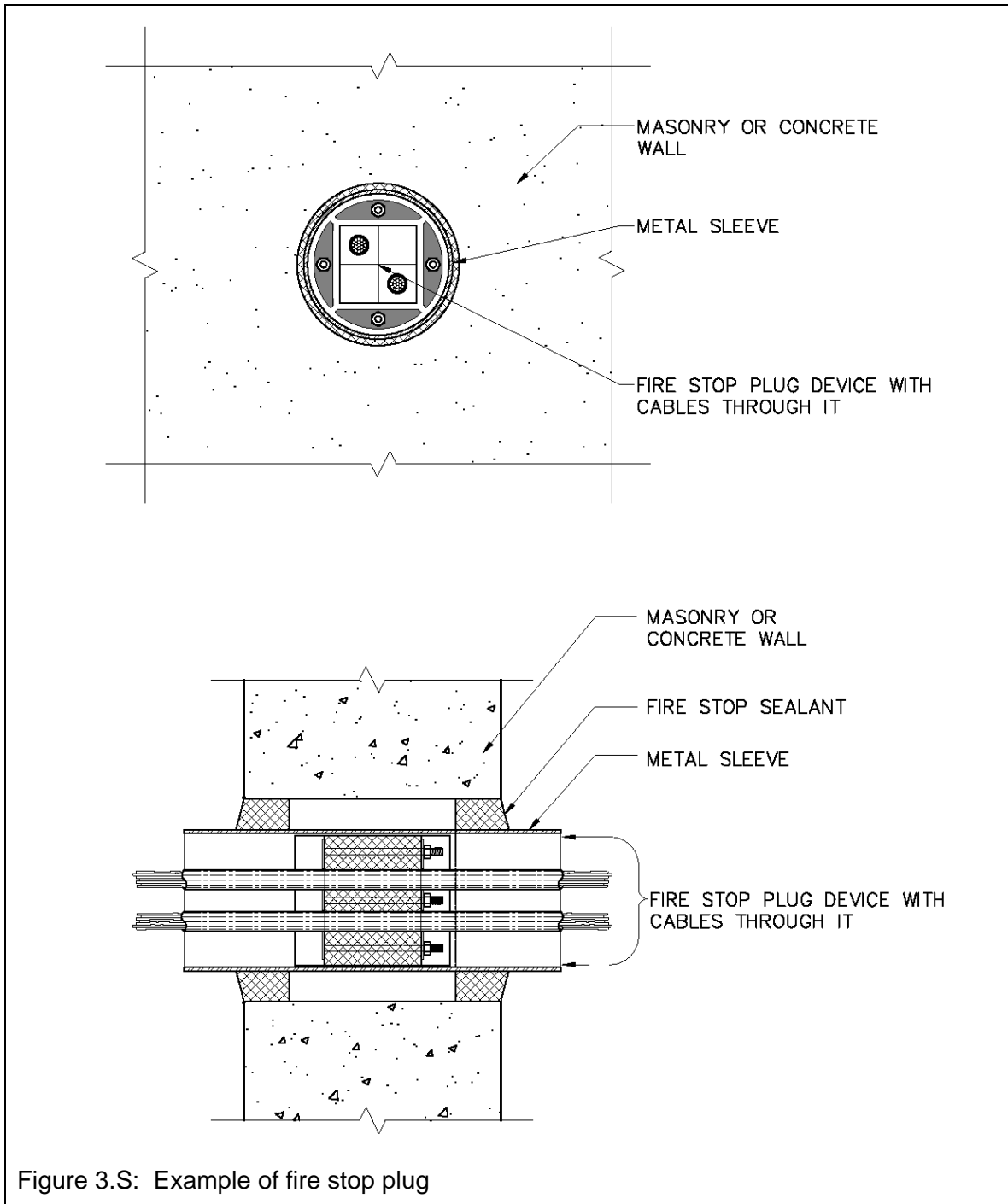
3.15 Fire Stop Devices

Fire stop devices are manufactured products usually designed for attachment to a fire separation. They primarily consist of steel collars (see Figures 3.Q and 3.R), plugs or plates that are used in conjunction with wraps, caulks, putties and other products to create the fire stop system. (See Figure 3.S for fire stop plug.)

The wrap, caulk, putty or other product, in combination with the fire stop device, are often used to close an opening created by the melting of a combustible penetrating item.







A slightly different fire stop device from those above is an intumescent electrical box insert as shown in Figure 3.T. These are currently not listed to CAN/ULC S115 but are sometimes used in retrofit situations where it may not be practical to install another type of device.

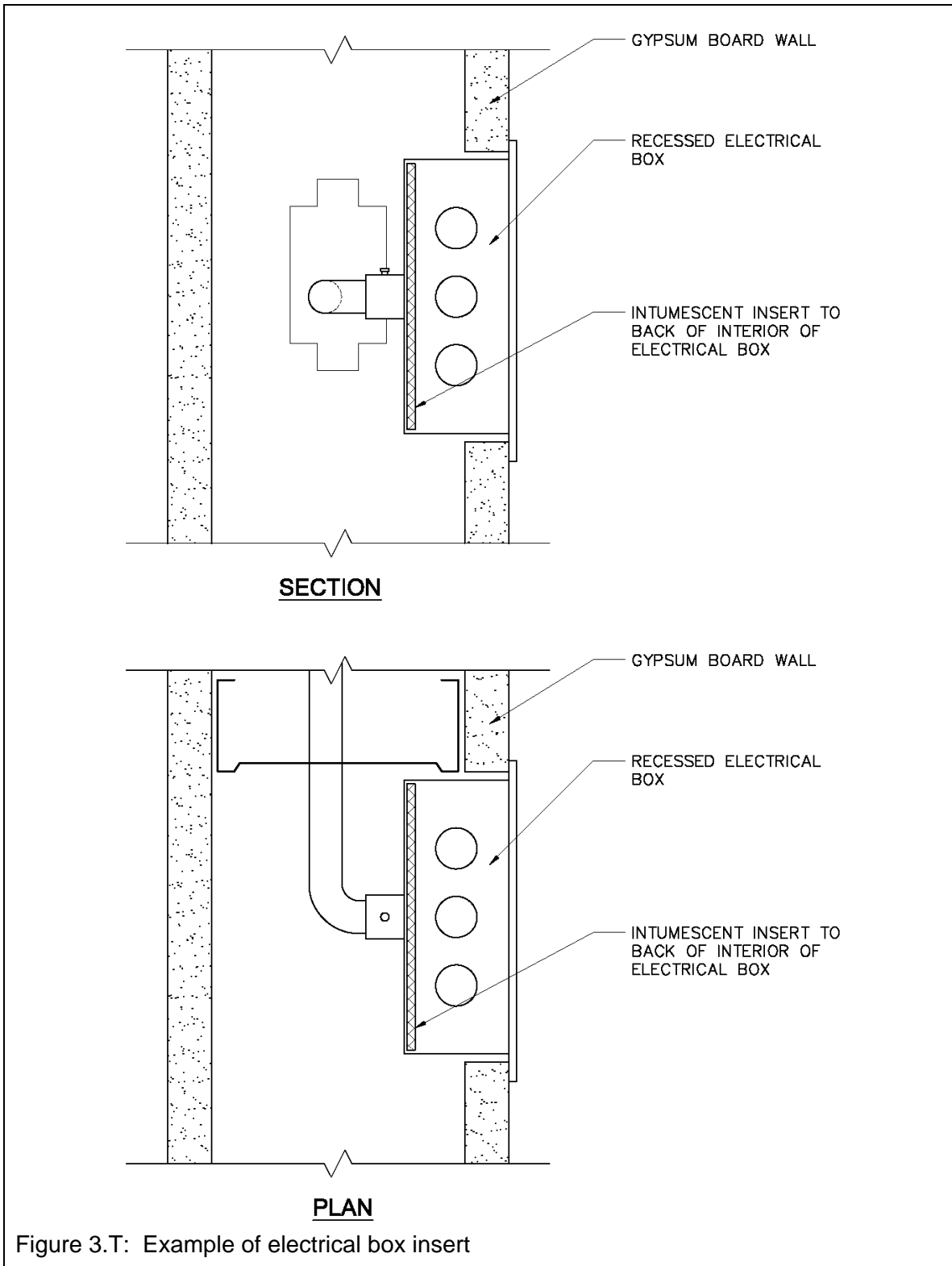
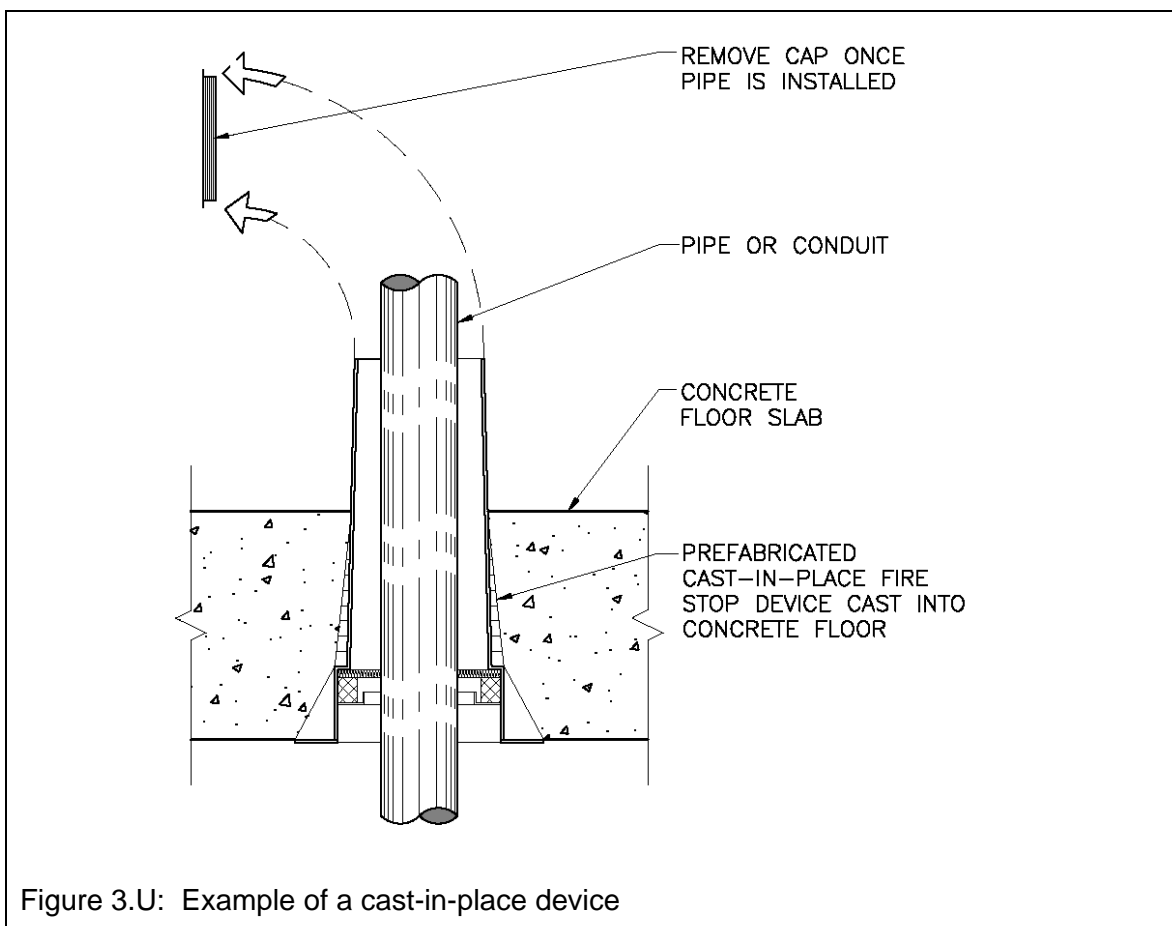


Figure 3.T: Example of electrical box insert

Another fire stop device is a "Track and Slip" system which combines a metal track with strips of gypsum board to create a fire stop at the top of a wall below a steel deck in particular. These devices allow movement to occur at the top of a wall – a common issue with metal roof and floor decks. These are described in Chapter 11 – Best Practice for Fire Stops for Construction Joints.

Another type of fire stop device is a cast-in-place fire stop. Plumbers typically install this system, often prior to the construction of walls and some floors. A similar cast-in-place device is a pre-manufactured product which allows the installer to place the fire stop before pouring the concrete (see Figure 3.U). These are often designed so that upon the installation of the penetrating item, the listed fire stop system is complete and no further installation work is required.



3.16 Generic Materials

While the various materials and systems listed above provide many solutions for fire stops, there are a number of generic materials that may be used as part of a listed fire stop system. Fibre insulations, which may be generic materials, are commonly used in many of the listed fire stop systems discussed in this chapter. The specific types of insulations used for these applications include mineral wool, ceramic fibre and, in some cases, glass fibre. For all listed fire stop systems, the specific type of insulation(s) stated in the listing must be used. When using these insulation materials in fire stop

systems, it is important to ensure that the thicknesses and densities meet those of the listing and that any compression requirements are closely followed.

Mineral wool – is a mineral fibre insulation processed from rock or slag. It is often used to fill spaces where its compressibility and resilience are needed to address structural movement in fire stop systems. It is commonly used as an insulating material in many of the systems described in this chapter as well as for building perimeter fire stops. Mineral wool begins to melt at approximately 1100°C.

Note: The term “mineral fibre” is used to describe a family of fibre insulation products which includes glass fibre. This latter product is treated separately in this Guide as shown below.

Ceramic fibre – is a space-age, high-temperature insulation product commonly used in the refractory industry. Ceramic fibre products are available in blanket or board form. Ceramic fibres are also incorporated into mastics to create a hard, non flexible fire stop system that can withstand high temperatures. The major advantage of ceramic fibre blanket or board products is their ability to withstand high temperatures. Ceramic fibre begins to melt at approximately 1800°C. On the other hand, fibres from these products constitute possible carcinogens so users should wear appropriate protective clothing and masks.

Glass fibre – is a mineral fibre insulation comprised of glass fibres rather than rock or slag. Some fire stop systems incorporate glass fibre insulation as a forming or packing material. The maximum temperature-resisting capabilities of glass fibre insulation are typically less than those of rock, slag or ceramic fibre insulations [3-6].

Chapter 3 References

- 3-1. *CAN/ULC-S115 – Standard Method of Fire Tests for Firestop Systems*, Underwriters' Laboratories of Canada, Scarborough, ON, September 2005.
- 3-2. Tamim, A., Firestopping Rated Wall and Floor Penetrations, *International Fire Protection*, International Fire Stop Council, Cleveland, OH, pp. 27-30.
- 3-3. *Firestop 101: An Introduction to Firestop*, International Firestop Council, Cleveland, OH, 2004.
- 3-4. *Perimeter Fire Barrier Systems*, International Firestop Council, Cleveland, OH, 2004.
- 3-5. *ASTM E2307, Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems using Intermediate-Scale, Multi-Story Test Apparatus*, American Society for Testing and Materials, West Conshohocken, PA, 2004.
- 3-6. *The Standard: FCIA Firestop Manual of Practice*, Firestop Contractors International Association, Wheaton, IL, 2001, Chapter 3.
- 3-7. Tamim, A., Intumescent Wrap Strip Firestopping Products, *International Fire Protection*, International Fire Stop Council, Cleveland, OH, pp. 53-58.

4.0 TYPES OF FIRE BLOCKS AND FIRE BLOCK MATERIALS

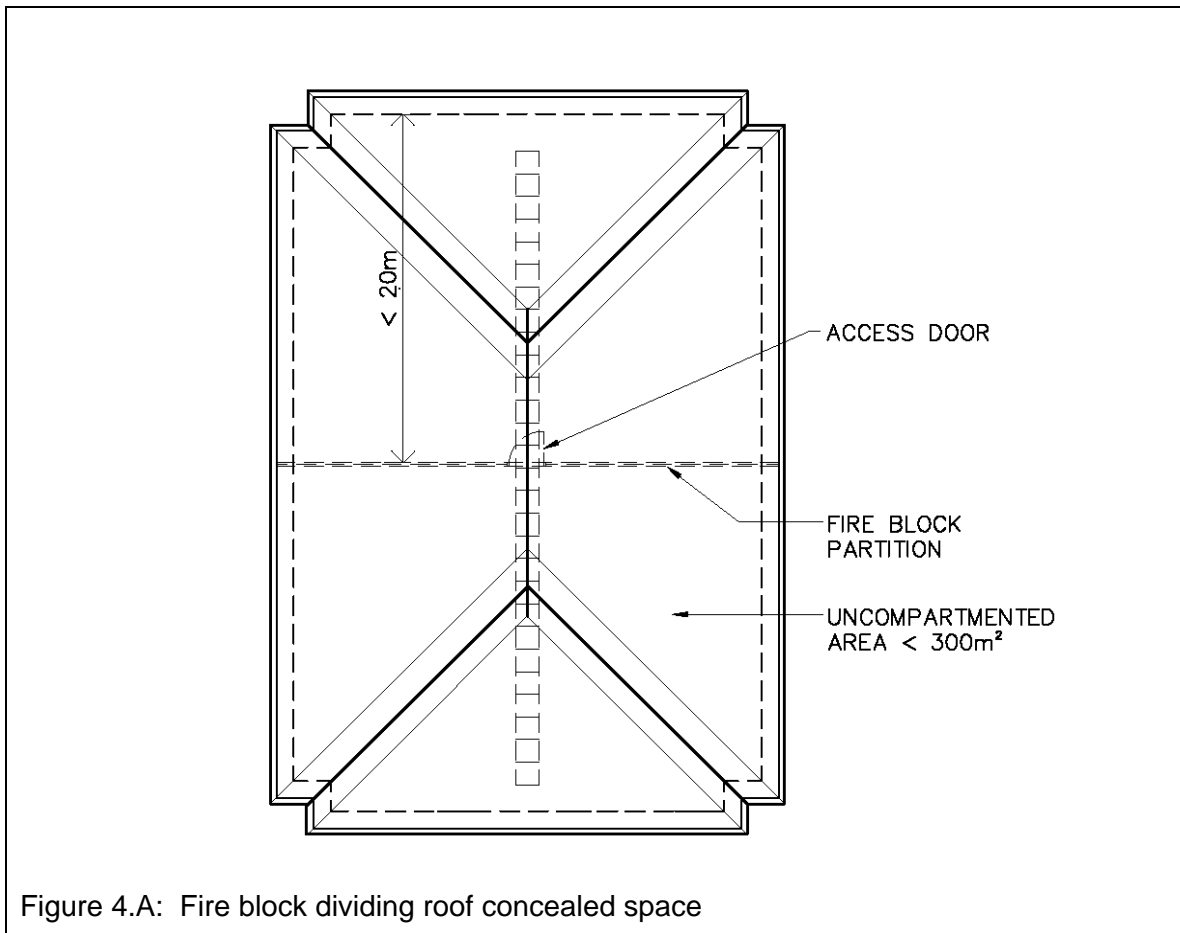
4.1 Introduction

Chapter 4 addresses the types of fire blocks, as defined in this Guide, and the materials of which fire blocks are permitted to be constructed. Within this Guide, fire blocks are materials or systems installed in concealed spaces to restrict the spread of fire and smoke. The following expands on that concept:

- Fire Blocks include concealed space division and protection between concealed spaces. In all cases for fire blocks, the protection will subdivide a concealed space or separate one concealed space from another. Fire blocks may be acceptable generic materials or are rated using CAN/ULC-S101 "Standard Methods of Fire Endurance Tests of Building Construction and Materials" [4-1].

4.2 Concealed Space Division

Certain concealed spaces are required by codes to be divided into smaller areas so that extensive fire spread will not occur inside the space (see Figure 4.A) and will not spread from that space to another concealed space (see Figure 4.B). As indicated in Chapter 1 – Introduction, the barriers that divide these concealed spaces are fire blocks as defined in this Guide. Section 2.4 discusses the technical basis for these fire blocks; and greater information on code requirements is provided in Chapter 6 – Code Requirements for Fire Block Installations and Sound Isolation.



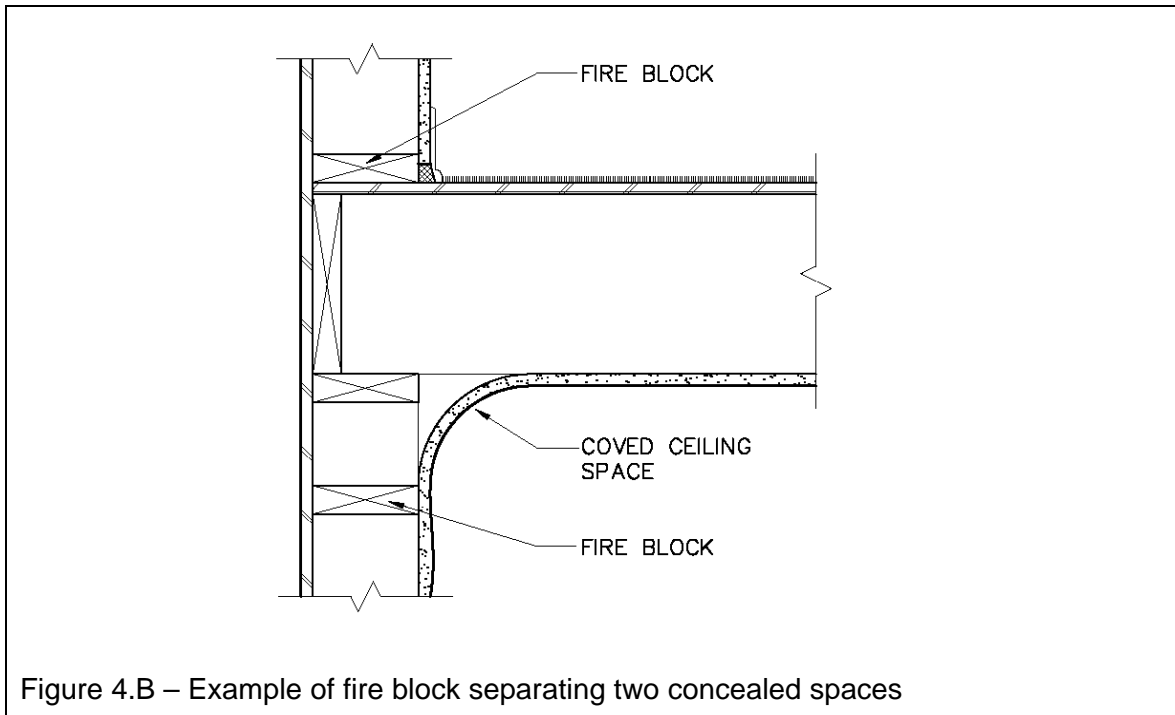


Figure 4.B – Example of fire block separating two concealed spaces

4.3 Fire Block Materials

Fire blocks, within the NBCC [4-2], are often built of the same construction materials used for the basic structural or non-structural assembly; e.g., gypsum board, solid lumber, plywood, oriented strand board and sheet steel. The code-required construction type (combustible/noncombustible) for the building often dictates the type of fire block material that can be used for a specific application. Other fire blocks, in addition to generic materials, are permitted by the NBCC but they must be materials or systems that can remain in place and resist the CAN/ULC-S101 standard fire exposure [4-1] for at least 15 min. For example, a blank opening listed fire stop system, which also meets the NBCC criteria for fire blocks, could be used where fire blocks are required. Greater detail on acceptable materials for fire blocks is provided in Chapter 6 – Code Requirements for Fire Block Installations and Sound Isolation. In this chapter, a general overview of these materials is provided.

Generic Materials – Generic fire block products permitted to be used by the NBCC include:

- gypsum board not less than 12.7 mm thick
- sheet steel not less than 0.38 mm thick
- solid lumber not less than 38 mm thick
- phenolic bonded plywood, waferboard or strandboard not less than 12.5 mm thick, with joints supported
- two thicknesses of solid lumber each not less than 19 mm thick
- semi-rigid fibre insulation board of glass, rock or slag
- wood nailing elements for interior finishes for spaces less than 50 mm deep
- asbestos board at least 56 mm thick (Part 9 only)

Fibre Insulations – There are a number of generic materials permitted by codes as providing acceptable fire block protection, including fibre insulation board products. These generic board products are accepted as fire blocks in some locations in the NBCC (see Chapter 6) provided certain conditions are met. The specific types of insulations used for fire block applications include mineral wool and, in some cases, glass fibre. (See Section 3.16 for further details.)

- Mineral wool – is a mineral fibre insulation processed from rock or slag. It is often used to fill spaces where its compressibility and resilience are needed to address structural movement. It is commonly used as an insulating material in listed fire stop systems.

Note: The term “mineral fibre” is used to describe a family of fibre insulation products which includes glass fibre.

- Glass fibre – is a mineral fibre insulation comprised of glass fibres rather than rock or slag. The maximum temperature-resisting capabilities of glass fibre insulation are typically less than those of rock, slag or ceramic fibre insulations [4-3].

Chapter 4 References

- 4-1. *CAN/ULC-S101-M, Standard Methods of Fire Endurance Tests of Building Construction and Materials*, Underwriters' Laboratories of Canada, Scarborough, ON, 1989.
- 4-2. *National Building Code of Canada*, Canadian Commission on Building and Fire Codes, National Research Council of Canada, Ottawa, ON, 2005.
- 4-3. *The Standard: FCIA Firestop Manual of Practice*, Firestop Contractors International Association, Wheaton, IL, 2001, Chapter 3.

5.0 CODE REQUIREMENTS FOR FIRE STOP INSTALLATIONS AND SOUND ISOLATION

5.1 Introduction

As part of any discussion of National Building Code of Canada (NBCC) [5-1] requirements for fire stops, it is important to first understand how the different parts of the NBCC apply to different buildings. In particular, the differences between the application of Parts 3 and 9 of the NBCC need to be understood.

- Part 3 contains the fire safety requirements for all large buildings of all major occupancies (e.g., assembly, residential, industrial), including the requirements for fire stops in those buildings.
- Part 9 applies only to some major occupancies (residential, business, mercantile and some industrial) and is limited to buildings of 3 storeys or less in building height and having a building area not exceeding 600 m² per storey. Part 9 is often likened to a "mini-code" for smaller buildings. Part 9 also addresses fire stops for those buildings.

Since Part 9 applies only to smaller buildings, some of its requirements are less restrictive and may rely on time-proven methods rather than formally tested systems to achieve safety. This is true for fire stops. Whereas a Part 3 building requires a tested fire stop for the protection of a through-penetration in a fire separation for most applications, Part 9 permits generic materials to be used for this application in many cases. This difference is explained in an Appendix Note to Sentence 9.10.9.6.(1) shown below. Those utilizing generic fire stop materials should ensure that the selected product is appropriate for the application both at the time of installation and for the longer term.

A-9.10.9.6.(1) Penetration of Fire-Rated Assemblies by Service Equipment.

This Sentence, together with Article 3.1.9.1., is intended to ensure that the integrity of fire-rated assemblies is maintained where they are penetrated by various types of service equipment.

For buildings regulated by the requirements in Part 3, fire stop materials used to seal openings around building services, such as pipes, ducts and electrical outlet boxes, must meet a minimum level of performance demonstrated by standard test criteria.

This is different from the approach in Part 9. Because of the type of construction normally used for buildings regulated by the requirements in Part 9, it is assumed that this requirement is satisfied by the use of generic fire stop materials such as mineral wool, gypsum plaster or Portland cement mortar. [Ref: A-9.10.9.6.(1) of NBCC 2005]

It is important, therefore, for those involved with fire stops to know which Part of the NBCC applies to a specific building since the minimum criteria for the selection of fire stops may vary.

5.2 NBCC Requirements for Continuity of Fire Separations

5.2.1 Introduction

Subsection 2.2.1 of this Guide described the essentials of fire compartmentation and fire separation continuity, and their importance within the context of the NBCC. In this Section, the details of the NBCC related to the continuity of fire separations will be further explained – for both Parts 3 and 9.

5.2.2 Fire Separation Continuity – Part 3

The basic Part 3 requirement for continuity of fire separations appears in Article 3.1.8.1.

3.1.8.1. General Requirements

- 1) Any wall, *partition* or floor assembly required to be a *fire separation* shall
 - a) except as permitted by Sentence (2), be constructed as a continuous element, and
 - b) as required in this Part, have a fire-resistance rating as specified (see Appendix A).
- 2) Openings in a *fire separation* shall be protected with *closures*, shafts or other means in conformance with Articles 3.1.8.4. to 3.1.8.17. and Subsections 3.1.9. and 3.2.8. (See Appendix A.) [Ref: 3.1.8.1. of NBCC 2005]

As explained in 2.2.1 of this Guide, this requirement and its Appendix Note lay out the basis of the NBCC requirements for fire stops and fire blocks. The "other means ... in conformance with ... Subsection 3.1.9 ..." in Sentence 3.1.8.1.(2) point specifically to the fire stop requirements. The Appendix Note to Clause 3.1.8.1.(1)(b) (shown below) provides guidance on the need for fire separations to resist the spread of smoke for a finite time to achieve continuity of fire compartmentation. By inference, this Guide will assume that fire stops installed in fire separations (whether required to have a fire resistance rating or not) must be able to resist the passage of smoke to some extent, for a finite time. The NBCC is unclear as to the time span of resistance to smoke penetration for this protection.

A-3.1.8.1.(1)(b) Barrier to Control Smoke Spread. Although a fire separation is not always required to have a fire-resistance rating, the fire separation should act as a barrier to the spread of smoke and fire until some response is initiated. If the fire-resistance rating of a fire separation is waived on the basis of the presence of an automatic sprinkler system, it is intended that the fire separation will be constructed so that it will remain in place and act as a barrier against the spread of smoke for a period of time until the sprinklers have actuated and controlled the fire. [Ref: A-3.1.8.1.(1)(b) of NBCC 2005]

A related requirement for continuity of fire compartmentation in Sentence 3.1.8.3.(2) points to the need for fire stops in walls above suspended ceilings to be "smoke tight" (see below). This requirement applies only to certain fire separations which penetrate horizontal service spaces, such as spaces above a suspended ceiling. The purpose here is to maintain the continuity of vertical fire separations above a suspended ceiling to ensure adequate continuity of fire compartmentation for the entire space, below and above the ceiling.

3.1.8.3

- 2) The *fire separation* required by Sentence (1) shall terminate so that smoke-tight joints are provided where it abuts on or intersects
 - a. floor,
 - b. roof slab, or
 - c. roof deck. [Ref: 3.1.8.3.(2) of NBCC 2005]

As well, in Sentence 3.1.8.3.(4) and its Appendix Note (see below), the NBCC reinforces the need for fire stops to maintain fire compartment continuity at locations where fire separations abut other assemblies. The NBCC does not clearly indicate how the integrity of a fire separation should be maintained across a joint separating a rated fire separation from a non-rated separation. Examples include a rated wall abutting a non-rated roof and a rated floor abutting a non-rated curtain wall. In the latter case, the US Model Codes have adopted a new approach as discussed in 5.7.3.5.

3.1.8.3.(4) The continuity of a *fire separation* shall be maintained where it abuts another *fire separation*, a floor, a ceiling, a roof, or an exterior wall assembly. (See Appendix A.) [Ref: 3.1.8.3.(4) of NBCC 2005]

A-3.1.8.3.(4) Fire Separation Continuity. The continuity of a fire separation where it abuts against another fire separation, a floor, a ceiling or an exterior wall assembly is maintained by filling all openings at the juncture of the assemblies with a material that will ensure the integrity of the fire separation at that location. [Ref: A-3.1.8.3.(4) of NBCC 2005]

5.2.3 Fire Separation Continuity – Part 9

The parallel requirements in Part 9 for the continuity of fire separations can be found in Article 9.10.9.2. This reflects the Part 3 requirement and references the same Appendix Note.

9.10.9.2. Continuous Barrier

- 1) Except as permitted in Article 9.10.9.3., a wall or floor assembly required to be a *fire separation* shall be constructed as a continuous barrier against the spread of fire.
- 2) The continuity of a *fire separation* shall be maintained where it abuts another *fire separation*, a floor, a ceiling, a roof, or an exterior wall assembly. (See A-3.1.8.3.(4) in Appendix A.) [Ref: 9.10.9.2. of NBCC 2005]

The Part 9 requirement for continuity of fire separations through concealed spaces above suspended ceilings is found in Article 9.10.9.10. (see below). No mention is made in Part 9 of the need to have the joints between the fire separation and the deck above smoke tight.

Article 9.10.9.10 does, however, give clear instructions about continuity of fire separations when all of the fire resistance is provided in the ceiling membrane alone, as discussed in 2.2.3 of this Guide. The Part 9 requirement, which parallels the Part 3 requirement discussed in 2.2.3, is shown below:

9.10.9.10 Concealed Spaces above Fire Separations

- 1) Except as provided in Sentence (2), a *horizontal service space* or other concealed space located above a required vertical *fire separation* shall be divided at the *fire separation* by an equivalent *fire separation* within the space.

2) Where a *horizontal service space* or other concealed space is located above a required vertical *fire separation* other than a vertical shaft, such space need not be divided as required in Sentence (1) provided the construction between such space and the space below is constructed as a *fire separation* having a *fire-resistance rating* not less than that required for the vertical *fire separation*, except that where the vertical *fire separation* is not required to have a *fire-resistance rating* greater than 45 min, the *fire-resistance rating* of the ceiling may be reduced to 30 min. [Ref: 9.10.9.10. of NBCC 2005]

5.2.4 Provincial Variations

In reviewing provincial building codes across Canada, there would appear to be no differences in content and intent between the NBCC and the various provincial codes related to the requirements for continuity of fire separations. There are, however, some minor differences in wording which do not create technical differences with the NBCC.

5.3 NBCC Requirements for Protection of Service Penetrations

5.3.1 Service Penetrations Defined

With the need for continuity of fire compartments spelled out and the accompanying need for protection of openings, the NBCC [5-1] then provides extensive details about the protection of openings for building services installed in and running through fire-rated assemblies. The NBCC describes the types of service penetrations in Article 3.1.9.1. as:

- piping (including sprinkler piping)
- tubing
- ducts
- chimneys
- optical fibre cables
- electrical wires and cables
- totally enclosed noncombustible raceways
- electrical outlet boxes
- other similar building services

The NBCC further states in Article 3.1.9.1. that the penetration must be protected by a fire stop when:

- It penetrates a fire separation, or
- It penetrates a membrane forming part of an assembly required to have a fire resistance rating.

Article 3.1.9.1 should be viewed as the omnibus requirement in that all service penetrations, whether combustible or noncombustible, must have fire stops where they penetrate a fire separation or a membrane in a fire-rated assembly. On the other hand, where an item penetrates only one membrane of an assembly not required to have a fire resistance rating, fire stops are not required. The non-penetrated membrane is assumed to provide all of the needed protection for such a non-rated fire separation.

Structural Member Penetration – While not specifically stated in the NBCC and not a "service penetration", it is good practice to provide fire stop protection for structural members which penetrate fire separations, such as a beam passing through a vertical fire separation. Penetrating structural members can be wood, steel or concrete. Figure 5.A shows an example of a steel beam penetrating a monolithic concrete wall with a listed fire stop system provided to protect the opening between the beam and the solid portions of the wall.

Fire stops for penetrations created by structural members should be specifically listed for that application and for the specific type of member. On some occasions, such listed fire stop systems may be part of a listed construction joint system, such as at the top of a wall. Drywall "mud" is not an appropriate fire stop for this application. (See Chapter 7 – Basic Issues Related to Best Practice for Fire Stops and Fire Blocks.)

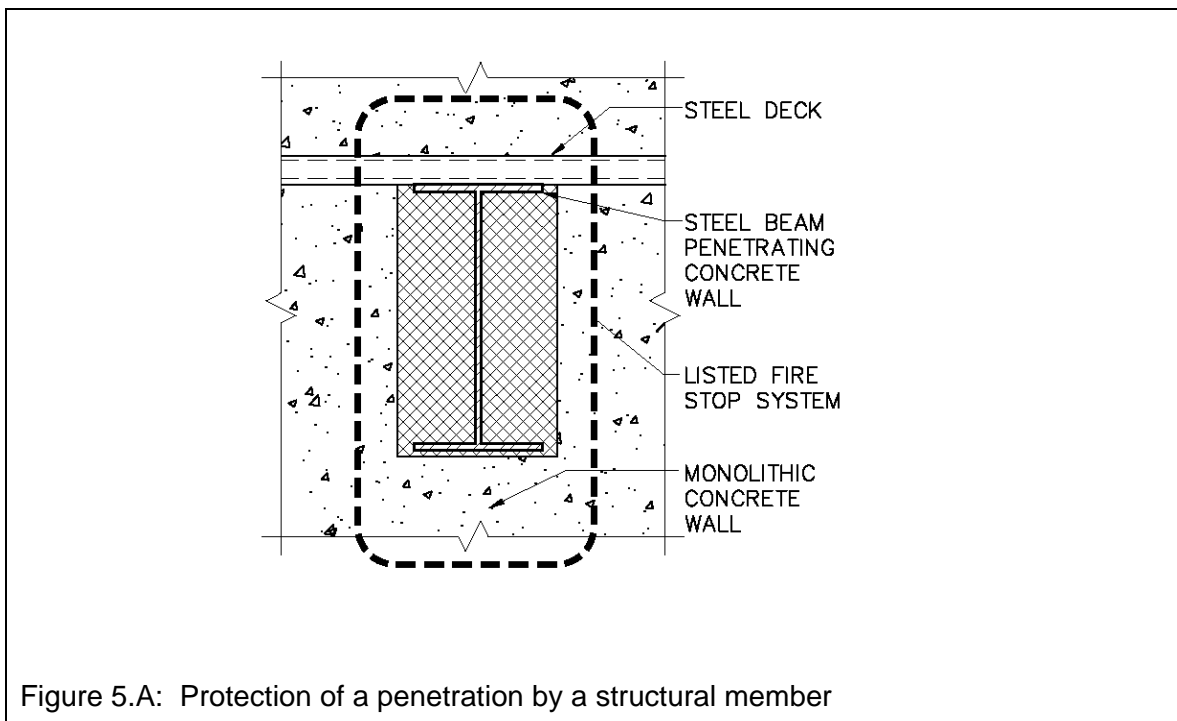


Figure 5.A: Protection of a penetration by a structural member

5.3.2 Basic Protection for Penetrating Items – Part 3

The two types of protection the NBCC permits for penetrating through most vertical and horizontal fire separations or through a membrane forming part of an assembly required to have a fire resistance rating are that the penetrating item must be [Ref: 3.1.9.1.(1) of NBCC 2005]:

- sealed by a fire stop system, meeting CAN/ULC-S115 [5-2] that has an F rating equal to the fire protection rating for a closure in the fire separation, or
- cast in place.

3.1.9.1.(1) Except as required by Sentence (2), piping, tubing, ducts, *chimneys*, optical fibre cables, electrical wires and cables, totally enclosed *noncombustible* raceways, electrical outlet boxes and other similar *building* services that penetrate a *fire separation* or a membrane forming part of an assembly required to have a *fire-resistance rating* shall be

- a) sealed by a fire stop system that, when subjected to the fire test method in CAN/ULC-S115, "Fire Tests of Firestop Systems," has an F rating not less than the *fire-protection rating* required for *closures* in the *fire separation* in conformance with Table 3.1.8.4., or
- b) cast in place (see Appendix A). [Ref: 3.1.9.1.(1) of NBCC 2005]

Cast in Place – Previous versions of the NBCC used the term "tightly fitted" and there was debate over the years as to what constituted "tightly fitted" as it relates to an opening for a penetrating item. In the 2005 NBCC, that term was replaced with "cast in place" with an Appendix Note to explain its meaning. Drywall "mud" would not meet the intent of the NBCC as cast in place protection.

A-3.1.9.1.(1)(b) Service Penetration. The intention behind the use of the term "cast in place" is to reinforce that there are to be no gaps between the building service and the membrane it penetrates. The term "cast in place" describes a typical means of fire stopping for a service penetration through a concrete slab or wall. [Ref: A-3.1.9.1.(1)(b) of NBCC 2005]

As well, provision must be made with cast in place protection for expansion and contraction of the service penetration through the wall or floor. Because the services cannot move when they pass through the floor or wall, some means to accommodate expansion/contraction, other than at the point of penetration, may need to be provided to achieve the expected performance (e.g., expansion joints).

The NBCC applies a higher standard in Sentence 3.1.9.1.(2) to protection for those services that penetrate a firewall or a horizontal fire separation (e.g., floor assembly) serving as a "firewall" in Article 3.2.1.2. (see further discussion in 7.2). A "firewall", a special type of fire separation that must be more robust than a normal vertical fire separation, is used to create separate "buildings" under the NBCC. Firewalls must have a minimum fire resistance rating of 2 h and must be designed so that the collapse of a "building" on either side will not cause the firewall to collapse. Horizontal fire separations that conform to Article 3.2.1.2. allow a large underground parking garage to be considered a separate "building" from the units above in a manner similar to that of vertical firewalls creating separate buildings. For firewalls and horizontal fire separations serving as "firewalls", the NBCC does not permit penetrating items to be cast in place but requires a listed fire stop system for all penetrating items. The NBCC also requires that these listed fire stop systems provide protection against temperature rise as well as flame-through. See Section 5.6 for information on "F" and "FT" ratings required by the NBCC.

3.1.9.1.(2) Piping, tubing, ducts, *chimneys*, optical fibre cables, electrical wires and cables, totally enclosed *noncombustible* raceways, electrical outlet boxes and other similar *building* services that penetrate a *firewall* or a horizontal *fire separation* that is required to have a *fire-resistance rating* in conformance with Article 3.2.1.2., shall be sealed at the penetration by a fire stop system that, when subjected to the fire test method in CAN/ULC-S115, "Fire Tests of Firestop Systems," has an FT rating not less than the *fire-resistance rating* for the *fire separation*. [Ref: 3.1.9.1.(2) of NBCC 2005]

5.3.3 NBCC Part 3 Fire Stop Protection Required for Specific Penetrating Items

The NBCC assumes that the general rules for protecting penetrating items outlined above in 5.3.1 and 5.3.2 will address most of the fire stop needs for Part 3 buildings. While there are numerous requirements for penetrations by wires, cables, electrical boxes, combustible pipes and steel ducts, there are only two specific requirements among those for fire stops: for combustible drain, waste and vent (DWV) piping and for polypropylene piping.

Combustible Drain, Waste and Vent (DWV) Piping – The NBCC permits combustible DWV piping to penetrate a fire separation or a membrane forming part of a fire separation in Sentence 3.1.9.4.(4):

3.1.9.4

4) *Combustible* drain, waste and vent piping is permitted to penetrate a *fire separation* required to have a *fire-resistance rating* or a membrane that forms part of an assembly required to have a *fire-resistance rating*, provided

- a) the piping is sealed at the penetration by a fire stop system that has an F rating not less than the fire-resistance rating required for the fire separation when subjected to the fire test method in CAN4-S115-M, "Standard Method of Fire Tests of Firestop Systems," with a pressure differential of 50 Pa between the exposed and unexposed sides, with the higher pressure on the exposed side, ..." [Ref: 3.1.9.4.(4) of NBCC 2005]

This requirement is intended to ensure that fire stops used with combustible DWV piping are capable of withstanding not only fire exposure but also fire exposure combined with higher pressures on the fire-exposed side of an assembly as a result of stack effect. This higher standard is intended to ensure that fire is not forced through the opening in a fire separation that can be created with the destruction of the combustible DWV piping (which would not normally contain a liquid). The protection described in this sentence would not be needed if the combustible DWV pipe penetrates only one membrane of an assembly not required to have a fire resistance rating (see NBCC Sentence 3.1.9.1.(1)).

Polypropylene Piping – The NBCC permits polypropylene piping to be used in both combustible and noncombustible buildings in the same manner as other combustible piping. In addition to the requirements for all combustible piping, the NBCC permits polypropylene piping and fittings to be used in buildings required to be of noncombustible construction for DWV piping for highly corrosive materials and for distribution of distilled or dialyzed water in sprinklered laboratory and hospital facilities, provided the piping is not located in a vertical shaft and is equipped with listed fire stop systems at penetrations of fire separations as outlined in Sentence 3.1.5.16.(3) (see below). Unpigmented polypropylene pipe is required in applications where ultra-high purity water must be transported from one location in a building to another. Pigmented polypropylene pipe is used for other applications permitted by the NBCC. Due to its enhanced burning characteristics, the NBCC requires the extra protection in Sentence 3.1.5.16.(3).

3.1.5.16.(3) Polypropylene pipes and fittings are permitted to be used for drain, waste and vent piping for the conveyance of highly corrosive materials and for

piping used to distribute distilled or dialyzed water in laboratory and hospital facilities in a *building* required to be of *noncombustible construction*, provided

- the building is sprinklered throughout,
- the piping is not located in a vertical shaft, and
- piping that penetrates a fire separation is sealed at the penetration by a fire stop system that, when subjected to the fire test method in CAN4-S115-M, "Standard Method of Fire Tests of Firestop Systems," has an FT rating not less than the fire-resistance rating of the fire separation. [Ref: 3.1.5.16.(3) of NBCC 2005]

As with combustible DWV piping, this requirement is intended to ensure that the fire stops used to protect polypropylene pipe penetrations must withstand a somewhat higher standard when used in laboratory and hospital facilities. In this case, the fire stop must have an FT rating equal to the fire resistance rating of the fire separation. The FT rating applies to both polypropylene DWV piping and also water piping. The requirements for a 30 mm outside diameter limitation on water piping [Ref: Sentence 3.1.9.4.(2) of NBCC 2005] and for testing combustible DWV piping with a 50 Pa pressure difference [Ref: Sentence 3.1.9.4.(4) of NBCC 2005] are also applicable to polypropylene piping in the absence of a specific exception in Sentence 3.1.5.16.(3).

Users should note that Sentences 3.1.9.4.(5) and (6) (see below) permit combustible DWV pipe to be used when penetrating fire separations, despite the performance requirement for noncombustible penetrations in Article 3.1.9.2. While the DWV pipe is permitted to be combustible in this application, there is no exclusion from the omnibus requirement in Article 3.1.9.1. requiring fire stops at service penetrations. As such, to comply with all of the requirements in Subsection 3.1.9., fire stops would be required for the combustible DWV pipe penetrations permitted in these sentences.

3.1.9.4.(5) *Combustible* drain piping is permitted to penetrate a horizontal *fire separation* provided it leads directly from a *noncombustible* water closet through a concrete floor slab.

6) *Combustible* drain, waste and vent piping is permitted on one side of a vertical *fire separation* provided it is not located in a vertical shaft. [Ref: 3.1.9.4. of NBCC 2005]

Fire Blocks Penetrated – The NBCC also specifically requires fire stops where fire blocks are penetrated by building services or structural members in Sentence 3.1.11.7.(6) (see below). In this case, the NBCC is not clear as to the performance expected of the fire stop, however, best practice would dictate that the fire stop provide protection at least equivalent to the fire block itself if the specified degree of fire compartment continuity is to be maintained in these concealed spaces.

3.1.11.7.(6) Where materials referred to in Sentences (1) to (4) are penetrated by construction elements or by service equipment, fire stop materials shall be used to seal the penetration. [Ref: 3.1.11.7.(6) of NBCC 2005]

5.3.4 Protection for Penetrating Items – Part 9

The general requirement for the protection of penetrations through fire separations in Part 9 is found in Sentence 9.10.9.6.(1).

9.10.9.6.(1) Piping, tubing, ducts, *chimneys*, wiring, conduit, electrical outlet boxes and other similar service equipment that penetrate a required *fire*

separation shall be tightly fitted or fire stopped to maintain the integrity of the separation. (See Appendix A.) [Ref: 9.10.9.6.(1) of NBCC 2005]

A-9.10.9.6.(1) Penetration of Fire-Rated Assemblies by Service Equipment.

This Sentence, together with Article 3.1.9.1., is intended to ensure that the integrity of fire-rated assemblies is maintained where they are penetrated by various types of service equipment.

For buildings regulated by the requirements in Part 3, fire stop materials used to seal openings around building services, such as pipes, ducts and electrical outlet boxes, must meet a minimum level of performance demonstrated by standard test criteria.

This is different from the approach in Part 9. Because of the type of construction normally used for buildings regulated by the requirements in Part 9, it is assumed that this requirement is satisfied by the use of generic fire stop materials such as mineral wool, gypsum plaster or Portland cement mortar. [Ref: A-9.10.9.6.(1) of NBCC 2005]

In Part 9, it can be seen that there is a different general standard from Part 3; openings for penetrating items in fire separations (both vertical and horizontal) can be "tightly fitted" or fire stopped. In Part 3, penetrating items in vertical and horizontal fire separations (not "firewalls") may be cast in place and the "tightly fitted" criterion has been changed to "cast in place". As well, as explained in 5.1 above, generic fire stop materials can be used for most fire stop applications in Part 9, except for those with combustible DWV piping as shown below. These parallel those previously noted in 5.3.3 for Part 3 buildings.

9.10.9.7.(2) *Combustible* drain, waste and vent piping not located in a vertical shaft is permitted to penetrate a *fire separation* required to have a *fire-resistance rating* or a membrane that forms part of an assembly required to have a *fire-resistance rating* provided the piping is sealed at the penetration by a firestop system that has an F rating not less than the *fire-resistance rating* required for the *fire separation*.

3) The rating referred to in Sentence (2) shall be based on CAN4-S115, "Fire Tests for Firestop Systems" with a pressure differential of 50 Pa between the exposed and unexposed sides, with the higher pressure on the exposed side. [Ref: 9.10.9.7. of NBCC 2005]

It should be noted that, unlike other Part 9 requirements for fire stops, these requirements for combustible DWV piping require an F rating in accordance with CAN/ULC-S115 [5-2]. This means a listed fire stop system would be required in these locations. Note that combustible DWV piping is not permitted by the NBCC in vertical shafts in both Parts 3 and 9.

Part 9 also contains a parallel requirement for the penetration of fire blocks in concealed spaces, however, the need for a "fire stop" for penetrations of the fire blocks is not specifically spelled out. Again, the intent of the NBCC is not clear but it would be good practice to provide protection for the penetration at least equivalent to that afforded by the fire block for the maintenance of fire compartment continuity.

9.10.16.4. Penetration of Fire Stops

1) Where fire stops are pierced by pipes, ducts or other elements, the effectiveness of the fire stops shall be maintained around such elements.
[Ref: 9.10.16.4. of NBCC 2005]

5.3.5 Provincial Variations

General – Depending on the adoption dates for the NBCC 2005, some provinces may still be using the NBCC 1995 which includes the permission for penetrations to be “tightly fitted” rather than “cast in place”. It is suspected that all provincial codes will use the NBCC 2005 terminology when officially adopted.

Quebec Building Code (QBC) – In defining the types of penetrating items, the QBC specifically names “telecommunications wires and cables” whereas the NBCC does not. The NBCC does, however, intend that telecommunications wires and cables be included in its use of the term “electrical wires and cables”. As well, in permitting combustible DWV pipes to penetrate fire separations with fire stops, the QBC specifically names central vacuum piping and bathroom exhaust ducts as being permitted with the same fire stop protection as DWV piping provided the vacuum piping and exhaust duct serve only one dwelling unit.

Ontario Building Code (OBC) – The OBC does not include the NBCC requirement limiting penetrations for combustible water distribution piping to 30 mm diameter. Under the OBC, combustible water distribution piping of all diameters may penetrate fire separations with the appropriate fire stops installed. The OBC also permits all combustible piping to penetrate a vertical or horizontal fire separation provided the fire compartments on both sides of the fire separation are sprinklered. In addition, the OBC permits combustible piping for chlorine gas not greater than 25 mm diameter to penetrate a fire separation between a public pool and the remainder of the building.

5.4 NBCC Requirements for Sound Control

5.4.1 Requirements in Part 5 and Part 9 of the NBCC

The 2005 revision of the NBCC defines the objective for sound isolation, but does not use the specific terminology of the 2005 version of the ASTM standards (which were published later).

Objective OH3 in the 2005 edition of the National Building Code of Canada deals with noise protection, as follows:

OH3 An objective of this Code is to limit the probability that, as a result of design or construction of the building, a person in the building will be exposed to an unacceptable risk of illness due to high levels of sound originating in adjacent spaces in the building (...). The risks of illness due to high levels of sound addressed in this Code are those caused by

—

OH3.1 - exposure to airborne sound transmitted through assemblies separating dwelling units from adjacent spaces in the building.

This objective (which applies only to dwelling units) is expressed as specific provisions in Part 5 and Part 9 of Division B of the National Building Code of Canada, as follows:

5.9.1.1. Sound Transmission Class

1) Sound transmission class ratings shall be determined in accordance with ASTM E413, "Classification for Rating Sound Insulation," using the results from measurements carried out in accordance with

a) ASTM E90, Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements," or

b) ASTM E336, Measurement of Airborne Sound Insulation in Buildings."

(See Appendix A)

5.9.1.2. Required Protection from Noise

1) Except as provided in Sentence (2), a dwelling unit shall be separated from every other space in a building in which noise may be generated by construction providing a sound transmission class rating not less than 50, measured in accordance with the standards referenced in Sentence 5.9.1.1. (1).

(See A-9.11.1.1. (1) in Appendix A.)

2) Construction separating a dwelling unit from an elevator hoistway or a refuse chute shall have a sound transmission class rating not less than 55, measured in accordance with the standards referenced in Sentence 5.9.1.1.(1).

Section 9.11.1. of the NBCC presents the same requirements, based on three ASTM standards, [5-3] to [5-5]. Note that the requirement does not explicitly differentiate between variants of the sound transmission class (STC, ASTC, FSTC). This reflects the less-precise terminology and the lack of standards addressing flanking transmission that were current when these provisions were established. This permits some ambiguity about intent – the requirement that the separating wall or floor assembly should have a construction that achieved STC 50 in laboratory testing can be construed as quite

different from the requirement that the construction in a building (including all openings and flanking paths) should achieve ASTC 50.

In 1992, the Canadian Codes Centre addressed this by publishing an interpretation that recognized this is

“an area in the Code where an approach somewhat different than normal has been taken. Normally, when the Code specifies a performance target, it is intended to apply to the as-built, in-place assembly. However, in the case of sound separations, the Standing Committee on Housing and Small Buildings felt that this approach was not practical since it would lead to frequent resort to expensive and difficult on-site testing of sound separations. The Committee therefore decided to allow the use of laboratory-rated assemblies.

[Consequences] that result from this approach are as follows: The builder is expected to use assemblies with STC ratings that at least satisfy the required minima, as determined either by testing or by reference to the tables in the Appendix, and to install such assemblies in accordance with good building practice. Good practice, in this case, would mean paying attention to openings and flanking paths. ...”

Essentially, the final responsibility for an official interpretation rests with the authority having jurisdiction, and the outdated terminology in the codes and previous versions of the ASTM standards, may create some legal flexibility. However, the opinion above suggests that –as a minimum – the separating assembly (including all fire stop systems used to seal openings at penetrations or the perimeter) should at least achieve the required STC performance in laboratory testing.

Good practice would further require that where fire stop systems and fire blocks are used to control any potential acoustical leaks between dwellings, the resulting built system should provide ASTC 50 between adjacent dwellings in the completed building (or ASTC 55 for elevators or refuse chutes). In this case, structure-borne transmission (including flanking due to fire blocks that short-circuit vibration breaks) should also be factored in.

5.4.2 Situations where STC ratings are not required for Fire Stops

Requirements for sound control generally apply to separations between occupied spaces – the provisions of the NBCC apply between dwellings, and additional design requirements for offices or dwellings also generally apply to sound isolation between adjacent rooms in a building. Whether the criteria are in terms of the sound transmission class of the separating assembly or the ASTC of the complete construction, they are concerned with sound reaching the space where a person may hear it.

Specific examples of good practice for fire stops maintaining the continuity of constructions separating occupied spaces are presented in Chapters 8 to 13.

However, in many cases, fire stops are required to maintain continuity of a fire separation between (hidden) service spaces. This could include equipment rooms, or other service spaces, such as the space above a gypsum board ceiling where pipes, ducts, or electrical services might be installed. In such cases, additional constructions such as the gypsum board ceiling contribute to sound attenuation, and the sound

attenuation provided between the occupied spaces (the rooms below the ceiling) by the complete built system may be significantly greater than that for the specific wall segment above the ceiling and any fire stops it may include. In such situations, although requirements for fire performance may apply, there is no basis for specifying a STC requirement for the fire stop or the hidden part of the separating assembly in which it is installed. Instead, the acoustical performance should be related to the overall separation required between occupied spaces, in terms of ASTC.

Similarly, no specific acoustic requirement can be specified for a fire stop at a penetration through just one surface of a cavity construction – such as a penetration of just the gypsum board ceiling of a floor/ceiling assembly. In such cases, the acoustical requirement should apply to the complete separating assembly. In practice, small penetrations through one surface of a joist floor or stud wall have little effect on the acoustical separation, especially if there is acoustical insulation in the cavity.

5.5 Rating of Fire Stops for Service Penetrations

5.5.1 Basic Part 3 Requirements for Rating Fire Stops

The NBCC requirement in Part 3 for rating through-penetration fire stops is by reference to CAN/ULC-S115 – Standard Method of Fire Tests of Firestop Systems [5-2]. This standard is referenced (see below):

- for fire separations in Clause 3.1.9.1.(1)(a);
- specifically for firewalls and horizontal fire separations (sometimes called "horizontal firewalls") in Article 3.2.1.2., in Sentence 3.1.9.1.(2);
- specifically for combustible drain, waste and vent piping in Clause 3.1.9.4.(4)(a); and
- specifically for polypropylene water and drain, waste and vent piping in Clause 3.1.5.16.(3)(c).

These four code requirements illustrate some of the criteria that a fire stop must meet in being evaluated in accordance with CAN/ULC-S115 (see 5.6 of this Guide for details on CAN/ULC-S115).

3.1.9.1. Fire Stopping of Service Penetrations

1) Except as required by Sentence (2), piping, tubing, ducts, *chimneys*, optical fibre cables, electrical wires and cables, totally enclosed *noncombustible* raceways, electrical outlet boxes and other similar *building services* that penetrate a membrane forming part of an assembly required to have a *fire-resistance rating*, or a *fire separation*, shall be

- a) sealed by a fire stop system that, when subjected to the fire test method in CAN4-S115-M, "Standard Method of Fire Tests of Firestop Systems," has an F rating not less than the *fire protection rating* required for *closures* in the *fire separation* in conformance with Table 3.1.8.4., or
- b) cast in place (see Appendix A).

2) Piping, tubing, ducts, *chimneys*, optical fibre cables, electrical wires and cables, totally enclosed *noncombustible* raceways, electrical outlet boxes and other similar *building services* that penetrate a *firewall* or a horizontal *fire separation* that is required to have a *fire-resistance rating* in conformance with Article 3.2.1.2., shall be sealed at the penetration by a fire stop system that, when subjected to the fire test method in CAN4-S115-M, "Standard Method of

Fire Tests of Firestop Systems," has an FT rating not less than the *fire-resistance rating* for the *fire separation*. [Ref: 3.1.9.1. of NBCC 2005]

3.1.9.4.

4) *Combustible* drain, waste and vent piping is permitted to penetrate a *fire separation* required to have a *fire-resistance rating* or a membrane that forms part of an assembly required to have a *fire-resistance rating*, provided

- a) the piping is sealed at the penetration by a fire stop system that has an F rating not less than the *fire-resistance rating* required for the *fire separation* when subjected to the fire test method in CAN4-S115-M, "Standard Method of Fire Test of Firestop Systems," with a pressure differential of 50 Pa between the exposed and unexposed sides, with the higher pressure on the exposed side. [Ref: 3.1.9.4.(4)(a) of NBCC 2005]

3.1.5.16.

3) Polypropylene pipes and fittings are permitted to be used for drain, waste and vent piping for the conveyance of highly corrosive materials and for piping used to distribute distilled or dialyzed water in laboratory and hospital facilities in a *building* required to be of *noncombustible construction*, provided

- a) the *building* is *sprinklered* throughout,
- b) the piping is not located in a vertical shaft, and
- c) piping that penetrates a *fire separation* is sealed at the penetration by a fire stop system that, when subjected to the fire test method in CAN4-S115-M, "Standard Method of Fire Tests of Firestop Systems," has an FT rating not less than the *fire-resistance rating* of the *fire separation*. [Ref: 3.1.5.16.(3) of NBCC 2005]

The four requirements shown above contain differences that a user should note:

- Clause 3.1.9.1.(1)(a) refers to an F rating that is not less than the "fire protection rating for closures" in fire separations. A fire protection rating for a closure in a fire separation in the NBCC usually is one rating step down from the rating of the fire separation itself [Ref: Table 3.1.8.4 of NBCC 2005]. For example, a closure in a fire separation requiring a 1 h fire resistance rating requires a minimum fire protection rating of 45 min. This clause means that a fire stop in a fire separation with a 1 h fire resistance rating requires an F rating of 45 min. (See 5.6 for explanation of F rating.)
- Sentence 3.1.9.1.(2) refers to an FT rating for a firewall or a horizontal fire separation in conformance with Article 3.2.1.2. (sometimes referred to as a "horizontal firewall") that is not less than "the fire resistance rating of the fire separation". This means that a fire stop in such a horizontal fire separation or firewall with a 2 h fire resistance rating must have fire stops with an FT rating of 2 h. (See 5.6 for explanation of FT rating.)
- The third variation appears in Sentence 3.1.9.4.(4) where fire stops for combustible drain, waste and vent piping must have an F rating not less than the fire-resistance rating of the fire separation, rather than the fire-protection rating of closures as noted above. As well, this specific fire stop must be tested with a 50 Pa pressure difference across the fire stop.
- The fourth variation in Sentence 3.1.5.16.(3) is specifically aimed at polypropylene DWV and water pipe used in laboratories or hospitals in noncombustible buildings. Fire stops for such piping penetrations must have an FT rating not less than the fire-resistance rating of the fire

separation, rather than the fire protection rating for closures as noted above. As well, it can be assumed that fire stops for polypropylene DWV pipe would also have to be tested with a 50 Pa pressure difference since the other requirements for rating fire stops for DWV pipe in Sentence 3.1.9.4.(4) are not waived for polypropylene pipe.

5.5.2 Basic Part 9 Requirements for Rating Fire Stops

Part 9 permits certain generic materials to be used, in most applications, rather than installing listed fire stops. Generally Part 9 does not require that fire stops conform to CAN/ULC-S115 – Standard Method of Fire Tests of Firestop Systems, except when combustible drain, waste and vent piping is used. These requirements are shown below.

9.10.9.6. Service Equipment Penetrating a Fire Separation

1) Piping, tubing ducts, *chimneys*, wiring, conduit, electrical outlet boxes and other similar service equipment that penetrate a required *fire separation* shall be tightly fitted or fire stopped to maintain the integrity of the separation. (See Appendix A.) [Ref: 9.10.9.6.(1) of NBCC 2005]

9.10.9.7.

2) *Combustible* drain, waste and vent piping not located in a vertical shaft is permitted to penetrate a *fire separation* required to have a *fire-resistance rating* or a membrane that forms part of an assembly required to have a *fire-resistance rating* provided the piping is sealed at the penetration by a fire stop system that has an F rating not less than the *fire-resistance rating* required for the *fire separation*.

3) The rating referred to in Sentence (2) shall be based on CAN4-S115, "Fire Tests for Firestop Systems" with a pressure differential of 50 Pa between the exposed and unexposed sides, with the higher pressure on the exposed side. [Ref: 9.10.9.7.(2) and (3) of NBCC 2005]

Except for those situations involving combustible drain, waste and vent piping, the required performance (rating) for fire stops in Part 9 must be determined from the Appendix Note to Sentence 9.10.9.6.(1) which states that acceptable generic materials, such as mineral wool insulation, gypsum plaster or Portland cement mortar, may be used. The actual fire performance of such generic fire stop materials, when installed in an assembly, may vary depending on such factors as density and thickness of material. While the specific fire performance has not been stated for these generic fire stop materials, it is reasonable, in trying to achieve Best Practice, to expect that the generic materials should be installed in sufficient thicknesses and at sufficient densities and compression that flames will be prevented from penetrating the fire stop for a period of time at least equivalent to the fire protection rating for closures in the fire separation (which is the minimum performance for fire stops expected elsewhere in the Code). It is assumed that a fire stop system which has been tested to achieve a flame-through rating (F rating) in accordance with CAN/ULC-S115, for the minimum fire protection rating time (45 min), would also meet this requirement, although it is not stated in Part 9.

Where a firewall is used to create two Part 9 "buildings" for the purposes of application of the NBCC, the firewall and any penetrations through it would need to conform to Part 3 of the NBCC. This means that fire stop systems for penetrations through that firewall would need to have an FT rating of at least 2 h as described above.

5.6 Requirements of CAN/ULC-S115

CAN/ULC-S115 [5-2] is the test standard used to evaluate fire stop systems under the NBCC. As with most fire test standards, CAN/ULC-S115 provides this evaluation through a series of tests, the results of which are reported as "ratings" depending on which tests have been successfully passed. These ratings include: F, FT, FH, FTH and L.

F Rating – is achieved if the fire stop remains in place in the opening during the standard fire test exposure for the required period without the passage of flame through the opening or the occurrence of flaming on any element on the unexposed face of the fire stop. For construction joint fire stops and those building perimeter fire stops adjacent to fire-rated exterior walls (see 3.4 and 3.6 of this Guide), the system must also resist heat to the extent that there is no glowing or flaming of a cotton pad placed on the unexposed side of the system.

The F Rating is the basic building block for fire stops required in the NBCC. It is intended to provide protection against the spread of flames through the opening but does not provide protection (except for construction joint fire stops and some building perimeter fire stops) against high temperatures on the unexposed side of the fire separation. In effect, it is like a fire door or a fire damper which also (in many cases) has to prevent the passage of flames and not limit temperature rise. It also does not provide protection against the spread of smoke.

Those designing and installing fire stops must be aware of the fact that combustible material stored or placed adjacent to fire stops with only an F Rating could ignite and thus spread fire on the non-fire-exposed side of the fire separation. Where such a situation is anticipated, Best Practice dictates that consideration should be given to a fire stop which also prevents a substantial rise in temperature during the required rating period.

FT Rating – is achieved if the fire stop has an F Rating for the required time period and also resists the transmission of substantial heat through the fire stop during the same required period such that the rise in temperature on the unexposed face of the fire stop does not exceed 181°C above the initial test temperature. The maximum temperature limit (which is approximately 200°C) is considered to be the point at which many combustible materials will begin to experience pyrolysis and possibly, over time, to ignite.

The FT rating is required by the NBCC for fire stops used to protect openings in firewalls and horizontal fire separations in Article 3.2.1.2. (sometimes referred to as "horizontal firewalls"). As explained previously, in those situations, the NBCC calls for a higher level of fire protection due to the more critical function that firewalls must provide under the NBCC. It is also required for polypropylene pipe applications (see 5.3.3).

FH Rating – is achieved when a fire stop has an F rating for the required time period and also resists the force of a hose stream, without developing openings for the prescribed period of hose stream application. If needed, the hose stream test can be conducted on a sample that has achieved one-half the F rating time period. That prescribed period of hose stream application is 65 s for every 10 m² of exposed area of

the fire stop test sample. While not required by the NBCC, an FH rating is a measure of the robustness of a fire stop following fire exposure, which is demonstrated through successfully passing a hose stream test.

FTH Rating – is achieved when a fire stop has an FT rating and also passes the hose stream test for the prescribed time. An FTH rating is also not required by the NBCC.

L Rating – is a measure of the quantity of air leakage through a fire stop as a means of determining the potential for smoke spread. L Ratings for fire stops are stated at a given air pressure differential and for a given temperature exposure (maximum 204°C). For blank and through-penetration fire stops, the L Rating is reported as a flow rate of air per unit surface area of the fire stop. For construction joint fire stops, the L Rating is reported as a volumetric flow rate per unit length of the exposed joint. The L Rating is not intended to prevent the movement of smoke through a fire stop while exposed to fire; rather, through a fire stop located at some distance from the fire and not exposed to high temperatures. At that remote location, the temperature may be somewhat above ambient (up to 204°C) but the expectation is that the fire stop will continue to resist the spread of smoke. There are currently no requirements in the NBCC for fire stops with L Ratings. A user could employ a listed fire stop system with an L Rating, where restricted movement of cold smoke is required.

Pressure Differentials – As was described in 5.6.1 and 5.6.2 of this Guide, the NBCC requires, in addition to the F or FT Ratings specified, that some fire stops be tested with a pressure differential between the fire-exposed and non-exposed sides. CAN/ULC-S115 provides the details on how to measure this differential pressure during the fire test to ensure that the intent of the NBCC is met. Fire stop systems are normally tested at a pressure differential of 2.5 Pa, however, to meet the 50 Pa specified in the NBCC, additional pressure is provided to the furnace to establish that higher limit. The pressure differential under which the fire stop is tested is reported in the technical documentation.

While the NBCC requires that only fire stops for combustible drain, waste and vent piping be tested with a 50 Pa pressure differential, a user would be prudent to use fire stops successfully tested with higher pressure differentials for many applications in high-rise buildings. The impact of stack effect on creating pressure differentials in most high-rise buildings is such that smoke could spread extensively through fire stops should they not be capable of resisting air movement caused by pressure differentials.

Construction Joints – The 2005 Edition of CAN/ULC-S115 contains a new requirement for cycling construction joint fire stops through their intended range of movement prior to the fire exposure test. This joint cycling (500 movement cycles) is intended to demonstrate the fire stop's movement capabilities as could occur in a building as well as its ability to resist fire spread following the 500 cycles of movement.

Certification Marks – Fire stop systems which have been tested to CAN/ULC-S115 and which are listed by certification agencies are marked as having met Canadian standards. Typically, the certification mark will have a small "C" in the 8 o'clock position on the mark. Typical marks are shown in Figure 5.B. Fire stop systems which have been tested to USA standards will have a small "US" in the 4 o'clock position or will have no indicators outside the area of the mark.

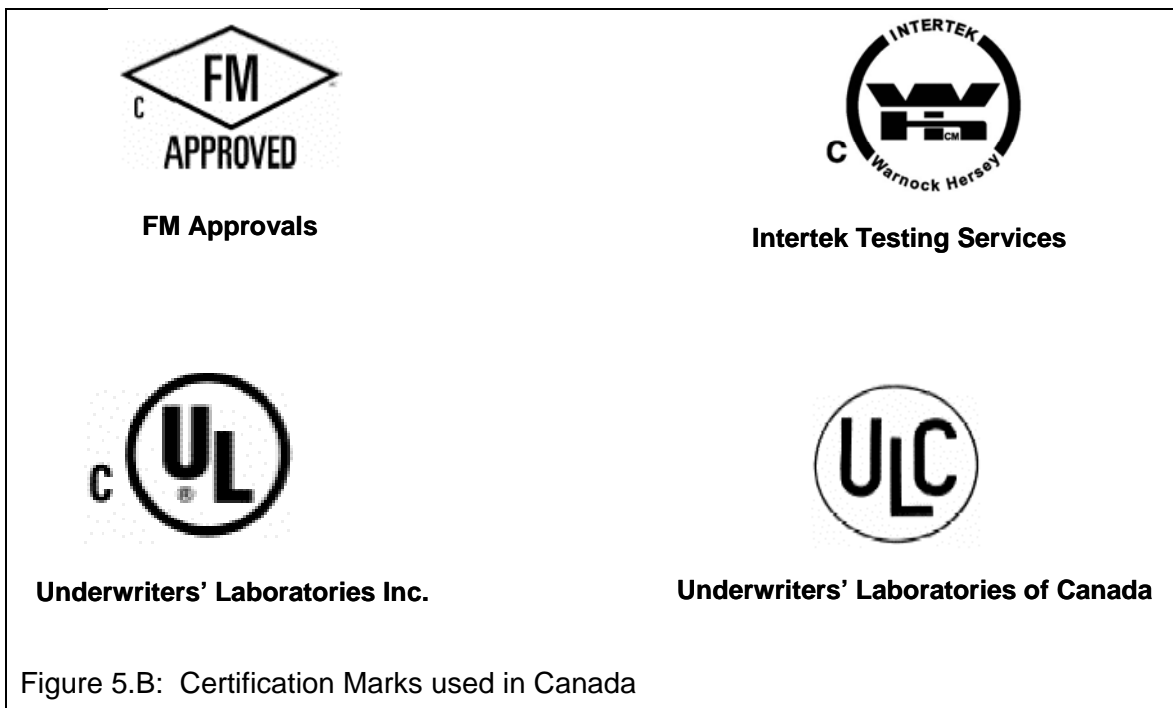


Figure 5.B: Certification Marks used in Canada

5.7 U.S. Model Code Requirements for Fire Stops (including Sound Control)

Canadian users of this Guide should be aware of the corresponding requirements for fire stops in the U.S.A. model codes to be able to recognize the differences between the two code regimes and their impact on fire stop products used in both countries. In particular, an understanding of U.S.A. model code requirements for fire stops will provide Canadian users with an understanding of any limitations they may encounter with a fire stop that has been listed to U.S.A. requirements. This section is not intended to be a detailed examination of U.S.A. building codes.

5.7.1 International Building Code

The International Building Code (IBC) [5-6] is the most widely used model building code in the U.S.A., forming the basis of many state and municipal building codes. In concept, the IBC treats fire stops and fire blocks in much the same manner that the NBCC does, however, there are a number of differences in the details.

Unlike the NBCC, which deals with "fire separations", whether horizontal or vertical, the IBC breaks down those separations into fire barriers, fire partitions, smoke barriers and smoke partitions. The IBC also deals with horizontal assemblies separately. With the exception of smoke partitions (which are similar to fire separations without a fire resistance rating in the NBCC), the requirements for protecting penetrations must conform to Section 712 of the IBC. Penetrations through smoke partitions must be protected with "an approved material to limit the free passage of smoke". Joint systems must conform to Section 713 of the IBC.

Fire Stops for Penetrations – Section 712 of the IBC provides the details for "the materials and methods of construction used to protect through penetrations and membrane penetrations". For the most part, the requirements for the protection of through penetrations and membrane penetrations resemble those of the NBCC. The IBC does, however, reference ASTM E814 or UL 1479 for testing (see 5.7.3.4).

For fire resistance rated walls, the IBC requires that fire stop systems have an F rating not less than that required for the fire resistance rating of the assembly and that it be tested with a positive pressure differential of 2.49 Pa. For horizontal fire rated assemblies and membrane penetrations of these assemblies, the IBC requires that fire stop systems have an FT rating of not less than 1 h but not less than the required rating of the floor penetrated. These fire stops are also required to be tested at a positive pressure differential of 2.49 Pa. The T rating on some fire stops is waived when the penetrating item is contained in the cavity of a wall.

Fire Resistant Joint Systems – In Section 713 of the IBC, joints between fire resistance rated assemblies must be protected by a fire stop system "designed to resist the passage of fire for a period not less than the required fire resistance rating of the wall, floor or roof in or between which it is installed". The IBC references ASTM E1966 or UL 2079 for testing joint systems (see 5.7.3.5). Specific criteria are spelled out in the IBC for protecting building perimeter joints where curtain walls are employed.

Sound Transmission – In Section 1207, the IBC requires that walls, partitions, and floor/ceiling assemblies separating dwelling units from each other (or from public or service areas) shall have an STC of 50 (45 if field-tested). Penetrations or openings must be treated to maintain the required ratings. Note that although the ASTC terminology is not used (because its introduction in the ASTM standards is too recent) the concept is inherent in the specific criterion for field testing. Thus these requirements are generally consistent with those in Canada.

5.7.2 NFPA 5000 – Building Construction and Safety Code

NFPA 5000 – Building Construction and Safety Code [5-7] is a model building code developed by the National Fire Protection Association as a complement to its hundreds of fire and life safety standards. For the most part, the requirements for fire stops are the same in NFPA 5000 as they are in the IBC. NFPA 5000 also addresses joints between assemblies in a similar manner to the IBC. NFPA 5000 does not require listed fire stops or joints for smoke partitions and smoke barriers (non-rated assemblies); instead openings must be protected by "a system or material capable of restricting the transfer of smoke".

NFPA 5000 addresses protection for through-penetrations and membrane penetrations in Section 8.8 using the same test methods as the IBC. The requirements for F and T ratings are also the same. Joint systems, including perimeter joints at curtain walls, are addressed in the same manner as the IBC.

5.7.3 USA Requirements for Rating Fire Stops

While Canadian users of this Guide may not need to know the specific details of the requirements in USA codes and standards for rating fire stops, the use of common construction materials and common construction practices between the USA and

Canada make it important that Canadian users have an appreciation of USA requirements. This is of particular importance when examining a USA listing for a fire stop for possible use in Canada. Often, fire stop systems are listed to both Canadian and USA standards; the manufacturers' technical literature will specifically address this issue. For these reasons, an overview of USA codes and standards requirements for rating fire stops will be included in this Guide. This is not intended to be a detailed examination.

There are two areas of major difference between the USA and Canadian requirements for rating fire stops: USA standards permit piping systems to be capped on both ends in the fire test for closed process or supply piping but this configuration is not permitted in CAN/ULC-S115 which permits capping only on the fire side. Secondly, USA standards permit combustible DWV pipe to be capped on the fire side and tested with a differential pressure of 2.5 Pa. In Canada, combustible DWV pipes are required to be tested with caps on the fire side but with a differential pressure of 50 Pa. In addition, USA standards also require a hose stream test in all cases whereas the Canadian standard treats the hose stream test as an optional rating and the USA codes require a separate test for building perimeter joints with non-rated curtain walls; as yet, there are no requirements in Canadian codes for these systems.

5.7.3.1. International Building Code (IBC) Requirements for Fire Rating of Fire Stops

In Section 712 - Penetrations, the IBC [5-6] requires that through-penetration fire stop systems in walls and horizontal fire-rated assemblies be tested in accordance with ASTM E814 – "Standard Test Method for Fire Tests of Through-Penetration Fire Stops" [5-8] or UL 1479 – "Standard for Fire Tests of Through-Penetration Fire Stops" [5-9]. Separate requirements are included for rating fire-resistant joints.

For wall assemblies, as an alternative to these tested fire stops, the IBC permits the annular space between a steel, ferrous or copper pipe or conduit to be protected with concrete, grout or mortar, within specified size limits under certain conditions; or with other generic materials that will prevent the passage of flame and hot gases when tested to the ASTM E119 [5-10] standard fire exposure for a time period at least equal to the fire resistance rating of the assembly. (The ASTM E119 standard fire exposure is the same as the CAN/ULC-S101 standard fire exposure.)

For horizontal fire-rated assemblies, as an alternative to tested fire stops, the IBC permits penetrations by steel, ferrous or copper conduits, pipes, etc. through a single floor assembly to be protected by generic materials provided the passage of flame and hot gases criteria are met, and maximum size limits for the penetrating item are not exceeded. As well, concrete, grout or mortar are permitted to protect openings through a single concrete floor assembly provided specified maximum size limits for the penetrating items are not exceeded. Electrical boxes of all types are permitted to be used as a type of fire stop, provided they comply with their listing in a fire-rated floor assembly.

5.7.3.2. International Building Code (IBC) Requirements for Acoustic Rating of Fire Stops

The need for acoustical ratings is clearly expressed in Section 1207. The IBC requires that walls, partitions, and floor/ceiling assemblies separating dwelling units from each other (or from public or service areas) shall have an STC of 50 (45 if field-tested).

Penetrations or openings must be treated to maintain the required ratings. Note that although the ASTC terminology is not used (because its introduction in the ASTM standards is too recent) the concept is inherent in the specific criterion for field testing. Thus these requirements are generally consistent with those in Canada.

5.7.3.3. NFPA 5000 Requirements for Rating Fire Stops

In Section 8.8 – Penetrations, NFPA 5000 [5-7], states the general requirement for protecting through-penetrations and membrane penetrations. This requirement is for fire stop systems to conform to ASTM E814 [5-8] or UL 1479 [5-9]. Separate requirements are in place for rating building perimeter fire stops. As alternatives to tested fire stops, NFPA 5000 permits other arrangements to be used to protect through-penetration openings:

- Penetrations tested and installed as part of a fire-tested assembly.
- Penetrations enclosed in a fire-rated shaft.
- Concrete, grout or mortar where a cast-iron, copper or steel piping or steel conduit or tubing penetrates a concrete or masonry assembly, with specified size limits.
- For a one-storey penetration, generic fire stop materials which are capable of preventing the passage of flame and hot gases for a period at least equal to the fire resistance rating of the assembly, with specific size limits. This solution is limited to steel, ferrous or copper cables, cable or wire with steel jackets, cast-iron, steel or copper pipes or steel conduit or tubing.

5.7.3.4. ASTM E814 and UL 1479

Both the USA model codes use ASTM E814 [5-8] or UL 1479 [5-9] as their base reference documents for rating through-penetration fire stops. Since these two documents are essentially the same, the following discussion will relate only to ASTM E814, which contains many of the same requirements as CAN/ULC-S115. See 5.7.3 above for a discussion of the differences between the USA standards and CAN/ULC-S115.

In ASTM E814, the fire stop can be assigned an F Rating when it remains in the opening for the duration of the fire test and withstands the hose stream test for a specified time, depending on the fire resistance of the assembly. A T Rating can be assigned when the fire stop remains in place for the fire test period, withstands the hose stream test and the temperature on the unexposed face of the fire stop does not exceed a temperature rise of 181°C above its initial temperature.

UL 1479 also includes tests to determine the rate of air leakage through a fire stop at a specified pressure difference across the sample (similar to CAN/ULC-S115). The result of this test is an L Rating. L Ratings are not required in the USA model building codes. UL 1479 also addresses environmental aging of fire stops prior to testing.

UL 1479 has also recently introduced a W Rating which is a measure of water resistance of a fire stop – designed to address potential water damage or leakage during construction and following a fire. This rating is intended to identify systems which will not allow the passage of water under the test conditions, and whether water exposure

will deteriorate the fire stop to the extent that its performance is compromised during a fire test. The W Rating is also not required by codes in the U.S.A. or Canada.

5.7.3.5. IBC and NFPA 5000 Requirements for Rating Construction Joints

Both the IBC and NFPA 5000 separate the requirements for rating construction joints and curtain wall/floor joints (perimeter fire stops). For construction joints, both Codes reference ASTM E1966 – "Standard Test Method for Fire Resistive Joint Systems" [5-11] or UL 2079 – "Standard for Tests for Fire Resistance of Building Joint Systems" [5-12]. The construction joints being assessed in these standards are floor-to-floor, wall-to-wall, head-of-wall and floor-to-wall joints. Perimeter joint fire stops, where curtain walls are used, will be discussed later in this section. UL 2079 is almost the same as ASTM E1966, so will not be discussed further in this Guide.

Construction Joints – ASTM E1966 [5-11] contains many of the same test criteria as ASTM E814, however, a separate standard has been developed due to the unique characteristics of construction joints. For example, ASTM E1966 explains that construction joints are permanent, integral parts of a building in which their width, movement, capabilities and location may have structural considerations. On the other hand, through-penetration fire stops may be added or removed from a building and their openings filled.

ASTM E1966 contains a requirement for a movement cycling test. This test is conducted prior to a fire test to ensure that a joint can withstand the typical movement it may encounter during its life in a building environment [5-13]. The conduct of the movement cycling test is described in ASTM E1399 – Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems [5-14], which is used also to determine the ability of joints to resist building movement without fire exposure.

To pass ASTM E1966, a construction joint must pass:

- a movement cycling test,
- the fire endurance test (including a temperature rise limit),
- an integrity test in which transmission of flames and hot gases cannot occur,
- a load application test for those joints in structurally-loaded assemblies, and
- the hose stream test for wall-to-wall, top-of-wall and floor-to-wall applications.

Building Perimeter Fire Stops – Both the IBC and NFPA 5000 contain requirements for separate tests for perimeter fire stops installed adjacent to the outside walls of buildings. The IBC describes the performance of a building perimeter fire stop as being able to prevent the interior spread of fire which is determined by a system that remains in place and is capable of resisting the passage of flame and hot gases for a period at least equal to the fire resistance of the floor assembly. NFPA 5000 contains the same performance criteria.

A new test method has evolved in the USA for the evaluation of perimeter fire stops where non-rated curtain walls are used – The Intermediate Scale Multi-Story Apparatus [5-15;5-16]. The new test method is designed to assess fire spread potential through the perimeter fire stop and also via the curtain wall itself. Both the IBC and NFPA 5000 reference ASTM E2307 [5-16]. In addition to F and T Ratings, the new test

requires that flames emitting from a window opening in the lower floor of the test apparatus do not break through a window in the floor above.

Chapter 5 References

- 5-1. National Building Code of Canada, Canadian Commission on Building and Fire Codes, National Research Council of Canada, Ottawa, ON, 2005.
- 5-2. CAN/ULC-S115 – Standard Method of Fire Tests for Firestop Systems, Underwriters' Laboratories of Canada, Scarborough, ON, September 2005.
- 5-3. *ASTM E 90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements*, ASTM International, West Conshohocken, PA, 2004
- 5-4. *ASTM E 336-05, Standard Test Method for Measurement of Airborne Sound Insulation in Buildings*, ASTM International, West Conshohocken, PA, 2005
- 5-5. *ASTM E 413-04, Classification for Rating Sound Insulation*, ASTM International, West Conshohocken, PA, 2004
- 5-6. International Building Code, International Code Council, Inc., Country Club Hills, IL, 2006.
- 5-7. NFPA 5000 – Building Construction and Safety Code, National Fire Protection Association, Quincy, MA, 2006.
- 5-8. ASTM E814 – Standard Test Method for Fire Tests of Through-Penetration Fire Stops, American Society for Testing and Materials, West Conshohocken, PA, 2002.
- 5-9. UL 1479 – Standard for Fire Tests of Through-Penetration Fire Stops, Underwriters Laboratories Inc., Northbrook, IL, 2003.
- 5-10. ASTM E119 – Test Methods for Fire Tests of Building Construction and Materials, American Society for Testing and Materials, West Conshohocken, PA, 2000.
- 5-11. ASTM E1966 – Standard Test Method for Fire-Resistive Joint Systems, American Society for Testing and Materials, West Conshohocken, PA, 2001.
- 5-12. UL 2079 – Standard for Tests for Fire Resistance of Building Joint Systems, Underwriters Laboratories Inc., Northbrook, IL, 1998.
- 5-13. Construction Joint Firestopping and Testing, International Firestop Council, Cleveland, OH.
- 5-14. ASTM E1399 – Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems, American Society for Testing and Materials, West Conshohocken, PA, 2000.
- 5-15. Perimeter Fire Barrier Systems, International Firestop Council, Cleveland, OH.
- 5-16. ASTM E2307 – Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems using Intermediate-Scale, Multi-story Test Apparatus, American Society for Testing and Materials, West Conshohocken, PA, 2004.

6.0 CODE REQUIREMENTS FOR FIRE BLOCK INSTALLATIONS AND SOUND ISOLATION

6.1 Introduction

As part of any discussion of National Building Code of Canada (NBCC) requirements for fire blocks [6-1], it is important to first understand how the different parts of the NBCC apply to different buildings. In particular, the differences between the application of Parts 3 and 9 of the NBCC need to be understood.

As indicated in Chapter 5 when discussing the code requirements mandating the installation of fire stops, the NBCC provisions in Parts 3 and 9 differ slightly, including the provisions for fire blocks. It is important to know which Part of the NBCC is being used and whether or not the NBCC is referring to a fire stop or a fire block, despite the fact that the NBCC uses the term "fire stop" for both. (Users are directed to the definitions in Chapter 1 – Introduction and the discussion in 5.1.)

6.2 NBCC Requirements for Fire Blocks in Concealed Spaces

6.2.1 Introduction

Section 2.5 of this Guide illustrated the issues which the NBCC is attempting to address in terms of fire blocks in concealed spaces. Recall that the NBCC uses the term "fire stop", whereas the terms "fire stop" and "fire block" are used in this Guide. With fire blocks, the NBCC is attempting to restrict the size of a concealed space and thus prevent widespread fire growth in an area not normally accessible to firefighting; and to prevent a fire in one concealed space from spreading into an adjoining concealed space.

6.2.2 Part 3 Requirements for Fire Blocks in Wall Assemblies

The basic requirements for fire blocks in concealed spaces in Part 3 of the NBCC treat concealed spaces in walls differently from other concealed spaces. The general requirement is contained in Article 3.1.11.1. and then the specific requirements follow.

3.1.11.1. Separation of Concealed Spaces

1) Concealed spaces in interior wall, ceiling and crawl spaces shall be separated from concealed spaces in exterior walls and *attic or roof spaces* by fire stops conforming to Article 3.1.11.7. [Ref: 3.1.11.1.(1) of NBCC 2005]

Part 3 goes on in Article 3.1.11.2 to require fire blocks in concealed spaces in walls in the following locations:

- At every floor level, thus containing a fire in a wall cavity to only 1 storey.
- At every ceiling forming part of a fire resistive assembly, thus preventing fire spread into a fire resistive floor or ceiling assembly.
- To divide concealed spaces in walls so that the maximum horizontal dimension is 20 m and vertical dimension 3 m, thus limiting the maximum wall concealed space to 60 m².

3.1.11.2. Fire Stopping in Wall Assemblies

- 1) Except as permitted by Sentence (2), fire stops conforming to Article 3.1.11.7. shall be provided to block off concealed spaces within a wall assembly
 - a) at every floor level,
 - b) at every ceiling level where the ceiling forms part of an assembly required to have a fire-resistance rating, and
 - c) so that the maximum horizontal dimension is not more than 20 m and the maximum vertical dimension is not more than 3 m.
- 2) Fire stops conforming to Sentence (1) are not required provided
 - a) the wall space is filled with insulation,
 - b) the exposed construction materials and any insulation within the wall space are noncombustible,
 - c) the exposed construction materials and any insulation within the wall space have a flame-spread rating not more than 25 on any exposed surface, or on any surface that would be exposed by cutting through the material in any direction, and fire stops are installed so that the vertical distance between them is not more than 10 m, or
 - d) the insulated wall assembly contains not more than one concealed air space, and the horizontal thickness of that air space is not more than 25 mm. [Ref: 3.1.11.2.(2) of NBCC 2005]

In Article 3.1.11.2., the NBCC also recognizes that there are certain situations where a concealed space in a wall will not permit fire to spread and so relaxes the above requirements for fire blocks:

- The first exception permits fire blocks to be omitted in a wall cavity filled with insulation. Research [6-2] has shown that wall cavities filled with insulation, including foamed plastics, are not prone to vertical fire spread much beyond the area of the exposing flame.
- The second exception permitting fire blocks to be omitted recognizes that, even though there may be an air space in the wall cavity between the insulation and the cavity walls, if the exposed materials (including insulation) in the cavity are noncombustible, then there is little likelihood of fire spread beyond the exposing flame. Even in the vertical position, fire does not spread upward in a cavity lined with noncombustible materials.
- The third exception permitting fire blocks to be omitted is also based on the previously-mentioned research [6-2]. That work demonstrated that if insulation, including foamed plastic, had a flame spread rating of not more than 25, then fire did not spread beyond the storey of ignition inside those wall cavities. The NBCC has, however, added a safety factor requirement in that while fire blocks are not required where they would be normally at each floor, fire resistive ceiling or every 3 m vertically, fire blocks are required every 10 m vertically (or approximately every 3 storeys in a typical office or apartment building). It is not known whether or not the "construction materials" referenced in Clause 3.1.11.2.(2)(c) includes such services as wiring and piping. Typically, "construction materials" do not include services such as wiring and piping.
- The fourth exception is also based on Reference 6-2 and more recent research [6-3] which further demonstrated that fire would not spread through a vertical air gap in a wall cavity that was 25 mm thick or less. That research showed that fire would not spread more than 1.2 m up a 25 mm air gap in a wall cavity. This is approximately one-half the typical wall

height of a storey and thus did not pose a risk to a storey above, or to a membrane-protected fire resistive assembly. The research in Reference 6-2 had shown that an air gap of 25 mm or less in width did not allow sufficient oxygen into the assembly for burning to occur and thus fire did not spread.

6.2.3 Part 9 Requirements for Fire Blocks in Wall Assemblies

The parallel Part 9 requirements are, in principle, similar to the Part 3 requirements for fire blocks in vertical concealed spaces. The basic requirements in Article 9.10.16.1 provide greater detail than those in Part 3:

9.10.16.1. Required Fire Stops in Concealed Spaces

- 1) Vertical concealed spaces in interior walls and exterior walls shall be separated by fire stops
 - a) one from the other, and
 - b) from horizontal concealed spaces.
- 2) Horizontal concealed spaces in attics, roof spaces, ceilings, floors, and crawl spaces shall be separated by fire stops
 - a) one from the other, and
 - b) from vertical concealed spaces. [Ref: 9.10.16.1. of NBCC 2005]

Sentences 9.10.16.1(1) and (2) above require the basic protection of fire blocks between adjacent vertical and horizontal concealed spaces. These are essentially the same as for Part 3. The specific requirements for fire blocks in concealed spaces in wall assemblies are contained in Article 9.10.16.2:

9.10.16.2. Required Fire Stops in Wall Assemblies

- 1) Except as permitted in Sentence (2), fire stops shall be provided to block off concealed spaces within wall assemblies, including spaces created by furring,
 - a) at each floor level,
 - b) at each ceiling level where the ceiling contributes to part of the required fire-resistance rating, and
 - c) at other locations within the wall, so that the distance between fire stops does not exceed 20 m horizontally and 3 m vertically.
- 2) Fire stops described in Sentence (1) are not required provided
 - a) the width of the concealed wall space does not exceed 25 mm,
 - b) the exposed construction materials within the space are noncombustible,
 - c) the exposed construction materials within the space, including insulation but not including wiring, piping or similar services, have a flame-spread rating of not more than 25, or
 - d) the concealed wall space is filled with insulation. [Ref: 9.10.16.2. of NBCC 2005]

Sentence 9.10.16.2.(1) is effectively identical to the Part 3 requirement. The exceptions in Sentence (2) are slightly different in that the limit on the 10 m vertical continuous concealed space in a wall is not included here. This absence of this requirement is probably in recognition of the 3-storey limit on buildings permitted to be built to Part 9 requirements. This Sentence also makes it clear that combustible wiring, piping and similar services located in a wall assembly may have a flame spread rating greater than 25 and fire blocks are still not required.

6.2.4 Part 3 Requirements for Fire Blocks between Vertical and Horizontal Concealed Spaces

In addition to the general requirements for the separation of vertical and horizontal concealed spaces by fire blocks, the NBCC goes further in Article 3.1.11.4 to require fire blocks in specific locations.

3.1.11.4. Fire Stopping between Vertical and Horizontal Spaces

- 1) Fire stops conforming to Article 3.1.11.7. shall be provided
 - a) at all interconnections between concealed vertical and horizontal spaces in interior coved ceilings, drop ceilings and soffits in which the exposed construction materials within the space have a flame-spread rating more than 25, and
 - b) at the end of each run and at each floor level in concealed spaces between stair stringers in which the exposed construction materials within the space have a flame-spread rating more than 25.
- [Ref: 3.1.11.4. of NBCC 2005]

As explained earlier, the intent here is that a fire in one concealed space should not be able to move into an adjacent concealed space. In particular, it would appear that the requirement is trying to prevent a fire in a vertical concealed space (wall assembly) from moving upward and then horizontally across a space above a ceiling or in a floor assembly. These concepts are illustrated in Figure 6.A, which is extracted from the National Housing Code of Canada [6-4].

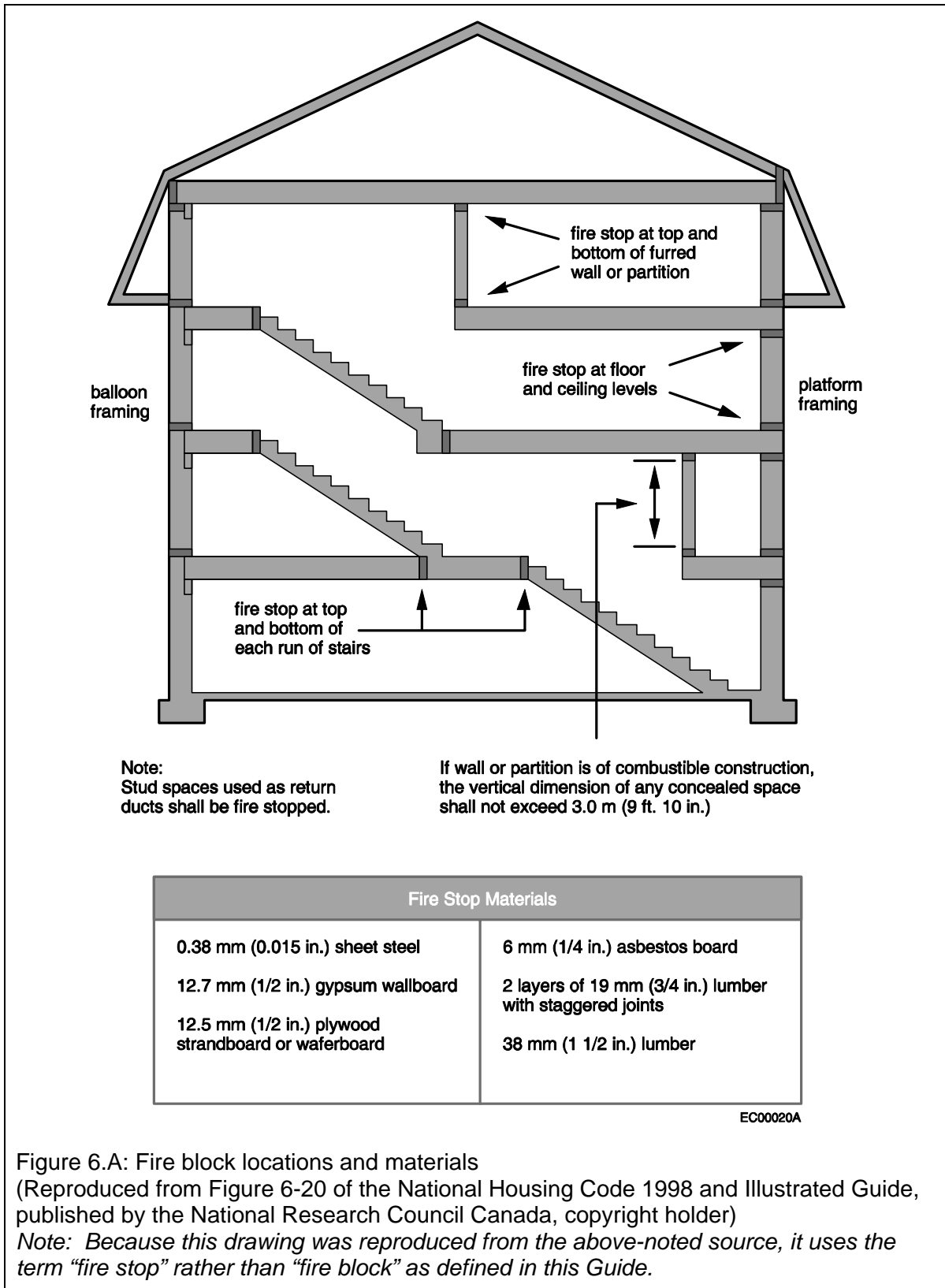


Figure 6.A: Fire block locations and materials
 (Reproduced from Figure 6-20 of the National Housing Code 1998 and Illustrated Guide, published by the National Research Council Canada, copyright holder)
Note: Because this drawing was reproduced from the above-noted source, it uses the term “fire stop” rather than “fire block” as defined in this Guide.

The research in Reference 6-2 and experience over the years has shown that fire does not spread extensively in concealed spaces in which the exposed materials have a flame spread rating (FSR) of 25 or less. In this case, for example, fire blocks would not be required if the materials exposed to the concealed space were gypsum board (FSR approximately 25) whereas they would be required if the materials were plywood which has not been treated to resist flame spread (FSR over 50).

6.2.5 Part 9 Requirements for Fire Blocks between Vertical and Horizontal Concealed Spaces

The corresponding general Part 9 requirements for the separation of vertical and horizontal concealed spaces are found in Sentences 9.10.16.1(1) and (2) (see above). The specific requirements to install fire blocks to separate these concealed spaces are contained in Sentences 9.10.16.1.(3) and (4) shown below:

9.10.16.1.(3) Fire stops shall be provided at all interconnections between concealed vertical and horizontal spaces in interior coved ceilings, drop ceilings and soffits where the exposed construction materials within the concealed spaces have a surface *flame-spread rating* greater than 25.
4) Fire stops shall be provided at the top and bottom of each run of stairs where they pass through a floor containing concealed space in which the exposed construction materials within the space have a surface *flame-spread rating* greater than 25." [Ref: 9.10.16.1.(3) and (4) of NBCC 2005]

These Part 9 requirements are the same as those in Part 3 discussed in 6.2.4.

6.2.6 Part 3 Requirements for Fire Blocks in Horizontal Concealed Spaces

The Part 3 requirements for fire blocks for concealed ceiling or roof spaces of combustible construction are stated in Article 3.1.11.5.

3.1.11.5. Fire Stopping of Horizontal Concealed Spaces

1) Except for crawl spaces conforming to Sentence 3.1.11.6.(1), horizontal concealed spaces within a floor assembly or roof assembly of *combustible construction*, in which sprinklers are not installed, shall be separated by construction conforming to Article 3.1.11.7. into compartments not more than

- 600 m² in area with no dimension more than 60 m if the exposed construction materials within the space have a flame-spread rating not more than 25, and
- 300 m² in area with no dimension more than 20 m if the exposed construction materials within the space have a flame-spread rating more than 25.

(See Appendix A.)

2) A concealed space in an exterior cornice, a mansard style roof, a balcony or a canopy in which exposed construction materials within the space have a *flame-spread rating* more than 25, shall be separated by construction conforming to Article 3.1.11.7.

- at locations where the concealed space extends across the ends of required vertical fire separations, and
- so that the maximum dimension in the concealed space is not more than 20 m." [Ref: 3.1.11.5. of NBCC 2005]

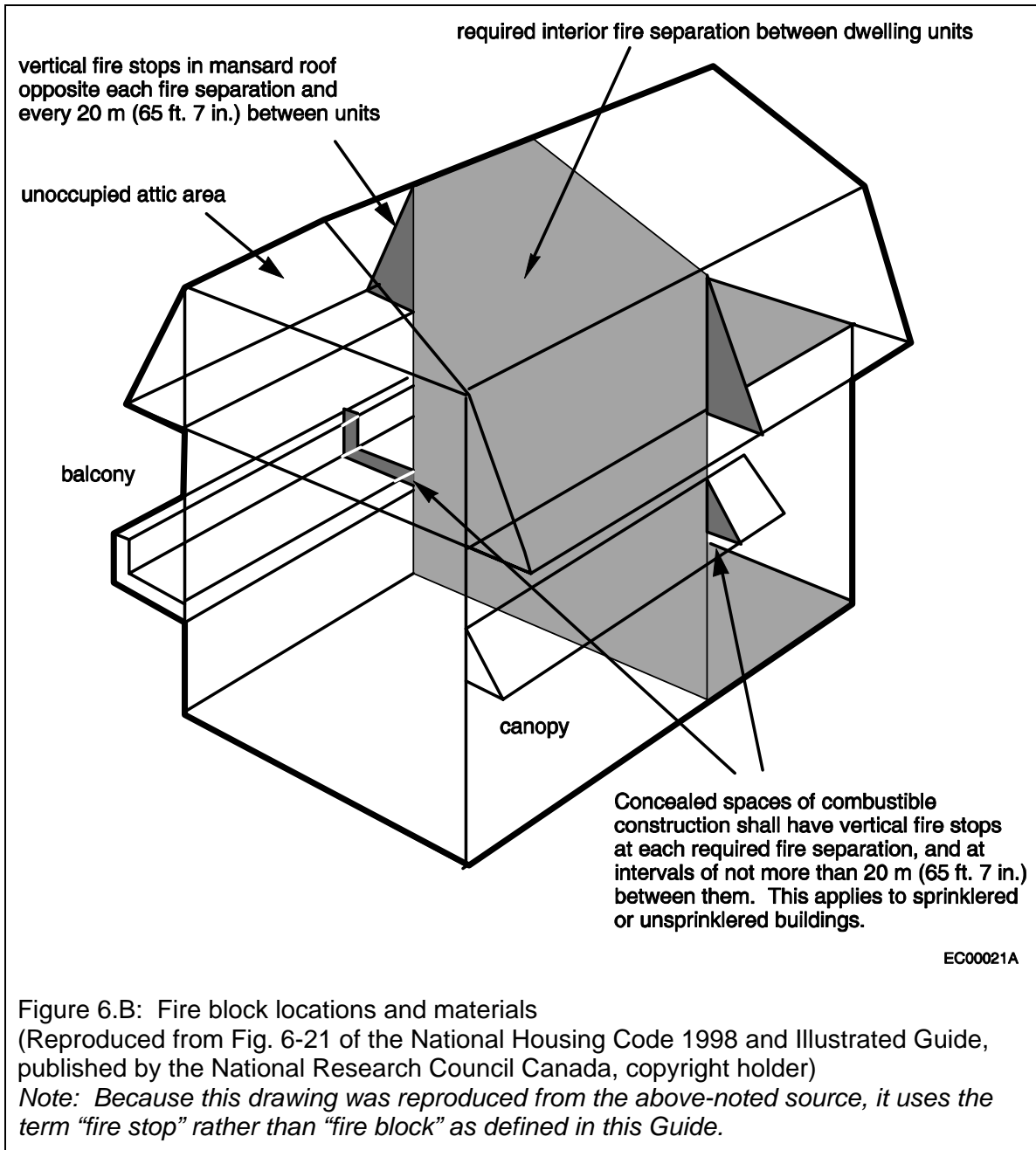
Sentence 3.1.11.5.(1) addresses two types of horizontal concealed spaces; which may occur in a ceiling or roof space or a floor space. Crawl spaces are addressed separately (see 6.2.8).

- Those where all construction materials in the space (regulated by the NBCC) have a flame spread rating of not more than 25 – which are permitted to have compartments not greater than 600 m² with no dimension greater than 60 m.
- Those where any construction material in the space has a flame spread rating greater than 25 (e.g., untreated wood panels, etc.) – which are permitted to have compartments not greater than 300 m² with no dimension greater than 20 m.

This difference in requirements recognizes the higher potential for fire spread over materials with higher flame spread ratings. Regardless of the flame spread rating, it should be noted that fire blocks are not required where these horizontal concealed spaces of combustible construction are sprinklered. This permission to omit fire blocks is in recognition of the capability of sprinkler systems to limit fire spread to areas specified in the sprinkler system design.

Article 3.1.11.5. goes on to address exterior cornices, mansards, balconies and canopies which have exposed construction materials with a flame spread rating greater than 25. Fire blocks must be installed in these concealed spaces where the concealed space extends across the end of a required vertical fire separation (such as between townhouses or apartments) and also where the maximum dimension in the concealed space is greater than 20 m. No exception is made in the NBCC to omit these fire blocks where such spaces are sprinklered.

The concept of such fire blocks is illustrated in Figure 6.B, which is extracted from the National Housing Code of Canada [6-4].



6.2.7 Part 9 Requirements for Fire Blocks in Roof Spaces, Balconies and Canopies

The equivalent requirements for fire blocks in concealed spaces in roof assemblies, balconies and canopies are found in Sentences 9.10.16.1(5) to (7):

9.10.16.1.(5) In unsprinklered *buildings of combustible construction*, every concealed space created by a ceiling, roof space or unoccupied attic space shall be separated by fire stops into compartments

- a) not more than 60 m in greatest dimension, and
- b) where such space contains exposed construction materials having a surface flame-spread rating greater than 25, not more than 300 m² in area.

6) No dimension of the concealed space described in Sentence (5) shall exceed 20 m.

7) Concealed spaces in mansard or gambrel style roofs, exterior cornices, balconies and canopies of *combustible construction* in which the exposed construction materials within the space have a surface *flame-spread rating* exceeding 25 shall have vertical fire stops at intervals of not more than 20 m and at points where such concealed spaces extend across the ends of required vertical *fire separations*. [Ref: 9.10.16.1.(5)-(7) of NBCC 2005]

These requirements are slightly different from those in Part 3 in the following aspect:

- Part 3 permits fire blocks to be omitted when the combustible concealed ceiling or roof space has sprinklers installed in it. Many Part 9 buildings are not sprinklered and Part 9 permits fire blocks to be omitted if the "building" is sprinklered, regardless of whether sprinklers are installed in the concealed space. It should be noted that NFPA 13R – Installation of Sprinkler Systems in Residential Occupancies up to and including Four Stories in Height [6-5] permits the omission of sprinklers in certain combustible concealed spaces, including roof spaces and unoccupied attics. Part 9 permits this reference standard to be used.

The requirements for fire blocks in concealed spaces in ceilings, roofs and attics and in mansards, cornices, balconies and canopies in Part 9 are identical to those in Part 3.

6.2.8 Requirements for Fire Blocks in Crawl Spaces

The NBCC requirements for fire blocks in crawl spaces are contained in Article 3.1.11.6:

3.1.11.6. Fire Stopping of Crawl Spaces

1) A crawl space which is not considered as a *basement* by Article 3.2.2.9. and in which sprinklers are not installed, shall be separated by construction conforming to Article 3.1.11.7. into compartments not more than 600 m² in area with no dimension more than 30 m." [Ref: 3.1.11.6. of NBCC 2005]

This requirement for fire blocks applies only to those crawl spaces in which sprinklers are not installed and that are not considered as basements. Other crawl spaces must conform to Article 3.1.11.5. The size of compartments within a fire blocked area is restricted to 600 m² in area with no dimension greater than 30 m.

There are no equivalent Part 9 requirements for fire blocks in crawl spaces, probably based on the fact that Part 9 only applies to buildings with a maximum building area of 600 m².

6.2.9 Fire Blocks Between Nailing and Supporting Elements

The NBCC contains two requirements for fire blocks in concealed spaces formed by a drop ceiling and wood nailing elements, and by a raised floor and wood nailing elements in Article 3.1.11.3:

3.1.11.3. Fire Stopping Between Nailing and Supporting Elements

1) In a *building* required to be of *noncombustible construction*, a concealed space in which there is an exposed ceiling finish with a *flame-spread rating* more than 25, shall be provided with fire stops conforming to Article 3.1.11.7. between wood nailing elements, so that the maximum area of the concealed space is not more than 2 m².

2) In a *building* required to be of *noncombustible construction*, fire stops conforming to Article 3.1.11.7. shall be provided in the concealed spaces created by the wood members permitted by Sentence 3.1.5.8.(2) so that the maximum area of a concealed space is not more than 10 m²." [Ref: 3.1.11.3. of NBCC 2005]

Both of these Sentences apply to buildings of noncombustible construction. In Sentence (1), if the flame spread rating of the ceiling finish (exposed to the concealed space) exceeds 25, fire blocks must be provided to create areas not greater than 2 m². In this case, the fire blocks can be the wood members to which the dropped ceiling is attached.

Sentence 3.1.11.3.(2) applies to a floor raised not more than 300 mm above a noncombustible floor slab (surface) which is supported by wood members. In this case, as in Sentence (1), the wood members can be used as fire blocks with the maximum area in the concealed space limited to 10 m². It should be noted that this requirement applies regardless of the flame spread rating of the flooring itself.

6.2.10 Provincial Variations

There appear to be no specific technical differences between the provincial building codes and the NBCC related to the requirements for the installation of fire blocks. There are some minor differences in wording that do not create technical differences.

6.3 Rating of Fire Blocks

6.3.1 Basic Part 3 Requirements for Rating Fire Blocks

The required fire performance for fire blocks in the NBCC is stated in Sentences 3.1.11.7.(1) to (3) for noncombustible construction and Sentences 3.1.11.7.(4) and (7) for combustible construction. These differ considerably from the requirements discussed in 5.6 of this Guide for fire stops. Recall that the NBCC calls both fire stops and fire blocks "fire stops".

3.1.11.7. Fire Stop Materials

- 1) Except as permitted by Sentences (2) to (4) and (7), materials used to separate concealed spaces into compartments shall remain in place and prevent the passage of flames for not less than 15 min when subjected to the standard fire exposure in CAN/ULC-S101-M, "Standard Methods of Fire Endurance Tests of Building Construction and Materials."
- 2) Gypsum board not less than 12.7 mm thick and sheet steel not less than 0.38 mm thick need not be tested in conformance with Sentence (1) provided all joints have continuous support.
- 3) In a *building* required to be of *noncombustible construction*, wood nailing elements described in Article 3.1.5.6. need not be tested in conformance with Sentence (1).
- 4) In a *building* permitted to be of *combustible construction*, in a *combustible* roof system permitted by Sentence 3.1.5.3.(2), and in a raised platform permitted by Sentence 3.1.5.8.(2), materials used to separate concealed spaces into compartments are permitted to be
 - a) solid lumber not less than 38 mm thick,
 - b) phenolic bonded plywood, waferboard, or strandboard not less than 12.5 mm thick with joints supported, or
 - c) two thicknesses of lumber, each not less than 19 mm thick with joints staggered, where the width or height of the concealed space requires more than one piece of lumber not less than 38 mm thick to block off the space." [Ref: 3.1.11.7.(1) to (4) of NBCC 2005]

3.1.11.7

- 7) In *buildings* permitted to be of *combustible construction*, semi-rigid fibre insulation board produced from glass, rock or slag is permitted to be used to block the vertical space in a double stud wall assembly formed at the intersection of the floor assembly and the walls (provided the width of the vertical space does not exceed 25 mm and the insulation board)
 - a) has a density not less than 45 kg/m³,
 - b) is securely fastened to one set of studs,
 - c) extends from below the bottom of the top plates in the lower *storey* to above the top of the bottom plate in the upper *storey*, and
 - d) completely fills the portion of the vertical space between the headers and between the wall plates.
 (See Appendix A.) [Ref: 3.1.11.7.(7) of NBCC 2005]

General Requirement – The general requirement for fire blocks for Part 3 buildings is stated in Sentence 3.1.11.7.(1) as being that they must remain in place and prevent flame-through for a period of 15 min when subjected to the standard fire exposure (time-temperature curve) in CAN/ULC-S101 - Standard Methods of Fire Endurance Tests of Building Construction and Materials [6-8]. It is useful to note that the standard fire exposure (time-temperature curve) used in CAN/ULC-S101 is identical to that used in CAN/ULC-S115 [6-9] for fire stops. Thus, if a fire stop has been evaluated by CAN/ULC-S115 and has remained in place and achieved an F Rating of at least 15 min, it can be used for this fire block application. One significant difference between fire blocks and fire stops is the rating period specified in the NBCC. While most fire stops under the NBCC Part 3 must possess a rating of at least 45 min, a fire block may have a rating of 15 min when tested to the same fire exposure.

Noncombustible Construction – Generic materials are permitted to be used for fire blocks in noncombustible construction for Part 3 buildings without having to be tested. Sentence 3.1.11.7.(2) permits minimum 12.7 mm thick gypsum board and minimum 0.38 mm thick sheet steel to be used without being tested to CAN/ULC-S101

(as described above), provided the joints in the materials have continuous support. This joint protection is required to ensure that the generic material will remain in place (e.g., not warp) under fire conditions for 15 min. Sentence 3.1.11.7.(3) also permits wood nailing elements, used for attaching interior finishes (e.g., drywall, flooring) to be used as fire blocks, however, the depth of the space created by the nailing elements is limited to 50 mm thickness for this application.

Combustible Construction – The NBCC permits wood-based generic materials and semi-rigid fibre insulation board to be used for fire blocks in buildings of combustible construction and in certain applications in noncombustible buildings built according to Part 3. Sentence 3.1.11.7.(4) permits wood fire blocks to be used in combustible roof systems and in raised platforms (e.g., stages) in noncombustible buildings and in all applications in combustible buildings provided they are:

- solid lumber at least 38 mm thick.
- plywood, waferboard or OSB at least 12.5 mm thick with supported joints.
- solid lumber in two thicknesses at least 19 mm thick with joints staggered in certain specified circumstances.

For these applications, it is anticipated that the specified generic wood materials will char or deteriorate at a rate that the expected minimum fire block performance of 15 min has been achieved.

Sentence 3.1.11.7.(7) permits glass, rock or slag semi-rigid fibre insulation board to be used to block the vertical space (≤ 25 mm width) in a double stud wall. This application was proven on the basis of research conducted at NRCC [6-3].

6.3.2 Basic Part 9 Requirements for Rating Fire Blocks

Part 9 of the NBCC provides a list of permitted materials for fire blocks, which for the most part, parallels the materials permitted under Part 3. This list appears in Article 9.10.16.3. Regardless of the type of construction used (Part 9 permits both combustible and noncombustible construction to be used), the materials specified in Part 3 can be used as fire blocks, including those which have been tested by exposure to the CAN/ULC-S101 standard fire exposure as described in Part 3 of the NBCC. The only addition to the list is 6 mm thick asbestos board, which is not used today but which may be present in some existing buildings. Part 9 also permits semi-rigid fibre insulation board for the same application as Part 3 as noted above.

9.10.16.3. Fire Stop Materials

- 1) Fire stops shall be constructed of not less than
 - a) 0.38 mm sheet steel,
 - b) 6 mm asbestos board,
 - c) 12.7 mm gypsum wallboard,
 - d) 12.5 mm plywood, OSB or waferboard, with joints having continuous support,
 - e) 2 layers of 19 mm lumber with joints staggered,
 - f) 38 mm lumber, or
 - g) materials conforming to Sentence 3.1.11.7.(1). [Ref: 9.10.16.3.(1) of the NBCC 2005]

6.3.3 Provincial Variations

In the Ontario Building Code (OBC), the permission to use semi-rigid insulation board as a fire block material in double stud (wythe) walls does not have a limit on the width of the vertical space whereas the NBCC permits this solution only for spaces where the width does not exceed 25 mm.

6.4 **U.S. Model Code Requirements for Fire Blocks and Draft Stops**

Canadian users of this Guide should be aware of the corresponding requirements mandating fire blocks in the U.S.A. model codes to be able to recognize the differences between the two code regimes. In particular, an understanding of U.S.A. model code requirements for fire blocks will provide Canadian users with an understanding of any limitations they may encounter. This section is not intended to be a detailed examination.

6.4.1 International Building Code

The International Building Code (IBC) [6-6] is the most widely used model building code in the U.S.A., forming the basis of many state and municipal building codes. In concept, the IBC treats fire blocks in much the same manner that the NBCC does, however, there are differences in the details. The IBC uses the term "draft stop" when describing fire blocks in larger horizontal concealed spaces such as floor/ceiling spaces, attic spaces and mansards. These larger fire blocks are intended to restrict the movement of air in these large spaces.

In Section 717, the IBC requires fire blocks (and draft stops) in combustible concealed spaces. Fire blocks are required to be installed "to cut off concealed draft openings (both vertical and horizontal) and shall form an effective barrier between floors, between a top story and a roof or attic space". The locations that fire blocks are required effectively mirror those described for the NBCC above. Draft stops are required to subdivide combustible horizontal concealed spaces in floor/ceiling assemblies. The sizes of areas to be divided by draft stops (fire blocks in this Guide) are slightly different from those in the NBCC, however, the basic principles of the two codes remain the same. In the IBC, draft stops are not required where the combustible concealed space is equipped with an automatic sprinkler system.

6.4.2 NFPA 5000 – Building Construction and Safety Code

NFPA 5000 – Building Construction and Safety Code [6-7] is a model building code developed by the National Fire Protection Association as a complement to its hundreds of fire and life safety standards. For the most part, the requirements for fire blocks (and draft stops) are the same in NFPA 5000 as they are in the IBC. NFPA 5000 also permits draft stops to be omitted where the space is protected with an automatic sprinkler system.

6.4.3 USA Requirements for Rating Fire Blocks

While Canadian users of this Guide may not need to know the specific details of the requirements in USA codes and standards for rating fire blocks, the use of common construction materials and common construction practices between the USA and

Canada make it important that Canadian users have an appreciation of USA requirements. For these reasons, an overview of USA codes and standards requirements for rating fire blocks will be included in this Guide. This is not intended to be a detailed examination.

6.4.3.1. IBC Requirements for Rating Fire Blocks

The IBC [6-6] addresses the issue of fire spread through concealed spaces in Section 717. While in this Guide, the term "fire block" has been employed when addressing the division of concealed spaces, the IBC uses two terms "fire blocks" and "draft stops". Both terms refer to the division of concealed spaces. In the IBC, fire blocks are intended to resist the spread of flames through a smaller concealed space whereas draft stops are intended to restrict air movement in larger concealed spaces such as crawl spaces, floor/ceiling assemblies, roof/ceiling assemblies and attics.

The IBC permits the following generic materials to be used for fire blocks:

- 51 mm thick nominal lumber or 2 layers of 25 mm thick nominal lumber with broken lap joints
- 18.3 mm thick wood structural panel with joints backed
- 19 mm thick particleboard with joints backed
- gypsum board
- cement fibreboard
- mineral or glass fibre batts or blankets
- other approved materials installed to remain in place.

Draft stops under the IBC are permitted to be constructed of the following generic materials:

- 12.7 mm thick gypsum board
- 9.5 mm thick wood structural panel or particleboard
- other approved materials adequately supported.

As with the NBCC, the actual performance under fire conditions for these various materials will differ from one material to another, some being better than others. These materials have been chosen by the IBC code committees based on past performance for that purpose.

6.4.3.2. NFPA 5000 Requirements for Rating Fire Blocks

In a similar manner to the IBC, NFPA 5000 [6-7] in Section 8.14 uses both the terms "fire blocks" and "draft stops", for the same purposes as the IBC. NFPA 5000 defines a draft stop, however, as being able to resist the passage of smoke and heat whereas IBC focuses on the passage of smoke only. NFPA 5000 also permits generic materials to be used for both fire blocks and draft stops.

In NFPA 5000, fire blocks are required to be constructed of the following:

- nominal 51 mm thick lumber or 2 layers of 25 mm thick lumber with broken lap joints
- 18 mm thick wood structural panel with joints backed
- 19 mm thick particleboard with joints backed
- gypsum board

- cement fibreboard
- mineral or glass fibre batts or blankets, or
- other approved materials which can resist the spread of fire and smoke within the concealed space.

In NFPA 5000, generic materials for draft stops are also permitted as follows:

- 13 mm thick gypsum board
- 12 mm thick wood structural panel
- other approved materials which are adequately supported.

The specific fire performance of these generic materials under fire exposure is not known; however, it can be assumed that, over time, all have proven to be adequate for the required purpose.

6.5 Requirements for Sound Control

Requirements for sound control that apply to fire stops and fire blocks are discussed in Chapters 2 and 5. In most cases, fire blocks will have negligible effect on sound isolation, but there are situations where fire blocks do facilitate structure-borne sound transmission, and hence reduce the apparent sound transmission class (ASTC) for the separating construction between adjacent occupancies.

As noted in Chapter 5, although there is some ambiguity in Code requirements, good practice would require that where fire blocks are used in constructions required to provide sound isolation between occupied spaces in buildings, the resulting built system should provide the specified ASTC. Some examples of good practice are presented in Chapter 13.

Chapter 6 References

- 6-1. National Building Code of Canada, Canadian Commission on Building and Fire Codes, National Research Council of Canada, Ottawa, ON, 2005.
- 6-2. Choi, K.K. and Taylor, W., Combustibility of Insulation in Cavity Walls, *Journal of Fire Sciences*, Vol. 2, No. 3, May/June 1984. (Also DBR Paper No. 1248/NRCC 23925)
- 6-3. Nightingale, T.R.T. and Sultan, M.A., Sound Isolation and Fire Resistance of Assemblies with Fire Stops, *Construction Technology Update* No. 16, Institute for Research in Construction, National Research Council of Canada, Ottawa, ON, 1998.
- 6-4. National Housing Code of Canada and Illustrated Guide, Canadian Commission on Building and Fire Codes, National Research Council of Canada, Ottawa, ON, 1998.
- 6-5. NFPA 13R – Installation of Sprinkler Systems in Residential Occupancies up to and including Four Stories in Height, National Fire Protection Association, Quincy, MA, 2002.
- 6-6. International Building Code, International Code Council, Inc., Country Club Hills, IL, 2003.
- 6-7. NFPA 5000 – Building Construction and Safety Code, National Fire Protection Association, Quincy, MA, 2003.

- 6-8. CAN/ULC-S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials, Underwriters' Laboratories of Canada, Scarborough, ON, 1989.
- 6-9. CAN/ULC-S115 – Standard Method of Fire Tests for Firestop Systems, Underwriters' Laboratories of Canada, Scarborough, ON, 2005.

7.0 BASIC ISSUES RELATED TO BEST PRACTICE FOR FIRE STOPS AND FIRE BLOCKS

This Chapter contains best practice issues that relate to more than one of the subjects addressed in Chapters 8 to 13. It also contains material of a more general nature related to the fire safety and acoustic design, installation, inspection and maintenance of fire stops and fire blocks.

7.1 Engineering Judgements

During design and installation, there are numerous occasions when specific conditions do not lend themselves to any listed fire stop systems. In these cases, the designer or installer will seek an alternative solution to the listed fire stop systems to protect the opening in the fire separation. In the context of fire stop systems, these alternative solutions are called "engineering judgements". In the NBCC, these would be termed "alternative solutions". It is important for users to realize that engineering judgements are not intended as substitutes for listed fire stop systems, where they exist; but are intended for use where a specific field application, for which there is no listed fire stop system, is encountered, or where all of the requirements for a listed system cannot be practically met in a field application.

When accepted by an Authority Having Jurisdiction (AHJ), engineering judgements are effectively considered to be acceptable under the requirements of a building code. As such, it is incumbent on the person preparing the engineering judgement to demonstrate fully, using technical or other supporting data, that the solution being proposed will provide the same or better performance in the field as a listed fire stop system will. Guidelines for the development and substantiation of engineering judgements for fire stops are found in References 7-1 and 7-2.

In addition to References 7-1 and 7-2, the following provide general guidance to those preparing or evaluating engineering judgements:

1. For the most part, engineering judgements should be prepared by a professional individual or organization independent of the manufacturer or others involved in the specific application.
2. The engineering judgment should clearly state:
 - a) the project involved and the name of the professional preparing the engineering judgement,
 - b) the applicable code requirement(s),
 - c) why the applicable code requirement (or listing requirement) cannot be met using a listed fire stop system,
 - d) the specific details of the construction assembly involved,
 - e) the proposed alternative fire stop solution, including sketches or drawings if necessary.
3. The engineering judgement should demonstrate, on the basis of test data or equivalent documentation, how the alternative solution provides the same level of performance, under fire conditions, as a listed fire stop system would provide in a similar application.
4. The engineering judgement should include detailed instructions on the installation of the alternative solution and any special instructions related to long term performance.

Users are reminded that engineering judgements are proposals to a local AHJ for application to a specific construction project. Upon review, the AHJ may accept the proposal, may reject the proposal or may accept the proposal with conditions that must be met. It is only after the AHJ has accepted the engineering judgement that the alternative solution can be installed and be in conformance with the applicable building code.

7.2 Fire Separations and Fire "Walls" above Parking Garages – F and FT Ratings

In addressing the details of best practice for fire stops, it is necessary to understand the differences related to fire stop systems between fire separations and firewalls, and fire separations above parking garages (described in Article 3.2.1.2. of the NBCC). These latter fire separations are treated, by the NBCC, similar to firewalls. Penetrations in these latter fire separations above parking garages are protected with fire stop systems in the same manner as penetrations of 2 h firewalls. One important issue about which a user should be aware is the role under the NBCC that a floor assembly above a parking garage plays in a building. The NBCC uses the term "storage garage" to describe what is commonly called a parking garage in practice. Under the NBCC, a parking garage may, in some cases, be considered a separate "building" from the perspective of the Code.

3.2.1.2. Storage Garage Considered as a Separate Building

1) A *basement* used primarily as a *storage garage* is permitted to be considered as a separate *building* for the purposes of Subsection 3.2.2., provided the floor and roof assemblies above the *basement* above the adjoining ground level are constructed as *fire separations* of masonry or concrete having a *fire-resistance rating* not less than 2 h, except as permitted by Sentence (2). [Ref. 3.2.1.2 (1) of NBCC 2005]

In those situations where a parking garage in a basement is deemed a separate "building" by Article 3.2.1.2. of the NBCC, the floor assembly above the parking garage is considered to be like a "firewall". Fire stops for penetrations through this assembly require an FT rating. If a parking garage in a basement and the building(s) above are deemed to be one "building" for the purposes of NBCC application, then fire stops for penetrations through the floor assembly above the parking garage need only have an F rating. Table 7.A provides a summary of required ratings for fire stops through both types of fire separations [7-3].

Table 7.A**Fire Stops for Penetrations above a Basement Parking Garage**

Garage Classification	Fire-Resistance Rating of Floor-Ceiling Assembly Above Garage in Basement	Fire Stop Rating		
		F Rating⁽¹⁾ Most Services	F Rating Combustible DWV Pipe⁽²⁾	FT Rating⁽³⁾ All Services
Separate Building	2 h (NBCC 3.2.1.2)	N/A ⁽⁴⁾	N/A ⁽⁴⁾	2 h
Same Building (most cases)	1 ½ h (NBCC 3.3.5.6.(1))	1 h	1 ½ h	N/A ⁽⁴⁾
Same Building (Institutional, F1)	2 h (NBCC Table 3.1.3.1)	1 ½ h	2 h	N/A ⁽⁴⁾

Notes to Table 7.A

⁽¹⁾F Rating – must prevent flame through.

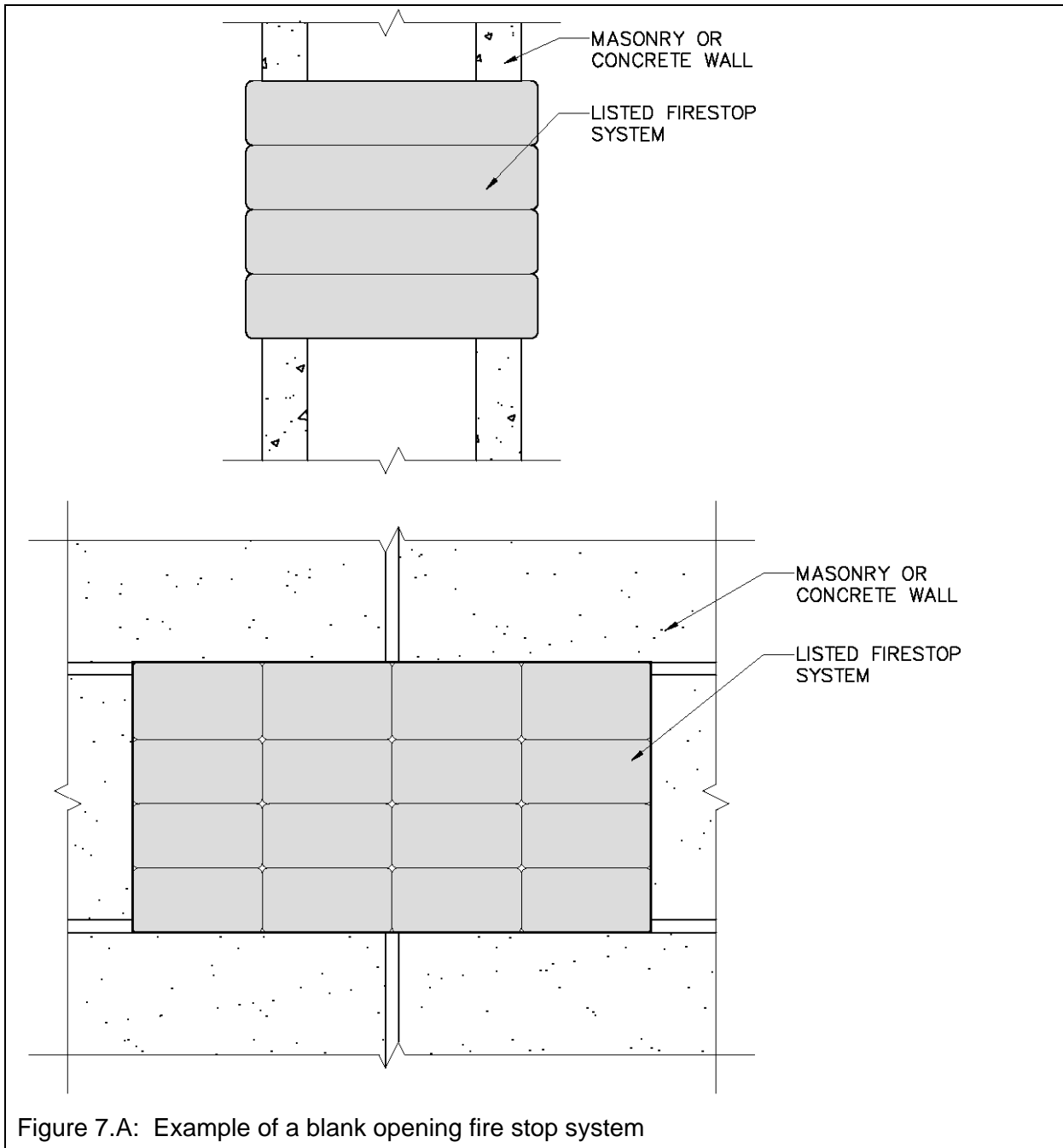
⁽²⁾Fire stops for combustible DWV piping must also be tested with a pressure differential of 50 Pa.

⁽³⁾FT Rating – must prevent flame through and temperature rise and combustible DWV pipe must be tested with a pressure differential of 50 Pa.

⁽⁴⁾N/A – Not Applicable but may be used to satisfy the F Rating requirement

7.3 Abandoned Openings Requiring Protection

There are occasions when, in error, a hole is cut in a fire separation or a fire-rated membrane or where a penetrating item is removed from an opening, thus having a detrimental effect on the continuity of the fire separation. These openings must be appropriately protected to maintain the fire resistance rating of the assembly. Depending on the size of the opening and the surrounding construction, one solution to "filling the hole" is to close the opening with the same type of construction as the original assembly. Another option is to install a blank opening fire stop system as shown in Figure 7.A.



Users should consult the technical documentation for listed fire stop systems for options for protecting blank openings. For blank opening fire stop systems in floor and roof assemblies, care should be taken to ensure that the impact of vertical loads is addressed since loading and deflection of the assembly may dislodge the fire stop system. In other cases, the fire stop system may not be capable of withstanding a live load applied directly to it. Where products, that can be easily removed (such as pillows, bags, blocks), are used for blank opening fire stops, the fire stop may need to be protected by a wire mesh or similar protection if it is not located in a controlled area, such as above a ceiling or in a restricted-entry control room.

7.4 Multiple Penetrating Items

When a number of items are required to penetrate a fire separation, good practice dictates that they be spaced in such a manner that each penetrating item is surrounded by sufficient fire stop material and separated by sufficient base construction material to ensure the stability and integrity of the fire stop. As well, in stud walls, the top and bottom plates or tracks of walls are sometimes riddled with openings for pipe and cable penetrations, usually with installed fire stops, to such an extent that the structural integrity of the wall may be jeopardized. This practice of installing an excessive number of openings too close together should be avoided if best practice is to be achieved.

Multiple penetrations through a fire separation should be spread out to the greatest extent possible to achieve best practice. Where multiple penetration openings are needed through a gypsum board wall, many installations will require a frame around the larger openings to support the listed fire stop system and the penetrating item. An alternative to using individual listed fire stop systems, each with its penetrating item(s), is to use a specifically listed fire stop system for multiple penetrations – especially if the penetrations must be close together.

There are occasions when openings may contain combinations of penetrating items, such as both pipes and cables. When these situations occur, the user should select a listed fire stop system design that accommodates the assembly construction materials, and the various penetrating items to ensure the integrity of the fire stop system.

7.4.1 Spacing of Openings for Pipes Penetrating Stud Wall Plates or Tracks

For pipes penetrating stud (framed) wall plates or tracks, there are two possible situations that the user should consider:

- If a listed fire stop system allows multiple pipes within the same penetration opening or adjacent openings, the opening spacing shown for the listed assembly should be used.
- For other than listed fire stop systems with specified spacing requirements, the minimum opening spacing shown in Figure 7.B should be used. In this situation, fire stops often are installed between the pipes and the plate or track [7-3]. Good practice would suggest that pipes should be spaced at least the same diameter apart as the larger adjacent pipe.

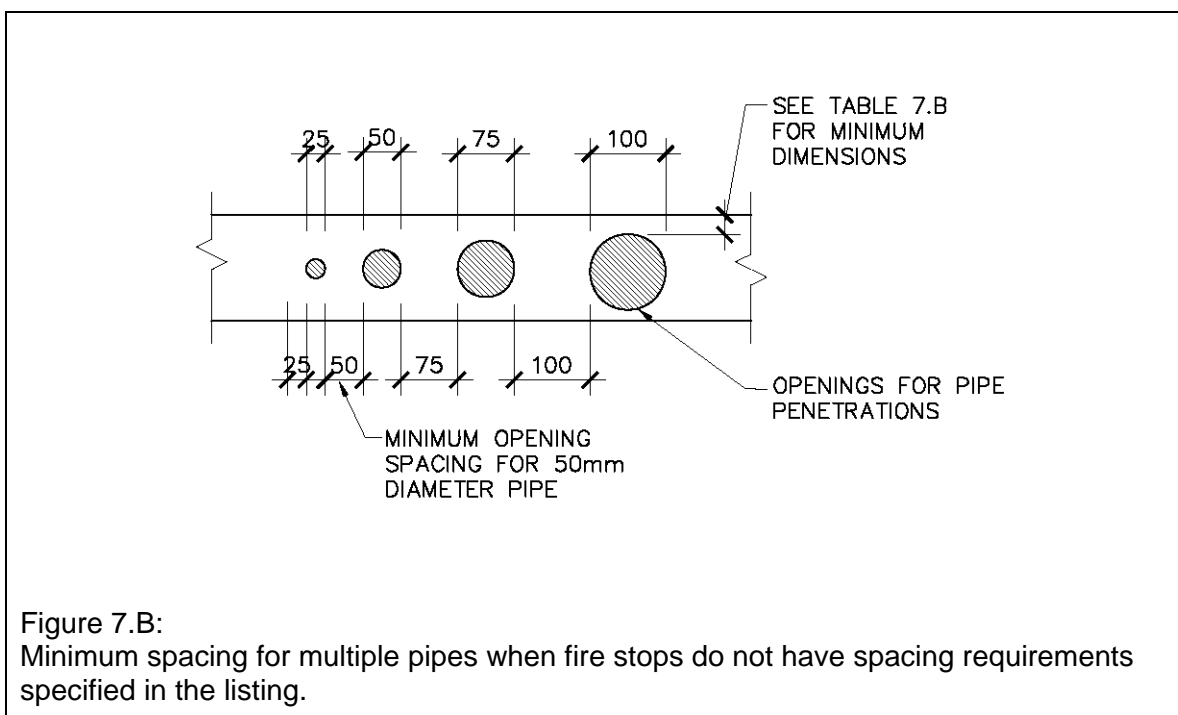
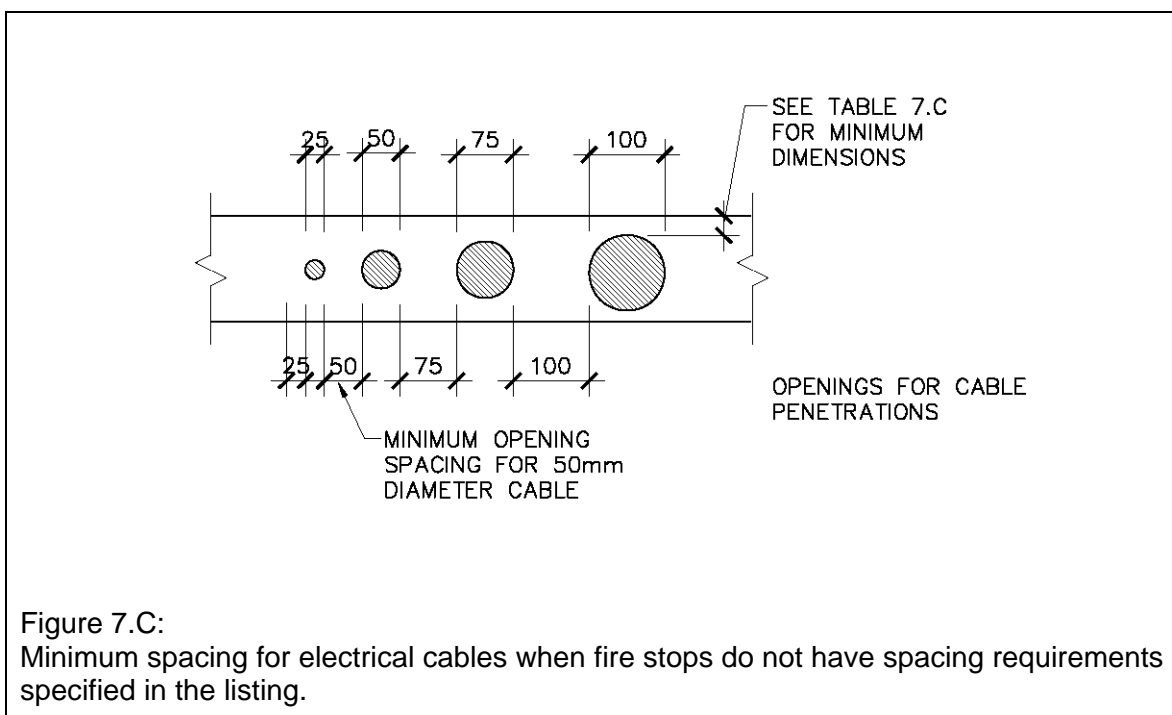


Figure 7.B:
Minimum spacing for multiple pipes when fire stops do not have spacing requirements specified in the listing.

7.4.2 Spacing of Openings for Electrical Cables Penetrating Stud Wall Plates or Tracks

As with pipe penetrations, the spacing of openings in stud (framed) wall plates or tracks for electrical cable penetrations should be designed to ensure the structural stability of the wall and to provide reasonable space to install fire stops. Again, the user should consider two possible situations:

- If a listed fire stop system design permits multiple cables or groups of cables to be installed in the same opening or adjacent openings, the technical documentation for the listed system should be used to address multiple penetration opening spacing.
- For other than listed systems with specified spacing requirements, factors such as the type of fire stop material installed, compatibility with the surrounding construction materials, system stability and the minimum annular space needed to install sufficient fire stop material need to be considered together. In the absence of a specific listed fire stop system, good practice would suggest that openings for cables or groups of cables should be spaced at least the same diameter apart as the opening for the larger cable or group of cables (see Figure 7.C). Fire stops often must be installed between the cable(s) and the plate or track [7-3] so the opening size must be larger than the cable itself.



7.4.3 Spacing of Openings for Penetrations Through Stud Walls

As with openings through wall plates and tracks, multiple openings through a fire separation itself can have a detrimental effect on the fire resistance rating of a stud wall unless the openings are properly spaced and protected. Listed fire stop systems for such multiple penetrations provide the minimum spacing between penetrating items. Where individual listed fire stop systems are used, best practice suggests that they be spaced sufficiently far apart so that the necessary resistance to fire spread provided by the base construction will be available. Figure 7.D provides guidance for spacing individual penetrations in stud walls with stud spacing at 610 mm O.C. Fewer openings would be permitted with studs spaced at 400 mm O.C.

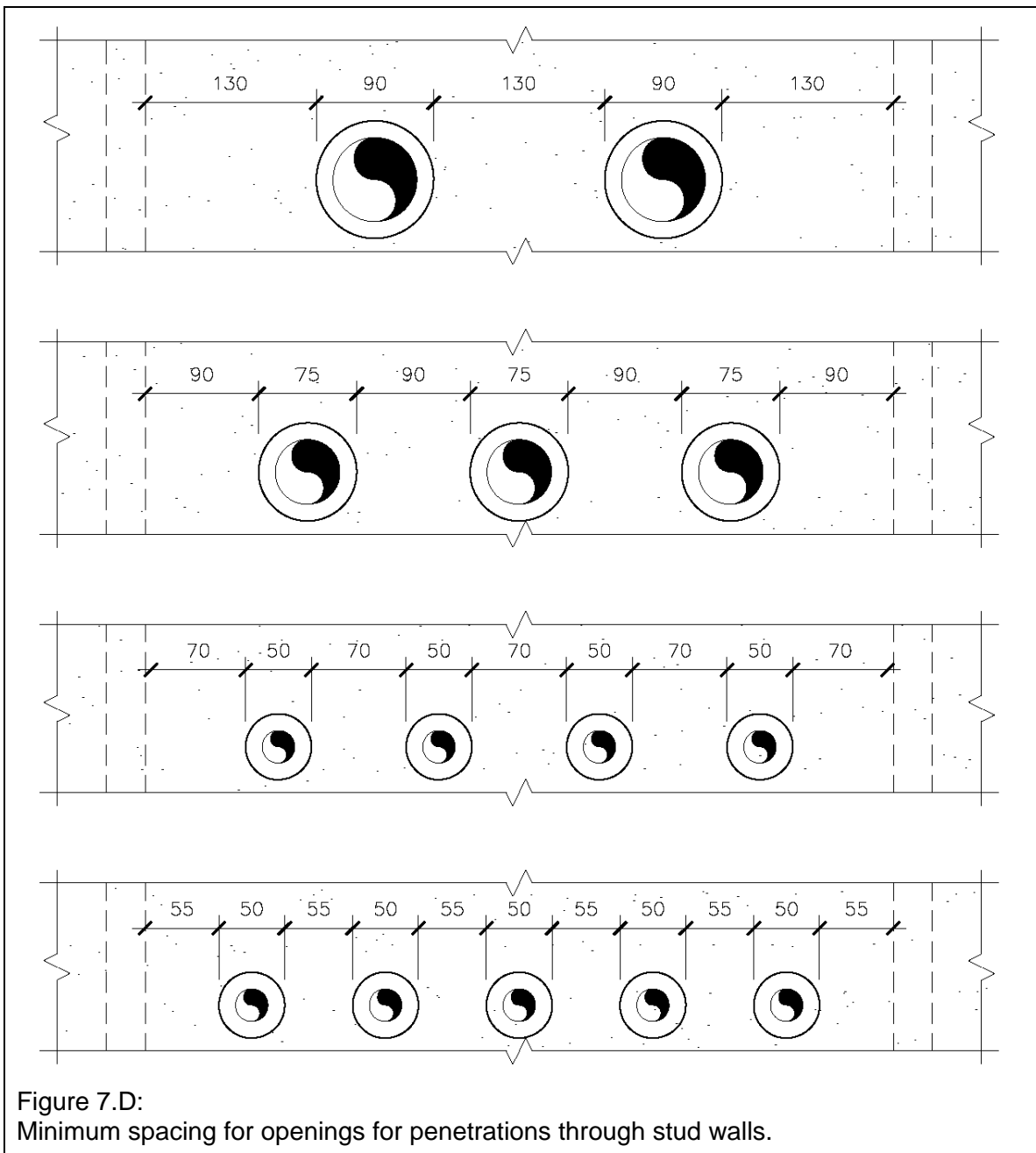


Figure 7.D:
Minimum spacing for openings for penetrations through stud walls.

Figure 7.D illustrates that there should be more base construction material on all sides of fire stops than the dimension of the opening for the penetrating item. The smaller the size of the opening, the more openings that can be provided in the space between the studs.

7.5 Minimum Stud (Framed) Wall Plate or Track Size for Penetrating Items

There is also concern about the minimum width of stud (framed) wall plates or tracks needed to permit openings for larger penetrating items and their required fire stops. If too much of the plate or track is removed for the opening, the assembly's structural integrity may be jeopardized or the fire stop system may not function properly. It is obvious that the larger the opening for penetrations, the larger the wall plate or track that will be needed. Good practice would suggest that Tables 7.B and 7.C be used for minimum wall plate or track sizes for different sizes of openings for pipe and cable penetrations in the absence of specific listed fire stop systems for this application. Users must also realize that the annular space through the wall plate or track is often somewhat larger than the diameter of the pipe or cable to permit the fire stop to be installed between the plate or track and the penetrating item [7-1]. If the penetrating item is not cast in place and there is little space between the penetrating item and the surrounding plate or track, a fire stop listed in this application should be used.

Table 7.B

Minimum Wall Plate or Track Size for Different Pipe Sizes

Pipe Size Opening (nominal pipe size)	Size of Wall Plate or Track
50 mm (2") or less	38 x 89 mm
Over 50 mm (2")	38 x 140 mm – or greater as required

Table 7.C

Minimum Wall Plate or Track Size for Different Cable Sizes

Group Cable Size Opening (cable size)	Size of Wall Plate or Track
63.5 mm (2.5") or less	38 x 89 mm
Over 63.5 mm (2.5")	38 x 140 mm – or greater as required

7.6 Use of Drywall Compound as a Fire Stop

Users are frequently faced with the possibility of using drywall compound with or without tape, or “drywall mud and tape” as a fire stop. While there are some specific instances where drywall mud and tape may be used, it is not permitted as a fire stop for penetrating items. The primary location that drywall mud and tape may be used as a fire stop is at a room corner (such as a wall to ceiling or wall to wall joint) where two sheets of drywall come together and the joints are backed with studs or joists. In this instance, the studs and joists themselves provide substantial protection against fire spread at the corners in addition to the minimal protection provided by the drywall mud. Drywall mud and tape should not be used where a drywall vertical fire separation abuts a dissimilar material, such as a steel deck, as the differential movement will cause damage to the mud. A listed fire stop system should be used in this application.

Users should note that in A-9.10.9.6.(1) of the NBCC, gypsum plaster is listed as a generic fire stop material acceptable under Part 9 of the NBCC. Gypsum plaster has been shown to possess greater fire resisting capabilities and less shrinkage than drywall mud and tape and, where appropriately used, will provide the level of protection intended by Part 9. Even gypsum plaster is not permitted for use as a fire stop in buildings constructed to Part 3 of the NBCC.

7.7 The Design and Installation Process for Fire Stops and Fire Blocks

Chapters 8 through 13 of this Guide provide users with examples of fire stop and fire block installations that will provide the level of protection intended by the NBCC. The user is reminded that best practice in fire stop design involves the design and specification, at the required locations shown in the Code and this Guide, of listed fire stop systems that have been tested to CAN/ULC-S115 – Standard Method of Fire Tests of Firestop Systems [7-4]. An important element in the design process is the submission of shop drawings and specifications of the proposed fire stop systems by the installer to the architect in advance of the work. After review with the installer, the architect should then submit the proposed fire stop system designs to the authority having jurisdiction for review and eventual approval.

To ensure that those responsible for review of design and specifications for fire stops and fire blocks have the necessary information for approvals, the designer and installer should incorporate the following into their submissions:

- Who will be responsible for the Scope of Work for fire stops.
- Locations of all fire separations on drawings and indicate whether F or FT ratings are required for fire stops.
- Location of joints requiring fire stops.
- Review with Client and Design Team for other design requirements that may be needed such as:
 - The needs for constant re-penetration requirements for cabling, etc (telecom buildings, computer and data centres).
 - Acoustical ratings for walls and floors.Show all special design needs on the drawings and specifications.
- Review and coordinate all mechanical and electrical needs and identify these requirements on drawings and specifications. These include:
 - Compatibility of fire stops with pipe, devices, insulation, etc.
 - Various types of pipes, insulation, sleeves, cabling, cable trays, bus ducts, ducts, etc.
 - Where possible, locate horizontal and vertical runs on drawings.
 - Review all multi-penetrations with mechanical and electrical contractors and locate on drawing. Coordinate with structural for special structural needs at concrete walls/floors and concrete block walls.
 - If movement can occur or is anticipated, use a listed elastomeric fire stop.
- Identify non-rated fire separation requirements.
- Identify and detail perimeter and construction joint requirements.
- Avoid multi-trade penetrations wherever possible.
- Generic details of minimum fire stop requirements should be incorporated.
- Specifications should reference items indicated above and should also incorporate the following items:
 - Referenced Standard in the applicable building code (e.g., CAN/ULC S115)
 - Submittals
 - Start up meetings with all concerned

- Mock-ups (Destructive Tests)
- Observations
- Destructive Tests of installed fire stops
- Pre-determining Engineering Judgements requirement
- Warranty
- Acceptable products and requirements for installers (e.g., FM or ULC Approved Installer)
- Set labelling/as-built requirements
- 3rd Party Inspections of installed fire stops
- Documentation required by Authority Having Jurisdiction or design professional at project completion (certification or verification).

As well, it is important that, having obtained the approvals based on the drawings and specifications, the construction process incorporate the following:

- Pre-fire stop installation meeting to coordinate fire stop and fire block efforts with all trades.
- Design listing provided for each penetration or joint type:
 - Contractors or fire stop contractors are responsible for submitting copies of the tested fire stop designs to be used on site.
 - Professionals have the primary responsibility for review of designs and monitoring of installation.
 - Local authorities having jurisdiction need to be aware of the designs being installed. They may attend mock-up inspections and may check a number of the designs submitted.
- Mock-up of specific Design Listings, if needed.
 - Determine percentage required to be available for destructive testing.
- Certification or verification of project completion.

By following this process, all involved in the design, approval and installation of fire stops and fire blocks will be fully apprised of the selected systems and able to establish any engineering judgements (see 7.1) that may be necessary in sufficient time to avoid project delays.

7.8 Fire Stop Installation Personnel Qualifications

As a result of the many fire stop systems and fire block products currently on the market and of the growing complexity of fire stop system designs, fire stop installers are being required to possess higher qualifications than previously needed. One means that a user has of ensuring that the installer is knowledgeable in fire stop installation is by requiring that the installer meet a minimum qualification standard.

The FM Global Standard for Approval of Firestop Contractors [7-5] and the ULC Qualified Firestop Contractor Program [7-6] were developed to provide users with a benchmark that installers must meet in order to be "approved" or "registered". Such contractors must pass examinations based on the FCIA Manual of Practice [7-7] and other requirements and must undertake continuing education to maintain their standing. Re-examination is required every three years. Under the UL Qualified Contractor Program, candidates are offered a U.S. or Canadian examination based on US or Canadian code requirements. In addition to the FCIA Manual of Practice, this Best Practice Guide will be a mandatory reading requirement for candidates preparing for the Canadian exam. Qualified contractors are eligible to use the ULC mark for Canada.

Installers, qualified to the standards, can be found throughout North America. Users can determine that the work has been performed by qualified installers by seeking the FM Global or UL/ULC mark on the completed fire stops in the field and by inquiring about certification from the installer. In addition, trade associations and others may offer detailed training for installation personnel. The user should review such training to ensure that the specific installation requirements for the project can be met by the installer.

7.9 Inspection of Fire Stops

Fire stops are currently installed by a number of trades using a myriad of fire stop products and systems. Given the number of products and systems and the number of potential installers, users may wish to verify the quality of fire stop installations in the field. One means of verifying appropriate installation of listed fire stop systems is through the use of independent inspection. This provides a user with confidence that what was designed has been properly installed. One means of ensuring that installed fire stop systems meet the intended safety level for the listing is through the application of ASTM E2174 – Standard Practice for On-Site Inspection of Installed Fire Stops [7-8] or ASTM E2393 – Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers [7-9].

These standards provide a complete procedure for conducting a fire stop inspection and cover the materials, the installation and selected field testing. As well, the Standards identify the necessary qualifications for the technical competence and the independence of the inspector. Users requesting application of the standards should be aware that the inspector will conduct "destructive-type verification" on a portion of installed fire stops to ensure that the installed fire stop will perform as intended by the certification for the listed system. While currently not required by codes in Canada, users wishing to achieve best practice in the installation of fire stops may ensure the quality of the installed fire stops through the use of independent inspectors using ASTM E2174 and E2393 as the basis for their work.

Chapter 7 References

- 7-1. Recommended IFC Guidelines for Evaluating Firestop Systems Engineering Judgements (EJ's), International Firestop Council, Cleveland, OH, 2001.
- 7-2. Recommended IFC Guidelines for Evaluating Perimeter Firestop Systems Engineering Judgements (EJs), International Firestop Council, Cleveland, OH, 2007.
- 7-3. Fire Stopping Service Penetrations in Buildings, The City of Calgary Building Regulations Division, Calgary, AB., 2003.
- 7-4. CAN/ULC-S115 – Standard Method of Fire Tests for Firestop Systems, Underwriters' Laboratories of Canada, Scarborough, ON, 2005.
- 7-5. FM-4991, Approval Standard for Approval of Firestop Contractors, Factory Mutual Research Corporation (FM Approvals), Norwood, MA, 2001.
- 7-6. Qualified Firestop Contractor Program Requirements, Underwriters Laboratories Inc., Northbrook, IL, 2006.
- 7-7. The Standard – FCIA Firestop Manual of Practice, Firestop Contractors International Association, Wheaton, IL, 2001.
- 7-8. ASTM E2174 – Standard Practice for On-Site Inspection of Installed Fire Stops, ASTM International, West Conshohocken, PA, 2001.
- 7-9. ASTM E2393 – Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers, ASTM International, West Conshohocken, PA, 2004.

8.0 BEST PRACTICE FOR FIRE STOPS FOR PIPE PENETRATIONS

8.1 Introduction

Note: Many of the illustrations and much of the text in this Chapter have been adapted from Reference 8-1.

The examples shown in this Chapter represent various means of achieving fire compartment continuity with fire stops. There are other fire stop systems that may serve this purpose. For reasons of brevity, these other solutions have not been illustrated.

This Chapter will provide information on best practices for fire stops for pipe penetrations through horizontal and vertical fire separations. Prior to addressing the details of best practice, it is first necessary to understand the types of fire separations that may be penetrated and thus require fire stops. The fire stops shown in this Chapter are for illustrative purposes only. There are a number of listed fire stop systems available to address most penetrations in fire separations. Care should be taken to select an appropriate fire stop system that meets the requirements of the fire separation being penetrated, the penetrating item, and the size of the opening.

A simplified diagram of a building over a parking garage is shown in Figure 8.A. For illustration purposes only, a noncombustible piping system is shown on the left side of the figure and a combustible piping system on the right. For both systems, pipe penetrations consist of horizontal penetrations through vertical fire separations (walls) and vertical penetrations through horizontal fire separations (floor and roof-ceiling assemblies), including those above a parking garage.

There are some cases where the NBCC allows the wall between a public corridor and the adjacent suites not to be constructed as a fire separation [Ref. 3.3.1.4. of the NBCC 2005]. In these cases, penetrations in the wall between the public corridor and the suites in Figure 8.A would not require fire stops.

With respect to fire stops, pipe penetrations of fire separations may be addressed in a number of ways depending on whether the pipes are combustible or noncombustible. Another issue relates to insulation around pipes (not part of the fire stop system), which needs to be addressed to obtain a proper seal for the fire stop. The combustible/noncombustible pipe issue has traditionally been considered by users to be more important in dictating which fire stop to use, however, the other factors, in combination with the type of pipe, may ultimately dictate the final selection for fire stops due to their influence on installed performance.

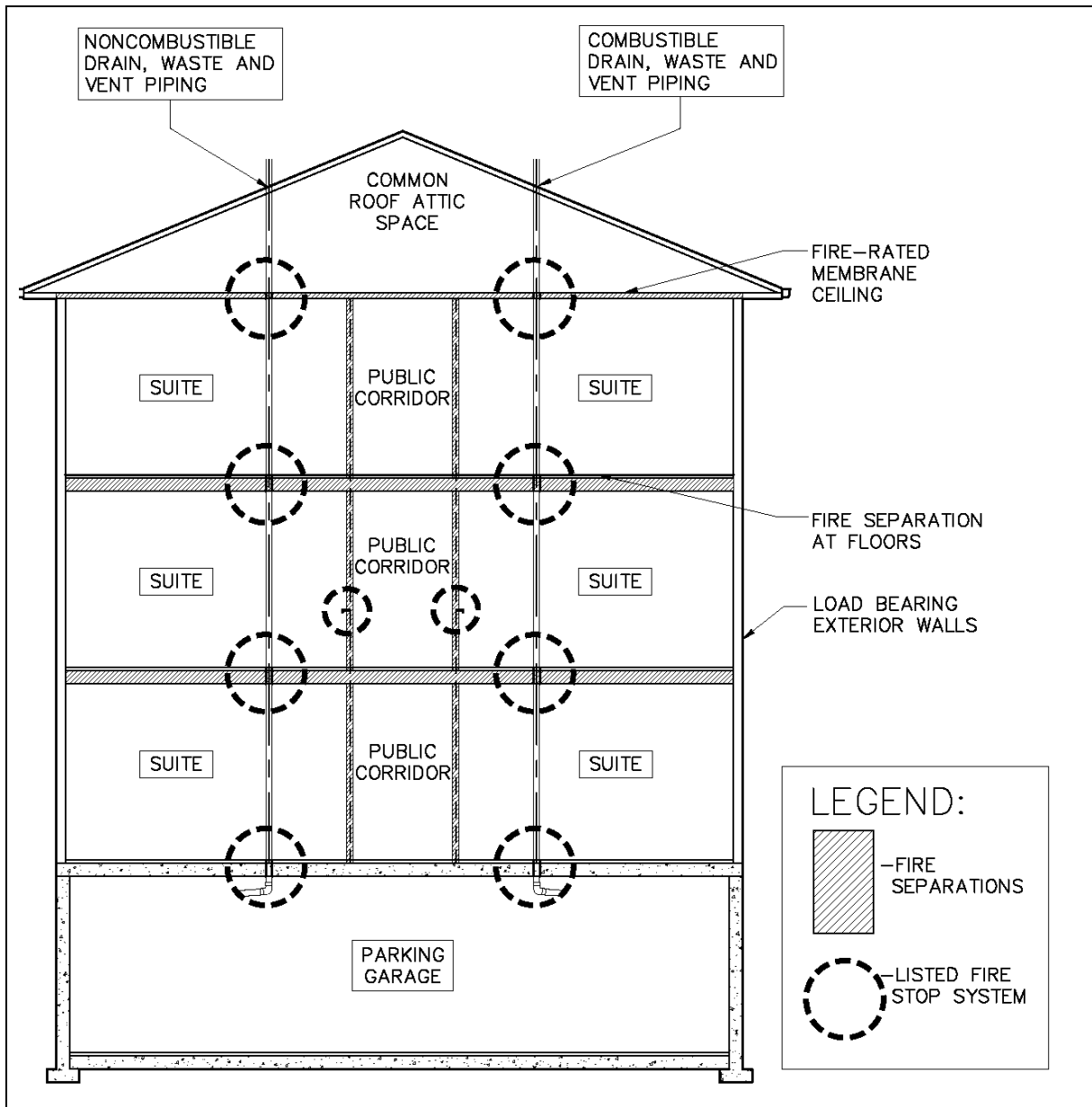


Figure 8.A:

Apartment building over a parking garage showing typical penetrations of combustibles and noncombustibles through rated fire separations. Note that the concrete floor between suites and garage, and walls separating the suites along each corridor may also be fire-rated assemblies in which listed fire stop systems might be required. (See text for need for fire separations for public corridor walls.)

Combustible Vacuum System Piping – While much of the discussion in this Chapter relates to combustible drain, waste and vent (DWV) piping, it is important to realize that best practice recommendations for combustible DWV piping are equally applicable to combustible vacuum system piping. All vacuum system piping must be equipped with fire stops where it penetrates a fire-rated assembly or a membrane

forming part of a fire separation. As well, fire stops for combustible vacuum system piping must be tested using the 50 Pa pressure differential requirement [Ref: 9.10.9.6.(9) of NBCC 2005].

Insulated Pipe Penetrations – There are situations where a pipe penetrating a fire separation must be insulated for thermal control reasons. This is not to be confused with insulation to achieve an FT rating for a listed fire stop system. In the former situation, fire stops must be designed to account for the impact of the fire stop on the insulation around the pipe. Fire stops for such insulated pipes are currently available for both noncombustible and combustible pipes. Different arrangements for fire stops are required for different types of pipe insulation and pipe materials. Specific listed fire stop systems should be used to account for these variables. The user should select a listed fire stop system appropriate for the type of pipe insulation and the type of pipe being used.

Figures 8.B.1 and 8.B.2 illustrate noncombustible and combustible pipe penetrations with pipe insulations. In Figure 8.B.1, the fire stop must be able to seal the opening either at the outer surface of the insulation or at the noncombustible pipe if the insulation can be damaged by the fire. In Figure 8.B.2, the fire stop must be able to seal the opening in such a way that the void created by the fire-damaged combustible pipe is also sealed.

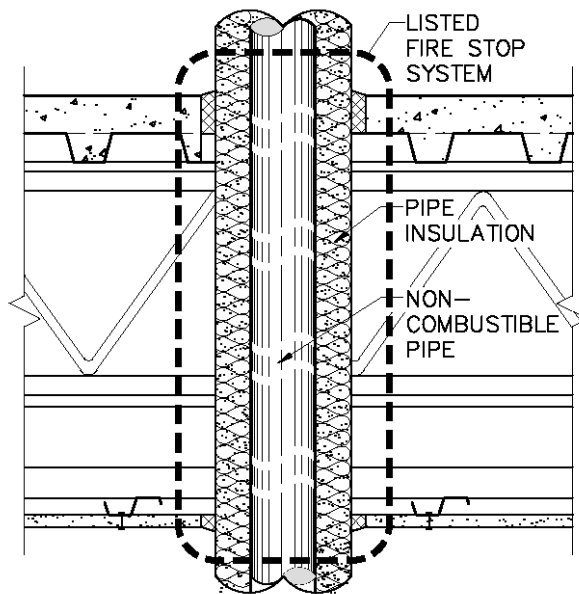


Figure 8.B.1:
Insulated noncombustible
pipe penetration through
fire-rated floor assembly

If Acoustical Separation is Required...

- The complete separating floor/ceiling construction (including treatment of all penetrations) should provide the required STC between occupancies.

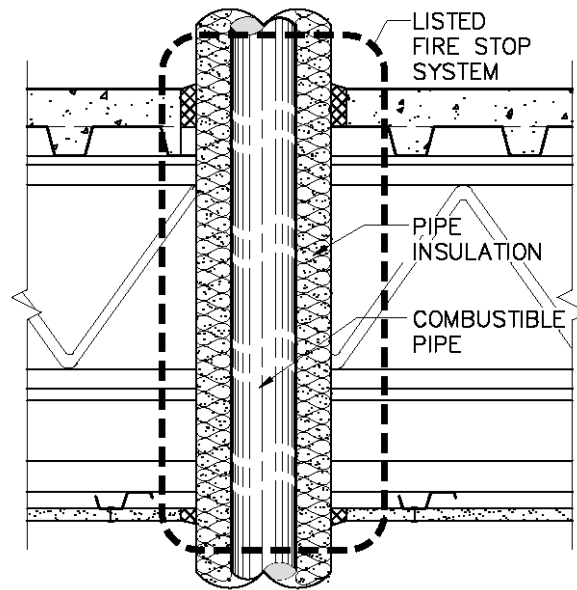


Figure 8.B.2:
Insulated combustible pipe
penetration through a fire-
rated floor assembly

If Acoustical Separation is Required...

- The complete floor/ceiling construction (including the fire stop system at any penetration through the assembly) should provide the required STC between occupancies.

Construction Issues – Users should be aware that listed fire stop systems are approved for specific types of construction (e.g., monolithic concrete, framed wood floors) and that they may not be interchangeable from one construction type to another. Users should also be aware that the installation of appropriate listed fire stop systems for pipe penetrations involves detailed preparation for such issues as coring, sleeving, annular spacing and angular penetrations. These issues should be discussed and resolved at a meeting held prior to the installation of the fire stops. The manufacturers' literature and the listing documentation should be consulted.

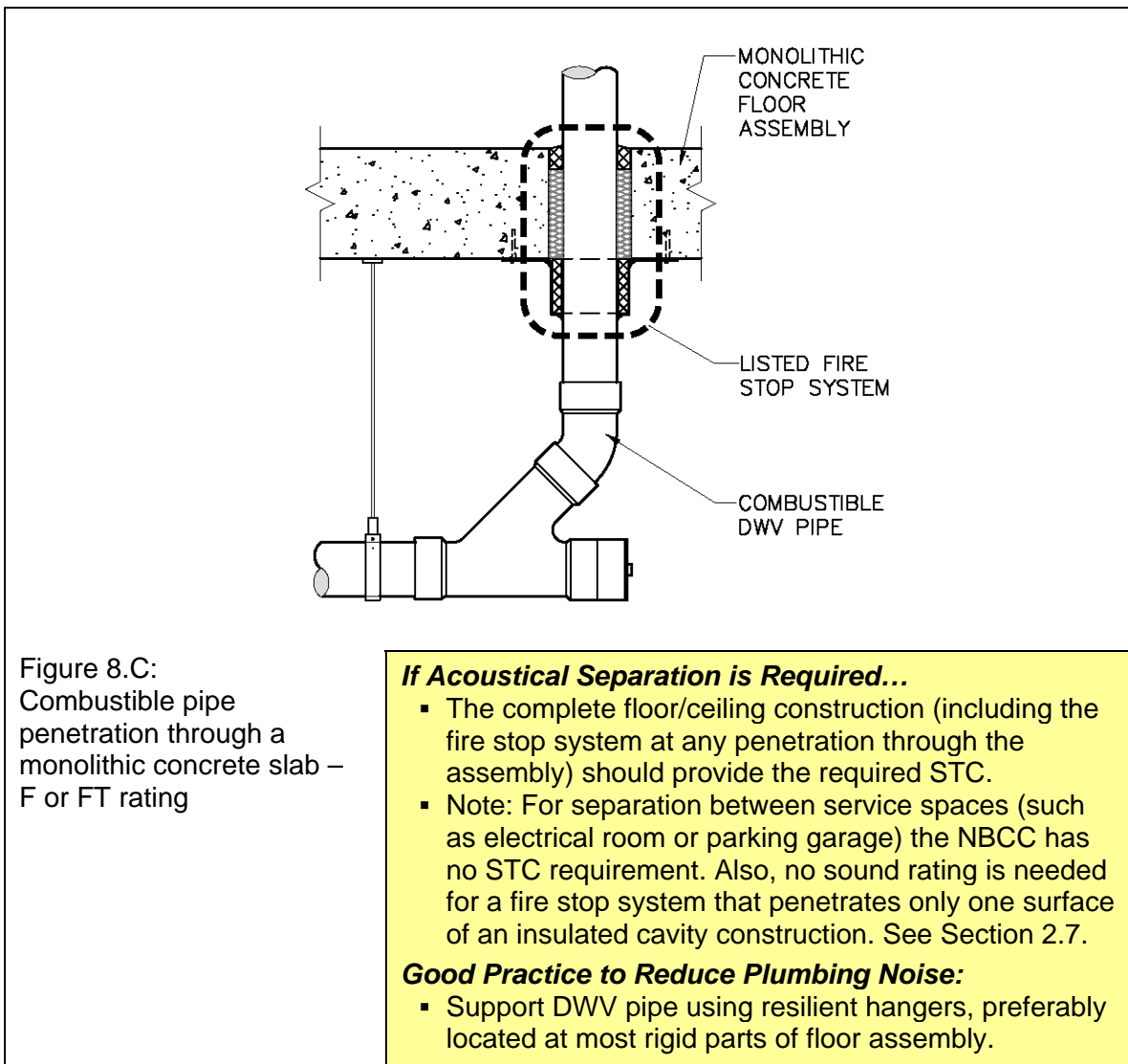
Fire-Rated Walls and Non-Fire-Rated Walls – In examining Figure 8.A, a user can see that the vertical runs of pipe inside the suites penetrate horizontal fire separations. Depending on the design, these pipes may be located inside a fire-rated wall (such as a wall dividing one suite from another) or inside a non-fire-rated wall. Users must be aware that some listed fire stop systems for pipe penetrations of floors require that the fire stop be located inside a fire-rated wall. (The listing will indicate the extent of fire resistance.) To be effective, then, the listed fire stop system needs to be inside a fire-rated wall. Otherwise, a listed fire stop system not requiring a fire-rated wall must be used.

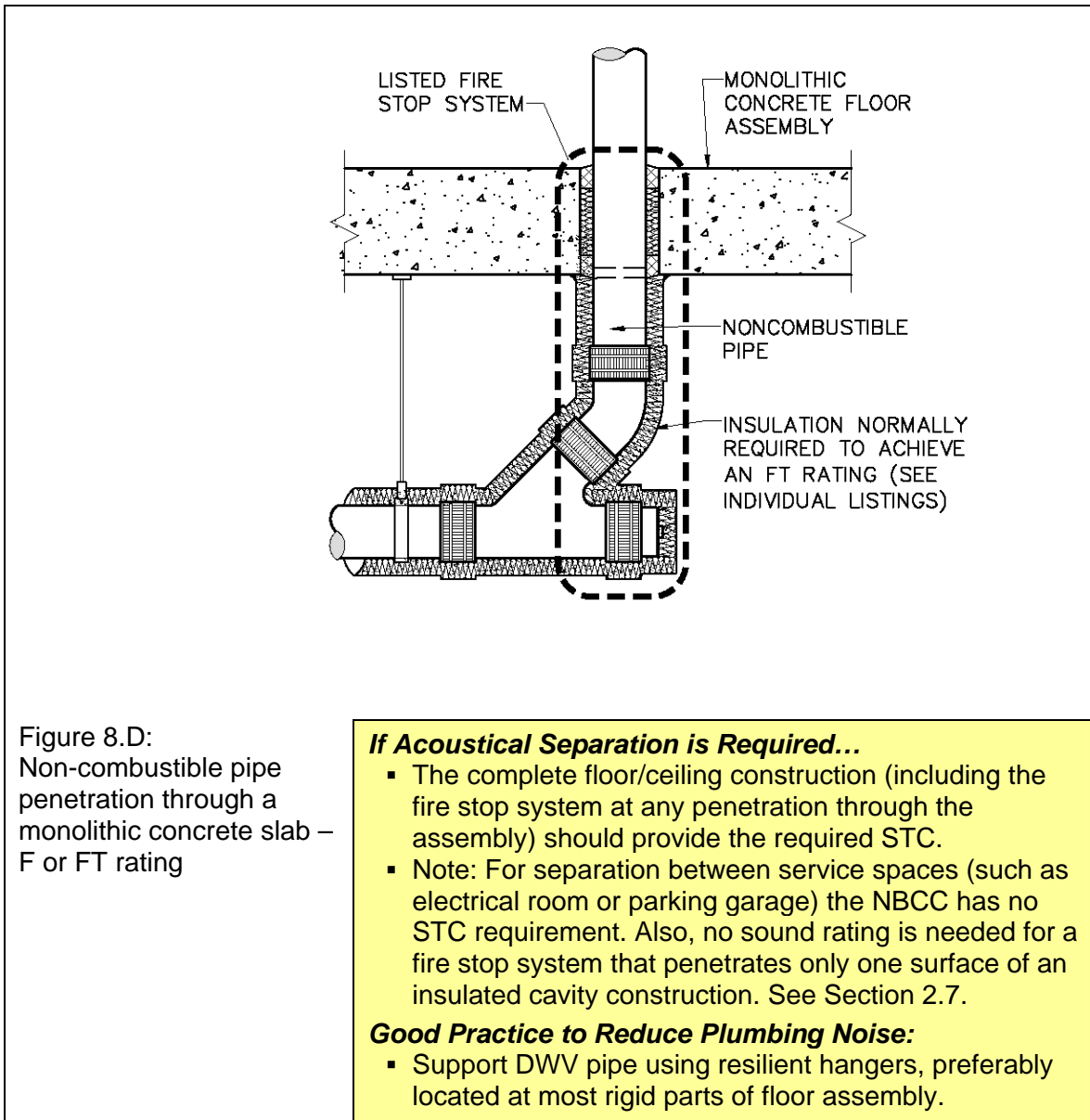
Compatibility of Fire Stops and Plastic Pipes – Certain CPVC pipes used for sprinkler systems or water distribution may be damaged by plasticizers, such as phthalates, used in some fire stops with the result that the pipe will eventually rupture.

Hot water pipes are particularly susceptible to such damage, but cold water pipes will also fail over time. Users should consult the fire stop and pipe manufacturers' technical literature to ensure that the listed fire stop system chosen is compatible with the CPVC pipes in the building.

8.2 Pipe Penetrations through Monolithic Concrete Floor Assemblies

In Figure 8.A, there are two types of fire-rated floor assemblies illustrated: a monolithic concrete floor over the parking garage and framed floor assemblies between other floors. These are typical of fire-rated floor assemblies that will require fire stops for pipe penetrations. Penetrations through framed floor assemblies will be addressed later in this Chapter. Depending on the type of pipe used, fire stop solutions for penetrations of a monolithic concrete floor assembly may differ as shown in the examples in Figures 8.C and 8.D for combustible and noncombustible pipe penetrations, respectively. Fire stops with combustible drain, waste and vent (DWV) pipe in Figure 8.C must be listed for a 50 Pa. pressure differential as well as achieving an F or FT rating.



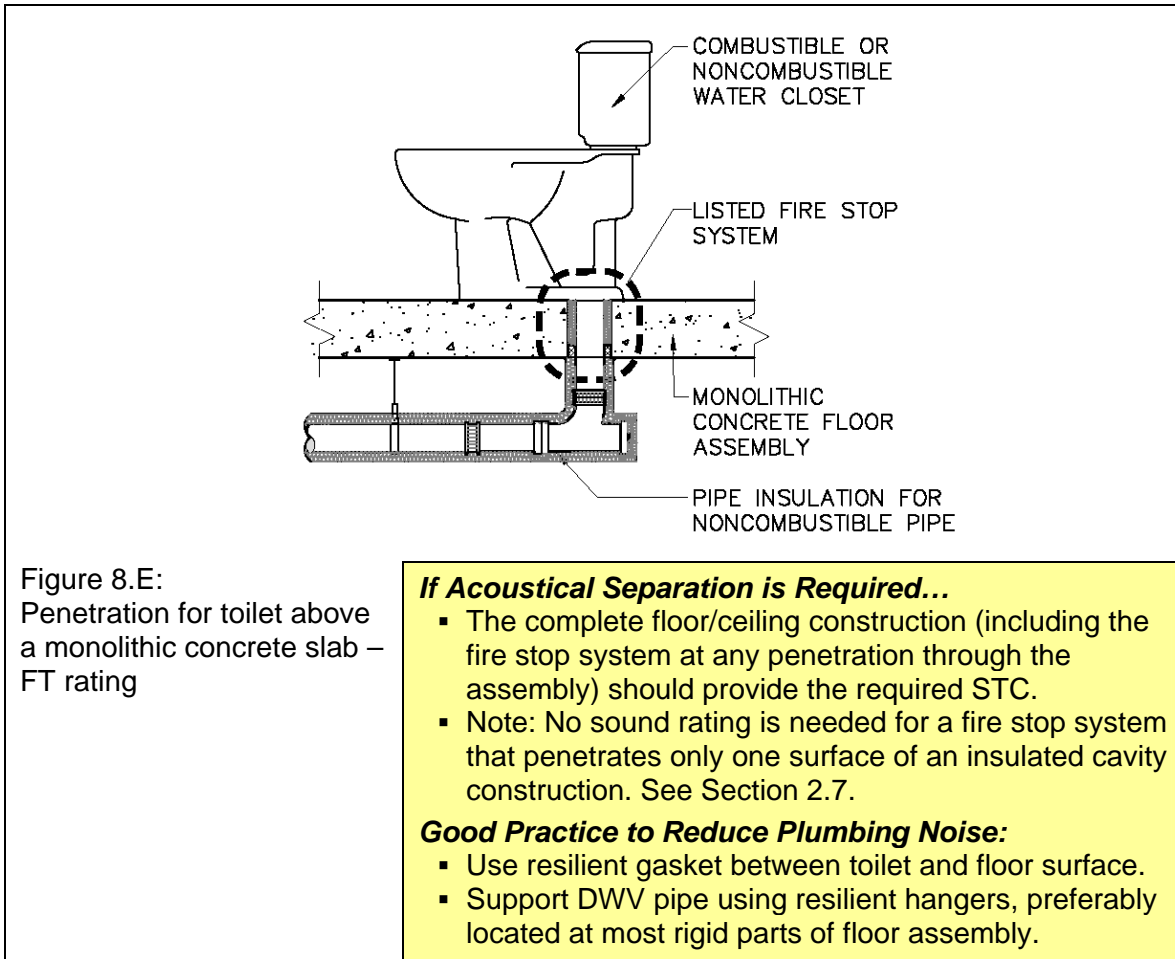


With noncombustible pipe, as shown in Figure 8.D, the extent to which the pipe must be insulated below the slab to achieve an FT rating is specified for the listed fire stop system chosen.

The NBCC does not permit combustible DWV pipe to be installed in a vertical shaft [Ref. 3.1.9.4.(4)(b) of the NBCC 2005]. There may, however, be situations where a user wishes to use combustible pipe in a basement parking garage and noncombustible pipe in a vertical shaft above the basement. The local authority having jurisdiction should be consulted prior to using this arrangement. See Section 8.12 – Transitions between Combustible and Noncombustible Pipe for further guidance.

8.3 Floor Penetrations for Toilets above Monolithic Concrete Floor Assemblies

FT Rating Required – DWV piping for toilets may pass through a monolithic concrete floor assembly with similar fire stop solutions to those noted in Figures 8.C and 8.D. Where the parking garage is a separate building as explained in Chapter 7, the penetration requires a fire stop with a 2 h FT rating as shown in Figure 8.E. The extent to which a noncombustible pipe would need to be insulated for an FT rating will be dictated by the listed fire stop system details. If combustible pipe is used, a listed fire stop system with a 2 h FT rating and tested at a 50 Pa pressure differential would be required.



F Rating Required – Where the parking garage and the building above are parts of the same building, the penetration through the monolithic concrete floor assembly using combustible pipe is permitted by the NBCC, provided the toilet (water closet) is non-combustible. [Ref: 3.1.9.4 (5) of NBCC 2005]. This permission to use combustible pipe arises from research conducted in the early 1970's at the National Research Council Canada [8-2; 8-3]. For such combustible pipe penetrations, a listed fire stop system with an F rating would be required. For noncombustible pipe, the NBCC would not require a listed fire stop system in this situation if the pipe were cast in place (see Figure 8.F) [Ref: 3.1.9.1(1)(b) of NBCC 2005], however, a listed fire stop system with an F rating could be used instead of casting the pipe in place.

"3.1.9.4

5) *Combustible* drain piping is permitted to penetrate a horizontal *fire separation* provided it leads directly from a *noncombustible* water closet through a concrete floor slab." [Ref: 3.1.9.4(5) of NBCC 2005]

"3.1.9.1

1) Except as required by Sentence (2), piping, tubing, ducts, *chimneys*, optical fibre cables, electrical wires and cables, totally enclosed *noncombustible* raceways, electrical outlet boxes and other similar *building* services that penetrate a *fire separation* or a membrane forming part of an assembly required to have a *fire-resistance* rating shall be

- a) sealed by a fire stop system that, when subjected to the fire test method in CAN/ULC-S115, "Fire Tests of Firestop Systems," has an F rating not less than the *fire-protection rating* required for *closures* in the *fire separation* in conformance with Table 3.1.8.4., or
- b) cast in place (see Appendix A).

(See also Article 3.1.9.4. for requirements regarding penetrations by *combustible* drain, waste and vent piping.) [Ref: 3.1.9.1(1) of NBCC 2005]

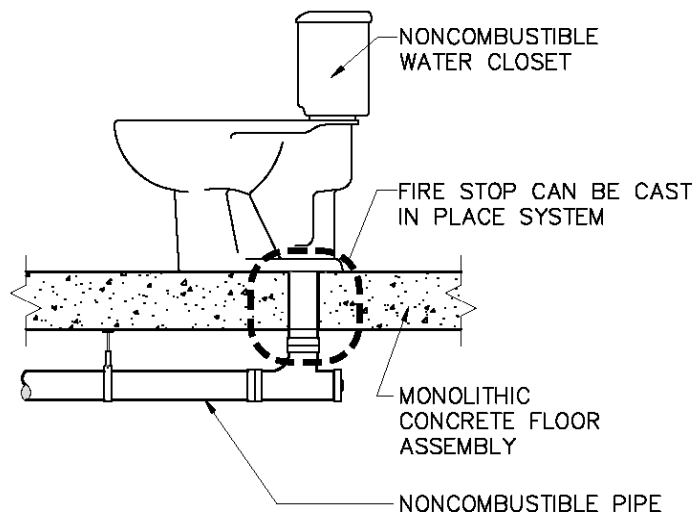


Figure 8.F:
Penetration for toilet above
a monolithic concrete slab –
F rating

If Acoustical Separation is Required...

- The complete floor/ceiling construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

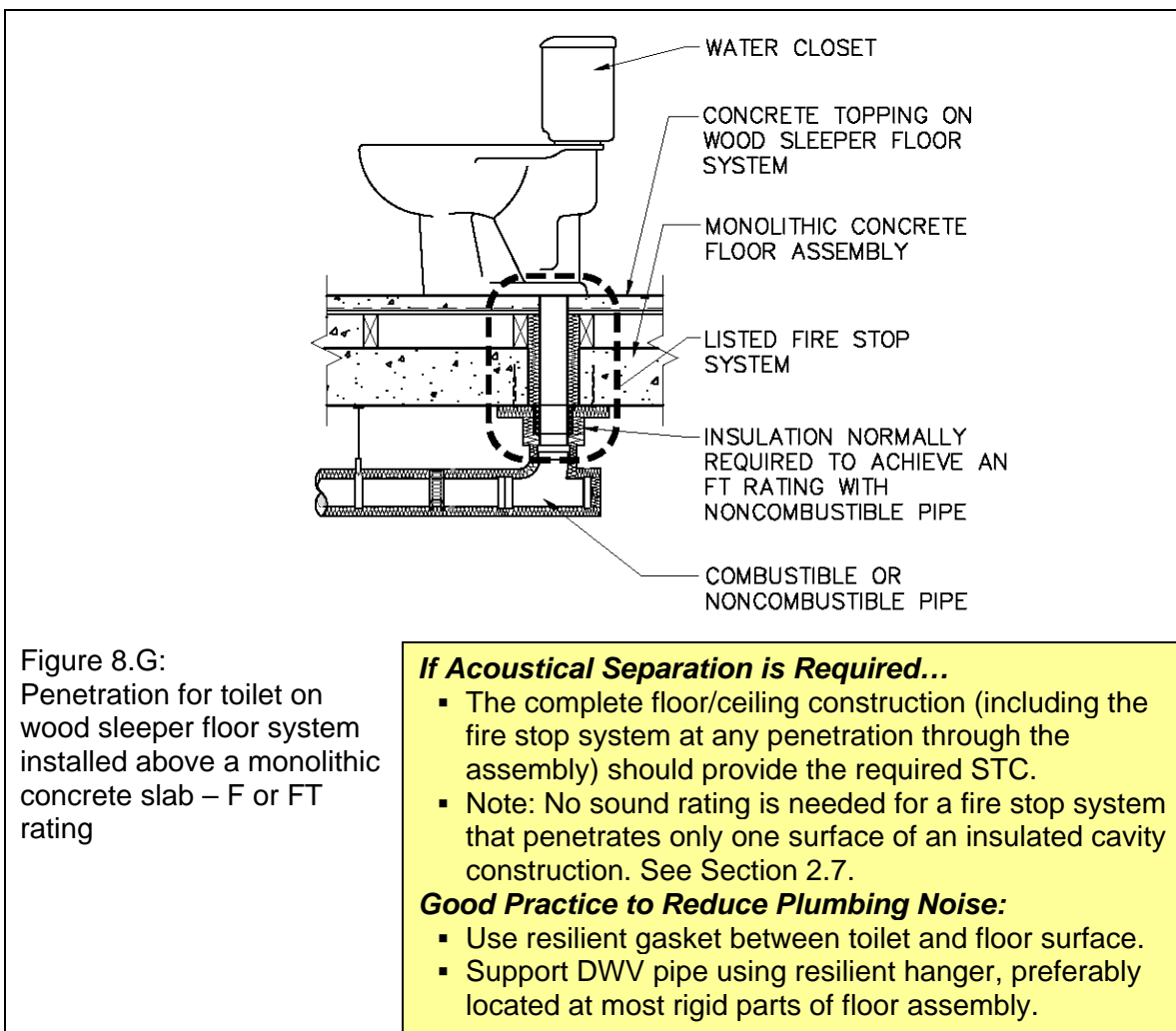
Good Practice to Reduce Plumbing Noise:

- Use resilient gasket between toilet and floor surface.
- Support DWV pipe using resilient hanger, preferably located at most rigid parts of floor assembly

While this penetration of a monolithic concrete floor assembly without a listed fire stop system is accepted by the NBCC, the user should ensure that any design of such a protected penetration is arranged so that the integrity of the floor fire separation is

maintained. With this arrangement, there are instances where a listed fire stop system may be required if fire separation integrity is to be achieved.

Wood Sleeper Floors – When a wood sleeper floor system is installed above a monolithic concrete slab, a somewhat different arrangement of fire stops may be required depending on whether a parking garage is considered a separate building or not. Figure 8.G illustrates one of the several available options. If noncombustible pipe penetrates an assembly that requires an FT rating, insulation will often be needed to cover the pipe for a specified distance from the fire stop to ensure that the FT rating is achieved. The specific distance for the insulation is stated in the listed fire stop system design. In using this type of wood sleeper floor system, the user should be aware that fire blocks may be required to subdivide the area of the wood sleeper floor (see Chapter 13).



8.4 Monolithic Concrete Floor Penetrations for Tubs and Showers

Figure 8.H illustrates an arrangement where a monolithic concrete floor is penetrated by piping for a tub or shower. The left side of Figure 8.H shows a combustible pipe penetration, and the right side shows a noncombustible pipe penetration. This figure illustrates a plumbing penetration through a slab where the parking garage is a separate building or where the parking garage and the floors above are considered in the same building. If noncombustible pipe penetrates an assembly and the fire stop is required to have an FT rating, insulation may be required to cover the pipe for some distance from the fire stop to achieve the FT rating. The specific distance for the insulation is specified in the listed fire stop system design.

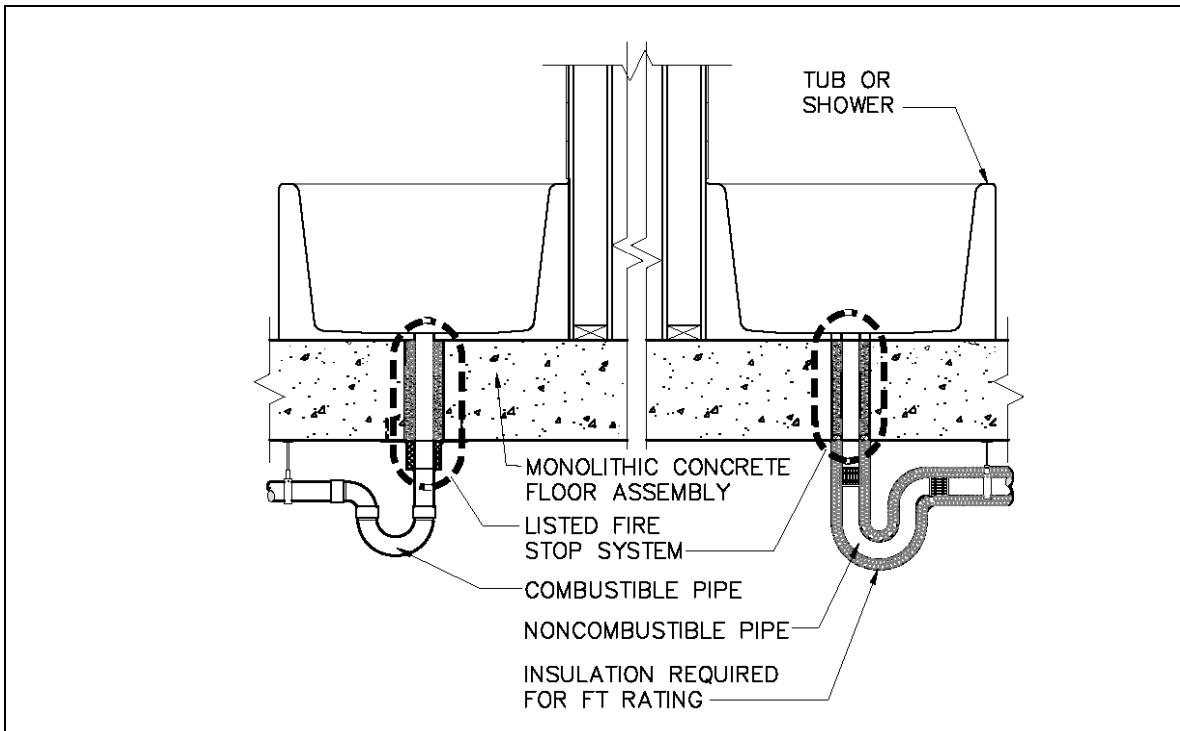


Figure 8.H:
Pipe penetration for a tub or shower above a monolithic concrete slab – F or FT rating. Left side illustrates a combustible pipe penetration and the right side shows a noncombustible pipe penetration.

If Acoustical Separation is Required...

- The complete floor/ceiling construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

Good Practice to Reduce Plumbing Noise:

- Support tub on a floating slab over the concrete floor.
- Support DWV pipe using a resilient hanger, preferably located at most rigid parts of floor assembly.

8.5 Pipe Penetrations through Framed Floor Assemblies

Piping, such as for water distribution or drain, waste and vent (DWV) purposes, often penetrates combustible or noncombustible framed floor assemblies. When penetrating a fire-rated framed floor assembly, fire stops are required at the ceiling membrane and at the floor level. The specific details will be provided for the listed fire stop system chosen. For piping greater than 30 mm in diameter, the NBCC permits only noncombustible water distribution piping to penetrate a horizontal fire separation (floor assembly). There are, however, listed fire stop systems available for larger diameter combustible DWV pipes that may be acceptable to some authorities. The 30 mm diameter restriction and the horizontal restriction are removed in the Ontario Building Code. Such penetrations must be equipped with fire stops at a membrane ceiling when that ceiling forms part of a fire-rated assembly and at the floor above as shown on the left side in Figure 8.I.1.

Combustible water distribution pipe not more than 30 mm in diameter may also penetrate floor fire separations with a listed fire stop system [*Ref. 3.1.9.4.(2) of NBCC 2005*] in the same manner as shown on the left hand side of Figure 8.I.1. The user should also note that the listed fire stop system selected may differ depending on whether the concrete is a topping over a fire-rated design subfloor or whether the concrete is an integral part of the fire-rated design, such as in composite designs.

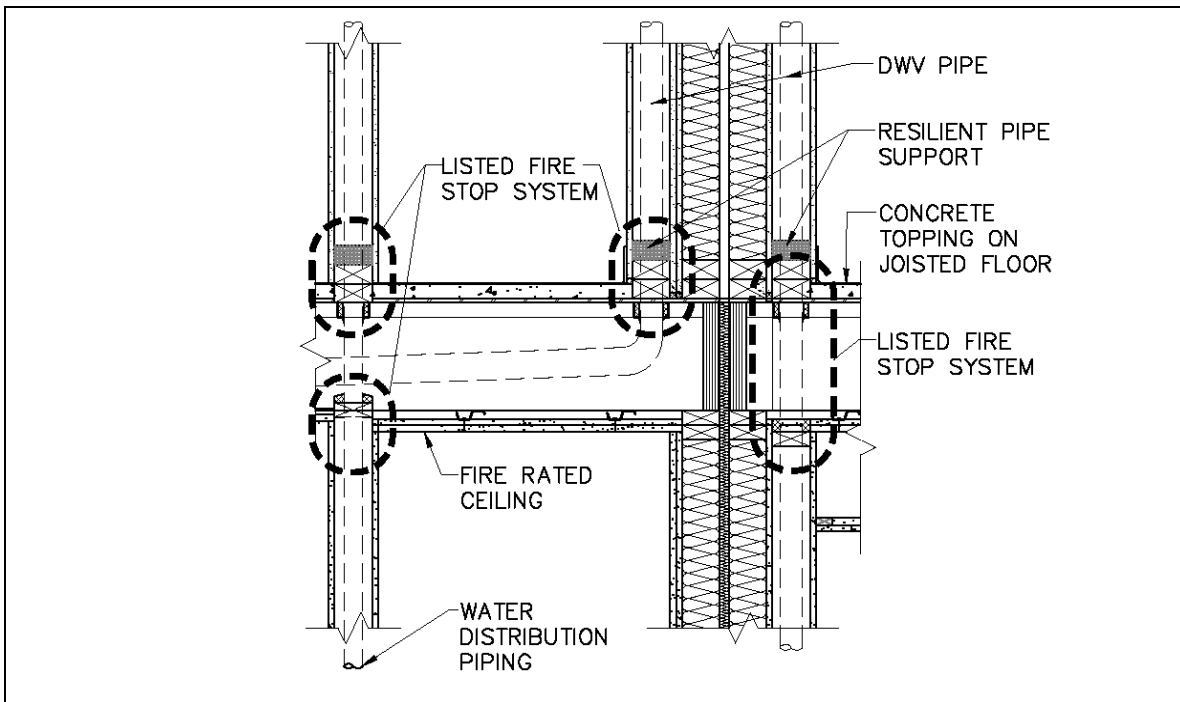


Figure 8.I.1:
Pipe penetration through a
framed floor assembly.

If Acoustical Separation is Required...

- Rated wall assembly with no penetration is one means of good practice to provide acoustic separation for side-by-side dwelling units
- The complete separating construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

Good Practice to Reduce Plumbing Noise:

- Use resilient support for DWV and water distribution pipe, (preferably supporting vertical pipes at most rigid parts of the framing, on bottom plate of chase or wall).
- See additional recommendations in Figures 8.K or 8.L

On the right side of Figure 8.I.1, there are two examples of DWV piping penetrating a framed floor system. To the left of the double wall, the vertical DWV piping does not run completely through the assembly but runs horizontally through the joist space. In this case, a listed fire stop system must be provided as per its listing. This is usually at the point where the pipe enters the wall above as well as at the top plate where the pipe enters the wall below after its horizontal run. To the right of the double wall in Figure 8.I.1, the DWV pipe runs completely through the floor assembly, penetrating both the subfloor and the ceiling. In this case, as well, a listed fire stop system must be provided at both points of penetration, as was the case for the water distribution pipe mentioned above.

Combustible sprinkler piping is permitted to penetrate a horizontal fire separation provided the fire compartments above and below are sprinklered. (See Figure 8.1.2) [Ref. 3.1.9.4.(1) of NBCC 2005] Figure 8.1.2 provides two arrangements for combustible sprinkler pipe penetrations of a framed floor assembly. On the left hand side of the figure, a sprinkler riser is located inside a non-fire-rated furred out wall and runs through the floor assembly from one sprinklered fire compartment to the one above. A listed fire stop system would be required at the ceiling level and at the floor level above. On the right hand side of the figure, the sprinkler riser runs inside a non-fire-rated partition up to a non-fire-rated ceiling installed below the fire-rated ceiling. In this case, no fire stop is required at the lower non-fire-rated ceiling but at the fire-rated ceiling and at the floor above.

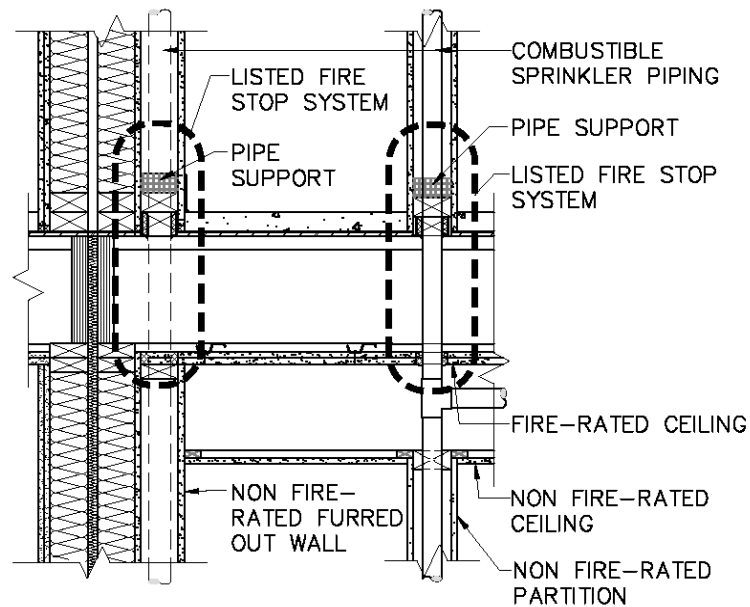


Figure 8.1.2:
Penetration of
combustible sprinkler
piping through a framed
floor assembly.

If Acoustical Separation is Required...

- The complete separating construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

Good Practice to Reduce Plumbing Noise:

- Because they normally create noise only in emergencies, resilient support is not required for sprinkler pipes.

Where combustible or noncombustible sprinkler piping penetrates a fire-rated ceiling membrane and leads directly to a sprinkler as shown in Figure 8.J.1, that penetration should be tightly fitted and covered with an escutcheon on the room side. Escutcheons are usually listed as part of a sprinkler system without a fire stop in the annular space. Changes to the installed sprinkler with a fire stop in the annular space between the pipe and the ceiling could impede sprinkler operation. Fire stops are often not provided at this ceiling penetration as they may potentially interfere with the distribution pattern of the sprinkler spray should the sprinkler position move, as a result of fire stop intumescence, for example. (See Figure 8.J.1)

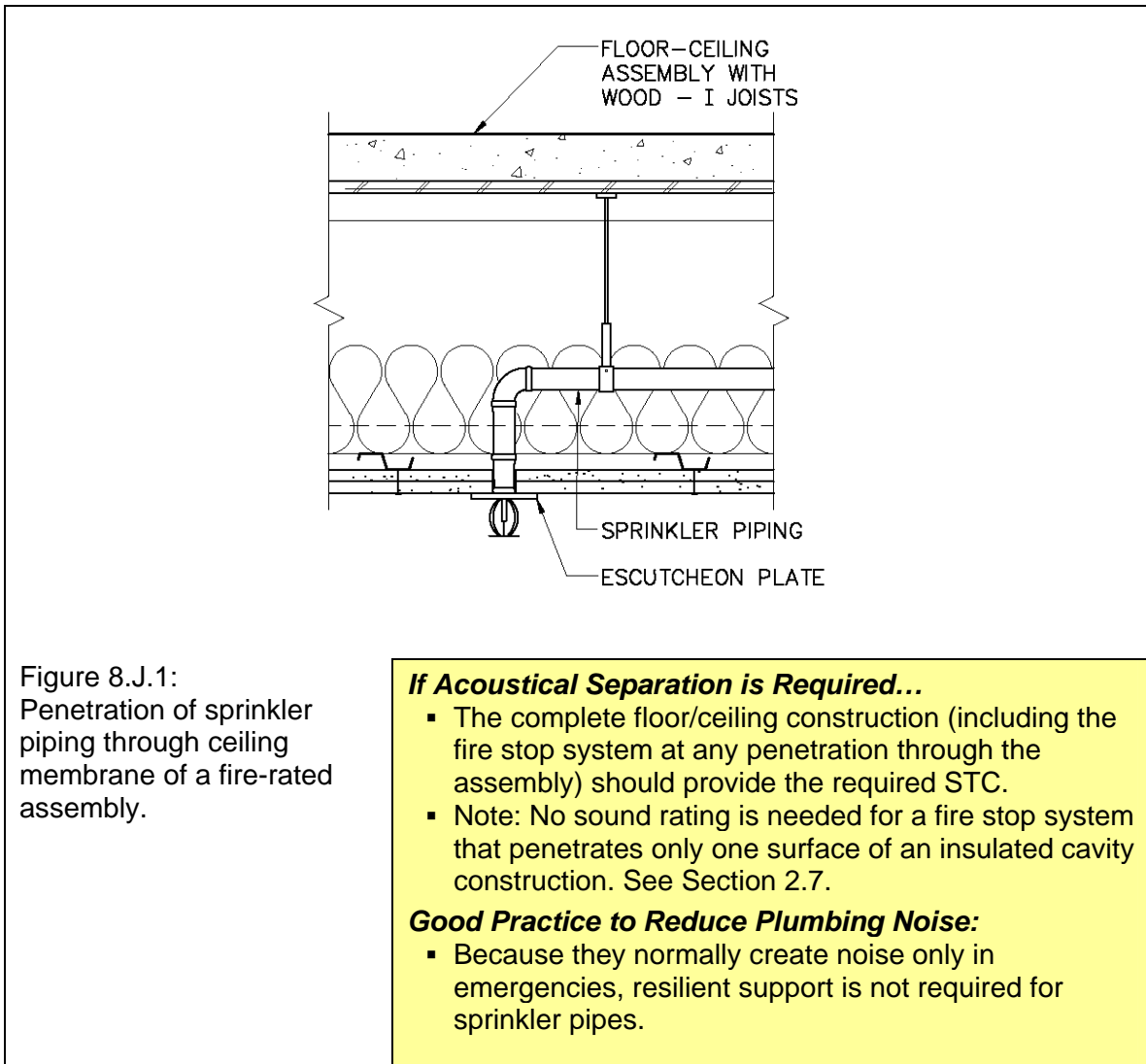


Figure 8.J.1:
Penetration of sprinkler piping through ceiling membrane of a fire-rated assembly.

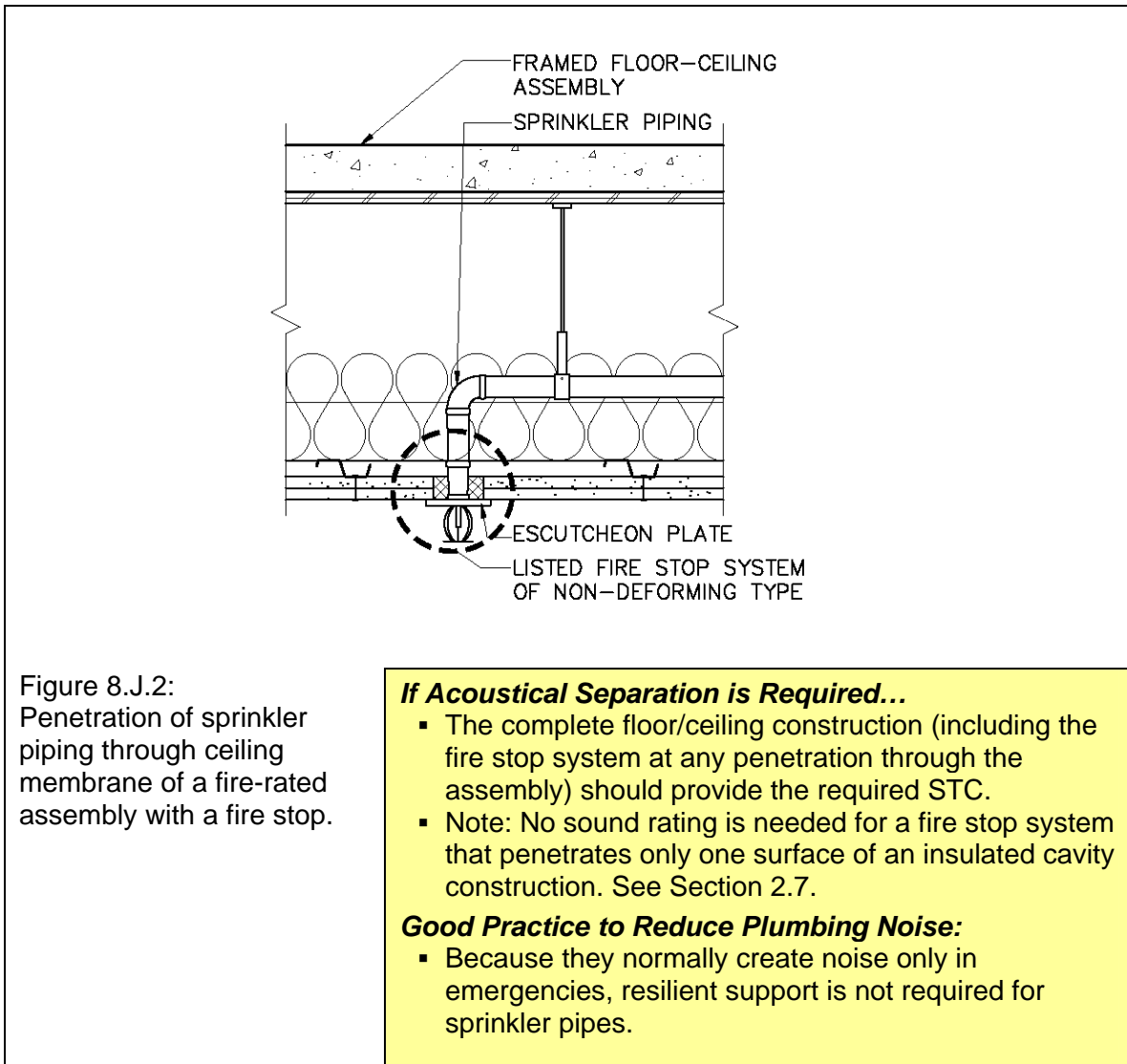
If Acoustical Separation is Required...

- The complete floor/ceiling construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

Good Practice to Reduce Plumbing Noise:

- Because they normally create noise only in emergencies, resilient support is not required for sprinkler pipes.

If employed, fire stops selected for this application should not deform under fire temperatures. Users should contact the manufacturer of the sprinkler to determine if fire stops can be used in this application. (See Figure 8.J.2) It is useful to note that the International Building Code specifically excludes fire stops for pipes penetrating a membrane and leading directly to sprinklers provided they are equipped with a metal escutcheon plate. (See Chapter 5 – Code Requirements for Fire Stop Installations and Sound Isolation.)



8.6 Pipe Penetrations through Framed Floor Assemblies for Toilets

DWV pipes for toilets often run between structural members in a fire-rated framed floor assembly until they reach the nearest plumbing stack. For this type of plumbing system, fire stops are required around the drain pipe where it penetrates the floor, at any point where the DWV pipe penetrates a fire-rated membrane forming part of a fire separation, and at the top and bottom plates of a wall assembly through which the DWV pipe passes. These are illustrated in Figure 8.K. The left hand side of Figure 8.K shows an illustration of a toilet DWV pipe leading to an interior partition below. The right hand side of the figure shows a toilet DWV pipe leading to a plumbing riser in a furred-out wall that forms a chase. Both of these arrangements require listed fire stop systems where shown.

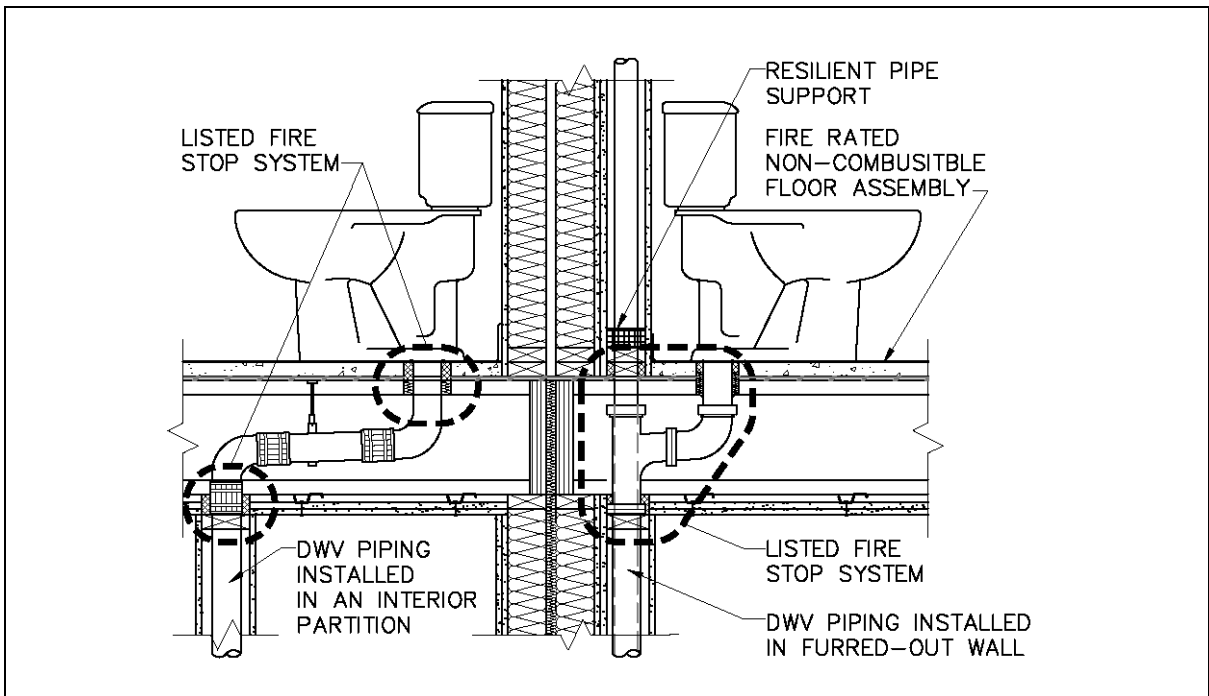


Figure 8.K:
Penetration of DWV pipe for a toilet through a framed floor assembly.

If Acoustical Separation is Required...

- Rated wall assembly with no penetration is one means of good practice to provide acoustic separation for side-by-side dwelling units
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

Good Practice to Reduce Plumbing Noise:

- Resilient gasket between toilet and floor
- Use resilient support for DWV and water distribution pipe (preferably located at most rigid parts of the framing, on bottom plate of chase or wall).
- Mount gypsum board on resilient metal channels for wall or ceiling whose framing supports pipes.
- Pipes not touching gypsum board or OSB surfaces
- Fill all cavities with fibrous absorptive material.

8.7 Pipe Penetrations through Framed Floor Assemblies for Tubs and Showers

Like penetrations for toilets, penetrations through fire-rated framed floor assemblies for DWV piping for tubs and showers must be provided with fire stops around the drain pipe where it penetrates the floor and at any point where the DWV pipe penetrates a fire-rated membrane forming part of a fire separation; e.g., at the top and bottom plates of walls above and below fire-rated floor assemblies. Specific details apply to each listed fire stop system. Figure 8.L illustrates arrangements with combustible and noncombustible pipe requiring an F rating. For best practice, the opening for a floor drain should be cut to the shape and size of the drain pipes. However, if the opening for a floor drain is cut square, a robust board product (gypsum board, cement board, plywood, OSB), cut to the shape of the floor drain pipe, should be installed below the subfloor to close the square hole in the floor. The exact board product is specified for the listed fire stop system that is installed between the board and the drain pipe. For best practice, the user should use a design that will prevent water from deteriorating the board product or supporting the growth of mould in this area.

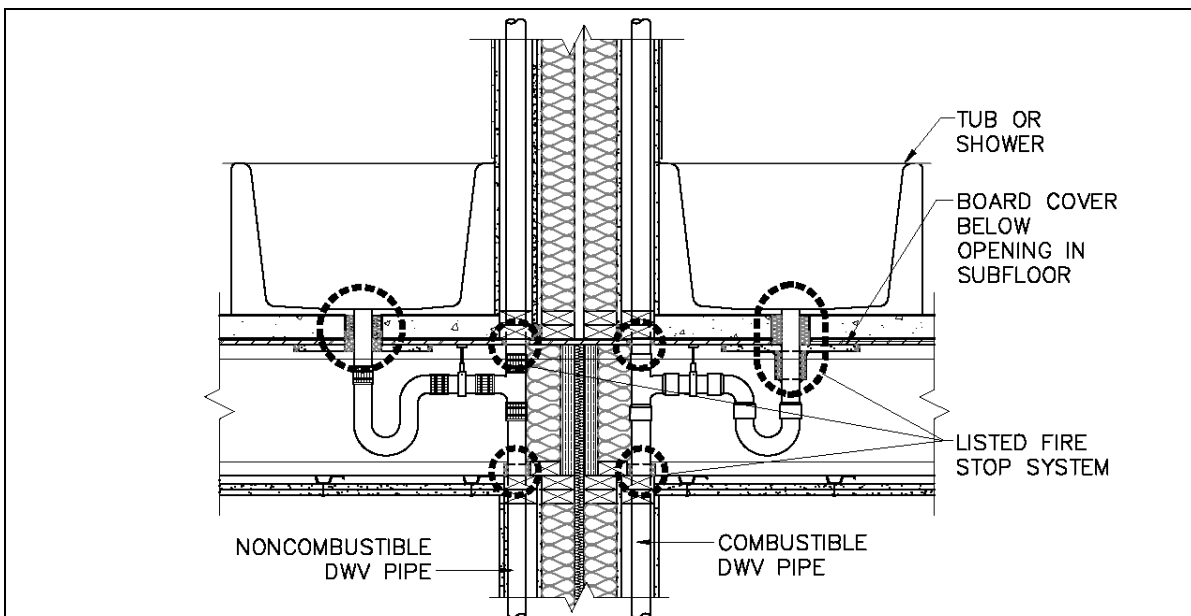


Figure 8.L:
Penetration of DWV pipe for tubs or showers through a framed floor assembly.

If Acoustical Separation is Required...

- Rated wall assembly with no penetration is one means of good practice to provide acoustic separation between side-by-side dwelling units.
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

Good Practice to Reduce Plumbing Noise:

- Use resilient support for DWV and water distribution pipe (preferably located at most rigid parts of the framing, on bottom plate of chase or wall).
- Mount gypsum board on resilient metal channels for wall or ceiling whose framing supports pipes.
- Pipes not touching gypsum board or OSB surfaces
- Fill all cavities with fibrous absorptive material.

8.8 Pipe Penetrations through Monolithic Concrete or Masonry Walls

The type of fire stop for pipe penetrations through monolithic concrete or masonry walls depends on whether the wall is a firewall or a fire separation. When penetrating a firewall, piping must be designed in such a manner that its collapse will not cause the collapse of the firewall – and any fire stops must take that requirement into account. As well, any pipe penetration of a firewall must be provided with a fire stop with an FT rating not less than the fire resistance rating of the firewall. [Ref. 3.1.9.1.(2) of NBCC 2005] To achieve the FT rating with noncombustible pipe, the pipe may need to be insulated for some distance from the wall. The specific distance for the insulation is specified in the listed fire stop system design. This insulation could also extend equally on both sides of the firewall. When penetrating a monolithic concrete or masonry wall that is a fire separation, only an F rating is required. Figures 8.M.1, 8.M.2 and 8.M.3 illustrate examples of these arrangements.

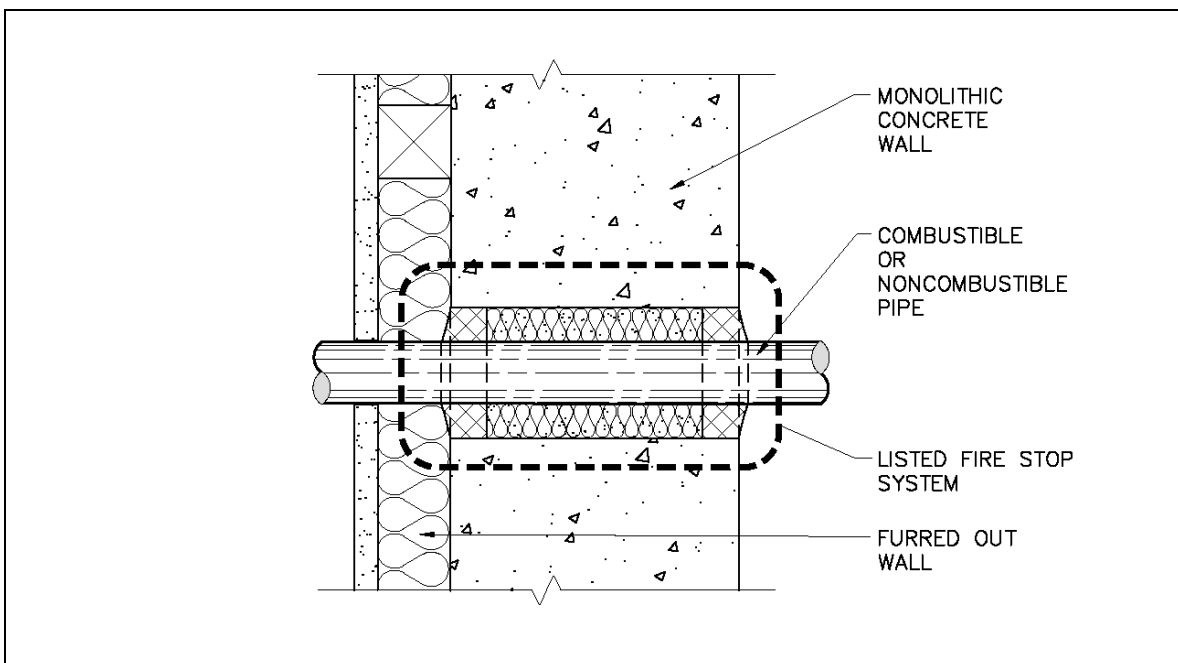


Figure 8.M.1:
Penetration of pipe through
monolithic concrete wall
assembly.

If Acoustical Separation is Required...

- Fire stop system in concrete or masonry walls deals with fire control. Gypsum board finish may be required for acoustics or aesthetics on either face (or both).
- STC requirement applies to the complete separating wall construction. With added gypsum board surface(s), no sound rating is required for fire stop.
- Where pipe penetrates the gypsum board, acoustical sealant should be used.

Where a void is formed in a hollow masonry wall such as shown in Figures 8.M.2 and 8.M.3, some listed fire stop systems will require the voids to be filled with concrete, grout or mortar before the fire stop is installed. Others may require a sleeve in the opening as shown in Figure 8.M.3. If the piping penetrating the monolithic concrete or masonry wall is combustible DWV piping, then the fire stop must also be tested with a

pressure differential of 50 Pa. The technical literature for listed fire stop systems will provide the necessary details.

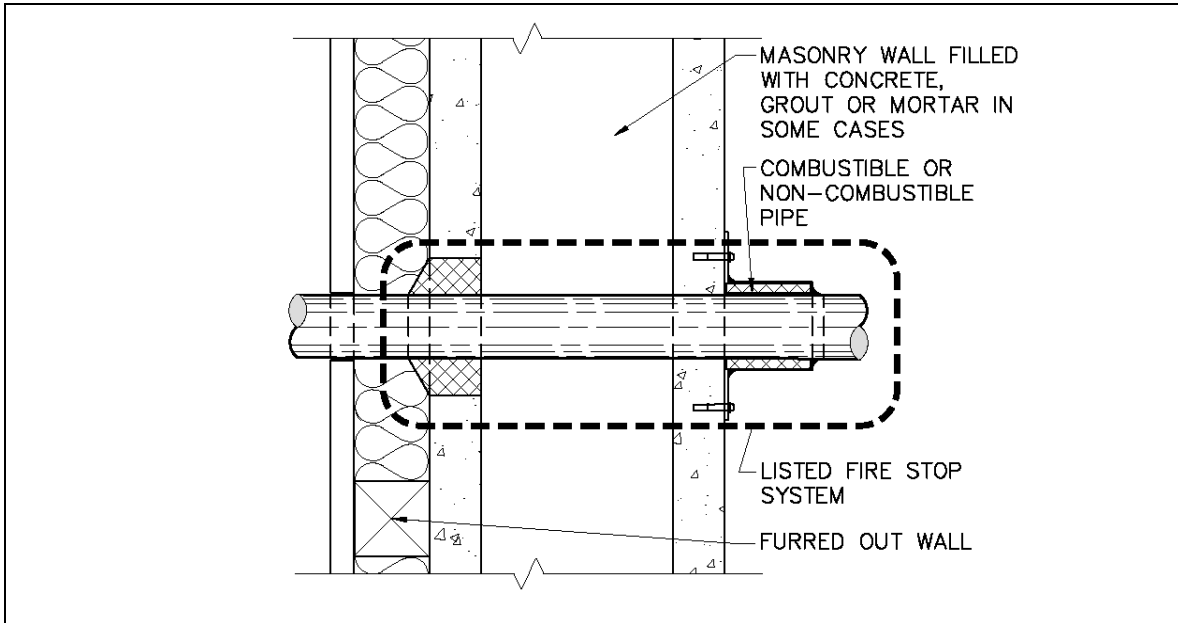
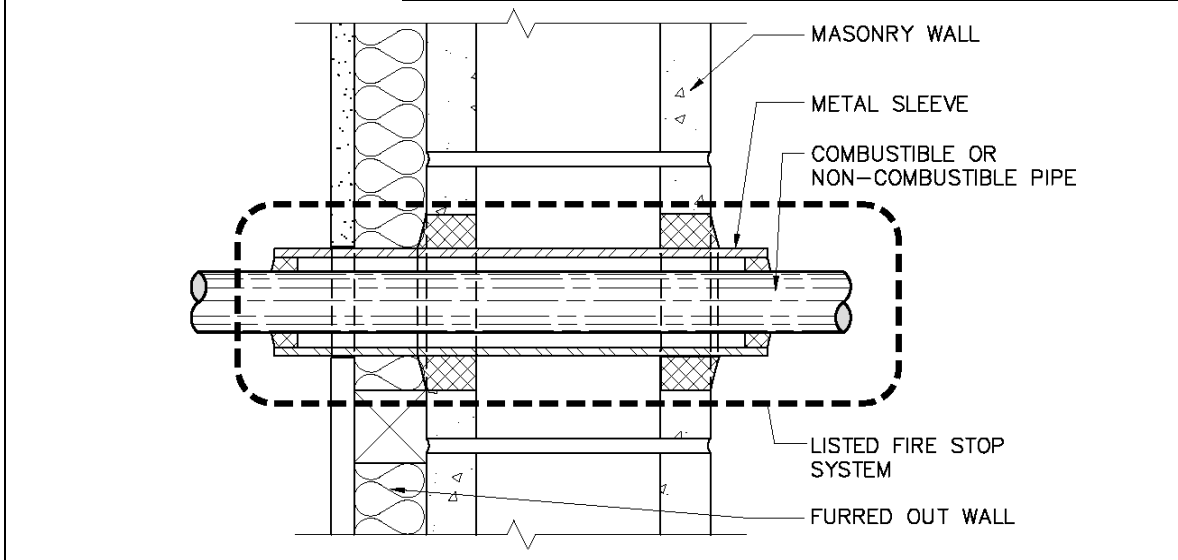


Figure 8.M.2:
Penetration of pipe through masonry wall assembly not using a sleeve.

If Acoustical Separation is Required...

- Fire stop system in concrete or masonry walls deals with fire control. Gypsum board finish may be required for acoustics or aesthetics on either face (or both).
- The complete wall construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- With added gypsum board surface(s), no sound rating is required for fire stop. See Section 2.7.
- Where pipe penetrates the gypsum board, acoustical sealant should be used.

Figure 8.M.3:
Penetration of pipe through masonry wall assembly using a sleeve.



8.9 Pipe Penetrations through Stud Walls

Stud walls are often used to conceal various types of piping. For these stud walls, which achieve a great deal of their fire resistance by virtue of the fire-rated gypsum board membrane, listed fire stop systems must be provided at the locations where the piping enters and exits the wall. Figure 8.N illustrates a typical arrangement for water distribution piping inside a stud wall. Fire stops are required at the locations where the pipe penetrates the wall membrane and at the point where it penetrates the wall bottom plate or track.

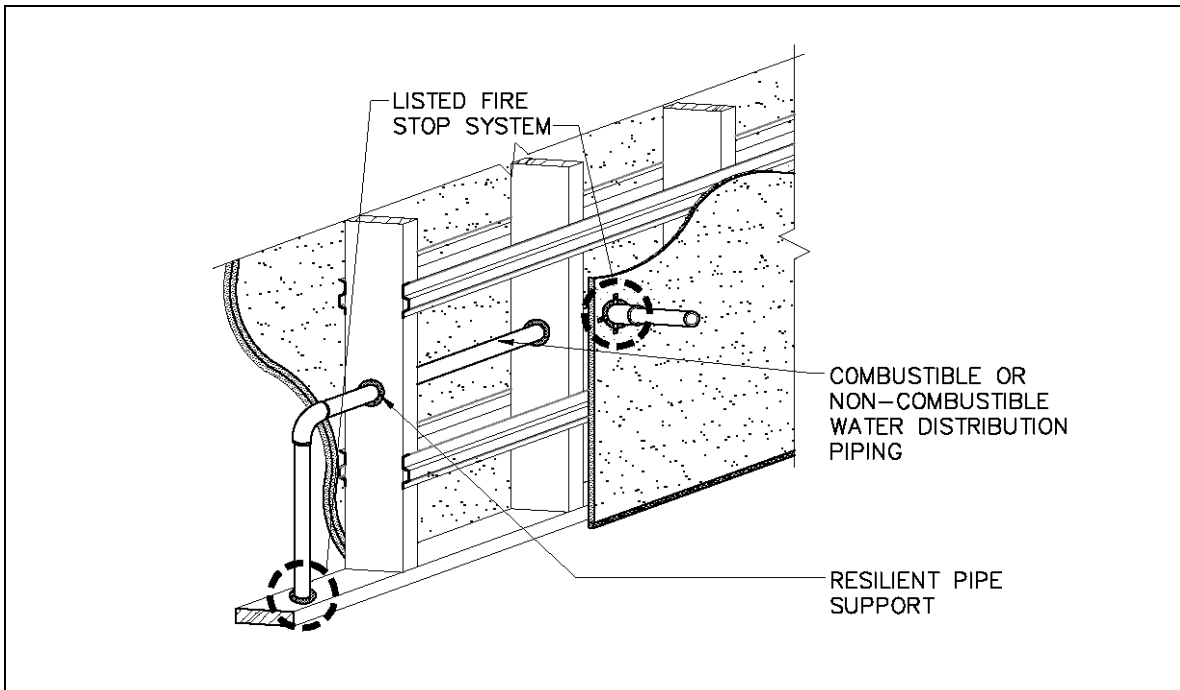


Figure 8.N:
Penetration of water supply pipe through membrane of wall assembly.

If Acoustical Separation is Required...

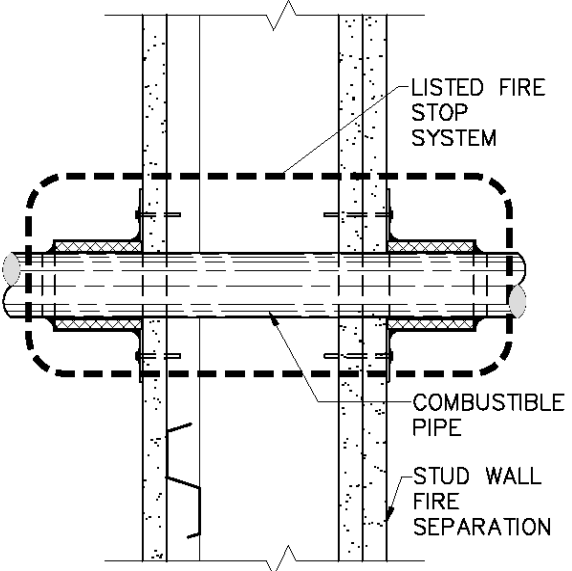
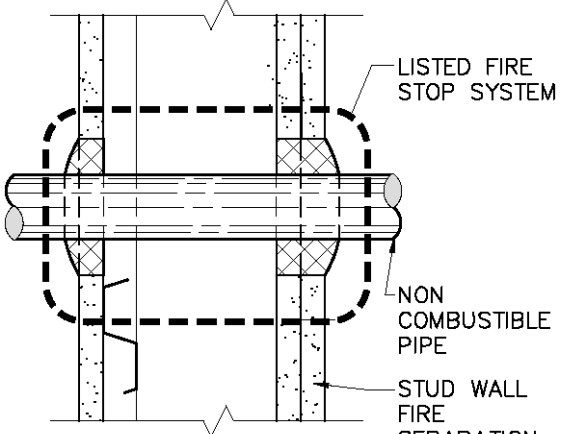
- The complete wall construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

Good Practice to Reduce Plumbing Noise:

- Use resilient support where pipe is attached to stud or penetrates framing.
- Use a fire stop that provides minimal vibration transfer from the pipe to the gypsum board
- Mount gypsum board on resilient metal channels for wall or ceiling whose framing supports pipes.
- Pipes must not touch gypsum board or OSB surfaces.
- Fill all cavities with fibrous absorptive material.

Where a pipe fully penetrates a fire-rated stud wall, listed fire stop systems are required at the membrane penetrations on both sides of the wall as shown in Figure 8.O.

Fire stops are required at both membranes since interior fire separations are rated from both sides. The listed fire stop system must be selected on the basis of the type of pipe as shown in Figures 8.O.1 and 8.O.2.

	
<p>Figure 8.O.1: Penetration of a combustible pipe through a fire-rated wall assembly.</p>	<p><i>If Acoustical Separation is Required...</i></p> <ul style="list-style-type: none"> ▪ The complete wall construction (including the fire stop system at any penetration through the assembly) should provide the required STC. <p><i>Good Practice to Reduce Plumbing Noise:</i></p> <ul style="list-style-type: none"> ▪ Use a fire stop that provides minimal vibration transfer from the pipe to the gypsum board ▪ Mount gypsum board on resilient metal channels for wall or ceiling whose framing supports pipes. ▪ Pipes must not touch gypsum board or OSB surfaces. ▪ Fill all cavities with fibrous absorptive material.
<p>Figure 8.O.2: Penetration of a noncombustible pipe through a fire-rated wall assembly.</p>	
	

DWV piping may partially or fully penetrate stud walls as well. The NBCC does not permit combustible DWV piping to be located in a vertical shaft [Ref. 3.1.9.4.(4)(b) of NBCC 2005] so an arrangement as shown in Figure 8.P.1 is sometimes used. In Figure 8.P.1, the vertical DWV pipe is located in a chase which is equipped with fire stops at the stud wall top and bottom plates or tracks at each floor level. Users should note that some listed fire stop systems require the DWV piping to be located only inside a fire-rated wall so care must be taken to ensure that walls are fire-rated where these fire stops are used. Details are provided in the literature for the listed fire stop system. Fire stops may not be required at the wall penetrations since the chase is not a fire-rated wall in this case. Should the DWV pipe be located in a vertical shaft, it would need to be noncombustible and listed fire stop systems provided at the wall penetrations.

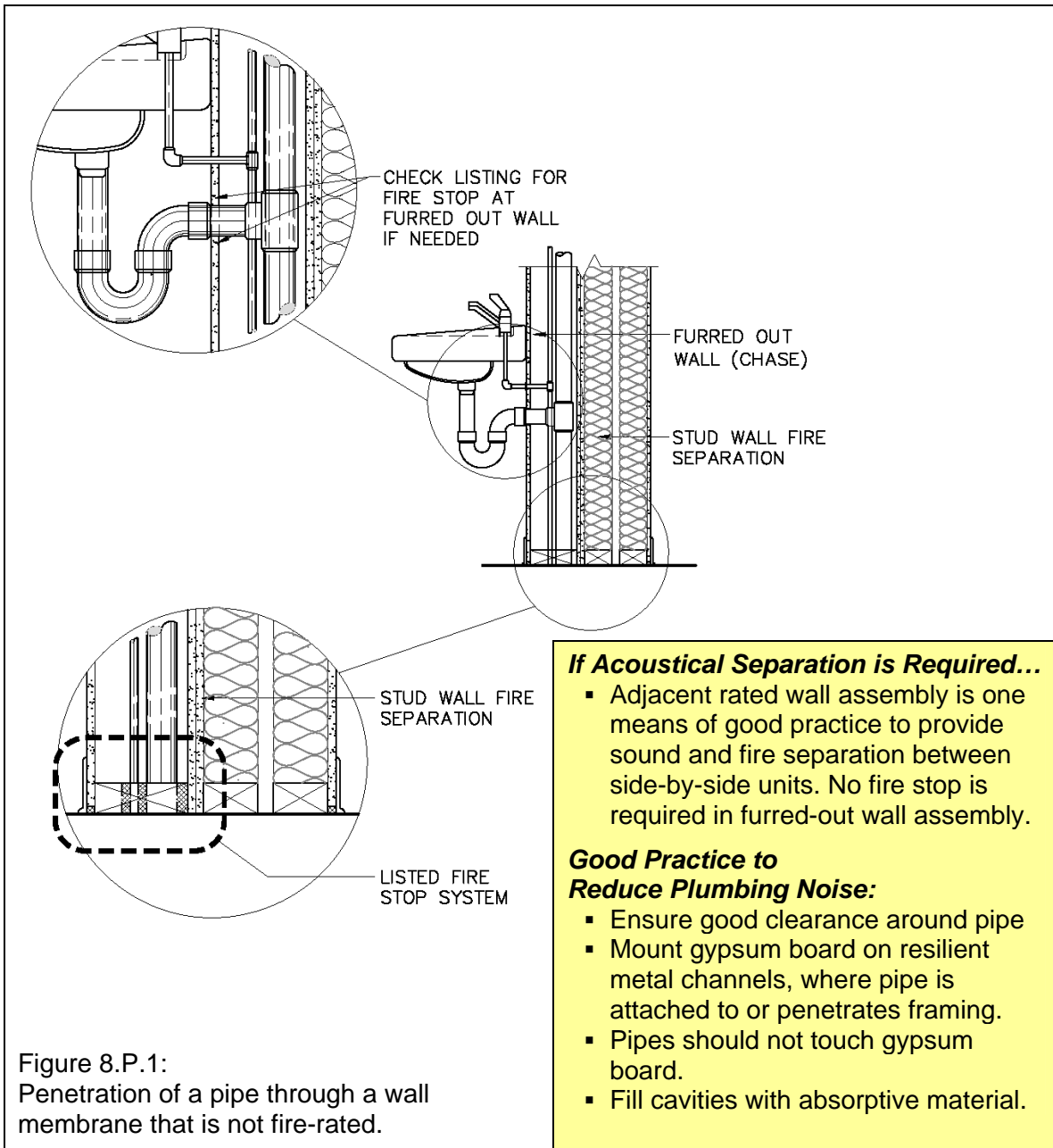
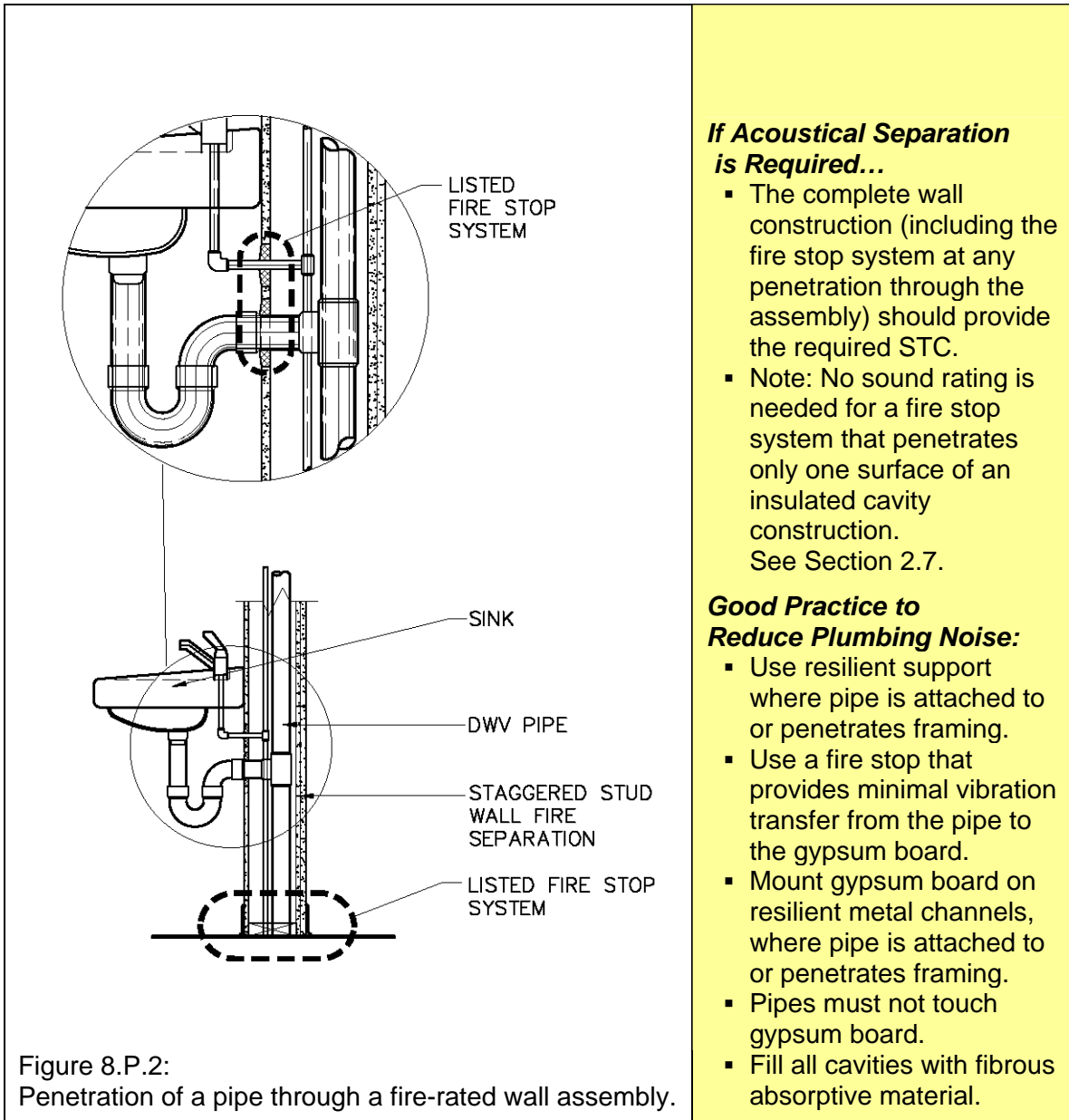


Figure 8.P.2 shows DWV pipe penetrations through a fire-rated membrane in a stud wall fire separation. In this case, fire stops are required at fire-rated membrane wall penetrations as well as at the top and bottom plates. Users should note that some listed fire stop systems require the DWV piping to be located only inside a fire-rated wall so care must be taken to ensure that walls are fire-rated where these fire stops are used. Details are provided in the literature for the listed fire stop system.



If Acoustical Separation is Required...

- The complete wall construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

Good Practice to Reduce Plumbing Noise:

- Use resilient support where pipe is attached to or penetrates framing.
- Use a fire stop that provides minimal vibration transfer from the pipe to the gypsum board.
- Mount gypsum board on resilient metal channels, where pipe is attached to or penetrates framing.
- Pipes must not touch gypsum board.
- Fill all cavities with fibrous absorptive material.

Laundry Rooms – For laundry room pipe penetrations, an arrangement similar to Figure 8.P.1 is necessary. In this case, a furred-out non-rated wall is used due to the impracticality of providing a fire stop at the location where the laundry drain attaches to the drain pipe inside the wall. This arrangement is illustrated in Figure 8.Q. The fire stop at the bottom plate or track inside the furred-out wall needs to be appropriate for situations where a fire stop is located in a non-fire-rated wall. The literature for the listed fire stop system needs to be consulted. Users should note that some listed fire stop systems require the DWV piping to be located only inside a fire-rated wall so care must be taken to ensure that walls are fire-rated where these fire stops are used.

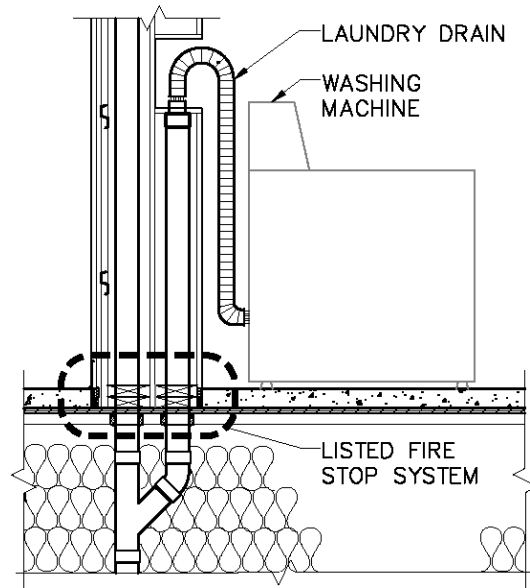


Figure 8.Q:
Penetration of a drain pipe
through a furred-out wall
assembly.

If Acoustical Separation is Required...

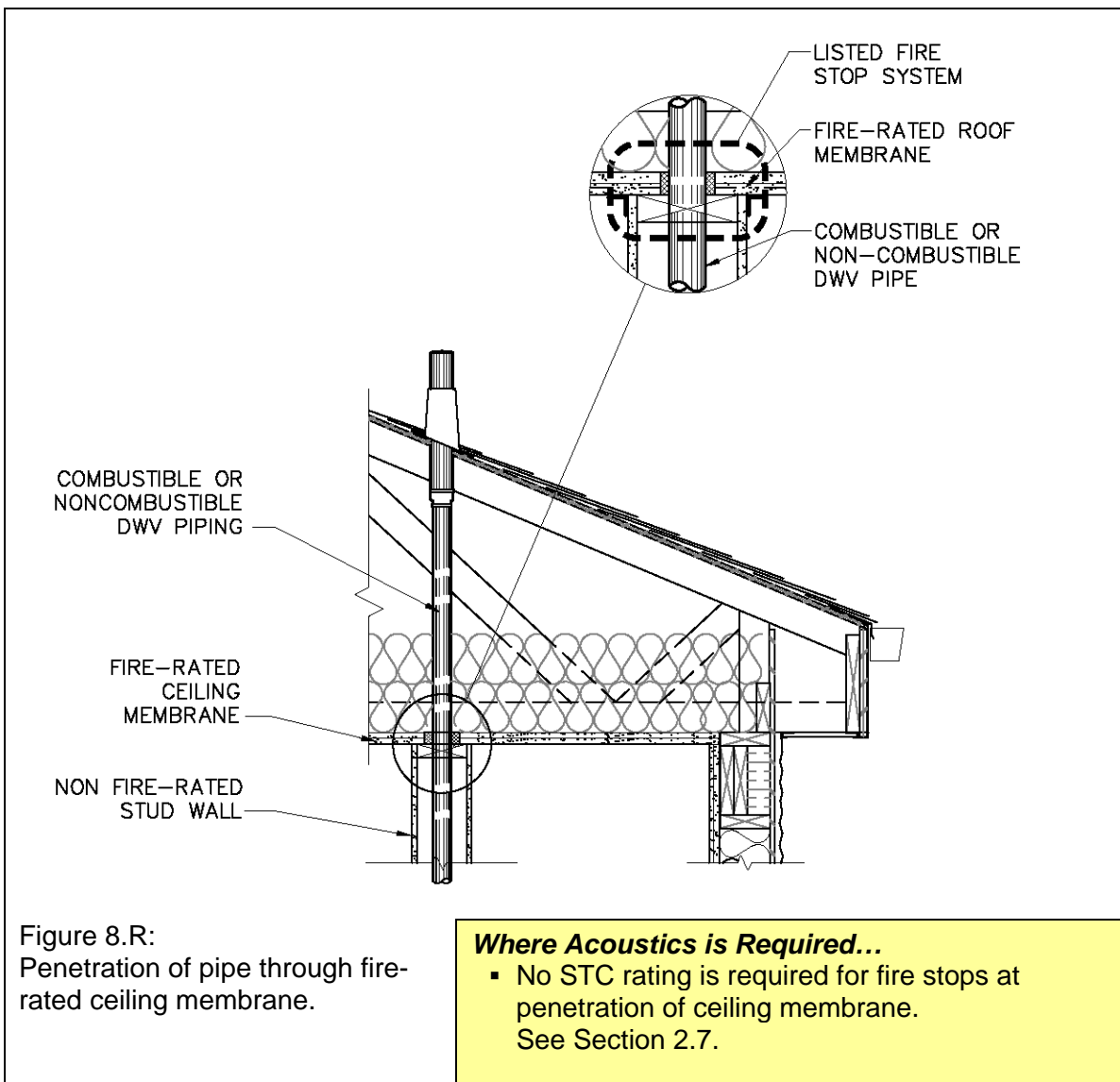
- The complete wall construction, including the fire stop system at any penetration through the assembly, should provide the required STC. Rated wall assembly with no penetration is one means of good practice to provide acoustical separation for side-by-side dwelling units
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

Good Practice to Reduce Plumbing Noise:

- Support appliance on concrete over resilient underlay.
- Use resilient support for DWV and water distribution pipe (preferably located at most rigid parts of the framing, on bottom plate of chase or wall).
- Mount gypsum board on resilient metal channels for wall or ceiling whose framing supports pipes.
- Pipes must not touch gypsum board or OSB surfaces.
- Fill all cavities with fibrous absorptive material.

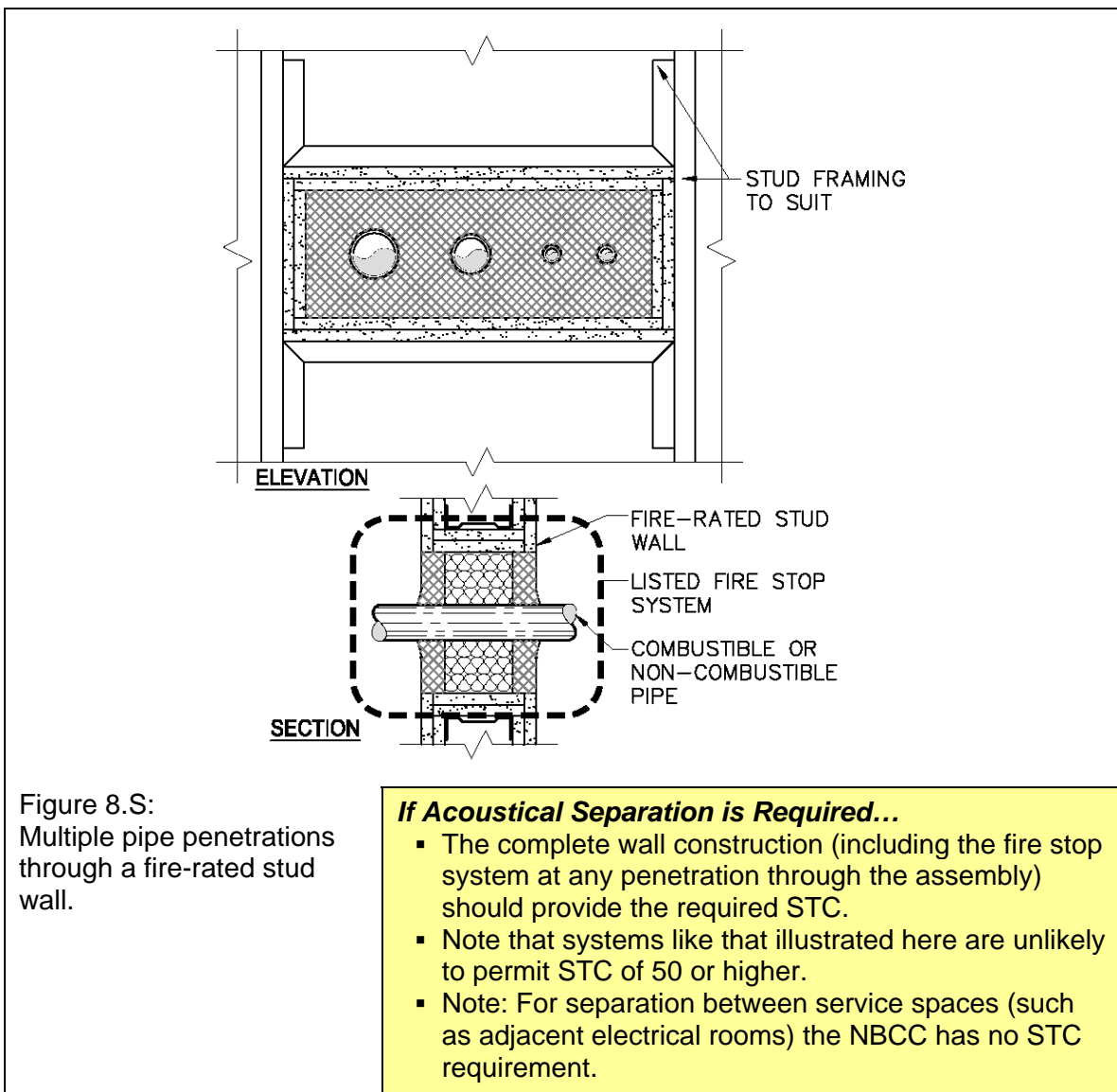
8.10 Pipe Penetrations through Framed Roof Spaces

Many buildings are required to have fire-rated roof assemblies. Where these fire-rated roof assemblies are present, pipe penetrations into the concealed roof space must be equipped with fire stops at the fire-rated membrane ceiling level. Figure 8.R illustrates this arrangement. In many cases, as explained in Subsection 2.2.3, roof assembly fire ratings are being provided entirely in the ceiling membrane. When this arrangement is used, fire stop systems, specific to this application, would be required and Figure 8.R details still apply. (See Section 2.2.3 for details.) Fire stops for water distribution or sprinkler piping (not directly feeding sprinklers) should be installed in the same manner as shown in Figure 8.R. Sprinkler piping directly serving sprinklers should, however, still be installed as per Figure 8.J in the same manner as for fire-rated floor-ceiling assemblies.



8.11 Multiple Pipe Penetrations

As discussed in Chapter 7, it is often necessary to run a number of pipes through a stud wall fire separation. Some listed fire stop systems include provisions for multiple items penetrating a single protected opening; others include single penetrating items. Where these penetrations occur in close proximity to each other, it is recommended that additional precautions be taken to ensure the integrity of the fire separation. In some cases, a framed opening will be provided as shown in Figure 8.S; in other cases, it is not. The listing details will indicate if one is required or not. The user should refer to the details for the listed fire stop system selected. Figure 8.S illustrates an arrangement where multiple pipes penetrate a fire-rated gypsum board wall. Spacing between pipes in this case is governed by the details for the listed fire stop system. (See information on spacing of openings in Chapter 7.)



8.12 Transitions between Combustible and Noncombustible Pipe

As explained earlier in this Chapter, the type of fire stop to be employed for a pipe penetration of a fire separation depends on the type of pipe penetrating the assembly. In some buildings, only one type of pipe (combustible or noncombustible) will be used and the same type of fire stops can be used throughout. There are, however, situations where both combustible and noncombustible pipe are used. The NBCC is not clear on how these transitions should be addressed; however, some exceptions to using one type of pipe exist as discussed below and in Section 8.3.

In Sentence 3.1.9.4.(5), the NBCC permits combustible DWV pipe to penetrate a horizontal fire separation if it leads directly from a noncombustible water closet through a concrete floor slab. (See middle portion of Figure 8.T.) In Sentence 3.1.9.4.(4), the NBCC also permits combustible DWV piping to penetrate a fire separation provided it is equipped with a listed fire stop system tested with a 50 Pa pressure differential and the pipe is not located in a vertical shaft. (See upper portion of Figure 8.T.)

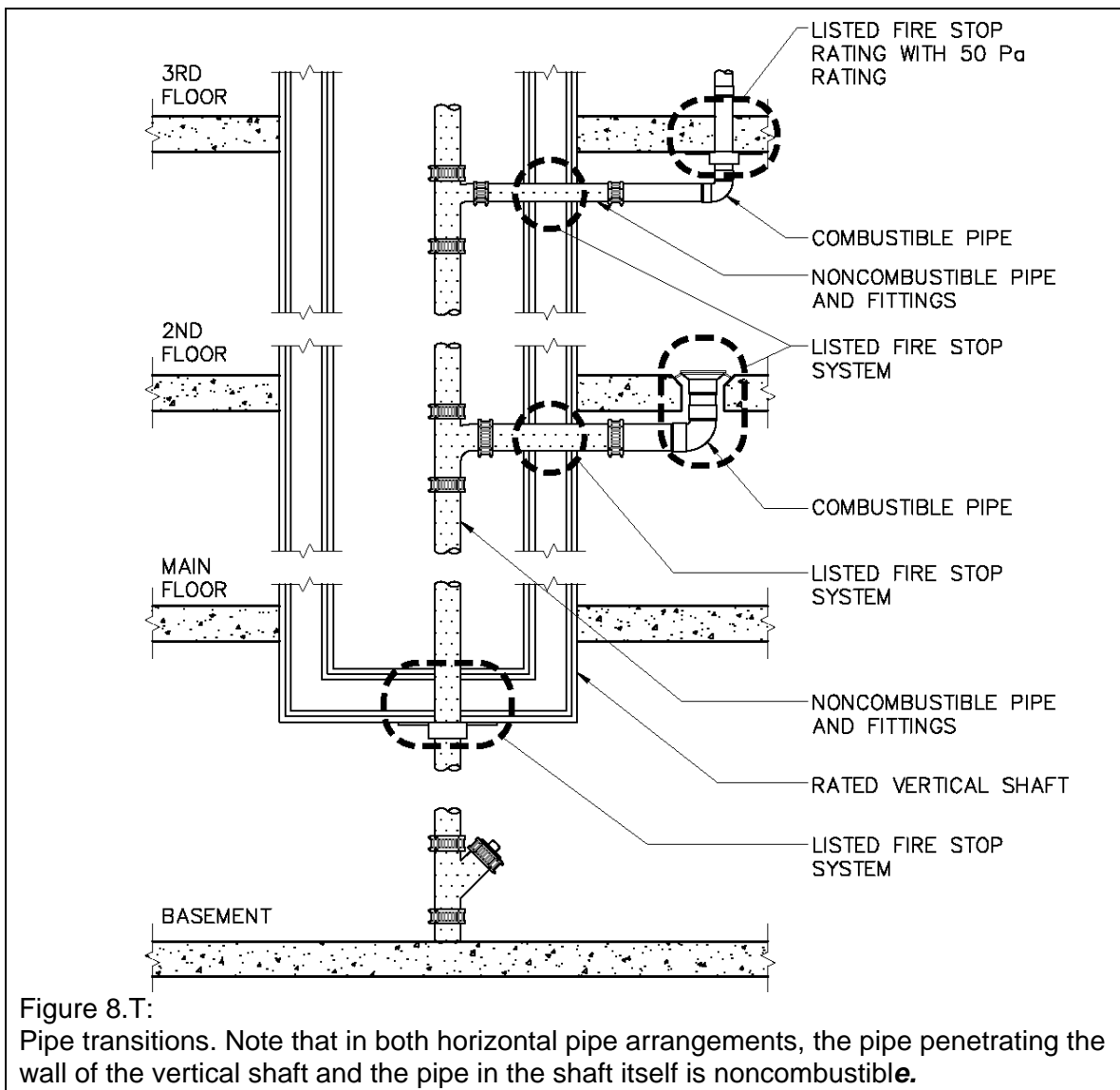
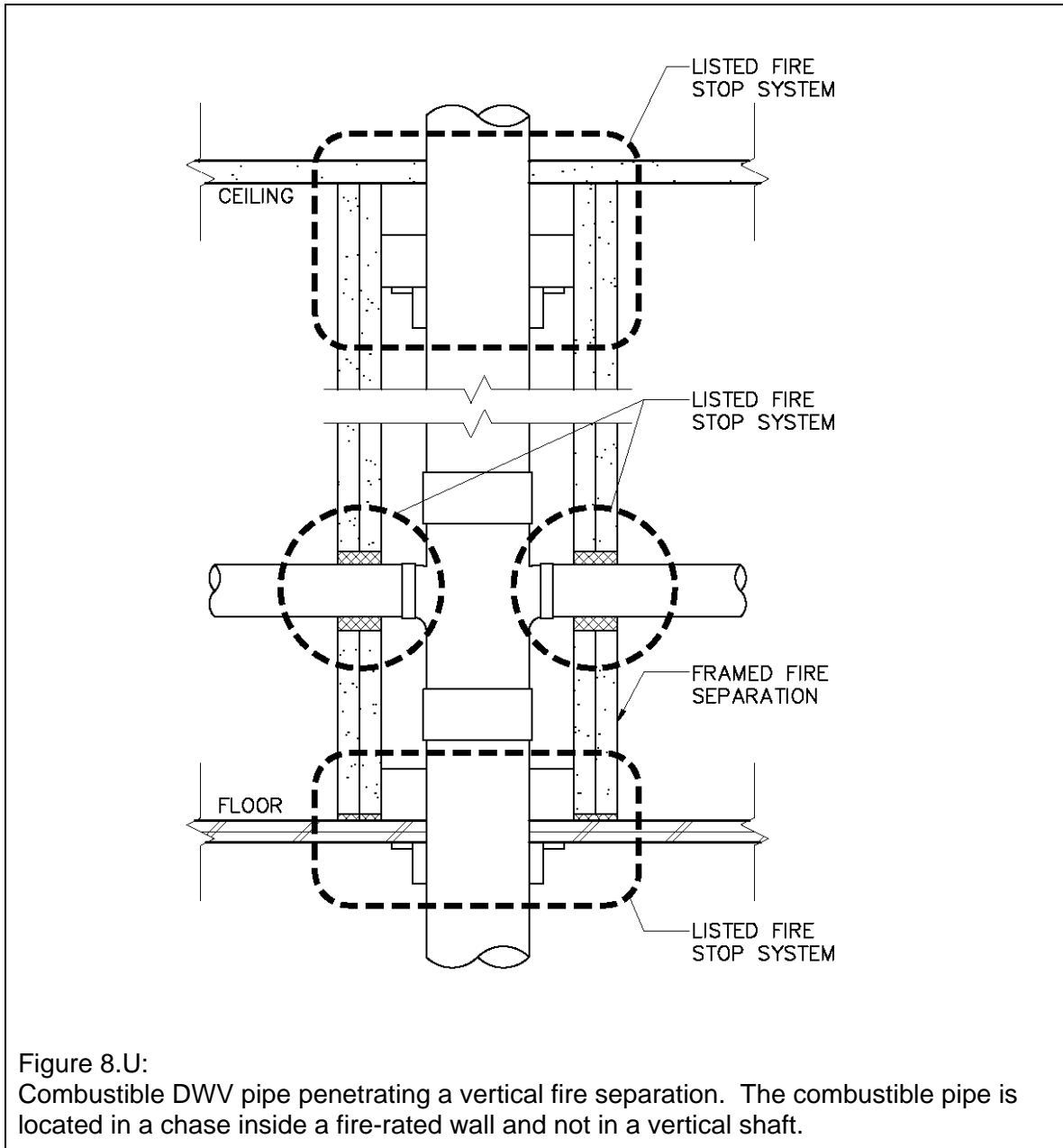


Figure 8.T:

Pipe transitions. Note that in both horizontal pipe arrangements, the pipe penetrating the wall of the vertical shaft and the pipe in the shaft itself is noncombustible.

The NBCC, in Sentence 3.1.9.4.(6) also permits combustible DWV pipe to penetrate a vertical fire separation, provided the combustible pipe is not located in a vertical shaft. See Sections 8.8 and 8.9 above for discussions on fire stops for this application. In Figure 8.U, it can be seen that the vertical run of pipe is located in a chase inside a wall and not in a vertical shaft. The type of fire stop chosen will depend on whether or not the wall is fire-rated.



In some situations involving a parking garage below a concrete slab, some designers would like to use combustible pipe in the parking garage below the slab and noncombustible pipe above the slab. The pipe above the slab is in a vertical shaft (see Section 8.3 above) and a listed fire stop system is installed at the point of penetration of the slab. That fire stop would require an F or FT rating and be tested with a 50 Pa pressure differential. This is illustrated in Figure 8.V. Some of these fire stops may require a minimum distance above the slab before the pipe transition can occur.

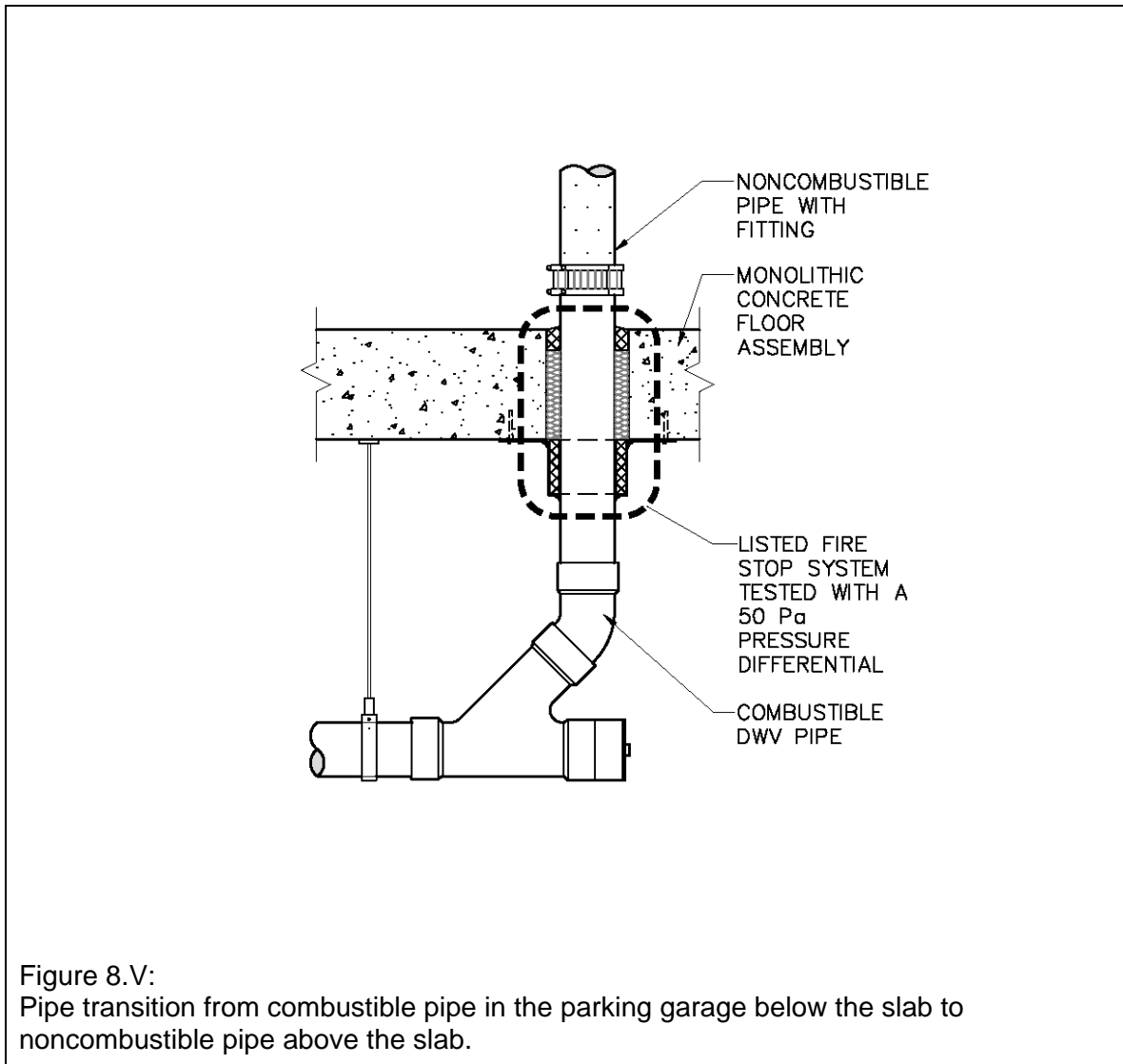


Figure 8.V:
Pipe transition from combustible pipe in the parking garage below the slab to noncombustible pipe above the slab.

There are numerous other possible variations of combustible/noncombustible pipe transitions that can occur in a plumbing system, including those for water pipes. As the NBCC is unclear as to its intent in many of these specific cases, the local authority having jurisdiction should be consulted prior to any installations involving such transitions.

Chapter 8 References

- 8-1. Fire Stopping Service Penetrations in Buildings, The City of Calgary Building Regulations Division, Calgary, AB., 2003.
- 8-2. McGuire, J.H., Penetration of Fire Partitions by Plastic DWV Pipe, *Fire Technology*, Vol. 9, No. 1, National Fire Protection Association, Quincy, MA., 1973.
- 8-3. McGuire, J.H., A Full Scale Fire Test of a Wall Penetrated by Plumbing Facilities, Building Research Note No. 97, Institute for Research in Construction, National Research Council Canada, Ottawa, ON, 1974.

9.0 BEST PRACTICE FOR FIRE STOPS FOR ELECTRICAL SERVICE PENETRATIONS

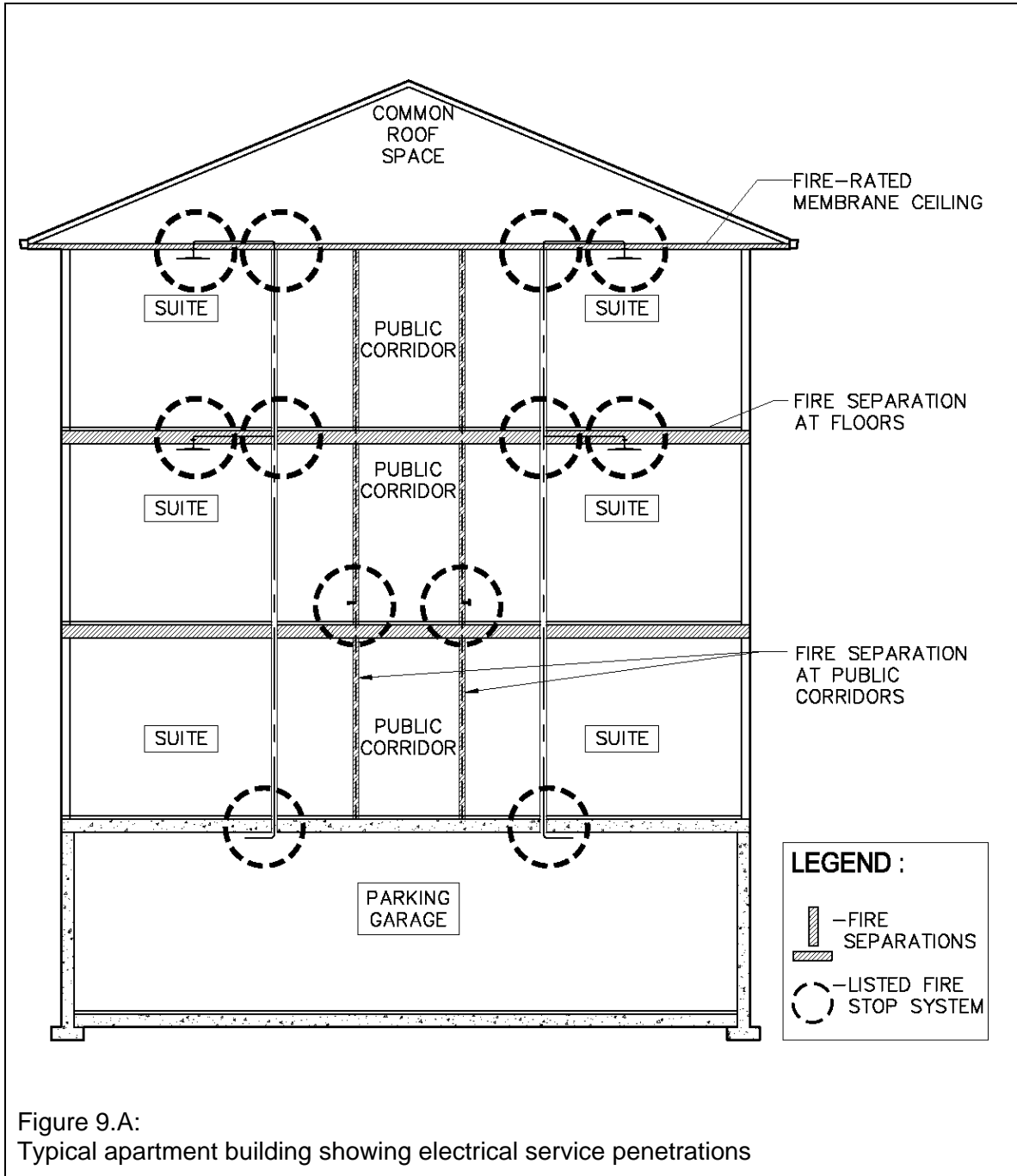
9.1 Introduction

Note: Many of the illustrations and much of the text in this Chapter have been adapted from Reference 9-1.

The examples shown in this Chapter represent various means of achieving fire compartment continuity with fire stops. There are other fire stop systems that may serve this purpose. For reasons of brevity, these other solutions have not been illustrated.

This Chapter will provide information on best practices for fire stop systems for penetrations for electrical services through horizontal and vertical fire separations. The types of electrical service penetrations to be addressed include wiring, conduit, raceways, cable trays and electrical boxes.

Figure 9.A illustrates a simple building located over a parking garage. As explained in Chapter 7, the arrangement of building(s) above a parking garage creates two fire stop situations – those requiring FT ratings and those requiring F ratings. Figure 9.A shows a number of typical electrical service penetrations requiring fire stops that could occur in such a building. These services can penetrate both fire separations as well as fire-rated membranes



Electrical Rooms – A common practice in many buildings is to build a main electrical room in the basement of the building. If a basement parking garage is classified as a separate building and the wiring passes immediately out of an electrical room in such a basement to the other floors, Section 9.2 provides examples of means to achieve FT ratings for fire stop systems. Electrical rooms are often stacked above one another on each storey and are often fire separated (but may not be required to be) from the remainder of the floor and from each other as shown in Figure 9.B.

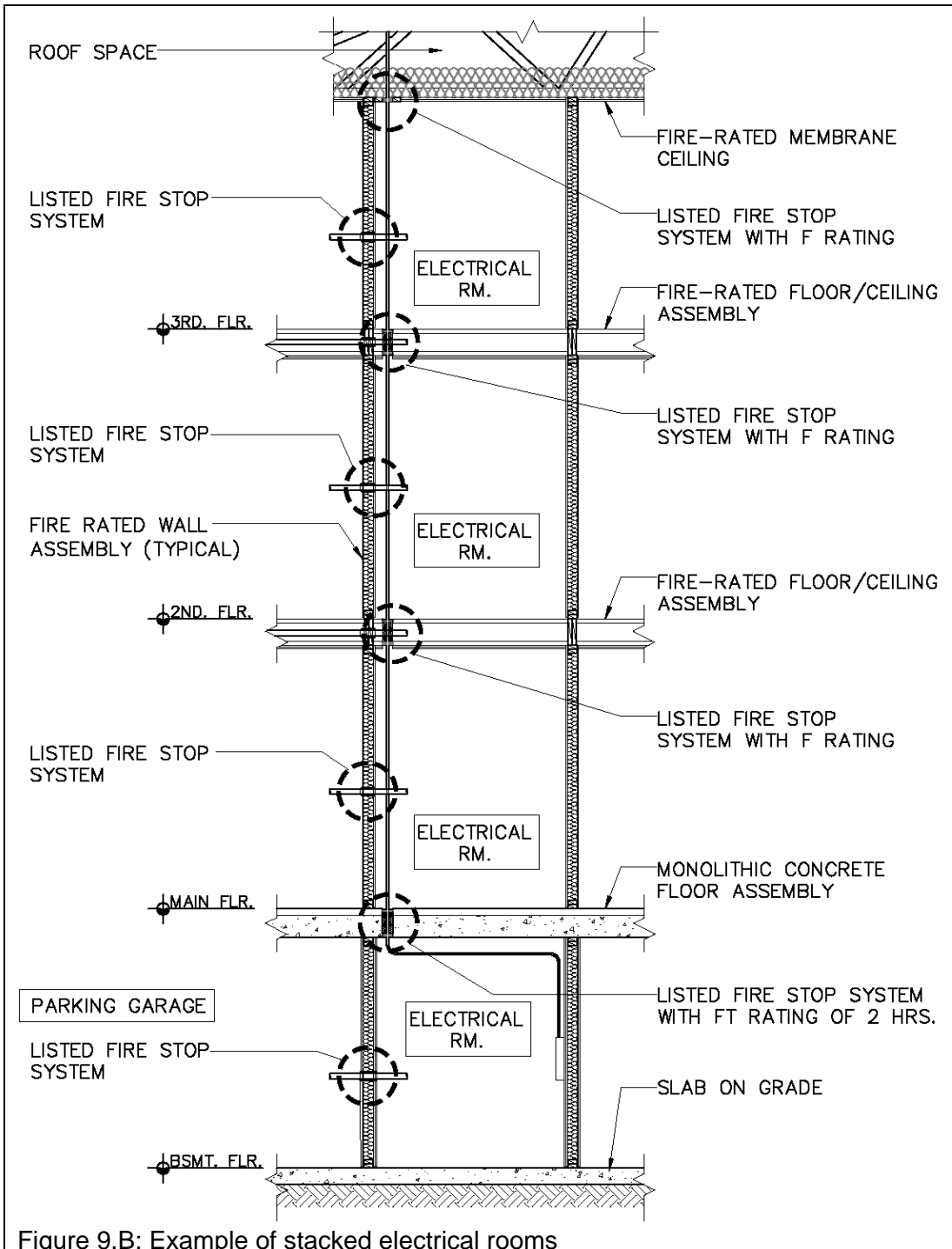


Figure 9.B: Example of stacked electrical rooms

Fire stop systems need to be provided where all wiring enters or leaves fire-rated electrical rooms. Figure 9.B illustrates the arrangement where the parking garage and the building(s) above are considered separate buildings, and thus FT ratings are required for penetrations through the concrete slab over the parking garage. Where the parking garage and the building above are considered to be in the same building, Section 9.2 also describes other fire stop arrangements. The arrangement of electrical rooms shown in Figure 9.B is often used when wires are run in the floor/ceiling assembly above a public corridor on each floor and from that ceiling space into an electrical panel in each suite. In that situation, fire stops are required where the wiring leaves the Electrical Room and for the penetration of the fire separation between the corridor and the suites. Examples of means of providing fire stops in framed floor/ceiling assemblies, monolithic walls and framed wall (stud) assemblies are provided in Sections 9.3 to 9.5.

Compatibility of Fire Stops with Cables – Users of fire stop systems for jacketed electrical cables should be aware that the fire stop system material(s) chosen must be compatible with the cable jacket material. Users should consult the fire stop and cable manufacturers' technical literature for guidance as incompatibility of the fire stop system and the cable jacket could lead to destruction of the jacket and possible electrical safety problems.

FT Ratings for Cable Penetrations – Except for small diameter individual cables, there are a limited number of fire stop systems for cables with FT ratings. This absence of listings appears to be related to heat conduction through the copper wires from the fire-exposed side to the unexposed side of the fire stop system. As such, users frequently are required to develop equivalent solutions, some of which are illustrated in this Chapter. These are suggested as possible solutions to this problem.

Multiple Types of Cables in a Single Penetration – Some listings for cable penetrations do not address the mixing of various types of cables in the same bundle or in a cable tray penetration, nor do they address the permitted quantities of each type of cable in a mixed tray (or penetration). Some listings permit mixing cables in bundles or in trays. These listed systems exist for single openings incorporating a limited mixture of individual cable types. Care must be taken to ensure that the characteristics of the different mix of cable types and quantities of each type conform to the listing. As an example, a listed fire stop system permitting six of 3/C 2-AWG cable, four of 1/C 300-MCM and two of 2/C 16-AWE cable cannot be used when the opening contains 12 of 1/C 300-MCM cables.

When cable trays are used, it is critical to conform to the type and size of cable trays permitted by the listed fire stop system. The quantities of the electrical cables and wires permitted in each listed system are often indicated in terms of maximum percent loading or cross sectional area of the cable trays. The specific criteria provided in the listing must be followed to ensure that the listed fire stop system will perform its intended function.

Electrical Conduit at Top of Wall – Field situations occur where electrical conduit is installed directly against a ceiling or in the flutes of a steel deck and where a vertical fire separation is required to abut this ceiling or deck. This creates a problem in obtaining a proper fire stop installation since movement of the ceiling, deck or conduit may damage the fire stop. One solution is to have conduit bent downward from the

ceiling or deck approximately 150 mm at the location of the vertical fire separation and then bent upward on the other side of the fire separation location. This penetration through the wall can then be equipped with an appropriate listed fire stop system for this application. As well, there are listed fire stop systems specifically designed for this application.

9.2 Electrical Service Penetrations through Monolithic Concrete Floor Assemblies

In Figure 9.A, there are two possible code-related situations for the monolithic concrete floor assembly above the parking garage: when the parking garage is considered a separate building with fire stops requiring an FT rating of 2 h; and when the parking garage and the suites above are in the same building with the fire stops requiring an F rating of 1 h.

A basic arrangement of cables penetrating a monolithic concrete floor assembly is shown in Figure 9.C. For a penetration requiring an FT rating, listed fire stop systems are available for small groups of cables (see manufacturers' technical information) and for larger groups of cables or larger diameter cables.

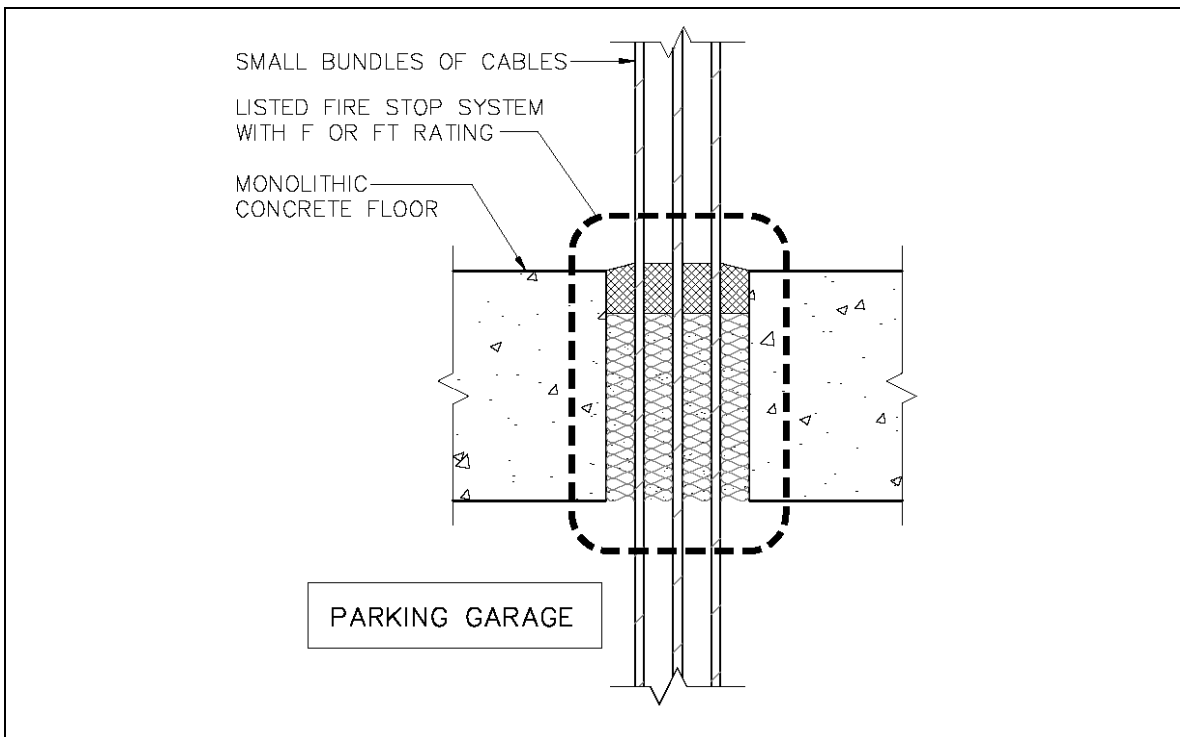


Figure 9.C:
Cable penetrations of a monolithic concrete floor assembly

If Acoustical Separation is Required ...

- The complete floor/ceiling construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: For separation between service spaces (such as electrical room or parking garage) the NBCC has no STC requirement. See Section 2.7.

Where an FT rating is required for larger groups of cables or where conduit is required, the arrangement shown in Figure 9.D may be used. Figure 9.D illustrates arrangements where either an F or an FT rating is required. In either case, the conduit is usually surrounded by the fire stop system rather than the fire stop surrounding the individual cables shown in Figure 9.C. For the arrangement shown in Figure 9.D to obtain an F rating, fire stops would normally be needed only between the conduit and the slab.

Some penetrations may also require that the conduit be insulated for a distance from the fire stop to ensure that an FT rating is achieved, when required. Where insulation is provided over metallic conduit to achieve an FT rating, the fire stop system and insulation must be evaluated for possible ampacity reduction for the conductors since heat from the cables, during normal operation, would not be able to be dissipated as easily through the conduit insulation. Where insulation over the conduit is used, the fire stop system, insulation and conduit arrangement should be reviewed by the electrical regulatory authorities as it may also have to meet the requirements of UL Subject 1712 – Tests for Ampacity of Insulated Electrical Conductors Installed in the Fire Protective System [9-2].

While there is no specific Canadian standard for this application, the Canadian Electrical Code, Part 1, [9-3] requires that maximum ampacities of cables be reduced where insulation could increase the temperature beyond a certain range.

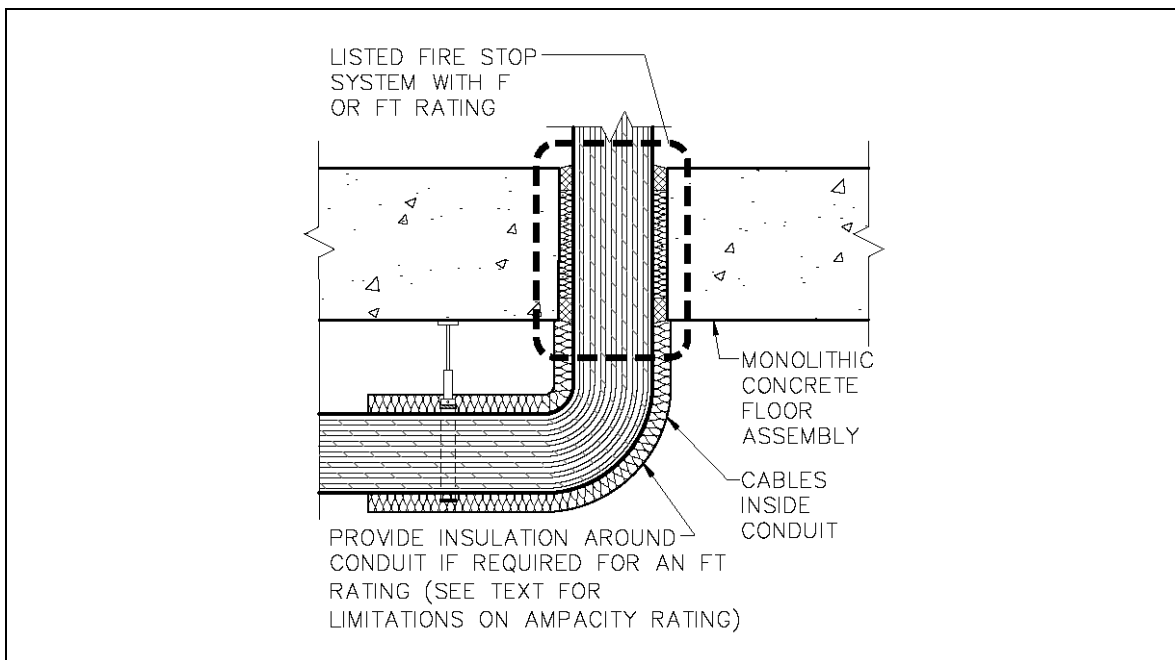


Figure 9.D:
Conduit penetration of a monolithic concrete floor assembly

If Acoustical Separation is Required...

- The complete floor/ceiling construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: For separation between service spaces (such as electrical room or parking garage) the NBCC has no STC requirement. See Section 2.7

In the absence of using a listed fire stop system to obtain an FT rating for cables penetrating concrete slabs over parking garages, a generic solution has been accepted by some authorities to obtain an equivalent FT rating. That generic solution involves enclosing the cables at the parking garage level inside an electrical service room which is surrounded by fire separations having a 2 h fire resistance rating. This is similar to the situation shown in Figure 9.B except that a more robust fire-rated enclosure is provided at the parking garage level. If there is no appreciable accumulation of combustibles in the service room, the 2 h F-rated fire stop through the slab should provide equivalent protection to an FT rating of 2 h, when combined with the 2 h fire-rated service room enclosure. This arrangement is illustrated in Figure 9.E.

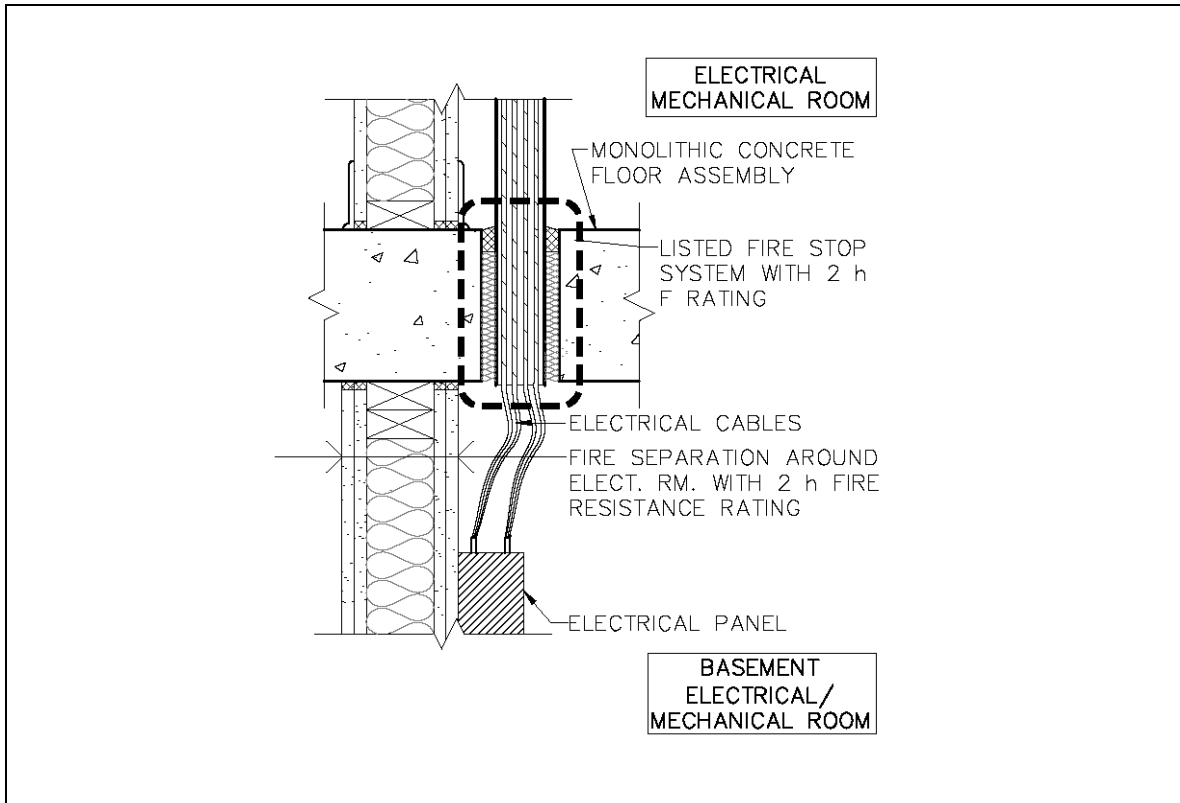


Figure 9.E:
Cables penetrating monolithic concrete floor above an electrical service room to obtain FT rating in lieu of FT-rated fire stop systems

If Acoustical Separation is Required...

- The complete floor/ceiling construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: For separation between service spaces (such as electrical room or parking garage) the NBCC has no STC requirement. See Section 2.7.

9.3 Electrical Service Penetrations through Framed Floor Assemblies

Framed floor assemblies achieve a significant degree of their fire resistance by virtue of fire-rated membranes, in many cases comprised of gypsum board. Electrical service penetrations of these assemblies often involve the penetration of the ceiling membrane, the floor above, or both, depending on the arrangement of the cables and conduit. Figure 9.F illustrates two arrangements of listed fire stop systems through framed floor assemblies. The fire stop arrangement in Figure 9.F will be the same whether the construction is wood or steel framing members. The fire stop system may vary depending on the type of construction materials used for the structure and the ceiling membrane.

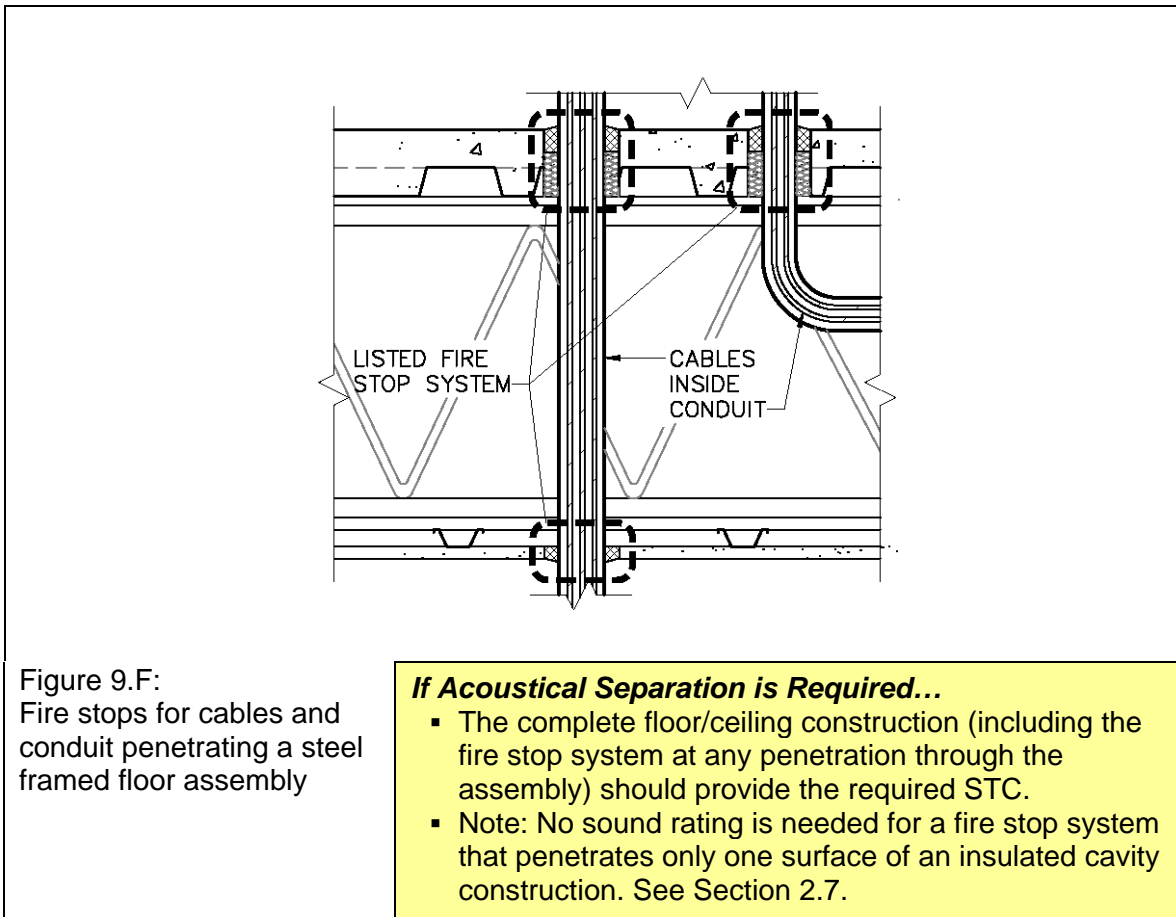


Figure 9.F:
Fire stops for cables and
conduit penetrating a steel
framed floor assembly

If Acoustical Separation is Required...

- The complete floor/ceiling construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

The installation of light fixtures and ceiling fans often requires that fire-rated framed assemblies be penetrated for electrical boxes. Such boxes are often recessed in the fire-rated ceiling membrane as shown in Figure 9.G. Figure 9.G illustrates two examples of fire stops around an electrical box using a fire-rated enclosure and a fire stop putty system. The fire-rated enclosure option has been accepted by some authorities having jurisdiction as a means of addressing this issue.

Fire stop putty systems, including mouldable putties (as shown in Figures 9.G.1 and 9.G.2 for example) are not yet listed by ULC but have been listed by cUL to meet CAN/ULC S101. Those wishing to use such systems should refer to listings from USA certification agencies, in which some mouldable putty products may be listed to American standards comparable to CAN/ULC S101.

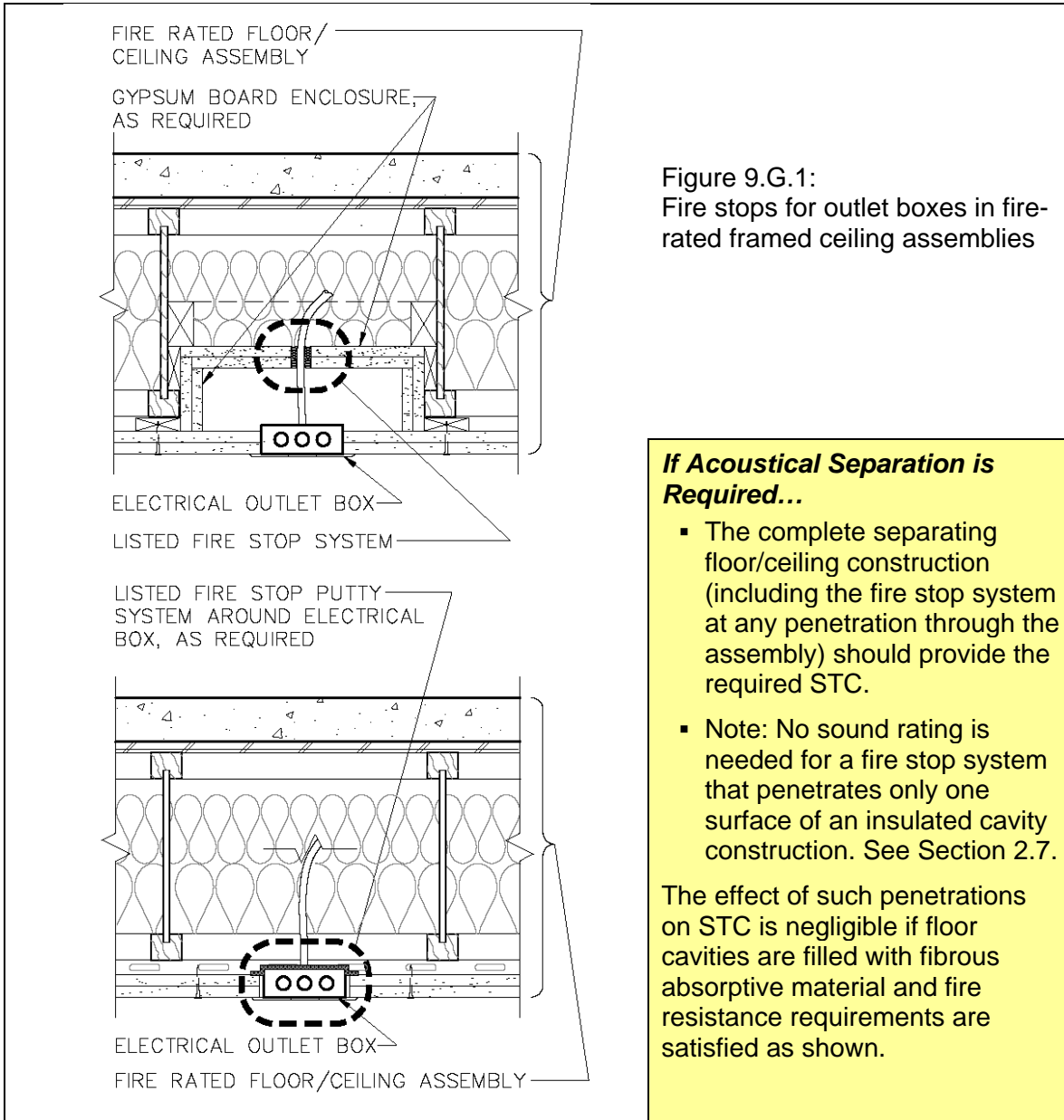
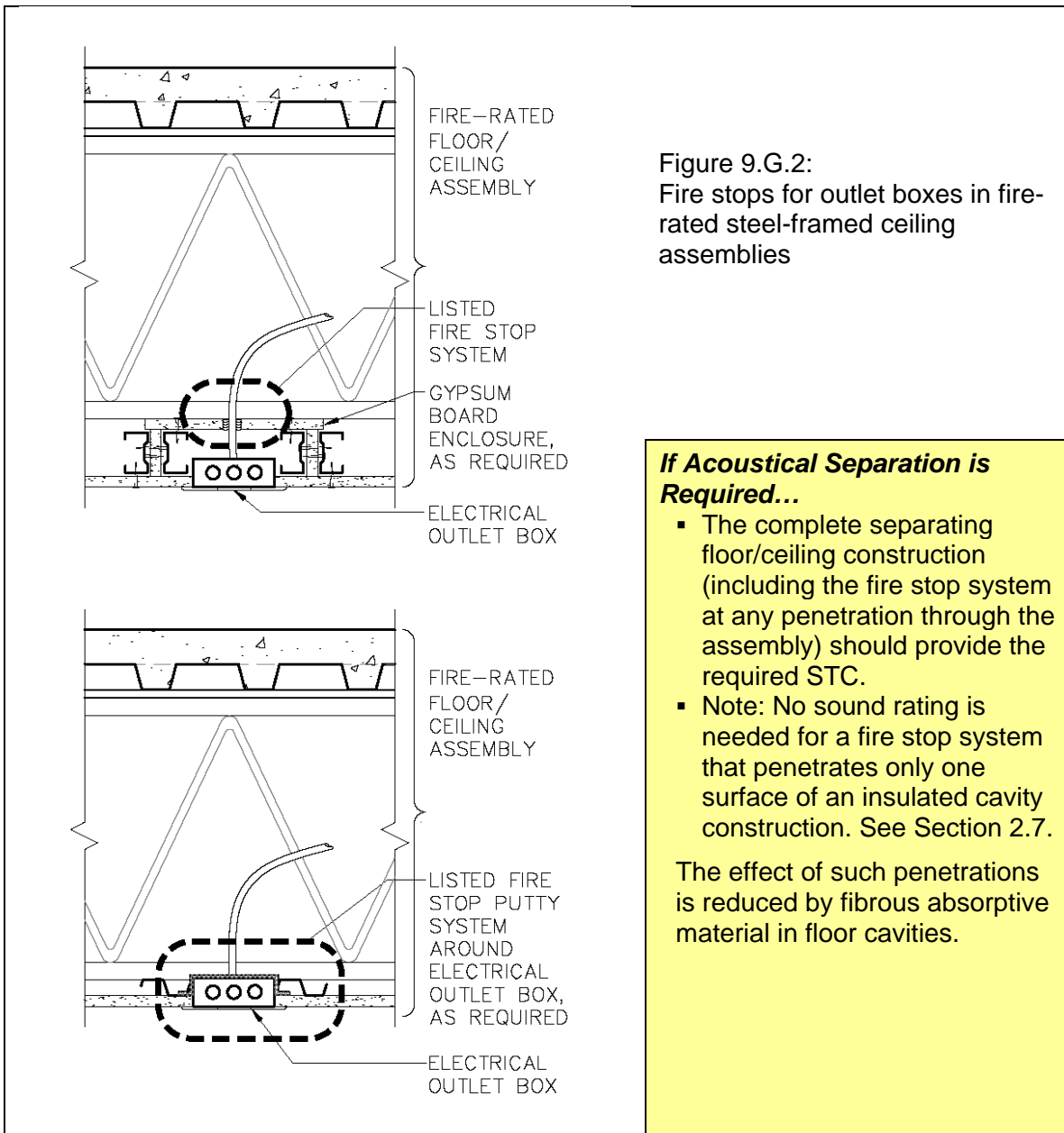


Figure 9.G.1:
Fire stops for outlet boxes in fire-rated framed ceiling assemblies

Electrical Box Penetrations – The extent of fire stop protection for electrical boxes penetrating fire-rated membranes (e.g., as shown in Figure 9.G.1), required by Sentence 3.1.9.1.(1) of the NBCC, is not entirely clear. While Sentence 3.1.9.1.(1) requires that such electrical boxes be “sealed with a fire stop system”, there are fire-rated assemblies using fire-rated membranes listed to CAN/ULC-S101 that permit a small number, size and aggregate area of noncombustible electrical boxes to penetrate the membrane - without the need for a listed fire stop system. Current thinking by the

NBCC advisors is that a listed vertical or horizontal assembly with a size and area of noncombustible electrical boxes, as permitted by the listing, does not require fire stop systems. Should the number/area of boxes exceed the limit specified in the listing, then listed fire stop systems would be required.

For ceiling assemblies where all of the fire resistance is provided in the membrane itself (see Guide 2.2.3), any electrical box penetrations would be required to be equipped with listed fire stop systems since those membranes must meet both temperature rise and flame-through criteria.



A different arrangement, shown in Figure 9.H, results in a system that does not require a fire stop around the electrical box since the "dropped" ceiling is not required to be fire-rated. The entire fire-rated floor assembly is located above this dropped ceiling.

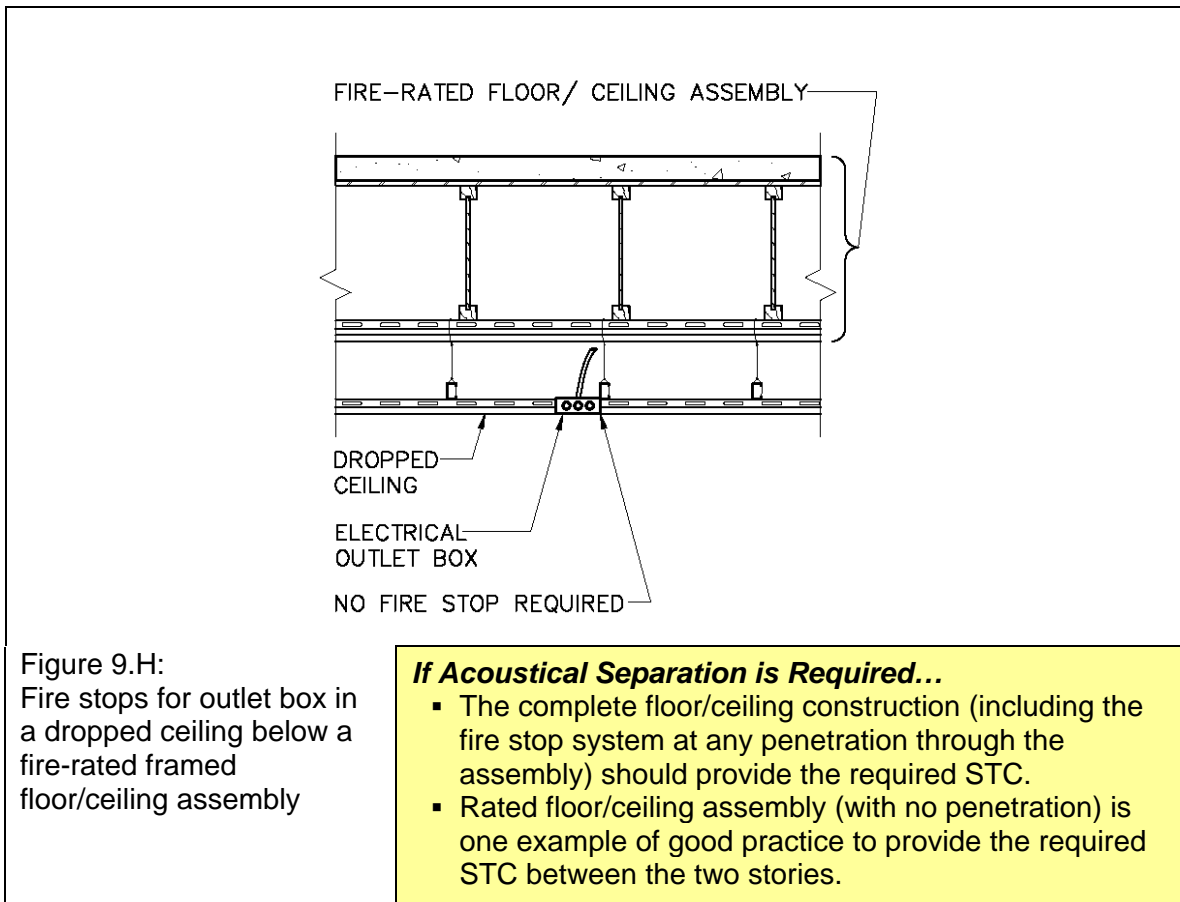


Figure 9.H:
Fire stops for outlet box in a dropped ceiling below a fire-rated framed floor/ceiling assembly

If Acoustical Separation is Required...

- The complete floor/ceiling construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Rated floor/ceiling assembly (with no penetration) is one example of good practice to provide the required STC between the two stories.

9.4 Electrical Service Penetrations through Monolithic Concrete or Masonry Walls

As with pipe penetrations (see Section 8.8), the type of fire stop system required for electrical service penetrations for monolithic concrete or masonry walls depends on whether the wall is a firewall or a fire separation. When penetrating a firewall, the electrical service penetration must be designed in such a manner that its collapse will not cause the collapse of the wall itself – and fire stops must take that requirement into consideration [Ref. 3.1.10.1.(4) of NBCC 2005]. Any electrical service penetration of a firewall must also have an FT rating not less than the required fire resistance rating of the wall itself. If noncombustible conduit is used, insulation may need to be provided over the conduit for some distance from both sides of the wall to obtain an FT rating. If insulation is used, the electrical authority should be consulted to determine if possible ampacity de-rating of the cable may be needed. An alternative would be to have the system tested in accordance with UL Subject 1712 – Tests for Ampacity of Insulated Electrical Conductors Installed in the Fire Protective System [9-2].

When penetrating a vertical fire separation of monolithic concrete or masonry construction that is not a firewall, only an F rating is required for the fire stop. Figure 9.1 illustrates arrangements of electrical service penetrations of monolithic concrete or masonry walls. Where electrical cables penetrate a concrete or masonry wall using a sleeve arrangement, fire stop systems should be provided between the sleeve and the wall and between the cables inside the sleeve. Specific details for these fire stop systems can be found in the manufacturers' technical literature.

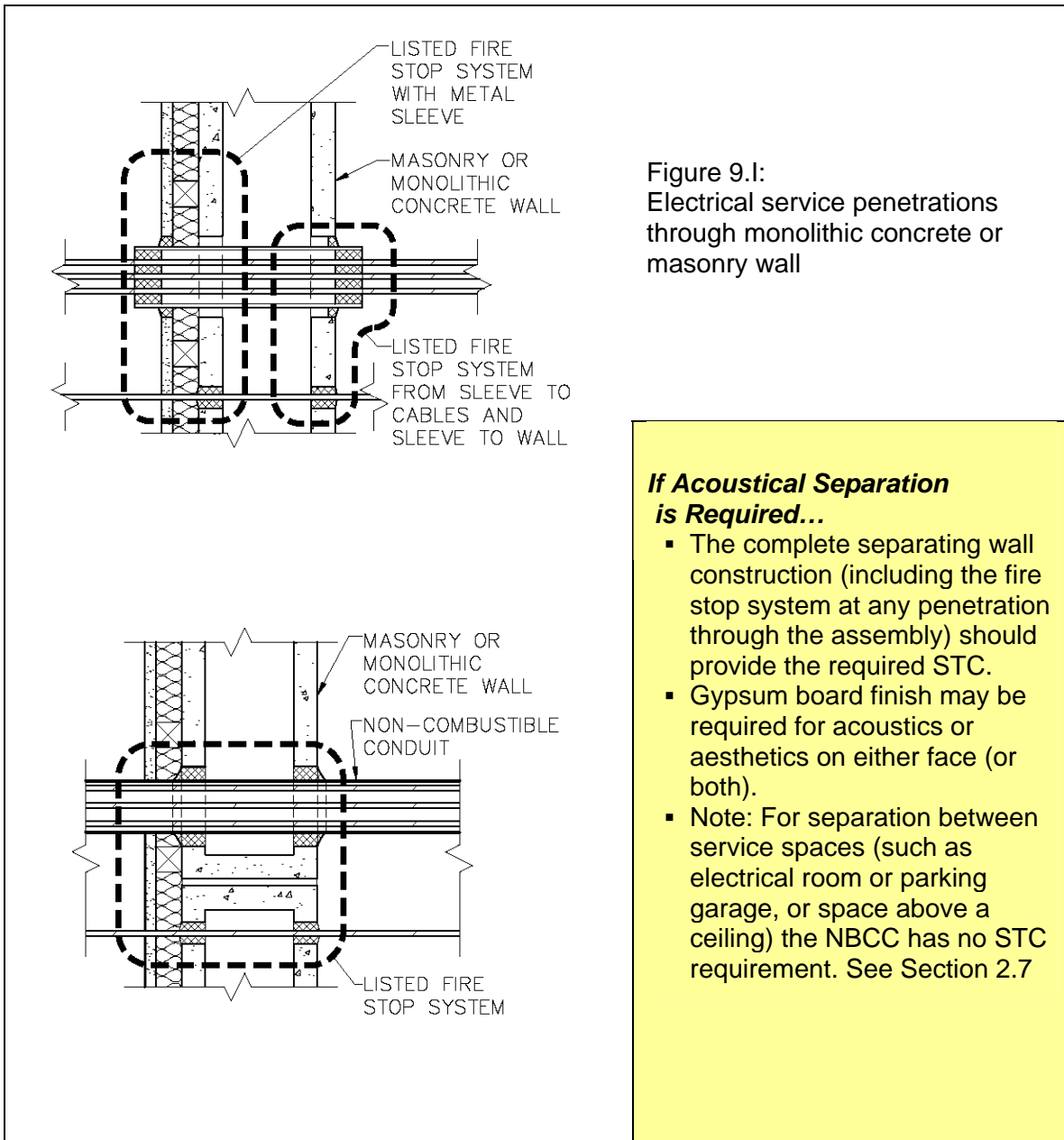


Figure 9.1:
Electrical service penetrations
through monolithic concrete or
masonry wall

***If Acoustical Separation
is Required...***

- The complete separating wall construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Gypsum board finish may be required for acoustics or aesthetics on either face (or both).
- Note: For separation between service spaces (such as electrical room or parking garage, or space above a ceiling) the NBCC has no STC requirement. See Section 2.7

9.5 Electrical Service Penetrations through Stud Wall Assemblies

Framed steel and wood stud wall assemblies are often used to conceal electrical cables and raceways. At those locations where the electrical service penetrates the fire-rated membrane for the stud wall assembly, fire stops must be provided. Typical arrangements of electrical wiring in conduit at penetrations of a stud wall assembly are shown in Figure 9.J.

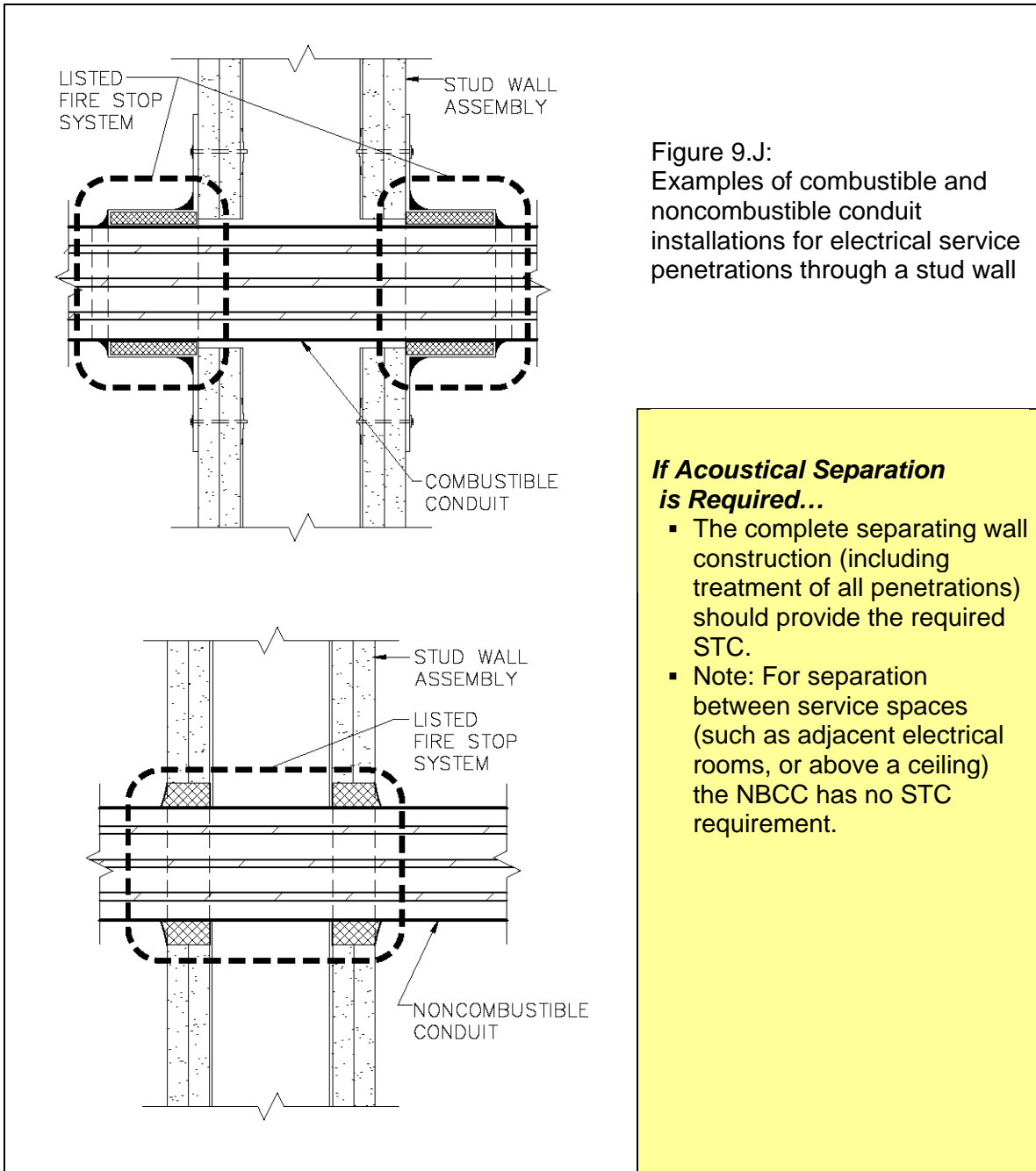


Figure 9.J:
Examples of combustible and noncombustible conduit installations for electrical service penetrations through a stud wall

If Acoustical Separation is Required...

- The complete separating wall construction (including treatment of all penetrations) should provide the required STC.
- Note: For separation between service spaces (such as adjacent electrical rooms, or above a ceiling) the NBCC has no STC requirement.

Examples of electrical service penetrations without conduit are illustrated in Figure 9.K. Where sleeves are used to pass wires through a stud wall assembly, fire stops are required for the space between the sleeve and the wall assembly and for the space where the cables enter and exit the sleeve as shown in the lower figure. Specific details for these fire stop systems can be found in the manufacturers' technical literature.

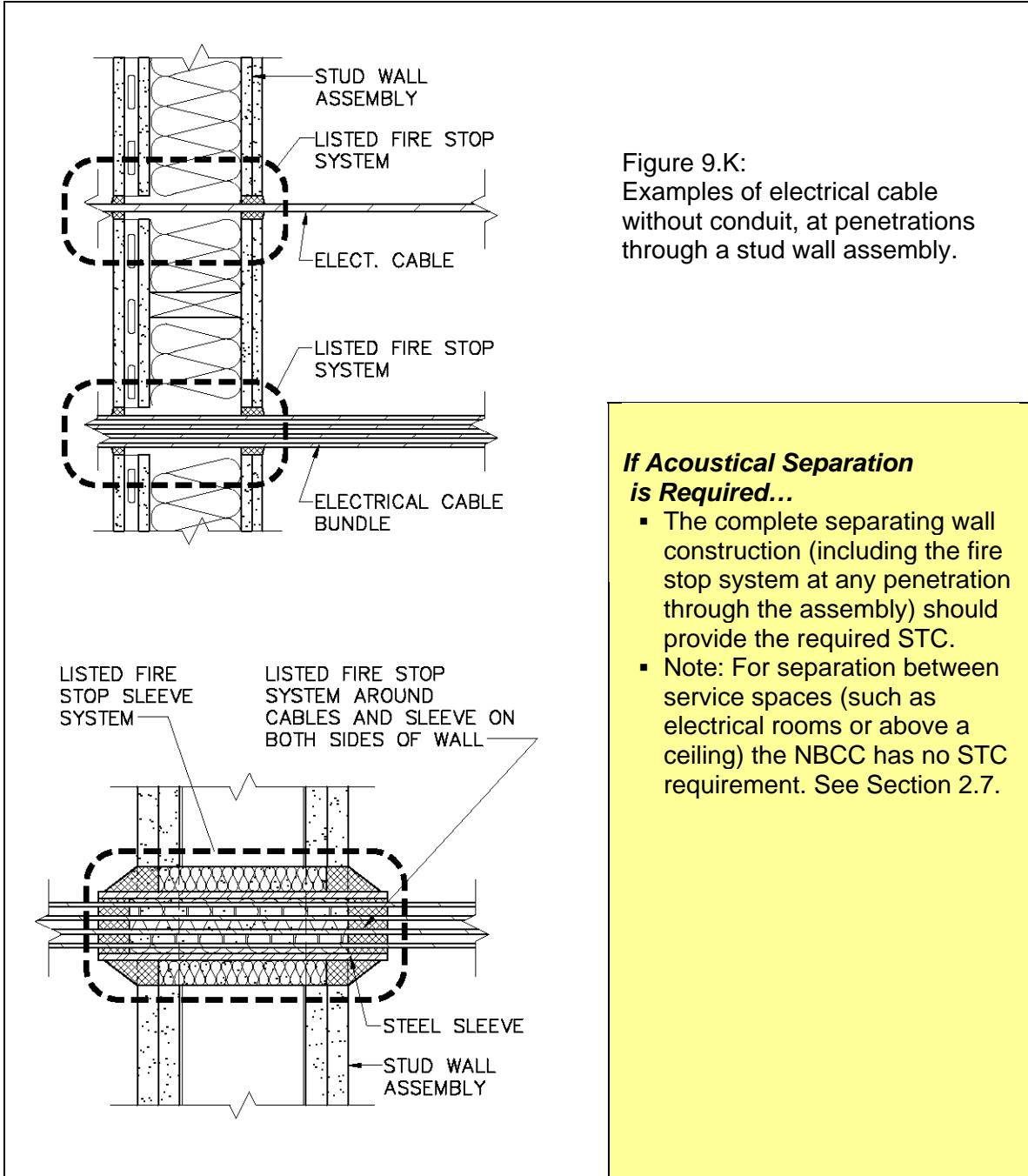


Figure 9.K:
Examples of electrical cable without conduit, at penetrations through a stud wall assembly.

If Acoustical Separation is Required...

- The complete separating wall construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: For separation between service spaces (such as electrical rooms or above a ceiling) the NBCC has no STC requirement. See Section 2.7.

Electrical Panels – Electrical panels normally are not located in a stud wall assembly fire separation, in part because their size makes it difficult to provide appropriate fire stops. Rather, electrical panels can be located in a non-fire-rated wall assembly and then no fire stops are required; or they can be located in a furred-out wall assembly located adjacent to a fire separation as shown in Figure 9.L which would also not require fire stops. The locations where cables from the electrical panel penetrate the fire-rated membrane still require fire stops. Another possible option would be to frame and install a gypsum board enclosure around the opening in the fire-rated wall assembly to create a recessed cavity for the electrical panel. This latter arrangement has been accepted by some authorities as providing equivalent protection.

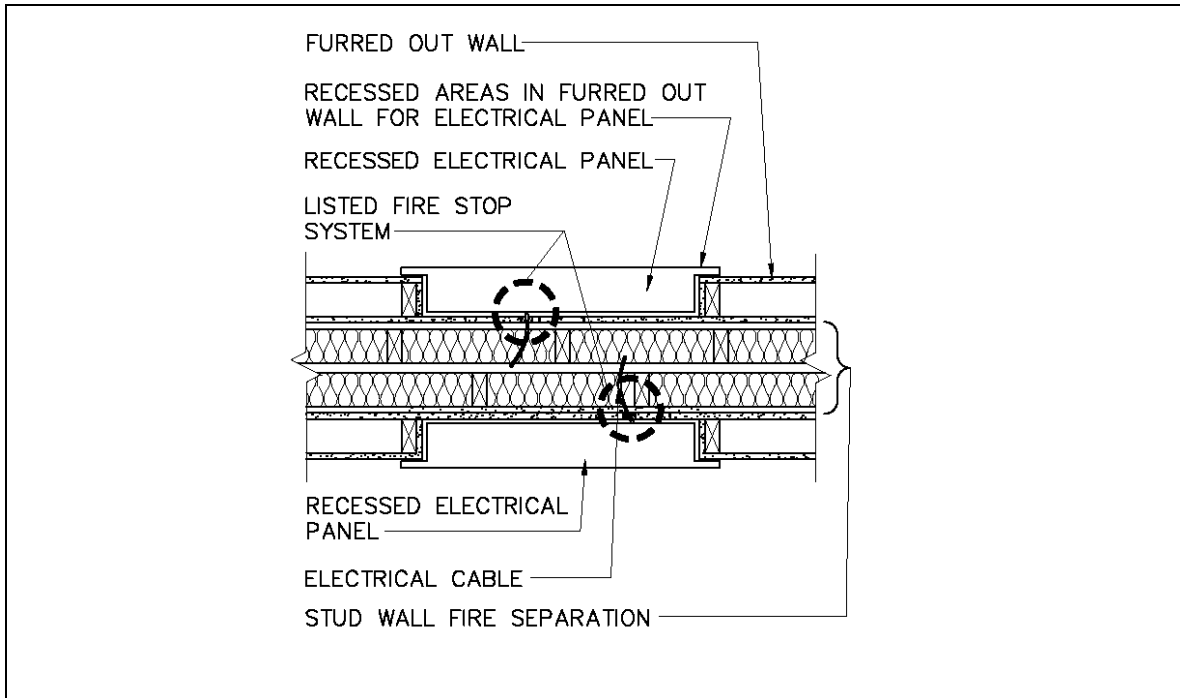


Figure 9.L:
Example of electrical panel opening in framed furred-out wall assembly

If Acoustical Separation is Required...

- The complete separating wall construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Rated wall assembly with no penetrations is one example of good practice to achieve required STC separation between side-by-side units.
- Sealed cable penetrations through gypsum board behind the electrical panel will not reduce STC of rated wall assembly, and adjacent furred-out assembly tends to increase STC.

Electrical Outlet Boxes – The NBCC is unclear as to the extent to which electrical boxes need to be protected or offset to ensure that the integrity of the fire separation is maintained [Ref: NBCC Sentence 3.1.9.3.(6)] As a reasonable position to achieve the necessary integrity, electrical outlet boxes should be installed in fire-rated stud wall assemblies so that there is at least one full stud space between boxes on opposite faces of the assembly. Listed fire stop systems for the boxes on both faces should be utilized. As illustrated in Figure 9.M, the electrical boxes on both sides of the wall assembly need to be provided with fire stops. Figure 9.M shows an arrangement of a double stud wall assembly with greater than one stud space spacing between electrical outlet boxes. For a single stud wall in the lower portion of the figure, the electrical outlet boxes can be in adjacent stud spaces since each stud space is essentially a cavity sealed by framing on four sides. See discussion in Section 9.3 where fire stops may not be required in some assemblies.

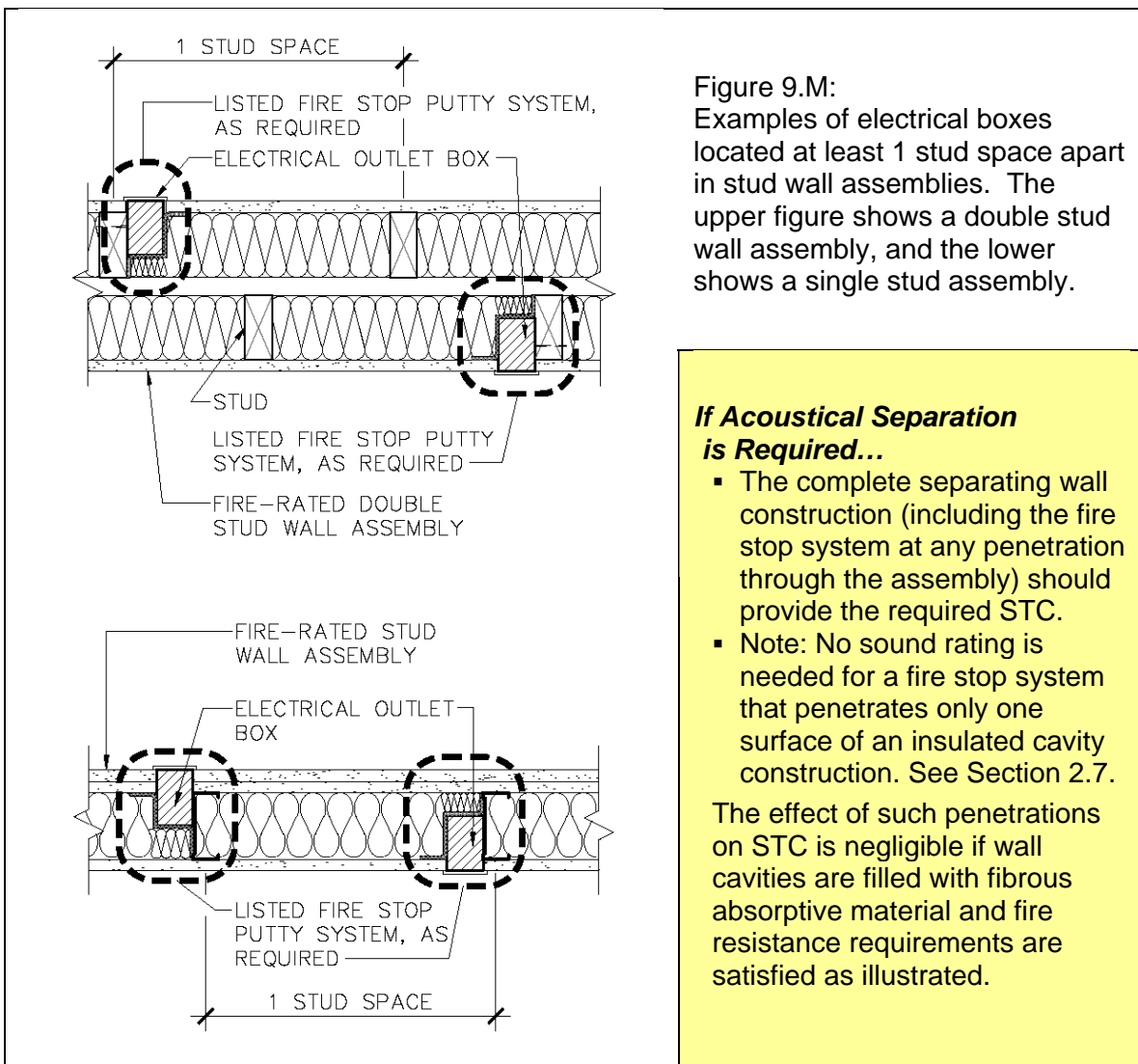


Figure 9.M:
Examples of electrical boxes located at least 1 stud space apart in stud wall assemblies. The upper figure shows a double stud wall assembly, and the lower shows a single stud assembly.

If Acoustical Separation is Required...

- The complete separating wall construction (including the fire stop system at any penetration through the assembly) should provide the required STC.
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

The effect of such penetrations on STC is negligible if wall cavities are filled with fibrous absorptive material and fire resistance requirements are satisfied as illustrated.

If there is less than one full stud space between electrical boxes as shown in Figure 9.N, additional protection for the penetration is required. Figure 9.N illustrates one arrangement in which electrical outlet boxes can be installed where there is less

than one full stud space between boxes. In this case, the box on one side of the double stud wall is enclosed by a horizontal fire block cross brace and gypsum board to isolate it from the box on the opposite side of the wall. In this arrangement, fire stops are required where the electrical cable penetrates the fire block cross brace and for the electrical box on the opposite side of the wall. The listed fire stop system should be installed in accordance with the manufacturers' technical literature.

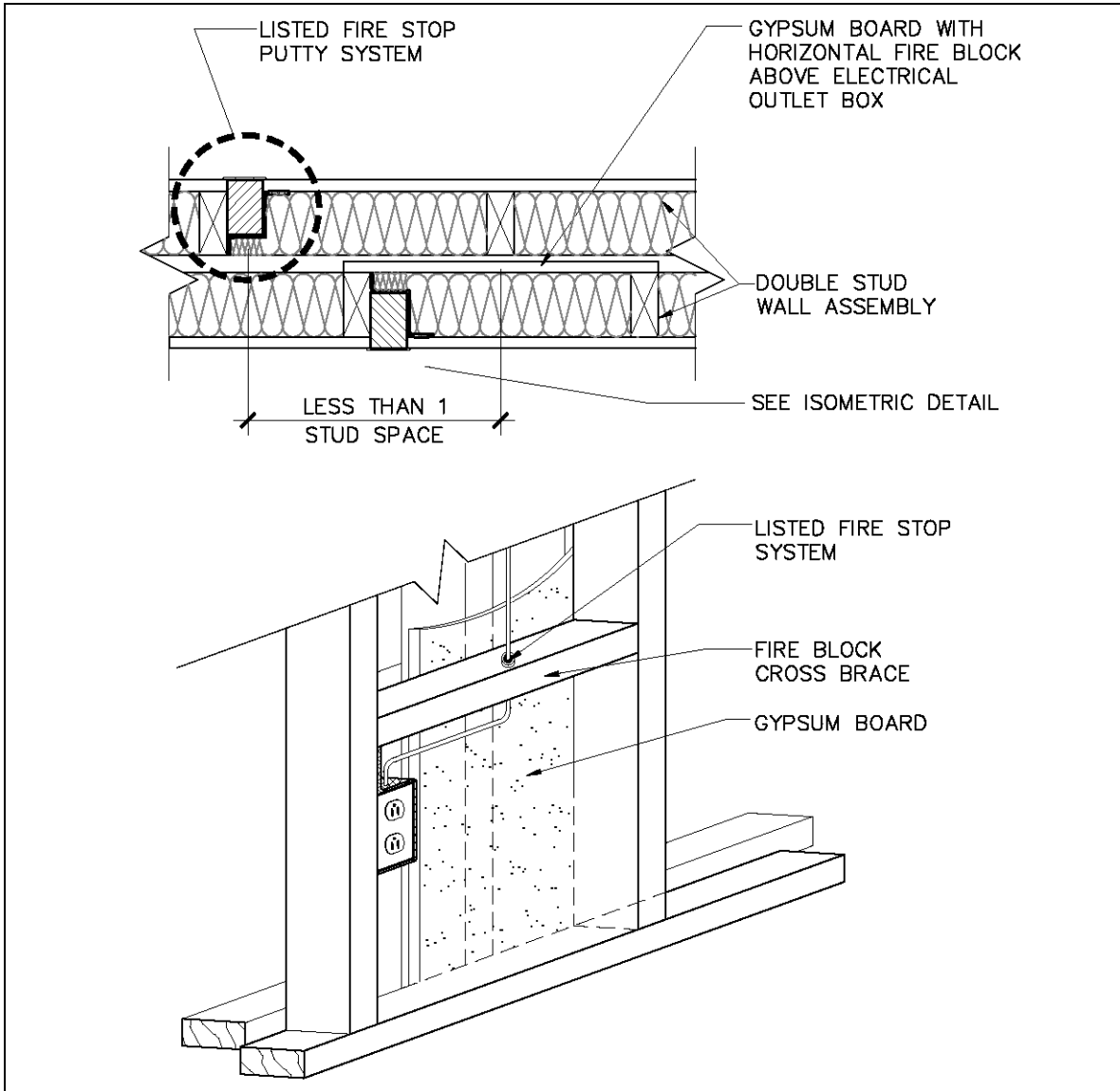


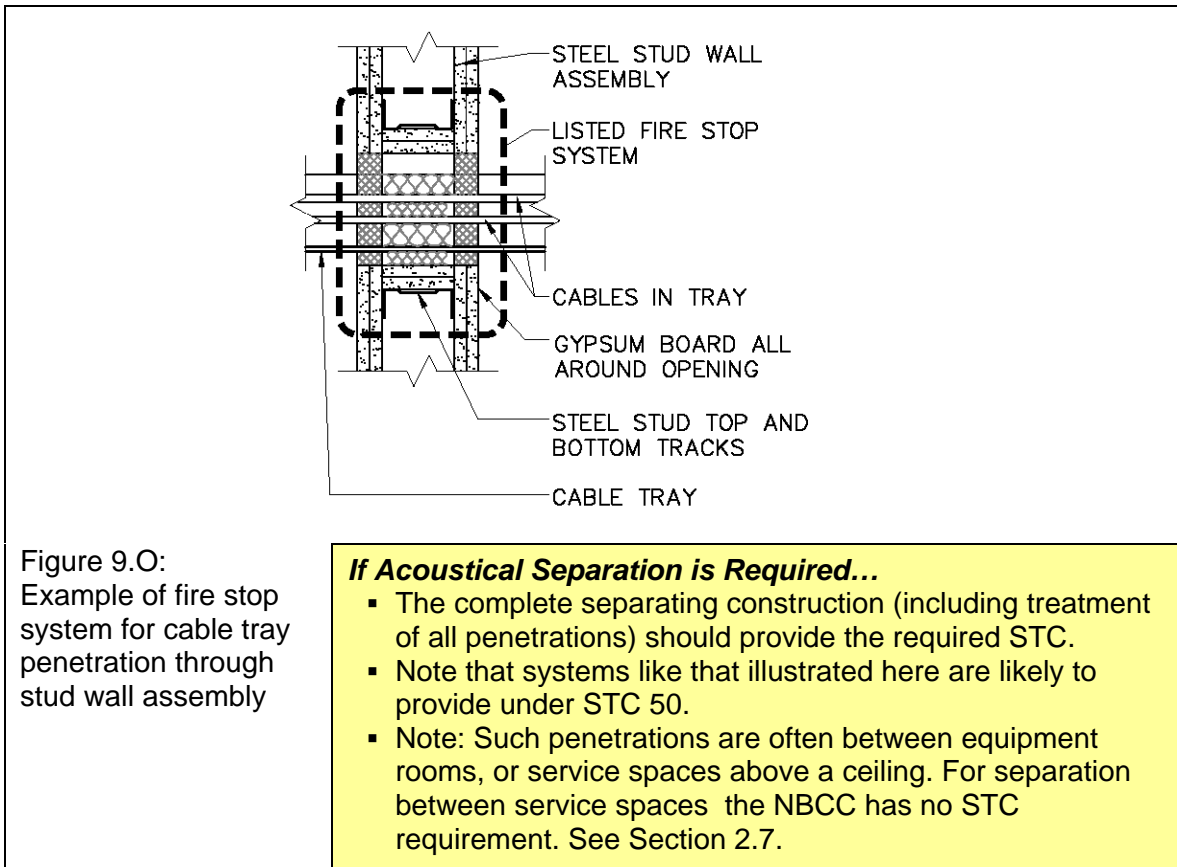
Figure 9.N:
Example of electrical outlet boxes less than one stud space apart in a double wall assembly

If Acoustical Separation is Required...

- The complete separating construction (including treatment of all penetrations) should provide the required STC.
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7. The effect of such penetrations on STC is negligible if wall cavities are filled with fibrous absorptive material and fire resistance requirements are satisfied as illustrated.

9.6 Cable Tray Penetrations

Since cable trays represent reasonably large penetrating items, care should be taken to ensure the integrity of the fire separation at this penetration. Users can find listed fire stop systems for cable tray penetrations or may sometimes use an arrangement such as shown in Figure 9.O. In this latter case, it is important to provide fire stops between the cable tray and the fire-rated membrane as well as between the cables in the tray. In some cases, the fire stop system will be installed in a framed opening as shown in Figure 9.O; in other cases, the listed fire stop may be installed without the opening being framed. Users should consult the manufacturers' technical literature for details.



Chapter 9 References

- 9-1. Fire Stopping Service Penetrations in Buildings, The City of Calgary Building Regulations Division, Calgary, AB., 2003.
- 9-2. UL Subject 1712 – Tests for Ampacity of Insulated Electrical Conductors Installed in the Fire Protection System, Underwriters Laboratories Inc., Northbrook, IL, 2006.
- 9-3. Canadian Electrical Code, Part 1, Canadian Standards Association, Rexdale, ON, 2006.

10.0 BEST PRACTICE FOR FIRE STOPS FOR MECHANICAL SERVICE PENETRATIONS

10.1 Introduction

Note: Many of the illustrations and much of the text in this Chapter have been adapted from Reference 10-1.

The examples shown in this Chapter represent various means of achieving fire compartment continuity with fire stops. There are other fire stop systems that may serve this purpose. For reasons of brevity, these other solutions have not been illustrated.

This Chapter provides information on best practices on fire stops for penetrations for mechanical services through horizontal and vertical fire separations. Mechanical service penetrations include ducts (for such services as bathroom and kitchen fans and clothes dryers), with and without fire dampers, and chimneys and vents for heating appliances.

Figure 10.A illustrates a simple apartment building located over a parking garage. The figure shows a number of typical mechanical service penetrations requiring fire stops that could occur in such a building. These mechanical services can penetrate both horizontal and vertical fire separations as well as fire-rated membranes. Mechanical services that penetrate the exterior walls of buildings will normally not require fire stops at the exterior walls since exterior walls are not considered to be fire separations. If the exterior wall is required to have a fire resistance rating, however, fire stops may be required around a mechanical service penetration if the penetration is not considered an “unprotected opening” for the purposes of determining distances to property lines and between buildings on the same property.

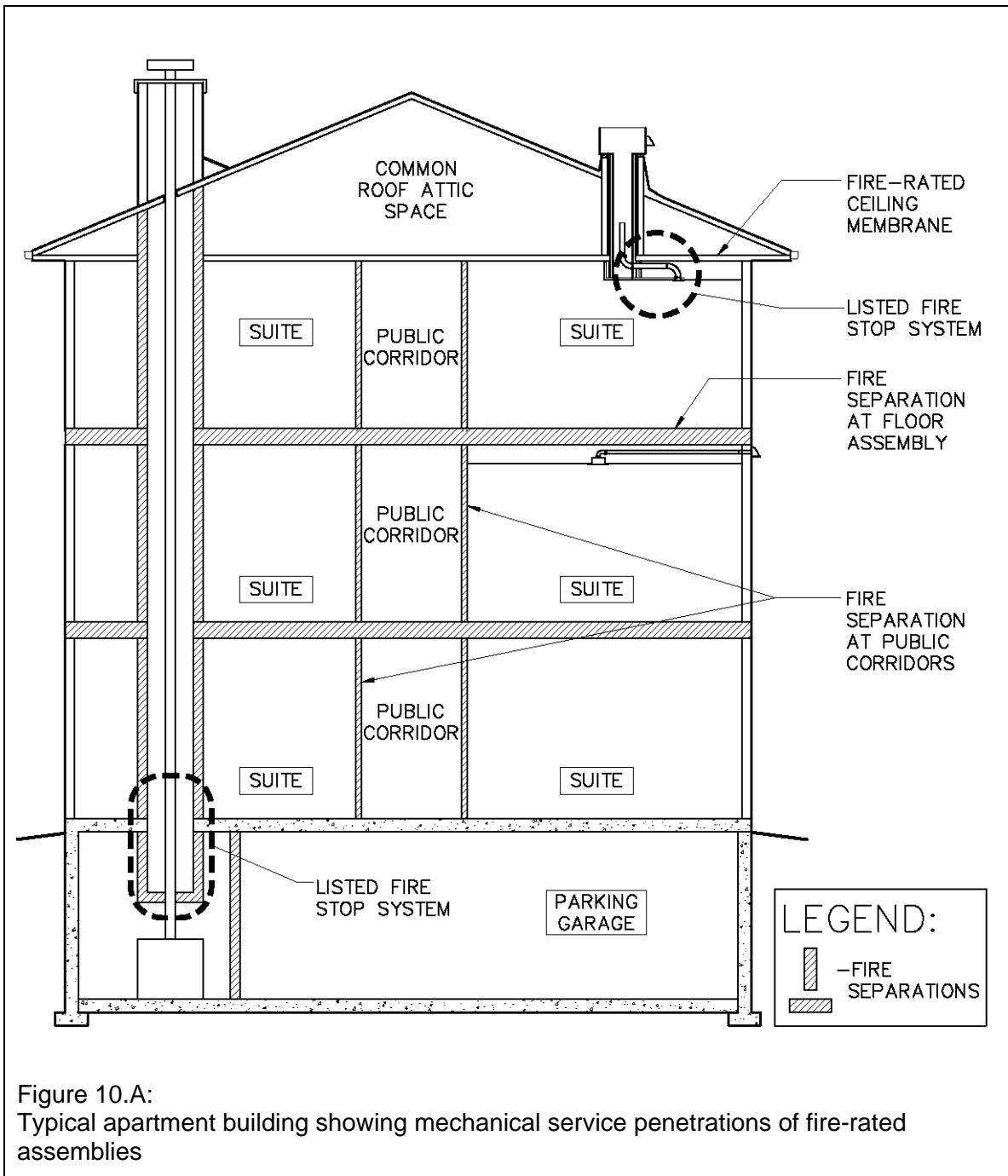
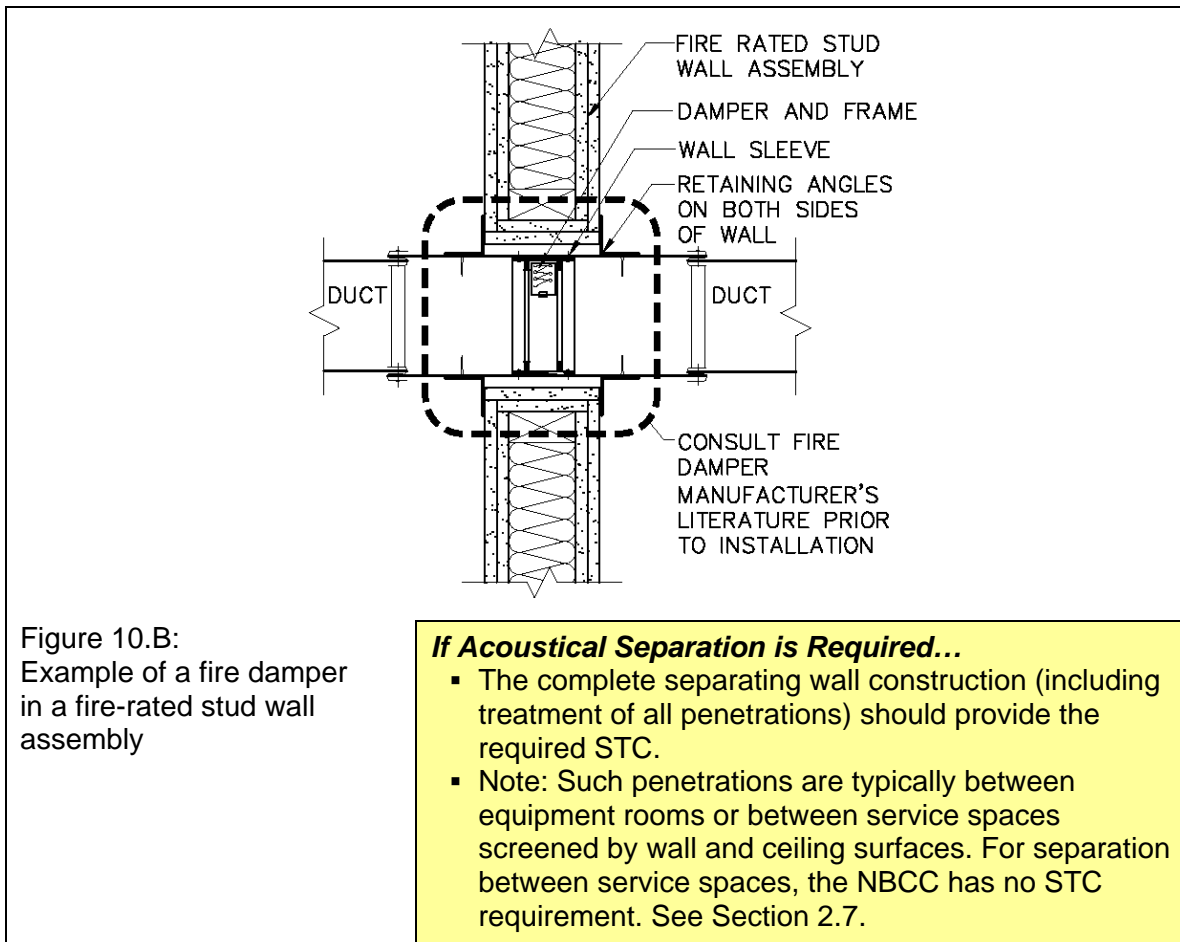


Figure 10.A:
Typical apartment building showing mechanical service penetrations of fire-rated assemblies

Ducts that Require Fire Dampers – Most ducts wholly or partially passing through fire separations require fire dampers at the point of penetration. A typical example of a fire damper installation for a duct penetration in a vertical fire separation is shown in Figure 10.B. Users are cautioned to review the fire damper manufacturer's installation instructions related to the use of any product in the opening between the damper and the fire separation, and around the retaining angles, as these may curtail the proper operation of the fire damper [10-2] and void the listing for the damper. The retaining angles on both sides of the fire separation, as shown in Figure 10.B, may perform a fire stop function when installed according to the fire damper manufacturer's instructions.



The SMACNA Technical Paper on Improper Fire Damper Installation [10-3] states that if fire dampers are not installed in accordance with the specific mounting and installation requirements contained in the manufacturer's listing, then the listings for the dampers are void. Sealing the retaining angles is not a requirement for a listed fire damper installation. If sealing is provided, only the specific sealants that have been tested by the manufacturer and included in the listed installation instructions should be used. Fire stop caulks and putties are not typically listed for this application. The annular space between the fire damper sleeve and the edge of the opening in the fire separation is required for thermal expansion of the damper as the result of heated air flow. Fire stops must not be installed in this space since they will impede the operation of the fire damper.

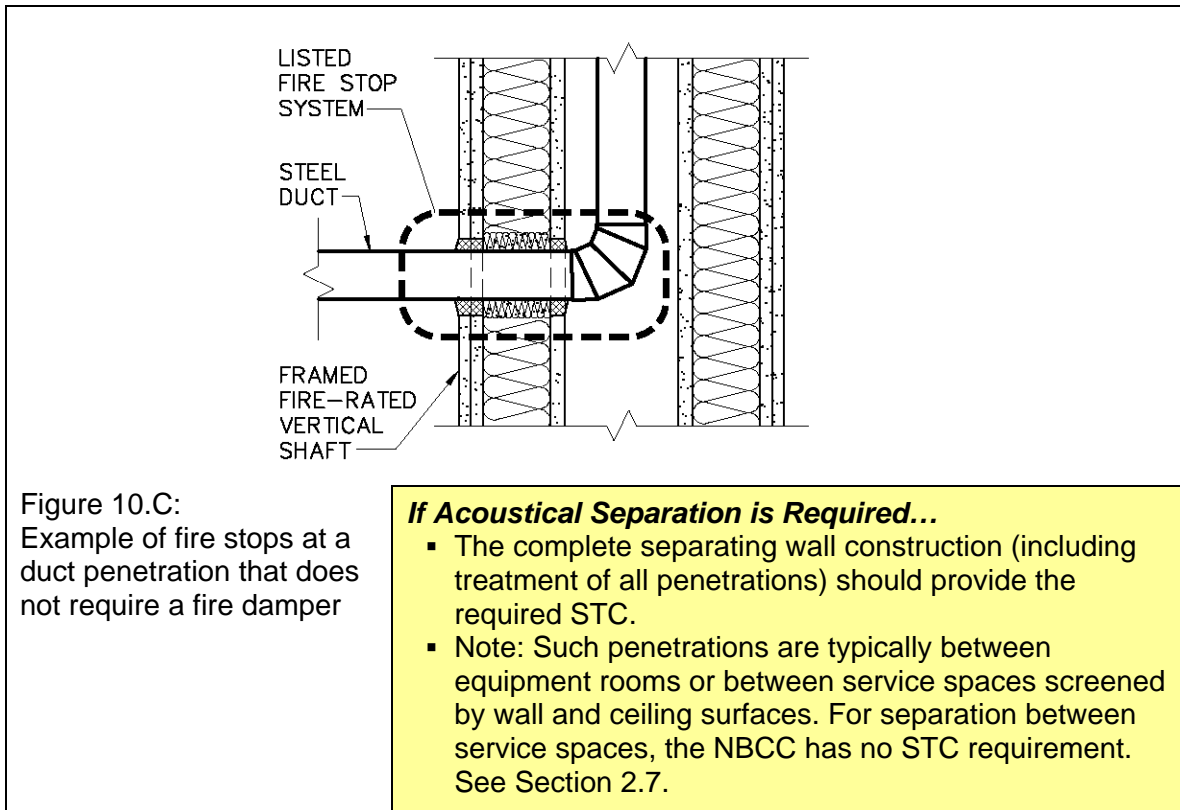
Users must be aware that the NBCC will eventually reference the 2007 edition of NFPA 80 – Standard for Fire Doors and Opening Protectives [10-4] for the installation of fire dampers. In the current NBCC, it is unclear as to specific requirements for the installation of fire dampers.

Ducts that Do Not Require Dampers – The NBCC permits some arrangements of ducts penetrating fire separations without the need for fire dampers at the points of penetration. These are addressed in Article 3.1.8.8.

3.1.8.8. Fire Dampers Waived

- 1) *Fire dampers* need not be provided in *noncombustible* branch ducts that have a melting point above 760°C and that penetrate a required *fire separation* provided the ducts
 - a) serve only air-conditioning units or combined air-conditioning and heating units discharging air not more than 1.2 m above the floor and have a cross-sectional area not more than 0.013 m², or
 - b) are connected to *exhaust duct* risers that are under negative pressure and in which the air flow is upward as required by Article 3.6.3.4. and are carried up inside the riser not less than 500 mm.
 - 2) A duct penetrating a vertical *fire separation* not required to have a *fire-resistance rating* need not be equipped with a *fire damper* at the *fire separation*.
 - 3) A *noncombustible* duct that penetrates a horizontal *fire separation* not required to have a *fire-resistance rating* need not be equipped with a *fire damper* at the *fire separation*.
 - 4) A *noncombustible* duct that penetrates a *fire separation* that separates a *vertical service space* from the remainder of the *building* need not be equipped with a *fire damper* at the *fire separation* provided
 - a) the duct has a melting point above 760°C, and
 - b) each individual duct exhausts directly to the outside at the top of the *vertical service space*.
 - 5) A continuous *noncombustible* duct having a melting point above 760°C that penetrates a vertical *fire separation* as required by Sentence 3.3.1.1.(1) between *suites* of other than *residential or care or detection occupancy* need not be equipped with a *fire damper* at the *fire separation*.
 - 6) A duct that serves commercial cooking equipment and penetrates a required *fire separation* need not be equipped with a *fire damper* at the *fire separation*.
- (See also Article 6.2.2.6.) [Ref: 3.1.8.8 of NBCC 2005]

Where fire dampers are not required when ducts penetrate a fire separation, fire stops should be provided in the opening around the duct as shown in Figure 10.C. Most of these situations that do not require fire dampers often assume the installation of smaller sized steel ducts (melting point above 760°C) and that ducts constructed of lower melting point materials and ducts with larger diameters may require additional measures to ensure the integrity of the fire stop [10-2]. Users should consult the fire stop manufacturer's technical literature to determine appropriate fire stops for these non-steel and larger diameter ducts.



From the NBCC requirements noted above, it can be seen that the following are the typical locations where dampers are not required:

- Noncombustible kitchen and bathroom exhaust ducts (with fans) that penetrate a vertical service shaft (see Figure 10.C). The exhaust duct is continuous from the fan housing to the exterior of the building [Ref: Sentence 3.1.8.8.(4) of NBCC 2005].
- Noncombustible kitchen and bathroom exhaust ducts (without fans) that penetrate a common exhaust duct in a vertical service shaft. In this case, there is an exhaust fan at the top of the shaft. Where the duct enters the shaft, a 500 mm (20 in.) upturn can be provided in the common exhaust duct [Ref: Sentence 3.1.8.8.(1) of NBCC 2005].
- Noncombustible ducts passing through a fire separation not required to have a fire-resistance rating [Ref: Sentences 3.1.8.8.(2) and (3) of NBCC 2005]. These fire separations are not considered sufficiently robust to require the addition of dampers in noncombustible ducts.
- Continuous steel ducts passing through vertical fire separations (walls) between suites, except in residential, or care or detention occupancies [Ref: Sentence 3.1.8.8.(5) of NBCC 2005].
- Ducts, serving commercial cooking equipment, which penetrate a fire separation [Ref: Sentence 3.1.8.8.(6) of NBCC 2005]. Dampers in these ducts could become coated with grease and create fire problems. Because these ducts cannot be equipped with fire dampers, they are enclosed in rated shafts or wraps if they pass through fire separations.

As can be seen from the examples above, NBCC exceptions to fire damper requirements do not exempt a mechanical service penetration in a fire separation from the need for fire stop systems. When fire dampers are present, however, fire damper manufacturers often do not permit the installation of fire stops as they may impede the operation of the damper.

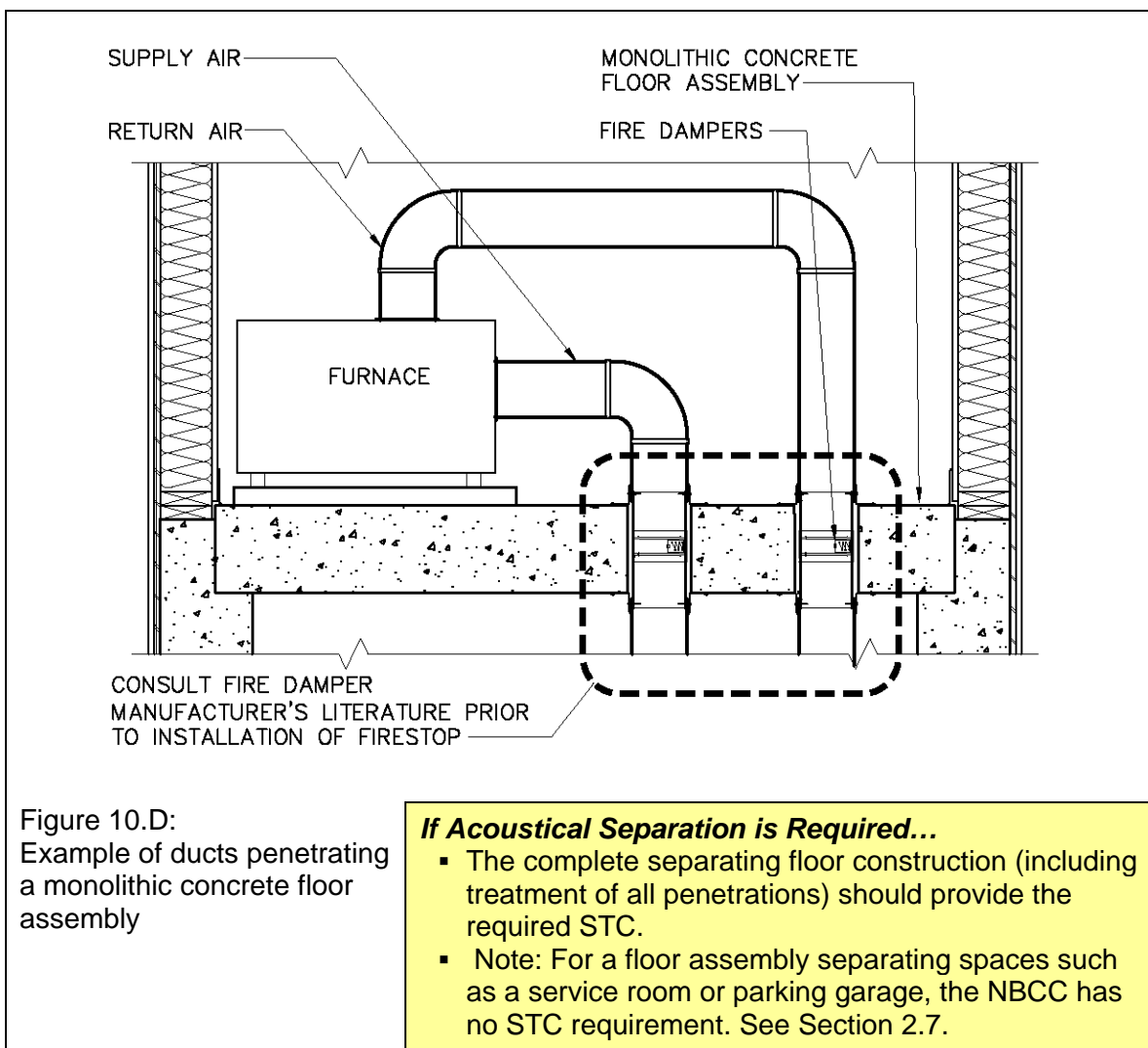
Ducts serving commercial cooking equipment (grease ducts) are permitted to penetrate fire separations without fire dampers and would be expected to require listed fire stop systems at the points of penetrations. Many grease ducts will be installed in an insulated enclosure for reasons of reduced clearances to structural members or penetrations of fire separations (see NFPA 96 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations [10-5]). Users should be aware that duct wraps may also require listed fire stop systems at the point of penetration of a fire separation. Duct wrap systems are assigned a ULC-FRD design number which indicates required fire stops at fire separations. This requirement for fire stops also applies to ventilation ducts which have been assigned ULC-FRD design numbers. These latter ducts are listed by ULC using ISO 6944 – Fire Resistance Tests – Ventilation Ducts [10-6].

Membrane-Ratings and Fire Stops for Duct Penetrations – Users are reminded of the information related to the differences between assembly ratings and membrane ratings described in 2.2.3 of this Guide. Where a duct penetrates an assembly for which all of the fire resistance is assumed to be in the membrane, provision will have to be made to provide additional protection to prevent excessive temperature rise in the space above the ceiling. This may be an occasion where a listed duct wrap will be needed to provide thermal protection of the space above the membrane ceiling. Alternatively, the duct may need to be run in a joist space which has been lined with gypsum board or other material which provides the same thermal protection as the ceiling membrane. (See Figures 10.J.1 and 10.K.1 as examples of this latter concept.)

10.2 Mechanical Service Penetrations through Monolithic Concrete Floor Assemblies

In Figure 10.A, there are two common configurations for the fire-rated slab above a parking garage as described in Section 7.1: when the parking garage is considered a separate building from the suites above with fire stops requiring an FT rating of 2 h; and when the parking garage and the suites above are considered to be in the same building with the fire stops requiring an F rating of 1 h.

Figure 10.D illustrates ducts penetrating a monolithic concrete floor assembly. In this Figure, the ducts would normally require fire dampers and hence fire stops may not be permitted or required unless specifically identified by the fire damper manufacturer (see also Figure 10.E for greater detail).



If fire dampers are not required, then fire stops would need to be provided as shown on the right hand side of Figure 10.E. If the monolithic concrete floor assembly creates a separate building, then these fire stop systems would require an FT rating; if not a separate building, then an F rating would be required.

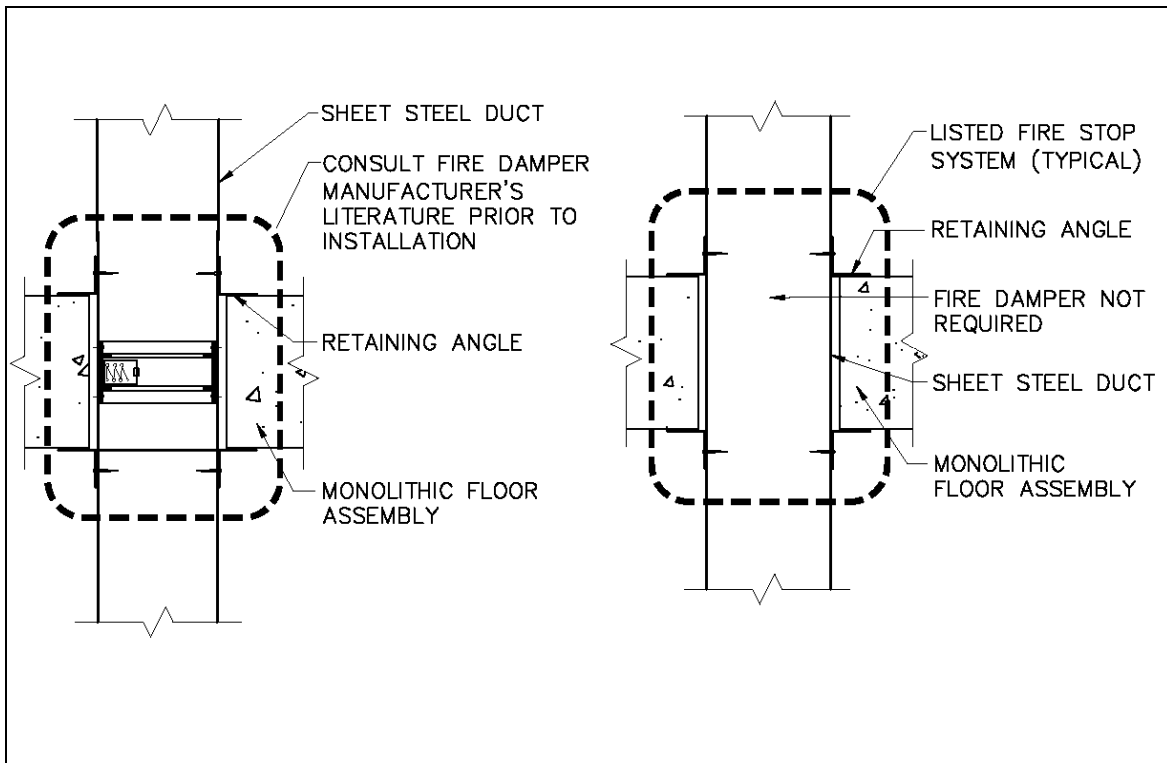


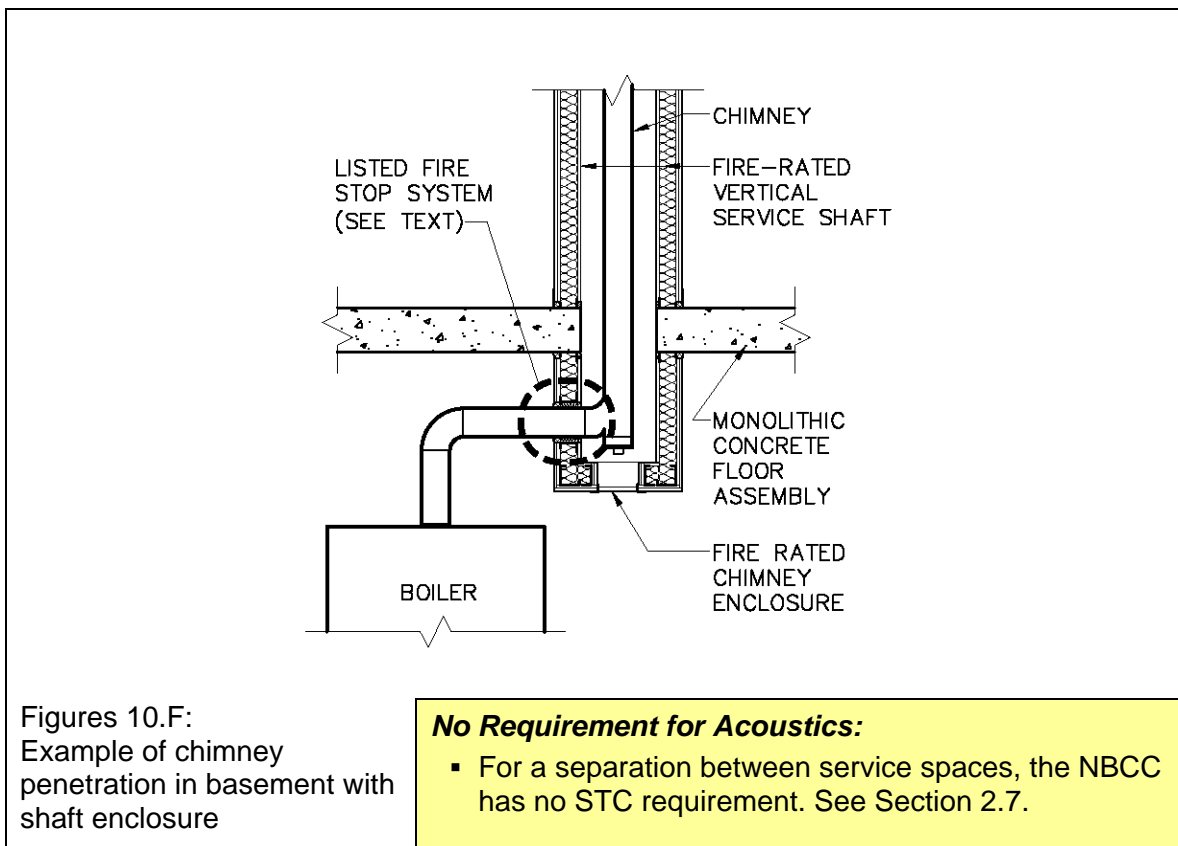
Figure 10.E:
Example of duct penetrations of a monolithic concrete floor assembly with and without fire dampers

If Acoustical Separation is Required...

- The complete separating construction (including treatment of all penetrations) should provide the required STC.
- Note: For a separation between service spaces, the NBCC has no STC requirement. See Section 2.7.

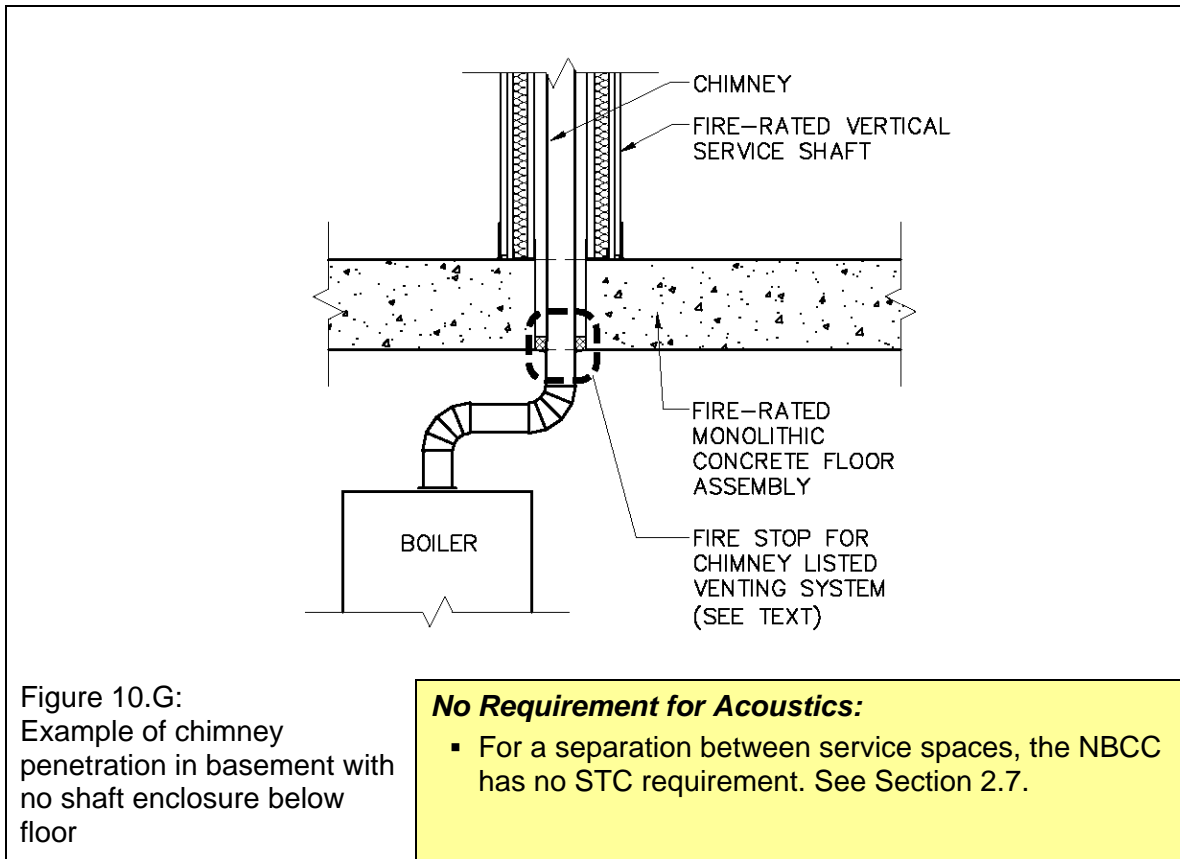
In some buildings, the boiler room is located in the basement with a chimney venting through the roof. With this arrangement, a fire damper cannot be provided in a chimney since it could malfunction and close inadvertently. The chimney must therefore be installed in a fire-rated vertical shaft. Provision must be made, however, to prevent a fire originating in the boiler room from entering the vertical shaft.

Figure 10.F presents one means to prevent fire from leaving a Boiler Room and entering a vertical service shaft. If the parking garage is a separate building, then the enclosure around the chimney flue would need to have a 2 h fire resistance rating and fire stops would require an FT rating. If the parking garage is not a separate building, then the enclosure and the fire stops would have a lesser rating, probably 1 h and an F rating. Fire stops for this application often are integral with the listed chimney venting system and may not be listed to CAN/ULC-S115.



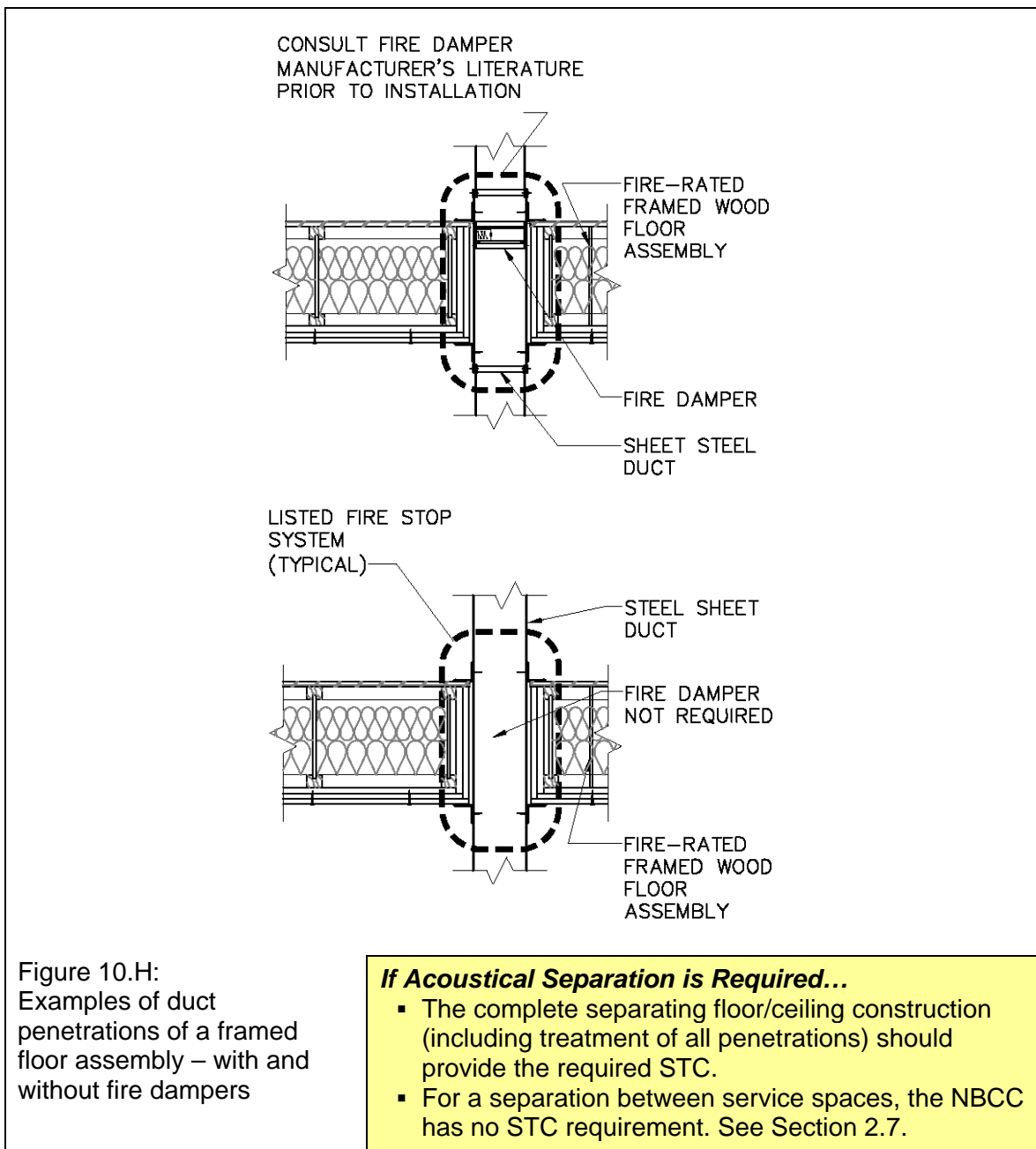
A second arrangement that is considered to provide equivalent protection would be to provide a fire stop system at the point where the chimney penetrates the monolithic concrete floor assembly as shown in Figure 10.G.

In this arrangement, a fire stop is provided only at the bottom of the vertical shaft. This type of fire stop is usually a component of the listed chimney venting system and may not be listed to CAN/ULC-S115.



10.3 Mechanical Service Penetrations through Framed Floor Assemblies

Fire-rated framed floor assemblies often achieve a great deal of their fire resistance by virtue of gypsum board ceiling membranes. Mechanical service penetrations of these assemblies often involve the penetration of the ceiling membrane, the floor above, or both. Given the size of many duct penetrations, it is important to locate and protect duct penetrations in such a manner that the fire resistance rating of the assembly is not compromised. For duct penetrations through a framed floor assembly, an arrangement as shown in Figure 10.H, for example, may be used.



A common approach to avoid duct penetrations of fire-rated framed floor assemblies is to locate ducts in unrated ceiling enclosures or soffits located below the fire-rated assembly as shown in Figure 10.1. In residential buildings, which have kitchen, bathroom and dryer exhaust ducts, this arrangement is often a solution since these ducts normally are exhausted through an exterior wall. In this arrangement, fire stops would not be required where the lower ceiling membrane is penetrated. Since the ducts in this case do not penetrate a fire-rated assembly, they could be of combustible materials.

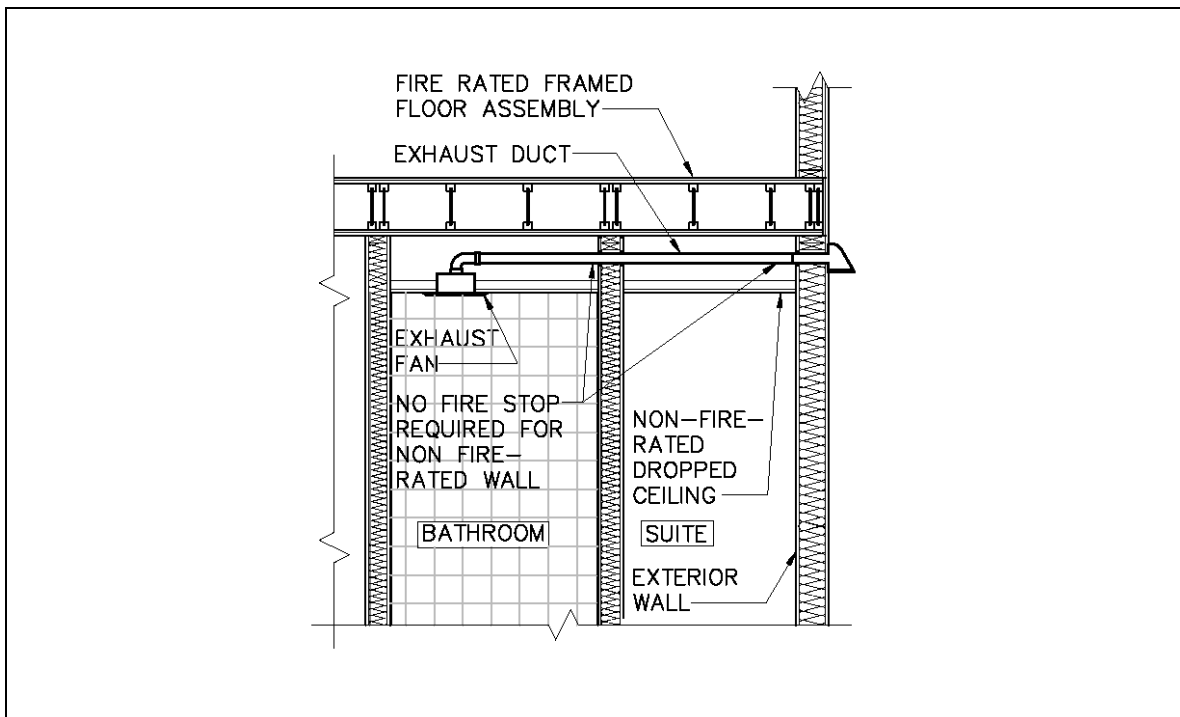


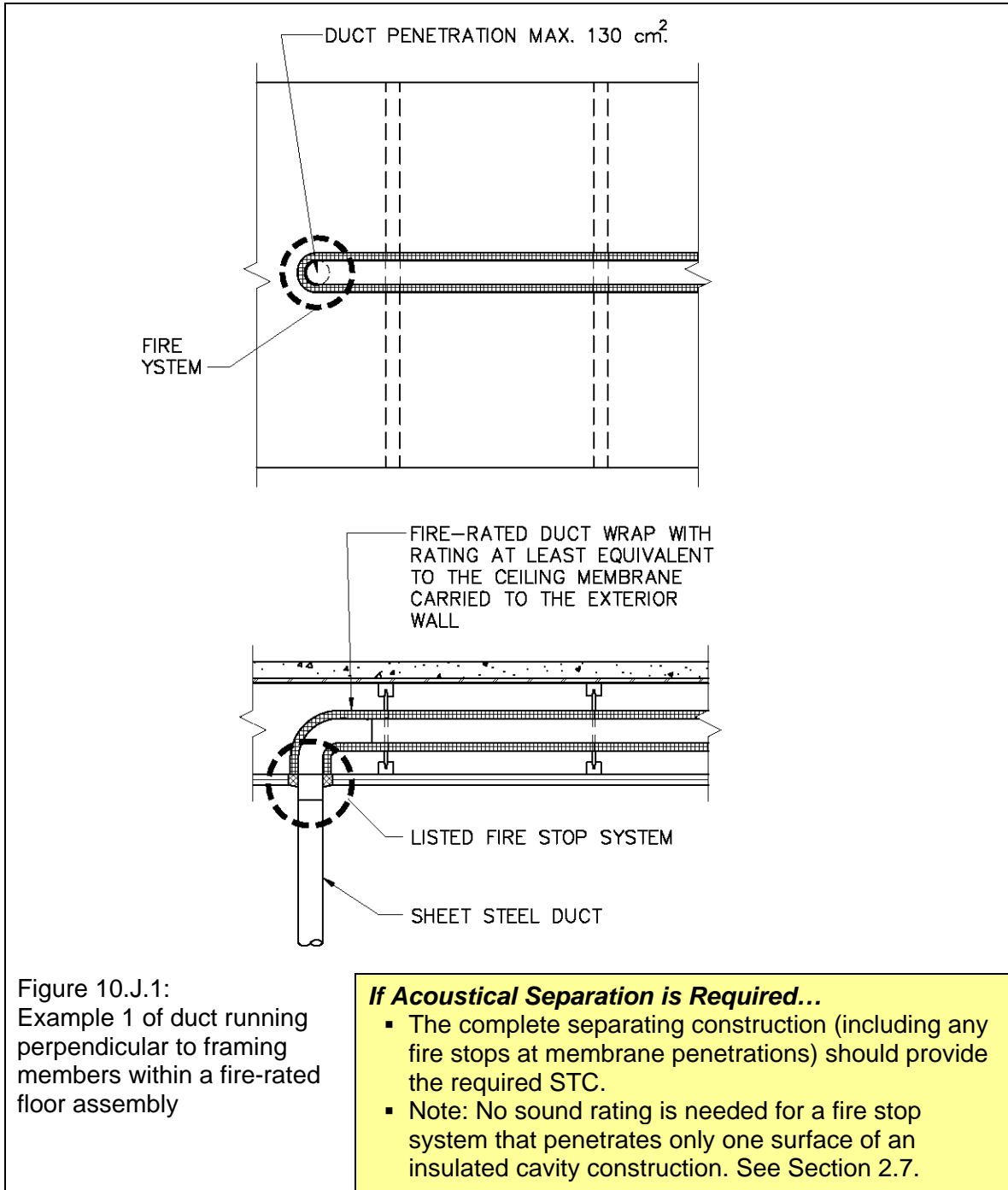
Figure 10.1:
Example of duct running through a horizontal space below a framed fire-rated floor assembly

If Acoustical Separation is Required...

- The complete separating construction (including any fire stops at penetrations) must provide the required STC, for both vertical and horizontal separations.
- For penetrations to the exterior, or between service spaces screened by wall or ceiling surfaces, the NBCC has no STC requirement..

In situations where a fire-rated gypsum board membrane in a listed floor/ceiling assembly is penetrated for a duct opening, additional protection must be provided. When proprietary steel or wood framed floor assemblies are used, proprietary duct penetration arrangements covered by the listing are required. The following arrangements were developed as possible solutions to penetrations through floor-ceiling assemblies using generic materials which have been assigned fire resistance ratings on the basis of Tables in Appendix A to Part 9 of the NBCC. (See 2.2.5 of this Guide)

Figures 10.J.1 and 10.J.2 show two examples of arrangements where the duct inside the framed assembly runs perpendicular to the framing members. Figure 10.J.1 illustrates an arrangement where the duct itself is protected to the exterior wall or vertical fire separation. Figure 10.J.2 illustrates the creation of a "tunnel" of gypsum board and rock fibre insulation for the duct inside the framing member spaces. The listed fire stop system in this case may be part of the listing for the fire-rated duct wrap.



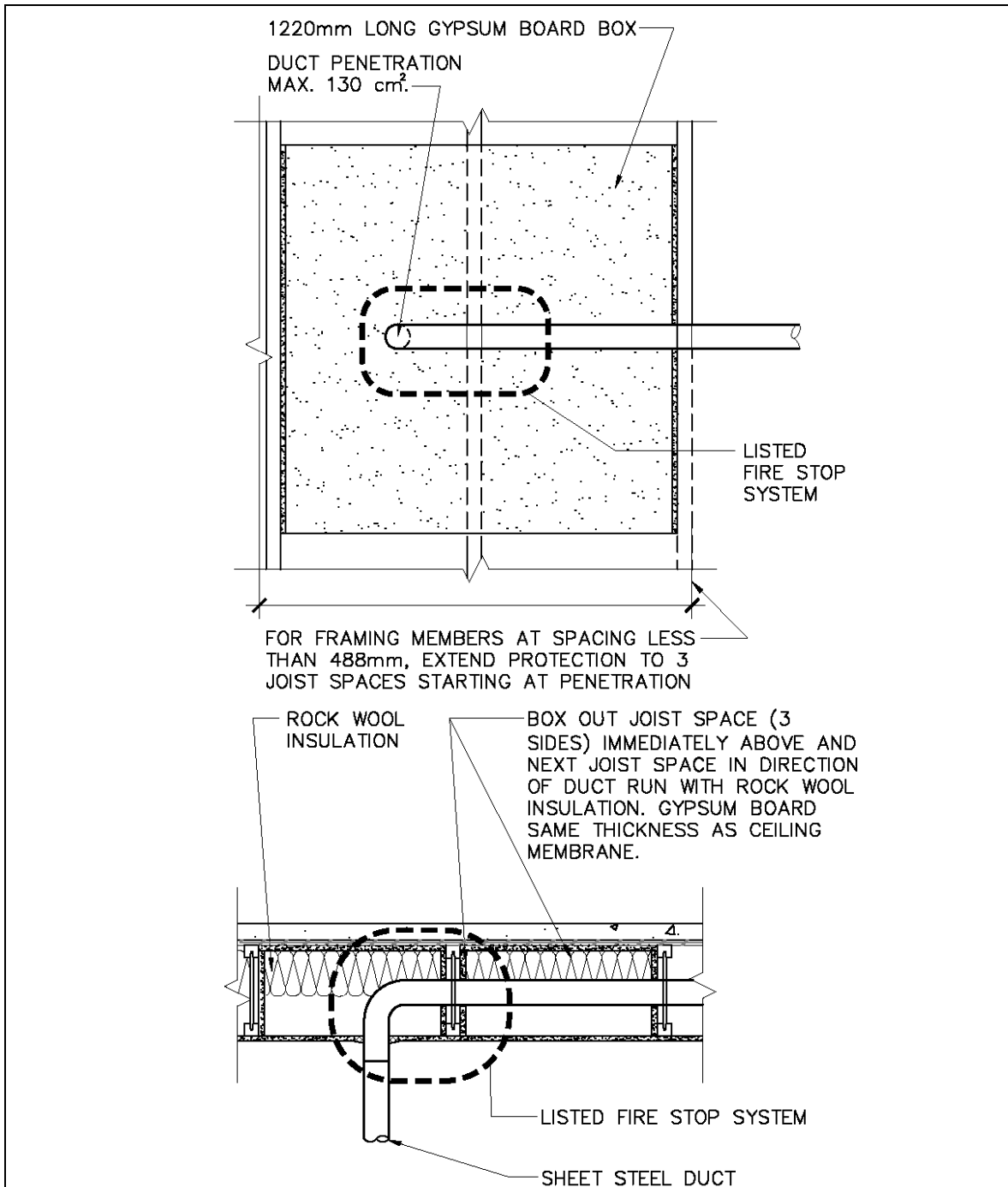
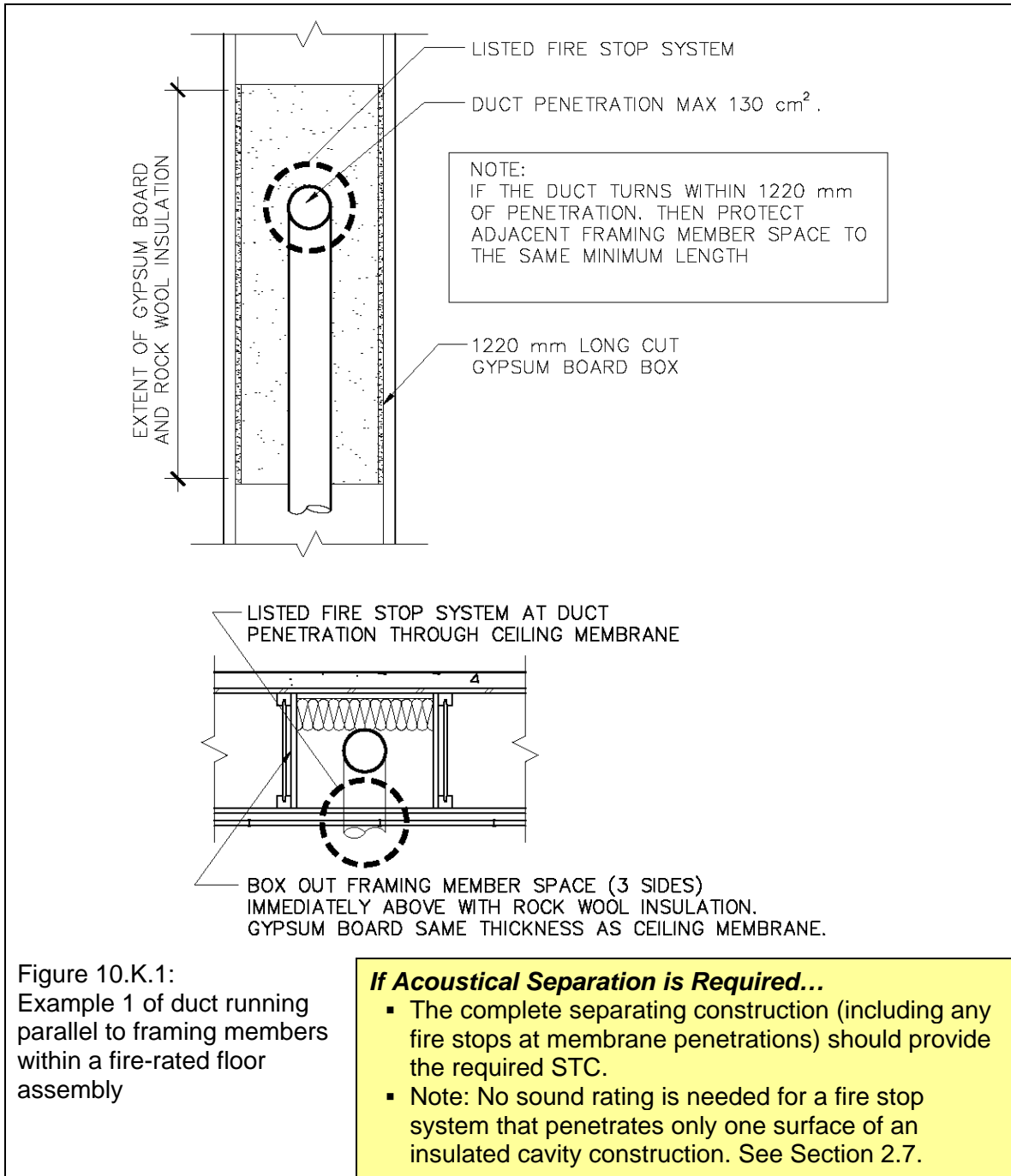


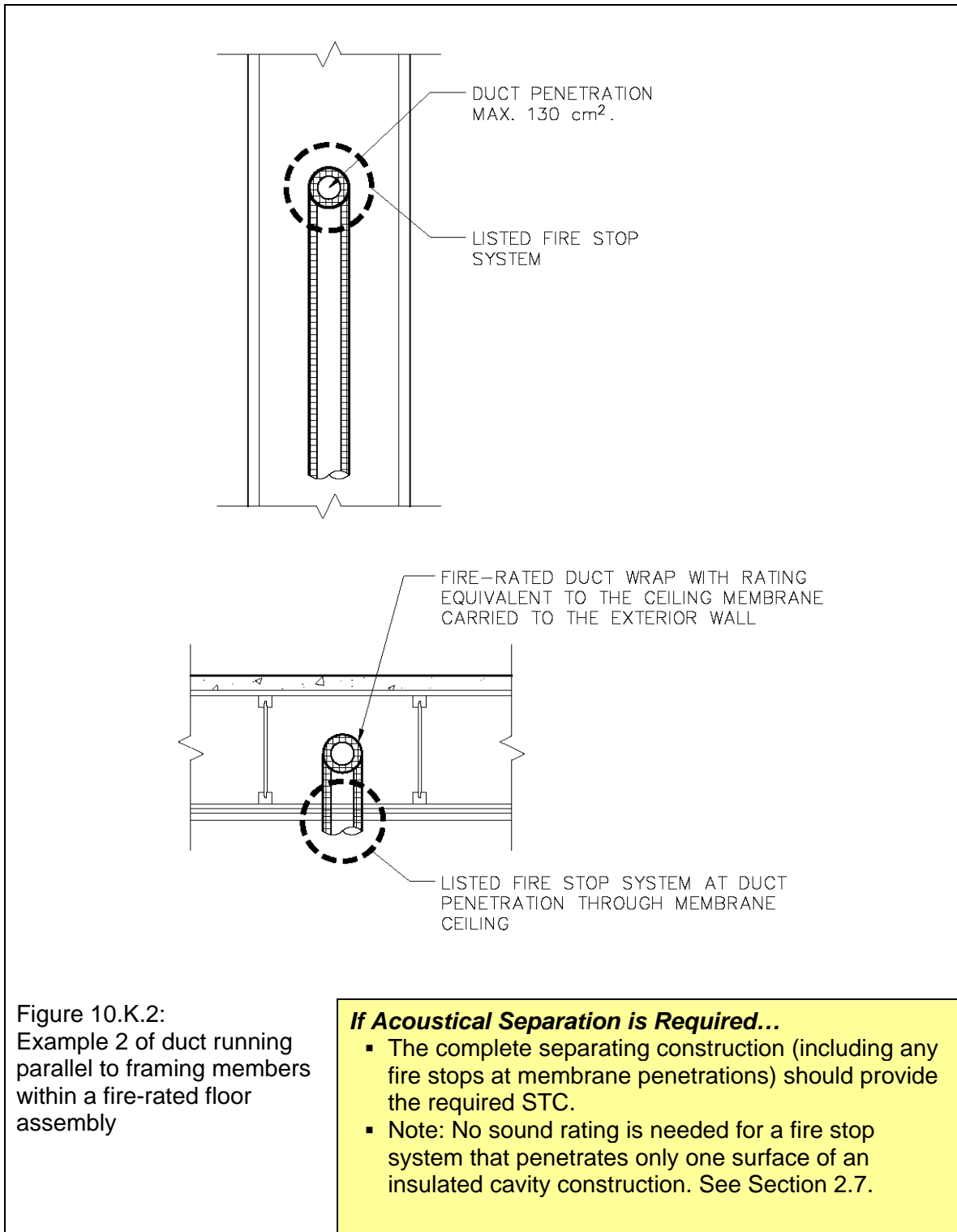
Figure 10.J.2:
Example 2 of duct running perpendicular to framing members within a fire-rated floor assembly

If Acoustical Separation is Required...

- The complete separating construction (including any fire stops at membrane penetrations) should provide the required STC.
- Note: No sound rating is needed for a fire stop system that penetrates only one surface of an insulated cavity construction. See Section 2.7.

Figures 10.K.1 and 10.K.2 illustrate two examples of a duct running parallel to the framing members. In Figures 10.J and 10.K, fire stop systems are provided at the points where the duct penetrates the fire-rated membrane ceiling.





10.4 Mechanical Service Penetrations through Monolithic Concrete or Masonry Walls

Fire stops for duct penetrations of monolithic concrete or masonry walls are predicated on the presence or absence of fire dampers at the point of penetration since fire stops may impede the operation of fire dampers. Figure 10.L illustrates examples of both arrangements with and without fire dampers. The fire damper manufacturer's technical literature should be consulted prior to the installation of a fire stop system, where a fire damper is installed.

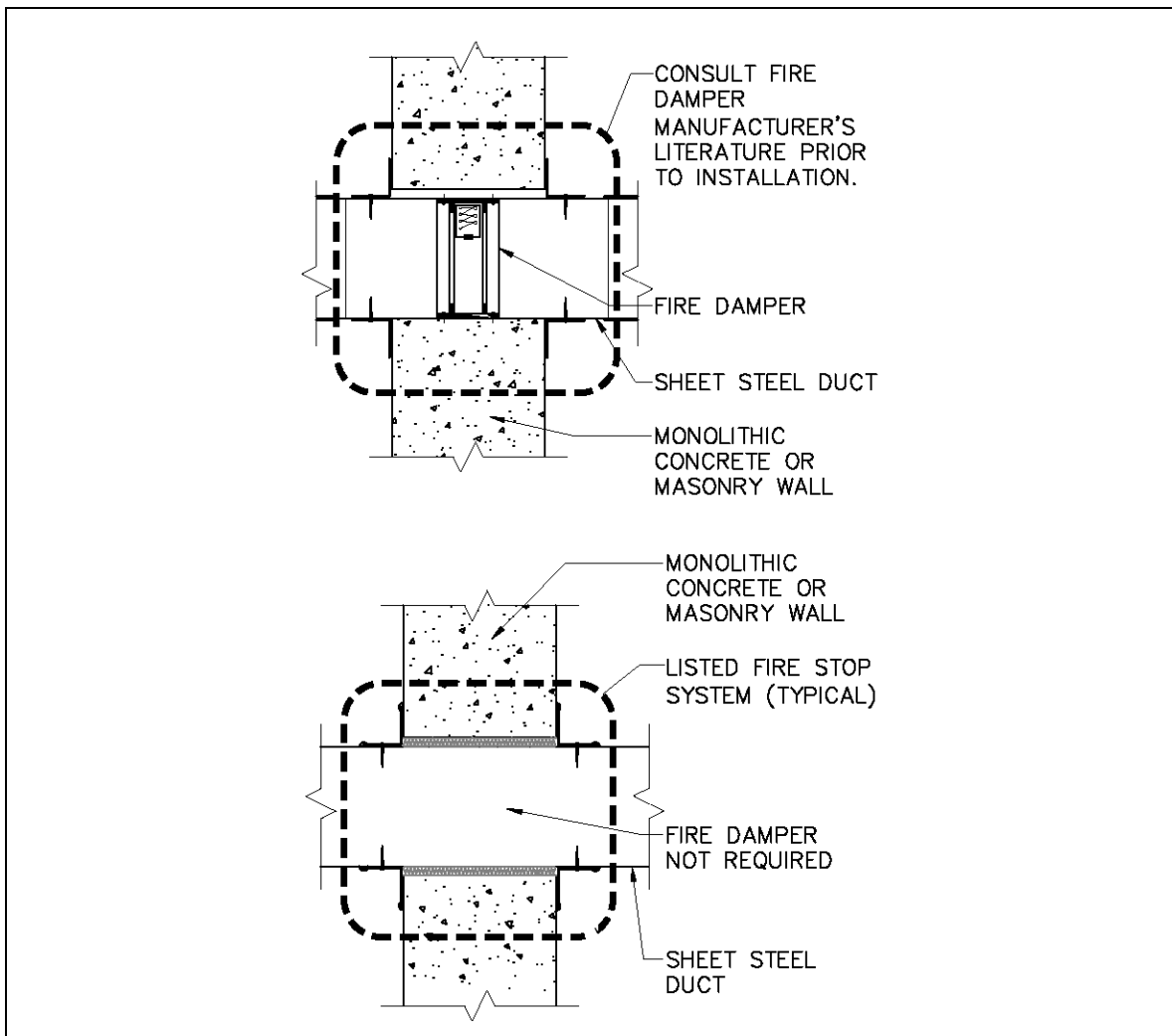


Figure 10.L:
Example of duct penetration of a monolithic concrete or masonry wall with and without fire dampers

If Acoustical Separation is Required...

- The complete separating construction (including treatment of all penetrations) should provide the required STC.
- Note: Such penetrations are often between equipment rooms or between service spaces screened by wall and ceiling surfaces. For separation between service spaces, the NBCC has no STC requirement. See Section 2.7.

10.5 Mechanical Service Penetrations through Framed Stud Wall Assemblies

Ducts are not frequently installed inside fire-rated stud wall assemblies but are often located in a furred-out wall assembly adjacent to the fire rated wall, or in a wall assembly not required to be fire rated, such as an inside wall in a suite. In these cases, fire stops and fire dampers are usually not required.

In Figure 10.M.1, fire dampers and sometimes fire stops would be required where the duct penetrates the fire-rated wall at the top and at the duct entry point. In Figure 10.M.2, where the duct is in a non fire-rated wall (such as an inside wall within a suite), no fire stop is required.

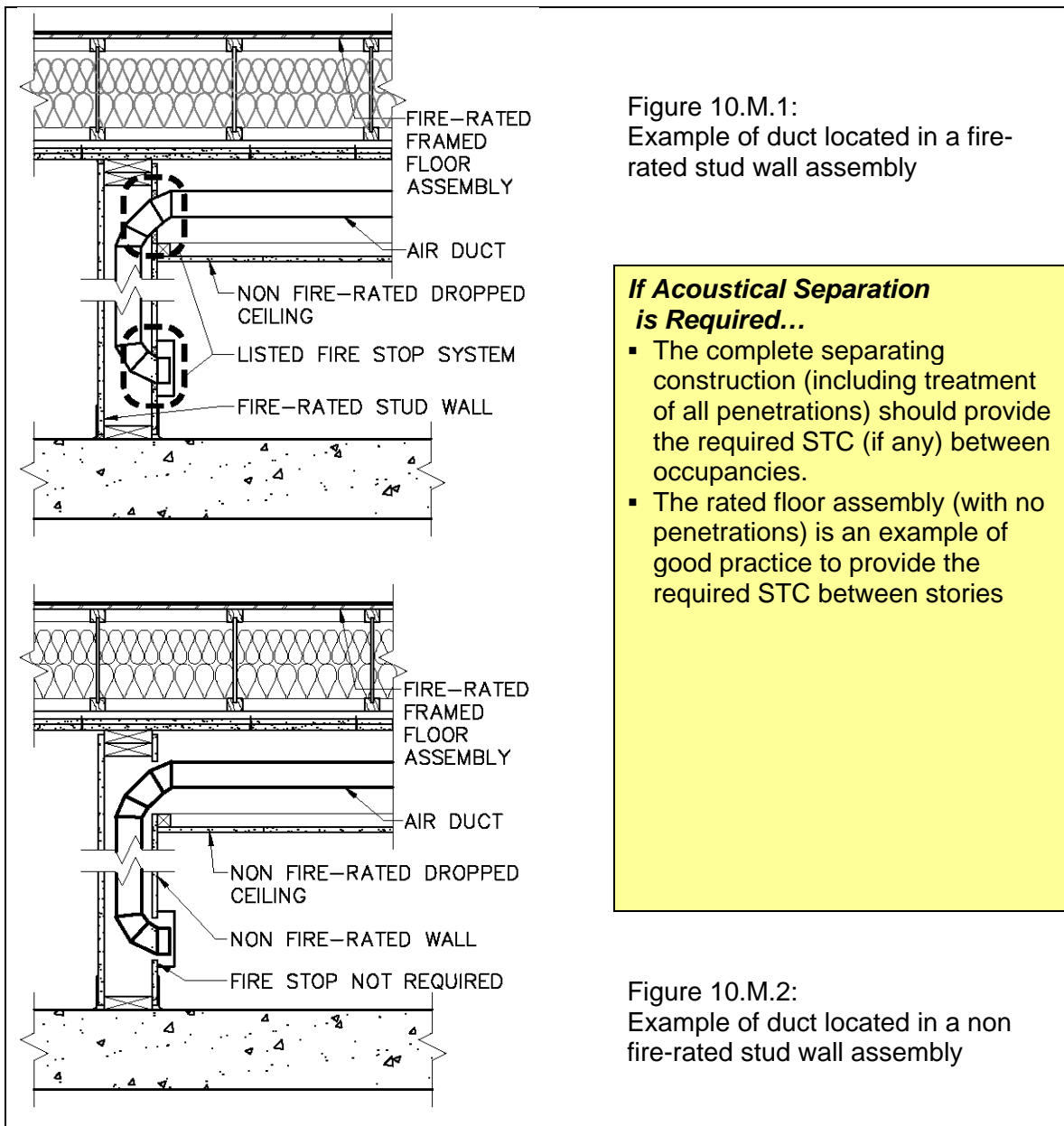


Figure 10.N shows a duct located in a furred-out wall adjacent to a fire-rated wall. Fire stops are not required where the duct penetrates the furred-out wall.

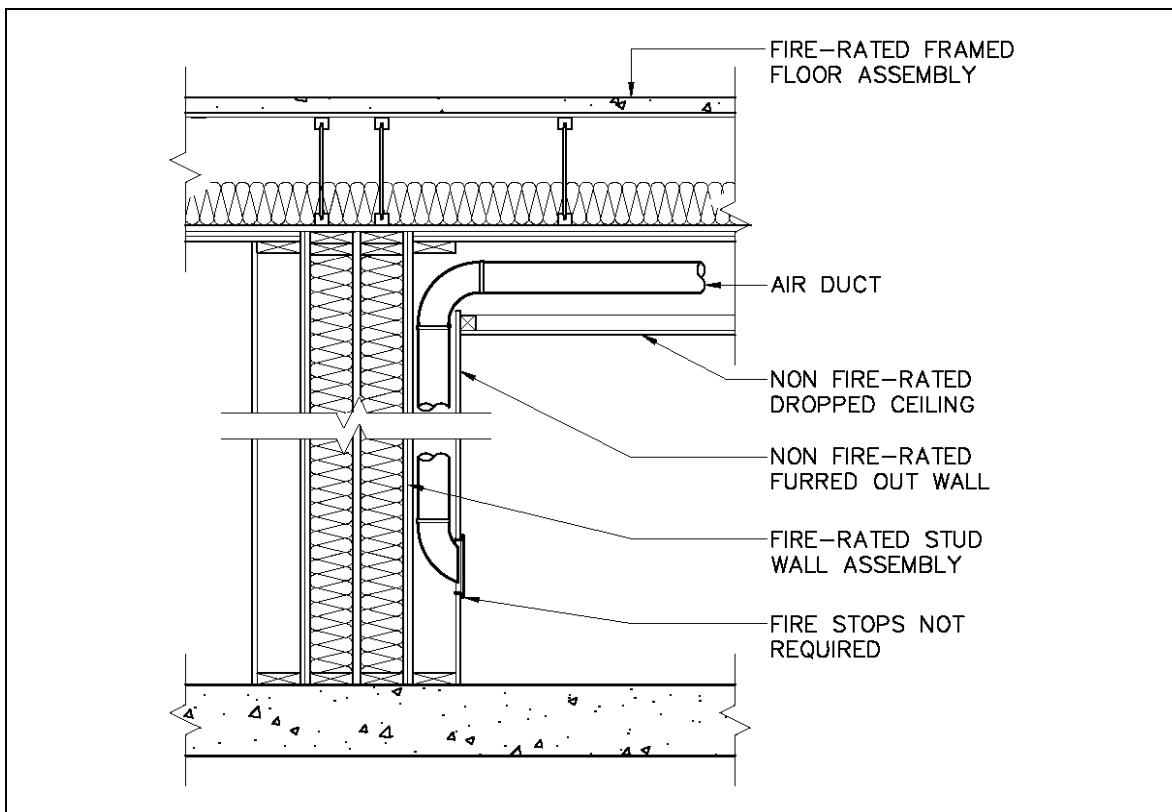
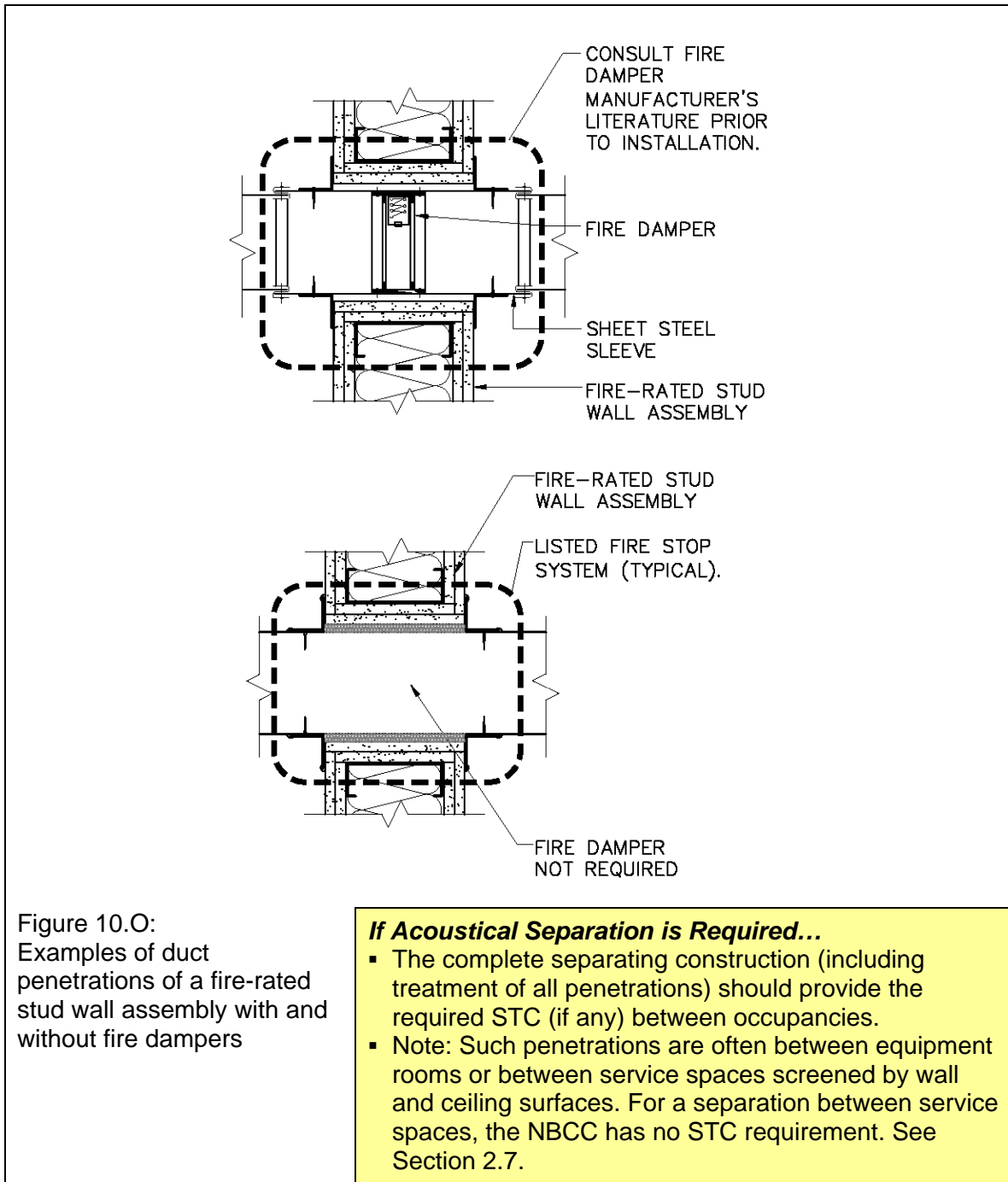


Figure 10.N:
Example of duct located in a furred-out stud wall assembly

If Acoustical Separation is Required...

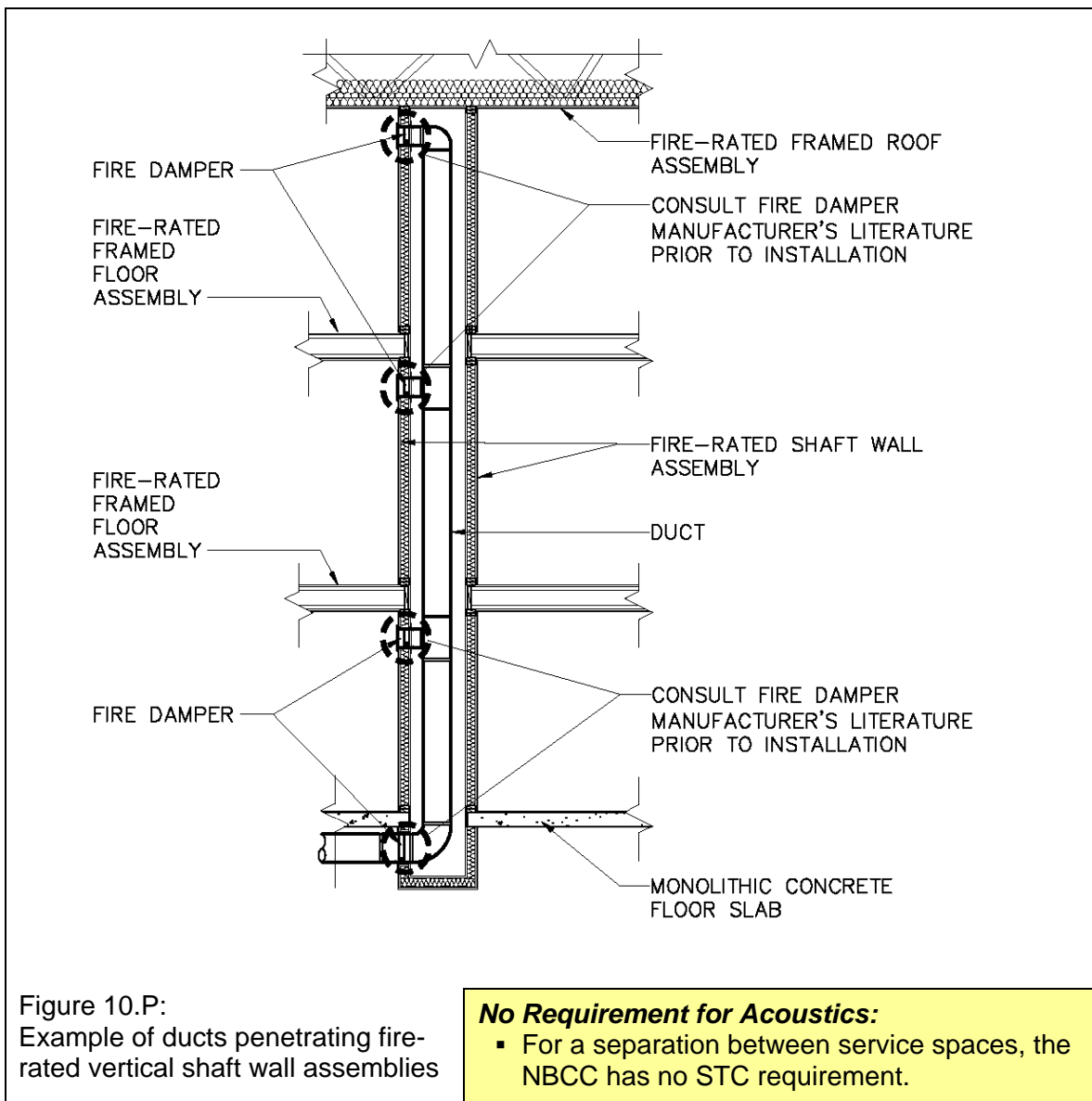
- The complete separating construction (including treatment of all penetrations) should provide the required STC (if any) between occupancies.
- The rated floor assembly and rated wall assembly (with no penetrations) are an example of good practice to provide the required STC between stories.

Where ducts penetrate a fire-rated stud wall assembly and fire dampers are installed, the need for fire stop systems is predicated on the instructions of the fire damper manufacturer. Figure 10.O shows duct penetrations with and without fire dampers at the point of penetration. Where fire dampers are installed, fire stops may not be permitted to ensure proper functioning of the fire damper. The fire damper manufacturer's technical literature should be consulted.



10.6 Duct Penetrations and Vertical Shafts

Ducts for Pressurization – Frequently, duct systems, such as for corridor pressurization, are located in vertical shafts required to be fire separated from adjacent spaces. These shafts are often built using stud wall assemblies. For these systems, as illustrated in Figure 10.P, fire dampers are required at each point that the duct penetrates the fire-rated shaft wall assembly. Fire stops will typically not be required to ensure the proper operation of the fire damper. The fire damper manufacturer's literature should be consulted. Alternatively, ULC lists pressurization ducts using ISO-6944 [10-5], a test method which includes the fire stop systems as part of the listed enclosure protection system for the duct.



Ducts with a Common Exhaust Fan – Where a constantly-running exhaust fan is located at the top of a vertical shaft, ducts may penetrate vertical shafts without fire dampers as discussed in Section 10.1. In this arrangement, fire stops are required where the ducts penetrate the fire-rated vertical shaft wall assembly as shown in Figure 10.Q. In Figure 10.Q, fire stops would not be required at the exhaust duct penetration of the ceiling since it is not part of a fire-rated assembly.

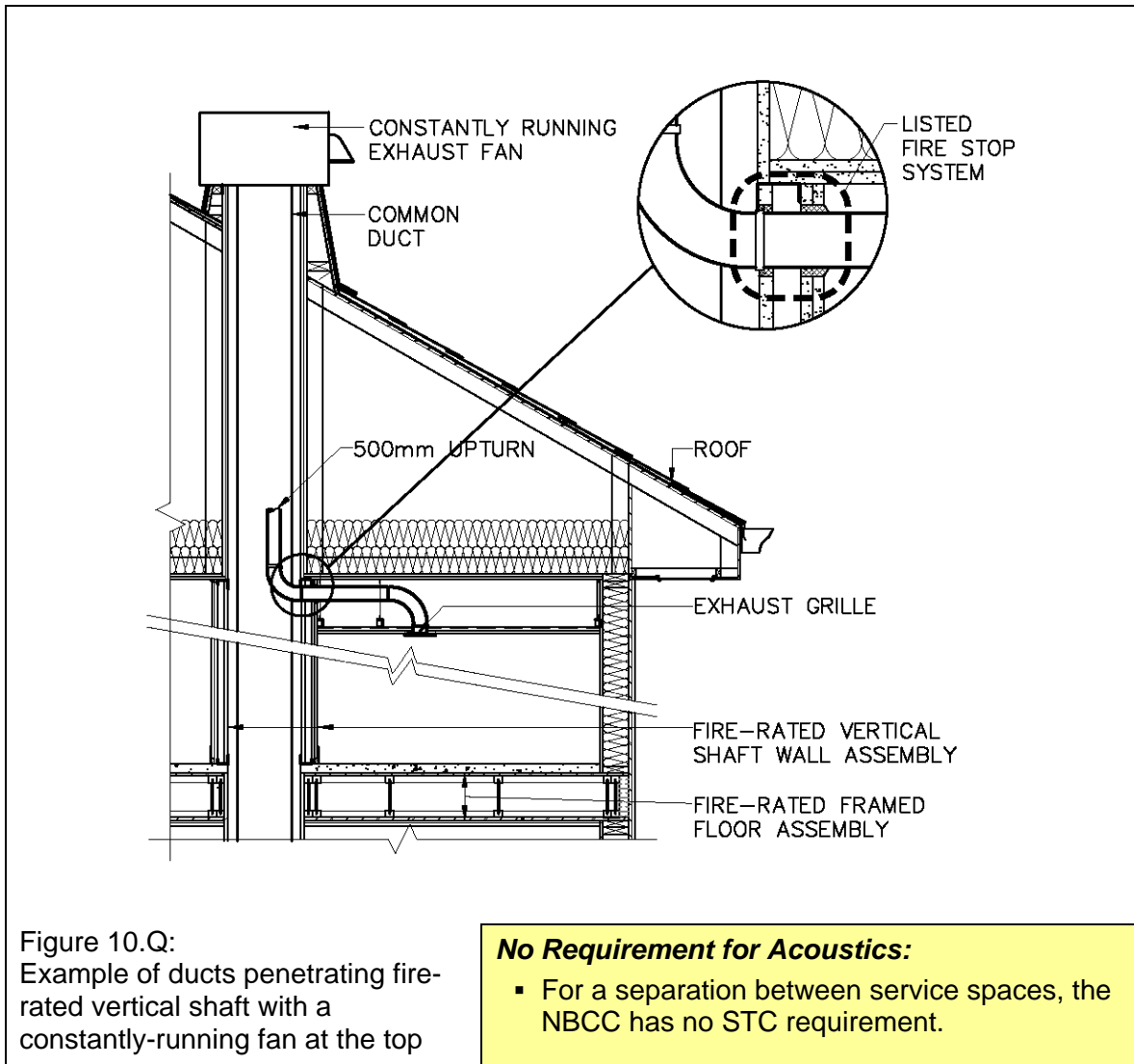
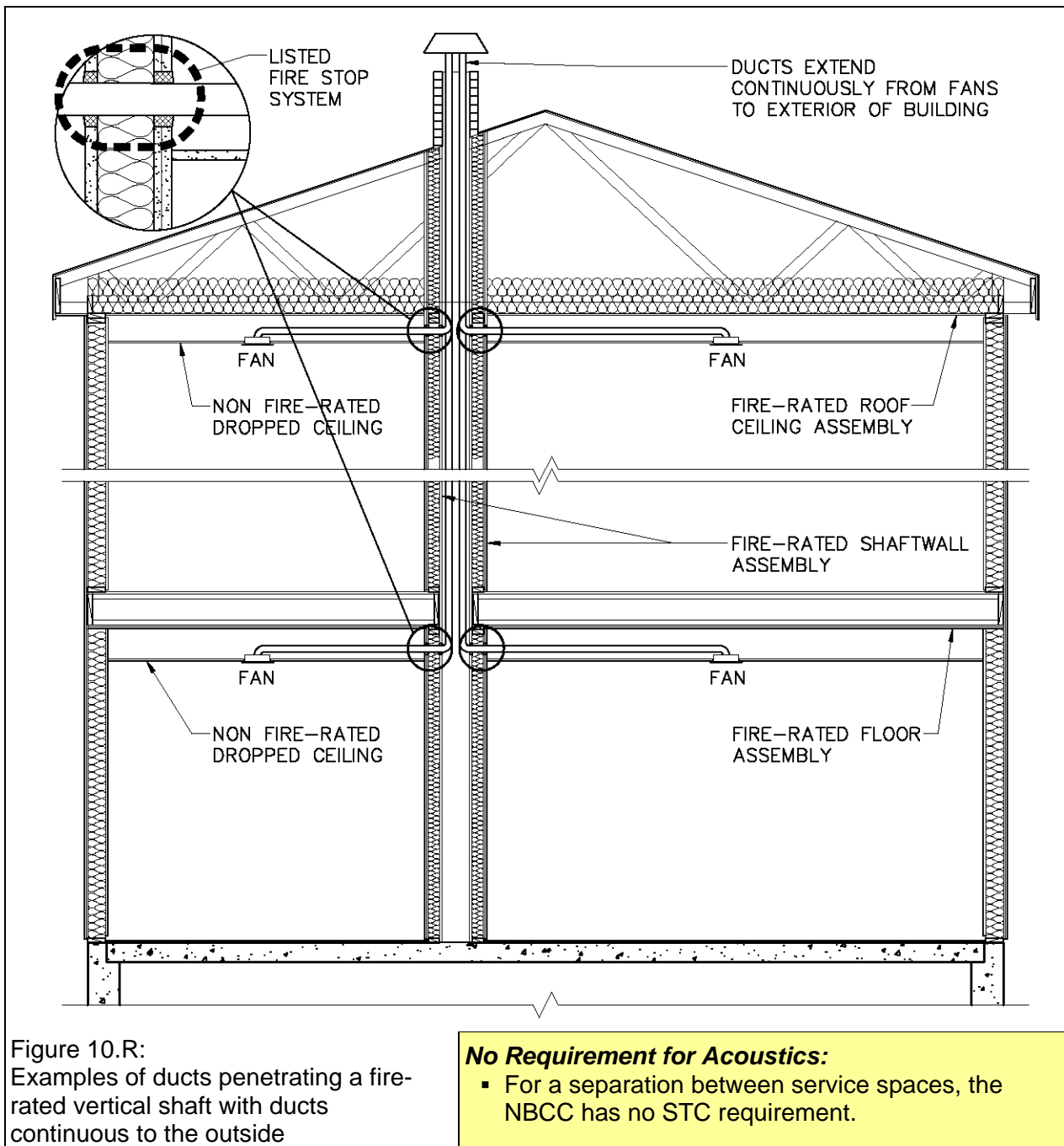


Figure 10.Q:
Example of ducts penetrating fire-rated vertical shaft with a constantly-running fan at the top

No Requirement for Acoustics:

- For a separation between service spaces, the NBCC has no STC requirement.

Multiple Ducts in a Vertical Shaft – As shown in Figure 10.R, there are arrangements where individual fans, installed in suites, exhaust through ductwork which is continuous to the outside, passing through a vertical shaft. The vertical shaft wall assemblies are required to be fire-rated. In this situation, fire dampers are not required at the point of penetration of the vertical shaft (see Section 10.1) and fire stops must be installed where the duct penetrates the fire-rated wall of the vertical shaft. Listed fire stop systems for this application may be of a type that must be installed from both sides of the shaft wall or of a type that may be installed from the room side only.



Chapter 10 References

- 10-1. Fire Stopping Service Penetrations in Buildings, The City of Calgary Building Regulations Division, Calgary, AB., 2003.
- 10-2. The Standard, Firestop Contractors International Association, Wheaton, IL, 2001.
- 10-3. Technical Paper on Improper Fire Damper Installation, Sheet Metal and Air Conditioning Contractors National Association, Chantilly, VA, 2006.
- 10-4. NFPA 80 – Standard for Fire Doors and Opening Protectives, National Fire Protection Association, Quincy, MA, 2007.
- 10-5. NFPA 96 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations, National Fire Protection Association, Quincy, MA, 2004.
- 10-6. ISO Standard 6944 – Fire Resistance Tests – Ventilation Ducts, International Organization for Standardization, Geneva, Switzerland, 1985.

11.0 BEST PRACTICE FOR FIRE STOPS FOR CONSTRUCTION JOINTS

The examples shown in this Chapter represent various means of achieving fire compartment continuity with fire stops. There are other fire stop systems that may serve this purpose. For reasons of brevity, these other solutions have not been illustrated.

11.1 Introduction

Section 3.4 described the various types of construction joints that may require fire stops in the field, including seismic joints, expansion joints and joints at the tops and bottoms of fire separation walls. While the NBCC does not make specific mention of fire stops for construction joints, their need is clearly implied through the requirements for continuity of fire separations as described in 5.2.2 of this Guide. Fire stops for these linear construction joints should consider the fact that there is movement at the joint as a result of loads due to occupancy, temperature differences or seismic activity. This movement, over time, could damage the fire stop thus reducing its effectiveness [11-1]; thus the movement must be accommodated in design and installation.

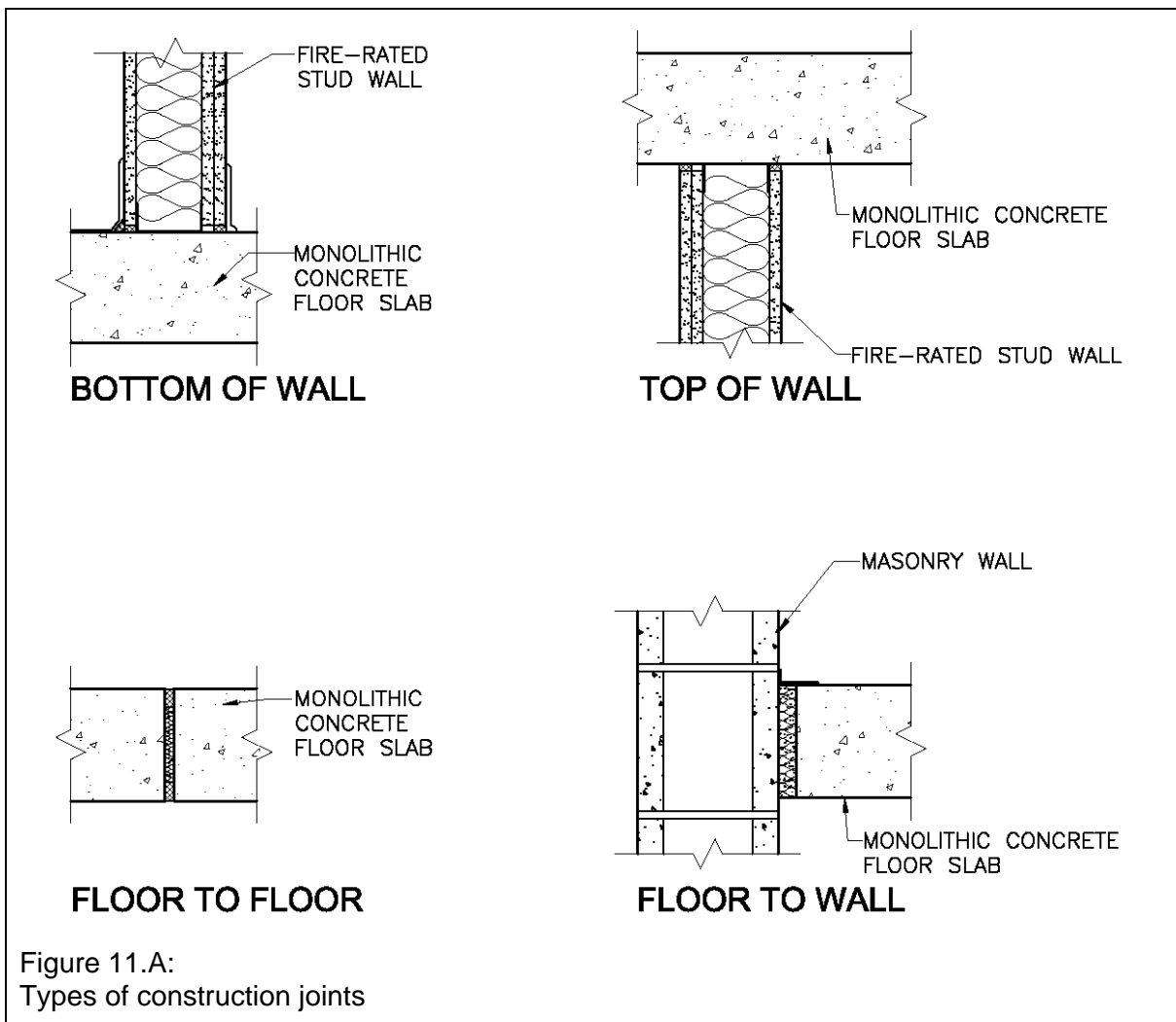


Figure 11.A:
Types of construction joints

In this Chapter, best practice related to the following construction joints will be discussed (see Figure 11.A):

- Bottom of wall
- Top of wall
- Floor to floor
- Wall to wall
- Floor to wall

Floor to perimeter wall joints (perimeter fire stops) are addressed in Chapter 12.

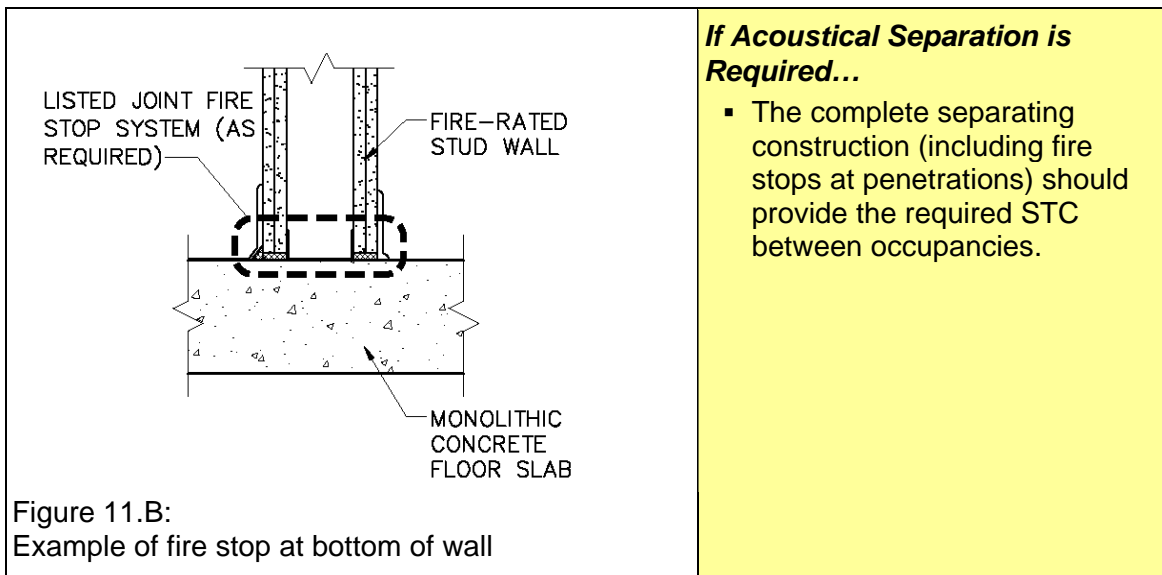
Because construction joints may move when installed in a building, best practice recommends that users specify listed fire stop systems which have been fire tested after having first been subjected to a number of movement cycles as specified in CAN/ULC-S115 [11-2] or ASTM E1399 [11-3]. In ASTM E1399, depending on the type of joint, the number of required movement cycles varies. In CAN/ULC-S115, the minimum number of movement cycles is 500.

In the U.S.A., construction joint fire stops are tested using ASTM E1966 [11-4] or UL 2079 [11-5]. Both of these standards require a minimum number of movement cycles for the listed fire stop system prior to fire testing.

The user should be aware that the listed fire stop systems, for the applications noted in this chapter, are joint fire stop systems which must meet specific requirements for those joints in CAN/ULC-S115. Other listed fire stop systems, not listed as joint systems, may not be suitable for these applications.

11.2 Fire Stops for Bottom of Wall Joints

In constructing vertical fire separations using gypsum board and some masonry walls, a gap frequently occurs at the bottom of the wall due to irregularities in the floor finish, or to the installer trying to obtain as tight a joint as possible at the top of the wall. This linear gap, between the floor and the bottom edge of the wall, which represents a discontinuity in the fire separation that could allow the passage of fire and smoke, should be protected with a listed fire stop system as shown in Figure 11.B. The bottom-of-wall fire stops are generally of the caulk, sealant or spray type as described in Chapter 3. Typically, bottom-of-wall joints are not considered to be as critical as top-of-wall joints due to the nature of upward fire growth and high temperatures in a room or space.

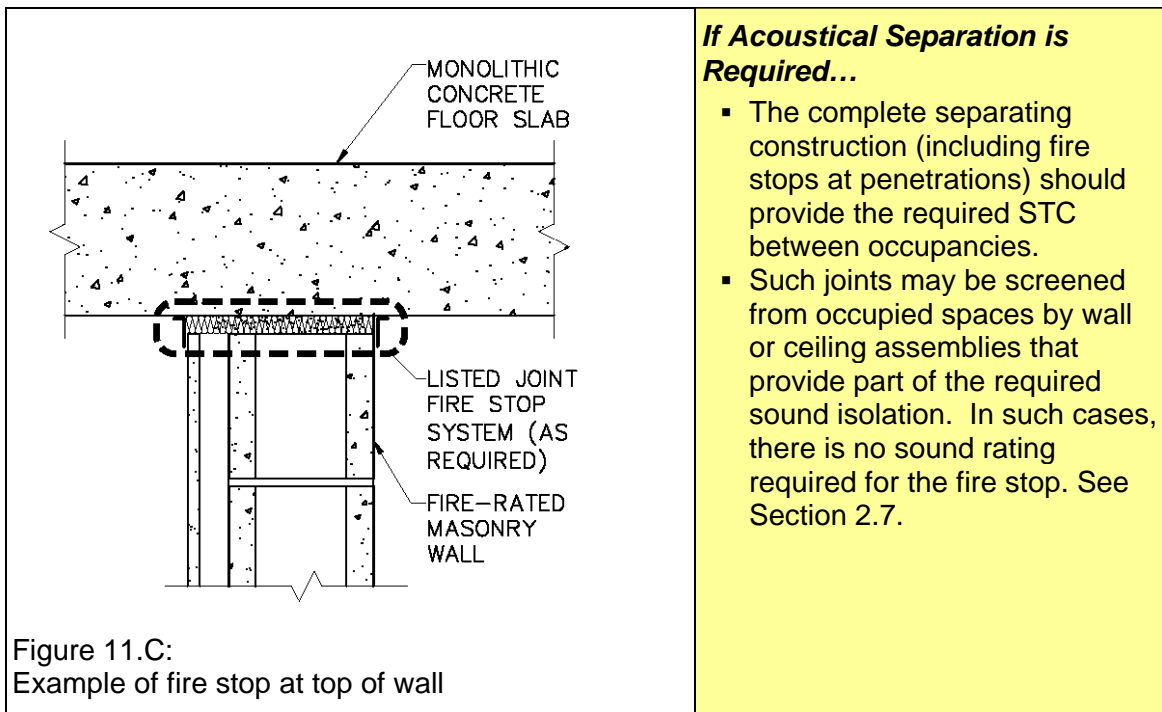


In framed construction, where a wood stud wall abuts a plywood or OSB subfloor, a listed fire stop system is not required. Acoustic sealant may be used in this application to prevent sound transmission through any leakage openings. Listed fire stops, while desirable, are not required for this application since the linear joint is backed by a steel or wood stud or track and since the similar materials are more likely to move approximately the same amount thus minimizing the potential for through-openings. (See also 7.6.)

11.3 Fire Stops for Top of Wall Joints

Tops of gypsum board and masonry walls also require fire stops to ensure the continuity of fire separations (see Figure 11.C). In some buildings, a 13 to 25 mm gap is

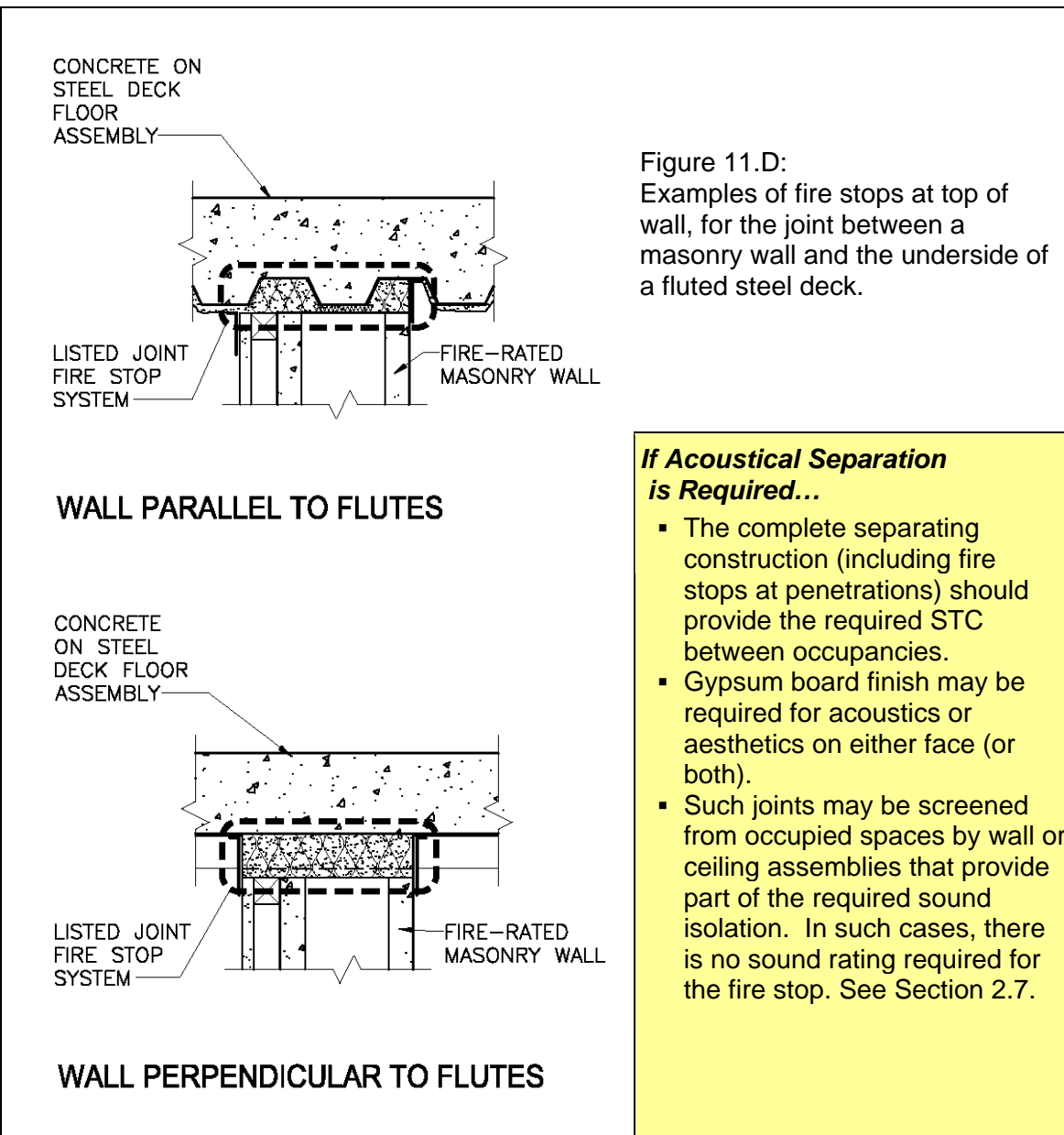
maintained between the underside of the floor or deck and the top of a wall to address floor deflection and to ensure that loads are not transferred to the wall. In these situations, where the top of a wall abuts a concrete slab, a steel deck or other fire-rated membrane, the fire stop often will be of the caulk or sealant type when the gap is not extensive. As with bottom of wall joints described in 11.2, the fire stop at the top of the wall is to fill a linear gap that may occur due to the irregularities in fit between the wall and the floor or roof assembly above. It should be noted that support angles are sometimes required at the tops of walls to anchor them to the deck above.



As explained for bottom of wall joints, where a stud wall assembly abuts a gypsum board-protected framed floor or roof assembly, drywall mud and tape or acoustical sealant may be used in lieu of a listed fire stop system to seal the joint. This permission is in recognition of the joints being backed by a wood stud or steel track which has traditionally functioned adequately at preventing fire spread through these gaps in these specific circumstances.

There are other situations where a vertical fire separation abuts a corrugated deck where there can be a significant gap between the top of the vertical fire separation and the flutes of the deck. This can be a particular problem when the deck itself is expected to move under normal conditions or as a result of thermal exposure.

One arrangement of providing fire stops at the tops of walls with a corrugated deck above is shown in Figure 11.D. In this arrangement, the listed fire stop system must accommodate the expected movement of the deck above the wall. Systems that cannot accommodate this movement should not be used for top-of-wall applications. Figure 11.D shows different arrangements depending on whether the wall is parallel or perpendicular to the deck flutes.



Another arrangement for fire stops at the tops of gypsum board walls when movement is expected, is to use a listed mechanical track and slip fire stop system (see Figure 11.E). In this fire stop system, a metal track is attached to the underside of the deck and the gypsum board wall installed below the track [11-6]. The wall is not fastened to the track but has an additional gypsum board strip cut to fit the contour of the deck and overlap the wall below. This strip is installed outside, overlaps the wall, and is attached to the track above. The arrangement allows the roof to move up and down without gaps occurring in the gypsum board fire stop protection.

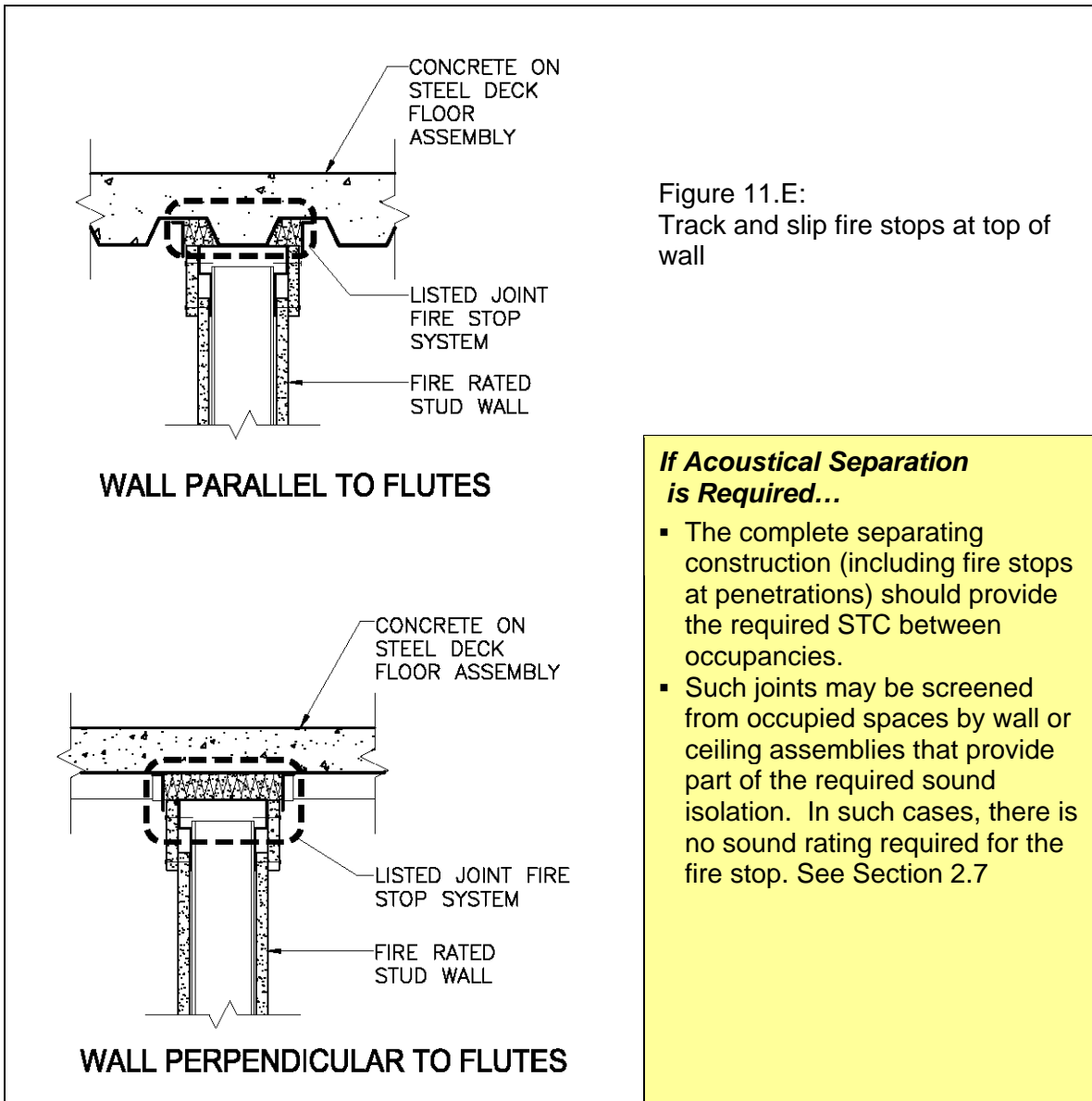
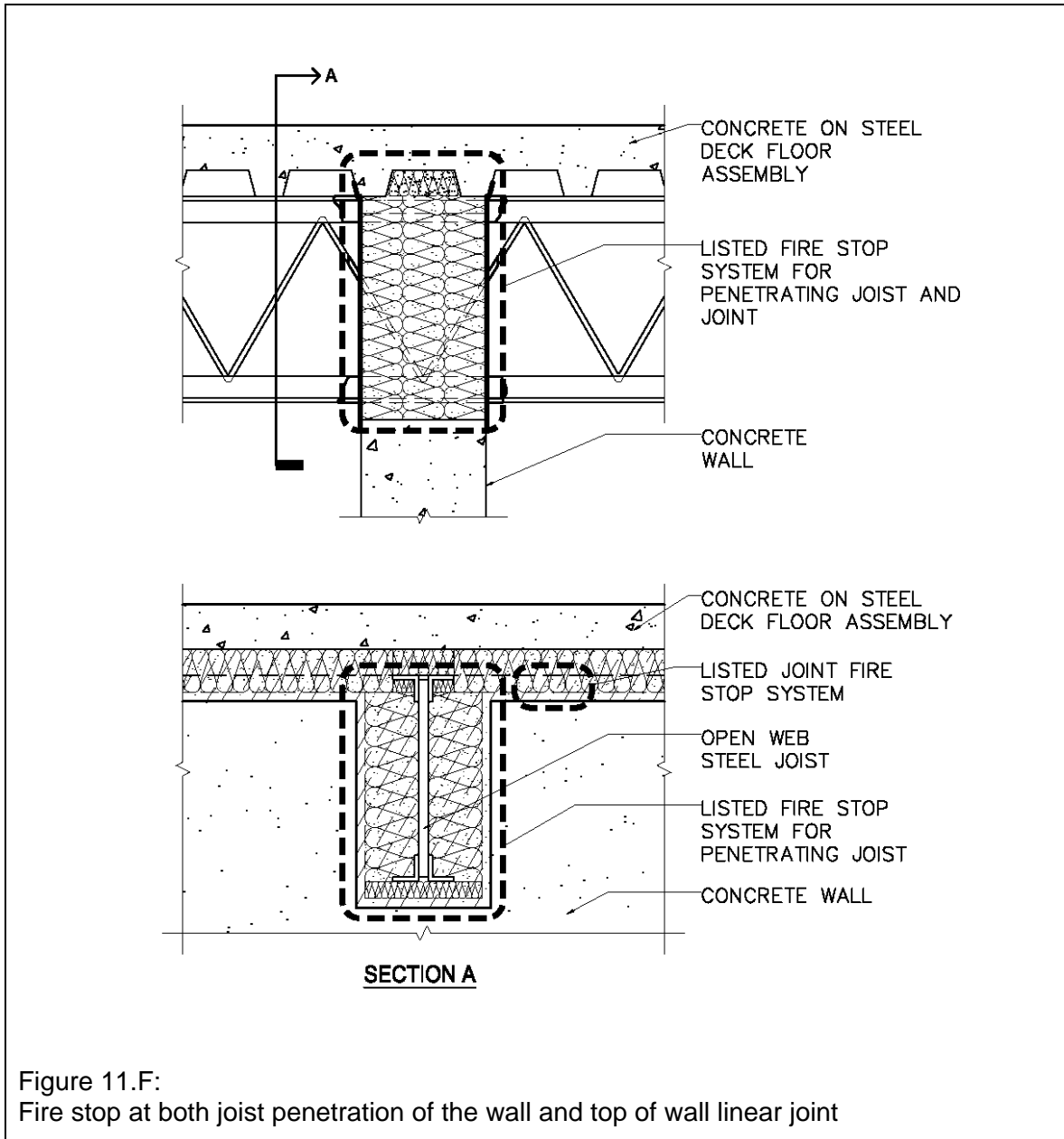


Figure 11.E:
Track and slip fire stops at top of wall

There are also situations where a vertical fire separation will abut a corrugated deck that is supported by a steel joist frame. In this case, the listed fire stop systems must address both the joist penetration of the wall and the top of wall linear joint. An example of this is illustrated in Figure 11.F.



11.4 Fire Stops between Adjacent Floors

There are many situations in large buildings where fire-rated floor assemblies meet to form an expansion joint or a seismic joint; such joints require appropriate listed fire stop systems. Since these joints are expected to move during the normal life of the building, fire stops installed to protect the joints must be capable of withstanding movement as described in Section 11.1. A typical floor-to-floor expansion joint is shown in Figure 11.G.

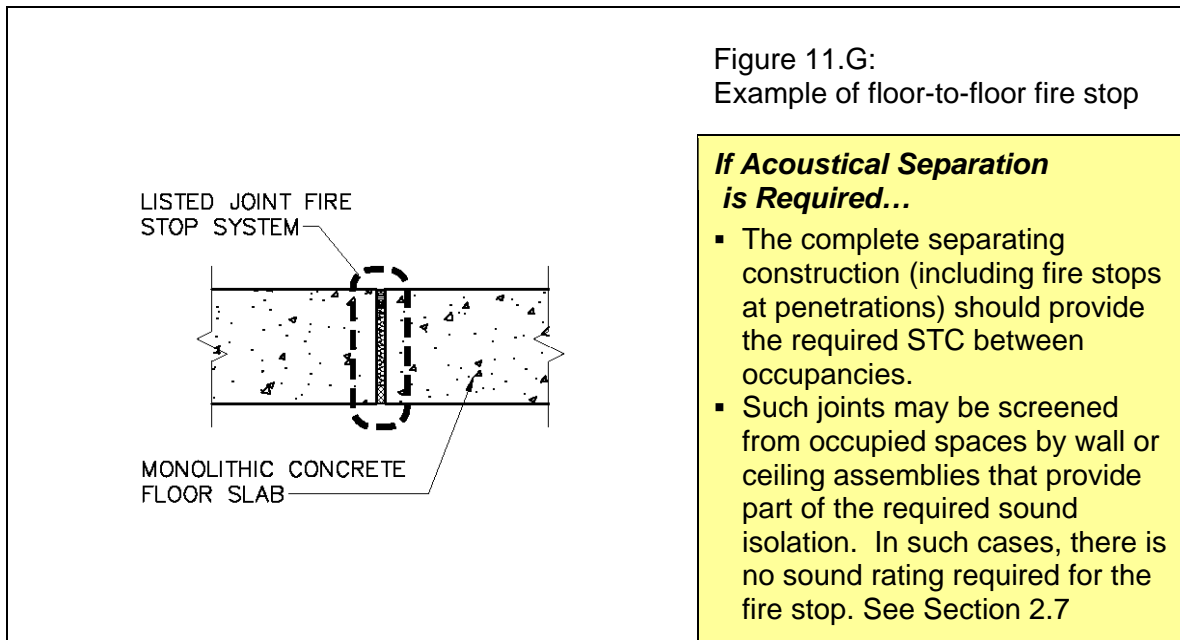


Figure 11.G illustrates the case with a joint between two concrete floor slabs. A similar joint arrangement could occur between two discontinuous framed floor assemblies, in some cases also requiring a listed joint fire stop system. In addressing fire stops of the type shown in Figure 11.G, the various parameters that could affect fire stop performance [11-1] must be evaluated, including:

- The nominal width of the joint. With the movement of the building, the joint width will increase and decrease. The user must ensure that the listed fire stop system can withstand the compression that will occur when the joint width decreases and the extension as the joint increases in width. As well, if fibre batts or blankets are used, the orientation of the fibre batts or blankets must conform to the orientation in the listing. In installing fibre batts or blankets, the extent of the compression of the fibre upon installation is important to ensure both movements. Guidance is provided in the fire stop manufacturers' technical literature and in the individual listings.
- The thickness of the sealant. If required by the listing, the sealant must also be capable of adjusting to movement – especially when being stretched thinner than when installed. Again, the fire stop manufacturers' technical literature or the listing should be consulted for guidance.
- The overlap distance of the sealant. This overlap distance, on the base fire separation adjacent to the joint, must be as specified in the listing to ensure appropriate bonding to the base fire separation material.

11.5 Fire Stops between Adjacent Walls

When adjacent walls come together to form expansion or seismic joints, the same situation as described in Section 11.4 exists and the parameters that could affect fire stop performance are the same. Figure 11.H illustrates fire stop arrangements where two fire separation walls meet to form a construction joint.

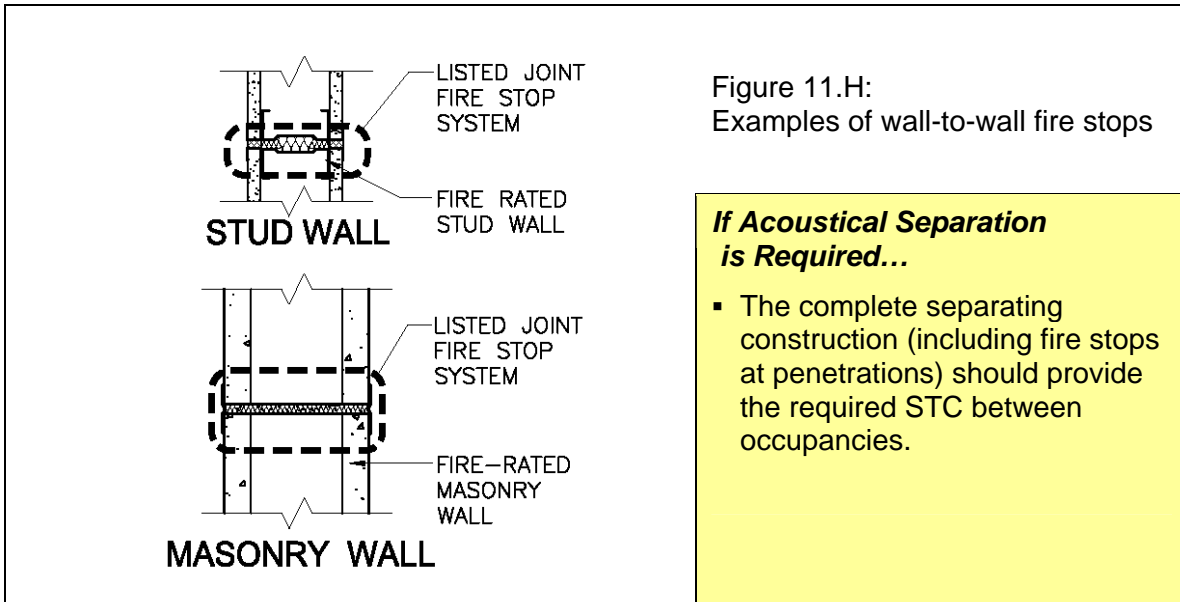


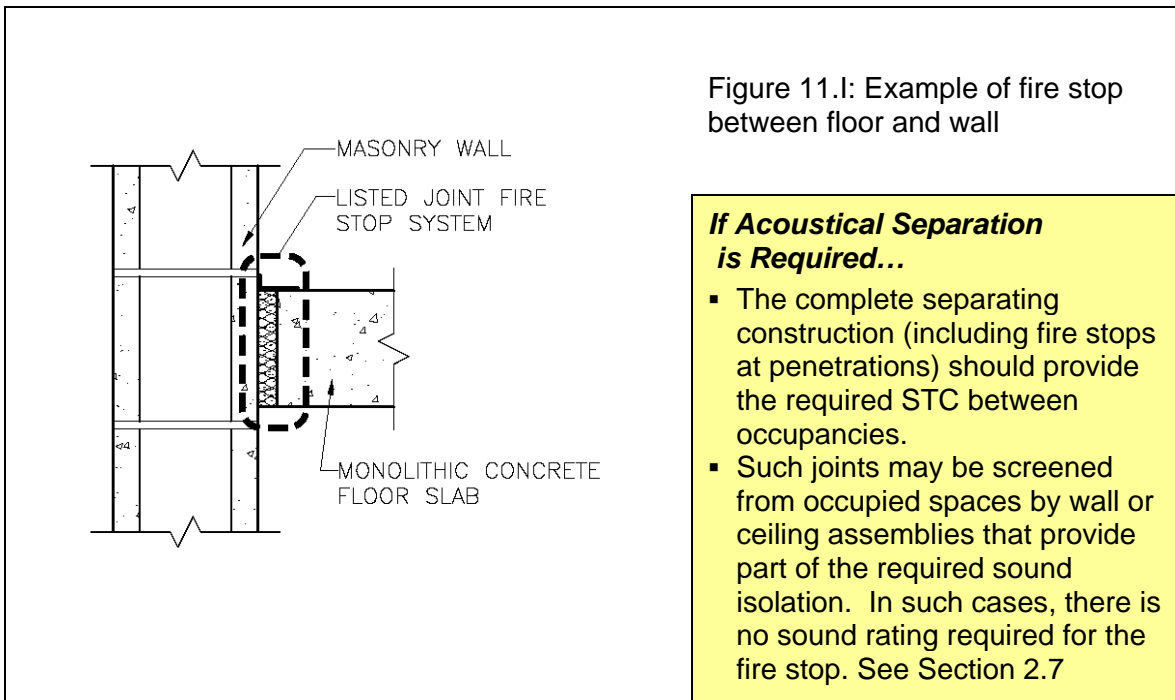
Figure 11.H:
Examples of wall-to-wall fire stops

If Acoustical Separation is Required...

- The complete separating construction (including fire stops at penetrations) should provide the required STC between occupancies.

11.6 Floor-to-Wall Fire Stops

There are situations where fire-rated floor assemblies abut fire-rated wall assemblies as shown in Figure 11.I. In these cases, listed fire stop systems must be installed at the location where the floor abuts the wall. Where floors abut a non-fire-rated curtain wall, perimeter fire stops as described in Chapter 12 should be used.



Chapter 11 References

- 11-1. Construction Joint Firestopping and Testing, International Firestop Council, Cleveland, OH, 2003.
- 11-2. CAN/ULC-S115 – Standard Method of Fire Tests of Firestop Systems (2nd Draft, 3rd Edition), Underwriters' Laboratories of Canada, Scarborough, ON, 2005.
- 11-3. ASTM E1399 – Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems, ASTM International, West Conshohocken, PA, 2000.
- 11-4. ASTM E1966 – Standard Test Method for Fire-Resistive Joint Systems, ASTM International, West Conshohocken, PA, 2001.
- 11-5. UL 2079 – Standard for Tests for Fire Resistance of Building Joint Systems, Underwriters Laboratories Inc., Northbrook, IL, 1998.
- 11-6. The Standard – Firestop Manual of Practice, Firestop Contractors International Association, Wheaton, IL, 2001.

12.0 BEST PRACTICE FOR BUILDING PERIMETER FIRE STOPS

The examples shown in this Chapter represent various means of achieving fire compartment continuity with fire stops. There are other fire stop systems that may serve this purpose. For reasons of brevity, these other solutions have not been illustrated.

12.1 Introduction

Fire stops between the edges of floor assemblies and curtain walls of various types can be essential to preventing fire spread from one floor to another. As indicated in Chapter 3, a fire stop at the perimeter of a floor assembly, when the exterior wall is fire-rated, is a type of construction joint fire stop (see Chapter 11). When the exterior wall is not fire-rated, the combination of curtain wall system and building perimeter fire stops must be properly designed to enable them to fulfil their fire stop function. These latter fire stops are evaluated for resistance to fire spread in conjunction with the curtain wall itself.

The NBCC requires building perimeter fire stops only through application of the general requirement in Sentence 3.1.8.3.(4) described in 2.2.1 of this Guide. Effectively, building perimeter fire stops ensure the continuity of a horizontal fire separation where it abuts "... an exterior wall assembly". The NBCC also does not contain specific requirements for the rating of building perimeter fire stops; CAN/ULC-S115 provides requirements for the assurance of continuity of fire separations so should be considered as a basis of best practice for selecting such fire stops, where applicable. It should be noted that CAN/ULC-S115 does not specifically address building perimeter fire stops in its current edition. Some authorities in Canada use the UL Perimeter Fire Containment System as a best practice for non-fire-rated curtain walls abutting a fire-rated floor assembly as an interim measure. Such systems are tested for joint movement as well as for fire resistance.

12.2 Best Practice for Building Perimeter Fire Stops with Fire-Rated Exterior Walls

Fire-rated exterior walls may be comprised of masonry or concrete or may achieve their fire rating through the application of gypsum board on the interior face of the exterior wall. They may also achieve a fire resistance rating through the construction of separate walls inside curtain walls where the exterior walls require a fire resistance rating for spatial separation purposes. Whichever form the fire-rated exterior wall takes, fire stops are required between the edge of an abutting floor assembly and the interior face of the wall.

Figure 12.A illustrates a typical arrangement of this type of construction for concrete/masonry exterior walls.

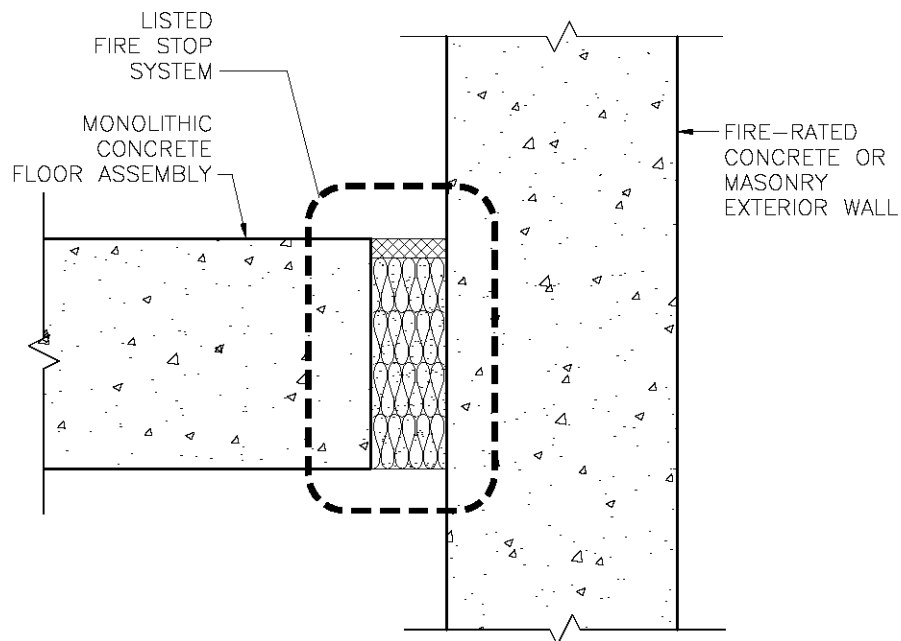


Figure 12.A:
Building perimeter fire stop at a
fire-rated concrete or masonry
exterior wall

If Acoustical Separation is Required...

- The complete separating construction (including fire stops at perimeter joint or penetrations) should provide the required STC between occupancies.
- Such joints may be screened from occupied spaces by wall or ceiling assemblies that provide part of the required sound isolation. In such cases, there is no sound rating required for the fire stop. See Section 2.7.

The fire stop illustrated in Figure 12.A will typically be constructed of mineral or ceramic fibre with a caulk, troweled-on or spray applied sealant at the top or bottom surfaces of the insulation, as required for the listed fire stop system. The design of the mineral or ceramic fibre must account for the insulation thickness and density, the orientation of the fibres and the extent to which the insulation is compressed, as this joint will experience movement during its normal life. These factors will, in part, be influenced by the distance between the wall and the edge of the floor slab. The manufacturers' technical literature should be consulted. In designing this type of fire stop, the user should evaluate the need for mechanical attachment to help keep the insulation in place as the wall assembly moves under normal conditions and fire exposure. This would also be specified by the manufacturer of the fire stop.

Where a fire-rated exterior gypsum board/stud wall is used, the gypsum board protecting the interior face of the wall must be installed in such a manner to ensure that the required performance of the fire stop is achieved. (See Figure 12.B as an example). The fire stop manufacturers' technical literature should be consulted in the design of this detail.

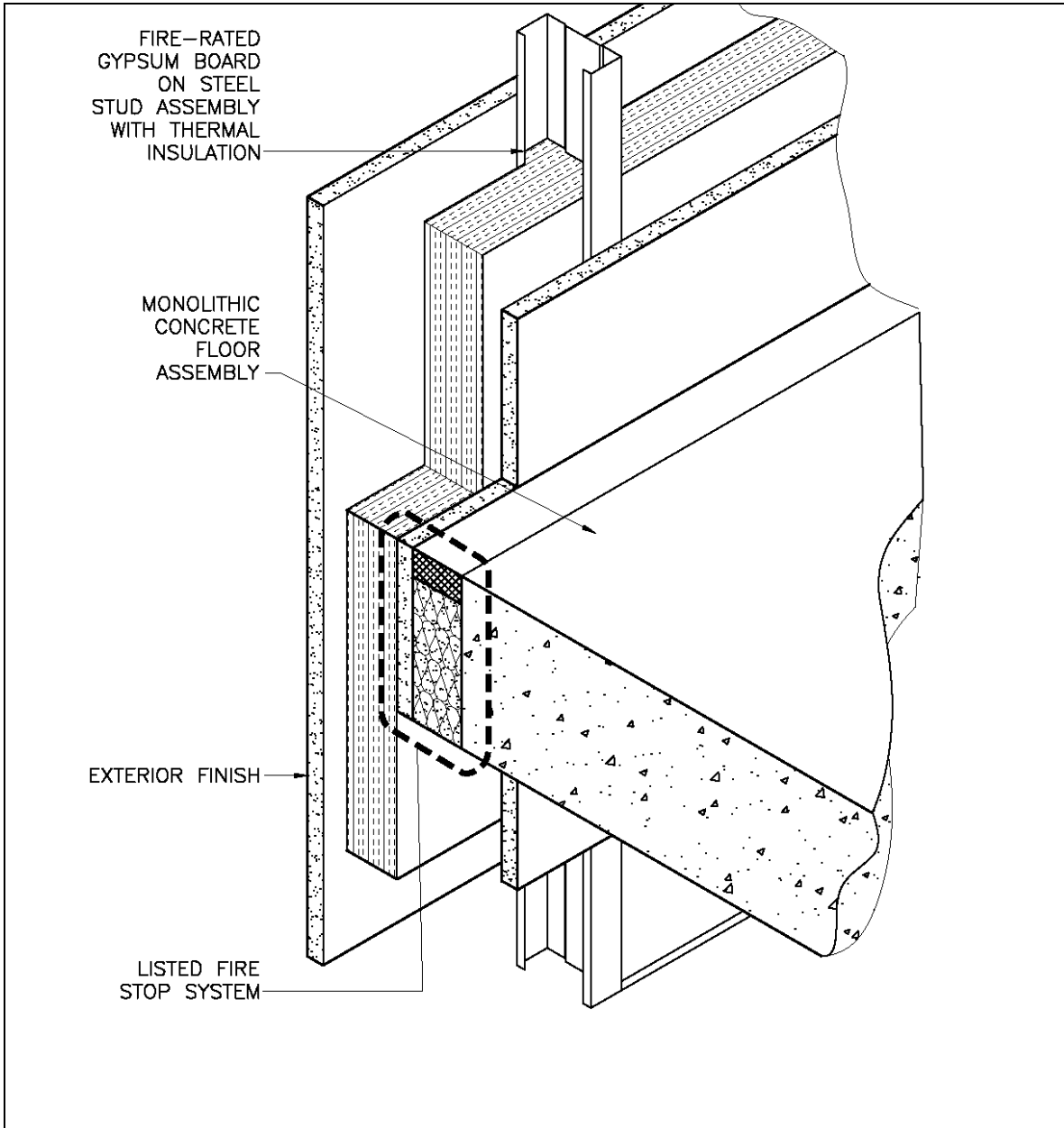


Figure 12.B:
Building perimeter fire stop
at a fire-rated exterior stud
wall

If Acoustical Separation is Required...

- The complete separating construction (including fire stops at perimeter joint or penetrations) should provide the required STC between occupancies.

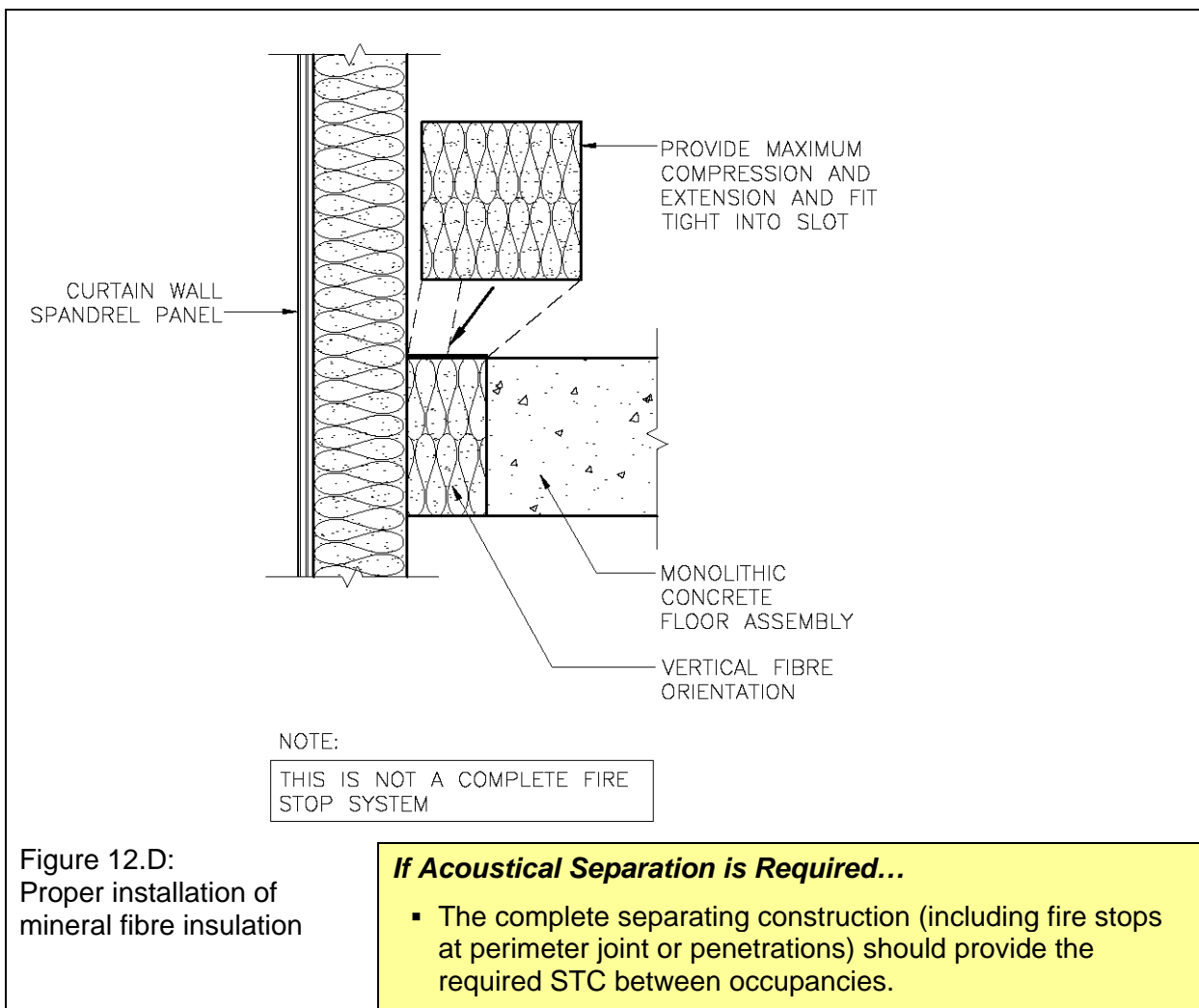
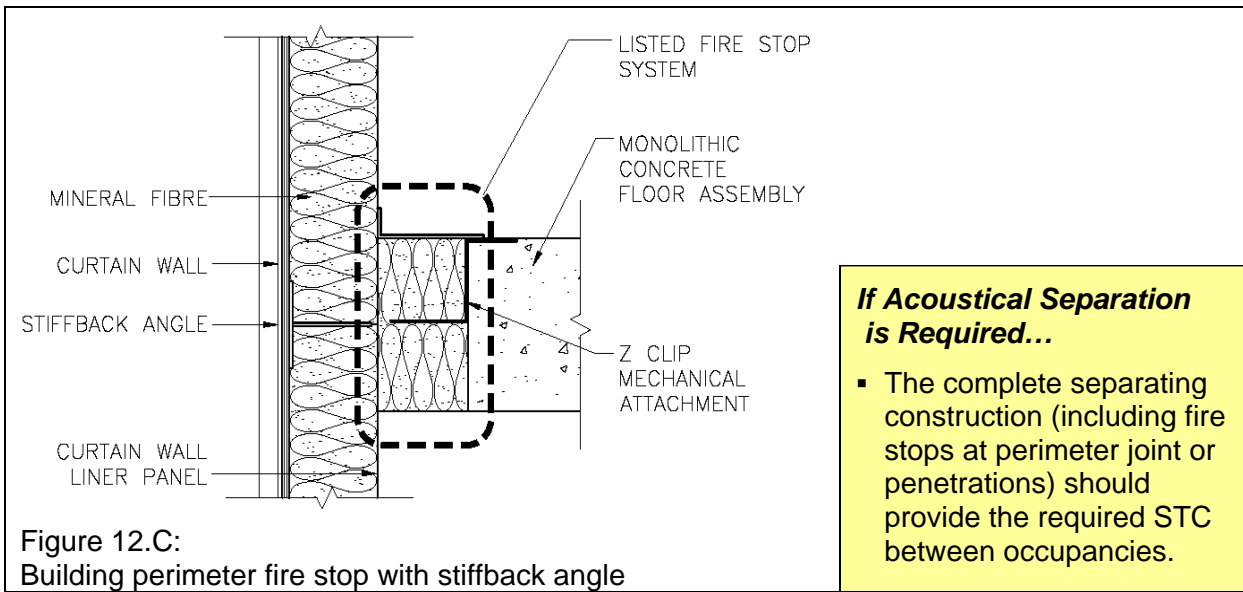
12.3 Best Practice for Building Perimeter Fire Stops with Non-Fire-Rated Exterior Walls

Many curtain wall systems (e.g., aluminum framed, glass) are non-fire-rated. Since fire attack on these walls could have an impact on fire spread from one floor to those above, a user should carefully consider how the building perimeter fire stops will be designed for this application. In many instances, the problem is one of support of the fire stop to keep it in place throughout the duration of the fire. Experience has shown [12-1] that the improper orientation of the insulation fibres and the lack of appropriate compression of the insulation may cause sufficient shrinkage that a gap forms through the fire stop. As well, if the insulation and finish on the inside face of the exterior wall assembly is not sufficiently resistant to fire attack, the fire may spread through the wall, or fire damage to the wall may cause the fire stop to fall out. In either case, the needed fire stop protection will be breached. The designer should ensure that the exterior wall insulation, its interior finish, and the fire stop are designed to perform together to protect the opening.

Three examples of best practice details that can provide a fire stop at the building perimeter are presented below. All of these are incorporated in many listed fire stop manufacturers' designs [12-1].

1. The use of stiffback angles to keep the spandrel wall insulation pressed tightly against the fire stop (see Figure 12.C). The stiffback angle is mounted from mullion to mullion at the floor line to provide support for the compression of the mineral wool insulation serving as part of the listed fire stop system.
2. The proper vertical orientation and compression of the mineral wool fire stop insulation (see Figure 12.D). The mineral wool portion of the listed fire stop system is oriented with its grain running vertically and is compressed to provide a tight fit against the spandrel wall insulation without the need for mechanical attachment (clips).
3. Correctly supporting the wall insulation through mechanical attachment (see Figure 12.E). In this case, the mineral wool portion of the listed fire stop system does not have to be compressed as much as in Figure 12.D since the clips hold it in the slot between the spandrel wall and the floor assembly.

In the U.S.A., perimeter fire stops with non-fire-rated exterior curtain walls are tested and listed using the Intermediate Scale Multi-Storey Apparatus (ASTM E2307) [12-2]. A number of designs have been evaluated and listed for this application. While this test method has not yet been adopted in Canada, users may wish to specify a listed design from the U.S.A. as evidence of having met the intent of the NBCC requirement for building perimeter fire stops. Where a user wishes to use an assembly listed to ASTM E2307, it should be noted that Canadian designs for curtain walls may be different from those tested with the fire stop. Where a curtain wall with unique features is anticipated, a user may need to rely on an engineering judgement to design a perimeter fire stop for that specific application (see Section 7.1).



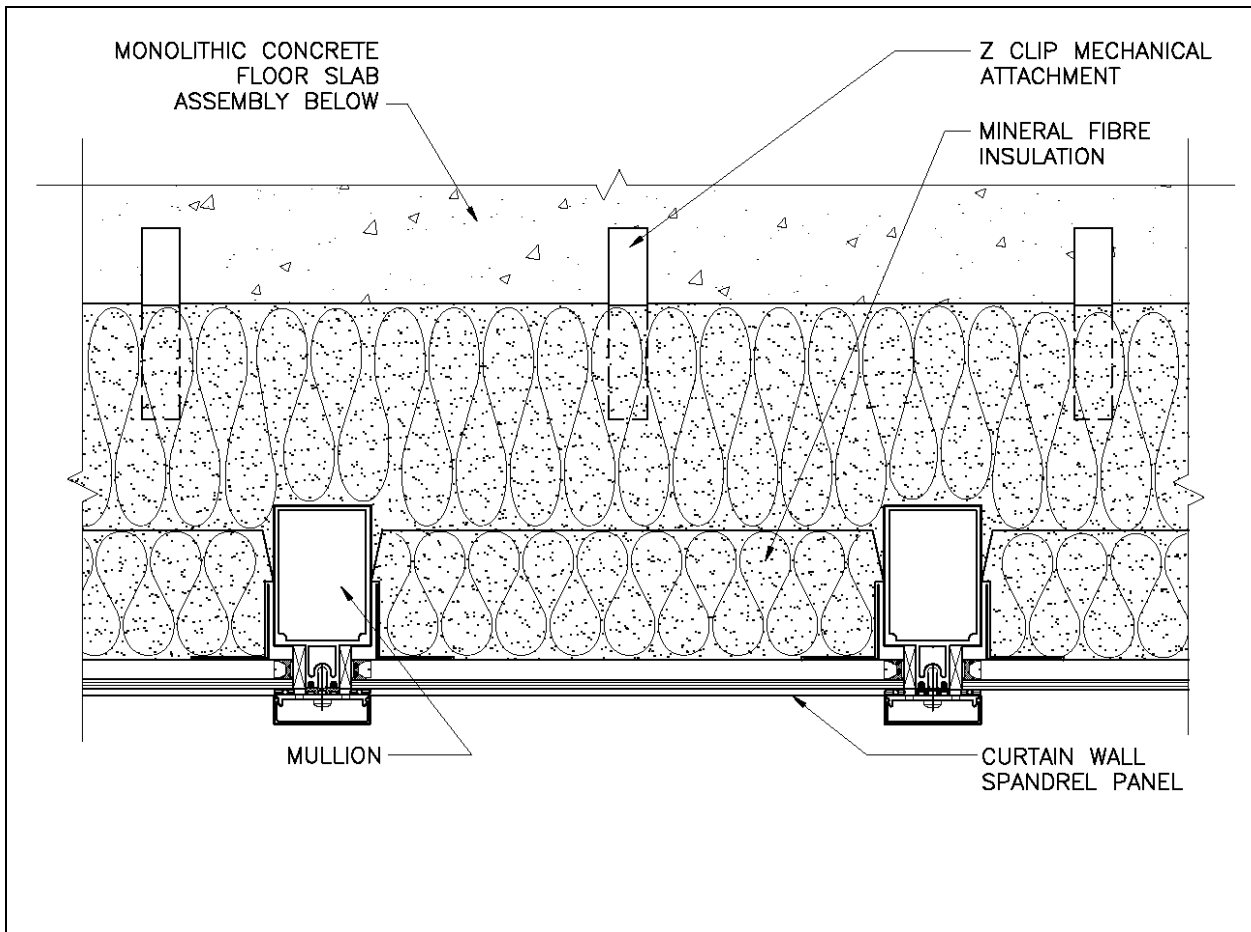


Figure 12.E:
Building perimeter fire stop at
curtain wall with mechanical
attachment

If Acoustical Separation is Required ...

- The complete separating construction (including fire stops at perimeter joint or penetrations) should provide the required STC between occupancies.

Chapter 12 References

- 12-1. Building Fire Perimeter Systems, International Firestop Council, Cleveland, OH.
- 12-2. ASTM E2307 – Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale Multi-Story Test Apparatus, ASTM International, West Conshohocken, PA, 2004.

13.0 BEST PRACTICE FOR FIRE BLOCKS

13.1 Introduction

In Chapter 2, it was noted that the purposes of fire blocks are:

- to restrict the size of a concealed space and thus prevent widespread fire growth in a location not normally accessible to firefighting, and
- to prevent a fire in one concealed space from moving into an adjacent concealed space.

As well, in Chapter 4, it was noted that fire block materials for buildings of noncombustible construction are restricted to fire-rated (listed) systems, gypsum board or sheet steel. On the other hand, fire blocks for buildings of combustible construction may be solid lumber, plywood, OSB or any of those for noncombustible construction.

In this chapter, best practice for fire blocks, in both combustible and noncombustible construction, will be explained. The fire blocks of interest will be the following:

- Fire blocks in wall assemblies
- Fire blocks in horizontal concealed spaces, including crawl spaces
- Fire blocks between vertical and horizontal concealed spaces
- Fire blocks between nailing elements

The Chapter will address fire blocks in combustible and noncombustible construction for the first of these three; the fourth relates only to noncombustible construction. In the first three, the fire block materials may be different for combustible and noncombustible construction. Other details are virtually identical.

13.2 Fire Blocks in Wall Assemblies

13.2.1 Overview

Chapter 6 pointed out that fire blocks are required in wall assemblies in the following locations:

- At every floor level
- At every ceiling forming part of a fire-rated assembly, and
- To divide wall concealed spaces so that the maximum horizontal dimension is 20 m and the maximum vertical dimension is 3 m.

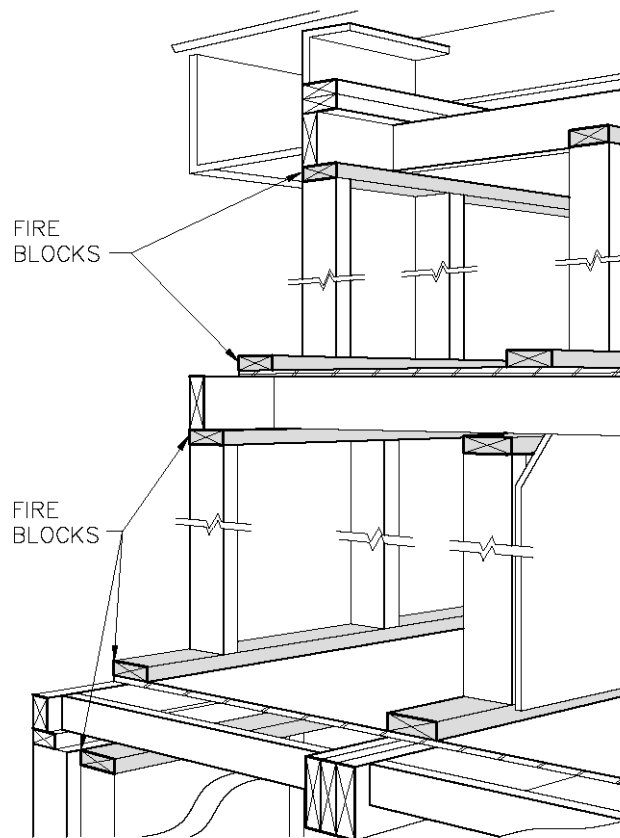
Exceptions to these requirements for fire blocks to block off concealed spaces in walls are permitted provided:

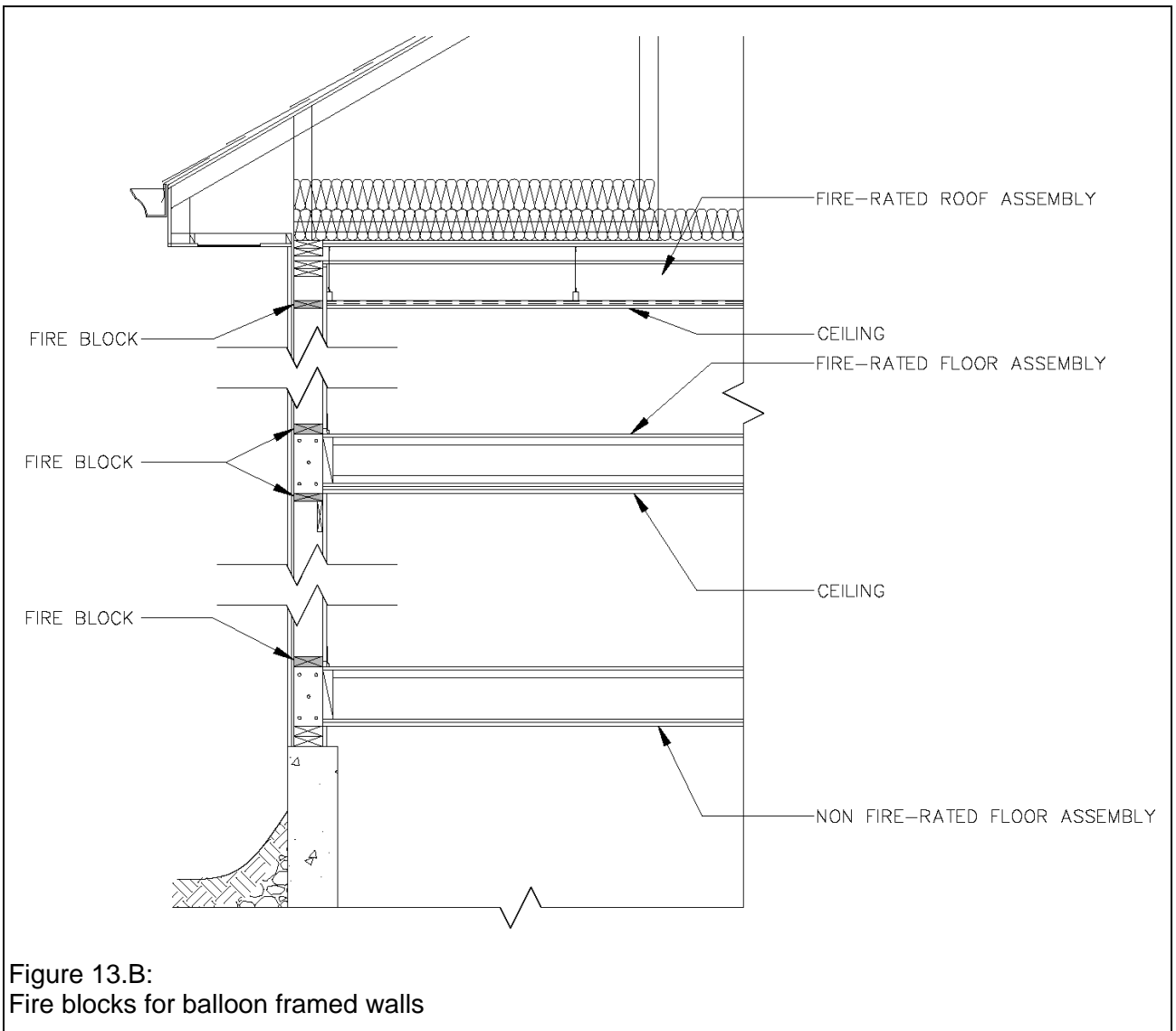
- The wall space is filled with insulation, or
- The exposed construction materials including insulation are noncombustible, or
- The exposed construction materials, including insulation, have a flame spread rating of 25 or less (applies to fire blocks at every floor level and at every ceiling forming part of a fire-rated assembly only), or
- The insulated wall assembly contains only 1 air space whose horizontal thickness does not exceed 25 mm.

13.2.2 Fire Blocks at Floor Levels and at Fire-Rated Ceilings

Floor Levels – Figure 13.A shows a typical arrangement of fire blocks in platform-frame construction. Note that the floor plate (solid lumber at least 38 mm thick) serves as a fire block on this occasion. A steel floor track (at least 0.38 mm thick) for a steel stud wall would also serve as an acceptable fire block for this arrangement. Figure 13.B shows the needed fire blocks at floor levels for a balloon-framed wall. The same types of materials can be used for fire blocks in balloon-framed as for platform-framed construction. If the conditions noted in the exceptions in 13.2.1 apply, then those fire blocks would not be required.

Figure 13.A:
Fire blocks for platform framed walls
(Based on Figure 6-22 from the
National Housing Code 1998 and
Illustrated Guide, published by the
National Research Council
Canada).





Ceiling Levels – Where a ceiling forms part of a fire-rated floor or roof assembly, fire blocks are required at ceiling level. These fire blocks are to ensure the required fire resistance rating of the floor or roof assembly by blocking fire spread from the wall cavity to the cavity of the horizontal assembly. In Figure 13.A, the top plates of the walls serve as required fire blocks, assuming that the horizontal assemblies are required to be fire-rated and that the ceiling will be installed at the top of the wall as shown. If the ceiling is to be suspended below the top of the wall, then fire blocks would also have to be installed at the level of the ceiling. In Figure 13.B, fire blocks would have to be installed inside the wall at ceiling level for balloon-framed construction. If the conditions noted in the exceptions in 13.2.1 above apply, then these fire blocks would not be required.

13.2.3 Fire Blocks in Large or High Walls

In large area walls or high walls, fire blocks must be provided every 3 m vertically and 20 m horizontally to prevent large-scale fire spread inside the wall assembly. This concept is illustrated in Figure 13.C. If the conditions noted in the exceptions in 13.2.1 above apply, then fire blocks at 20 m apart horizontally and 3 m apart vertically would not be required. Fire blocks would, however, still be required every 10 m vertically when the exposed construction materials, including insulation, have a flame spread rating of 25 or less and none of the other exceptions noted in 13.2.1 above apply.

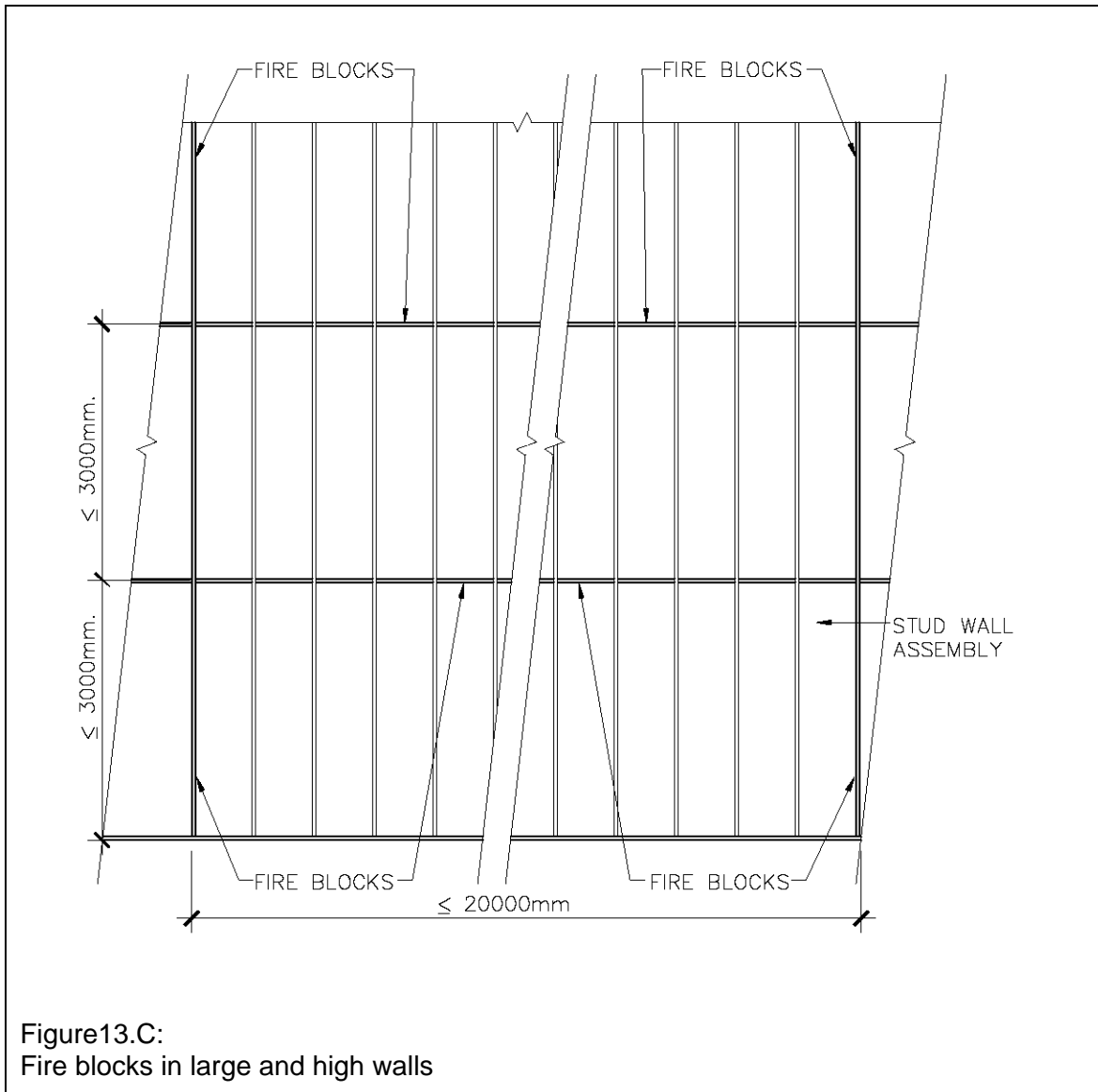


Figure 13.C:
Fire blocks in large and high walls

13.2.4 Fire Blocks if Wall Air Gap is Less than or Equal to 25 mm Wide

Figure 13.D.1 shows an arrangement where fire blocks would not be required in the air gap in the wall assembly since the width of the gap through the wall and the floor assembly between the vertically-stacked walls is less than or equal to 25 mm wide.

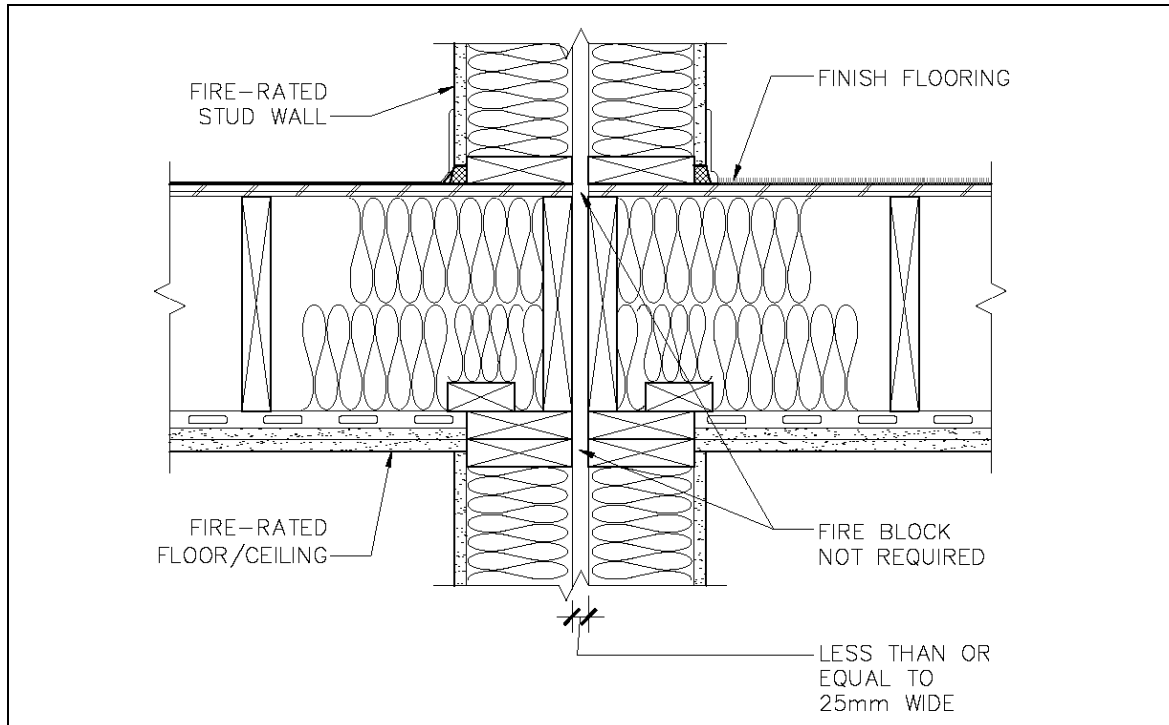


Figure 13.D.1:
Floor/wall cavity where
fire block is not
required because air
gap is 25 mm or less
wide

If Acoustical Separation is Required...

- The complete separating construction should provide the required STC between vertically adjacent (one-above-the-other) occupancies. Note that the apparent STC is reduced by structure-borne transmission via the floor/wall junction. (See reference 13-2).
- The complete separating construction should provide the required STC between side-by-side occupancies.

Good Practice for Acoustics:

- Note that in this case, with no rigid connections between the two rows of studs, the Apparent STC between side-by-side occupancies is not reduced by structure-borne transmission. A rigid fire block such as gypsum board, wood, or steel reduces Apparent STC. (See references 13-1 and 13-2 for possible solutions).

If the structural joists adjacent to the air gap in Figure 13.D.1 provide an air gap wider than 25 mm (as could happen with wood-I joists or trusses aligned parallel to the walls), then fire blocks would be required at the ceiling and the floor levels. It should also be noted that this exception to fire blocks at the floor and ceiling levels applies only when the cavities between the studs on both sides of the wall are filled with insulation as shown in Figure 13.D.1.

Should the walls below or above the floor assembly have insulation on only one side, as shown in Figure 13.D.2, then a fire block is required at both the floor and ceiling levels. For gaps less than or equal to 25 mm wide, semi-rigid fibre insulation board is permitted to be used as a fire block for this air gap in the floor assembly as illustrated in Figure 13.D.2. The insulation board must completely fill the air gap between the headers and the top and bottom plates of the walls as shown in Figure 13.D.2.

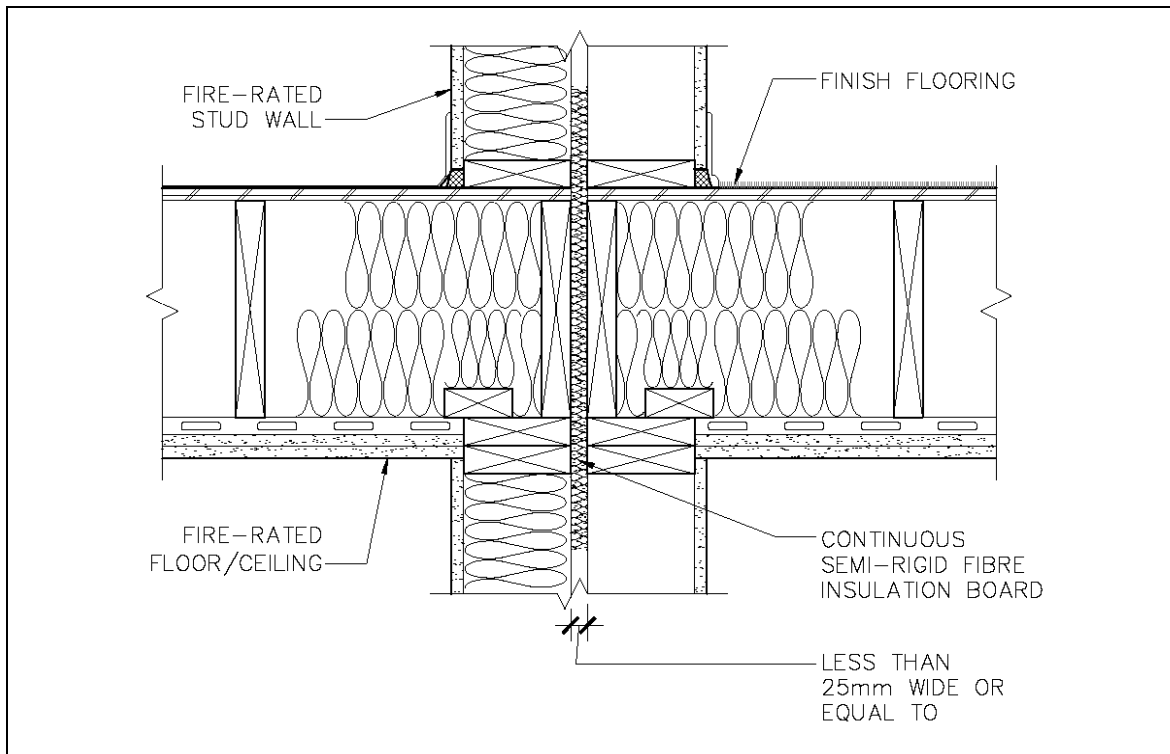


Figure 13.D.2:
Floor/wall cavity less than
or equal to 25 mm wide
with fire block

If Acoustical Separation is Required...

- The complete separating construction should provide the required STC between vertically adjacent (one-above-the-other) occupancies. Note that the apparent STC is reduced by structure-borne transmission via the floor/wall junction. (See reference 13-2 for possible solutions)
- The complete separating construction should provide the required STC between side-by-side occupancies.

Good Practice for Acoustics:

- Note that in this case, with no rigid connections between the two rows of studs, the Apparent STC between the side-by-side occupancies is not reduced by structure-borne transmission. A rigid fire block such as gypsum board, wood, or steel reduces Apparent STC. (See references 13-1, 13-2).

There are occasions when a non-fire-rated floor assembly frames into a fire-rated wall assembly as shown in Figure 13.D.3. This illustrates a fire separation between storeys within side-by-side dwelling units (such as row houses) with no requirement for a fire- or sound-rated floor ceiling assembly between storeys inside the units. For this assembly, it can be seen that the fire resistance rating of the wall assembly may be compromised should the fire break through the ceiling gypsum board (or other finish) and attack the sides of the framed floor members. A gypsum board fire block attached to the side of the framed floor members above the wall as shown in Figure 13.D.3 prevents horizontal fire spread to the opposite side of the vertical fire separation. The gypsum board thickness in this case should be at least the same as that used for the wall assembly below the floor assembly.

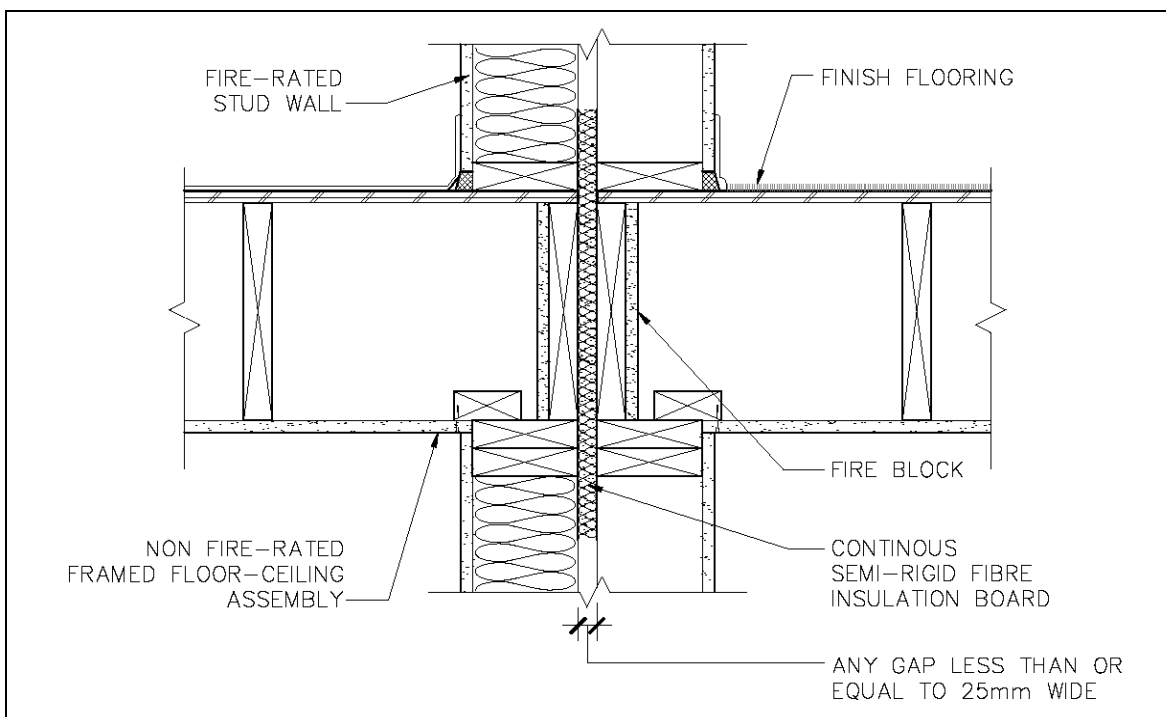


Figure 13.D.3:
Floor/wall cavity less than or equal to 25 mm wide, with non-fire-rated floor

If Acoustical Separation is Required...

- The complete separating construction should provide the required STC between side-by-side occupancies.
- No requirement for fire- or sound-rated floor-ceiling assembly for separation between stories within dwellings.

Good Practice for Acoustics:

- Note that in this case, with no rigid connections between the two rows of studs, the Apparent STC between the side-by-side occupancies is not reduced by structure-borne transmission. A rigid fire block such as gypsum board, wood, or steel reduces Apparent STC. (See reference 13-2 for possible solutions).

An alternative to the semi-rigid insulation board would be to have a continuous 16 mm OSB subfloor across the air gap; this has acoustical implications, but might be

required for structural reasons in some jurisdictions. No fire block is required at ceiling level since this is a non-fire-rated floor assembly.

13.2.5 Fire Blocks if Air Gap is Greater than 25 mm Wide

Where the width of the air gap in a wall assembly exceeds 25 mm, best practice dictates that fire blocks must be installed at both the floor and fire-rated ceiling levels. Figure 13.E.1 illustrates one example of this concept with the solid lumber top plate in the lower wall being the fire block at ceiling level and the 16 mm thick OSB subfloor or the bottom plate in the upper wall being the fire block at floor level. These fire blocks will prevent vertical fire spread through the gap. This fire block arrangement will work regardless of the width of the air gap between the floor framing members.

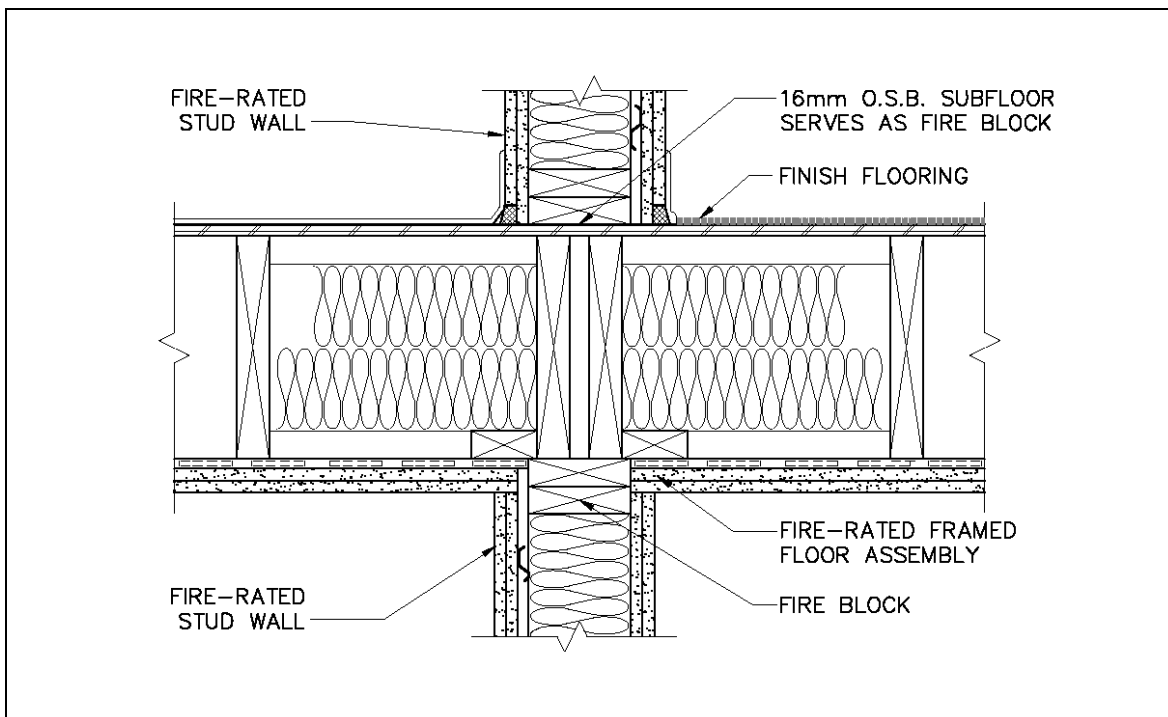


Figure 13.E.1:
Examples of fire blocks at
ceiling and floor levels with
floor/wall cavity greater than
25 mm wide

If Acoustical Separation is Required...

- The complete separating construction should provide the required STC between side-by-side occupancies.
- The complete separating construction should provide the required STC between the vertically adjacent (one-above-the-other) occupancies.

Good Practice for Acoustics:

- Note that due to structural connections across the floor/wall junction, the Apparent STC in both directions is reduced by structure-borne transmission.
(See reference 13-2 for possible solutions)

Figure 13.E.2 illustrates an example of a double stud wall with an air gap greater than 25 mm wide. For this arrangement, the 16 mm OSB subfloor provides a fire block at the floor level and a continuous semi-rigid fibre insulation board provides a fire block at the ceiling level. While a solid fire block (lumber, gypsum board, etc.) could be used at ceiling level, its negative impact on sound separation from one side of the wall to the other makes it a less desirable choice.

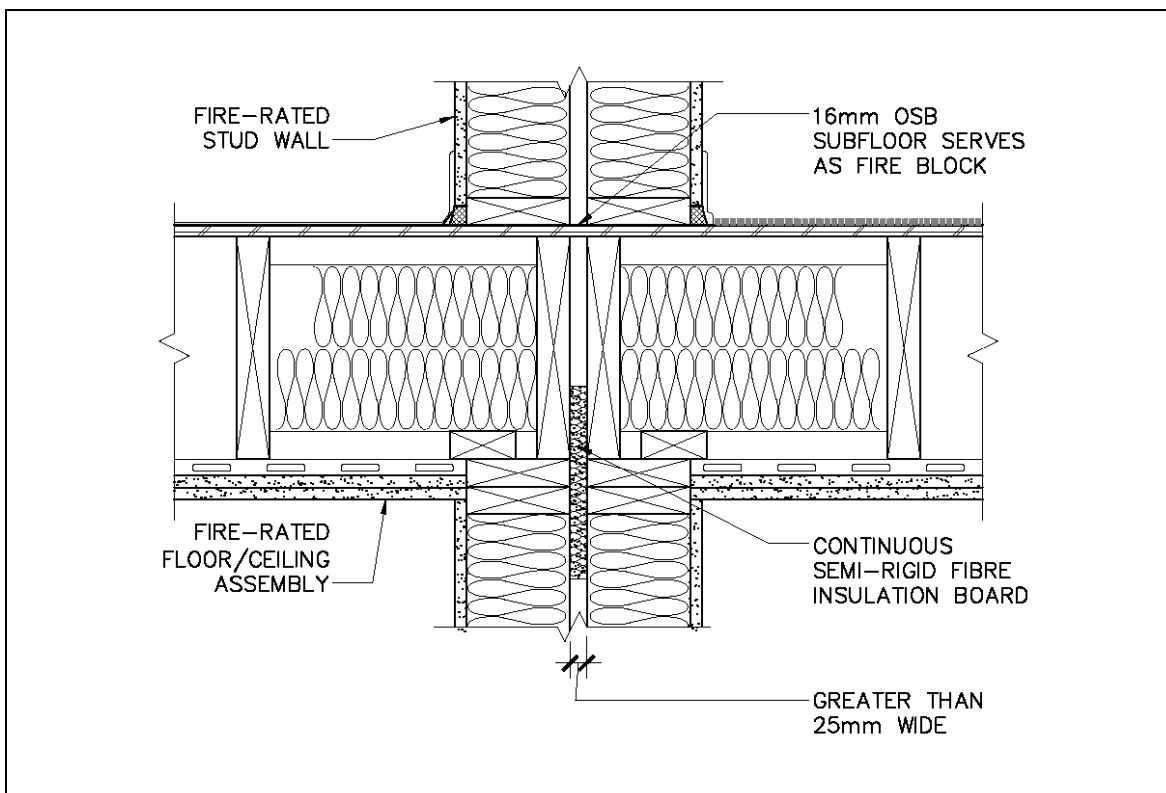


Figure 13.E.2:
Examples of fire blocks at
ceiling and floor levels with
air gap greater than
25 mm wide

If Acoustical Separation is Required...

- The complete separating wall construction should provide the required STC between side-by-side occupancies.
- The complete separating floor construction should provide the required STC between the vertically adjacent (one-above-the-other) occupancies.

Good Practice for Acoustics:

- Note that due to structural connections at the floor level, the Apparent STC between the side-by-side occupancies is reduced by structure-borne transmission; this could be worsened by rigid blocking at the ceiling level.
(See reference 13-2 for possible solutions)

Figure 13.F illustrates a fire separation between side-by-side 2-storey dwelling units where the intermediate floor is not required to be fire- or sound-rated. In the arrangement in Figure 13.F, the fire block at floor level is provided by the 16 mm OSB subfloor. This may be required for structural reasons, such as control of seismic or wind loading, especially for 3- or 4-storey apartment construction.

Since this is not a fire-rated assembly, no fire block is required at ceiling level. Gypsum board is attached, however, to the sides of the framed floor members to prevent a fire from penetrating the fire-rated wall assembly at this location. The thickness of the gypsum board should be the same as for the wall assembly below.

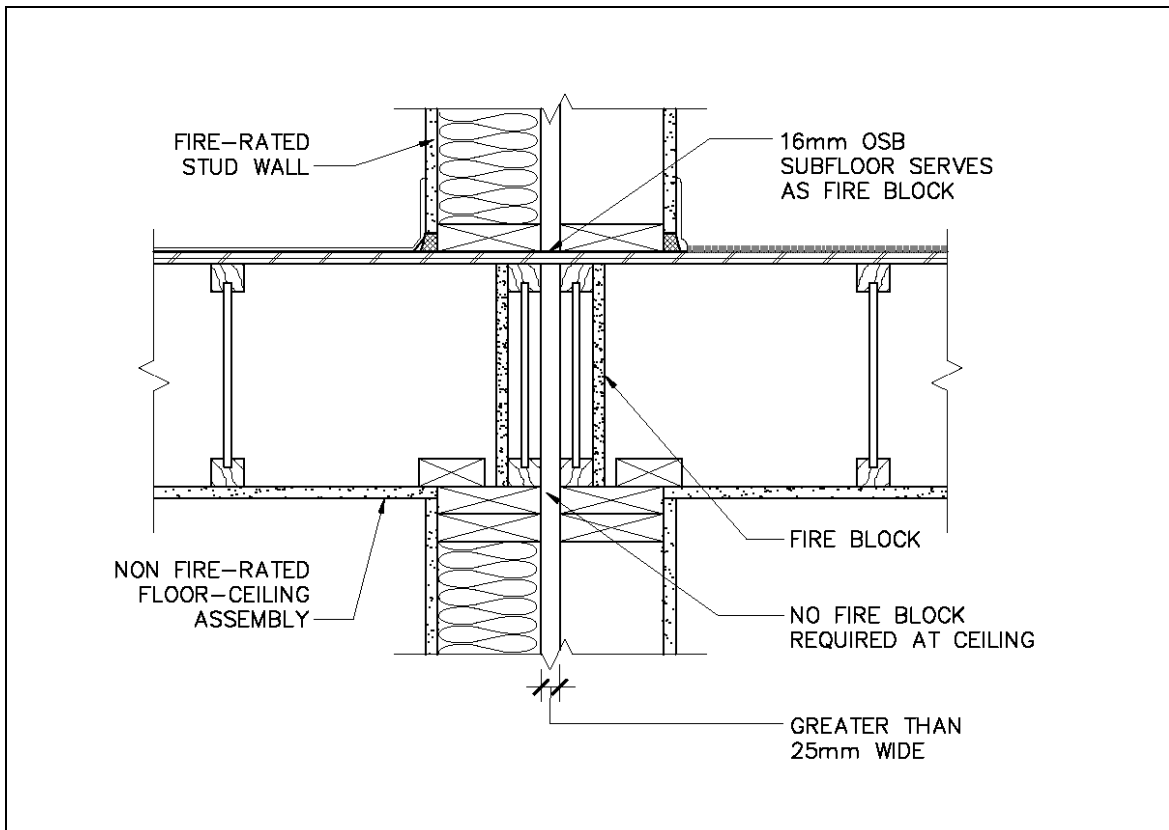


Figure 13.F:
Example of fire block at floor level with an air gap greater than 25 mm wide on non-rated floor assembly

If Acoustical Separation is Required...

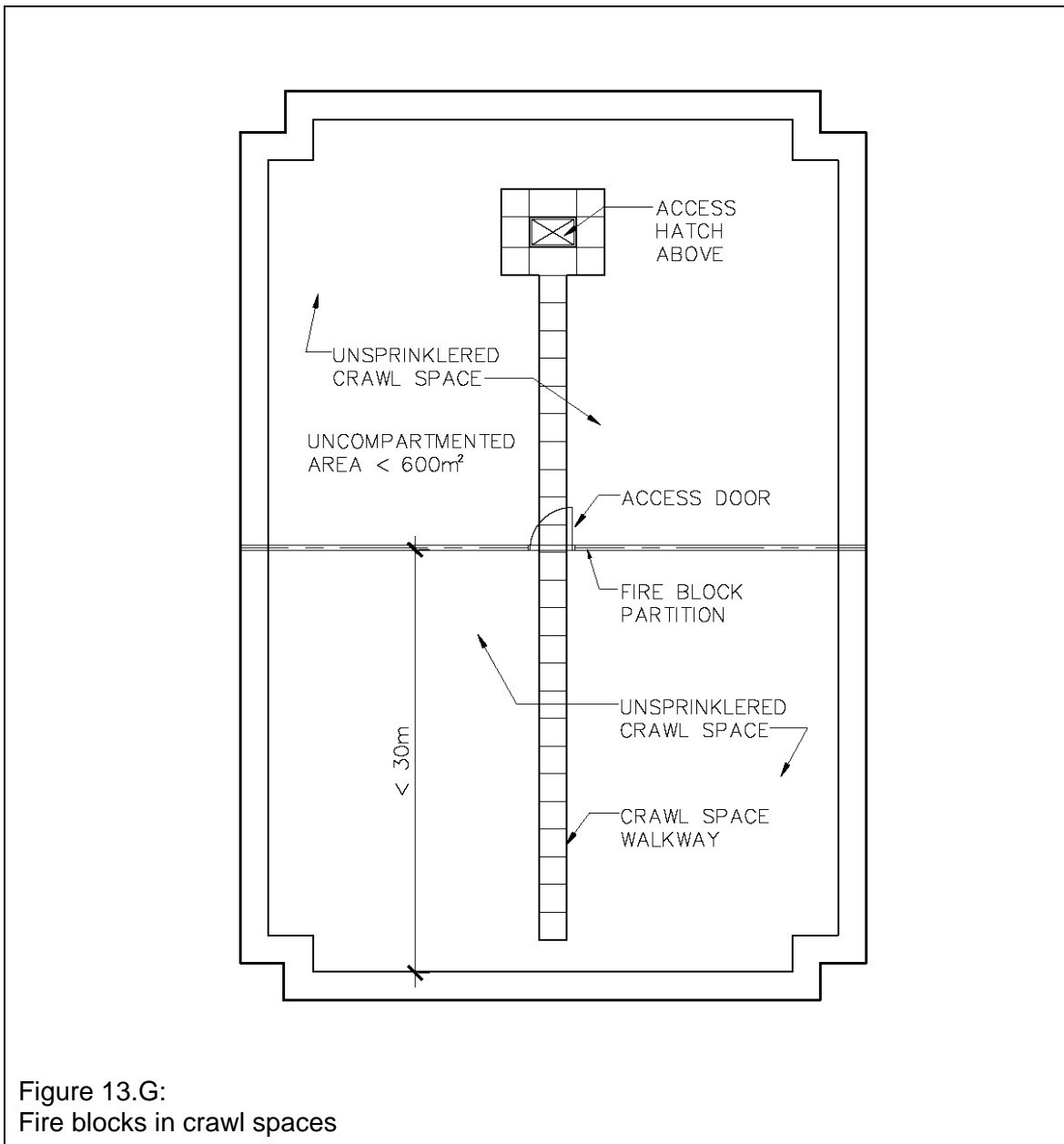
- The complete separating wall construction should provide the required STC between side-by-side occupancies.
- This illustrates a separation between stories within the dwellings (no requirement for fire- or sound-rated floor-ceiling assembly).

Good Practice for Acoustics:

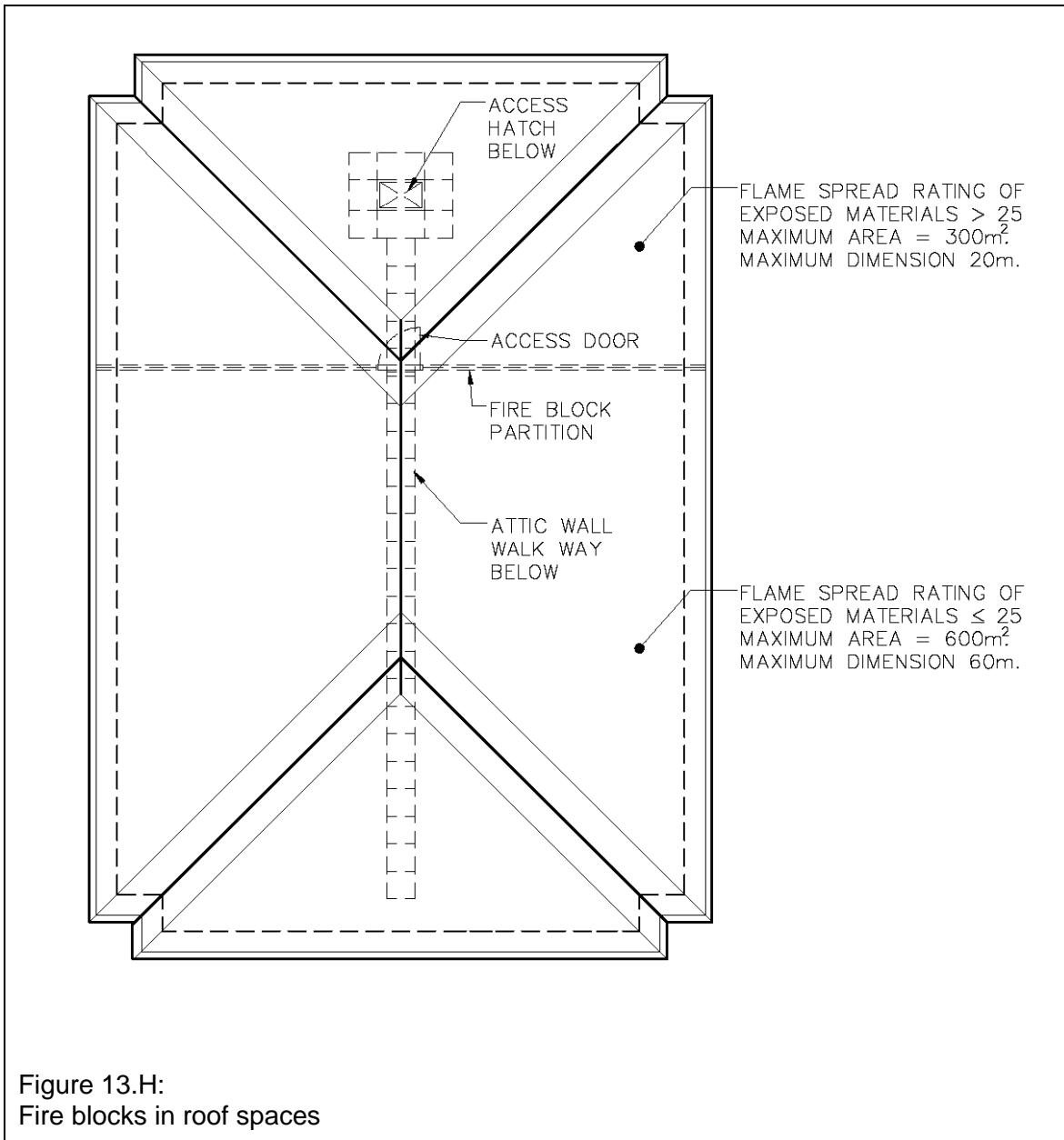
- Note that due to structural connections at the floor level, the Apparent STC between the side-by-side occupancies is reduced by structure-borne transmission.
(See reference 13-2 for possible solutions)

13.3 Fire Blocks in Horizontal Concealed Spaces

In horizontal concealed spaces, Chapter 6 illustrates different code requirements for fire blocks depending on whether the concealed space is a roof space, a crawl space, a canopy or mansard space, or a balcony floor space. For a crawl space that is not sprinklered, the maximum area without fire blocks is 600m^2 and the maximum dimension is 30 m as illustrated in Figure 13.G. These fire blocks are required for both combustible and noncombustible construction.



For unsprinklered roof or ceiling spaces, the limits without fire blocks are related to the flame spread rating of the exposed materials. For exposed materials with a flame spread rating of 25 or less, (e.g., gypsum board on steel framing) the limits are 600 m² and 60 m without fire blocks. For exposed materials with a flame spread rating greater than 25 (e.g., non-fire retardant treated plywood on wood framing), the limits are 300 m² and 20 m. This concept is illustrated in Figure 13.H for materials with flame spread ratings greater than 25, and for flame spread ratings of 25 or less.



Other horizontal concealed spaces in combustible construction must also be equipped with fire blocks. The most common instance occurs where a concealed space runs across the end of a vertical fire separation, such as between two townhouses or apartments. (See Figure 13.1) As well, fire blocks are required so that the maximum dimension in a combustible concealed space does not exceed 20 m.

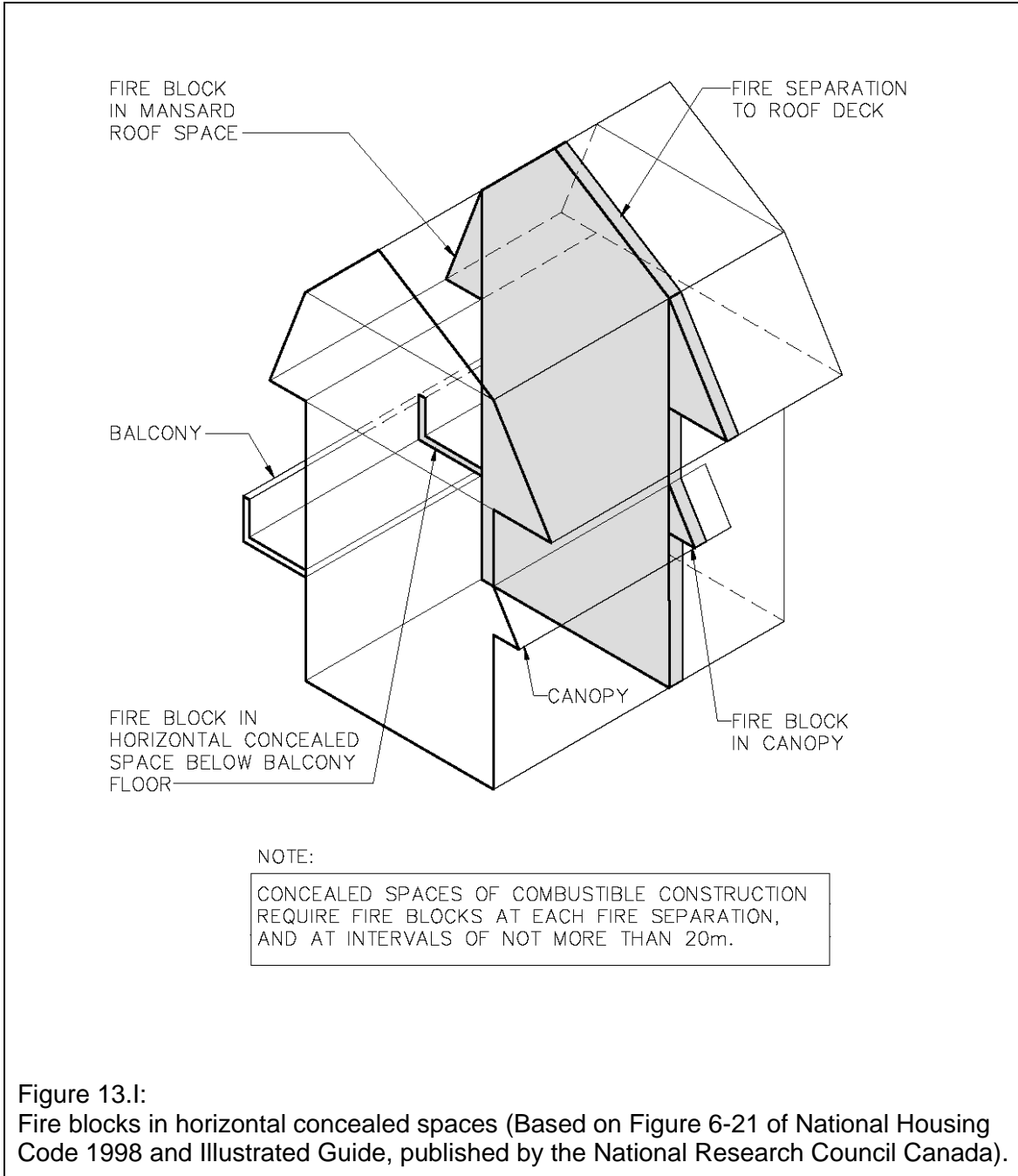
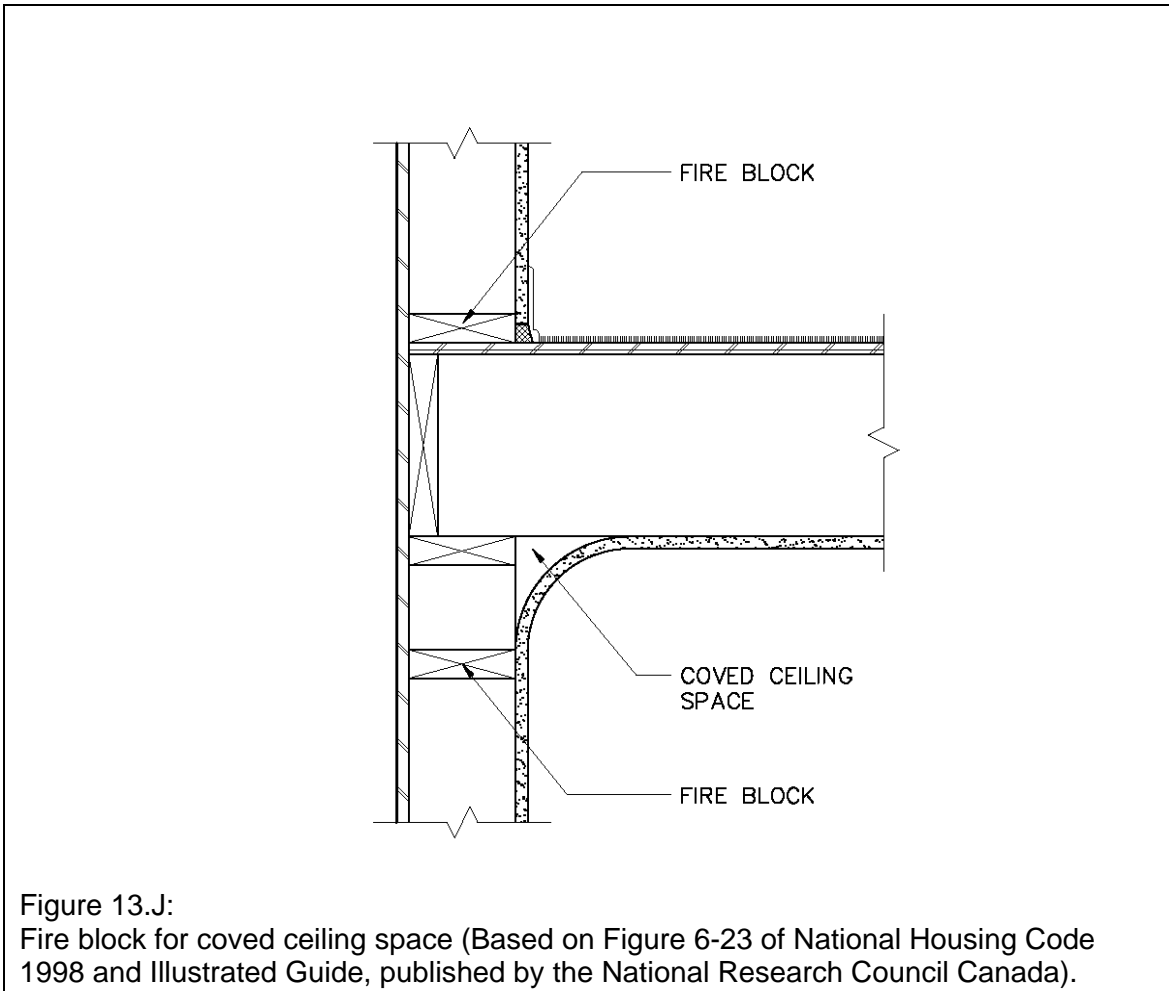


Figure 13.1:
Fire blocks in horizontal concealed spaces (Based on Figure 6-21 of National Housing Code 1998 and Illustrated Guide, published by the National Research Council Canada).

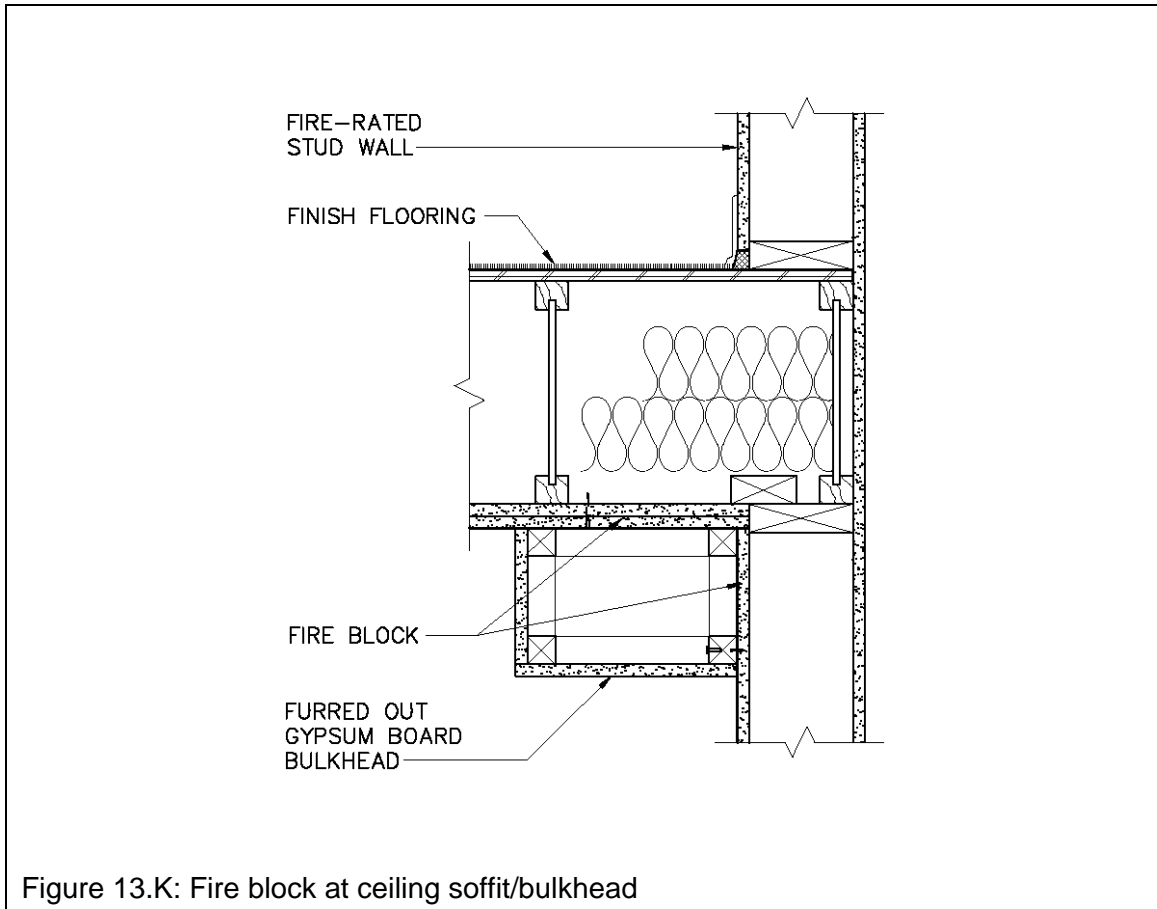
13.4 Fire Blocks Between Horizontal and Vertical Concealed Spaces

Many of the fire blocks installed in wall spaces (as shown in Section 13.2) also serve as fire blocks to prevent fires from spreading from a vertical concealed space to a horizontal one, or vice-versa. There are also other connections between horizontal and vertical concealed spaces that require fire blocks, as illustrated in following figures.

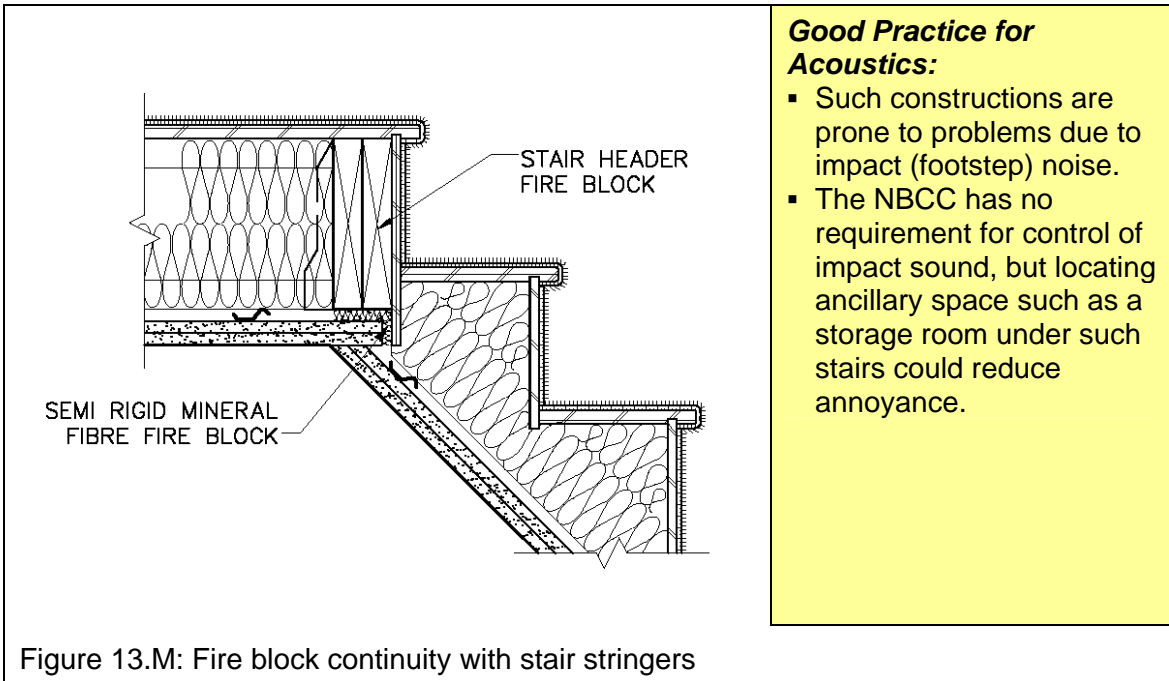
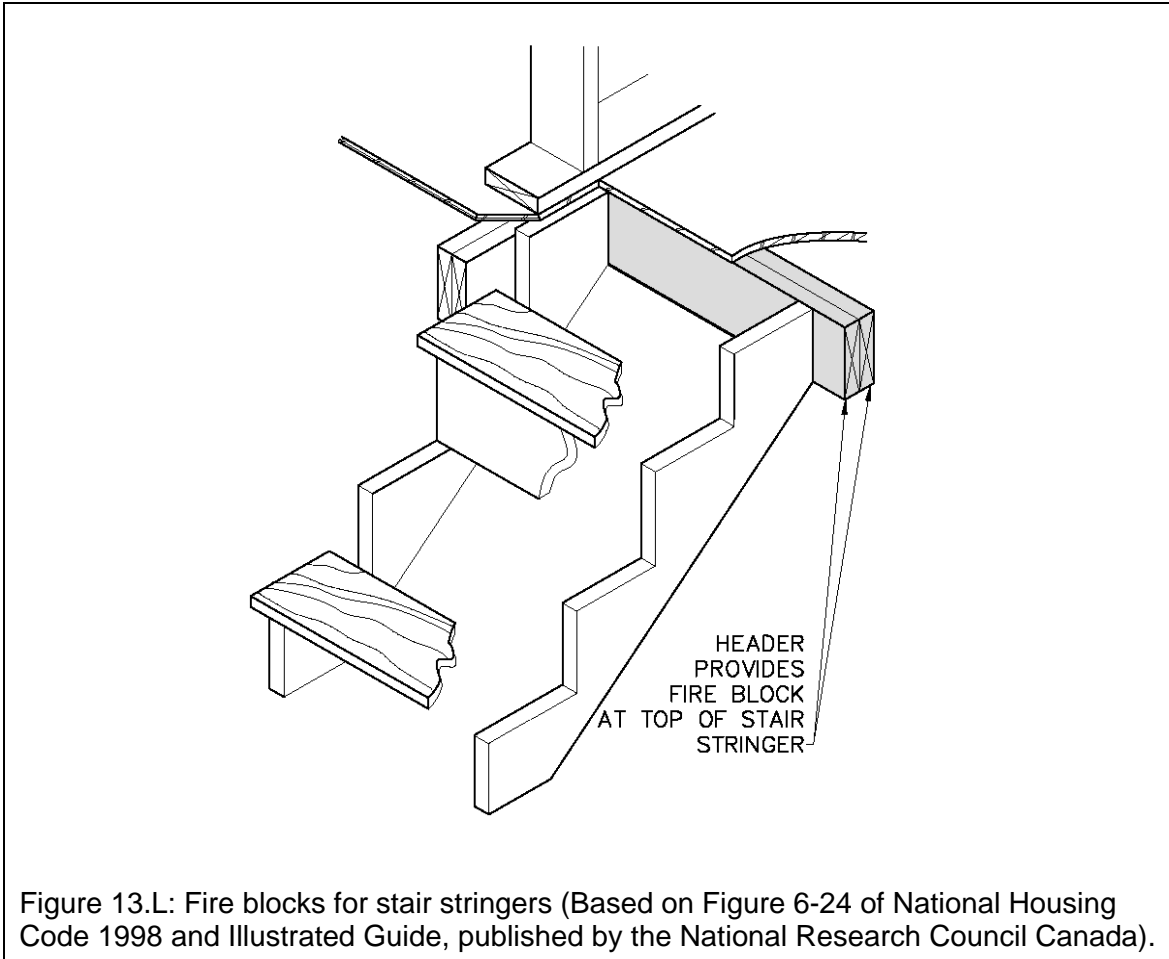
A fire block is required at a coved ceiling space as shown in Figure 13.J. when the exposed materials have a flame spread rating greater than 25. This would also apply to a dropped ceiling where a fire block would be required at the level of the ceiling.



A fire block is required at a soffit, where the exposed materials have a flame spread rating greater than 25, in particular where a wall and ceiling come together as shown in Figure 13.K. In this arrangement the gypsum board serves as a fire block. Should the gypsum board on the wall below terminate at the level of the soffit (bulkhead), a fire block (probably solid lumber) would need to be installed in the wall at that level.

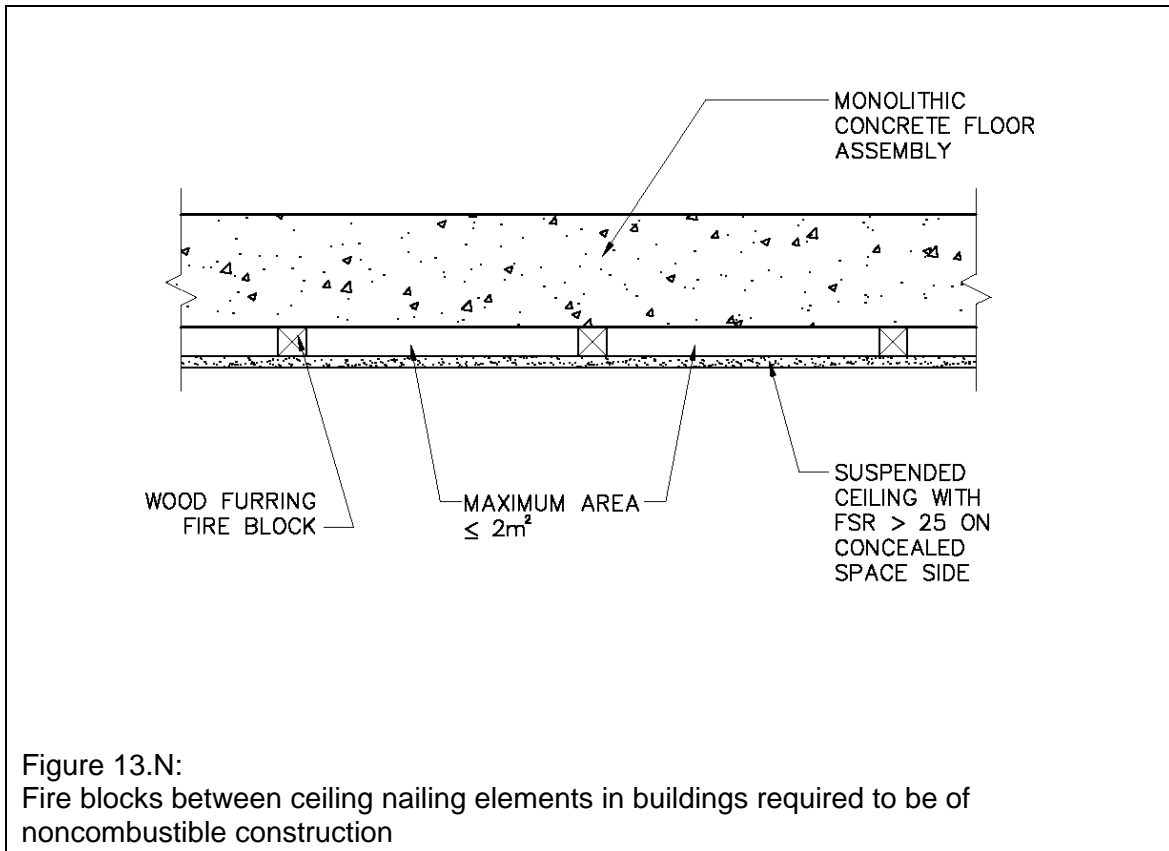


A fire block is required in concealed spaces, where the exposed materials have a flame spread rating greater than 25, between stair stringers at the end of each run and at each floor level as shown in Figure 13.L. For this arrangement, the required header for the opening for the stair will often provide the fire block. There are also arrangements where additional materials may be needed to achieve the continuity of the fire block as shown in Figure 13.M.

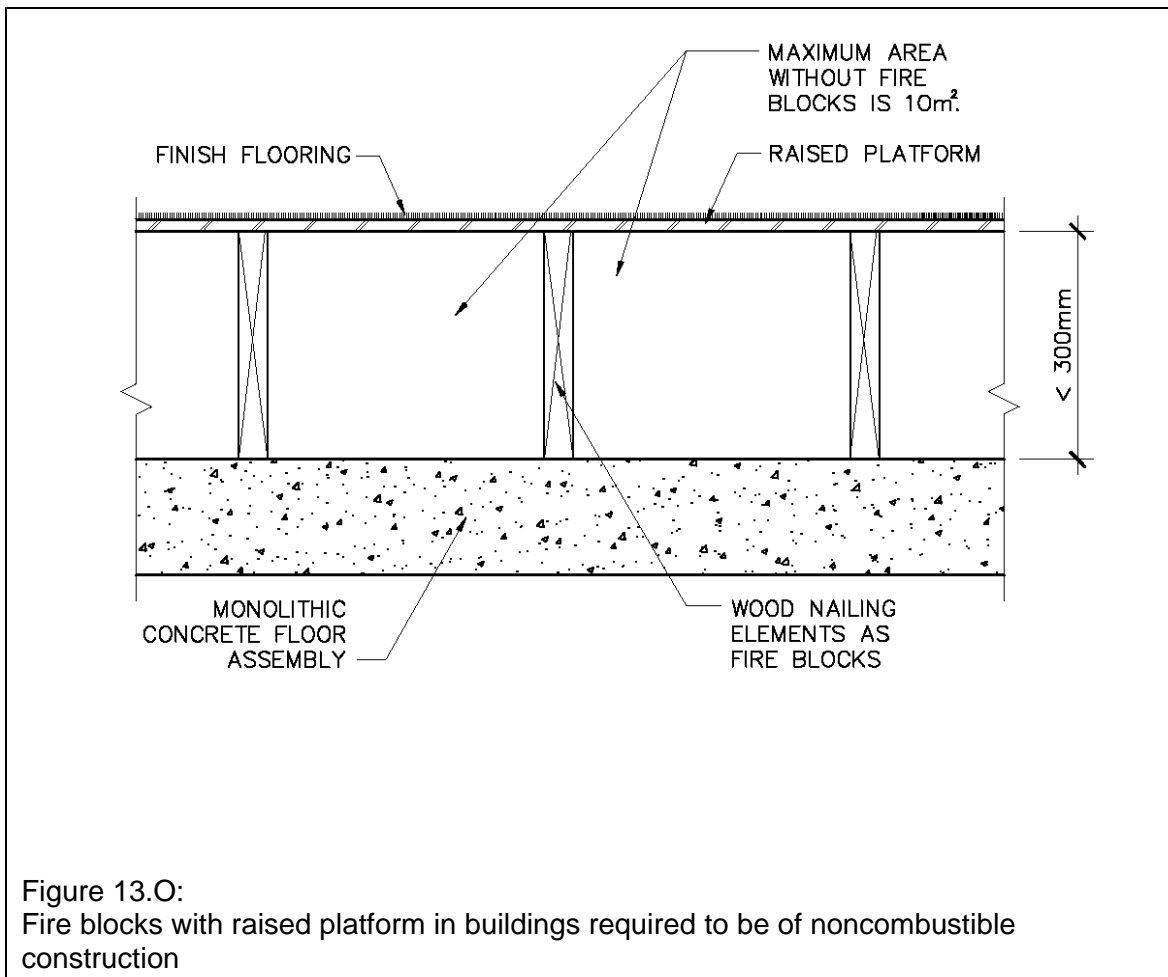


13.5 Fire Blocks Between Nailing Elements

Certain combustible elements, such as wood framing and furring, are permitted in noncombustible construction, however, concealed spaces formed using these combustible members must be provided with fire blocks to limit the size of these concealed spaces. These requirements apply only to buildings required to be of noncombustible construction. Figure 13.N illustrates an arrangement where a combustible ceiling is suspended using wood furring. In this case the wood nailing elements serve as fire blocks and limit the concealed areas to 2 m².



There are other arrangements where, in buildings required to be of noncombustible construction, raised platforms using wood framing elements are permitted. These raised platforms must have the concealed spaces below them equipped with fire blocks to limit the area of the concealed space to 10 m². This is illustrated in Figure 13.O. The wood framing elements can serve as the fire blocks in this construction if they are sufficiently robust. This could also apply to wood furring used to support a floor above a concrete slab.



Chapter 13 References

- 13-1 Nightingale, T.R.T. and Sultan, M.A., Sound Isolation and Fire Resistance of Assemblies with Fire Stops, Construction Technology Update No. 16, Institute for Research in Construction, National Research Council of Canada, Ottawa, ON, 1998.
- 13-2 Quirt, J.D.; Nightingale, T.R.T. and King, F., Guide for Sound Insulation in Wood Frame Construction, Research Report 219, Institute for Research in Construction, National Research Council Canada, Ottawa, ON, 2006