Guide for sound insulation in wood frame construction. Part 1: controlling flanking at the wall-floor junction

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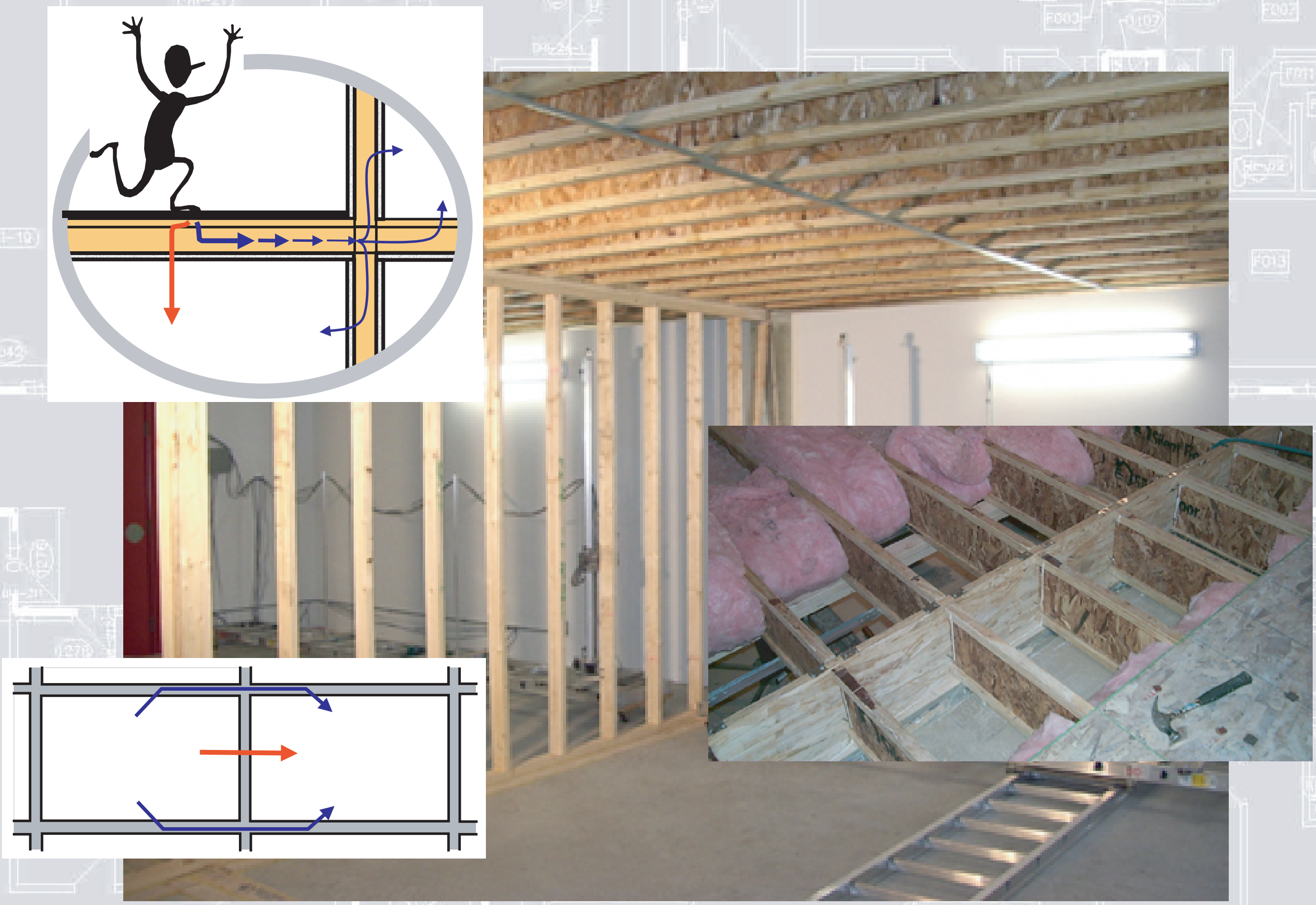

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Preamble and Acknowledgement

This Guide addresses *flanking transmission* of sound through wood framed construction. Continuous structural elements at the junction of a partition wall and floor provide a transmission path by-passing the separating partition between two noise-sensitive spaces.

Flanking transmission is sound transmission between two rooms by paths other than directly through the nominally separating wall or floor assembly. Flanking exists in all buildings and its importance in determining the apparent sound insulation (that perceived by the occupants) depends on of the construction details of the walls, the floors and their junctions.

This Guide is the derivative of two industry-sponsored research projects conducted at IRC/NRC. The focus and construction details were decided by a Steering Committee of technical representatives from each of the supporting partners. Partners included Canada Mortgage and Housing Corporation (in first phase only), Forintek Canada Corporation, Marriott International, National Research Council Canada, Owens Corning, Trus Joist, and USG Corporation.

Organization of this Guide

After a brief presentation of the **basic concepts** of flanking sound transmission in buildings, this guideline divides into three main parts.

The first part outlines a **design approach** for wood frame construction. It begins with a summary of the construction details that significantly affect sound transmission, and finishes with a four-step approach for systematically applying data in this Guide to establish a suitable design.

The following two parts examine transmission of **sound from airborne sources**, and **impact sound from footsteps**, respectively and provide the data that can be used with the design approach. Each of these parts begins by explaining basic concepts and terminology, and then presents performance for a series of typical constructions and the typical effect of changes to those constructions to improve the resulting sound isolation.

Overview of Content and Intended Application

The intent of this guide is to present the findings from a substantial experimental research study, in a form that can be used as a framework for design.

This guide focuses on wood-framed assemblies because that was the priority of the study on which it is based. Other types of walls and floors with concrete or steel structural assemblies also have significant reduction of sound isolation due to flanking, but they are outside the scope of this guide.

The experimental study included only a limited set of constructions. Specific constraints imposed on the research specimens are discussed further in the section on performance of typical assemblies. Many materials and many construction details were kept constant, to avoid masking the effect of the systematic modifications. As a result, clear and consistent trends could be associated with specific construction changes, but it must be recognized that the results may not capture the effect of all significant variants.

To show trends clearly, and to provide a framework for design estimates, expected sound transmission ratings are presented for each construction. For a number of specific cases, detail drawings and specifications including identification of specific proprietary materials are presented, and these are documented further in a detailed report.

Although it is not repeated at every step of this guide, it should be understood that some variation is to be expected in practice due to substitution of “generic equivalents” or changing specific design details.   Despite this caveat, the authors believe that trends shown here do provide a good estimate of the flanking in typical wood-framed constructions.

Basic Concepts

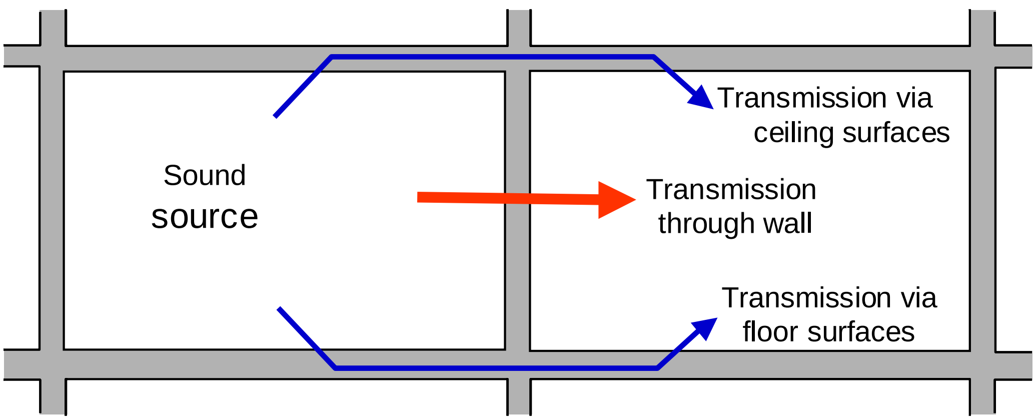
Basic Concepts for Structure-borne Transmission of Sound

Because all types of construction have some transmission of structure-borne vibration, the sound isolation between rooms in buildings is systematically less than the STC for the separating wall or floor.

This section introduces the basic concepts for describing structure-borne sound, and explains the terminology.

For adjacent rooms in a building, the sound isolation is often much less than would be expected from the rated sound transmission class (STC) of the separating wall or floor.

This happens because, in addition to direct transmission through the separating construction (which is what the STC indicates), the sound causes structure-borne vibration in all surfaces of the source room. Some of this vibration is transmitted across the surfaces (walls, floors or ceiling), through the junctions where these surfaces connect, and is radiated as sound into the receiving room.



The following diagrams show transmission at the floor/wall junction, in more detail. Vibration can be transmitted via many paths, but in practice a few paths transmit most of the energy.

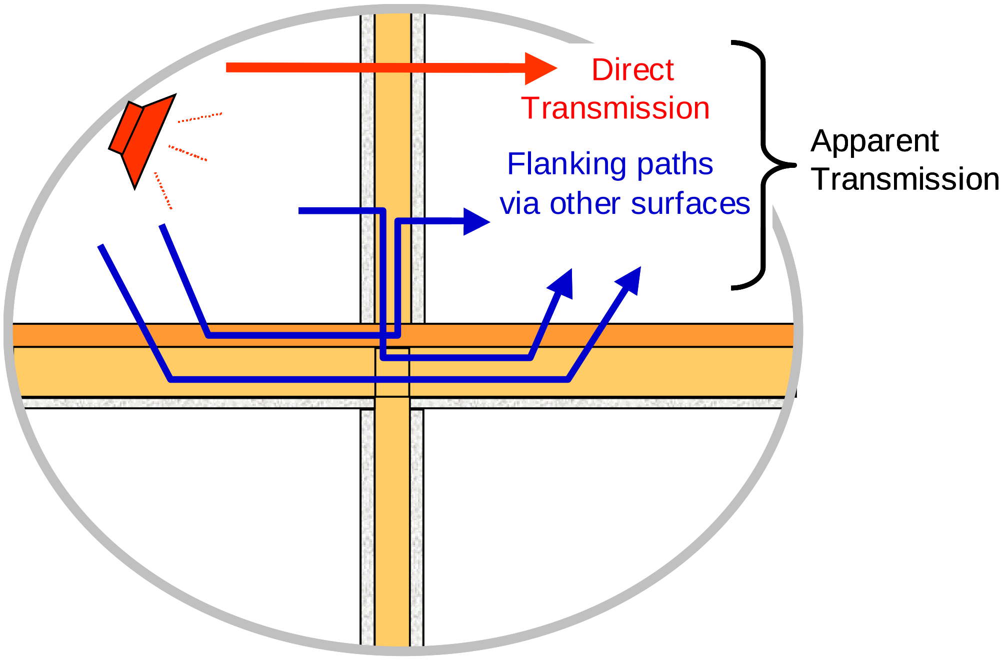
In wood-framed construction (where the ceiling is typically supported on resilient metal channels to reduce direct transmission through the floor/ceiling assembly) the main paths for this structure-borne transmission involve the wall/floor junction, so this is the focus for most of the following discussion.

Basic Concepts for Airborne Sound Sources

Sound in a room may come from many sources – someone talking, or the loudspeakers of a TV or stereo sound system. In the following drawings a red loudspeaker is used to indicate such sound sources, referred to as airborne sound sources.

A separate section deals with the transmission of **impact noise due to footsteps**

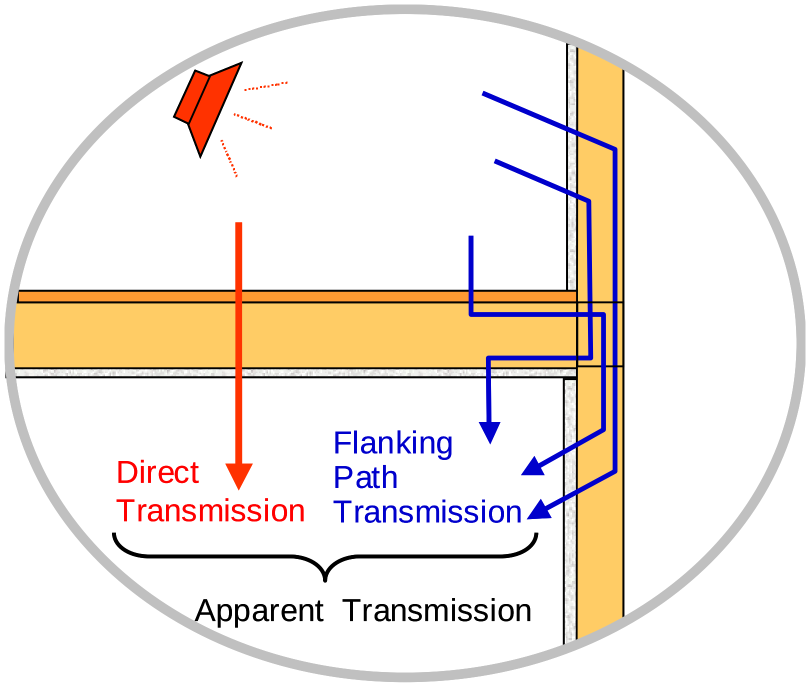
Some of the sound energy may be transmitted directly across the wall and floor assemblies and some via the floor/wall junction, as indicated by the arrows. In addition to the Direct Transmission through the separating wall (the STC for the wall describes this), there are other paths involving structure-borne transmission across the floor and wall surfaces, which acoustical standards call "Flanking Transmission" because they transmit vibration *around* the partition nominally separating the two rooms.



The Apparent Transmission includes both the Direct Transmission through the wall and the additional energy transmitted by Flanking Transmission via structure-borne paths, so the resulting Apparent-STC is lower than the STC rating for direct transmission through the wall.

From the occupants' perspective, all that matters is the overall sound isolation between the adjacent spaces, including the effect of all transmission paths. For airborne sound, the Apparent-STC provides a standardized estimate of this sound isolation.

For sound transmission between rooms separated by a floor, flanking transmission tends to reduce the Apparent-STC relative to the value for direct transmission through the floor assembly. As indicated by the arrows, there are generally a number of structure-borne flanking transmission paths in addition to direct transmission through the separating floor assembly.



Which paths are most significant depends on details of the wall and floor assemblies. Discussion of typical constructions later in this guide will show only the most important paths, but it should be remembered that changing some of the details could add other significant paths that reduce the overall sound isolation.

Whether for transmission from the room above to the room below, or vice versa, the Apparent-STC is the same (and the same transmission paths are important) for airborne sound.

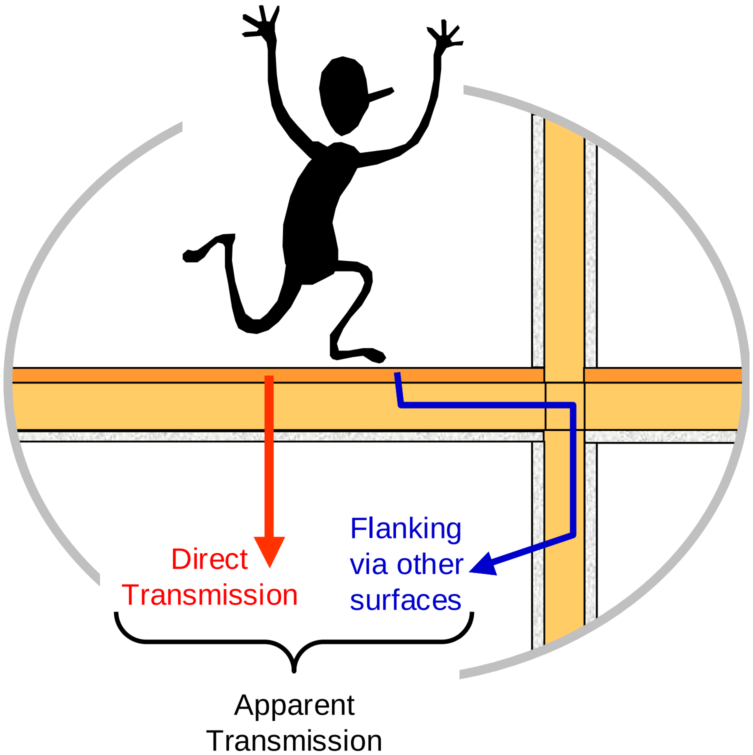
Summary – Basic Concepts for Airborne Sources

Because all types of construction have some flanking transmission, the Apparent-STC between rooms in buildings is systematically less than the STC for the separating wall or floor.

Flanking significantly reduces the apparent sound isolation for some constructions, but it can be systematically controlled.

Basic Concepts for Impact Sound Sources

The impact noise of primary concern is that due to footsteps. In the following drawings a small person is used to represent impact sound sources. This figure is sized to fit on the drawings; in the later drawings, scaling considerations would suggest a very small person, which is quite suitable because young children running and jumping pose some of the most severe tests of impact insulation for lightweight wood framed construction.



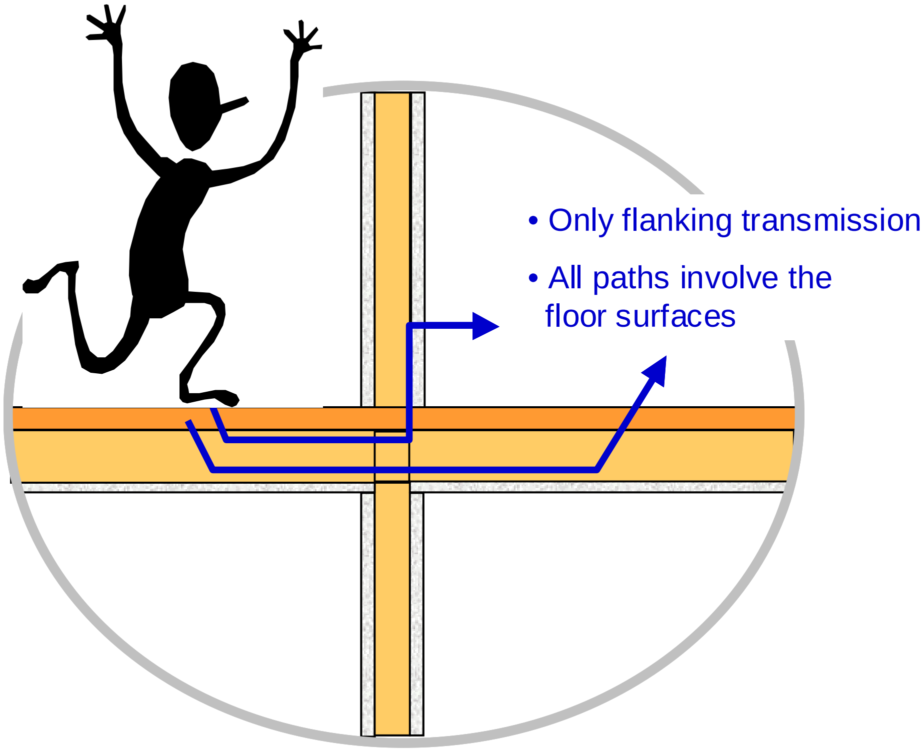
A separate section deals with the parallel problem of controlling **noise from airborne sound sources** such as someone talking, or the loudspeakers of a TV or stereo sound system.

As indicated by the arrows, some of the impact sound energy may be transmitted directly through the floor assemblies (the laboratory IIC for the floor rates this) and some is structure-borne transmission (flanking) across the floor assembly and via the floor/wall junction into attached surfaces that radiate the sound. From the occupants' perspective, all that matters is the overall sound insulation between the adjacent spaces, including the effect of all transmission paths.

When the receiving room is below the impact source, the Apparent Transmission includes both the Direct Transmission through the floor and the additional Flanking Transmission via structure-borne paths, so the resulting Apparent-IIC[1] tends to be lower than the IIC rating for direct transmission.

[1] For consistency with terminology in the section on airborne sources, the term "*Apparent* Impact Insulation Class (*Apparent*-IIC)" is used here. The pertinent ASTM standard (E1007) calls this quantity Field Impact Insulation Class, but only applies to the case of vertical transmission.

For side-by side rooms, flanking may also cause serious impact sound transmission, despite the absence of direct transmission. As indicated by the arrows, there are generally a number of structure-borne flanking transmission paths.



Which transmission paths are most significant depends on details of the wall and floor assemblies. Discussion of typical constructions later in this guide will show only the most important paths, but it should be remembered that changing some of the details could add other significant paths that reduce the overall sound insulation.

Summary – Basic Concepts for Impact Sources

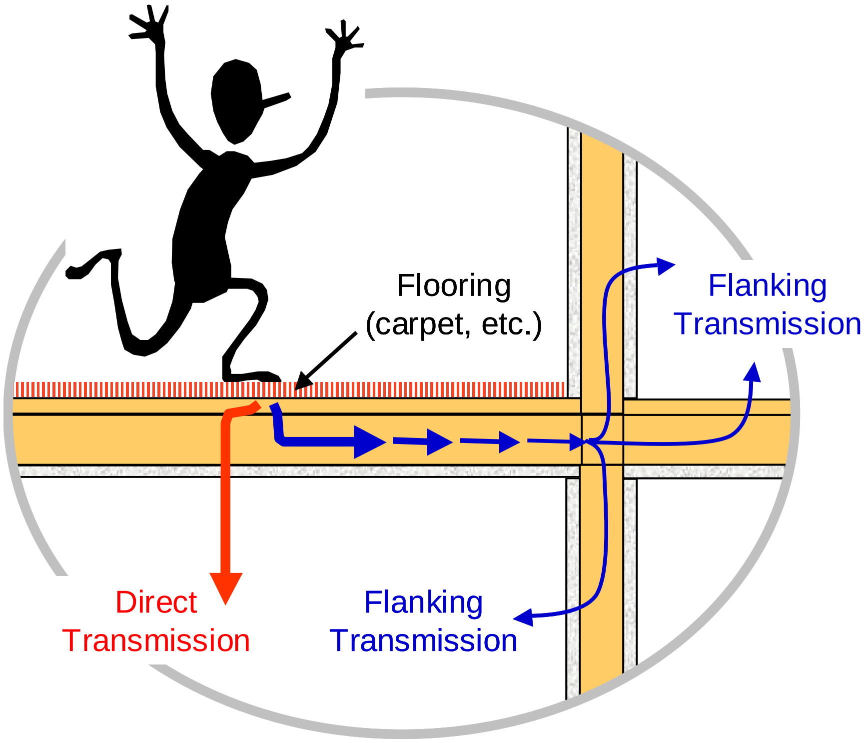
Flanking transmission of impact sound is a concern both for rooms beside and below the one where footsteps are creating impact sound. Because all types of construction have some flanking transmission, the Apparent-IIC to the room below is systematically less than the IIC for the separating floor.

Flanking significantly reduces the apparent sound insulation for some constructions, but it can be systematically controlled.

Basic Concepts for Impact Transmission on Joist Floors

For lightweight wood framed construction, the transmission of structure-borne sound is quite complicated, because several factors can change the strength of the transmitted footstep sound.

One obvious factor is the floor surface. Toppings that increase surface weight reduce impact sound at low frequencies, but hard surfaces increase the high frequency sound. Adding flooring such as carpet over the basic floor assembly gives a softer surface that reduces the impact energy injected into the underlying floor, especially for high frequencies.



Some of the impact energy is transmitted as structure-borne vibration across the floor assembly and via the floor/wall junction into attached surfaces that radiate the flanking sound into adjacent rooms, as indicated by the arrows.

For lightweight joist floors, the vibration energy is attenuated before it reaches the floor/wall junction. The vibration is attenuated more for transmission across the floor perpendicular to the joists than in the direction parallel to the joists, and adding a topping to the floor changes the rate of attenuation.

Summary –Concepts for Impact Sound on Joist Floors

The strength of the structure-borne impact sound reaching adjacent rooms depends on:

- the floor surface,
- the direction of floor joists relative to the wall,
- how far the impact source is from the floor/wall junction.

Design Approach

This section begins with a brief listing of some important findings for flanking involving the wall/floor junction that may influence the sound insulation achieved by a wood frame building.

Key Factors for Flanking:

Except where required for wind and seismic loads, building elements (such as OSB, gypsum board, joists, etc.) should not be continuous across or under a partition because they can introduce strong flanking paths.

Whether the room pairs are separated by a partition floor or a wall, unless the floor has a massive and resiliently isolated topping, the dominant flanking path typically involves the top surface of the floor and the flanking junction formed by intersection of the wall and floor. One of the most important factors in determining the magnitude of the floor flanking path(s) is joist orientation (parallel versus perpendicular to the flanking junction).

In comparison to the effects associated with continuity and joist orientation, other details (junction blocking details at the wall/floor junction, solid lumber versus wood-I joists, OSB versus plywood subfloor) were not particularly important. Wall type (single versus double stud) was important for side-by-side rooms, but not as important for one room above the other.

Flanking paths involving the floor can be significantly suppressed by adding a floor topping, but joist orientation remains a factor because the effectiveness of a topping depends on the floor to which it is applied. In general, a topping affects airborne and impact sources differently, and affects direct and flanking transmission paths differently:

- For airborne sound insulation, the most important factor is the mass of the applied topping. Topping installation (bonded, placed, or floating on a resilient material) is also significant but less important.
- For impact sound insulation, there are three important factors – topping mass, topping installation and, hardness of the exposed topping surface. A significant increase in mass is required to improve low frequency impact sound insulation. Resilient support of a topping tends to improve performance. A hard subfloor or topping surface (such as concrete) tends to worsen impact noise and lower the IIC, but addition of a floor covering tends to mask this in practice

Floor coverings can significantly improve the apparent impact sound insulation when the floor covering reduces the hardness of the floor surface. Thus, carpet will be more effective than vinyl and both tend to be more effective when applied over hard concrete or gypsum concrete surfaces than over comparatively soft surfaces like OSB.

Flanking paths involving gypsum board surfaces can be significantly suppressed by mounting the gypsum board on resilient channels. Adding resilient channels is more effective than directly attaching another layer of gypsum board.

The preceding observations are limited to constructions examined in the supporting study and are not necessarily applicable to an arbitrary construction, so the results should be used with care. However, they should be sufficient to identify the most important parameters when considering the acoustical design of a wood frame construction for noise sources other than plumbing or HVAC.

It should also be noted that there are factors such as room dimension (which determines the relative length of the junctions), and typical location for impact sources, that cannot be adequately addressed in a simple design approach like that presented here. Such factors may be important, but their effect can only be estimated using a more detailed calculation.

The following discussion assumes that the use for the rooms – and hence the apparent airborne and impact sound insulation needed between them – has been chosen.

There are basically four steps in the design approach. However, several iterations may be required to arrive at a design that satisfies requirements for sound insulation, fire resistance and structural integrity.

Step 1 – Select possible partitions

Possible partitions (wall and floor assemblies) must have a direct sound insulation rating (STC, and IIC if relevant) that is at least as great as the required apparent sound insulation between rooms.

Step 2 – Establish basic framing details

While basic framing details typically will not change which flanking path is dominant for a particular junction, they can change the magnitude of flanking transmission. Thus, the next step is to take the wall and floor assemblies chosen in Step 1, and to decide the configuration that will minimise flanking transmission and hence provide the greatest apparent sound insulation.

The tables below provide a listing of the factors and their effect on the dominant flanking path for horizontally and vertically separated rooms.

Because results from the supporting study indicated that flanking is most severe for horizontally separated rooms, the design should begin by considering design details for horizontally separated rooms.

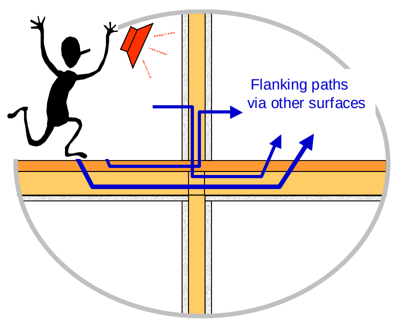
Step 2a – Horizontally separated rooms

The dominant flanking path for this room pair is from the floor in one room to the floor in the other. Other paths (floor-wall and wall-floor) are relatively unimportant except when a floor topping is applied.

Particular attention should be paid to floor and wall details that will affect transmission from one floor to the other.

The table indicates that – with or without a topping – the preferred joist orientation is parallel to the flanking junction when the partition wall is single stud construction. However, when the partition wall is double stud construction the preferred joist orientation is perpendicular, if there is no topping. (There are no data to indicate the trend when the partition wall is double stud and there is a topping).

Horizontally Separated Rooms



Floor Element and Condition		**Wall Type (double stud best)** [2]	
		Single Stud	**Double Stud**
Joist	**Orientation**	Parallel better than Perpendicular	Perpendicular better than Parallel
	Continuity	Avoid[3]	Avoid
	Type	Minimal difference	Minimal difference
Subfloor	**Continuity**	Minimal difference	Discontinuous much better
	Type (OSB/plywood)	Minimal difference	Minimal difference
Topping rank	**Floating LEVELROCK**	1	1
	Bonded LEVELROCK	2	2
	OSB overlay	3	3

It is recognised that the preferred joist orientation cannot be used at the junction with all noise sensitive spaces, so the preferred joist orientation should be reserved for the junction between those of greatest concern.

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[2] When the rooms are horizontally separated by a partition wall there is less flanking involving the subfloor when the wall is of double stud construction

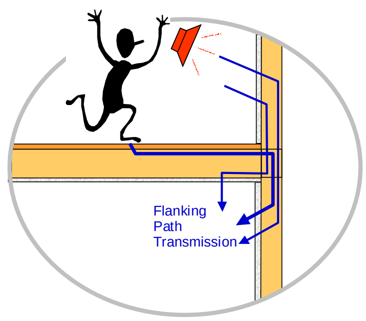
[3] Support joists on one side of the wall using joist hangers.

Step 2b – Vertically separated rooms

The dominant flanking path is from the floor in the room above to the wall(s) in the room below when the gypsum board ceiling is mounted on resilient channels. Other paths (wall-wall and wall-ceiling) are relatively unimportant except when a very effective floor topping is applied.

For vertically separated rooms, there will typically be four wall floor junctions contributing to the flanking transmission. At first glance this might make the design process appear more complicated than for horizontally separated rooms but it is actually simpler. If the same wall type is used at each junction and all four junctions contribute then there is no advantage to a particular joist orientation. This is because the joists will be parallel to two junctions and perpendicular to the other two.

Vertically Separated Rooms



Floor Element and Condition		Wall Type (minimal difference) [4]	
		Single Stud	**Double Stud**
Joist	**Orientation**	Parallel better than Perpendicular	Perpendicular better than Parallel
	Continuity	N/A	N/A
	Type	Minimal difference	Minimal difference
Subfloor	**Continuity**	N/A	N/A
	Type (OSB/plywood)	Minimal difference	Minimal difference
Topping rank	**Floating** LEVELROCK	1	1
	Bonded LEVELROCK	2	2
	OSB overlay	3	3

The table suggests that the only major advantage can be gained if the two of the walls are single stud and two are double stud, and joists are oriented parallel to the single stud walls, and perpendicular to the double stud walls.

[4] When the rooms are vertically separated by a partition floor flanking involving the subfloor is not particularly sensitive to the type of wall

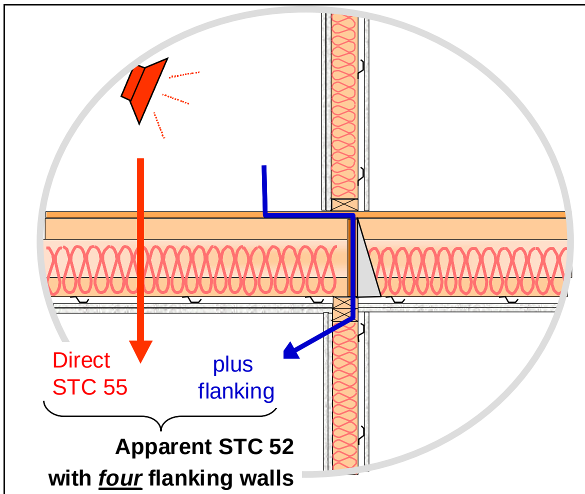
Step 3 – Optimize surface treatments

Because one or more surfaces of the separating floor or wall will support flanking paths, it is best to choose a partition design that also minimises flanking transmission.

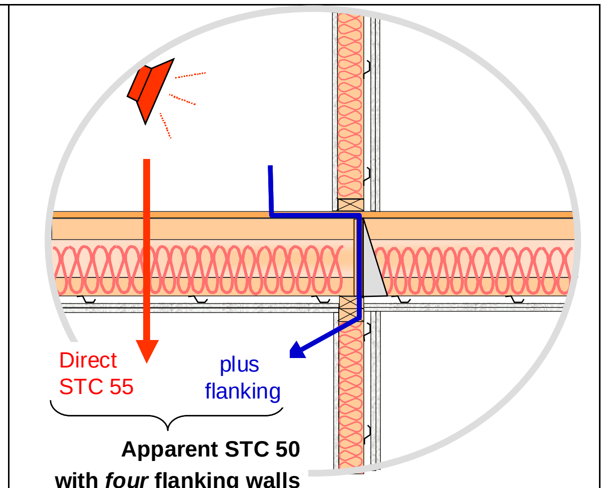
Locate extra surface layers where they provide most benefit. Increase the weight of direct attached gypsum board surfaces expected to involve a significant flanking path, or resiliently mount the gypsum board.

An example is given to illustrate the point.

The example has a single stud wall with resilient channels on one side of the partition wall, in apartment construction. The dominant vertical flanking path involves the supporting wall(s) below, and the same wall(s) must adequately suppress direct transmission between horizontally separated rooms. As shown in the sketches, layers of gypsum board should be placed to maximize the number of direct attached layers, while meeting the sound insulation and fire resistance requirements for the wall.



Better



Worse

Best for Flanking: Mounting the gypsum board on both sides of the wall on resilient channels minimises flanking for all paths, but requirements for racking resistance of the wall may prevent this.

Vertical insulation between the rooms to the right of the wall should approach the direct STC of 55 in all cases, because the resilient channels on the walls reduce flanking to insignificance.

Adding more layers of material is effective ***only*** if they are properly positioned. In general it is most effective to increase the mass of the subfloor, which improves ***all*** the flanking paths (vertical and horizontal) as well as the direct path for vertical transmission.

The final task is to estimate the apparent airborne and apparent impact sound insulation and determine whether the chosen joist orientation and basic wall type will meet the design goals.

If the apparent airborne or impact sound insulation is deficient, then Steps 1 to 3 must be repeated with some changes, or one must accept that a topping will be required and go to Step 4.

Step 4 – Establish the topping and floor covering

Because the dominant flanking path involves the floor for both horizontally and vertically separated rooms, a floor topping can be a very effective treatment to make-up for any deficiencies remaining after Step 3.

Tables of **changes in apparent airborne** and **changes in apparent impact** sound insulation for specific toppings can be used to select a possible topping.

Using softer floor covering (carpet instead of vinyl) in the source room can be used to improve the impact sound insulation, but this will not improve the airborne sound insulation because these coverings are limp and lightweight.

Sound from Airborne Sources

Flanking in Typical Wood-framed Constructions (for airborne sources)

This section gives information on flanking transmission for some common wood-frame constructions It deals with sound transmission from airborne sound sources such as loudspeakers or people speaking. A similar section on **Impact Sound Transmission** presents the corresponding cases with noise from footsteps.

This section is divided into two parts, considering the apparent sound transmission between two adjacent rooms that are:

1. one above the other (separated by a floor)
2. one beside the other (separated by a wall)

As noted in the introduction, the experimental study included only a limited set of constructions, all of them wood-framed. Other specific constraints imposed on the research specimens included the following:

- Many of the materials were specific proprietary products, which are identified in individual assembly specifications in a later section, with details of their installation. It should be understood that some variation must be expected in practice if "generic equivalents" are substituted or details are changed.
- Floor assemblies used wood joists spaced 406 mm on centre, with a subfloor surface of 19 mm OSB or plywood. Their ceilings had 2 layers of 15.9 mm fire-rated gypsum board, installed on resilient metal channels, spaced 406 mm on centre.
- Horizontal wall-wall paths were suppressed by resilient mounting of surface layers on walls other than the separating wall between side-by-side rooms. From the relative significance of the wall-wall path in vertical transmission, this is expected to be a minor concern, but that was not verified in this study.

To some degree these consistent factors limited the significant flanking paths. In wood-framed construction with the ceiling supported on resilient metal channels to reduce direct transmission through the floor/ceiling assembly, the main paths for structure-borne transmission involve the wall/floor junction, so this is the focus for most of the following discussion.

Because many materials and construction details were kept constant, clear and consistent trends could be associated with specific construction changes, but it must be recognized that the results may not capture the effect of all significant variants. Despite this caveat, the authors believe that trends shown here do provide a good estimate of the main flanking problems in typical wood-framed constructions.

Vertical Flanking in Basic Wood-framed Constructions
(One room <u>above</u> the other, airborne sound source)

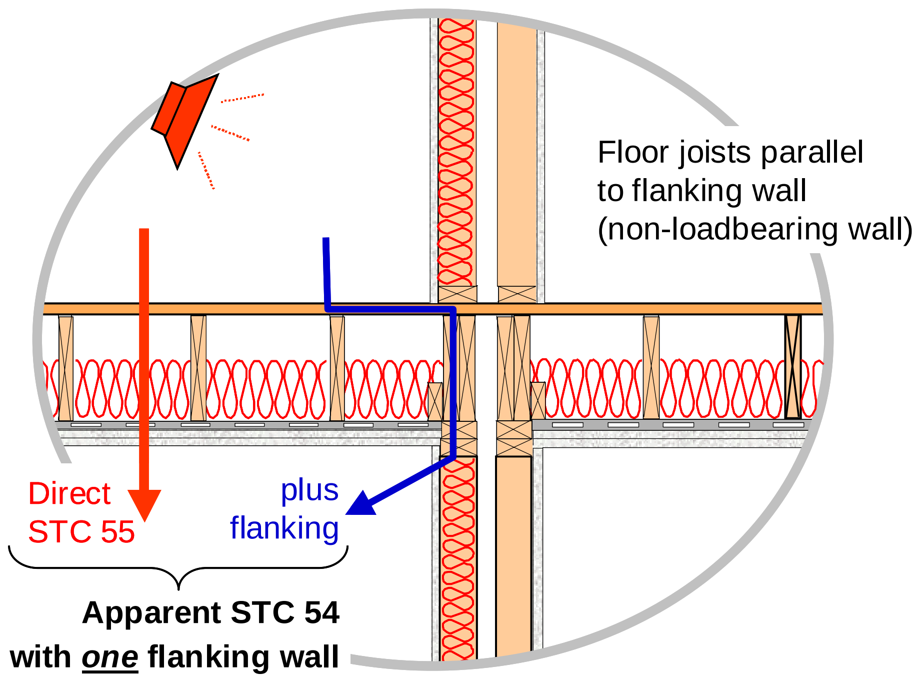
For the case where one room is above the other, there are two key issues:

1. The main flanking path is consistently from the subfloor of the room above to the walls of the room below or vice versa, if the floor surface is a layer of oriented strand board (OSB) or of plywood directly fastened to the top of the floor joists.

2. Reduction of Apparent-STC by flanking depends on the flanking transmission via <u>all</u> walls of the room below.

The discussion starts with flanking via just one wall (to explain relative significance of specific aspects of the constructions), and then shows the combined effect of flanking via all wall surfaces in the room below.

Sound transmission paths are shown in the figure below, for the case where floor joists are parallel to the flanking wall and that wall has double wood stud framing. The dominant flanking path is via the subfloor of the room above and wall of the room below.



The STC of 55 for direct sound transmission through the floor/ceiling system would be good enough to satisfy most occupants most of the time. The Apparent-STC was lower by 1 or 2 in all cases studied, even including only the flanking by <u>one</u> wall.

Changes in the construction can alter the flanking transmission and hence the Apparent-STC, and a number of specific variants are listed in the table below, with their typical effect.

The Apparent-STC seems to change only slightly, and remains close to the STC 55 rating for direct transmission through the floor.

Change in Construction	**Typical Effect due to <u>one</u> flanking wall[1]**	**Resulting Apparent-STC[1]**
Changing Floor Materials: OSB subfloor ⇒ plywood, or dimensional wood floor joists ⇒ wood-I joists	change not significant	53-55
Changing Framing of floors, or of walls, or of floor/wall junction	May be significant (see next case)	53-55
Changing Walls Below: On walls below, 1 layer ⇒ 2 layers of gypsum board	less flanking	54-55
On walls below, mount gypsum board on resilient metal channels	negligible flanking	55

Note 1: Apparent-STC values in this table include only the direct transmission via the floor (STC 55) and flanking via one wall – how to include flanking via all significant walls of the room below is explained later.

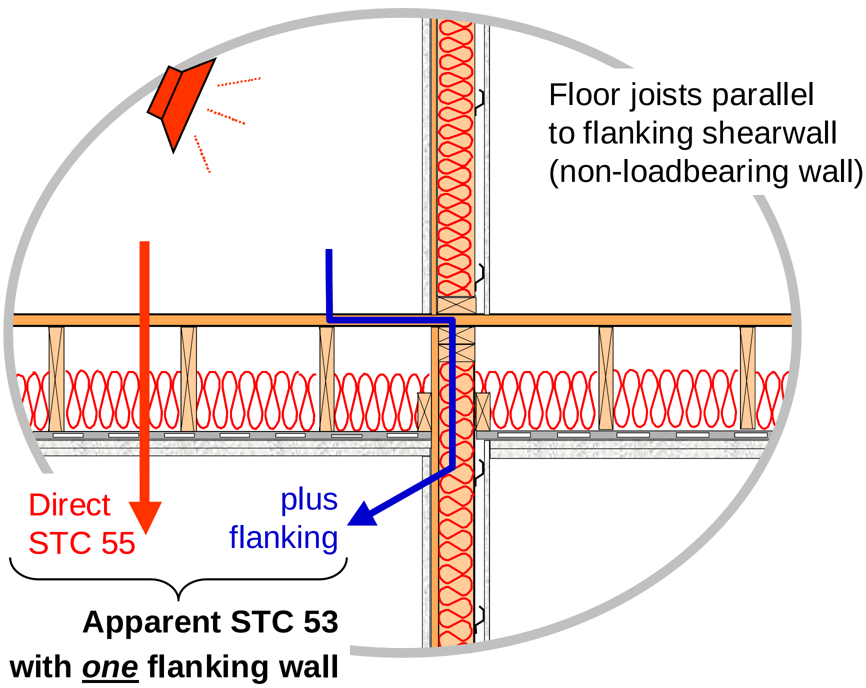
Note 2: All cases shown in the table above assume a floor assembly with 19 mm OSB subfloor attached over joists spaced 400 mm on centre, and a ceiling with two layers of fire-rated gypsum board supported on resilient metal channels, spaced 400 mm apart (typical STC=55 for direct transmission). With changes to the floor/ceiling system, the direct transmission through the ceiling and hence the significance of the flanking could change appreciably, as illustrated in the next table.

In practice, the Apparent-STC may vary depending on the specific products used and the details of installation as noted above, but this table (like similar tables in later sections) shows explicit values to clarify the trends to be expected with the listed individual changes.

Changing the orientation of the floor joists relative to the wall of concern (from parallel to the wall to perpendicular to the wall), or changing the wall framing from double row of studs to single studs or to staggered studs with a common plate, or changing the construction at the floor/wall junction all have some effect on the flanking transmission from the upper room to the one below, or vice versa. Most of these changes in vertical flanking transmission due to framing variations are small enough so they can be ignored in practice.

There seems to be slightly more vertical flanking when the floor joists are perpendicular to the wall (i.e. - for a load-bearing wall) than when joists are parallel. However, the difference is small and floor joists are normally parallel to some walls in the room below and perpendicular to others, so an average value can be used with reasonable confidence.

Vertical flanking has been found to be significantly worse only for the case with a shear wall where the joists are parallel to the wall and the plates at top/bottom of the wall framing are directly connected to the subfloor, as illustrated below.



In this case, the Apparent-STC of 53 was significantly lower than for other cases tested. Hence this case is treated differently in the following table showing the combined effect of flanking paths via all the significant walls in the room below.

Table of Typical Vertical Flanking (basic floor)

The following table gives Apparent-STC due to the combined effect of direct transmission through the basic floor/ceiling, plus total flanking transmission via four walls of the room below, for four specific cases.

	Better Floor: 2 layers of gypsum board on resilient metal channels spaced @600mm (Direct STC= 59 with no topping)	**Floor with** 2 layers of gypsum board on resilient metal channels spaced @400mm (Direct STC= 55 with no topping)	**Worse Floor:** 1 layer of gypsum board on resilient metal channels spaced @400mm (Direct STC= 51 with no topping)
All Walls with resilient channels supporting gypsum board in room below **(Best case: no flanking)**	59	55	51
Walls with 2 layers of gypsum board applied directly to the studs	54	52	50
Walls with 1 layer of gypsum board applied directly to the studs	52	51	49
Worst Case Walls: Single layer applied to all walls, one is shear wall	50	49	48

*Note: This table presents Apparent-STC expected with a basic OSB or plywood subfloor. The section on **Changes to Control Vertical Flanking** gives the effect of modifying the floor surface.*

For intermediate situations where walls are a mix of these cases, a weighted linear average should be used. For example, when the gypsum board of one wall in the lower room is on resilient channels, two walls have 2 layers directly attached to the studs, and the fourth wall has a single layer directly attached gypsum board, the weighted linear average of the values for the "Better Floor" would be [(59+2x54+52)/4], giving Apparent-STC 55.

The Apparent-STC expected due to all paths was calculated from the best estimates for direct transmission plus flanking paths for all significant walls in the room below. The latter were based on an average of the flanking transmission with floor joists parallel or perpendicular to the wall, for single stud or double stud walls. As noted above, the difference among these configurations is small and floor joists are normally parallel to some walls in the room below and perpendicular to others, so an average value can be used with reasonable confidence.

Summary – Vertical Flanking in Typical Constructions

For the case where one room is above the other, the Apparent-STC between two rooms is systematically less than the STC for direct transmission through the separating floor.

There are three main issues:

1. The main flanking path is consistently from the subfloor of the room above to the walls of the room below or vice versa, if the subfloor is a layer of oriented strand board (OSB) or of plywood directly fastened to the top of the floor joists.
2. Some changes in the wall below can significantly reduce transmission via a specific wall surface. Adding a second layer of gypsum board reduces flanking, and mounting gypsum board on resilient channels should reduce flanking to insignificance for most practical floor assemblies.
3. Reduction of Apparent-STC by flanking depends on the flanking transmission via all walls of the room below.

As discussed in the detailed report[5], the estimates in this section should be applied only for cases where wall and floor details are within the range of the tested specimens (see specifications in section on **Changes to Control Horizontal Flanking**)

[5] *Flanking Transmission at the Wall/Floor Junction in Multifamily Dwellings -- Quantification and Methods of Suppression,* Research Report, Institute for Research in Construction, National Research Council Canada, (168), 2005 (RR-168)

Horizontal Flanking in Basic Wood-framed Constructions
One room <u>beside</u> the other, airborne sound source)

For the case where one room is beside the other, there are two key issues:

1. The main flanking path is consistently from the floor of one room to the floor of the room beside, if the subfloor is a continuous layer of oriented strand board (OSB) or of plywood directly fastened to the top of the floor joists.

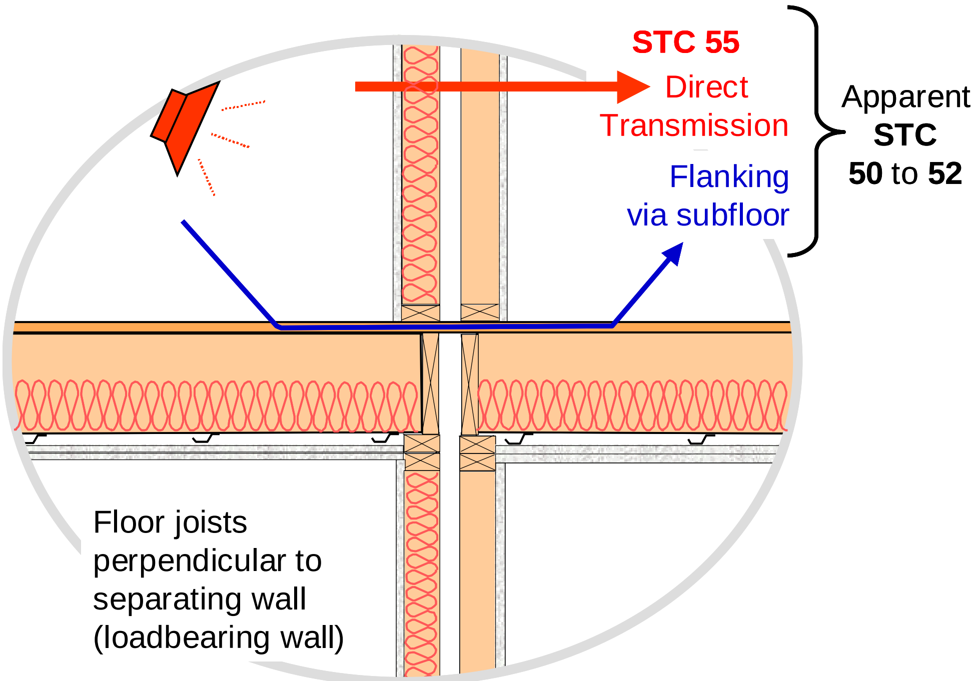
2. Reduction of Apparent-STC may be affected by details of the floor assembly, the wall assembly, and the continuity of structural elements across the floor/wall junction.

Note that the above assumes that other horizontal paths (wall-wall and ceiling-ceiling paths) are not significant. This will be the case if there are resilient channels or other vibration breaks in such paths.

To highlight the key factors influencing flanking across floor/wall junctions, a number of typical configurations are presented, proceeding from cases where the flanking effect is rather small to cases where flanking drastically reduces the sound isolation.

With the subfloor continuous across the junction at a double stud wall, Apparent-STC is appreciably below the STC 55 for direct transmission through the separating wall.

[Link to Corresponding Impact]



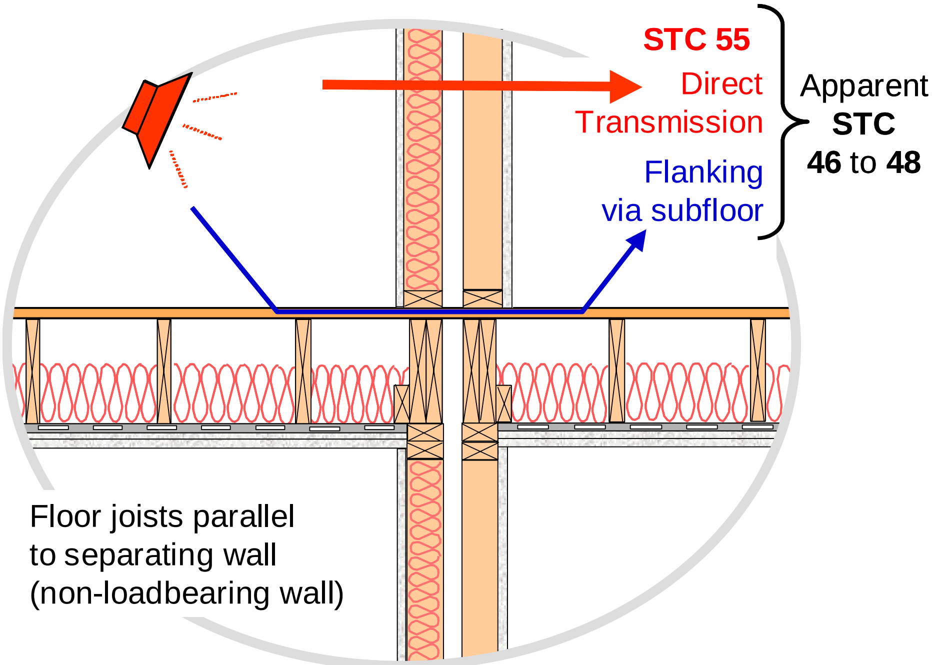
The Apparent-STC may be changed by specific changes in the floor assembly, the floor/wall junction, or the wall assembly.

Change in Construction	Typical Effect	Apparent STC
Changing Floor: 16 mm OSB subfloor ⇒ plywood subfloor, or dimensional wood floor joists ⇒ wood-I joists	Change not significant	50-52
Changing Floor/Wall Junction: Subfloor break at wall cavity	Improvement depends on firestop[1]	50-55 depends on firestop[1]
Changing Wall: Double gypsum board on each side and insulation on each side (Direct STC 66)	Improvement depends on firestop[1]	52-66 depends on firestop[1]

[1] See *Best Practice Guide on Fire Stopping and Fire Blocking and Its Impact on Sound Transmission*, available late 2005 from, Institute for Research in Construction, National Research Council Canada.

With the subfloor continuous across the junction at a double stud wall, and floor joists parallel to the wall, the Apparent-STC is even farther below the STC 55 for direct transmission through the separating wall.

[Link to Corresponding Impact](#)



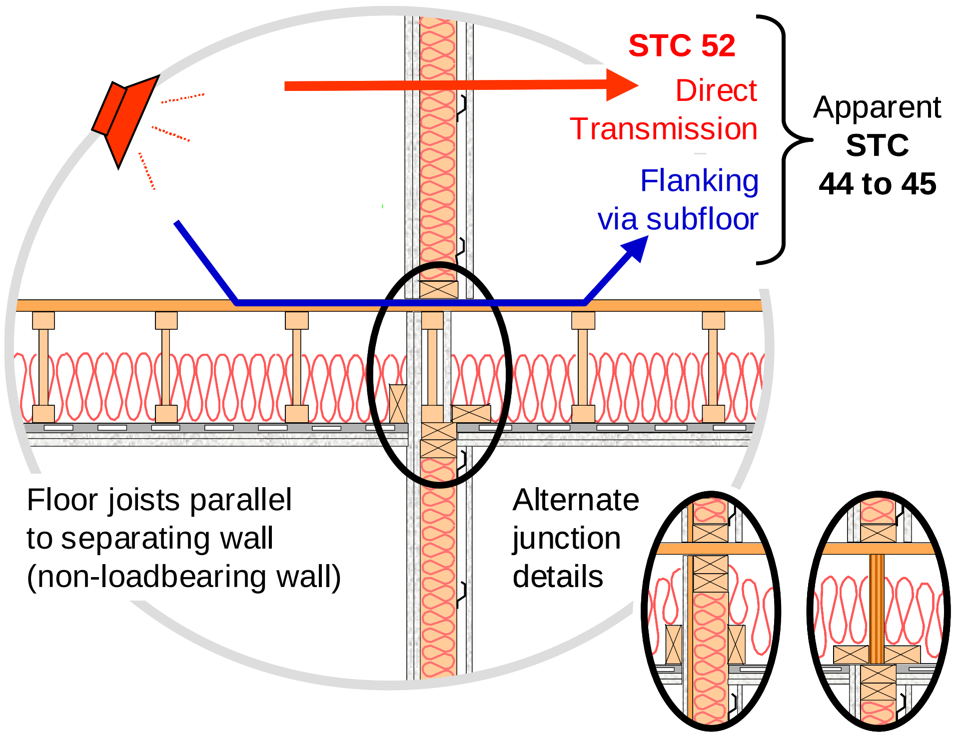
The Apparent-STC may be changed by specific changes in the floor assembly, the floor/wall junction, or the wall assembly.

Change in Construction	Typical Effect	Apparent STC
Changing Floor: 16 mm OSB subfloor ⇒ plywood subfloor, or dimensional wood floor joists ⇒ wood-I joists	Change not significant	46-48
Changing Floor/Wall Junction: Subfloor break at wall cavity	Improvement depends on firestop[1]	46-57 depends on firestop[1]
Changing Wall: Double gypsum board on each side and insulation on each side (Direct STC 66)	Improvement depends on firestop[1]	48-66 depends on firestop[1]

[1] See *Best Practice Guide on Fire Stopping and Fire Blocking and Its Impact on Sound Transmission*, available late 2005 from, Institute for Research in Construction, National Research Council Canada.

With the floor joists parallel to the separating wall, changing from the double stud wall to a simpler single stud wall assembly permits more transfer of structural vibration across the junction, and hence lowers the Apparent-STC to about 45.

Link to Corresponding Impact

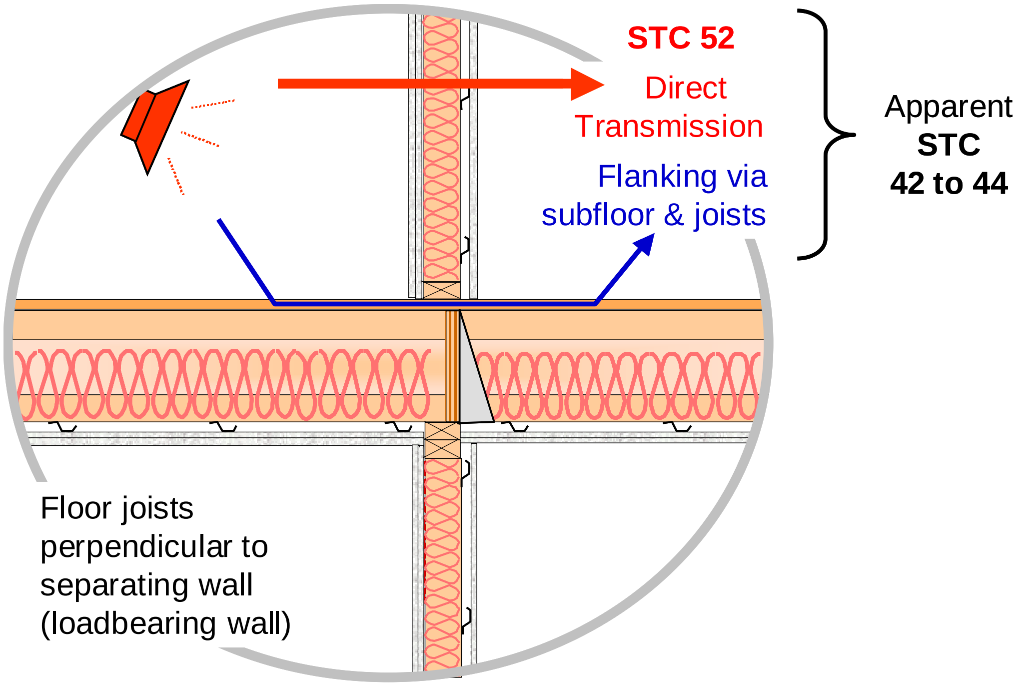


Changing the materials in the floor assembly, or changing to alternate floor/wall junction detail at the junction, or improving the wall assembly have only slight effect on the Apparent-STC, except that the shear wall lowers the Apparent-STC to 42.

Change in Construction	**Typical Effect**	**Apparent STC**
Changing Floor: 16 mm OSB subfloor ⇒ plywood subfloor, or wood-I floor joists ⇒ dimensional wood joists	Change not significant	44-45
Changing Floor/Wall Junction: Subfloor break at wall or alternate fire block details	Slightly worse (shear wall is worst)	42-45
Changing Wall: 2 layers of gypsum board on each side (Direct STC 57)	Slight improvement	45-47

With the single stud wall assembly, changing orientation of the floor joists from parallel to the separating wall to perpendicular gives more transfer of structural vibration across the floor and alters the junction; this lowers the Apparent-STC even further, to about 43.

Link to Corresponding Impact

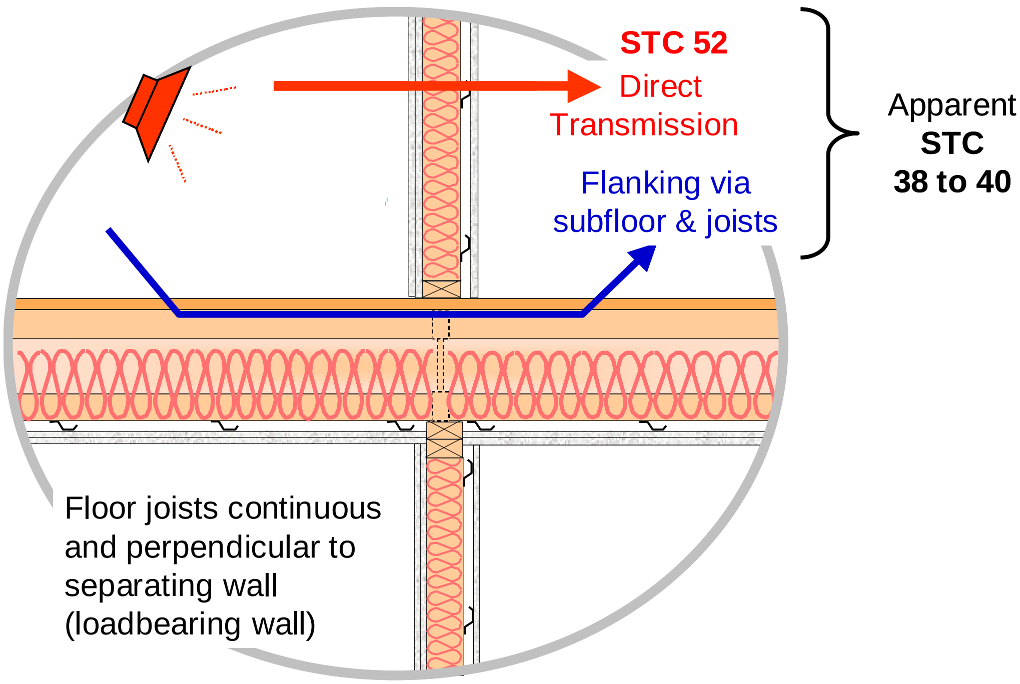


Changing materials in the floor assembly has only a slight effect on the Apparent-STC. In this case, the transmission from floor to floor is clearly dominant, so improving the separating wall to Direct STC 57 barely affects the overall Apparent-STC (and greater improvements in the wall would have the same minimal benefit.)

Change in Construction	**Typical Effect**	**Apparent STC**
Changing Floor: 16 mm OSB subfloor ⇒ plywood subfloor, or wood-I floor joists ⇒ dimensional wood joists	Change not significant	42-44
Changing Floor/Wall Junction: Subfloor break at wall	Change not significant	(no change)
Changing Wall: 2 layers of gypsum board on each side (Direct STC 57)	Change not significant	(no change)

With the subfloor and the joists continuous across the floor/wall junction, but the same single stud wall assembly and floor details, there is more transfer of structural vibration across the junction. This lowers the Apparent-STC to below 40.

Link to Corresponding Impact



Changing materials in the floor assembly has a slight effect on the Apparent-STC. In this case, the transmission from floor to floor is so dominant that improving the separating wall to a Direct STC of 57 has negligible effect on the overall Apparent-STC

Change in Construction	Typical Effect	Apparent STC
Changing Floor: 16 mm OSB subfloor ⇒ plywood subfloor, or wood-I floor joists ⇒ dimensional wood joists	Change not significant	38-40
Changing Floor/Wall Junction: Subfloor break at wall	Slight improvement	39-41
Changing Wall: 2 layers of gypsum board on each side (Direct STC 57)	Change not significant	38-40

Summary – Horizontal Flanking in Typical Constructions

For the case where one room is beside the other, the Apparent-STC between two rooms is systematically less than the STC for direct transmission through the separating wall.

There are four main issues:

1. The main flanking path is consistently from the floor of one room to the floor of the other, if the subfloor is a layer of oriented strand board (OSB) or of plywood directly fastened to the top of the floor joists.
2. Reduction of Apparent-STC by flanking is mainly due to the continuity of floor components across the floor/wall junction.
3. Changes in the orientation of the floor joists, or the details of the floor/wall junction can significantly alter the flanking transmission.
4. In the worst cases, the flanking transmission can be much stronger than direct transmission through the nominally separating wall, so that improvements to the wall itself have negligible effect on the Apparent-STC.

Changes to Control Airborne Flanking

Changes to Control Vertical Flanking
(One room <u>above</u> the other, Airborne sound source)

Changes to control flanking must be focused on the elements of the dominant flanking path. For the case where one room is above the other (vertical transmission):

1. The main flanking path is consistently from the subfloor of the room above to the walls of the room below, or vice versa, if the basic floor surface is a layer of oriented strand board (OSB) or of plywood directly fastened to the top of the floor joists.
2. The two surfaces that can be modified to reduce flanking transmission are the walls below and the floor surface above.

The effects of simple changes to the walls of the room below are presented in detail in the earlier section on flanking in typical basic constructions. The combined flanking transmission via all walls of the room below must be considered. Typical Apparent-STC values are listed in the **Table of Typical Vertical Flanking**

- The worst case is with a single layer of gypsum board directly attached to the studs of all the walls below.
- Adding a second layer of directly attached gypsum board provides slight reduction in the flanking transmission.
- If the gypsum board is mounted on resilient metal channels, the flanking via that surface is reduced enough so that it can be ignored. Any such walls need not be included as significant when assessing flanking transmission. Note that resilient channels ***must*** be mounted between the studs and the gypsum board, not between two layers of gypsum board.

In addition to the effect of specific gypsum board treatment of the walls in the room below, the Apparent-STC can also be improved by changing the floor surface.

- Adding a topping over a basic plywood or OSB subfloor gives more attenuation both for direct transmission through the floor and for the dominant flanking transmission paths.
- Adding a topping gives different improvements for direct transmission through the floor and for flanking transmission.
- To complicate matters further, the change in flanking due to adding a topping depends on the type of topping and on the orientation of the floor joists relative to the flanking wall. However, an average value can be used as a slightly conservative design estimate because the floor joists are normally parallel to some walls in the room below and perpendicular to others.

Table of Change in Vertical Flanking due to Toppings

The following Table gives change in Apparent-STC expected from adding a topping, due to direct transmission through the floor/ceiling combined with flanking transmission via the walls of the room below.

		Better Floor: 2 layers of gypsum board on resilient metal channels @600mm (Direct STC= 59 with no topping)	**Floor with** 2 layers of gypsum board on resilient metal channels @400mm (Direct STC= 55 with no topping)	**Worse Floor:** 1 layer of gypsum board on resilient metal channels @400mm (Direct STC= 51 with no topping)
With no floor topping		*Table of Typical Vertical Flanking* ***gives Apparent -STC.***		
All Walls with resilient channels supporting gypsum board in room below **(No flanking)**	Stapled 19 mm OSB topping[2]	+5	+5	+4
	Bonded 25 mm LEVELROCK topping[2]	+11	+11	+11
	38 mm LEVELROCK topping on QUIETZONE mat[2]	+15	+15	+15
All Walls with 1 or 2 layers of gypsum board applied directly to the studs in room below	Stapled 19 mm OSB topping[2]	+4	+4	+4
	Bonded 25 mm LEVELROCK topping[2]	+8	+8	+9
	38 mm LEVELROCK topping on QUIETZONE mat [2]	+11	+12	+13

Note 1: This table presents the change in Apparent-STC expected when a topping is added over a basic OSB or plywood subfloor surface. Add this to the Apparent-STC for the basic system, given in the ***Table of Typical Vertical Flanking****.*

Note 2: Specifications and detail drawings for the basic assemblies and added toppings are given in the following section on ***Changes to Control Horizontal Flanking***

Changes to Control Horizontal Flanking

(One room beside the other, Airborne sound source)

Changes to control flanking must be focused on the elements of the dominant flanking path. For the case where one room is beside the other (horizontal transmission):

1. The main flanking path is consistently from the floor of one room to the floor of the room beside, if the basic floor surface is a layer of oriented strand board (OSB) or of plywood directly fastened to the top of the floor joists.

2. The only surfaces that can be modified to significantly reduce flanking transmission are the floors in the two rooms.

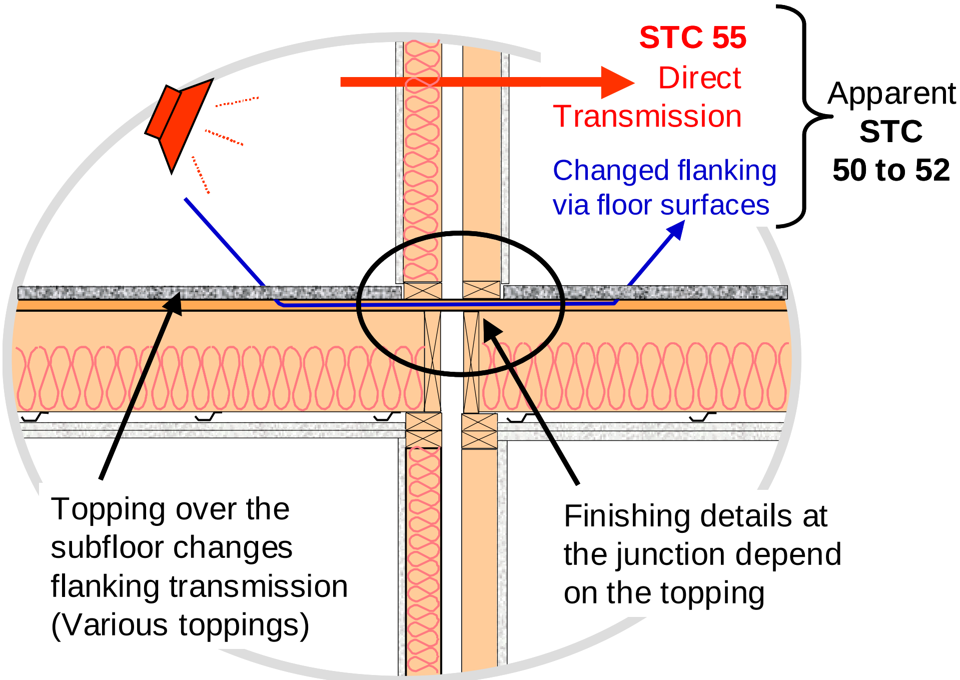
3. The incremental effect of adding a floor topping depends not just on the topping but also on the floor over which it is applied. In particular, the improvement due to a topping may depend strongly on the orientation of the floor joists relative to the floor/wall junction.

4. In some cases, the change in the flanking transmission is substantial, and coupled with improvements to the wall itself may provide a very high Apparent-STC.

Because the effect of toppings depends quite strongly on the supporting floor assembly, the effect is shown for each of the basic floor assemblies in turn.

The Apparent-STC between the side-by-side rooms can be improved by installing a floor topping over the basic OSB or plywood subfloor.

[Link to Corresponding Impact]



Direct transmission though the separating wall limits the Apparent-STC in some cases.

Expected performance with each topping is listed in the table, for the cases with the illustrated basic wall (STC 55), and with a better wall (STC 66) that has double gypsum board on each face and insulation in both stud cavities. No data are available for gypsum concrete toppings with this wall and floor combination.

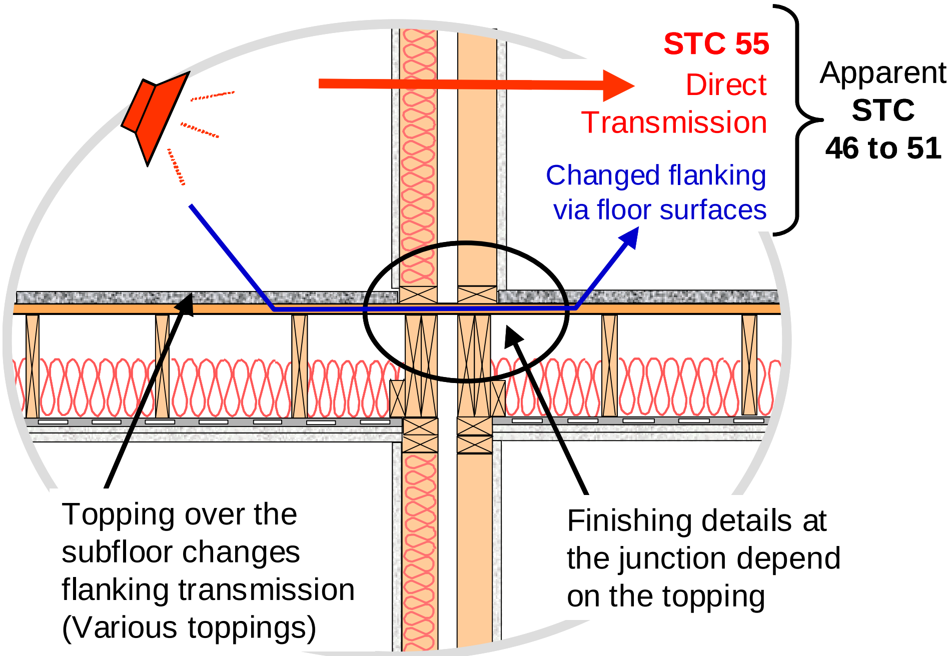
Floor Topping [detail drawings]	**Apparent-STC (Wall STC 55)**	**Apparent-STC (Wall STC 66)**
No topping (basic subfloor)	50	52
19 mm OSB stapled to subfloor	51	60

Note: These estimates were obtained from evaluation of a limited set of specimens built with specific products that are identified in the detailed descriptions. Using "generic equivalents" may change results.

With the joists parallel to the separating wall, the improvement in Apparent-STC due to adding toppings is significant.

Expected performance with each topping is listed in the table, for the cases with the illustrated basic wall (STC 55), and with a better wall (STC 66) that has double gypsum board on each face and insulation in both stud cavities. No data are available for gypsum concrete toppings with this wall and floor combination.

Link to Corresponding Impact

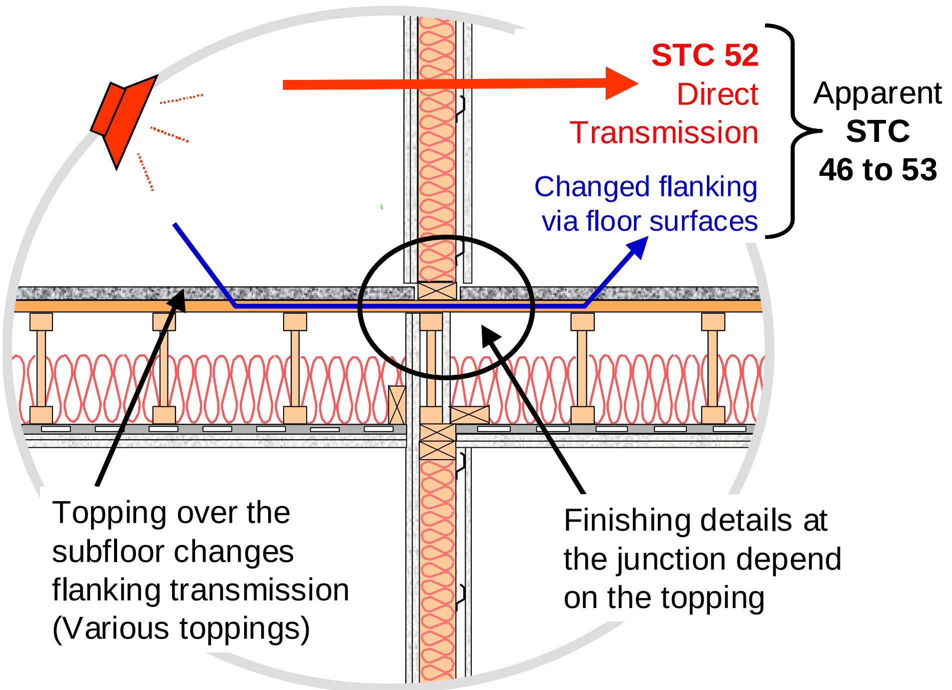


Floor Topping [detail drawings]	Apparent-STC (Wall STC 55)	Apparent-STC (Wall STC 66)
No topping (basic subfloor)	46	48
19 mm OSB stapled to subfloor	51	Not measured

Note: These estimates were obtained from evaluation of a limited set of specimens built with specific products that are identified in the detailed descriptions. Using "generic equivalents" may change results.

With the single stud wall, the improvement in Apparent-STC is limited by direct transmission through the wall in many cases. With a better wall, reduction of flanking transmission via the floor is more evident.

[**Link to Corresponding Impact**]



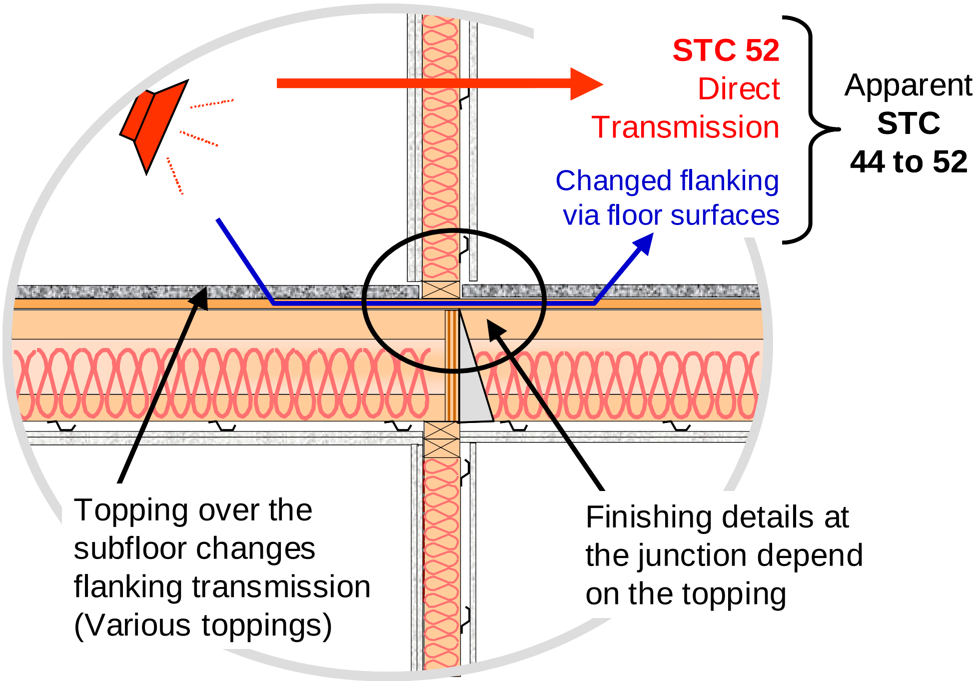
Expected performance with each topping is listed in the table, for the cases with the illustrated basic wall (STC 52), and with a better wall (STC 57) that has double gypsum board on each face.

Floor Topping [detail drawings]	**Apparent-STC (Wall STC 52)**	**Apparent-STC (Wall STC 57)**
No topping (basic subfloor)	46	47
19 mm OSB stapled to subfloor	51	53
25 mm LEVELROCK gypsum concrete bonded to subfloor	51	54
38 mm LEVELROCK gypsum concrete on QUIETZONE mat covering subfloor	53	57

Note: These estimates were obtained from evaluation of a limited set of specimens built with specific products that are identified in the detailed descriptions. Using "generic equivalents" may change results.

With the joists perpendicular to the separating wall, the improvement in Apparent-STC due to adding toppings is greater.

[Link to Corresponding Impact]



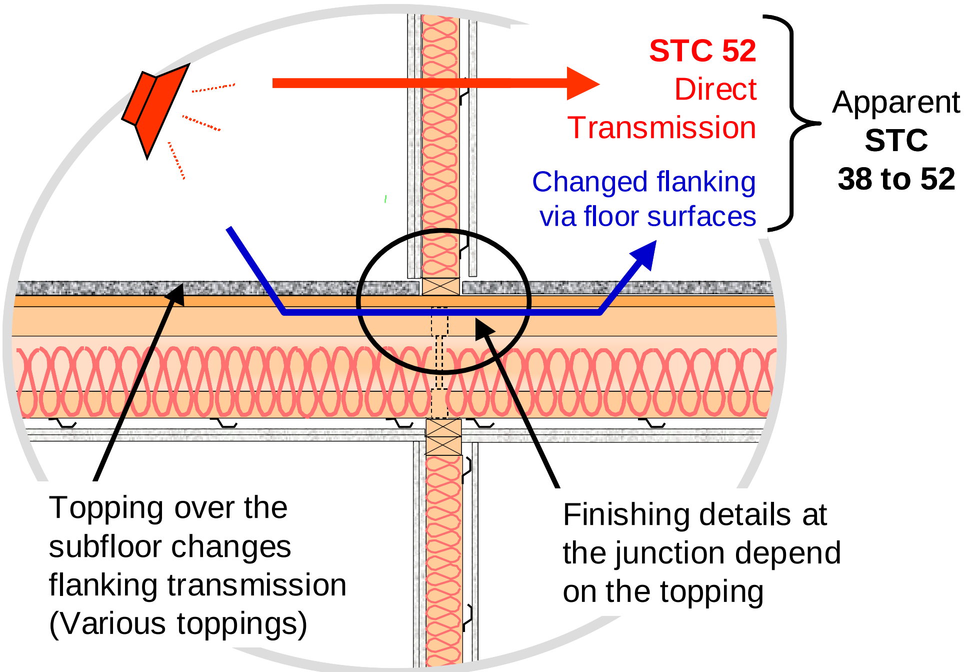
Expected performance with each topping is listed in the table, for the cases with the illustrated basic wall (STC 52), and with a better wall (STC 57) that has double gypsum board on each face.

Floor Topping [detail drawings]	**Apparent-STC (Wall STC 52)**	**Apparent-STC (Wall STC 57)**
No topping (basic subfloor)	44	44
19 mm OSB stapled to subfloor	49	51
25 mm LEVELROCK gypsum concrete bonded to subfloor	50	52
38 mm LEVELROCK gypsum concrete on QUIETZONE mat covering subfloor	52	55

Note: These estimates were obtained from evaluation of a limited set of specimens built with specific products that are identified in the detailed descriptions. Using "generic equivalents" may change results.

With the joists perpendicular to the separating wall, the improvement in Apparent-STC due to adding toppings is greater, especially in the case of the gypsum concrete topping bonded to the subfloor.

[Link to Corresponding Impact]



Expected performance with each topping is listed in the table, for the cases with the illustrated basic wall (STC 52), and with a better wall (STC 57) that has double gypsum board on each face.

Floor Topping [[detail drawings]]	**Apparent-STC (Wall STC 52)**	**Apparent-STC (Wall STC 57)**
No topping (basic subfloor)	38	38
19 mm OSB stapled to subfloor	48	49
25 mm LEVELROCK gypsum concrete bonded to subfloor	51	54
38 mm LEVELROCK gypsum concrete on QUIETZONE mat covering subfloor	52	56

Note: These estimates were obtained from evaluation of a limited set of specimens built with specific products that are identified in the detailed descriptions. Using "generic equivalents" may change results.

Summary – Changes to Control Horizontal Flanking
(One room beside the other, Airborne sound source)

Changes to control flanking must be focused on the elements of the dominant flanking path. For the case where one room is beside the other (horizontal transmission):

1. The main flanking paths are consistently from the floor of one room to the floor and the separating wall surface of the adjacent room. Hence, the two surfaces that can be modified to reduce flanking transmission are the floor surface and the wall.

2. The effects of specific floor toppings are listed in the tables above.

3. The Apparent-IIC also depends on the separating wall. Values are listed for cases with an improved wall. When transmission via the separating wall is suppressed, adding a topping yields a greater improvement in Apparent-STC.

Sound from Impact Sources

Flanking in Typical Wood-framed Constructions

This section gives information on flanking transmission for some common wood-frame constructions It deals with sound transmission from Impact sound sources such as footsteps. A similar section on **Airborne Sound Transmission** presents the corresponding cases with noise from speech, TV, or other airborne sources.

This section is divided into two parts, considering the apparent sound transmission between two adjacent rooms that are:

1. one above the other (separated by a floor)
2. one beside the other (separated by a wall)

As noted in the introduction, the experimental study included only a limited set of constructions, all of them wood-framed. Room dimensions were kept constant. Other specific constraints imposed on the research specimens included the following:

- Many of the materials were specific proprietary products, which are identified in individual assembly specifications in a later section, with details of their installation. It should be understood that some variation must be expected in practice if “generic equivalents” are substituted or details are changed.

Floor assemblies used wood joists spaced 406 mm on centre, with a subfloor surface of 19 mm OSB or plywood. Their ceilings had 2 layers of 15.9 mm fire-rated gypsum board, installed on resilient metal channels, spaced 406 mm on centre.

- Horizontal wall-wall paths were suppressed by resilient mounting of surface layers on walls other than the separating wall between side-by-side rooms. From the relative significance of the wall-wall path in vertical transmission, this is expected to be a minor concern, but that was not verified in this study.

All cases shown in the drawings and tables that follow (unless specifically identified as different) assume these common construction details. To some degree these consistent factors limited the significant flanking paths. In wood-framed construction with the ceiling supported on resilient metal channels to reduce direct transmission through the floor/ceiling assembly, the main paths for structure-borne transmission involve the wall/floor junction, so this is the focus for most of the following discussion.

Because many materials and construction details were kept constant, clear and consistent trends could be associated with specific construction changes, but it must be recognized that the results may not capture the effect of all significant variants. Changing common components such as the wood-I joists or the gypsum board could raise or lower the Apparent-IIC by 2 or 3. Despite this caveat, the authors believe that trends shown here do provide a good estimate of the main flanking problems in typical wood-framed constructions.

Vertical Flanking in Basic Wood-framed Constructions
(One room <u>above</u> the other, Impact sound source)

For the case where one room is above the other, there are two key issues:

1. The main flanking path is consistently from the subfloor of the room above to the walls of the room below.

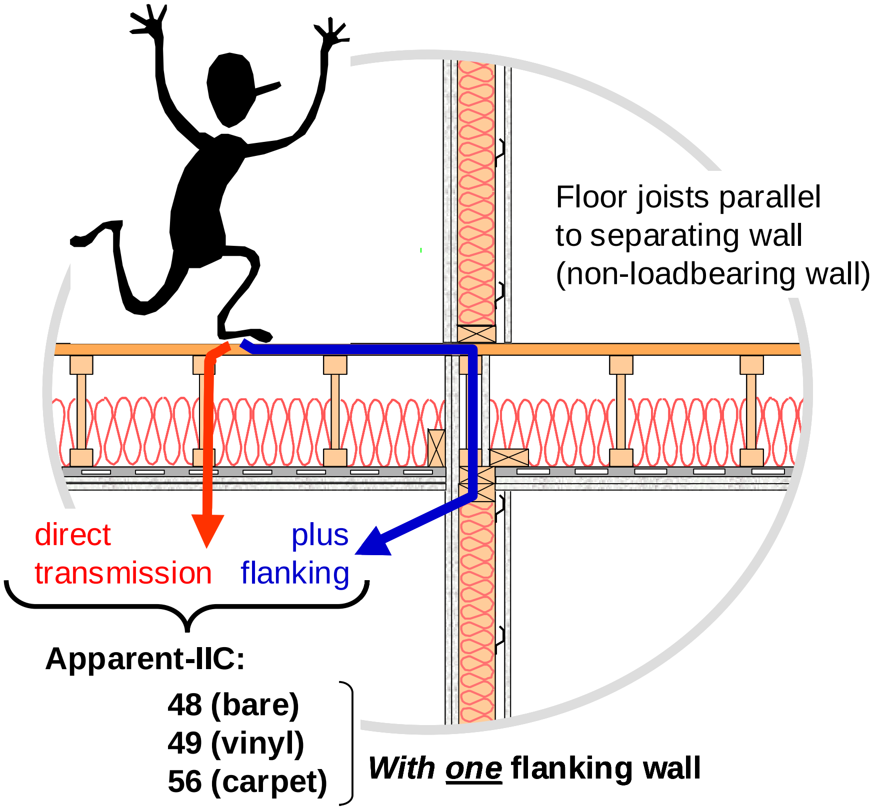
2. Reduction of Apparent-IIC by flanking depends on the flanking transmission via <u>all</u> walls of the room below.

The discussion starts with flanking via just one wall (to explain relative significance of specific aspects of the constructions).

In normal practice, especially with flanking via all four walls of the room below, more flanking energy would be transmitted, resulting in even lower Apparent-IIC. This is presented in more detail later in this section, for representative scenarios.

Changes in the construction can alter the flanking transmission and hence the Apparent-IIC, and a number of specific variants are listed in the following example, with their typical effects. The table in the following example (like similar tables in later sections) shows explicit values for Apparent-IIC, to illustrate the trends to be expected with the specified changes. Obviously, in practice the Apparent-IIC may vary from the values given here, depending on the specific products used and the details of installation.

Sound transmission paths are shown in the figure below, for the case with floor joists parallel to the flanking wall, which has single wood stud framing.



For vertical transmission, the Apparent-IIC agreed within experimental uncertainty for all the cases tested. The values presented here are representative values, as explained later. Adding vinyl flooring or carpet over the subfloor generally improved the Apparent-IIC. The same treatment was used for all cases reported here, to show typical benefit.

Change in Construction	**Typical Effect due to one flanking wall**	**Resulting Apparent-IIC**[6]
Changing Floor Materials: OSB subfloor ⇒ plywood, or wood-I joists ⇒ wood joists	change not significant	48 (bare) 49 (vinyl) 56 (carpet)
Changing Walls Below: On walls below, 2 layers ⇒ 1 layer of gypsum board	change not significant	48 (bare) 49 (vinyl) 56 (carpet)
On walls below, mount gypsum board on resilient metal channels	Flanking insignificant (Apparent-IIC approaches direct IIC for the floor)	48 (bare) 50 (vinyl) 57 (carpet)

[6] *Apparent-IIC values in this table include the direct transmission via the floor plus flanking via one wall, with the impact source 2 m from that wall – how to include flanking via all significant walls of the room below is explained later.*

Flanking transmission from the upper room to the one below may also be affected by:

- changing the orientation of the floor joists, from parallel to the flanking wall to perpendicular to the wall. (Vertical flanking tends to be stronger with floor joists perpendicular to the wall than with the joists parallel.)
- changing the wall framing from single studs to double row of studs or to staggered studs with a common plate, or
- changing the construction at the floor/wall junction.

Most changes in vertical flanking transmission due to these framing variations are small enough so the performance can be presented here in terms of average values.

Estimating Apparent-IIC for Combined Paths (Vertical Transmission)

The following *Table of Typical Vertical Flanking (Impact)* presents an estimate of the Apparent-IIC due to direct transmission plus flanking paths for all significant walls in the room below.

- This had to account for the attenuation of vibration across the floor assembly, which is more rapid perpendicular to the joists than parallel to the joists. The estimates were based on the measured transmission in each direction, averaged over the single stud and double stud wall cases studied. Two scenarios were considered:
- In one scenario, the impact source was at the middle of a moderate-sized (4.5 m x 4.5 m) room, and all four walls of the room below were included as flanking paths. Although vibration transmission across the floor is very different parallel versus perpendicular to the joists, floor joists are normally parallel to two walls in the room below and perpendicular to the others, so a value based on this combination should be representative.
- In the second scenario, the source was located near a corner, 1 m from each of two walls. Because of attenuation across the floor, more vibration would reach the nearby walls, but the transmission via the two distant walls would be relatively unimportant.

The two cases led to predictions for Apparent-IIC that differed by 1 or less for all of the floor/wall cases considered here.

For all the wall/floor cases studied, the following table provides a design estimate of the Apparent-IIC (due to direct transmission plus flanking paths for all significant walls in the room below) if the floor has a basic OSB or plywood subfloor.

In essence, the effects of impact source location tend to average out for vertical flanking transmission, and estimates for the following tables were calculated using the second scenario above.

If all walls in the room below have their gypsum board mounted on resilient channels, those wall surfaces will not contribute significantly to the flanking. This yields the best case, with only direct transmission through the floor, given in the top row of the table.

With the gypsum board attached directly to the wall studs, the Apparent-IIC will be considerably lower. Results with a double layer of gypsum board are only marginally better than a single layer, but one row of the table presents values for each of these cases. Where these wall surfaces are mixed, a linear average should provide a representative design estimate.

Table of Typical Vertical Flanking (Impact)

The following table gives Apparent-IIC due to the combined effect of direct transmission through the basic floor/ceiling, plus total flanking transmission via all walls of the room below. The estimates in this table should be applied only for cases where wall and floor details are within the range of the tested specimens.

	Better Floor/ceiling: 2 layers of gypsum board on resilient metal channels spaced @600mm	**Good Floor/ceiling:** 2 layers of gypsum board on resilient metal channels spaced @400mm	**Worse Floor/ceiling:** 1 layer of gypsum board on resilient metal channels spaced @400mm
All Walls with resilient channels supporting the gypsum board in room below (No flanking)	53 (bare) 53 (vinyl) 64 (carpet)	48 (bare) 50 (vinyl) 57 (carpet)	46 (bare) 48 (vinyl) 55 (carpet)
Walls with 2 layers of gypsum board applied directly to the studs in room below	48 (bare) 49 (vinyl) 59 (carpet)	46 (bare) 47 (vinyl) 55 (carpet)	44 (bare) 46 (vinyl) 54 (carpet)
Walls with 1 layer of gypsum board applied directly to the studs in room below	46 (bare) 47 (vinyl) 57 (carpet)	45 (bare) 46 (vinyl) 54 (carpet)	43 (bare) 45 (vinyl) 53 (carpet)

Note: This table presents Apparent-IIC expected with a basic OSB or plywood subfloor. The section on ***Changes to Control Vertical Flanking (Impact)*** *gives the effect of modifying the floor surface by adding a topping.*

Summary – Vertical Flanking in Typical Constructions, for Impact

For the case where one room is above the other, the Apparent-IIC between two rooms is systematically less than the IIC for direct transmission through the separating floor.

There are four main issues:

1. The flanking path is from the floor of the room above to the walls of the room below.
2. Adding flooring finishes such as carpet can significantly change the Apparent-IIC.
3. Reduction of the Apparent-IIC by flanking depends on the flanking transmission via <u>all</u> walls of the room below.
4. Some changes in the wall below can significantly reduce transmission via a specific wall surface. Adding a second layer of gypsum board slightly reduces flanking, and mounting gypsum board on resilient channels should reduce flanking to insignificance for most practical floor assemblies.

Horizontal Flanking in Typical Wood-framed Constructions
One room <u>beside</u> the other, Impact sound source)

For the case where one room is beside the other, there are four key issues:

1. The flanking paths for impact sound are from the floor of the room where the impact occurs to the floor and the surface of the separating wall in the room beside.
2. If the impact source moves closer to the separating wall/floor junction, the Apparent-IIC increases. (important for corridors)
3. Apparent-IIC is changed by a flooring surface, such as vinyl flooring or carpet, but the improvement depends on the underlying floor.
4. Apparent-IIC is affected by details of the floor assembly, the wall assembly, and the continuity of structural elements across the floor/wall junction.

In all these cases, the horizontally transmitted impact sound is ***entirely*** due to structure-borne flanking transmission.

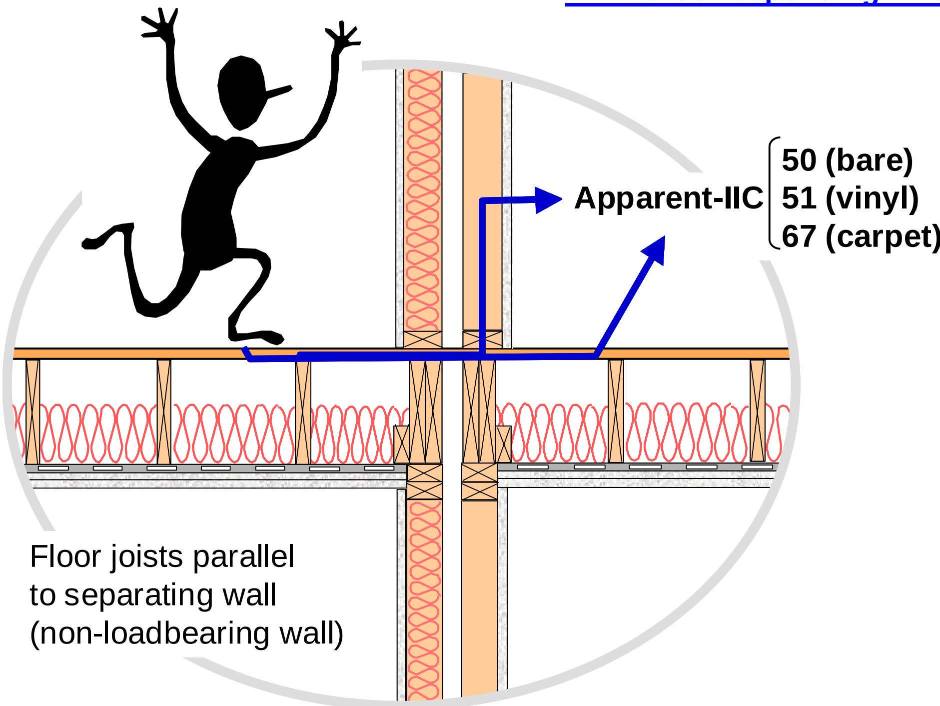
Note that the above summary assumes that other horizontal paths (such as floor-ceiling paths) are not significant. This will be the case if there are resilient channels or other vibration breaks in such paths. If the gypsum board ceiling is attached directly to the joists, then transmission on the diagonal must also be considered.

Some of the above issues assume different significance when considering design for a room adjacent to a corridor, as opposed to two side-by-side rooms with similar use. In particular, a corridor will typically involve impacts close to the separating wall (1 m is used as representative), whereas a distance of 2 m is more appropriate for a typical room. Hence, two representative distances are used in this section.

To highlight the key factors influencing flanking across floor/wall systems, a number of typical configurations are presented, proceeding from cases where the flanking effect is rather small to cases where flanking causes rather poor sound insulation.

With the subfloor continuous across the junction at a double stud wall, Apparent-IIC is low enough to be a problem, especially if the source is close to the separating wall.

[Link to Corresponding Airborne]



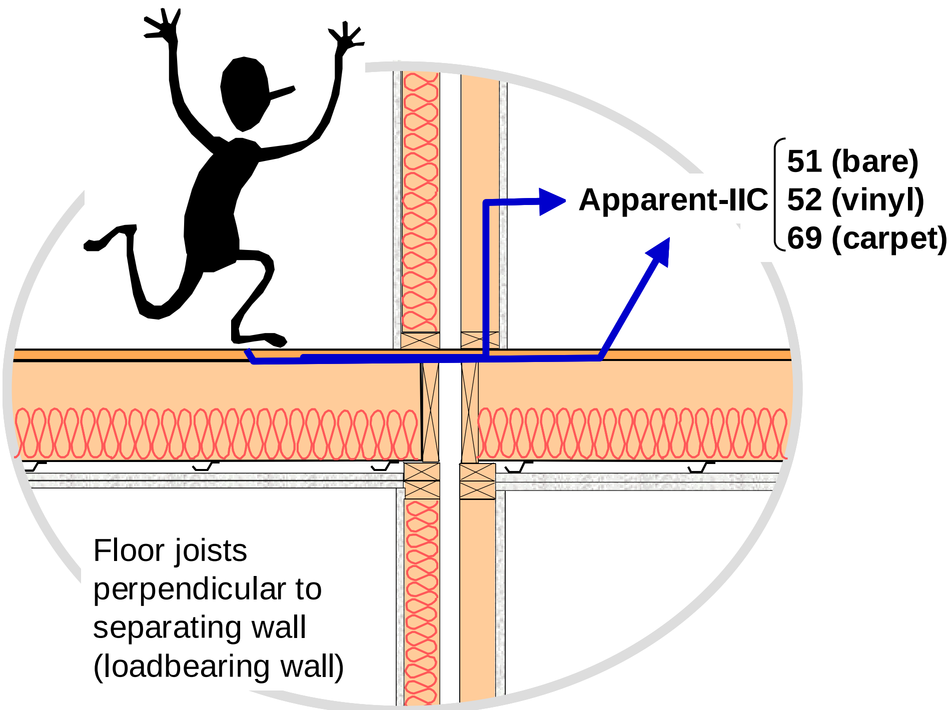
The Apparent-IIC may be changed by specific changes in the floor assembly, the floor/wall junction, or the wall assembly.

Change in Construction	**Typical Effect**	**Apparent-IIC** (source at 2 m)
Changing Floor: 16 mm OSB subfloor ⇒ plywood or wood joists ⇒ wood-I joists	Change not significant	49-51 (bare) 50-52 (vinyl) 56-58 (carpet)
Changing Floor/Wall Junction: Subfloor break at wall cavity	Improvement depends on firestop[1]	50-63 depends on firestop[1]
Changing Wall: Double gypsum board and insulation on both sides	Improvement depends on firestop[1]	53-64 depends on firestop[1]
For Corridors (impact source 1 m from wall): No data for quantitative values, but qualitatively expect lower Apparent-IIC, as with joists parallel to single stud wall. (See following cases).		

[1] See *Best Practice Guide on Fire Stopping and Fire Blocking and Its Impact on Sound Transmission*, available late 2005 from, Institute for Research in Construction, National Research Council Canada.

With the subfloor continuous across the junction at a double stud wall, and floor joists parallel to the wall, the Apparent-IIC is slightly better, especially with carpet applied over the OSB subfloor.

[Link to Corresponding Airborne](#)



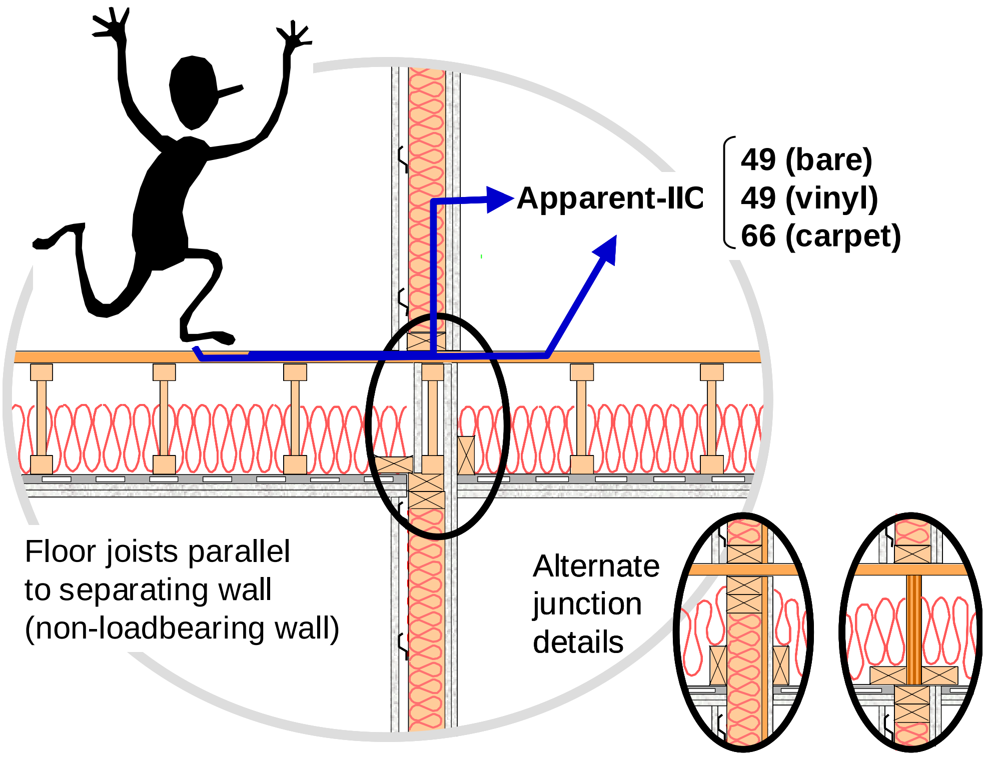
The Apparent-IIC may be changed by specific changes in the floor assembly, the floor/wall junction, or the wall assembly.

Change in Construction	Typical Effect	Apparent-IIC (source at 2 m)
Changing Floor: 16 mm OSB subfloor ⇒ plywood or wood joists ⇒ wood-I joists	Change not significant	50-52 (bare) 51-53 (vinyl) 70-71 (carpet)
Changing Floor/Wall Junction: Subfloor break at wall cavity	Improvement depends on firestop[1]	52-59 (bare) depends on firestop[1]
Changing Wall: Double gypsum board and insulation on both sides	Improvement depends on firestop[1]	51-64 (bare) depends on firestop[1]
For Corridors (impact source 1 m from wall): No data for quantitative values, but qualitatively expect lower Apparent-IIC as with joists perpendicular to single stud wall. (See following cases).		

[1] See *Best Practice Guide on Fire Stopping and Fire Blocking and Its Impact on Sound Transmission*, available late 2005 from, Institute for Research in Construction, National Research Council Canada.

With the floor joists parallel to the separating wall, changing from the double stud wall to a simpler single stud wall assembly permits more transfer of structural vibration across the junction, and hence lowers Apparent-IIC for the bare floor to 49 for impacts 2m from the wall.

Link to Corresponding Airborne

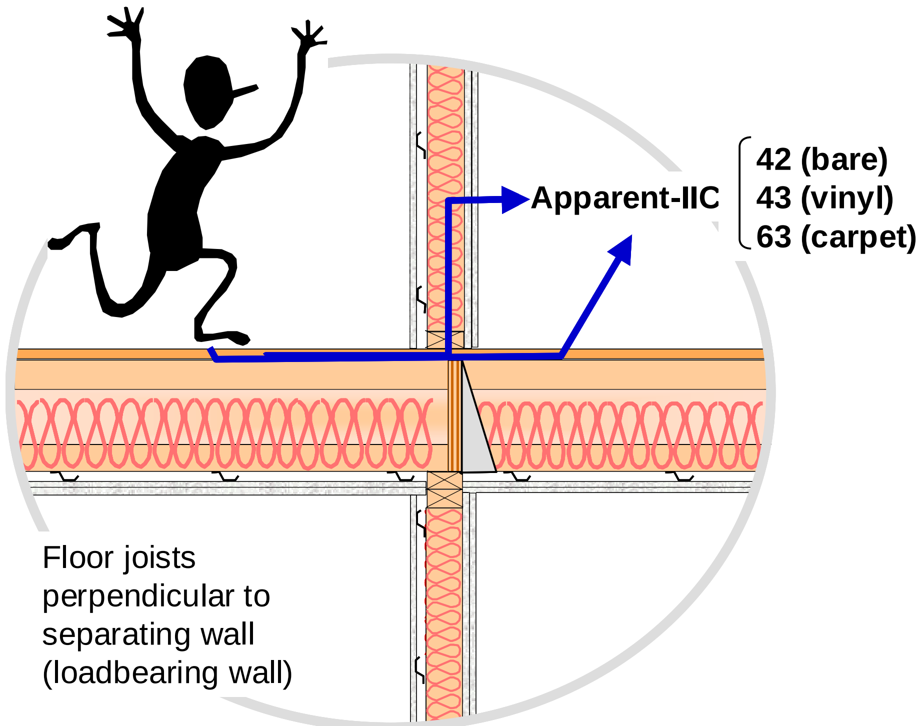


Changing the materials in the floor assembly, or the fire blocking detail at the junction, has little effect on the Apparent-IIC. Changing the wall surface facing the receiver has some effect. Removing the second layer of gypsum board on the receiving side would lower the Apparent-IIC by ~1, but putting the gypsum board on resilient channels suppresses flanking via the wall, raising the Apparent-IIC (see table).

Change in Construction	**Typical Effect**	**Apparent-IIC** (source at 2 m)
Changing Floor: 16 mm OSB subfloor ⇒ plywood or wood-I joists ⇒ wood joists	Change not significant	49 (bare) 49 (vinyl) 66 (carpet)
Changing Floor/Wall Junction: Subfloor break under wall or alternate junction details shown	Change not significant	(no change)
Changing Wall: Gypsum board on receiving room side on resilient channels	Improves	51 (bare) 52 (vinyl) 71 (carpet)
For Corridors (impact source 1 m from wall): Apparent IIC is lower by 6, 5, 3 for cases with bare, vinyl, carpet surface respectively.		

With the single stud wall assembly, changing orientation of the floor joists (from parallel to the separating wall to perpendicular) transmits more structural vibration across the floor and alters the junction. This lowers Apparent-IIC for the bare floor to 42 for impacts 2m from the wall.

Link to Corresponding Airborne



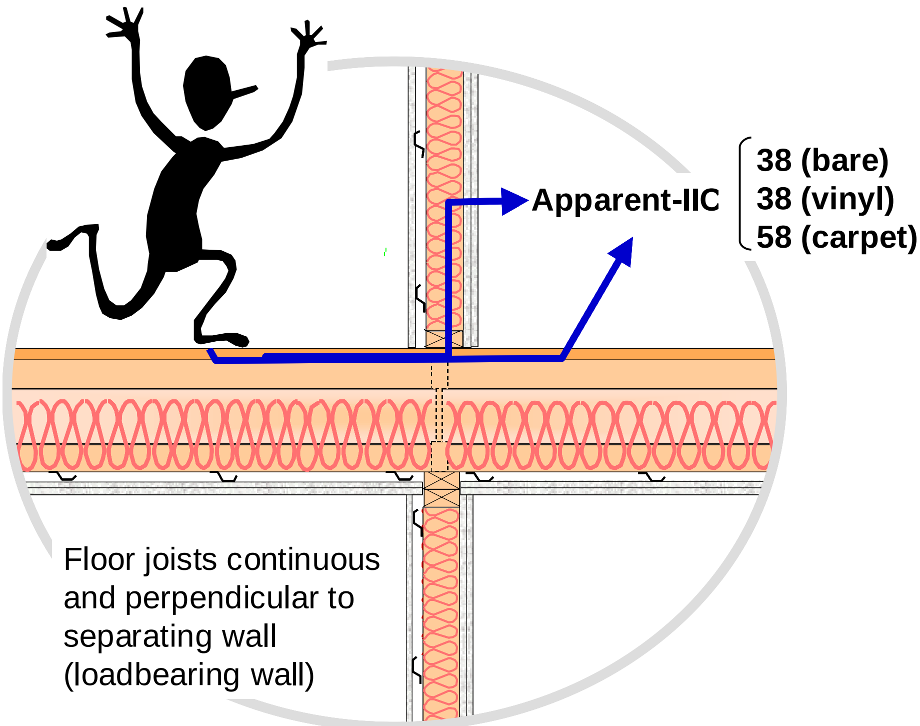
Changing materials in the floor assembly or cutting the subfloor at the junction have little effect on the Apparent-IIC. Changing the wall surface facing the receiver has some effect (but less than with the joists parallel, because the floor-floor path is more dominant):

- Removing the 2nd layer of gypsum board would lower Apparent-IIC by ~1.
- Mounting the gypsum board on resilient channels suppresses flanking via the wall, raising the Apparent-IIC (see table).

Change in Construction	**Typical Effect**	**Apparent-IIC** (source at 2 m)
Changing Floor: 16 mm OSB subfloor ⇒ plywood or wood-I joists ⇒ wood joists	Change not significant	42 (bare) 43 (vinyl) 63 (carpet)
Changing Floor/Wall Junction: Subfloor break under wall	Change not significant	(no change)
Changing Wall: Gypsum board on receiving room side on resilient channels	Improves slightly	43 (bare) 44 (vinyl) 65 (carpet)
For Corridors (impact source 1 m from wall): Apparent IIC is lower by 4, 3, 1 for cases with bare, vinyl, carpet surface respectively.		

With subfloor and joists both continuous across the floor/wall junction, but the same single stud wall and floor details, there is more transfer of structural vibration across the junction. This lowers Apparent-IIC for the bare floor to 38 for impacts 2m from the wall.

[Link to Corresponding Airborne]



Changing materials in the floor assembly, or cutting the subfloor under the wall at the junction, have little effect on the Apparent-IIC. Changing the wall surface facing the receiver has negligible effect, because the floor-floor path is dominant (See table).

Change in Construction	**Typical Effect**	**Apparent-IIC** (source at 2 m)
Changing Floor: 16 mm OSB subfloor ⇒ plywood or wood-I joists ⇒ wood joists	Change not significant	38 (bare) 38 (vinyl) 58 (carpet)
Changing Floor/Wall Junction: Subfloor break under wall at floor/wall junction	Change not significant	(no change)
Changing Wall: Gypsum board on receiving room side on resilient channels	Change not significant	38 (bare) 39 (vinyl) 59 (carpet)
For Corridors (impact source 1 m from wall): Apparent IIC is lower by 2, 2, 0 for cases with bare, vinyl, carpet surface respectively.		

Summary – Horizontal Flanking in Typical Constructions

For the case where one room is beside the other, the Apparent-IIC between two rooms is entirely due to flanking transmission.

There are three main issues:

5. When the floor assembly has a basic OSB or plywood subfloor, the main flanking path is consistently from the floor of one room to the floor of the other, although the wall of the receiving room also contributes in some cases.
6. Apparent-IIC is strongly affected by joist orientation and the continuity of floor components across the floor/wall junction.
7. Because vibration is attenuated across the floor assembly, as it spreads away from the source, the Apparent-IIC is lower when the impact occurs near the separating wall (as it would for corridors).

Changes to Control Impact Flanking

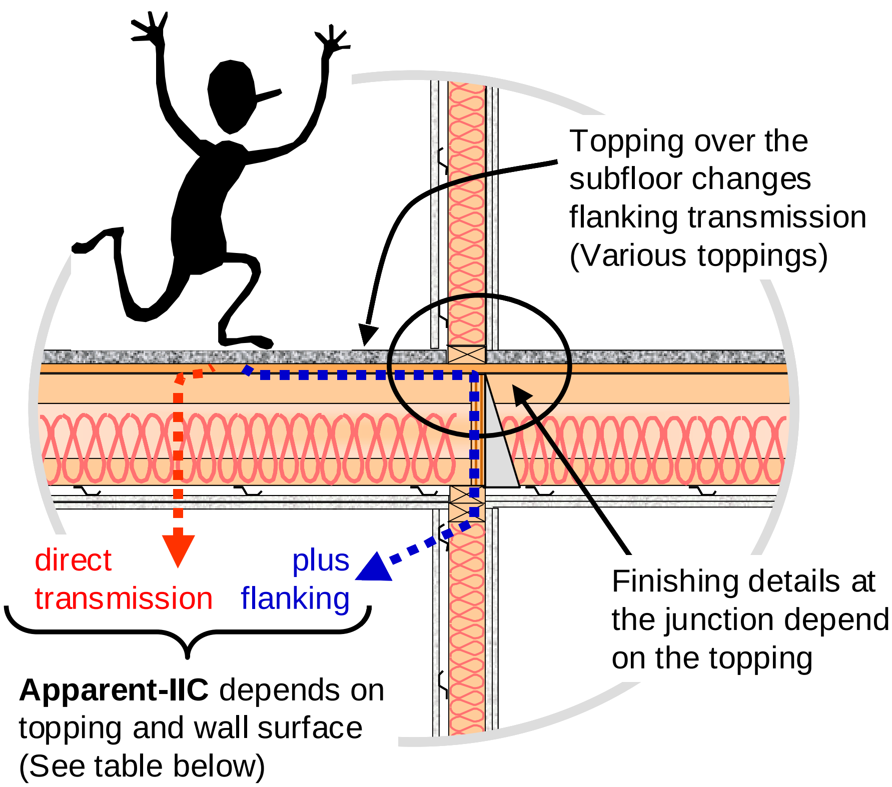
Changes to Control Vertical Flanking
(One room above the other, Impact sound source)

Changes to control flanking must be focused on the elements of the dominant flanking path. For the case where one room is above the other (vertical transmission):

3. The flanking path is consistently from the subfloor of the room above to the walls of the room below.

4. The two surfaces that can be modified to reduce flanking transmission are the walls below and the floor surface above.

The Apparent-IIC can be improved by changing the floor surface or the gypsum board surfaces of the walls in the room below. Adding a topping over the basic plywood or OSB subfloor changes attenuation both for direct transmission through the floor and for the dominant flanking transmission path. Changes for direct transmission through the floor and for flanking transmission are ***not*** equal.



The change in flanking due to adding a topping depends on the type of topping and on the orientation of the floor joists relative to the flanking wall. However, an average value can be used as a representative design estimate because the floor joists are normally parallel to some walls in the room below and perpendicular to others. Typical values for Apparent-IIC are listed in the **Table of Typical Vertical Flanking (Impact)**

The effects of simple changes to the walls of the room below are presented in the earlier section on flanking in typical basic constructions. The combined flanking transmission via all walls of the room below was considered, for two representative scenarios.

Table of Change in Vertical Flanking due to Toppings (Impact)

The following Table gives change in Apparent-IIC expected from adding a topping, due to direct transmission through the floor/ceiling combined with flanking transmission via the walls of the room below.

		Better Floor with 2 layers of gypsum board on resilient channels @600mm (Direct-IIC with no topping: 53, 54, 64)			**Good Floor** with 2 layers of gypsum board on resilient channels @400mm (Direct-IIC with no topping: 48, 50, 57)			**Worse Floor** with 1 layer of gypsum board on resilient channels @400mm (Direct-IIC with no topping: 46, 47, 55)		
	With no floor topping	See ***Table of Typical Vertical Flanking (Impact).***								
		Bare	Vinyl	Carpet	Bare	Vinyl	Carpet	Bare	Vinyl	Carpet
All Walls with resilient channels supporting the gypsum board in room below (No flanking)	Stapled 19 mm OSB topping[2]	+2	+3	+4	+3	+2	+4	+3	+2	+4
	Bonded 25 mm LEVELROCK topping[2]	-7	+1	+8	-7	-1	+8	-7	-1	+7
	38 mm LEVELROCK topping on QUIETZONE mat[2]	+7	+10	+10	+7	+9	+11	+7	+8	+12
Walls with 1 or 2 layers of gypsum board applied directly to the studs	Stapled 19 mm OSB topping[2]	+1	+1	+3	+1	+1	+4	+2	+1	+4
	Bonded 25 mm LEVELROCK topping[2]	-9	-3	+7	-9	-2	+8	-7	-2	+7
	38 mm LEVELROCK topping on QUIETZONE mat [2]	+3	+5	+8	+3	+5	+10	+5	+6	+10

*Note 1: This table presents the change in Apparent-IIC expected when a topping is added over a basic OSB or plywood subfloor surface. Add this change to the Apparent-IIC for the corresponding basic system listed in the **Table of Typical Vertical Flanking (Impact)**.*

*Note 2: Specifications and detail drawings for the basic assemblies and added toppings are given in the following section on **Changes to Control Horizontal Flanking (impact)***

For all the wall/floor cases studied, the preceding table provides a representative design estimate of the *change* in Apparent-IIC (due to direct transmission plus flanking paths for all significant walls in the room below) when toppings are added.

- If all walls in the room below have their gypsum board mounted on resilient channels, those wall surfaces will not contribute significantly to the flanking. This yields the best case, with only direct transmission through the floor, given in the top row of the table. (Note that resilient channels ***must*** be mounted between the studs and the gypsum board, not between two layers of gypsum board.)
- With the gypsum board attached directly to the wall studs in the room below, the Apparent-IIC will be considerably lower. The change due to a topping is almost identical whether the wall has a double layer of gypsum board or a single layer, so one row of the table presents the change expected for both cases.

Where these wall surfaces are mixed, a linear average should provide a rough estimate.

Summary – Changes to Control Vertical Flanking
(One room above the other, Impact sound source)

Changes to control flanking must be focused on the elements of the dominant flanking path. For footstep noise in the case where one room is above the other (vertical transmission):

1. The flanking path is from the floor of the room above to the walls of the room below.

2. The two surfaces that can be modified to reduce flanking transmission are the walls below and the floor surface above. The effects of specific changes are listed in the table above.

Changes to Control Horizontal Flanking
(One room beside the other, Impact sound source)

Changes to control flanking must be focused on the elements of the dominant flanking path. For footstep noise in the case where one room is beside the other (horizontal transmission):

1. The main flanking path is consistently from the floor of one room to the floor of the room beside, if the basic floor surface is a layer of oriented strand board (OSB) or of plywood directly fastened to the top of the floor joists.

2. The key surfaces to modify to significantly reduce flanking transmission are the floors in the two rooms.

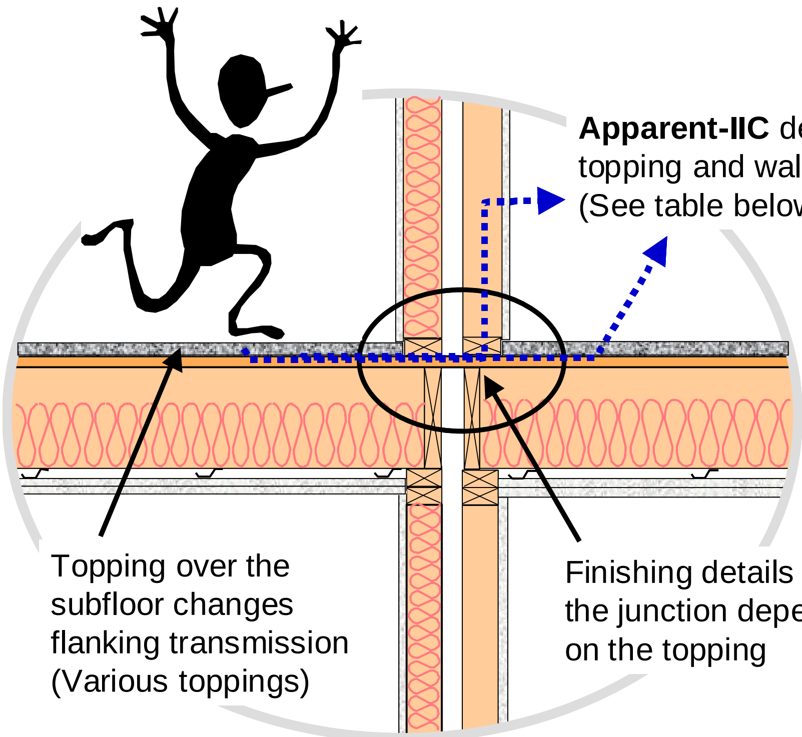
3. The incremental effect of adding a floor topping depends not just on the topping but also on the floor over which it is applied. In particular, the improvement due to a topping may depend strongly on the orientation of the floor joists relative to the floor/wall junction.

4. In some cases, the change in the floor-floor flanking transmission is substantial, and coupled with improvements to the wall itself may provide a very high Apparent-IIC.

Because the effect of toppings depends quite strongly on the supporting floor assembly, the effect is shown for each of the basic floor assemblies in turn.

The Apparent-IIC between the side-by-side rooms can be improved by installing a floor topping over the basic OSB or plywood subfloor.

Link to Corresponding Airborne



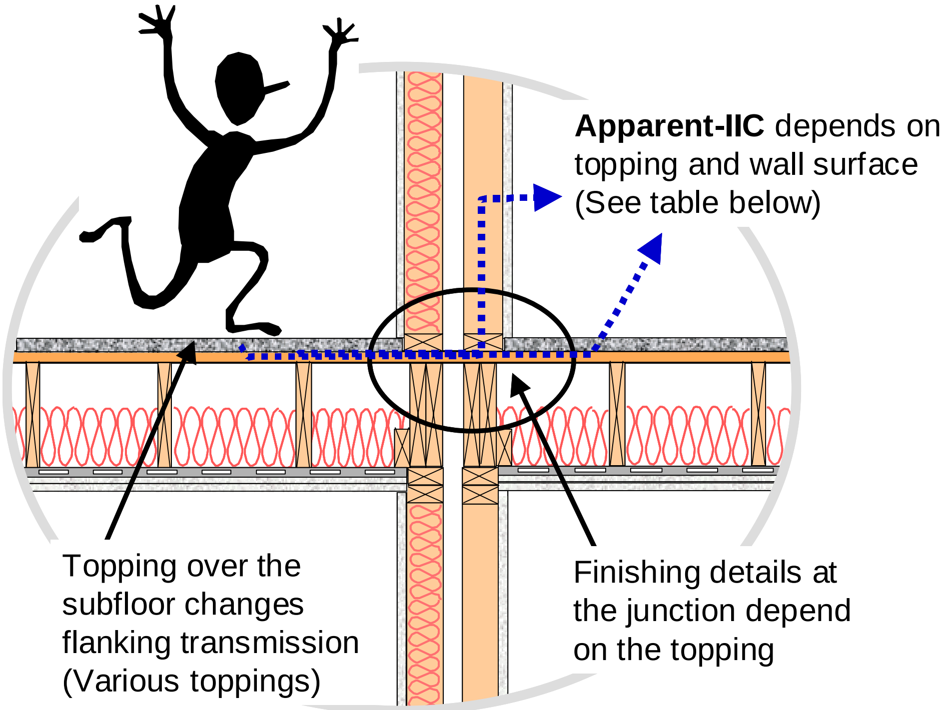
Expected performance with each topping is listed in the table, with a bare floor and with two added flooring finishes. No data are available for gypsum concrete toppings.

Floor Topping [detail drawings]	**Apparent-IIC**		
	Bare	**Vinyl**	**Carpet**
No topping (basic subfloor)	51	52	69
19 mm OSB stapled to subfloor	55	57	71

Note: These estimates were obtained from evaluation of a limited set of specimens built with specific products that are identified in the detailed descriptions. Using "generic equivalents" may change results.

With the joists parallel to the separating wall, the improvement in Apparent-IIC due to adding toppings is similar to that with the joists perpendicular.

Link to Corresponding Airborne



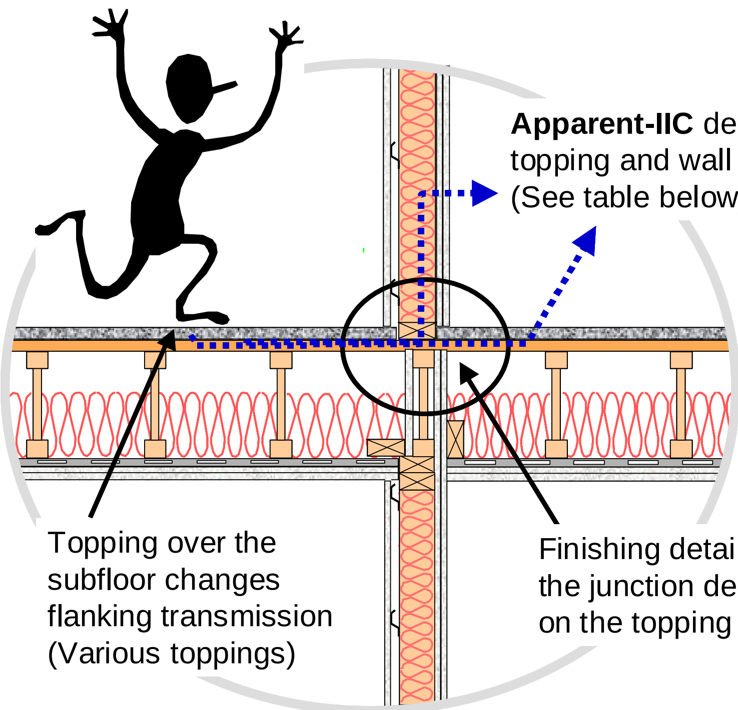
Expected performance with each topping is listed in the table, with a bare floor and with two added flooring finishes. No data are available for gypsum concrete toppings.

Floor Topping [detail drawings]	**Apparent-IIC**		
	Bare	**Vinyl**	**Carpet**
No topping (basic subfloor)	51	52	67
19 mm OSB stapled to subfloor	56	57	67

Note: These estimates were obtained from evaluation of a limited set of specimens built with specific products that are identified in the detailed descriptions. Using "generic equivalents" may change results.

With the single stud wall, the Apparent-IIC was evaluated for each topping, including the effect of flanking via the wall in the receiving room.

Link to Corresponding Airborne



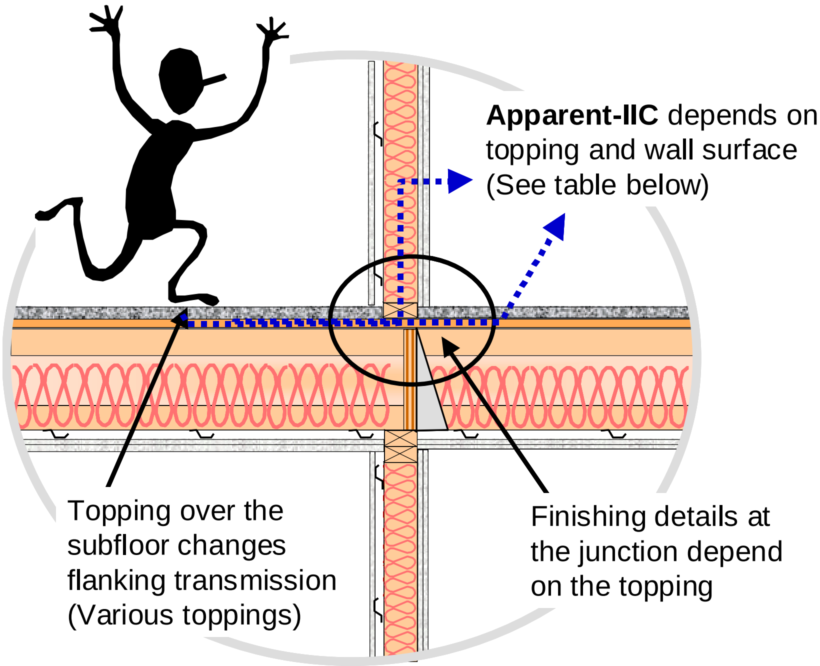
Expected performance with each topping is listed in the table, with a bare floor and with two added flooring finishes. Changes expected due to modifying the wall surface are given in preceding data for basic subfloor.

Floor Topping [detail drawings]	**Apparent-IIC** *(Impact 2 m from wall)* **Bare**	**Vinyl**	**Carpet**
No topping (basic subfloor)	49	49	66
19 mm OSB stapled to subfloor	53	54	67
25 mm LEVELROCK gypsum concrete bonded to subfloor	36	43	72
38 mm LEVELROCK gypsum concrete on QUIETZONE mat covering subfloor	53	57	76
For Corridors** (impact 1 m from wall)* ***Apparent-IIC changes by:			
No topping, or 19 mm OSB	-5	-5	-3
Bonded 25 mm LEVELROCK topping	-3	-2	-1
Floating 38 mm LEVELROCK topping	-1	-1	-2

Note: These estimates were obtained from evaluation of a limited set of specimens built with specific products that are identified in the detailed descriptions. Using "generic equivalents" may change results.

With the joists perpendicular to the separating wall, the Apparent-IIC was generally lower. Apparent-IIC was evaluated for each topping, including the effect of flanking via the wall in the receiving room.

Link to Corresponding Airborne



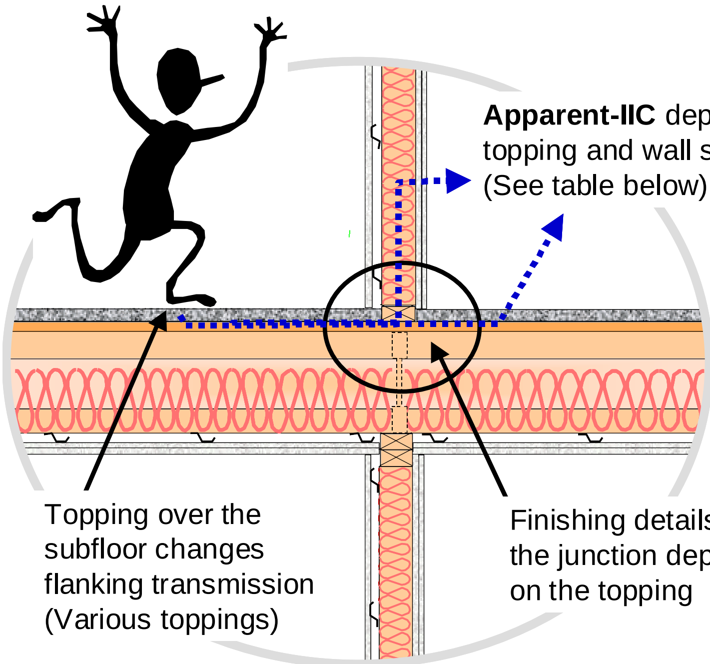
Expected performance with each topping is listed in the table, with a bare floor and with two added flooring finishes. Changes expected due to modifying the wall surface are given in preceding data for basic subfloor.

Floor Topping [detail drawings]	**Apparent-IIC** *(Impact 2 m from wall)*		
	Bare	**Vinyl**	**Carpet**
No topping (basic subfloor)	42	43	63
19 mm OSB stapled to subfloor	47	47	61
25 mm LEVELROCK gypsum concrete bonded to subfloor	38	43	62
38 mm LEVELROCK gypsum concrete on QUIETZONE mat covering subfloor	46	50	68
For Corridors *(impact 1 m from wall)* ***Apparent-IIC changes by:***			
No topping or OSB	-4	-3	-1
Bonded 25 mm LEVELROCK topping	-3	-2	-1
Floating 38 mm LEVELROCK topping	0	-1	-2

Note: These estimates were obtained from evaluation of a limited set of specimens built with specific products that are identified in the detailed descriptions. Using "generic equivalents" may change results.

With the joists perpendicular to the separating wall and continuous, the Apparent-IIC was even lower. Apparent-IIC was evaluated for each topping, including the effect of flanking via the wall surface in the receiving room.

Link to Corresponding Airborne



Expected performance with each topping is listed in the table, with a bare floor and with two added flooring finishes. Changes expected due to modifying the wall surface are given in preceding data for basic subfloor.

Floor Topping [detail drawings]	**Apparent-IIC** *(Impact 2 m from wall)*		
	Bare	**Vinyl**	**Carpet**
No topping (basic subfloor)	38	38	58
19 mm OSB stapled to subfloor	46	47	60
25 mm LEVELROCK gypsum concrete bonded to subfloor	41	46	65
38 mm LEVELROCK gypsum concrete on QUIETZONE mat covering subfloor	45	49	69
For Corridors *(impact 1 m from wall)* ***Apparent-IIC changes by:***			
No topping or OSB	-3	-2	0
Bonded 25 mm LEVELROCK topping	-4	-3	0
Floating 38 mm LEVELROCK topping	-1	-1	-2

Note: These estimates were obtained from evaluation of a limited set of specimens built with specific products that are identified in the detailed descriptions. Using "generic equivalents" may change results.

Summary – Changes to Control Horizontal Flanking
(One room beside the other, Impact sound source)

Changes to control flanking must be focused on the elements of the dominant flanking path. For the case where one room is beside the other (horizontal transmission):

1. The main flanking paths are consistently from the subfloor of the room where the impact occurs to the floor and separating wall surface of the adjacent room.

2. The two surfaces that can be modified to reduce flanking transmission are the floor surface and the wall in the receiving room. The effects of specific toppings are listed in the tables above.

3. The Apparent-IIC also depends on how close the impact source is to the separating wall. Values are listed for typical rooms, and for the source close to the wall (as expected for a corridor).

Appendix – Construction drawings

The following tables provide hyperlinks to Adobe Acrobat files (pdf) files containing AutoCAD drawings of the assemblies referenced by this Guide. The corresponding AutoCAD drawing files have the same name as the pdf files but with the AutoCAD extension (drw), and are supplied with the CD-ROM.

Load Bearing Double Stud Partition Wall

Users are urged to see the drawings of **joint finishing details**.

Floor topping	**Partition Wall/Floor**	**Corridor Wall**
No topping (basic subfloor)	**SFCASP2A.pdf**	**SFFIGB32.pdf**
19 mm OSB stapled to subfloor	**SFCASP2B.pdf**	Same as above

Corresponding AutoCAD drawings (*.dwg) are given with the CD-ROM.

Return to Airborne Table **Return to Impact Table**

Non-Load Bearing Double Stud Partition Wall

Users are urged to see the drawings of **joint finishing details**.

Floor topping	**Partition Wall/Floor**	**Corridor Wall**
No topping (basic subfloor)	**SFCAS4A.pdf**	**SFFIGB32.pdf**
19 mm OSB stapled to subfloor	**SFCAS4D.pdf**	Same as above

Corresponding AutoCAD drawings (*.dwg) are given with the CD-ROM.

Return to Airborne table **Return to Impact table**

Single Stud Non-Load Bearing Partition Wall

Users are urged to see the drawings of **joint finishing details**.

Floor topping	Partition Wall/Floor	Corridor Wall
No topping (basic subfloor)	**SFCAS1BC.pdf**	**SFFIGB31.pdf**
19 mm OSB stapled to subfloor	**SFCAS1H.pdf**	Same as above
25 mm LEVELROCK gypsum concrete bonded to subfloor	**SFCAS1I.pdf**	Same as above
38 mm LEVELROCK gypsum concrete on QUIETZONE mat covering subfloor	**SFCAS1K.pdf**	Same as above

Corresponding AutoCAD drawings (*.dwg) are given with the CD-ROM.

Return to Airborne Table **Return to Impact Table**

Single Stud Load Bearing Partition Wall with Discontinuous Joists

Users are urged to see the drawings of **joint finishing details**.

Floor topping	Partition Wall/Floor	Corridor Wall
No topping (basic subfloor)	**SFCAS7A.pdf**	**SFFIGB34.pdf**
19 mm OSB stapled to subfloor	**SFCAS7E.pdf**	Same as above
25 mm LEVELROCK gypsum concrete bonded to subfloor	**SFCAS7F.pdf**	Same as above
38 mm LEVELROCK gypsum concrete on QUIETZONE mat covering subfloor	**SFCAS7D.pdf**	Same as above

Corresponding AutoCAD drawings (*.dwg) are given with the CD-ROM.

Return to Airborne Table **Return to Impact Table**

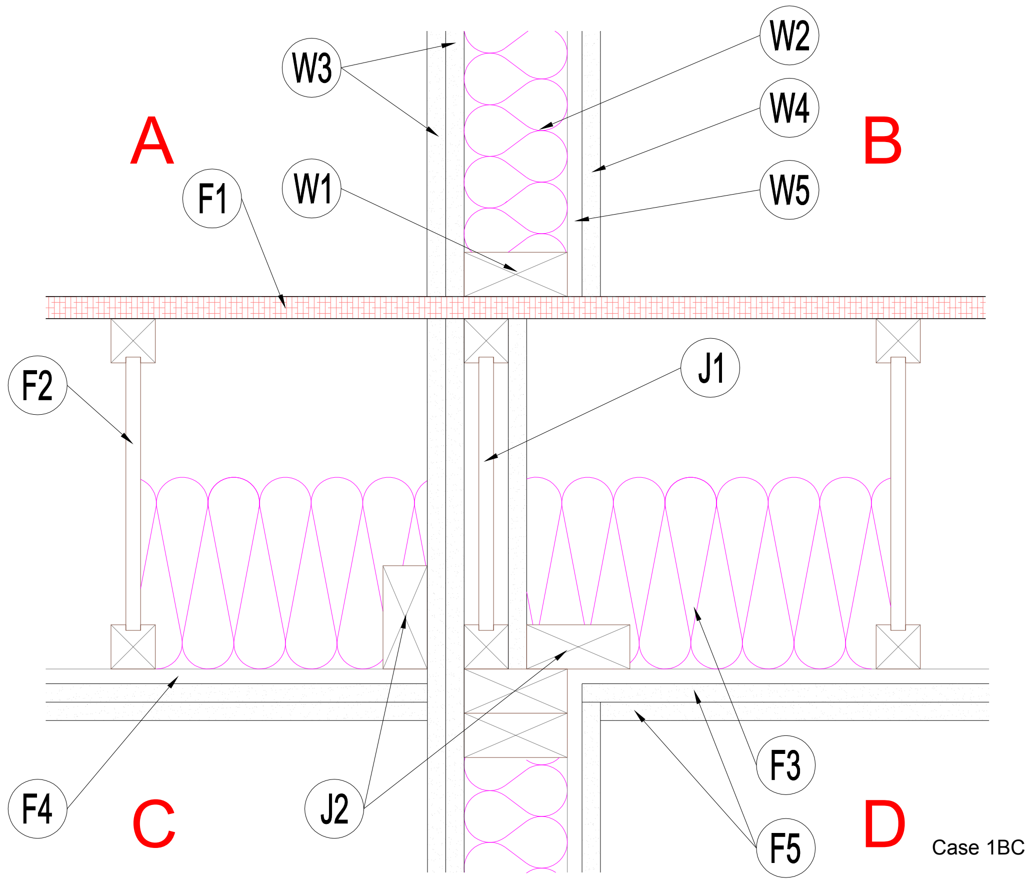
Single Stud Load Bearing Partition Wall with Continuous Joists

Users are urged to see the drawings of **joint finishing details**.

Floor topping	**Partition Wall/Floor**	**Corridor Wall**
No topping (basic subfloor)	**SFCAS6A.pdf**	**SFFIGB33.pdf**
19 mm OSB stapled to subfloor	**SFCAS6C.pdf**	Same as above
25 mm LEVELROCK gypsum concrete bonded to subfloor	**SFCAS6E.pdf**	Same as above
38 mm LEVELROCK gypsum concrete on QUIETZONE mat covering subfloor	**SFCAS6B.pdf**	Same as above

Corresponding AutoCAD drawings (*.dwg) are given with the CD-ROM.

Return to Airborne Table **Return to Impact Table**



Partition Wall:

W 1: Single 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double head plate.

W 2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W 3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The panels extend through the floor cavity to the underside of the subfloor. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

W 4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

W 5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Topping:

None

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: TJI® Pro 150 wood I-joists with 1-1/2" (38 mm) square flange and 11-7/8" (300 mm) depth spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

F4: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the joists using 1-5/8" (42 mm) drywall screws.

F5: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with the long axis perpendicular to the resilient channels using 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. Stagger joints by at least 16" (406 mm) in both directions. The screws placed so as not to penetrate into the joists.

Floor/Partition-Wall Intersection:

J1: TJI® Pro 150 wood I-joist, 11-7/8" (300 mm) deep, covered with 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panel.

J2: 2x4 (38x89 mm) nailing plates attached to studs in floor cavity to support ceiling resilient channels.

Common Details: Corridor walls, Caulking details.

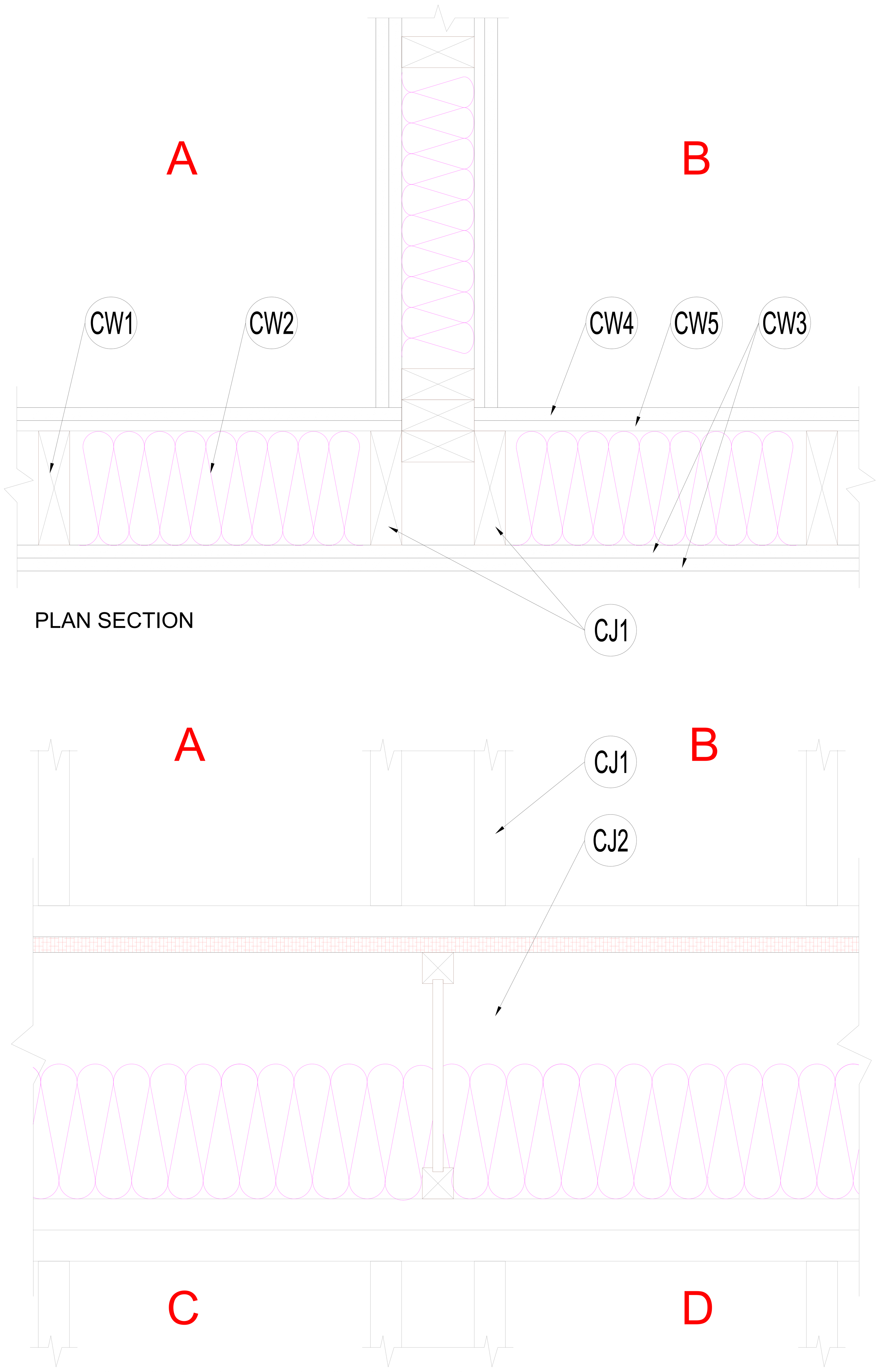


FIGURE: B.3.3

<u>Partition Wall</u>: Single stud, details specific to the wall/floor junction case.

<u>Corridor Wall</u>:

CW1: Single 2x6 (38x140 mm) wood stud wall with studs spaced 16" (406 mm) o.c., with double head plate.

CW2: 6" (140 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

CW3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

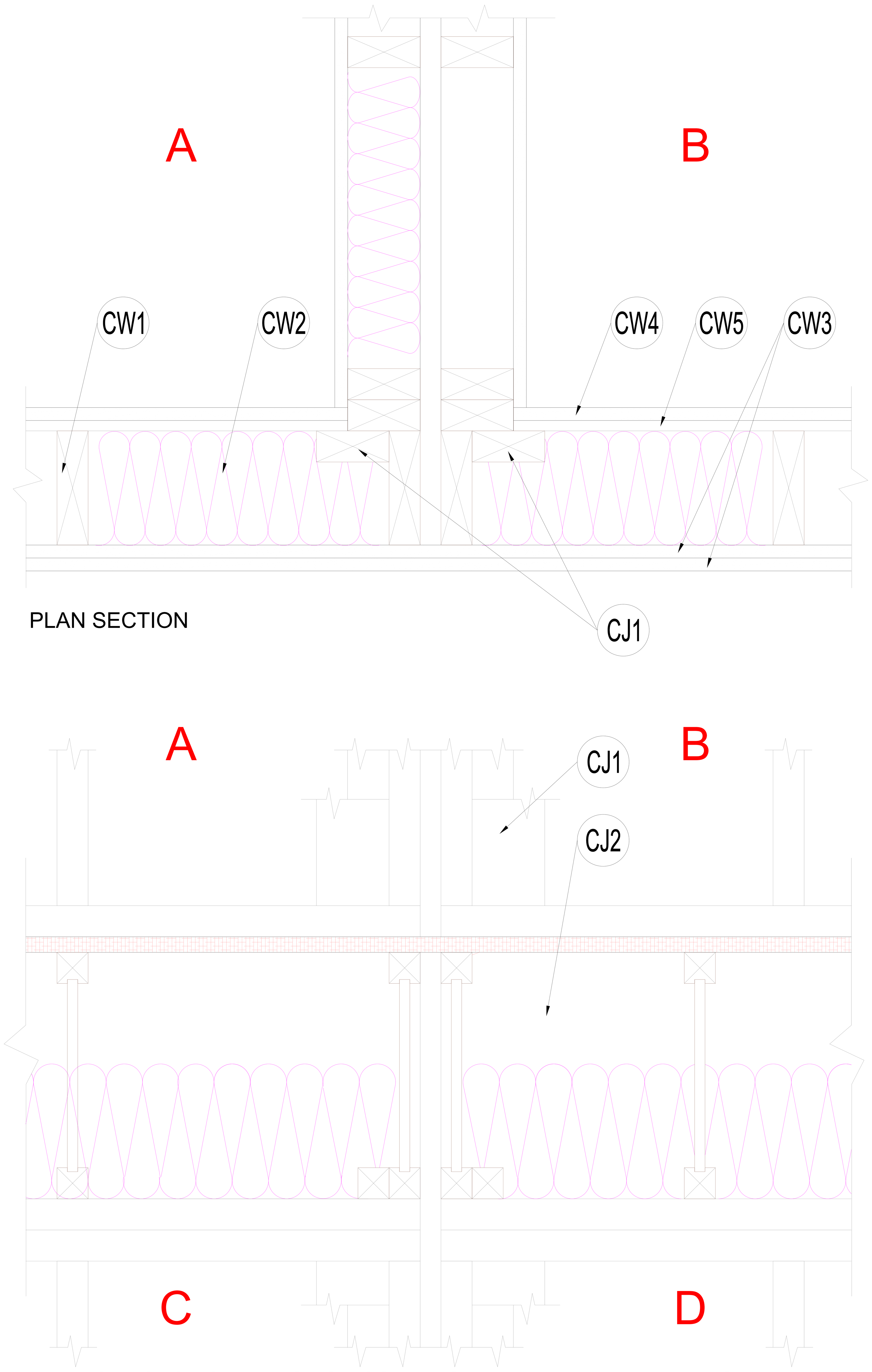
CW4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

CW5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

<u>Corridor Wall/Partition Wall Intersection:</u>

CJ1: 2x4 (38X89 mm) blocking material as required to support the RC's of the corridor wall.

CJ2: TimberStrand® laminated strand lumber (LSL) rimboard continuous across end of partition wall.



VERTICAL SECTION THROUGH CORRIDOR WALL FIGURE: B.3.2

Partition Wall: Double stud, details specific to the wall/floor junction case.

Corridor Wall:

CW1: Single 2x6 (38x140 mm) wood stud wall with studs spaced 16" (406 mm) o.c., with double head plate.

CW2: 6" (140 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

CW3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

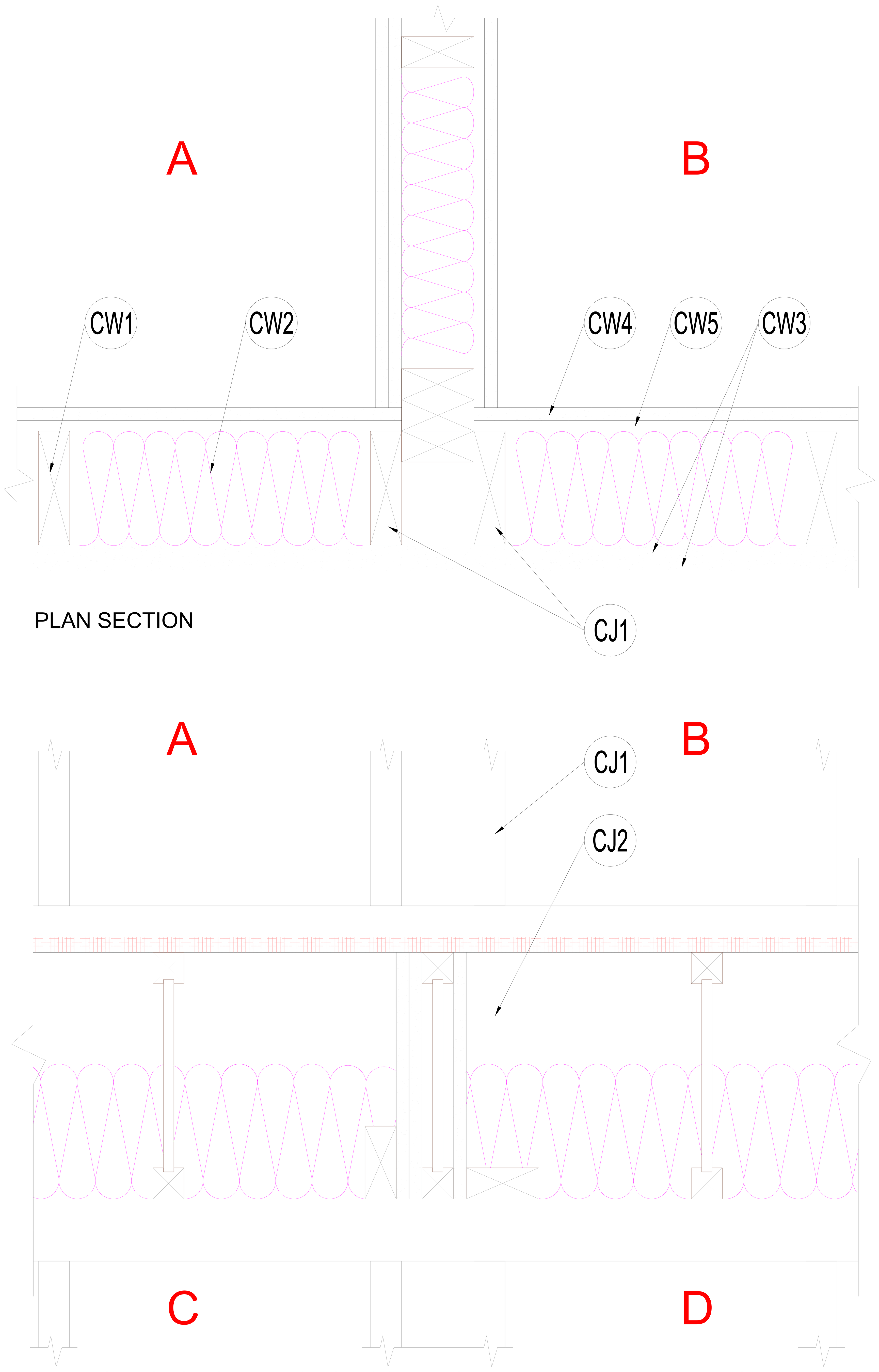
CW4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

CW5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Corridor Wall/Partition Wall Intersection:

CJ1: 2x4 (38X89 mm) blocking material as required to support the RC's of the corridor wall.

CJ2: TimberStrand® laminated strand lumber (LSL) rim board continuous across end of partition wall.



VERTICAL SECTION THROUGH CORRIDOR WALL FIGURE: B.3.1

Partition Wall: Single stud, details specific to the wall/floor junction case.

Corridor Wall:

CW 1: Single 2x6 (38x140 mm) wood stud wall with studs spaced 16" (406 mm) o.c., with double head plate.

CW 2: 6" (140 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

CW 3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

CW 4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

CW 5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Corridor Wall/Partition Wall Intersection:

CJ1: 2x6 (38X140 mm) blocking material as required to support the RC's of the corridor wall.

CJ2: TimberStrand® laminated strand lumber (LSL) rimboard continuous across end of partition wall.

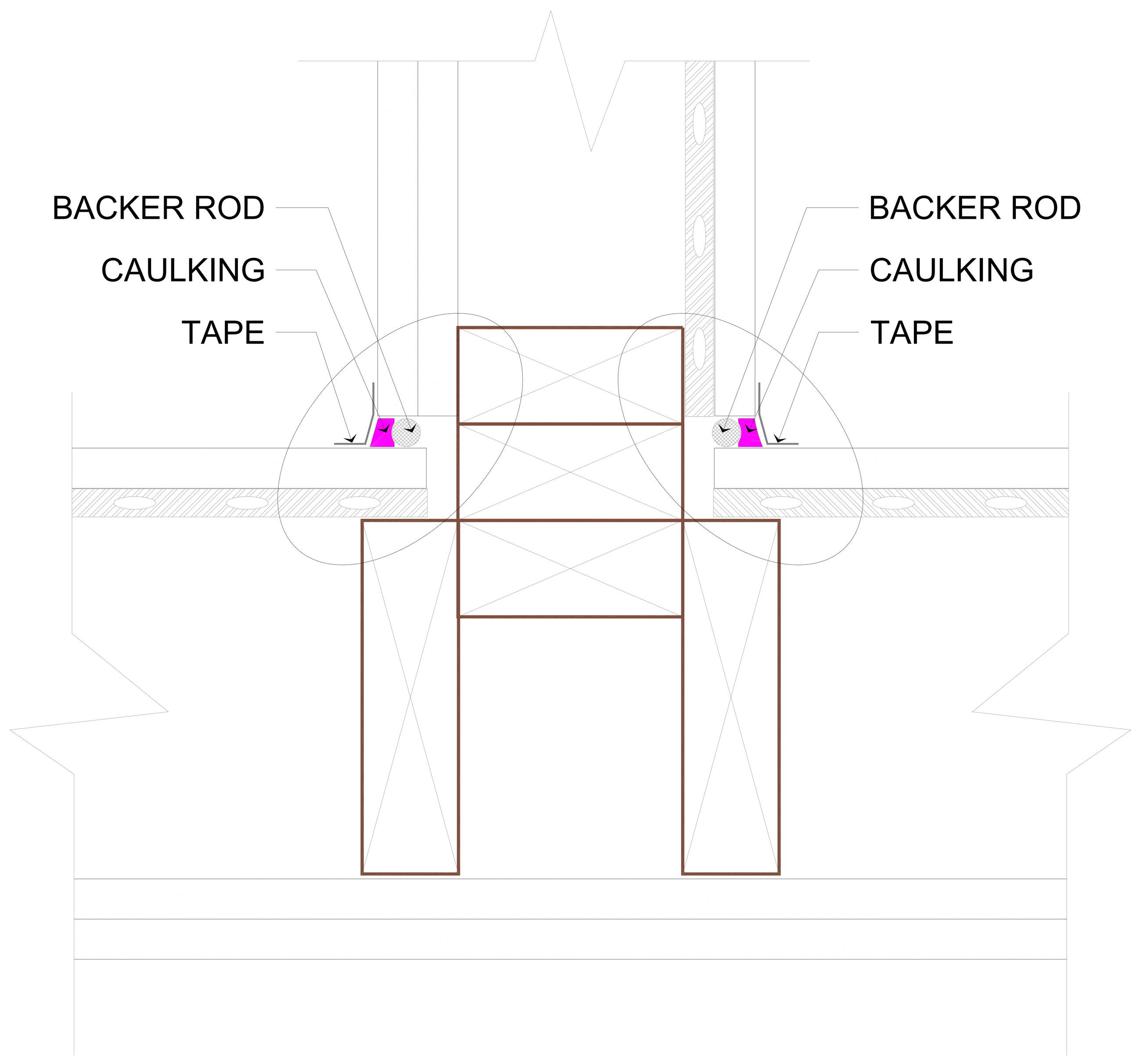


FIGURE: B.1

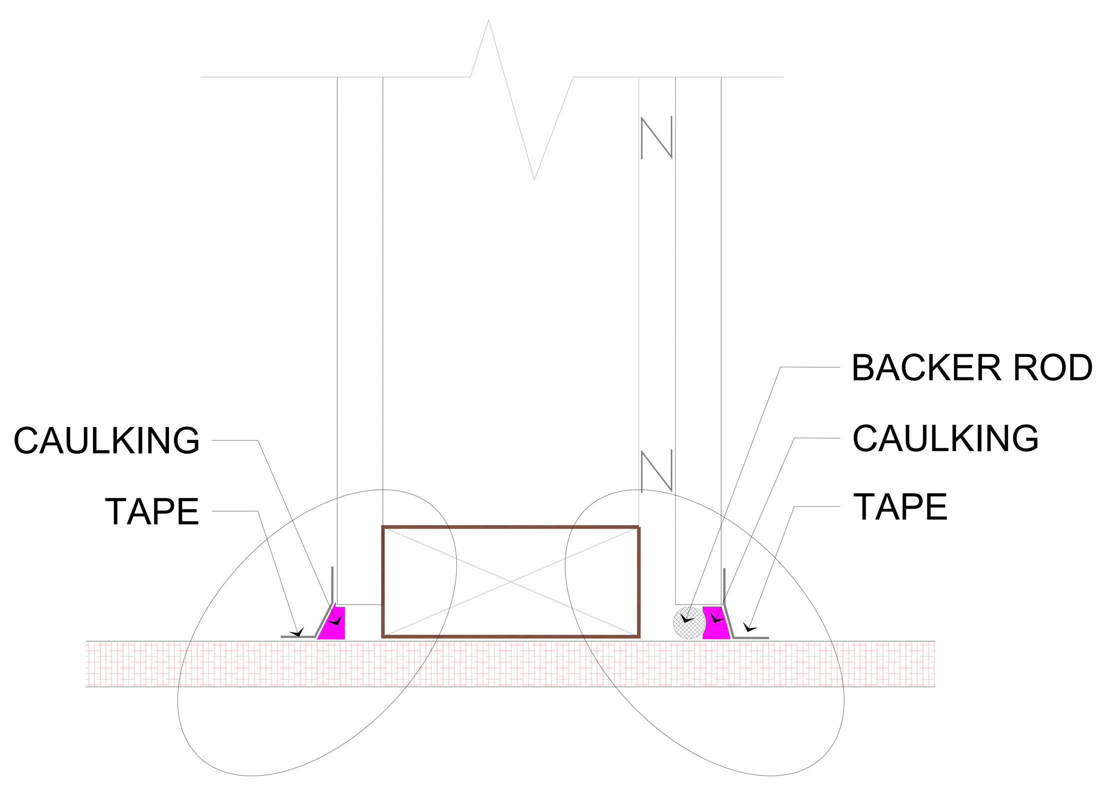
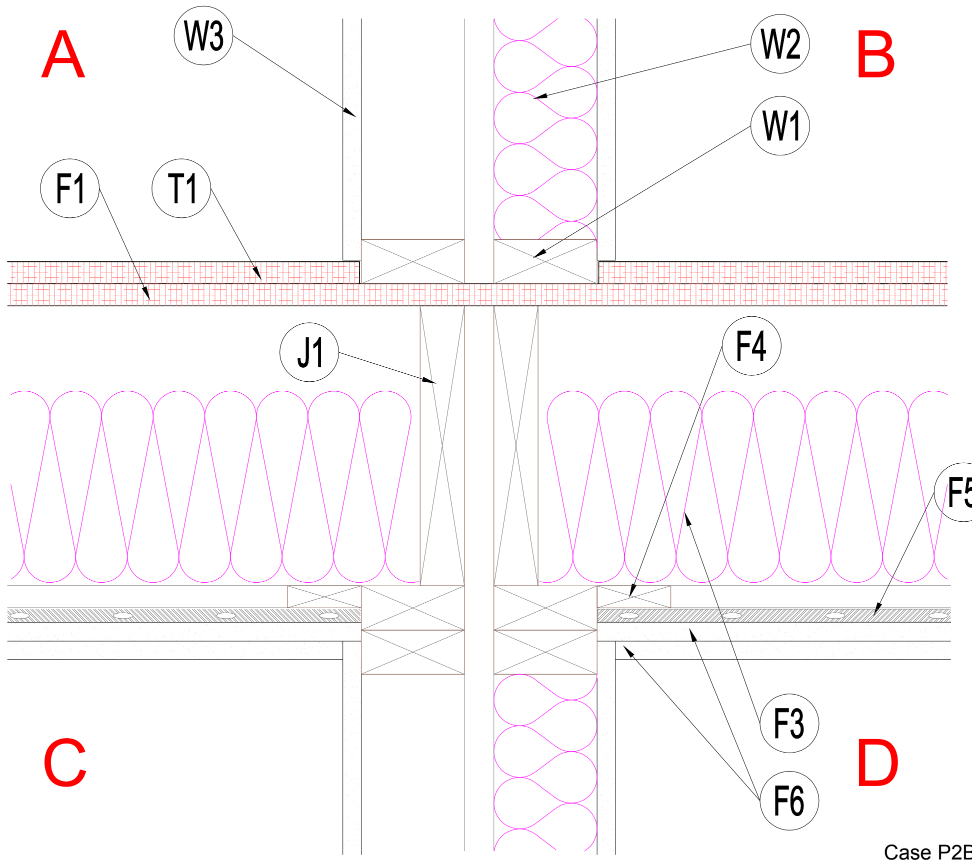


FIGURE: B.2



Partition Wall:

W1: Double 2x4 (38x89 mm) wood stud load-bearing wall having studs spaced 16" (406 mm) o.c., with double head plates. 1" (25 mm) separation between the rows of studs.

W2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling both wall cavities.

W3: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c.

Topping:

T1: 3/4" (19 mm) OSB overlay installed perpendicular to the subfloor with staggered joints fastened with staples not less than 1/16" (1.6 mm) diameter, and 1/2" (12.5 mm) crown and 1-1/2" (38 mm) length spaced at 6" (150 mm) o.c. along edge and 8" (203 mm) o.c. in the field.

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: 2x10" (38x235 mm) wood joists spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

F4: Bridging and strapping; 1x3 (19x64 mm) strapping 24" (610 mm) o.c. used as furring strips, 1x3 (19x64 mm) bracing no more than 72" (1800 mm) o.c. located at strapping points.

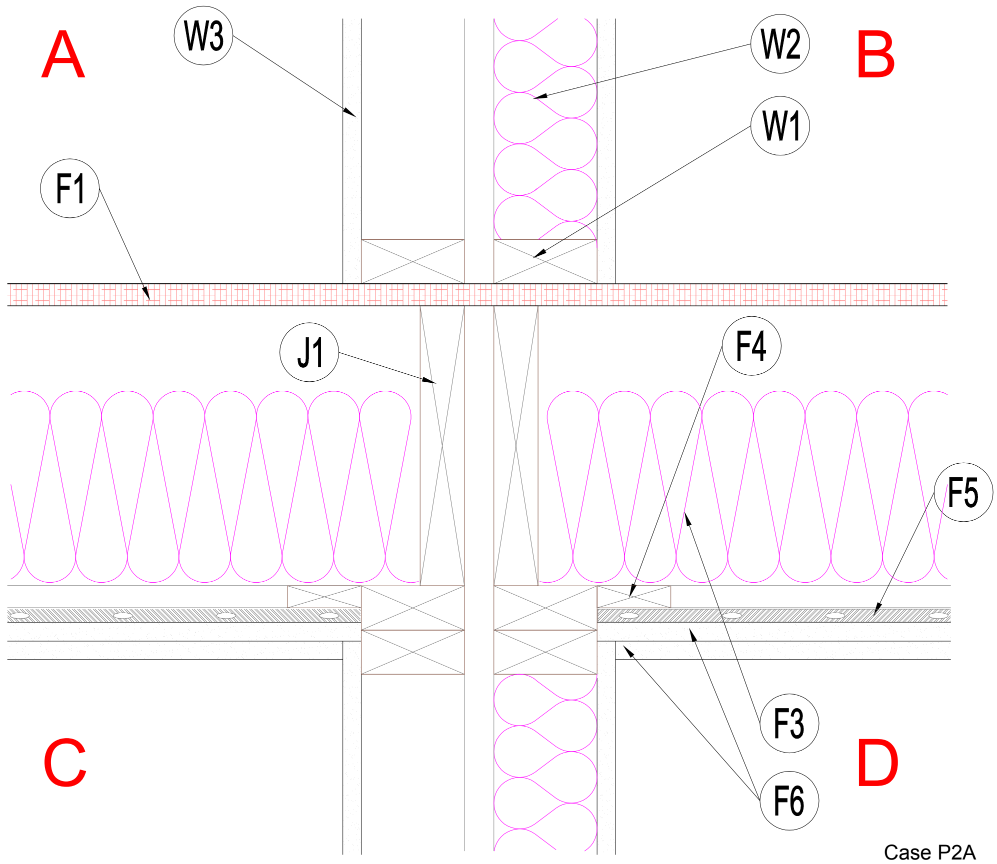
F5: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the strapping using 1-5/8" (42 mm) drywall screws.

F6: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. The screws placed so as not to penetrate into the strapping or joists.

Floor/Partition-Wall Intersection:

J1: Two 2x10 (38x235 mm) wood joists.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W1: Double 2x4 (38x89 mm) wood stud load-bearing wall having studs spaced 16" (406 mm) o.c., with double head plates. 1" (25 mm) separation between the rows of studs.

W2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling both wall cavities.

W3: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c.

Topping:

T1: None.

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: 2x10" (38x235 mm) wood joists spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

F4: Bridging and strapping; 1x3 (19x64 mm) strapping 24" (610 mm) o.c. used as furring strips, 1x3 (19x64 mm) bracing no more than 72" (1800 mm) o.c. located at strapping points.

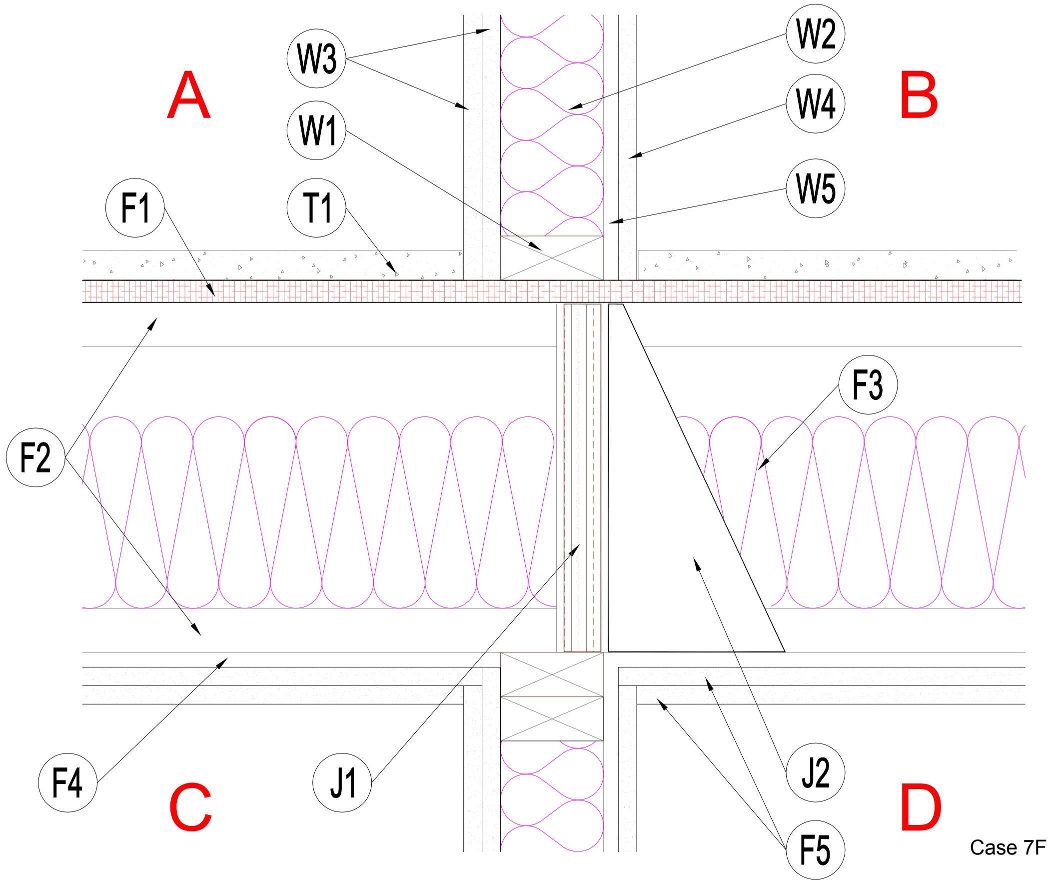
F5: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the strapping using 1-5/8" (42 mm) drywall screws.

F6: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. The screws placed so as not to penetrate into the strapping or joists.

Floor/Partition-Wall Intersection:

J1: Two 2x10 (38x235 mm) wood joists.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W1: Single 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double head plate.

W2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

W4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

W5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Topping:

T1: 1" (25 mm) nominal thickness LEVELROCK® Brand Floor Underlayment 2500 poured directly on the OSB subfloor.

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: TJI® Pro 150 wood I-joists with 1-1/2" (38 mm) square flange and 11-7/8" (300 mm) depth spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

F4: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the joists using 1-5/8" (42 mm) drywall screws.

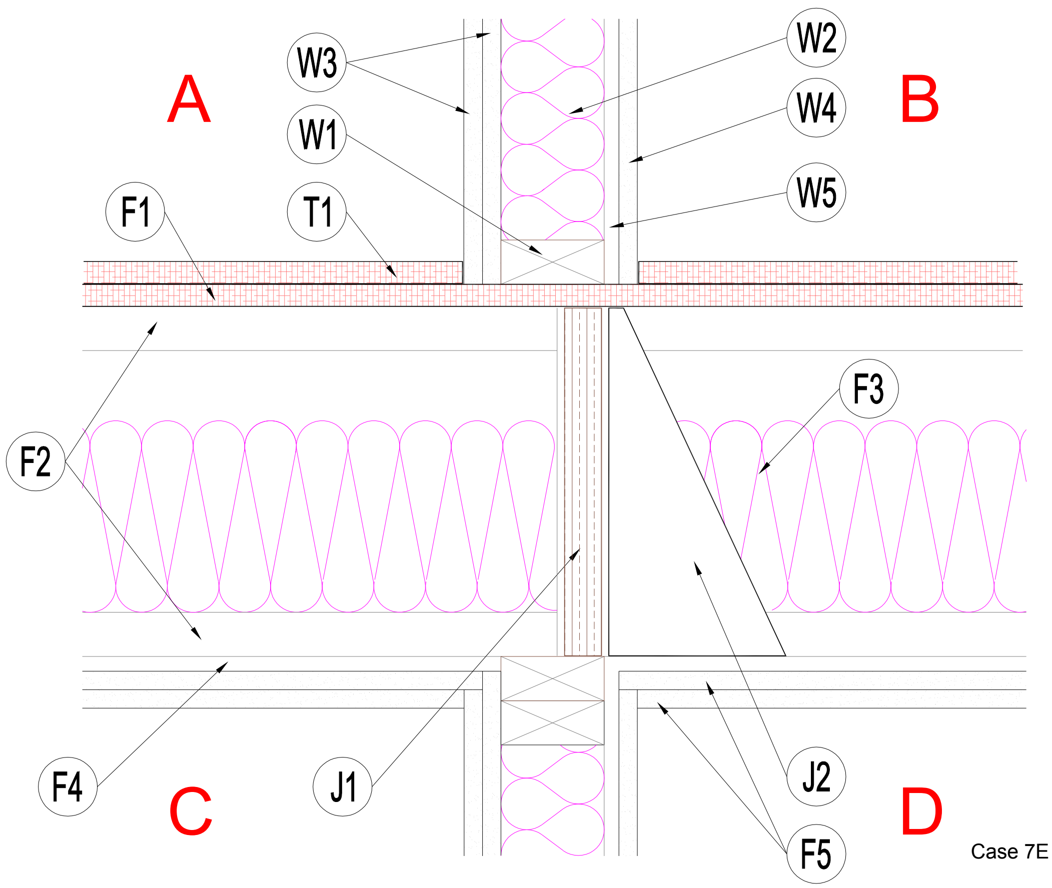
F5: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with the long axis perpendicular to the resilient channels using 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. Stagger joints by at least 16" (406 mm) in both directions. The screws placed so as not to penetrate into the joists.

Floor/Partition-Wall Intersection:

J1: The joists of one room rest on the partition wall butting into a TimberStrand® laminated strand lumber (LSL) rim board, 1-1/4" (32 mm) thick by 11-7/8" (300 mm) deep.

J2: Simpson Strong-Tie ITT211.88 joist hangers attached to the rim board.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W1: Single 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double head plate.

W2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

W4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

W5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Topping:

T1: 3/4" (19 mm) OSB overlay installed perpendicular to the subfloor with staggered joints fastened with staples not less than 1/16" (1.6 mm) diameter, and 1/2" (12.5 mm) crown and 1-1/2" (38 mm) length spaced at 6" (150 mm) o.c. along edge and 8" (203 mm) o.c. in the field.

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: TJI® Pro 150 wood I-joists with 1-1/2" (38 mm) square flange and 11-7/8" (300 mm) depth spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

F4: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the joists using 1-5/8" (42 mm) drywall screws.

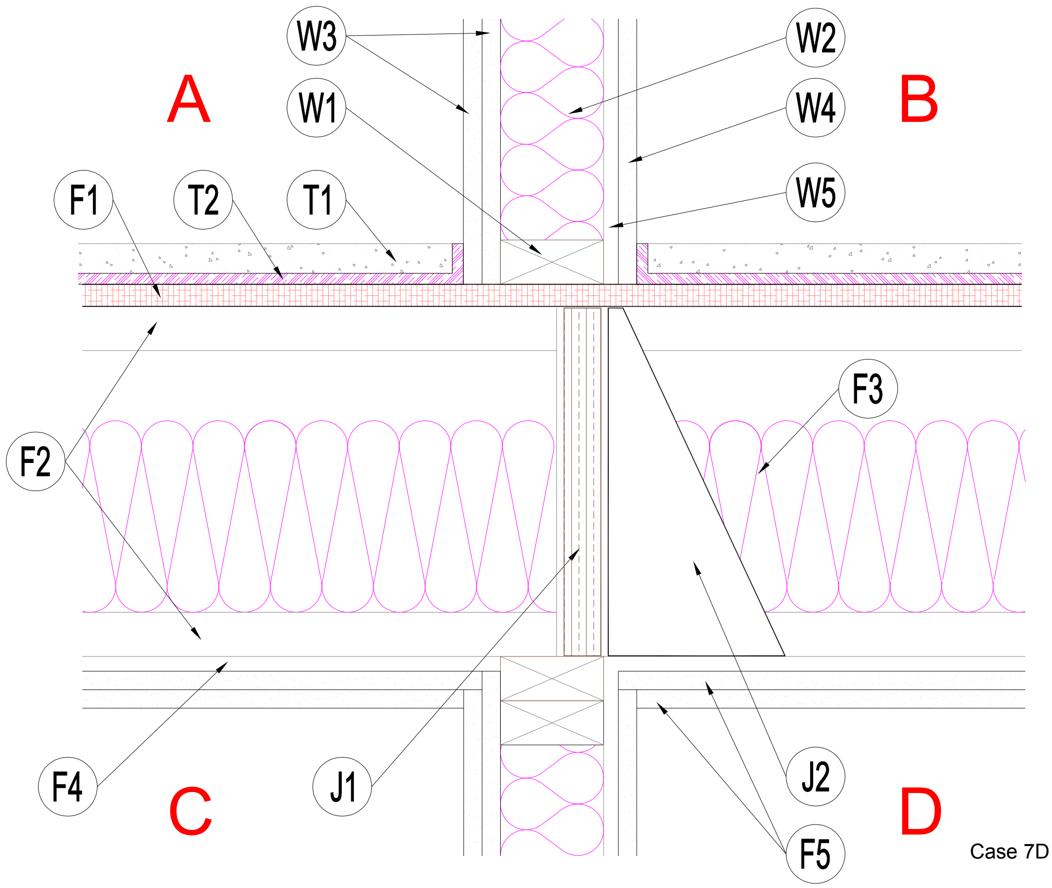
F5: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with the long axis perpendicular to the resilient channels using 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. Stagger joints by at least 16" (406 mm) in both directions. The screws placed so as not to penetrate into the joists.

Floor/Partition-Wall Intersection:

J1: The joists of one room rest on the partition wall butting into a TimberStrand® laminated strand lumber (LSL) rim board, 1-1/4" (32 mm) thick by 11-7/8" (300 mm) deep.

J2: Simpson Strong-Tie ITT211.88 joist hangers attached to the rim board.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W1: Single 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double head plate.

W2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

W4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

W5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Topping:

T1: 1" (25 mm) nominal thickness LEVELROCK® Brand Floor Underlayment 2500.

T2: QuietZone™ Acoustic Floor Mat nominal thickness 3/8" (9 mm). Tape all seams.

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: TJI® Pro 150 wood I-joists with 1-1/2" (38 mm) square flange and 11-7/8" (300 mm) depth spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

F4: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the joists using 1-5/8" (42 mm) drywall screws.

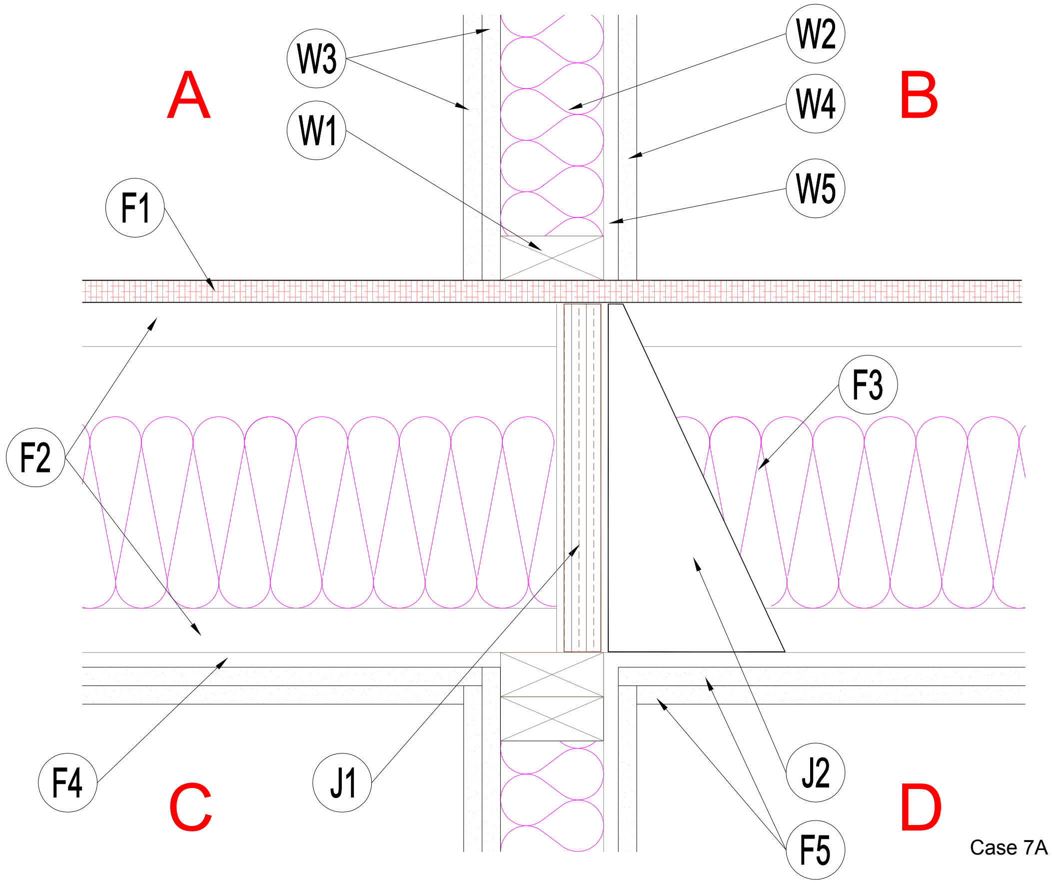
F5: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with the long axis perpendicular to the resilient channels using 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. Stagger joints by at least 16" (406 mm) in both directions. The screws placed so as not to penetrate into the joists.

Floor/Partition-Wall Intersection:

J1: The joists of one room rest on the partition wall butting into a TimberStrand® laminated strand lumber (LSL) rim board, 1-1/4" (32 mm) thick by 11-7/8" (300 mm) deep.

J2: Simpson Strong-Tie ITT211.88 joist hangers attached to the rim board.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W 1: Single 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double head plate.

W 2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W 3: Two layers of 5/8" (15.9 mm) SHEETROCK® Brand FIRECODE C CORE gypsum panels attached directly to the studs. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

W 4: One layer of 5/8" (15.9 mm) SHEETROCK® Brand FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

W 5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Topping:

None

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: TJI® Pro 150 wood I-joists with 1-1/2" (38 mm) square flange and 11-7/8" (300 mm) depth spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

F4: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the joists using 1-5/8" (42 mm) drywall screws.

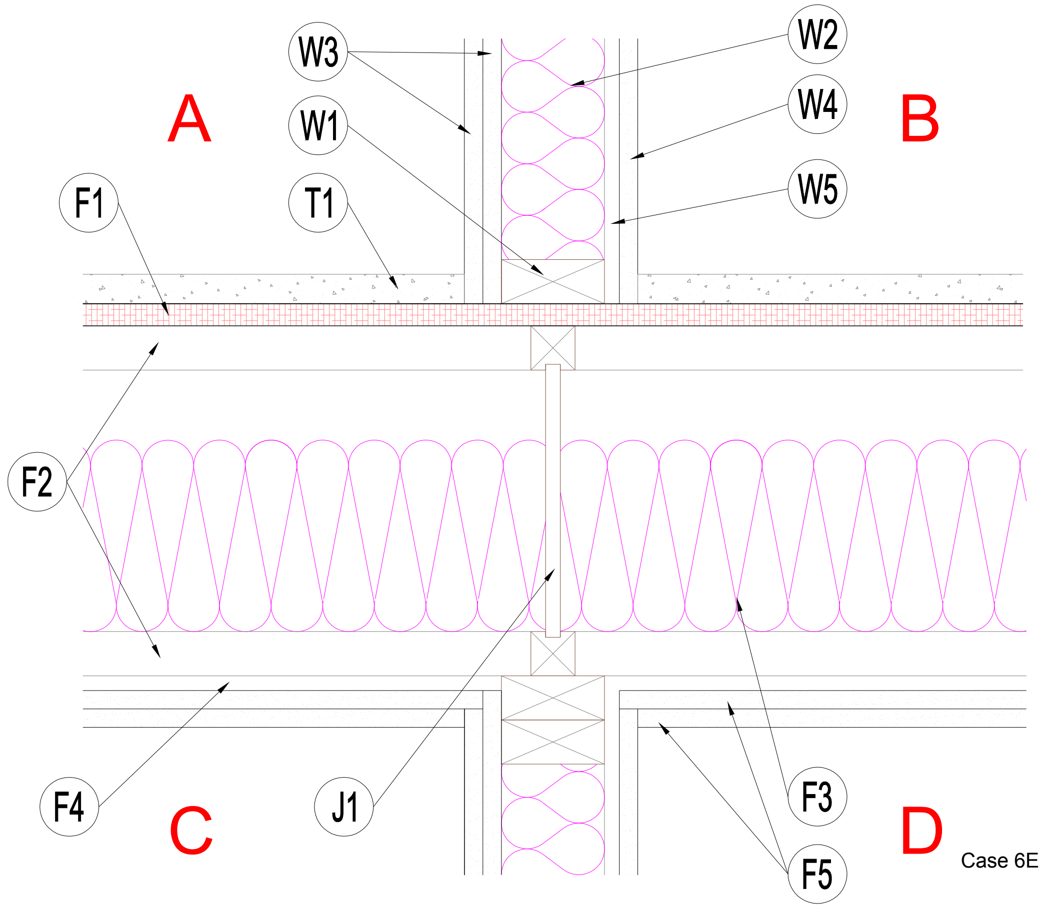
F5: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with the long axis perpendicular to the resilient channels using 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. Stagger joints by at least 16" (406 mm) in both directions. The screws placed so as not to penetrate into the joists.

Floor/Partition-Wall Intersection:

J1: The joists of one room rest on the partition wall butting into a TimberStrand® laminated strand lumber (LSL) rim board, 1-1/4" (32 mm) thick by 11-7/8" (300 mm) deep.

J2: Simpson Strong-Tie ITT211.88 joist hangers attached to the rim board.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W1: Single 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double head plate.

W2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

W4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

W5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Topping:

T1: 1" (25 mm) nominal thickness LEVELROCK® Brand Floor Underlayment 2500 poured directly on the OSB subfloor.

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: TJI® Pro 150 wood I-joists with 1-1/2" (38 mm) square flange and 11-7/8" (300 mm) depth spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

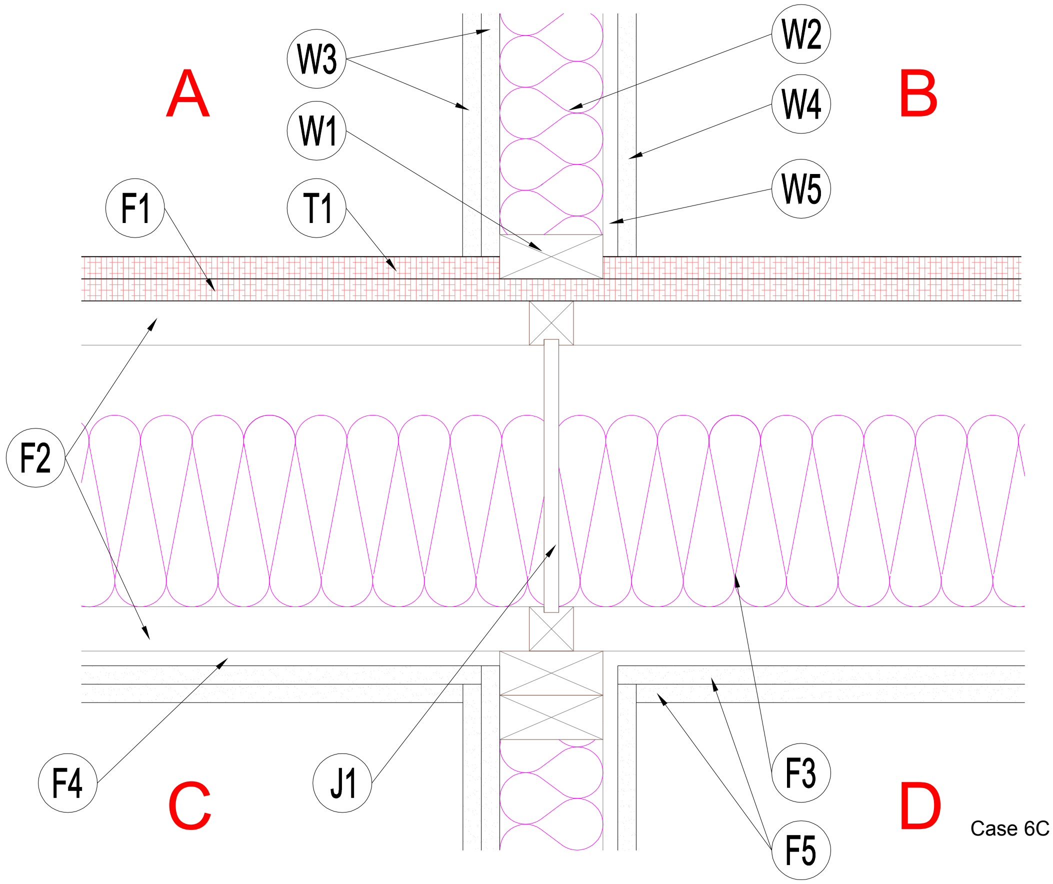
F4: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the joists using 1-5/8" (42 mm) drywall screws.

F5: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with the long axis perpendicular to the resilient channels using 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. Stagger joints by at least 16" (406 mm) in both directions. The screws placed so as not to penetrate into the joists.

Floor/Partition-Wall Intersection:

J1: TJI® Pro 150 wood I-joist, 11-7/8" (300 mm) deep.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W 1: Single 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double head plate.

W 2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W 3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

W 4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

W 5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Topping:

T 1: 3/4" (19 mm) OSB overlay installed perpendicular to the subfloor with staggered joints fastened with staples not less than 1/16" (1.6 mm) diameter, and 1/2" (12.5 mm) crown and 1-1/2" (38 mm) length spaced at 6" (150 mm) o.c. along edge and 8" (203 mm) o.c. in the field.

Floor:

F 1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F 2: TJI® Pro 150 wood I-joists with 1-1/2" (38 mm) square flange and 11-7/8" (300 mm) depth spaced 16" (406 mm) o.c.

F 3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

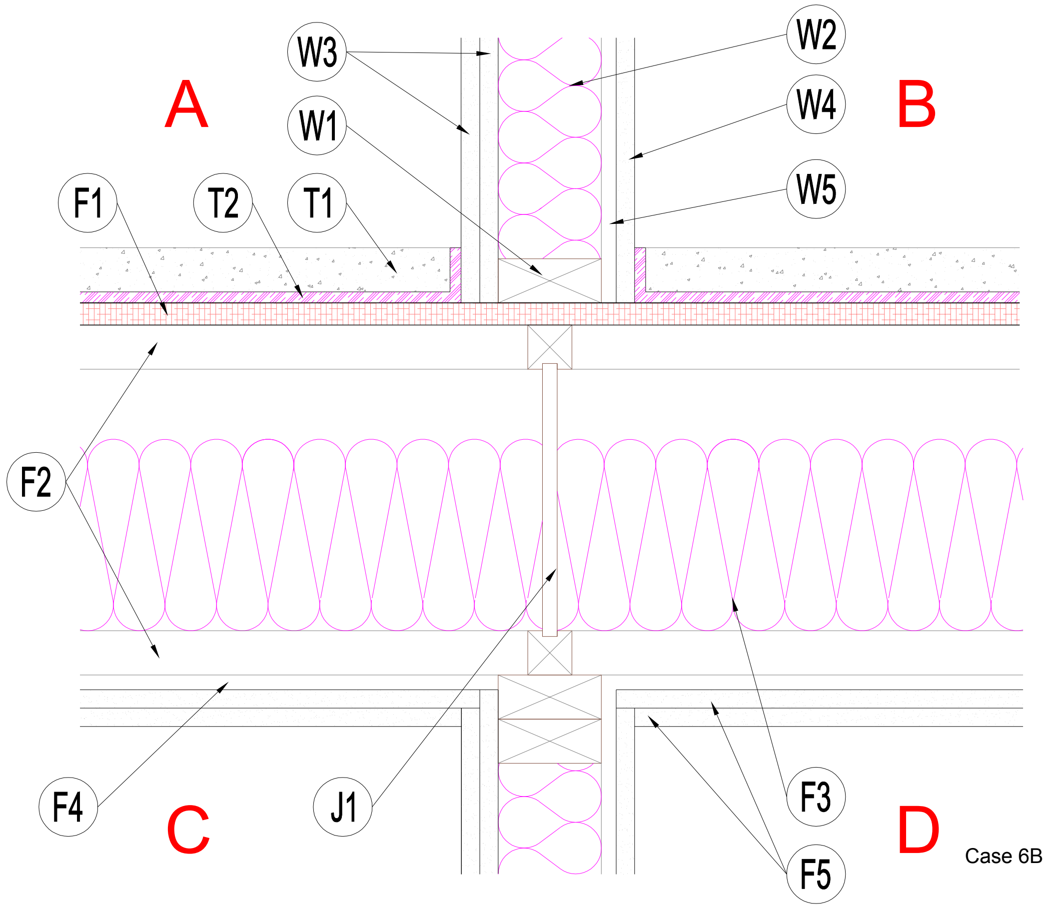
F 4: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the joists using 1-5/8" (42 mm) drywall screws.

F 5: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with the long axis perpendicular to the resilient channels using 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. Stagger joints by at least 16" (406 mm) in both directions. The screws placed so as not to penetrate into the joists.

Floor/Partition-Wall Intersection:

J1: TJI® Pro 150 wood I-joist, 11-7/8" (300 mm) deep.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W1: Single 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double head plate.

W2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

W4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

W5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Topping:

T1: 1-1/2" (38 mm) nominal thickness LEVELROCK® Brand Floor Underlayment 2500.

T2: QuietZone™ Acoustic Floor Mat nominal thickness 3/8" (9 mm). Tape all seams.

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: TJI® Pro 150 wood I-joists with 1-1/2" (38 mm) square flange and 11-7/8" (300 mm) depth spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

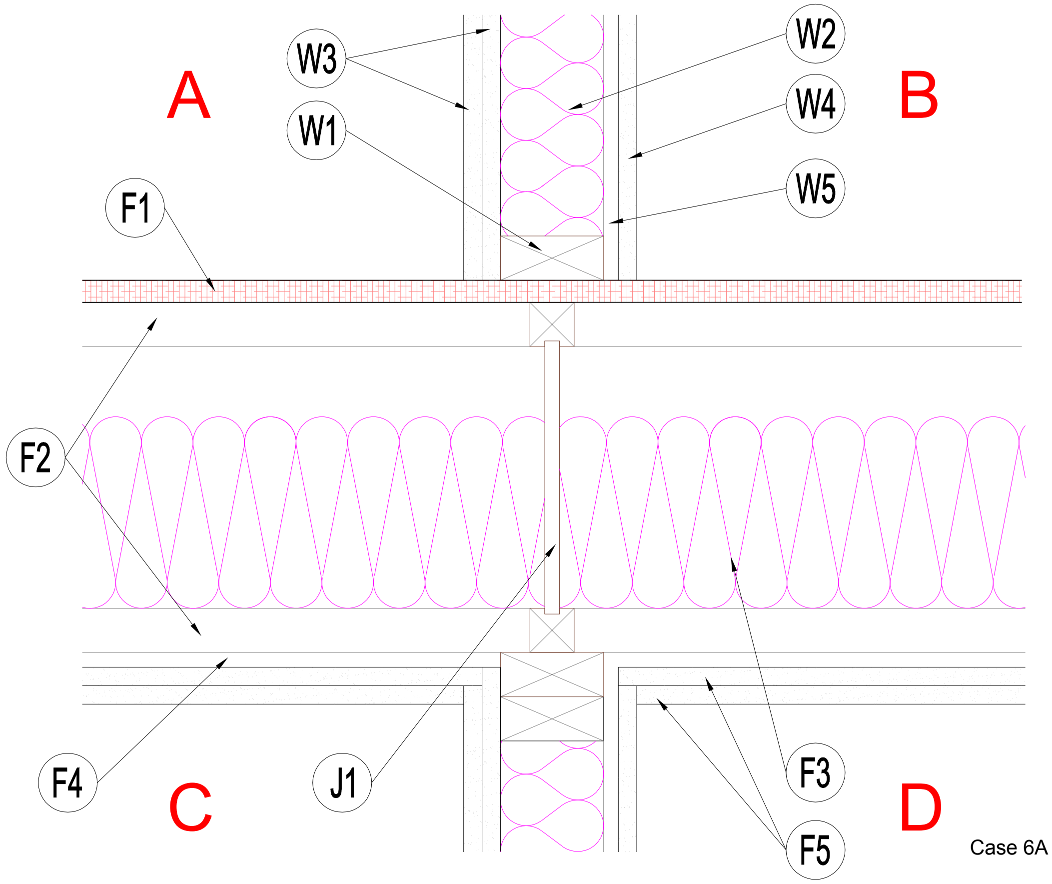
F4: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the joists using 1-5/8" (42 mm) drywall screws.

F5: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with the long axis perpendicular to the resilient channels using 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. Stagger joints by at least 16" (406 mm) in both directions. The screws placed so as not to penetrate into the joists.

Floor/Partition-Wall Intersection:

J1: TJI® Pro 150 wood I-joist, 11-7/8" (300 mm) deep.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W 1: Single 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double head plate.

W 2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W 3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

W 4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

W 5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Topping:

None

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: TJI® Pro 150 wood I-joists with 1-1/2" (38 mm) square flange and 11-7/8" (300 mm) depth spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

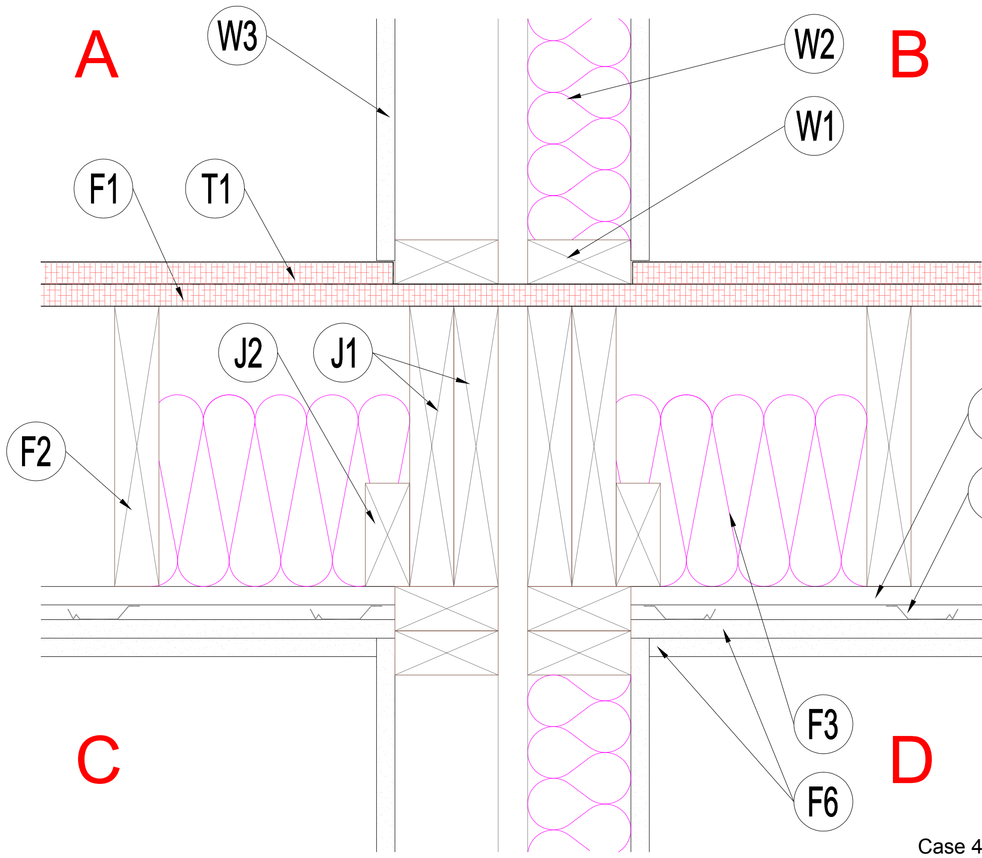
F4: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the joists using 1-5/8" (42 mm) drywall screws.

F5: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with the long axis perpendicular to the resilient channels using 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. Stagger joints by at least 16" (406 mm) in both directions. The screws placed so as not to penetrate into the joists.

Floor/Partition-Wall Intersection:

J1: TJI® Pro 150 wood I-joist, 11-7/8" (300 mm) deep.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W1: Double 2x4 (38x89 mm) wood stud load-bearing wall having studs spaced 16" (406 mm) o.c., with double head plates. 1" (25 mm) separation between the rows of studs.

W2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W3: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c.

Topping:

T1: 3/4" (19 mm) OSB overlay installed perpendicular to the subfloor with staggered joints fastened with staples not less than 1/16" (1.6 mm) diameter, and 1/2" (12.5 mm) crown and 1-1/2" (38 mm) length spaced at 6" (150 mm) o.c. along edge and 8" (203 mm) o.c. in the field.

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: 2x10" (38x235 mm) wood joists spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

F4: Bridging and strapping; 1x3 (19x64 mm) strapping 24" (610 mm) o.c. used as furring strips, 1x3 (19x64 mm) bracing no more than 72" (1800 mm) o.c. located at strapping points.

F5: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the strapping using 1-5/8" (42 mm) drywall screws.

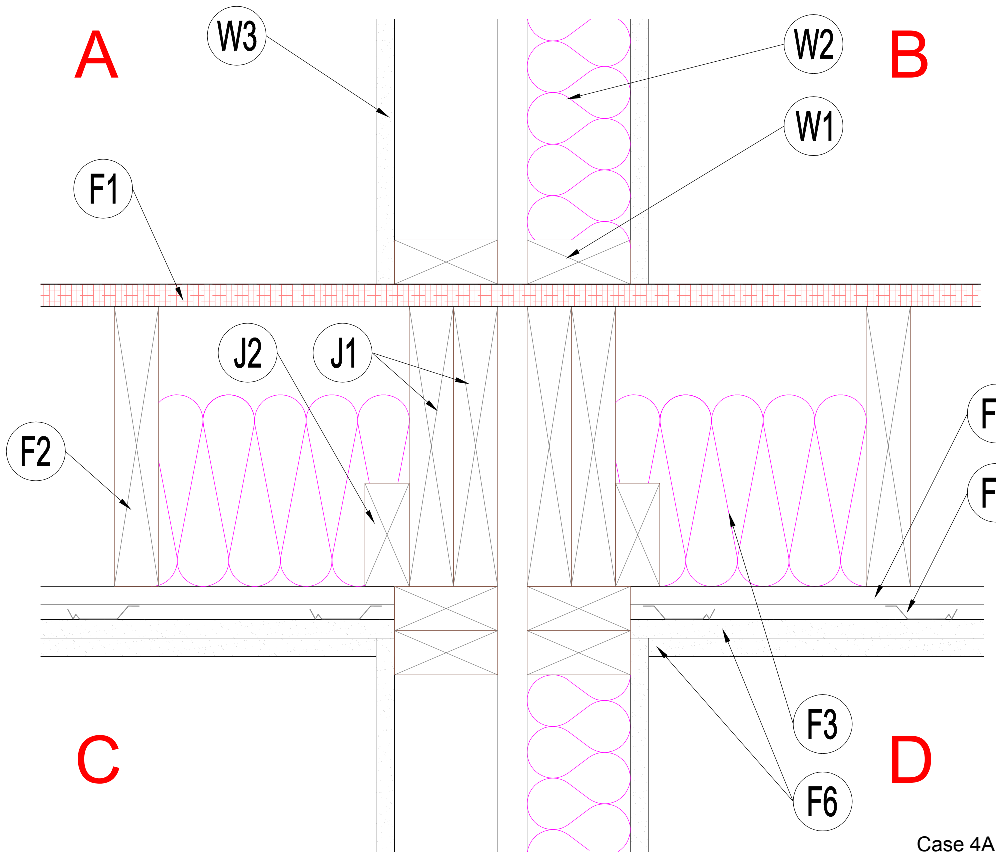
F6: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. The screws placed so as not to penetrate into the strapping or joists.

Floor/Partition-Wall Intersection:

J1: Two 2x10 (38x235 mm) wood joists.

J2: 2x4 (38x89 mm) nailing plates attached to studs in floor cavity to support strapping.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W1: Double 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double sole plates. 1" (25 mm) separation between the rows of studs.

W2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W3: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c.

Topping:

None

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field

F2: 2x10 (38x235 mm) wood joists spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

F4: Bridging and strapping; 1x3 (19x64 mm) strapping 24" (610 mm) o.c. used as furring strips, 1x3 (19x64 mm) bracing no more than 72" (1800 mm) o.c. located at strapping points.

F5: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the strapping using 1-5/8" (42 mm) drywall screws.

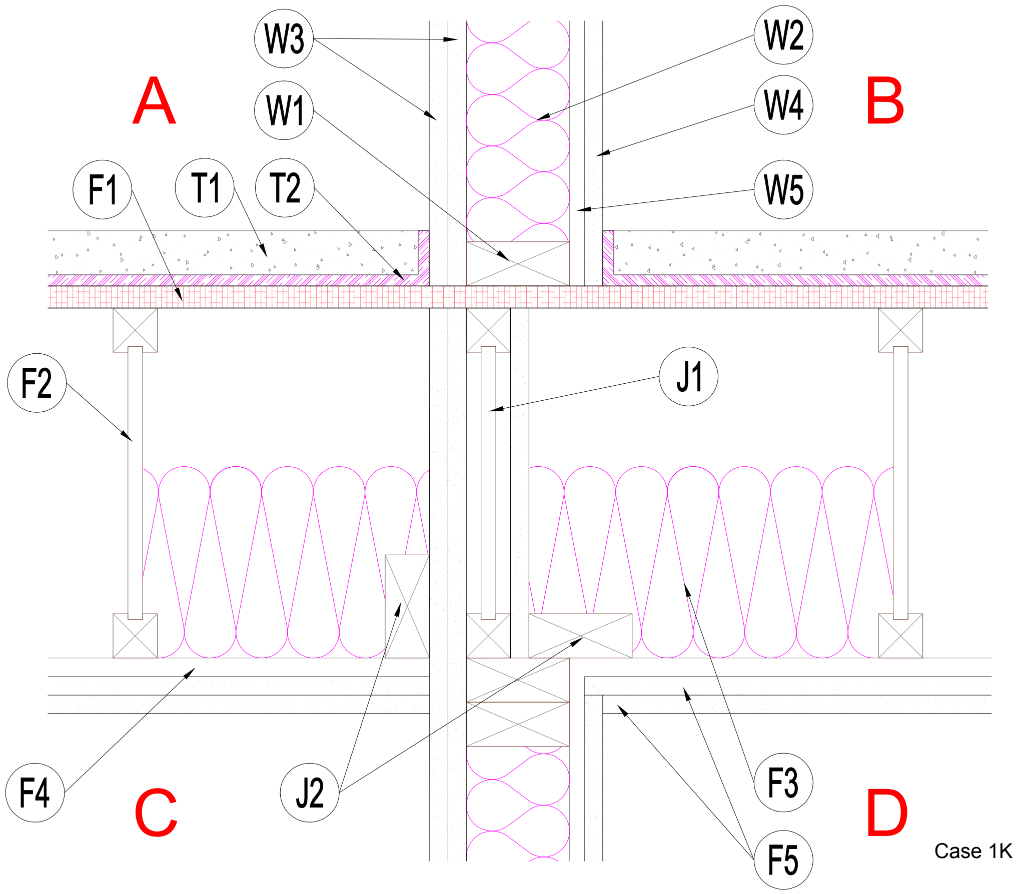
F6: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. The screws placed so as not to penetrate into the strapping or joists.

Floor/Partition-Wall Intersection:

J1: Two 2x10 (38x235 mm) wood joists.

J2: 2x4 (38x89 mm) nailing plates attached to studs in floor cavity to support strapping.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W 1: Single 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double head plate.

W 2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W 3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The panels extend through the floor cavity to the underside of the subfloor. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

W 4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

W 5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Topping:

T1: 1-1/2" (38 mm) nominal thickness LEVELROCK® Brand Floor Underlayment 2500.

T2: QuietZoneTM Acoustic Floor Mat nominal thickness 3/8" (9 mm). Tape all seams.

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: TJI® Pro 150 wood I-joists with 1-1/2" (38 mm) square flange and 11-7/8" (300 mm) depth spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

F4: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the joists using 1-5/8" (42 mm) drywall screws.

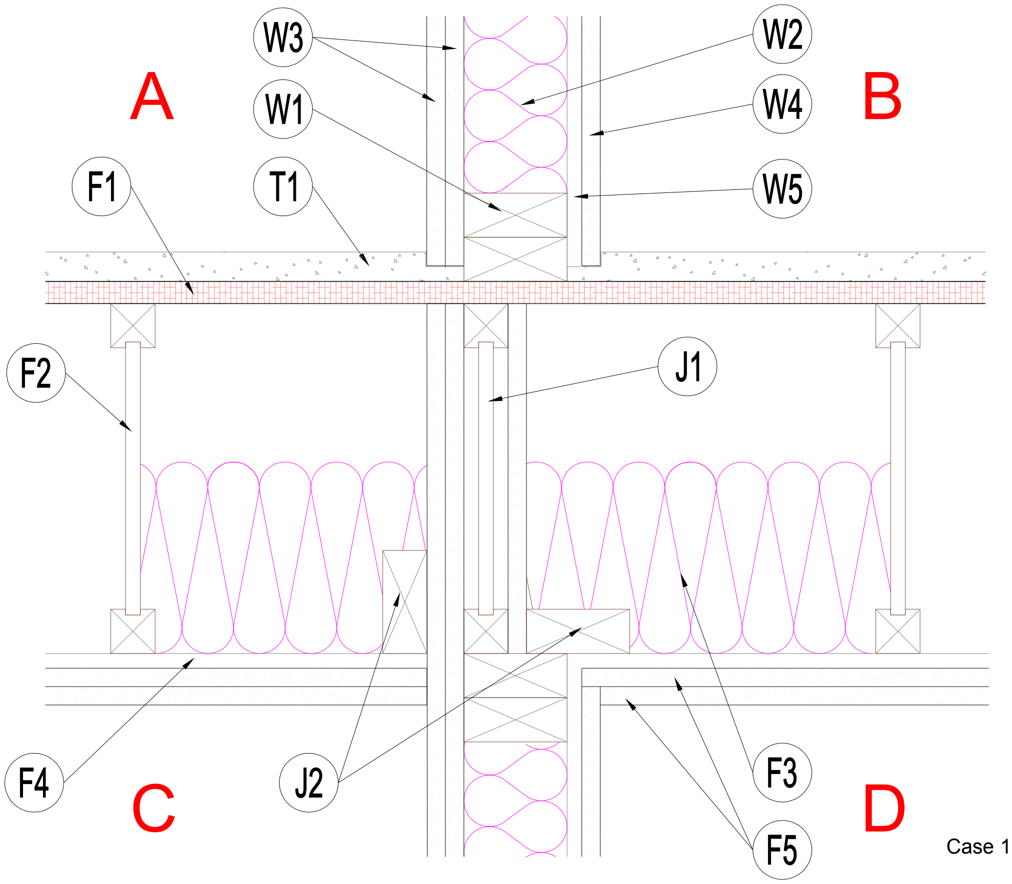
F5: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with the long axis perpendicular to the resilient channels using 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. Stagger joints by at least 16" (406 mm) in both directions. The screws placed so as not to penetrate into the joists.

Floor/Partition-Wall Intersection:

J1: TJI® Pro 150 wood I-joist, 11-7/8" (300 mm) deep, covered with 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panel.

J2: 2x4 (38x89 mm) nailing plates attached to studs in floor cavity to support ceiling resilient channels.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W 1: Single 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double head plate.

W 2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W 3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The panels extend through the floor cavity to the underside of the subfloor. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

W 4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

W 5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Topping:

T1: 1" (25 mm) nominal thickness LEVELROCK® Brand Floor Underlayment 2500 poured directly on the OSB subfloor.

Floor:

F1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F2: TJI® Pro 150 wood I-joists with 1-1/2" (38 mm) square flange and 11-7/8" (300 mm) depth spaced 16" (406 mm) o.c.

F3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

F4: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the joists using 1-5/8" (42 mm) drywall screws.

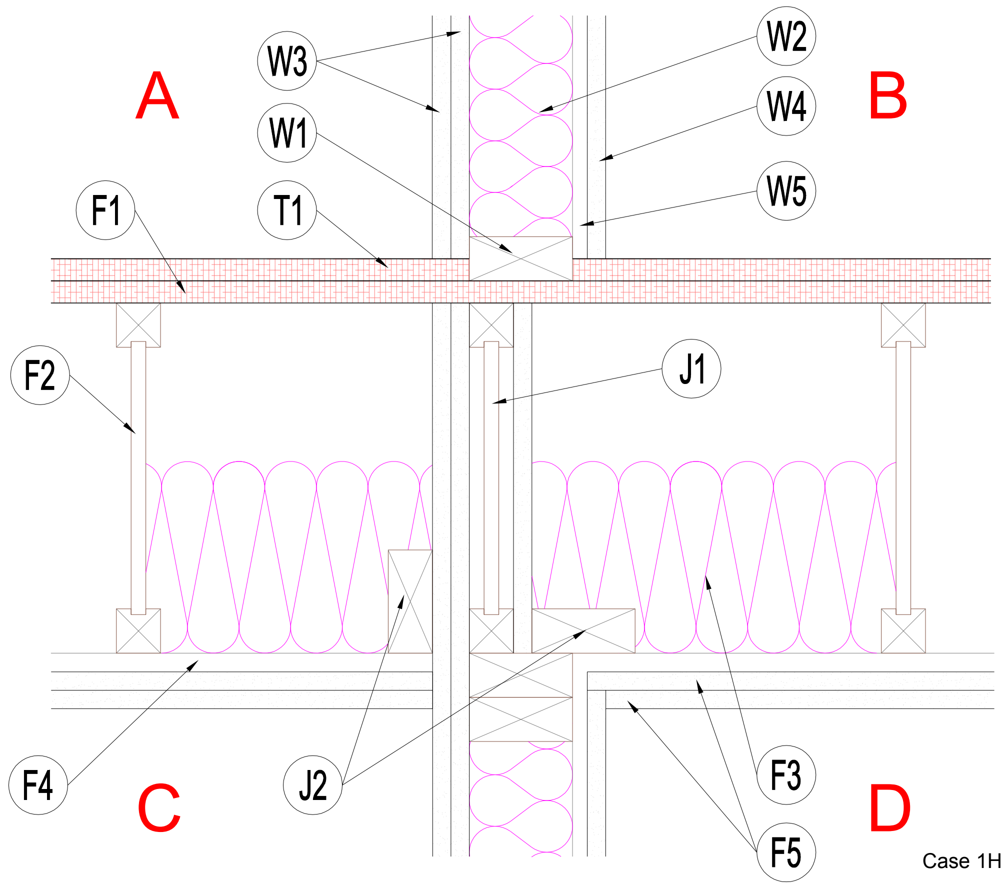
F5: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with the long axis perpendicular to the resilient channels using 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. Stagger joints by at least 16" (406 mm) in both directions. The screws placed so as not to penetrate into the joists.

Floor/Partition-Wall Intersection:

J1: TJI® Pro 150 wood I-joist, 11-7/8" (300 mm) deep, covered with 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panel.

J2: 2x4 (38x89 mm) nailing plates attached to studs in floor cavity to support ceiling resilient channels.

Common Details: Corridor walls, Caulking details.



Partition Wall:

W 1: Single 2x4 (38x89 mm) wood stud wall having studs spaced 16" (406 mm) o.c., with double head plate.

W 2: 3-1/2" (90 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

W 3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The panels extend through the floor cavity to the underside of the subfloor. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

W 4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

W 5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Topping:

T 1: 3/4" (19 mm) OSB overlay installed perpendicular to the subfloor with staggered joints fastened with staples not less than 1/16" (1.6 mm) diameter, and 1/2" (12.5 mm) crown and 1-1/2" (38 mm) length spaced at 6" (150 mm) o.c. along edge and 8" (203 mm) o.c. in the field.

Floor:

F 1: 3/4" (19 mm) OSB floor decking fastened with 2" (51 mm) or longer #10 straight shank wood screws placed 6" (150 mm) o.c. at edges and 12" (305 mm) o.c. in the field.

F 2: TJI® Pro 150 wood I-joists with 1-1/2" (38 mm) square flange and 11-7/8" (300 mm) depth spaced 16" (406 mm) o.c.

F 3: 6" (150 mm) Unfaced Thermal/Acoustic Batt Insulation.

F 4: Resilient channels spaced 16" (406 mm) o.c. The resilient channels installed perpendicular to the joists using 1-5/8" (42 mm) drywall screws.

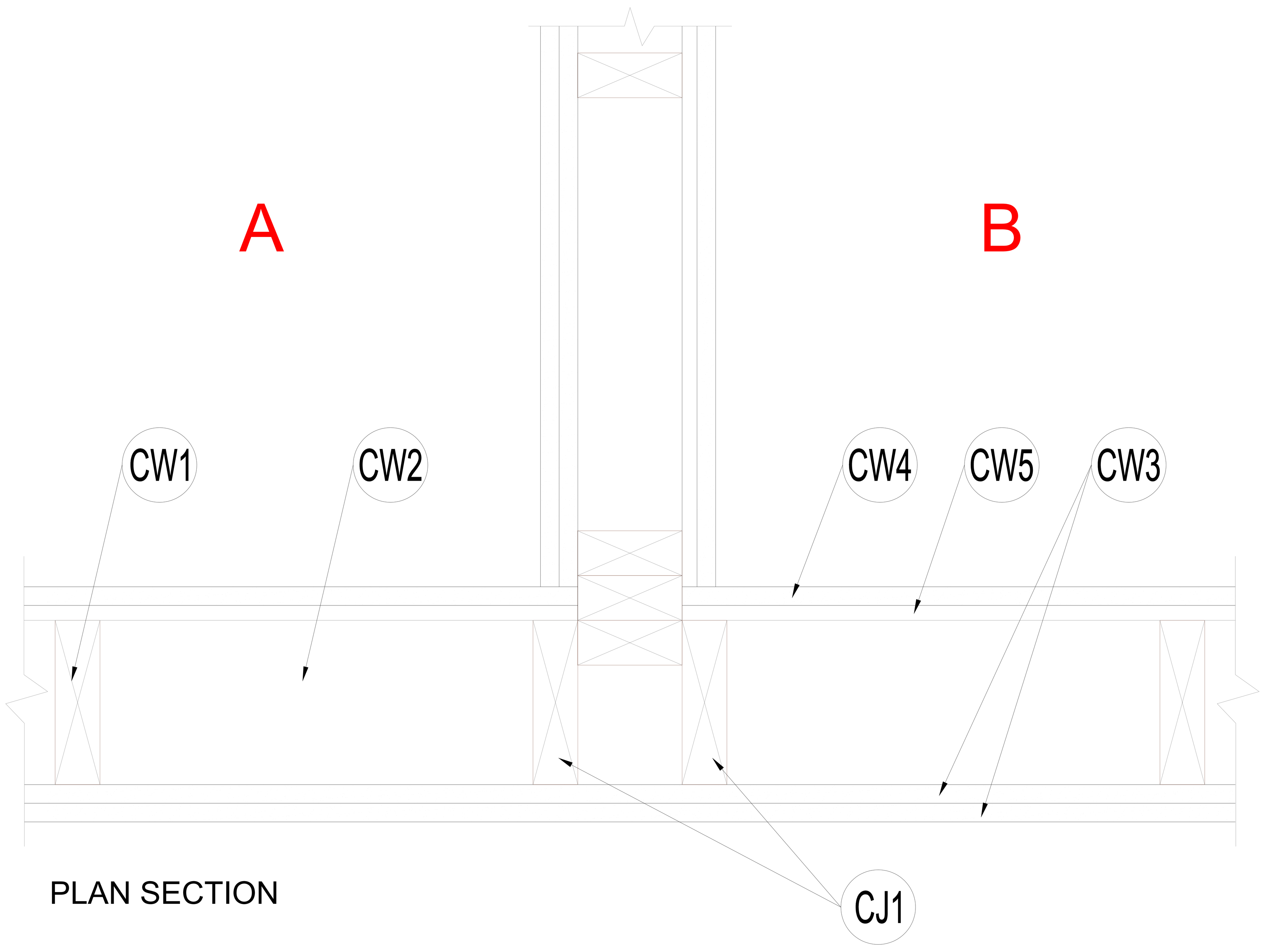
F 5: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels. The base layer attached with the long axis perpendicular to the resilient channels using 1-5/8" (42 mm) or longer screws placed 12" (305 mm) o.c. at the edges and 24" (610 mm) o.c. in the field. The face layer attached with 2" (52 mm) or longer screws placed 12" (305 mm) o.c. at the edges and in the field. Stagger joints by at least 16" (406 mm) in both directions. The screws placed so as not to penetrate into the joists.

Floor/Partition-Wall Intersection:

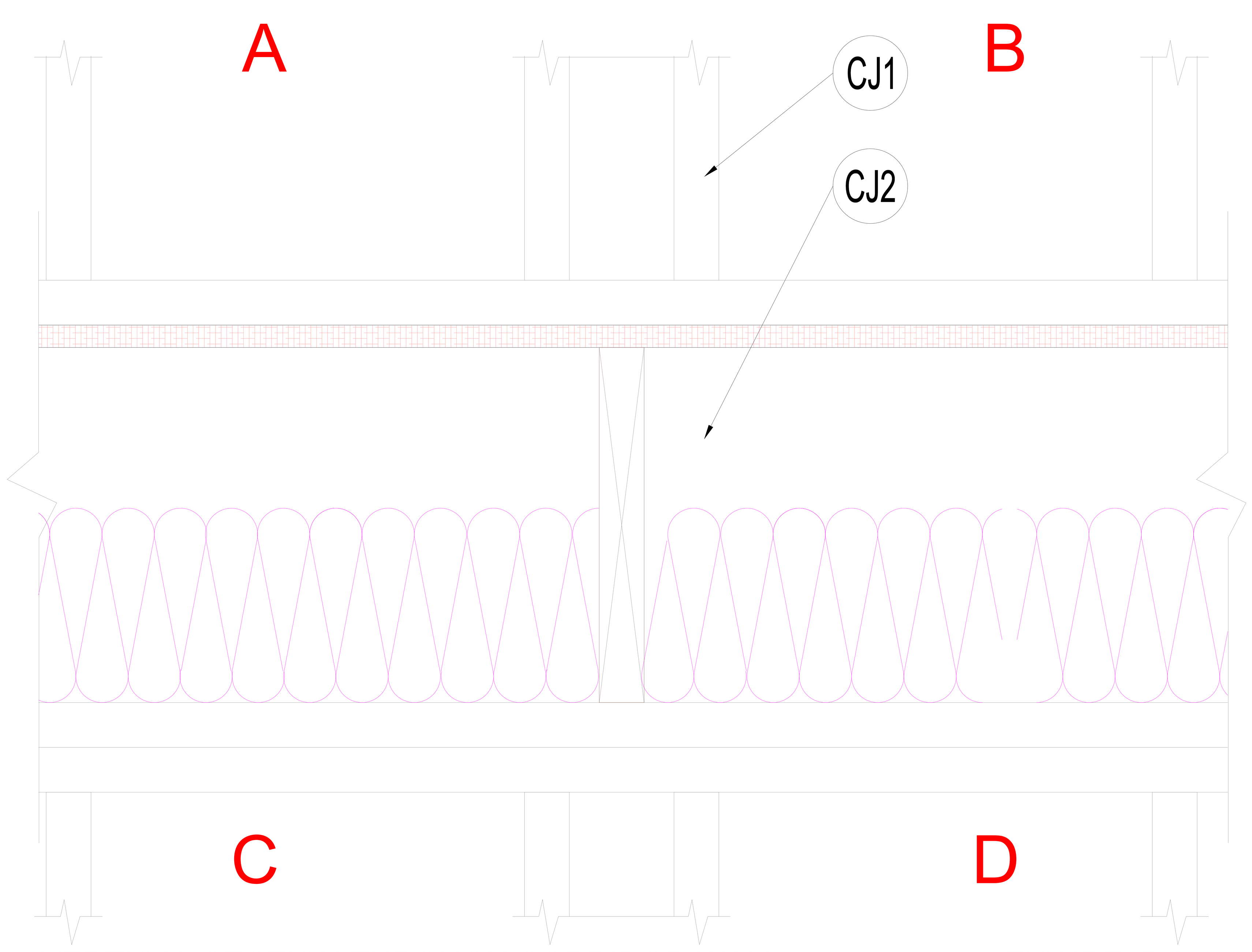
J 1: TJI® Pro 150 wood I-joist, 11-7/8" (300 mm) deep, covered with 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panel.

J 2: 2x4 (38x89 mm) nailing plates attached to studs in floor cavity to support ceiling resilient channels.

Common Details: Corridor walls, Caulking details.



PLAN SECTION



VERTICAL SECTION THROUGH CORRIDOR WALL

FIGURE: B.3.4

Partition Wall: Single stud, details specific to the wall/floor junction case.

Corridor Wall:

CW1: Single 2x6 (38x140 mm) wood stud wall with studs spaced 16" (406 mm) o.c., with double head plates continuous across the end of the partition wall.

CW2: 6" (140 mm) Unfaced Thermal/Acoustic Batt Insulation filling the wall cavity.

CW3: Two layers of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached directly to the studs. The base layer attached vertically using 1-5/8" (42 mm) drywall screws spaced 24" (610 mm) o.c. The face layer attached vertically and fastened with 2" (52 mm) or longer screws placed 16" (406 mm) o.c. Joints staggered by at least 16" (406 mm).

CW4: One layer of 5/8" (15.9 mm) SHEETROCK® BRAND FIRECODE C CORE gypsum panels attached via resilient channels. The panels attached to the channels using 1-5/8" (42 mm) drywall screws placed 12" (305 mm) o.c. The screws placed so as not to penetrate into the studs.

CW5: Resilient channels spaced 24" (610 mm) o.c. The resilient channels installed perpendicular to the studs using 1-5/8" (42 mm) drywall screws.

Corridor Wall/Partition Wall Intersection:

CJ1: 2x6 (38X140 mm) blocking material as required to support the RC's of the corridor wall.

CJ2: TimberStrand® rimboard is discontinuous across end of partition wall. TimberStrand® butts up on either side of blocking over partition wall.