Thermal bridging in residential buildings

The NCC Performance Requirements can be met using either a Performance Solution, Deemed-to-Satisfy (DTS) Solution, or a combination of both.

The following is a general representation and introduction to the DTS Provisions for thermal bridging in residential buildings.

It covers the DTS Provisions for thermal bridging in Class 1 buildings (houses), the sole-occupancy units (SOUs) of Class 2 buildings (apartments) and common areas of Class 2 buildings (apartment buildings). The information presented provides a national overview of the NCC and does not contain any state or territory variations.

This information is useful for architects, building designers, façade engineers, builders, and environmentally sustainable design (ESD) consultants.

What is thermal bridging?

Thermal bridging, in practical terms for the NCC, is an unintended path of heat flow between the outside and inside of the building.

Thermal bridges may occur where there is an interruption in the insulation or where highly conductive materials (e.g. metal) are used.

As an example, if a steel truss roof directly supports an insulated corrugated iron roof, the heat flows through the truss more readily than the surrounding insulation, negating the effect of the insulation (i.e. the truss acts as a thermal bridge).

Figure 1 Metal roof truss

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What are the impacts of thermal bridging?

Thermal bridges can significantly reduce the effectiveness of insulation (thermal resistance) in a house or apartment by essentially bypassing the insulation in favour of a more conductive material (e.g. metal). This results in either losing heat from inside the building to the outside on a cold day, or adding warmth to the inside of the building on a hot day.

This may cause unwanted comfort issues or an increase in energy use by the heating and cooling system.

Additionally, unaddressed thermal bridges may lead to condensation. This can occur when warm, moist air contacts a colder surface and condenses into water droplets. Condensation can result in mould growth, causing indoor air quality issues, negative health impacts for occupants, and potentially affects the durability of the structure.

Thermal bridging and the NCC

The NCC 2022 thermal bridging DTS Provisions for residential buildings aim to mitigate thermal bridging in metal-framed walls, roofs, ceilings, and floors. This is to ensure they have a performance level of at least 90 to 95% of their timber-framed counterparts.

The DTS Provisions only apply to repeating metal-framed elements in roofs and ceilings, floors and walls including spandrels.

To comply with the residential energy efficiency DTS Provisions, you must consider thermal bridging when using metal frames. However, you are not required to consider thermal bridging in timber-framed buildings. The exception to this is when you calculate Total R-Value for external walls of apartment buildings. Importantly, there are different thermal bridging requirements for houses, the common areas of apartment buildings and the SOUs (apartments).

Let's have a closer look at the thermal bridging requirements for houses, apartments and the common areas of apartment buildings in the NCC.

Thermal bridging in houses

The thermal bridging requirements in Volume Two apply to a Class 1 building (house) and a Class 10a building (non-habitable building such as a garage, shed or carport) with a conditioned space.

What is a conditioned space in NCC Volumes One and Two?

A conditioned space in Volume One is a space within a building, including a ceiling or under-floor supply air plenum or return air plenum, where the environment is likely, by the intended use of the space, to have its temperature controlled by air-conditioning.

A conditioned space in Volume Two is a space within a building that is heated or cooled by the building's domestic services, excluding a non-habitable room in which a heater with a capacity of not more than 1.2 kW or 4.3 MJ/hour is installed.

Part 13.2 Building fabric of the ABCB Housing Provisions Standard (Housing Provisions) contains the DTS Provisions for thermal bridging. The relevant clauses by building elements are in Table 1.

Table 1 Thermal bridging clauses for houses

Building element	Housing Provisions
Roofs and ceilings	13.2.3(3)
External walls	13.2.5(4)
Floors above unenclosed space or subfloor	13.2.6(3)

Roofs and ceilings

Clause 13.2.3(3) of the Housing Provisions prescribes methods for reducing thermal bridging in houses with a metal-framed roof.

The requirements of 13.2.3(3) are different for different roof constructions.

For a pitched roof with a horizontal ceiling, there are 4 compliance options:

1. Achieve the Total R-Value in Table 13.2.3s, calculated using a method that accounts for the effect of thermal bridging.

2. Increase the R-Value of ceiling insulation between ceiling frames by R0.5 more than the R-Value derived from 13.2.3(1).
3. Add a continuous ceiling insulation layer. 13.2.3 (3)(a)(iii) provides details on the insulation required and the correct methods for its installation.
4. Stacking 2 layers of insulation on top of each other to achieve the required R-Value for ceiling insulation as specified in 13.2.3 (1). See 13.2.3 (3)(a)(iv) for more details on how to install it.

For a flat, skillion or cathedral roof, there are 2 compliance options:

- Achieve the Total R-Value in Table 13.2.3t, calculated using a method that accounts for the effect of thermal bridging.
- Comply with Table 13.2.3u. Table 13.2.3u presents 2 methods to mitigate thermal bridging. These are increasing insulation between roof frame members to a specified minimum R-Value, or adding a continuous layer of insulation with a minimum R-Value as specified in Table 13.2.3u above or below the roof frame members.

External walls

Clause 13.2.5(4) of the Housing Provisions apply to a Class 1 building and prescribes methods for mitigating thermal bridging in external walls with the following construction types:

- Concrete block walls with internal lining fixed to a metal frame.
- Lightweight metal-framed walls.
- Masonry veneer metal-framed walls.

There are 2 options available to mitigate the effects of thermal bridging in external walls.

The first option is to achieve the applicable Total R-Value in Table 13.2.5p, Table 13.2.5q or Table13.2.5r calculated in accordance with AS/NZS 4859.2 Thermal insulation materials for buildings design.

The second option is to mitigate thermal bridging based on the type of wall. For:

- Concrete block walls with internal lining fixed to a metal frame (Table 13.2.5s): the options are either increase insulation to a specified minimum R-Value between wall framing or add a layer of continuous insulation as specified in Table 13.2.5s.
- Lightweight metal-framed walls (Table 13.2.5t): the options are either to install reflective insulation or add a layer of continuous insulation as specified in Table 13.2.5t.
- Masonry veneer metal-framed walls (Table 13.2.5u): the options are either install reflective insulation or add a layer of continuous insulation as specified in Table 13.2.5u.

Floors above unenclosed space or subfloor

Clause 13.2.6(3) of the Housing Provisions prescribes methods for reducing thermal bridging for a building with a metal-framed suspended floor.

There are 3 options available to comply with 13.2.6(3). They are:

1. Achieving the Total R-Value specified in Table13.2.6i calculated using a method that accounts for thermal bridging for a suspended floor above an enclosed subfloor space.
2. Achieving the Total R-Value as specified in Table13.2.6i using AS/NZS 4859.2 for all other floors.
3. Complying with one of the options in Table 13.2.6j. This can be achieved either by increasing insulation between the floor framing to a specified minimum R-Value or by adding a layer of continuous insulation as specified in Table 13.2.6j.

To better understand thermal bridging in houses and how to determine Total R-Value, see the examples in the Housing energy efficiency handbook.

All the tables mentioned earlier are in the ABCB Housing Provisions, available from the ABCB website.

Thermal bridging in an SOU

The thermal bridging requirements for SOUs (apartments) apply to building elements that are part of the external building fabric.

What is building fabric in NCC Volume One?
The basic building structural elements and components of a building including the roof, ceilings, walls, glazing and floors.

NCC Volume One, Part J3 Elemental provisions for an SOU of a Class 2 building, contains the DTS Provisions for thermal bridging in certain metal framed roofs and metal and timber framed external walls. These clauses are arranged by building elements in Table 2.

Table 2 Thermal bridging clauses for SOUs (apartments)

Building element	NCC Volume One reference
Roofs and ceilings	J3D7(3)
External walls and wall-glazing construction that is part of the external building fabric	J3D8, J3D9
Floors above unenclosed car park or undercroft or the like	Not required

There are no provisions for thermal bridging for SOU floors above a car park, undercroft, or the like in apartment buildings.

Roofs and ceilings

J3D7(3) prescribes methods for mitigating thermal bridging for SOUs (apartments) with a metal-framed roof. The requirements are different for different roof constructions.

The compliance options for a pitched roof with a horizontal ceiling are as follows:

1. Achieve the Total R-Value in Table J3D7s calculated using a method that accounts for the effects of thermal bridging.
2. Increase the R-Value of insulation between the ceiling frames by R0.5 more than the R-Value derived from J3D7(1).
3. Add a continuous ceiling insulation layer. J3D7(3)(a)(iii) provides details on the specification of the insulation and the correct methods for its installation.
4. Achieve the R-Value specified in J3D7(1) by stacking 2 layers of insulation on top of each other. See J3D7(3)(a)(iv) for details on how to install it.

The compliance options for a flat, skillion or cathedral roof are as follows:

- Achieve the Total R-Value in Table J3D7t calculated using a method that accounts for the effect of thermal bridging.
- Comply with Table J3D7u. This table gives 2 methods to mitigate thermal bridging. You can either increase the insulation between the roof frame members to a specified minimum R-Value or add a layer of continuous insulation as specified in Table J3D7u.

All the tables mentioned here are in Volume One of NCC 2022, available from the ABCB website.

External walls

In Part J3, J3D8 and J3D9 are related to the external walls and wall-glazing construction of SOUs (apartments). J3D8 and J3D9 do not specifically mention thermal bridging but specify a Total R-Value or Total U-Value which must account for thermal bridging.

J3D8(2) requires the Total R-Value to be determined in accordance with Specification 38 for spandrel panels in curtain wall systems, and in accordance with AS/NZS 4859.2 for all other walls.

J3D9(2) requires the Total System U-Value of wall-glazing construction to be calculated in accordance with Specification 37. This requires you to account for thermal bridging when calculating the Total System U-Value.

Specification 37 and 38 are in Volume Two of NCC 2022, available from the ABCB website.

Note:

In residential buildings, the extent of loss of performance due to thermal bridging in apartments is much less than in houses. This is due to the lower overall area of each dwelling exposed to the outside.

Thermal bridging in the common areas of apartment buildings

The energy efficiency requirements for common areas of a Class 2 building are different to those discussed above for the SOUs (apartments) of a Class 2 building.

J4D3(5) is the relevant clause for thermal bridging in common areas of apartment buildings and applies to metal and timber framed building envelopes, windows, and spandrel panels.

J4D3(5) requires consideration of thermal bridging when calculating/determining the required Total R-Value and Total System U-Value. These values must be calculated in accordance with:

- AS/NZS 4859.2 for a roof or floor
- Specification 37 for wall-glazing construction
- Specification 39 or Section 3.5 of Chartered Institution of Building Services Engineers (CIBSE) Guide A for soil or sub-floor spaces.

What is wall-glazing construction in NCC Volume One?

For the purposes of Section J in Volume One, the wall-glazing construction is combination of wall and glazing components comprising the envelope of a building, excluding—

- display glazing, and
- opaque non-glazed openings such as doors, vents, penetrations, and shutters.

This is consistent with how the NCC accounts for thermal bridging in commercial buildings.

Fixing thermal bridges

While adding more insulation can help to compensate for thermal bridges, to truly fix them a thermal break is needed.

A thermal break is an element with low thermal transmittance placed strategically to interrupt the heat flow path through thermal bridges.

For residential buildings, both Volumes One and Two, contain DTS Provisions for thermal breaks in metal-framed houses and apartment buildings.

These requirements are distinct from the thermal bridging mitigation requirements discussed above.

The thermal break requirements need to be met in addition to the thermal bridging requirements, where required.

The clauses for thermal break requirements (by building element) for houses and SOUs (apartments) and the common areas of apartment buildings are in Table 3.

Table 3 Thermal break clauses for houses, and SOUs and the common areas of apartment buildings

Building element	Building type/part	NCC Volume One reference
Roof	SOUs	J3D5
External walls	SOUs	J3D6
Roof	Houses	13.2.3(7)
External walls	Houses	13.2.5(5)
Spandrel panel	Common areas of apartment buildings	Specification 38