NEEC
NORTHWEST ENERGY EFFICIENCY COUNCIL

Continuous Insulation Fact Sheet

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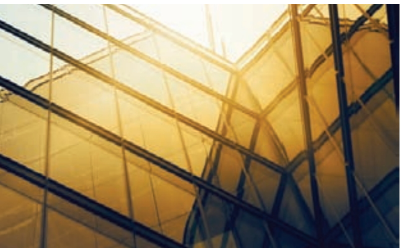

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WHAT IS THE PURPOSE OF THIS REQUIREMENT?

Approximately 30% of energy use in North America is consumed by buildings. While heat flow through the building enclosure cannot be prevented, it can be controlled to reduce the total energy consumption and to improve comfort.

Heat flow through a wall will always take the path of least resistance. Insulation works by trapping an insulating gas, often air, in a matrix which resists or prevents circulation. For it to function at its full potential, nothing can interrupt or penetrate through the insulating layer. In reality, this is not always practical or possible. For this reason, penetrations through the insulation, or thermal bridges, must be well understood in order to design and construct an effective wall assembly that properly accounts for losses in insulating value and minimizes these losses where possible.

Any time the insulating layer is interrupted, as it is in stud cavities or between exterior battens, or segmented in any way that results in a non-continuous later of insulation, the effective R-value of the insulation is reduced below the nominal value.

WHAT DOES THE WSEC REQUIRE?

Increases in thermal performance requirements in the WSEC have resulted in Continuous Insulation (c.i.) layers playing an increasingly important role in meeting both prescriptive requirements and overall building R-value targets. Continuous Insulation is defined as insulation that is continuous across all structural members without thermal bridges other than fasteners (i.e. screws and nails) and service openings. Therefore, any penetrations through the insulation (including but not limited to studs, Z-girts, clips, etc) result in decreases to the nominal insulation R-value. The NREC requires that these decreases be accounted for.

The WSEC requires that wall assemblies meet a maximum assembly U-value (area weighted average) or a minimum, nominal insulation R-value that is a function of:

- *Wall assembly type (mass, metal building, steel framed, wood framed or other),*
- *Building type (Residential except single family or Non-Residential),*
- *Location (Climate Zones 1 or 2 for Washington).*

These requirements are listed in WSEC Tables 13-1 and 13-2 (Climate Zone 1 and 2 respectively).

Washington State Climate Zones

There are two distinct climate zones in the state of Washington. A wetter and milder coastal zone (Zone 1) and a drier and cooler interior zone (Zone 2). As such, prescriptive requirements for insulation are more stringent in Climate Zone 2.

Thermal bridging through framing components reduces envelope insulation performance by 15-20% in wood frame construction and as much as 45-60% in metal frame construction.

How to Meet WSEC Requirements for Various Wall Types

There are three primary methods of determining whether a wall assembly complies with WSEC requirements.

- **Prescriptive R-value Approach –** *Utilizing the prescribed insulating layer R-values prescribed in WSEC Tables 13-1 and 13-2. Reviewing the nominal insulation R-value approach, all but one wall type (Non-residential, wood framed, Climate Zone 1) requires a layer of continuous insulation.*
- **U-value Lookup Tables Approach –** *WSEC Tables 10-5 provide a selection of commonly constructed wall types and their calculated overall U-value. Comparing a proposed wall assembly U-value from the lookup tables with the prescribed assembly U-value from WSEC Tables 13-1 and 13-2 is a calculation free way of determining compliance.*
- **U-value Zone Calculation Approach –** *The effective thermal resistance of most any wall assembly can be approximated through the Zone Method of Calculation, outlined in Chapter 27 of the 2005 ASHRAE Fundamentals Handbook[1]. The Zone Method requires computation effort not required in the other two approaches. This approach is most suited to structures with widely spaced metal members of substantial cross-sectional area. Essentially, the Zone Method divides the wall assembly into 2 parts: a portion equal to the nominal R-value of the wall and a portion surrounding the thermal bridging element of reduced R-value. The accuracy of the Zone Method is particularly sensitive to calculations involving thermal bridging by slender members such as tie rods over larger framing members, such as studs.*

Continuous Insulation Design Considerations

- **Moisture Flow Analysis:** *Installation of a c.i. layer into the wall assembly requires careful analysis of the potential impact on moisture flow pathways that may not have been previously considered in more conventional wall assemblies. Introducing a relatively vapor impermeable insulation layer on top of a vapor permeable weather resistive barrier can lead to problems.*
- **Insulation Compressibility:** *Cladding installed on a c.i. layer will need to carefully account for any increased deflection and movement tolerances associated with the new support requirements imposed by a c.i. layer. A more compressible insulation layer (ie. mineral wool) will result in greater deflection of the cladding layer under loads.*
- **Hidden Framing:** *Installing fasteners directed at wall studs through a 6″ layer of exterior c.i. can present unique challenges, not normally encountered in projects in which structural members are visible from the exterior. Successful execution will require a consistent methodology which displays the framing locations on the insulation itself.*

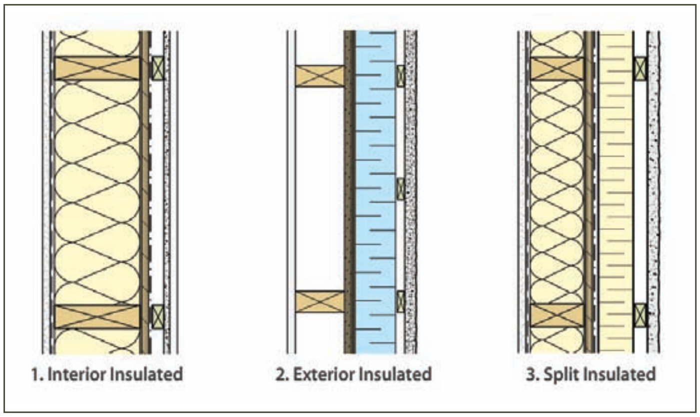
A Summary of Typical Wall Insulation Strategies

To improve the effectiveness of the insulation used in wall assemblies, insulation may be placed solely to the exterior of the sheathing (exterior insulated), or alternately in both the stud cavity and to the exterior of the sheathing (split insulated). These wall assemblies are used in non-combustible construction but currently are uncommon in wood-frame construction. As thermal performance requirements are enhanced there may be a need to consider these wall assembly types in wood-frame construction.

If a split insulation wall assembly is used, the type of insulation and placement of air, water and vapour control layers need to be carefully considered. In **Wall #3** below, the effective R-value for a wood wall assembly with R-12 fibreglass insulation is R-10.8. Two inches of continuous rigid insulation (not bridged by wood framing) has an effective R-value of R-8 depending on insulation type. Therefore, the effective R-value for this assembly is summed from the two parts to be R-18.8. The exterior airspace and cladding cannot be considered in the R-value calculation as the cavity is ventilated.

This wall meets the prescriptive requirements for Climate Zone 1 (R-15.6) in WSEC Tables 13-1, but does not meet the requirements for a steel framed wall in Climate Zone 2 (R-19.6).

It may be possible to achieve compliance in these latter situations; however it will require the use of the component approach or the systems analysis option for compliance.



Whole Building WSEC Compliance

The 2009 WSEC has more stringent building insulation requirements in an effort to provide buildings with a higher thermal resistance and thus reduce base loads on the building's HVAC system. There are three (3) options for meeting required thermal resistances – Prescriptive Option, Component Performance Option, and Systems Analysis Option.

Prescriptive Requirements Approach
Building enclosure component thermal resistances must meet minimum requirements set out in WSEC Tables 13-1 and 13-2. WSEC Chapter 13 distinguishes between Multi-Family Residential and Non-Residential buildings and tables are divided accordingly. The tables provide a summary of the minimum thermal resistance for each building enclosure element.

The maximum U-value considers the effects of framing thermal bridging, sheathing materials, and air films. The minimum insulation R-value approach is a nominal value for insulation only and excludes thermal bridging effects. While thermal bridging through wood framing (15% to 20% degradation) is not as significant as steel (45% to 60% degradation) – it still must be accounted for in calculations to determine assembly U-values.

For most assemblies, minimum insulation includes a requirement for continuous insulation (c.i.). Continuous insulation, usually placed as one of the outer layers within the assembly, may not be interrupted or thermally bridged except by fasteners. This can be an onerous requirement, as bridging includes strapping often used to attach cladding outboard of exterior insulation. This requirement is often the trigger for the use of a compliance path other than the prescriptive path. The tables also consider the thermal differences between wood-frame, steel-frame and mass concrete assemblies. The prescriptive path can often be followed unless:

> *the effective thermal resistance of an assembly cannot be met,*

> *there is desire to have window area that exceeds the maximum allowable percentage of wall area, or*

> *the continuous insulation requirement cannot be met.*

In these instances, one of the two following trade-off paths must be utilized.

Component Performance Approach
In this approach, prescriptive target requirements can be forgone in one area provided the increased U-value is made up through an increase in the thermal resistance of another component. Overall building U-value must meet or be less than the calculated U-value had all assemblies followed the prescriptive approach.

Systems Analysis Approach
This option is primarily composed of producing a computer model of the proposed building, simulated over the course of a year using climatic data, building site specific data, building design, operational characteristics, mechanical equipment and building loads (eg. occupant and lighting loads). Proposed thermal resistances for each component are input into the model and a simulation is run.

The results of the simulation must be presented in an energy analysis comparison report to meet the requirements of the Systems Analysis Option.

A building designed in accordance with this option will be deemed as complying with the WSEC if the calculated annual energy consumption is 8% less than a similar building (defined as a "standard design") whose enclosure elements and energy-consuming systems are designed in accordance with prescriptive requirements. In this way, individual building components can fall short of the prescriptive requirements while still meeting the overall thermal resistance target by incorporating higher thermal resistances in others.

Alterations to Existing Buildings

Alterations or repairs must comply with prescriptive requirements. In no case shall the energy efficiency of the building be decreased.

Fill exposed wall cavities with full depth batt insulation or insulation having an equivalent nominal R-value (2x4 framed walls to a minimum of R-15, 2x6 to a minimum of R-21).

Under certain circumstances, upgrading of the exiting R-value may be forgone. Refer to WSEC 1132.1 for exceptions.

Existing walls and floors exposed during demo without framing cavities need not be insulated. Existing roofs shall be insulated to the requirements of the WSEC if:

> *The roof is uninsulated or insulation is removed to the level of the sheathing, or*

> *All insulation in the roof/ceiling was previously installed exterior to the sheathing or nonexistent.*

Additional Information

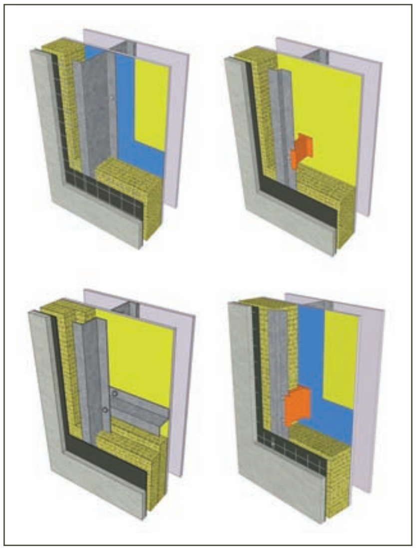
> ***ASHRAE Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings*** *www.ashrae.org*

> ***2009 ASHRAE Handbook – Fundamentals (I-P) or Fundamentals (SI)*** *www.ashrae.org*

> ***Wood Frame Design Guide – Multi-Unit Residential Buildings, Homeowner Protection Office,*** *2010 www.hpo.bc.ca*

Typical Wall Assemblies With Thermal Bridging

The following are examples of typical wall assemblies with thermal bridging through the exterior insulation layer:

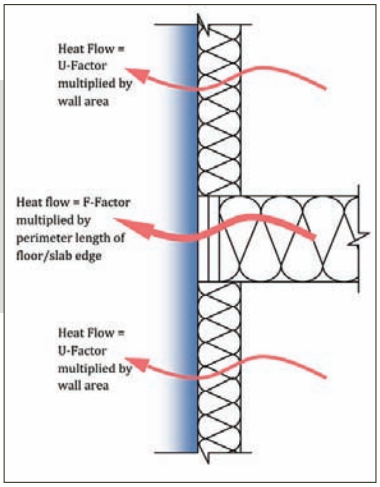


None of these wall assemblies can be considered to have a continuous insulation layer, and therefore, determination of the U-value requires looking up default values in WSEC Chapter 10 tables (if possible) or using the Zone Method of calculation.

Overall wall U-value requirements for metal framed walls, cannot meet prescriptive value requirements when stud/girt style cladding support options are employed. A clip style support or fasteners are the only options to meet this requirement under the prescriptive path. The WSEC does not provide a definition of what constitutes "fasteners" with respect to insulation penetration. However, any penetration not considered framing meets this requirement.

Slab and Floor Edges

The tops and bottoms of walls require special treatment due to the interruptions to cavity insulation that occurs at floor edges.



The following table lists example wall assemblies yielding effective wall R-values which meet or exceed the minimum prescriptive requirement of R-15.6 overall (Steel framed, non-residential, Climate Zone 1).

It can be seen that a significant number of typical wall assemblies (omitted from list), do not meet the prescriptive requirements.

Cladding Support & Insulation Thickness	Nominal Insulation R-value	Effective Insulation R-value	Effectiveness of Insulation	Overall Effective Wall R-value
3" Fiberglass Clip, 1 screw 3½" Mineral Fiber	14.7	13.0	88%	16.1
Wall with 1x6" and 4x 3" Fiberglass clips, 3½" Mineral Fiber	14.7	12.7	86%	15.8
3" Fiberglass Clip, 1 screw 4" Mineral Fiber	16.9	14.8	88%	17.9
6" Fiberglass Clip, 2 screws 4" Mineral Fiber	16.9	13.2	78%	16.4
Wall with 1x6" and 4x 3" Fiberglass clips, 4" Mineral Fiber	16.9	14.5	86%	17.6
Galvanized Steel Clip 6" Mineral Fiber	25.1	12.4	49%	15.6

Relevant Definitions

Advanced Framed Ceilings: Advanced framing assumes full and even depth of insulation extending to the outside edge of exterior walls.

Advanced Framed Walls: Studs framed on 24" centers with double top plate and single bottom plate. Corners use two studs of other means of fully insulating corners and one stud is used to support each header. Use at minimum R-10 insulation at headers. Interior wall intersection with exterior is insulated at the exterior.

Continuous Insulation: Insulation that is continuous across all structural members without thermal bridges other than fasteners (i.e. screws and nails) and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope. For the purposes of this definition of continuous insulation, only screws and nails are considered fasteners. Insulation installed between metal studs, z-girts, z-channels, shelf angles, or insulation with penetrations by brick ties and offset brackets, or any other similar framing is not considered continuous insulation, regardless of whether the metal is continuous or occasionally discontinuous or has thermal break material.

1 2005 ASHRAE Handbook – Fundamentals (I-P) or Fundamentals (SI) www.ashrae.org

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