## <u>Comment on Equivalent U-value for "Continuous Insulation" with Metal Penetrations</u> Duane Jonlin, City of Seattle

Footnote f to Table C402.2 provides an alternate path for "continuous insulation" that is penetrated by fasteners larger than screws & nails. It was based on a calculation done by the City of Seattle for the 2009 Seattle Energy Code, and requires thicker continuous insulation where penetrated by discontinuous support angles of various sizes.

However, a 2011 ASHRAE research project by Morrison Hershfield (RP-1365) provides measured values for thermal performance of such systems, and it demonstrates that the Seattle code overstates the influence of the metal penetrations by a factor of about 2. (One of the researchers involved explained that the Seattle calculation was based on a 2-dimensional analysis, which did not take into account the additional time required for heat to move across the metal fastener in the third dimension.)

There still is a significant effect for larger metal penetrations, and therefore, I propose that:

- Insulation thicknesses currently shown for penetrations smaller than 0.04% of the wall surface area are assigned to the larger penetrations in the footnote f table.
- Penetrations smaller than 0.04% are included in the definition of true "continuous insulation."
- f. For roof, wall or floor assemblies where the proposed assembly would not be continuous insulation, two alternate nominal R-value compliance options for assemblies with isolated metal penetrations of otherwise continuous insulation are:

Assemblies with true continuous insulation (criteria in table)(see definition)	Alternate option for assemblies with metal penetrations, but less greater than 0.0004 (less than 0.04%) but less than 0.08%	Alternate option for assemblies with metal penetrations, but less than 0.0008 (less than 0.08%)
R-11.4ci	R-14.3 w/ < 0.0004 metal penetrations	R-17.1 w/ < 0.0008 metal penetrations
R-13.3ci	R-16.6 w/ < 0.0004 metal penetrations	R-20.0 w/ < 0.0008 metal penetrations
R-15.2ci	R-19.0 w/ $< 0.0004$ metal penetrations	R 22.8 w/ < 0.0008 metal penetrations
R-30ci	R-38 w/ < 0.0004 metal penetrations	R-45 w/ < 0.0008 metal penetrations
R-38ci	R-48 w/ < 0.0004 metal penetrations	R-57 w/ < 0.0008 metal penetrations
R-13 + R7.5ci	R-13 + R9.4  w/ < 0.0004  metal penetrations	R-13 + R11.3 w/ < 0.0008 metal penetrations
R-13 + R10ci	R-13 + R12.5  w < 0.0004  metal penetrations	R-13 + R15 w/ < 0.0008 metal penetrations
R-13 + R12.5ci	R-13 + R15.6  w < 0.0004  metal penetrations	R-13 + R18.8 w/ < 0.0008 metal penetrations
R-13 + R13ci	R-13 + R16.3  w < 0.0004  metal penetrations	R-13 + 20  w/ < 0.0008  metal penetrations
R-19 + R8.5ci	R-19 + R10.6  w < 0.0004  metal penetrations	R-19 + R12.8  w/ < 0.0008  metal penetrations
R-19 + R14ci	R-19 + R17.5  w < 0.0004  metal penetrations	R-19 + R21 w/ < 0.0008 metal penetrations
R-19 + R16ci	R-19 + R20  w / < 0.0004  metal penetrations	R-19 + R24 w/ < 0.0008 metal penetrations
R-20 + R3.8ci	R-20 + R4.8  w/ < 0.0004  metal penetrations	R-20 + R5.7 w/ < 0.0008 metal penetrations
R-21 + R5ci	R-21 + R6.3  w/ < 0.0004  metal penetrations	R-21 + R7.5 w/ < 0.0008 metal penetrations

1. The ratio of the cross-sectional area, as measured in the plane of the surface, of metal penetrations of otherwise continuous insulation to the opaque surface area of the assembly is:

## i. less than 0.0004 (less than 0.04%).

- ii. equal to or greater than 0.0004 (less than 0.04%), but less than 0.0008 (less than 0.08%).
- 2. The metal penetrations of otherwise continuous insulation are isolated or discontinuous (e.g. brick ties or other discontinuous metal attachments, offset brackets supporting shelf angles that allow insulation to go between the shelf angle and the primary portions of the wall structure). No continuous metal elements (e.g. metal studs, z-girts, z-channels, shelf angles) penetrate the otherwise continuous portion of the insulation.
- 3. Building permit drawings shall contain details showing the locations and dimensions of all the metal penetrations (e.g. brick ties or other discontinuous metal attachments, offset brackets, etc.) of otherwise continuous insulation. In addition, calculations shall be provided showing the ratio of the cross-sectional area of metal penetrations of otherwise continuous insulation to the overall opaque wall area.

For other cases where the proposed assembly is not continuous insulation, see Section C402.1.2 for determination of U-factors for assemblies that include metal other than screws and nails.

CONTINUOUS INSULATION (ci): Insulation that is continuous across all structural members without thermal bridges, other than service openings and penetrations by metal fasteners with a cross-sectional area, as measured in the plane of the surface, of less than 0.04% of the opaque surface area of the assembly. 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.