Through-fastened metal roofs are screwed directly to the purlins and have fasteners that are exposed to the elements. The fasteners have integrated neoprene washers under the heads to provide a weathertight seal. Thermal spacer blocks are not used with through-fastened roofs because they may diminish the structural load-carrying capacity by "softening" the connection and restraint provided to the purlin by the metal roof panels. To meet the performance recommendations of this Guide, through-fastened roofs will generally require insulation over the purlins in the conventional manner, with a second layer of insulation added to the system. The second layer of insulation can be placed either parallel to the purlins (on top of the first layer) or suspended below the purlins.

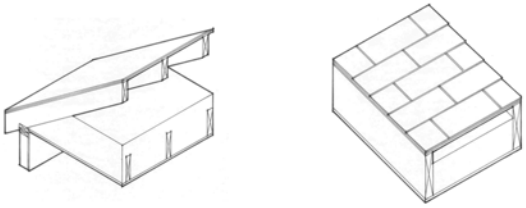
In climate zones 1 and 2, the recommended construction is standing-seam roofs with R-19 insulation blankets draped over the purlins.

In climate zones 3 through 8, the recommended construction is standing-seam roofs with two layers of blanket insulation. The first layer is draped perpendicularly over the purlins with enough looseness to allow the second insulation layer to be laid above it, parallel to the purlins.

In any case, rigid c.i. or other high-performance insulation systems may be used to meet the U-factors listed in Appendix A.

EN4 Roofs, Attics, and Other Roofs (Climate Zones: all)

Attics and other roofs include roofs with insulation entirely below (inside of) the roof structure (i.e., attics and cathedral ceilings) and roofs with insulation both above and below the roof structure (see Figure 5-3). Ventilated attic spaces need to (a) have the insulation installed at the ceiling line. Unventilated attic spaces may have the insulation installed at the roof line. When suspended ceilings with removable ceiling tiles are used, (b) the insulation needs to be installed at the roof line. For buildings with attic spaces, ventilation should be provided equal to 1 ft^2 of open area per 100 ft^2 of attic space. This will provide adequate ventilation as long as the openings are split between the bottom and top of the attic space.



(a) (b)

Figure 5-3. (EN4) Attics and other roofs.

EN5 Roofs, Single Rafter (Climate Zones: all)

Single rafter roofs have the roof above and ceiling below both attached to the same wood rafter, and the cavity insulation is located between the wood rafters (see Figure 5-4). Continuous insulation, when recommended, is installed to the bottom of the rafters and above the ceiling material. Single rafters can be constructed using solid wood framing members or truss type framing members. The cavity insulation should be installed between the wood rafters and in intimate contact with the ceiling to avoid the potential thermal short-circuiting associated with open or exposed air spaces.

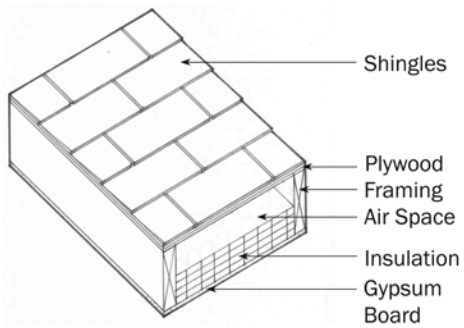
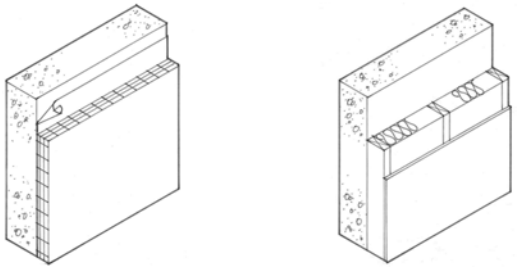


Figure 5-4. (EN5) Wood joists, single rafter.

EN6 *Walls, Mass* (Climate Zones: all)



(a) (b)

Figure 5-5. (EN6) Walls, mass—any concrete or masonry wall with a heat capacity exceeding 7 Btu/ft^{2}·°F.

Mass walls are defined as those with a heat capacity exceeding 7 Btu/ft^{2}·°F. Insulation may be placed on either the inside or the outside of the masonry wall. When insulation is placed (a) on the exterior of the wall, rigid c.i. is recommended (see Figure 5-5); when insulation is placed (b) on the interior of the wall, a furring or framing system may be used, provided the total wall assembly has a U-factor that is less than or equal to the appropriate climate zone construction listed in Appendix A.

The greatest advantages of mass can be obtained when insulation is placed on the exterior of the mass. In this case, the mass absorbs internal heat gains that are later released in the evenings when the buildings are not occupied.

EN7 *Walls, Metal Building* (Climate Zones: all)

In climate zones 1 and 2, a single layer of fiberglass batt insulation is recommended. The insulation is installed continuously perpendicular to the exterior of the girts and is compressed as the metal skin is attached to the girts (see Figure 5-6).

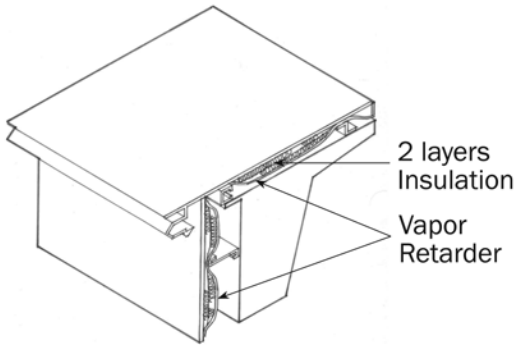


Figure 5-6. (EN7) Walls, metal building.

In climate zones 3 through 8, two layers of fiberglass batt insulation are recommended. The first layer is installed continuously perpendicular to the exterior of the girts and is compressed as the metal skin is attached to the girts. The second layer of insulation is installed parallel to the girts within the framing cavity.

In all climate zones, rigid c.i. is another option provided the total wall assembly has a U-factor that is less than or equal to the appropriate climate zone construction listed in Appendix A.