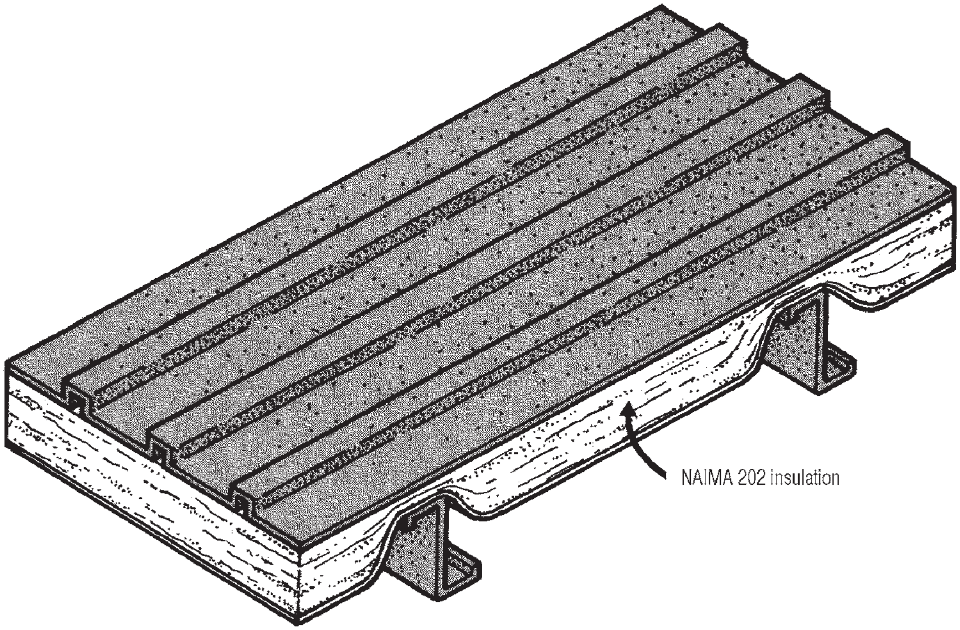

FIGURE 8.5 NAIMA system 1—insulation installed over purlins. (*Courtesy of NAIMA Metal Building Committee.*)

How to estimate the amount of heat lost through the framing? Some simply overlook it and pretend there is none—hardly an option for an enlightened designer. Others conduct a sophisticated parallel-flow analysis. Still others rely on the results of actual "hot box" testing. A simplified but practical way is to increase the supplied *R* values by 25 to 40 percent over those required by analysis. Standard federal government specifications[17] call for *R* values specified in the design drawings to be one-third (or as shown by local experience) larger than those calculated. These *R* values are determined at a mean temperature of 75°F in accordance with ASTM C 518.[18]

The thicker the insulation, the more efficiency it loses in an hourglass installation, since the heat loss through a purlin or girt stays almost constant.[19] So, while an insulation with an *R* value of 10 would lose 25 percent of its efficiency in this kind of installation, the one with an *R* value of 19 would lose 42 percent.[8]

There are other ways to determine realistic *U* factors for metal building walls and roofs, considering the effects of compressed insulation at girts and purlins and the effects of thermal short-circuiting at clips and fasteners. According to Crall,[20–22] the results of a three-dimensional finite-element analysis that considered these factors form the basis for the tables of assembly *U* factors found in Appendix A of ASHRAE Standard 90.1. Beyond introducing insulation to an uninsulated space in the first place, adding more insulation yields diminishing returns, as is clearly shown by the ASHRAE tables.

In addition to heat losses, the hourglass design encourages condensation on the roof purlins and wall girts during cold weather, since vapor retarder is located on the outside of the framing. Ironically, when humidity inside a building is high, the more effective the vapor retarder is, the more serious condensation may become—in some cases serious enough to be mistaken for roof leaks.

In an attempt to fit more insulation between the purlins, another system has been developed specifically for roofs. Here, the insulation fills almost all the space between the purlins, resulting in a slightly better installed *R* value (Fig. 8.6). The facing tabs on the sides of the vapor retarder are overlapped over the purlins for continuity. Still, the problems with thermal bridging and condensation are not resolved. This system requires insulation support bands running between the purlins, an extra-cost item.

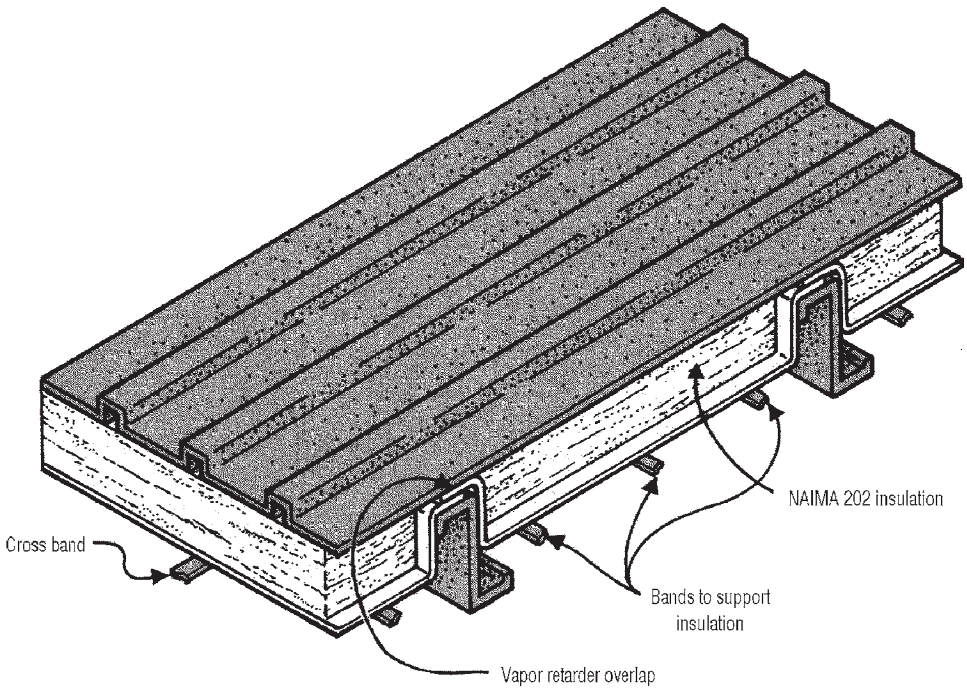

FIGURE 8.6 NAIMA system 2—insulation installed between purlins. (*Courtesy of NAIMA Metal Building Committee.*)

The third insulation-support system attempts to solve the problem of thermal bridging by relying on thermal blocks made of polystyrene-foam insulation and running on top of the purlins. The blocks have to stop at the standing-seam roof clips, but this design is clearly a major improvement over the previous ones. To further increase the system *R* value, a second unfaced filler layer of insulation may be added between the thermal blocks (Fig. 8.7). This design has been developed with standing-seam roofs in mind, because through-fastened roofs would need longer fasteners penetrating the blocks and potentially shattering them. Also, using strips of foam for roof panel support may jeopardize the effectiveness of the attachment, as discussed in Chap. 5. In any event, the system still does not address the problem of purlin condensation.

The fourth installation system combines the advantages of both the uncompressed filler insulation and the thermal blocks (Fig. 8.8). Its installed *R* value approaches that of the insulation alone, a major accomplishment. On the down side, the installation is rather laborious, still requires insulation support bands, and still does not solve the condensation problem.

The last system incorporates a new element: insulated ceiling board with an integral vapor retarder facing. The insulation board not only provides support for fiberglass blankets but also solves—at last—the problem of condensation by placing purlins within the insulated area. This is a premium system, in terms of both performance and price. For a still better performance, thermal blocks can be used on top, resulting in installed *R* values of over 34 when 1.5-in-thick foam boards are used (Fig. 8.9).

Which system to select? The choice depends on the building use, the climate, and the budget. Architects should become familiar with the new products and proprietary technologies entering the market. For example, the proprietary "Simple Saver System" by Thermal Design, Inc., is claimed to have improved on the traditional technology by using a continuous heavy-duty vapor retarder underneath the purlins and thus eliminating the purlin condensation problem. The liner is supported by