Workshop on Roof Applications of Heat Flux Transducers—*G. E. Courville and R. Orlandi*

A panel of eight workshop participants was present for the session on roof applications. The central topics discussed were thermal performance characteristics of roofing systems, heat flux transducer (HFT) application methods to be used for thermal measurement of roofs, and issues concerned with ASTM's role in guiding HFT users toward correct usage. Dr. Donald Larson gave a presentation on work conducted at Drexel University related to the thermal resistance measurements of spray-applied roofing systems using HFTs.

Thermal performance measurements made on roofs offer several advantages and disadvantages compared with other building envelope system measurements. The advantages are the following:

1. Roofs are horizontal and this characteristic, along with their location in the envelope, lessens the convective effects on HFT response inside the building envelope compared with the effects of HFT response on walls.
2. For the most part, roofs have thermal bridges in their construction with greater horizontal uniformity than, for example, typical wall systems have. This results in the possibility of simpler experimental analysis, that is, the use of fewer HFTs.

The disadvantages are the following:

1. Deck substrates are complicated.
2. Significant levels of moisture may be present in roofs, making moisture movement an important consideration.

HFT application methods were discussed for thermal measurement of roofs. These methods must be selected based on the purpose of the measurement. Different approaches and precision or accuracy levels may be expected for purposes of measuring roofs under static (material properties) and dynamic (performance properties) conditions. For static measurements, field calorimeter systems (for example, work at Drexel University) may be appropriate, while an *in situ* HFT calibration technique (for example, work at W. R. Grace & Co.) may be required to measure dynamic performance without significantly altering the environmental conditions.

In all cases, HFT calibration must be conducted in the manner of and, if possible, close to the range of intended use. HFTs can be embedded within the

structure or attached to surfaces exposed to the environment. The advantages of embedding HFTs over surface mounting HFTs are as follows:

1. A more controlled HFT response (higher precision) is obtained.
2. The laboratory HFT calibration [for example, the ASTM Test for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter (C 518-76)] is more appropriate and applicable but still must be performed in similar media and near the ranges of intended use.
3. It is more convenient for HFT calibration.

The advantages of surface mounting HFT over the embedding approach are as follows:

1. There is no misrepresentation of the roof system to be measured because of the nondestructive nature of this approach.
2. There is no need to penetrate the waterproof membrane.
3. Deleterious effects of moisture on HFT calibration are avoided.
4. The high cost of replacing HFTs lost in an embedding measurement is avoided.

Surface mounting the HFT underneath the roof deck substrate inside the building is preferred because of the greater environmental influences on the outside surface.

The origin of the R-value relationship used with non-steady-state measured data, where

$$R = \frac{\Sigma \Delta t}{\Sigma q}$$

must be investigated. Orlandi indicated that some assumptions used in this expression require the following:

(*a*) a periodic outside surface temperature,
(*b*) a constant inside surface temperature,
(*c*) no thermal mass effect, and
(*d*) no moisture.

The workshop group discussed the need for standards and accepted practices. It was suggested that it would be helpful to identify acceptable procedures for HFT application that are, if possible, common and routine and to develop ASTM accepted practices for these applications. This would guide users toward correct practices and would provide specifiers and manufacturers with input to aid in useful calibration. It was suggested that manufacturers should minimally provide more information on their calibration techniques.