The conditions for which shrinkage measurements are made are often not recorded.

Standards for foam insulation have requirements that under test conditions a freshly prepared specimen should not undergo shrinkage in excess of a specified percent in a given period of time (table 1). In North America, the Canadian standard [13] and the HUD bulletin [19] specified that the shrinkage should not exceed 4 percent in 28 days. The ASTM standard [17] specified that the shrinkage should not exceed 4 percent over the period of time required for the foam to dry to constant weight. These requirements are considered applicable to quality control only, since foams have been shown to undergo shrinkage greater than 4 percent in service. A methodology has not been developed to predict on the basis of laboratory tests the extent of shrinkage which a foam will undergo in service.

3.13.2 The Effect of Shrinkage on Thermal Performance

The extent to which shrinkage of foam insulation reduces the thermal efficiency of insulated walls depends upon the amount of shrinkage which occurs and the orientation of the cracks and gaps which result [31, 44]. Shirtliffe has indicated that the vertical shrinkage gaps along the studs are more important in reducing thermal efficiency than the horizontal gaps which occur in the foam [44]. The Canadian standard [13], DOE standard [18] and HUD bulletin [19] provided guidelines as to the effect of shrinkage on the efficiency of foam-insulated walls (table 1). In this regard, these standards used the term "effective thermal resistance" to indicate the calculated reduction of the laboratory measured value of the thermal resistance of the foam which is determined by a thermal conductivity test. This recognizes that the thermal efficiency of an insulation is based on simulated in-use conditions and not thermal conductivity alone. The Canadian standard indicated that foams in typical wood frame construction would be expected to shrink in service about 7 percent, resulting in an effective thermal resistance of the foam of 40 percent less than the thermal resistance determined by the thermal conductivity test [13]. The HUD bulletin [19] stated that 6 percent shrinkage would be expected in service and would result in an effective thermal resistance of the foam of 28 percent less than that based on the laboratory measured thermal conductivity value. The HUD Bulletin [19] also presented a plot estimating the effective thermal resistance of the installed foam as a function of the percent shrinkage. The DOE interim standard [18] indicated that the effective thermal resistance of foam should be taken as 30 percent less than that of the laboratory determined thermal conductivity value without considering the extent of shrinkage. The effective thermal resistances given in the HUD and DOE documents were also for wood frame construction. It is noted that the effective thermal resistance of 3.5 in. (90 mm) of foam, having a thermal resistance (R-value) of about 4.1 units per inch and subjected to a derating of 30 percent, would be about 10. This is about 15 percent less than the thermal resistance of a fibrous glass batt having an R-value of about 11.5.

The guideline concerning the effective thermal resistance of foams in service given in the Canadian standard was based on a summary of existing literature information [40]. For the HUD bulletin, the guideline on effective thermal resistance was based on a calculation for predicting the effect of air