Chapter C10
ICE LOADS—ATMOSPHERIC ICING

C10.1 GENERAL

In most of the contiguous United States, freezing rain is considered the cause of the most severe ice loads. Values for ice thicknesses due to in-cloud icing and snow suitable for inclusion in this standard are not currently available.

Very few sources of direct information or observations of naturally occurring ice accretions (of any type) are available. Bennett (1959) presents the geographical distribution of the occurrence of ice on utility wires from data compiled by various railroad, electric power, and telephone associations in the 9-yr period from the winter of 1928–1929 to the winter of 1936–1937. The data includes measurements of all forms of ice accretion on wires including glaze ice, rime ice, and accreted snow, but does not differentiate between them. Ice thicknesses were measured on wires of various diameters, heights above ground, and exposures. No standardized technique was used in measuring the thickness. The maximum ice thickness observed during the 9-yr period in each of 975 squares, 60 mi (97 km) on a side, in a grid covering the contiguous United States is reported. In every state except Florida, thickness measurements of accretions with unknown densities of approximately one radial inch were reported. Information on the geographical distribution of the number of storms in this 9-yr period with ice accretions greater than specified thicknesses is also included.

Tattelman and Gringorten (1973) reviewed ice load data, storm descriptions, and damage estimates in several meteorological publications to estimate maximum ice thicknesses with a 50-yr Mean Recurrence Interval in each of seven regions in the United States. *Storm Data* (NOAA 1959–Present) is a monthly publication that describes damage from storms of all sorts throughout the United States. The compilation of this qualitative information on storms causing damaging ice accretions in a particular region can be used to estimate the severity of ice and wind-on-ice loads. The Electric Power Research Institute has compiled a database of icing events from the reports in *Storm Data* (Shan and Marr 1996). Damage severity maps were also prepared.

Bernstein and Brown (1997) and Robbins and Cortinas (1996) provide information on freezing rain climatology for the 48 contiguous states based on recent meteorological data.

C10.1.1 Site-Specific Studies

In-cloud icing may cause significant loadings on ice-sensitive structures in mountainous regions and for very tall structures in other areas. Mulherin (1996) reports that of 120 communications tower failures in the United States due to atmospheric icing, 38 were due to in-cloud icing, and in-cloud icing combined with freezing rain caused an additional 26 failures. In-cloud ice accretion is very sensitive to the degree of exposure to moisture-laden clouds, which is related to terrain, elevation, and wind direction and velocity. Large differences in accretion size can occur over a few hundred feet and cause severe load unbalances in overhead wire systems. Advice from a meteorologist familiar with the area is particularly valuable in these circumstances. In Arizona, New Mexico, and the panhandles of Texas and Oklahoma, the United States Forest Service specifies ice loads due to in-cloud icing for towers constructed at specific mountaintop sites (U.S. Forest Service 1994). Severe in-cloud icing has been observed in southern California (Mallory and Leavengood 1983a and 1983b), eastern Colorado (NOAA Feb. 1978), the Pacific Northwest (Winkleman 1974, Richmond et al. 1977, and Sinclair and Thorkildson 1980), Alaska (Ryerson and Claffey 1991), and the Appalachians (Ryerson 1987, 1988a, 1988b, and 1990 and Govoni 1990).

Snow accretions also can result in severe structural loads and may occur anywhere snow falls, even in localities that may experience only one or two snow events per year. Some examples of locations where snow accretion events resulted in significant damage to structures are Nebraska (NPPD 1976), Maryland (Mozer and West 1983), Pennsylvania (Goodwin et al. 1983), Georgia and North Carolina (Lott 1993), Colorado (McCormick and Pohlman 1993), Alaska (Peabody and Wyman 2005), and the Pacific Northwest (Hall 1977 and Richmond et al. 1977).

For Alaska, available information indicates that moderate to severe snow and in-cloud icing can be expected. The measurements made by Golden Valley Electric Association (Jones et al. 2002) are consistent in magnitude with visual observations across a broad area of central Alaska (Peabody 1993). Several