IV. Aeromotive Methods and Equipment

The forces available for ventilation are here considered as either natural or mechanical, as in the discussion of general ventilation.

A. NATURAL AEROMOTIVE FORCES

Natural ventilation may be (*1*) gravity, motivated by the thermal forces of convection, or (*2*) anemotive, created by wind pressure. These two natural forces operate together in most cases, and a study of their effects has led to the concept of the "neutral zone" in thermal ventilation, modified by experimentally verified wind-pressure corrections.

Emswiler and Randall[15] gave the following analysis of the combined action of wind and thermal forces in producing air flow through a building:

> Even without any wind, a difference of temperature inside and outside will cause the pressure state inside to be less than that outside at the ground, and greater near the roof, so that inflow will occur at lower windows and outflow at upper windows. If the building is all one open throughout from bottom to top, or if arranged in stories in free communication from one to another, and if the temperature difference is great, the pressure difference created at a point near the ground and also at a point near the roof may be considerable. Thus, in a building 200 ft. high with 70° F. difference in temperature, this force alone causing inflow at the bottom and outflow at the top, may easily exceed 0.20 in. of water, which is the equivalent of a twenty-mile wind. If the building is multiple storied and there is absolutely no communication between stories, then the force of temperature difference is effectually nullified, or rather reduced to an amount proportional to the height of a single story. However, there is always some communication by means of stairs and otherwise, so that the force of temperature difference is more or less operative in some degree.
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> If the wind blows against a window of a building that is tightly sealed at all other points of possible ingress or egress of air, there will be no continuous infiltration at the window because the temporary excess of pressure outside will soon be equalized by a momentary inflow. If the building has an outlet of exactly the same area as the presumed infiltration area of the window, and this outlet opens into a region of neutral pressure, then the pressure in the room will be half as much as that produced by the wind outside. Infiltration will take place through the window, but with only half the force of the wind pressure. Something like this actually occurs in any building. Whatever air gets in at inflow points must escape somewhere else. In order to force the air out, there must be a greater pressure inside somewhere than that which prevails immediately outside. The inside pressure automatically assumes a value that will give the necessary head for outflow through openings available, *so that the outflow quantity will balances the inflow* [italics ours].

1. Wind Direction, Velocity, and Pressure

Few locations in the United States have what is actually a "prevailing" wind direction, if this is taken to mean a direction from which the wind blows most of the time. Not over 5 per cent of the land receives wind from one general direction as much as 50 per cent of the time. Wind data collected by the Weather Bureau at stations located on the tops of high buildings cannot be taken as representative

[15] J. E. Emswiler and W. C. Randall, *Trans. ASHVE*, **34**, 527 (1928).

conditions throughout the entire area. The observing stations in large located in order to sample a stratum of air that is unaffected by generated by surrounding structures.

The velocities of the winds at these elevated locations are higher than ground could be if no obstructions existed. For those design problems where the long wind velocity determines the quantity of natural ventilation expected, values about one half the indicated seasonal average velocities be chosen. Average wind velocities throughout the United States range 15 to 15 m.p.h. for all seasons of the year.[16]

cases where an occasional gust of wind, or the pressure of high wind for a few hours of a day would create dangerous reduction of ventilation where handling irritating or hazardous gases, vapors, or dusts, the ventilator be protected against such pressures. It is evident that a substantial wind applied to the side of a building in which a fan is mounted may seriously the volume of air moved and may even reverse the direction of flow when is not creating a high static pressure. Some type of baffle, "windbreaker,"

TABLE 14

Wind Velocity Pressure

Miles per hour	Linear feet per minute	Velocity pressure, VP[a] (inches of water)	Visible or physical effects
1	88	0.0005	Smoke rises vertically
2	176	0.0019	Direction of wind shown by smoke drift
3	264	0.0044	Moderate walking speed
4	352	0.0077	Fast walking speed
5	440	0.012	Wind felt on face; leaves rustle
10	880	0.048	Wind extends light flag
15	1320	0.11	Raises dust and loose paper
20	1760	0.19	Crested wavelets form on inland water
25	2200	0.30	Umbrellas used with difficulty
30	2640	0.44	Whole trees in motion
35	3080	0.59	Difficulty walking against wind
40	3520	0.77	Breaks twigs off trees
50	4400	1.2	Slight structural damage to buildings
60	5280	1.7	Considerable structural damage

[a] VP = (f.p.m./4000)² = 0.00048 (m.p.h.)².

automatic damper should be provided, or the fan should be selected for a higher static pressure to compensate for reasonable wind pressures above the average. Table 14 assembles some of the data needed for consideration of the wind velocity pressure factor.

[16] Dunham Bright, *Summer Weather Data*. The Marley Co., Kansas City, Kan., 1939.