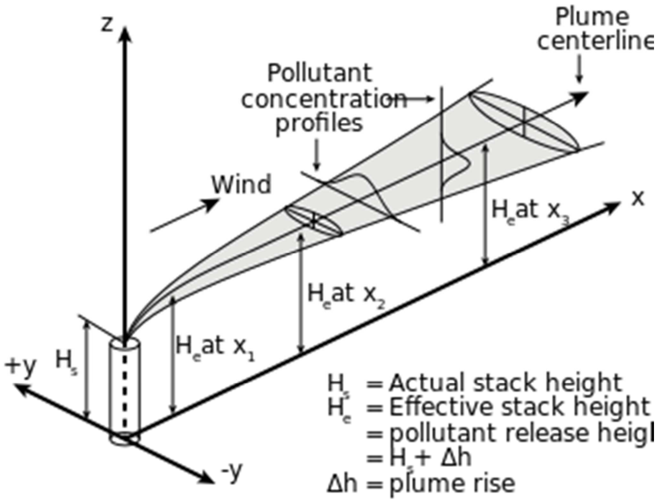
Briggs plume rise equations[edit]

The Gaussian air pollutant dispersion equation (discussed above) requires the input of *H* which is the pollutant plume's centerline height above ground level—and H is the sum of H_s (the actual physical height of the pollutant plume's emission source point) plus ΔH (the plume rise due the plume's buoyancy).



Visualization of a buoyant Gaussian air pollutant dispersion plume

To determine ΔH, many if not most of the air dispersion models developed between the late 1960s and the early 2000s used what are known as "the Briggs equations." G.A. Briggs first published his plume rise observations and comparisons in 1965.[6] In 1968, at a symposium sponsored by CONCAWE (a Dutch organization), he compared many of the plume rise models then available in the literature.[7] In that same year, Briggs also wrote the section of the publication edited by Slade[8] dealing with the comparative analyses of plume rise models. That was followed in 1969 by his classical critical review of the entire plume rise literature,[9] in which he proposed a set of plume rise equations which have become widely known as "the Briggs equations". Subsequently, Briggs modified his 1969 plume rise equations in 1971 and in 1972.[10][11]

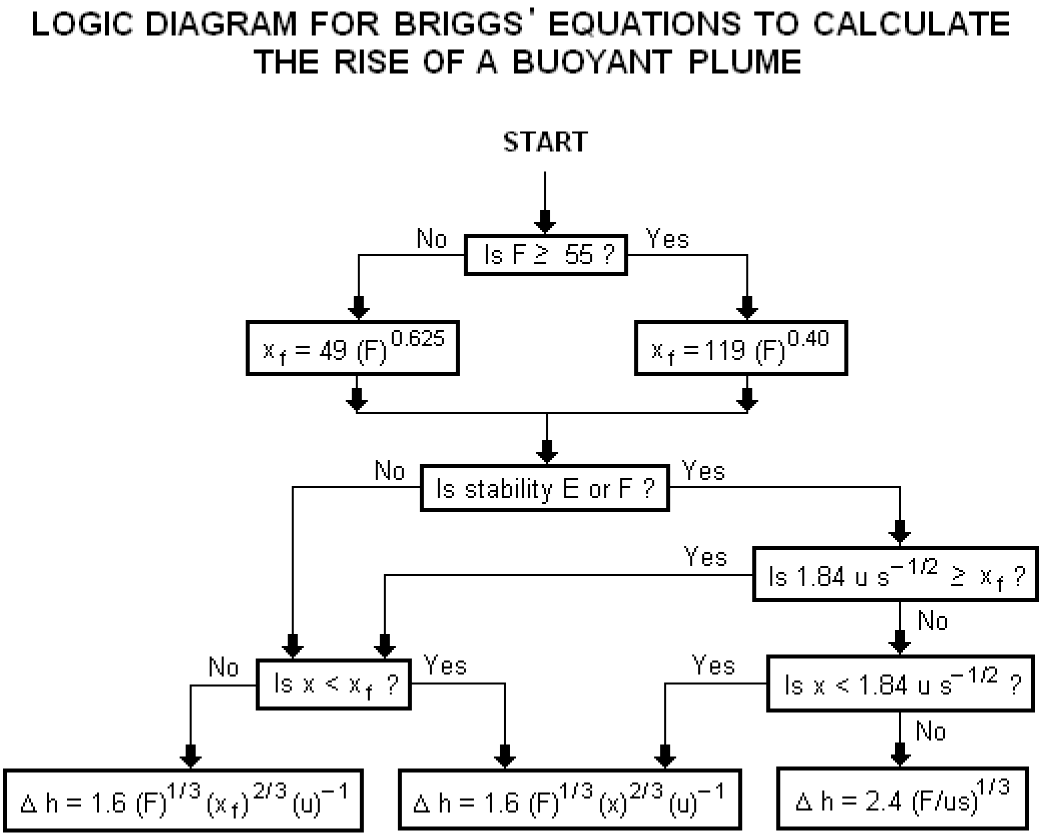
Briggs divided air pollution plumes into these four general categories:

- Cold jet plumes in calm ambient air conditions
- Cold jet plumes in windy ambient air conditions
- Hot, buoyant plumes in calm ambient air conditions
- Hot, buoyant plumes in windy ambient air conditions

Briggs considered the trajectory of cold jet plumes to be dominated by their initial velocity momentum, and the trajectory of hot, buoyant plumes to be dominated by their buoyant momentum to the extent that their initial velocity momentum was relatively unimportant. Although Briggs proposed plume rise equations for each of the above plume categories, ***it is important to emphasize that "the Briggs equations" which become widely used are those that he proposed for bent-over, hot buoyant plumes***.

In general, Briggs's equations for bent-over, hot buoyant plumes are based on observations and data involving plumes from typical combustion sources such as the flue gas stacks from steam-generating boilers burning fossil fuels in large power plants. Therefore the stack exit velocities were probably in the range of 20 to 100 ft/s (6 to 30 m/s) with exit temperatures ranging from 250 to 500 °F (120 to 260 °C).

A logic diagram for using the Briggs equations[4] to obtain the plume rise trajectory of bent-over buoyant plumes is presented below:



where:

Δh = plume rise, in m

F = buoyancy factor, in m^4s^{-3}

x = downwind distance from plume source, in m

$\mathbf{x_f}$ = downwind distance from plume source to point of maximum plume rise, in m

u = windspeed at actual stack height, in m/s

s = stability parameter, in s^{-2}

The above parameters used in the Briggs' equations are discussed in Beychok's book.[4]