EXPERIMENTAL METHOD (modified from Stewart RD, Stewart RS, Stamm W, Seelen RP. Rapid Estimation of Carboxyhemoglobin Level in Fire Fighters. *JAMA.* 1976;235(4):390–392. doi:10.1001/jama.1976.03260300016021)

One hundred seventy fire fighters of the First Battalion, Milwaukee Fire Department, volunteered to participate in this study. Two Emergency Medical Technicians from each shift were given six hours of instruction in the collection of breath samples, sample analysis, and the interpretation of breath-CO data.

To collect the breath samples the subjects were instructed to hold their breath for 20 seconds, then discard the first portion of their expired breath and collect the last portion (alveolar) in a gas sampling bag. The breath samples were immediately analyzed in a properly calibrated carbon monoxide gas analyzer. The elapsed time for breath sample collection and analysis averaged 90 seconds.

To establish the breath CO-blood COHb relationship, 71 paired alveolar breath and venous blood samples were collected from 56 fire fighters for CO and COHb analysis. Thereafter, the alveolar breath CO was used to estimate blood COHb.

The theoretical relationship between the amount of CO in the expired breath and the COHb in the blood was derived as follows: The Haldane equation expresses the relationship between COHb, CO tension, oxyhemoglobin, oxygen tension, and the affinity of CO for hemoglobin in a blood sample at equilibrium.

During the 20 seconds of breath holding, the tension of CO in the alveoli approximates the CO tension in the pulmonary capillaries. The oxygen tension stabilizes at approximately 80 mm Hg in Milwaukee. With this information, the Haldane equation can be solved for alveolar CO concentration in parts per million.

Further details are available in the cited paper.