chemical in a beaker of solution), then about 95% of the measurements will fall within plus or minus 20% (2 times the *CV*) of the true concentration.

Unfortunately, the property we are trying to measure — the employee's exposure concentration — is not a fixed physical property. The exposure concentrations are fluctuating in a lognormal manner. First, they are fluctuating over the 8-hour period of the TWA exposure measurement. Breathing zone grab samples (samples of less than about 30 minutes' duration, typically only a few minutes) tend to reflect the environmental variation within a day so that grab sample results have relatively high variation. However, this variation in the sample results can be eliminated by going to a full period sampling strategy as discussed by Leidel and Busch (M-1). Second, the day-to-day variation of the true 8-hour TWA exposures is also lognormally distributed.

Environmental variation is expressed by the *GSD*. A *GSD* of 1.0 represents absolutely no variation in the environment. *GSD*'s of 2.0 and above represent relatively high variation. Hald (M-22) states that the shape of lognormal distributions with low variations, such as those with *GSD*'s less than about 1.4, roughly approximate normal distribution shapes. For this range of *GSD*'s, there is a rough equivalence between the quantity $(GSD-1)$ and the *CV*, as follows:

GSD	$(GSD-1)$	*CV*
1.05	0.05	0.049
1.10	0.10	0.096
1.20	0.20	0.18
1.30	0.30	0.27
1.40	0.40	0.35

For those interested in a detailed study of the lognormal distribution, Aitchinson and Brown (M-23) is an excellent reference. Figure M-2 shows four different lognormal distributions that share a common arithmetic mean of 10 ppm. Four different variations are shown with *GSD*'s of 1.2, 1.5, 2.0, and 3.0.

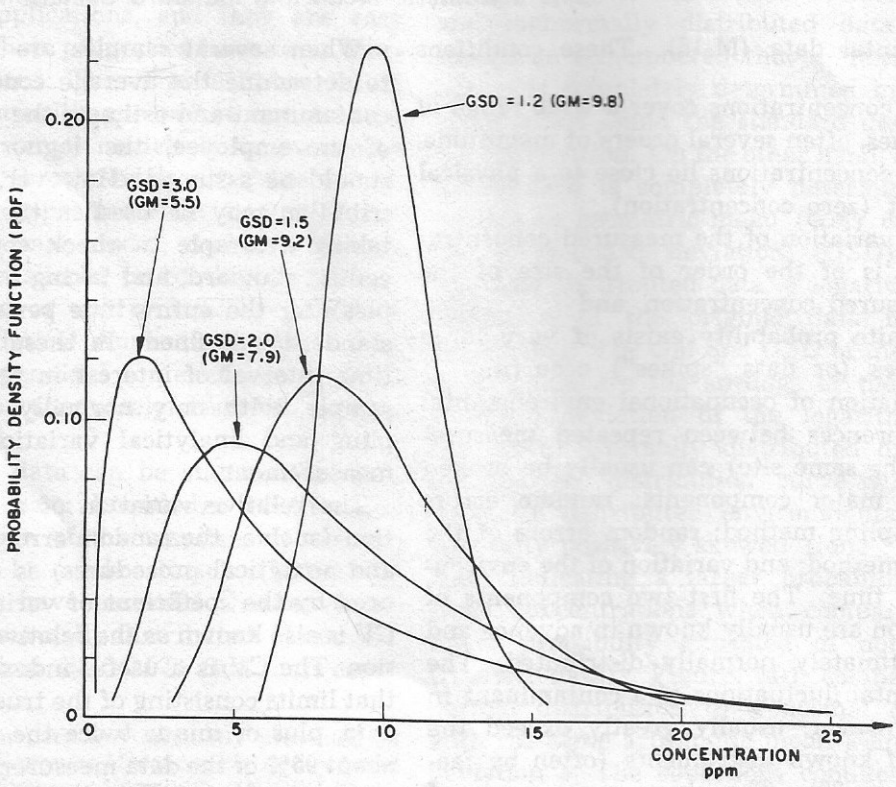

Figure M-2. Lognormal distributions for arithmetic mean concentration of 10 ppm.