40 C.F.R. § 1065.602

Statistics.

(a) *Overview.* This section contains equations and example calculations for statistics that are specified in this part. In this section we use the letter "y" to denote a generic measured quantity, the superscript over-bar "–" to denote an arithmetic mean, and the subscript "$_{ref}$" to denote the reference quantity being measured.

(b) *Arithmetic mean.* Calculate an arithmetic mean, *y* ~, as follows:

$$\bar{y} = \frac{\sum_{i=1}^{N} y_i}{N}$$

Eq. 1065.602-1

Example:

$N = 3$ $y_1 = 10.60$ $y_2 = 11.91$ $y_N = y_3 = 11.09$

$$\bar{y} = \frac{10.60 + 11.91 + 11.09}{3}$$

y ~ = 11.20

(c) *Standard deviation.* Calculate the standard deviation for a non-biased (*e.g.,* N–1) sample, σ, as follows:

$$\sigma_y = \sqrt{\frac{\sum_{i=1}^{N} (y_i - \bar{y})^2}{(N-1)}}$$

Eq. 1065.602-2

Example:

$N = 3$ $y_1 = 10.60$ $y_2 = 11.91$ $y_N = y_3 = 11.09$ *y* ~ = 11.20

$$\sigma_y = \sqrt{\frac{(10.60 - 11.2)^2 + (11.91 - 11.2)^2 + (11.09 - 11.2)^2}{2}}$$

$\sigma_y = 0.6619$

(d) *Root mean square.* Calculate a root mean square, rms_y, as follows:

$$rms_y = \sqrt{\frac{1}{N} \sum_{i=1}^{N} y_i^2}$$

Eq. 1065.602-3

Example:

$N = 3$ $y_1 = 10.60$ $y_2 = 11.91$ $y_N = y_3 = 11.09$

$$rms_y = \sqrt{\frac{10.60^2 + 11.91^2 + 11.09^2}{3}}$$

$rms_y = 11.21$

(e) *Accuracy.* Determine accuracy as described in this paragraph (e). Make multiple measurements of a standard quantity to create a set of observed values, y_i, and compare each observed value to the known value of the standard quantity. The standard quantity may have a single known value, such as a gas standard, or a set of known values of negligible range, such as a known applied pressure produced by a calibration device during repeated applications. The known value of the standard quantity is represented by $y_{ref}i$. If you use a standard quantity with a single value, $y_{ref}i$ would be constant. Calculate an accuracy value as follows:

$$accuracy = \left| \frac{1}{N} \sum_{i=1}^{N} (y_i - y_{refi}) \right|$$

Eq. 1065.602-4

Example:

$y_{ref} = 1800.0$ $N = 3$ $y_1 = 1806.4$ $y_2 = 1803.1$ $y_3 = 1798.9$

$$accuracy = \left| \frac{1}{3}((1806.4 - 1800.0) + (1803.1 - 1800.0) + (1798.9 - 1800.0)) \right|$$

$$accuracy = \left| \frac{1}{3}((6.4) + (3.1) + (-1.1)) \right|$$

$accuracy = 2.8$

(f) *t-test.* Determine if your data passes a t-test by using the following equations and tables: (1) For an unpaired t-test, calculate the t statistic and its number of degrees of freedom, v, as follows:

$$t = \frac{|\bar{y}_{ref} - \bar{y}|}{\sqrt{\frac{\sigma_{ref}^2}{N_{ref}} + \frac{\sigma_y^2}{N}}}$$

Eq. 1065.602-5

$$v = \frac{\left(\frac{\sigma_{ref}^2}{N_{ref}} + \frac{\sigma_y^2}{N}\right)^2}{\frac{\left(\frac{\sigma_{ref}^2}{N_{ref}}\right)^2}{N_{ref} - 1} + \frac{\left(\frac{\sigma_y^2}{N}\right)^2}{N - 1}}$$

Eq. 1065.602-6

Example:

$Y\ \tilde{}_{ref} = 1205.3$