

**Simplified Method for
Calculation of the Regression Line
(Appendix to IEEE Guide for the
Statistical Analysis of Thermal Life
Test Data, IEEE Std 101-1972)**

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B1. Scope and Purpose

The purpose of this appendix is to present a method for quickly plotting the regression line for a set of life data. This method may be used for any number of measurements at various test temperatures. After the regression line is plotted, the individual times to failure can also be plotted to give some indication of the linearity and variability of the data. If information about the confidence limits is required, it is suggested that a more detailed analysis be made in accordance with IEEE Std 101-1972.

B2. Equations for Insulation Life

It has been established that many insulations deteriorate in a manner so that the following equation applies.

$$L = Ae^{B/T} \quad (\text{Eq B1})$$

where

L = insulation life, in hours
 T = absolute temperature, in Kelvins
 A, B = constants for each insulation
 e = base of natural logarithms

Eq B1 may be expressed as a linear function by taking logarithms.

$$\log_{10} L = \log_{10} A + (\log_{10} e) B/T \quad (\text{Eq B2})$$

or

$$Y = a + bX \quad (\text{Eq B3})$$

where

$Y = \log_{10} L$
 $a = \log_{10} A$
 $X = 1/T$
 $b = (\log_{10} e) B$

Thus, data from testing at higher temperatures may be plotted on log L versus $1/T$ graph paper and a line extrapolated to lower temperatures. However, since the nature of logarithmic plots does not allow accurate extrapolation by the method of drawing the best apparent straight line through the data points, a more rigorous method must be used for greater accuracy and uniformity. By the use of the method of least squares, the constants a and b may be derived in terms of the experimental data obtained. These equations are as follows:

$$a = \frac{\sum Y - b \sum X}{N} \quad (\text{Eq B4})$$

$$b = \frac{N \sum XY - \sum X \sum Y}{N \sum X^2 - (\sum X)^2} \quad (\text{Eq B5})$$

where

$X = 1/T$ the reciprocal of the test temperature, in Kelvins

N = the number of end points used in the calculation

$Y = \log_{10} L$ the logarithm of the average life at each test point and where the summations are taken over N values.

Knowing the constant a and slope b of the regression line, the temperature at any required life value may be calculated from Eq B3 as follows:

$$T = \frac{1}{\frac{b}{Y - a}} = \frac{Y - a}{b}$$

Thus, for example, the temperature in degrees Celsius at 20 000 h is

$$T = \frac{b}{4.3010 - a} - 273 \quad (\text{Eq B6})$$

and the temperature at 2000 h is

$$T = \frac{b}{3.3010 - a} - 273 \quad (\text{Eq B7})$$