The estimation of electrical performance from highly censored test data

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Abstract

The analysis of accelerated ageing tests on electrical power cables often prove difficult as the data are highly censored: very few, or often no, failures have occurred. The technically preferred solution is to continue the experiments to give more failures; this is often not possible due to constraints on test resources and time. Thus analysis of highly censored data sets is essential as they represent considerable investments. This paper describes and illustrates a method to analyse these highly censored data and capitalise on the test data.

\[ P_f = 1 - \exp\left(\frac{t}{\alpha}\right)^{-\beta} \]  \hspace{1cm} (1)

The time \( t \) can be expressed in hours, days or cycles. The functionality of the distribution is defined by the scale \( \alpha \) and shape \( \beta \) parameters. The scale parameter \( \alpha \) represents the time by which 63% of the samples have failed.

To gain highly accurate estimates of the scale and shape parameters large numbers (>100) of test data are required. However for most engineering studies practically useful estimates of performance can be made with as little as 10 test data. Under some experimental test protocols even 10 data are difficult to achieve and often tests are terminated without failure data. In this case we refer to the data set as being highly censored: a censored datum is a unit that has been tested but has not failed. These tests represent considerable investments and some form of analysis is required to quantify the endurance performance of the product. Unfortunately the standard Weibull methods cannot provide good parameter estimates of these highly censored data.