Cable Lore

The 7th Power Law

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by Power Cable Engineering and Research

ANACONDA

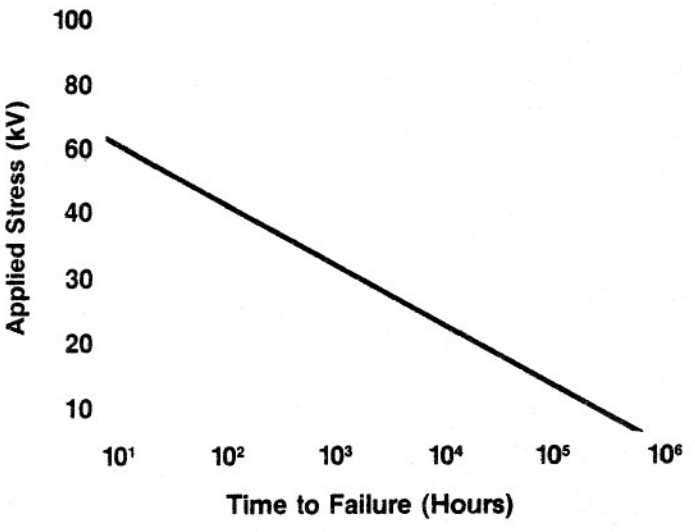
The first mathematical approach to cable life prediction began with the simple discovery of a relationship between time and electrical stress.

Called the "7th power law", this relationship states that every time the voltage stress on a cable is reduced by half, the life of the cable will be extended by 2^7, or by 128 times.

The exact mathematical relationship is: $T = T_0 \left(\frac{E_0}{E}\right)^N$

where T is the time to failure at operating stress E, T_0 is the time to failure at a test stress E_0, and the exponent N is a constant.[1]

T_0, E_0 and N can be experimentally determined for any cable, and the life T at an operating stress E can also be easily calculated. A graphic technique, using the relationship called a "voltage life curve", is shown below.



In a voltage life curve, time-to-failure data gained from a series of tests at different stresses is plotted on graph paper. The horizontal axis of the graph is a logarithm of time to failure and the vertical axis is the logarithm of the applied stress.

When plotted, the data produces a straight line if it obeys the power law, and the slope of the line determines N. This line can then be extrapolated to longer periods of time and an estimate obtained for the predicted time-to-failure at operating voltage.

As the value of N increases, the voltage life curve flattens and cable life similarly increases. In the past, the value seven has been the most often quoted figure, but more recent data indicates that values actually range from seven to 15. Thus, it turns out that in most cases, seven is a conservative value. Our data indicates that a more appropriate value for our EP cable is 10 in dry environments and nine in wet.

The slope of the Weibull curve (*see Cable Lore No. 65*) and the slope of the voltage life curve are closely related. In fact, voltage curves and their related theory are two of the building blocks which make up Weibull statistics in predicting cable reliability.

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[1] For many cable, N may be taken as 7.

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