

INSTRUMENT TRANSFORMER RELIABILITY

GE Energy
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In 1988 GE Meter began an accelerated life program to continually monitor and ensure high in-service reliability of our instrument transformers. Our database of performance expectations is now quite mature, and tracks well with actual in-service results. In addition, field studies of product installations have helped us find ways to improve our products, highlight application problems, and better understand customer expectations.

To estimate instrument transformer reliability, we use an analysis called the Maximum Likelihood method. This procedure sums the joint probability of failure with the reliability function. This method is based on the observation that the log of the time to failure is approximately a normal distribution. The Weibull function statistic and the failure points plotted are NOT a simple regression fit. The maximum likelihood method takes into account the history of survivor, censored, and failed transformers.

In reliability engineering, the characteristic life (alpha) is the statistic that defines the period required for 63.2% of the original population to fail. For general audiences we find the actuarial term "Life Expectancy" to be more descriptive. Life expectancy or Median Life is that period in the life cycle of a given population when half are gone. For some products (and living things), failure rate is a function of age. In contrast to this, there are products in which the risk of failure is *the same* at any time in the product life. These can be modeled using an exponential distribution. Published papers support the observation that the distribution failures in electrical coils due to aging of insulation fit this model, i.e.; the rate of failure is constant over time. Accelerated life tests and field studies confirm that this model applies to our dry type instrument transformers.

The maximum likelihood analysis does not give reliable results with few or no failures. In this situation, we assume that the distribution will be exponential, and use the chi-square statistic to estimate a minimum characteristic life at a given confidence level.

Product reliability at any particular installation is a function of many variables. In addition to the product design and process control provided by the manufacturer, application, environment, and maintenance all effect product reliability. To illustrate, we offer results of two Super-Bute reliability field studies. In northern Alaska, the life expectancy of a population of 114 Super Bute VT's over a 23 year period was estimated at 58.6 years. At a utility in Louisiana, 214 Super Bute VT's over a similar time span were studied. In one division of the utility, life expectancy was estimated to be only 24 years. However, at a different division of the *same* utility, the *same* product provided an estimated life expectancy of 53 years. This study highlighted how the environment, product application, and system maintenance can effect instrument transformer reliability. Combined with other investigations spanning 30 years of Super-Bute production, this evidence suggests that these products are capable of providing over 50-year life expectancy.

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