RELIABILITY PLOTTING

Reliability Plotting is a method for determining the shape of a distribution and using that knowledge to estimate what percentage of that population is "in specification" (that percentage is commonly referred to as the "% Reliability"). The distribution's shape is identified by means of a "Probability Plot" of the measurement ("variables") data derived from a random or representative sample taken from the population.

That entire process is summarily described in the following 6 sequential steps, for a one-sided lower specification limit:

1. The sample data values are charted onto a "cumulative probability plot", with the X-axis values being the raw data points arranged in numerical order with the lowest values on the left-hand side of the axis, and with the Y-axis values being the corresponding cumulative percentages. For the process being described here, the decimal % cumulative value that corresponds to each X-axis value is approximately the ratio of the data-point's rank divided by "N" (which is the total number of data points); e.g., if N=15, the X-axis's lowest data-point's % cumulative equals approximately 1/15, the median value on the X-axis equals approximately 8/15, and the largest value on the X-axis equals approximately 15/15. The resulting plot typically looks like an "S" shaped curve, with the Y-axis decimal values ranging from near 0.00 to near 1.00 (which is the equivalent of a range from near 0% to near 100%).
2. "Transformations" are chosen for the Y-axis values and/or the X-axis values in attempts to straighten-out that S-shaped curve. Common transformation are Log, square-root, or inverse, as well as others such as Z-table, t-table, or Chi-square table values; most of those transformations have been in use since reliability plotting was first invented, in the mid-20th century. In most cases, the best straight line is the one that generates the highest Correlation Coefficient, as determined by the classic method of Linear Regression.
3. After the combination of X-and-Y axis transformations is found that provides the best straight line, that line is extrapolated to the point on the X-axis that corresponds to the QC or Verification/Validation pass/fail criterion (a.k.a., "spec limit").
4. The Y-axis value that corresponds to that extrapolated X-axis value then has its 1-sided upper confidence limit calculated (typically, a 95% confidence limit is chosen), using the classic method that is appropriate for the mean of a point on a Linear Regression line.
5. That confidence limit is then back-transformed. For example, if the Y-axis had been transformed by taking the Log(base 10) of every % cumulative value, then the back-transformation is achieved by taking the anti-log of the confidence limit (that is, using the confidence limit as a power on a base of 10). The resulting value represents the decimal % of the population that is out-of-specification.
6. That %-out-of-specification value is then subtracted from 100%, to yield the desired result, namely the % Reliability. It can then be claimed that, at the confidence level used in step 4 above, the % of the population that meets specification is no worse than the calculated % Reliability.
