MATERION

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TECHNICAL TIDBITS

MATERION PERFORMANCE ALLOYS

OTHER STATISTICAL **PROCESS SYSTEMS**

There are other systems used to determine how certain you can be that your material will conform to specifications.

Don't worry, I have a system – A brief discussion of confidence limits, tolerance limits and the MMPDS Basis System.

- 95% Confidence
- T90 (90% Lower Tolerance Limit)
- T99 (99% Lower Tolerance Limit)
- Design Allowables
- S Basis
- B Basis
- A Basis

For example, the Metallic Materials Properties Development and Standardization (MMPDS) Handbook uses its own statistically-based system for determining quality of design data. The MMPDS Handbook provides design data for a number of different metallic materials that are permitted to be used in aircraft by U.S. government agencies such as the Federal Aviation Administration (FAA), the Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA). What these agencies have in common is a desire for reliability and a low tolerance for risk. The handbook is managed by a committee of government representatives and aircraft manufactures. Battelle Laboratories provides independent verification of the properties. Here are some prerequisite definitions:

T90 (90% Lower Tolerance Limit) -

This is a lower limit for an attribute that 90% of the population would be expected to exceed, under a given confidence level. If the data in the population are normally distributed, and if you have measured the entire population, then this would be equal to the 10th percentile, about 1.28 standard deviations below the mean. See Figure 1.

T99 (99% Lower Tolerance Limit) -

This is a lower limit for an attribute that 90% of the population would be expected to exceed, under a given confidence level. If the data in the population are normally distributed, and if you have measured the entire population, then this would be equal to the 1st percentile, about 2.33 standard deviations below the mean.

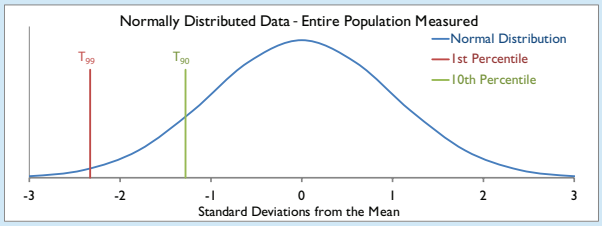

Figure 1. Generalization of Tolerance Limits.
99% of the samples would exceed the T99 lower tolerance limit and 99% of the area under the distribution curve falls to the right of it. Similarly, 90% of the samples would exceed the T90 lower tolerance limit and 90% of the area under the distribution curve falls to the right of it. (In this case the entire population is measured, so there is no uncertainty and there are no confidence limits.)

95% Confidence – This is a measure of how well your statistical analysis can predict the future. To have a 95% confidence means that for future measurements, 95% of the time you can expect it to be true that 90% of your measurements would exceed the T90 level. 90% confidence would indicate a tighter tolerance range and 99% confidence would be associated with a looser tolerance range. To have 100% confidence in your tolerance levels, you would need to measure the entire population and then compute the tolerance limits exactly using the standard deviation and the mean. The confidence level in predictions accounts for the fact that most of the time, you only have data for a portion of the population, since you cannot include metal that has not been made yet, and for more expensive tests or more obscure properties you would only test a statistically significant number of samples.

The next issue of Technical Tidbits will discuss how material properties are almost never constants and are almost always functions of some other parameter.

OTHER STATISTICAL **PROCESS SYSTEMS** (CONTINUED)

The MMPDS handbook contains **design allowables**, or numbers indicating the lower tolerance limits on specific material properties, with a certain level of risk of non-conformance. These levels are referred to as A-Basis, B-Basis and S-Basis. In order of most risk to least risk they are as follows:

S-Basis: This is the specification minimum from an appropriate government or military standard, such as an SAE or ASTM specification for this particular material. Odds are good that this number has been statistically derived at one point, but it might not have been derived using the rigor required for A-Basis specifications, so the number is less conservative than the others.

B-Basis: This is a statistically-derived number, namely the T90 lower-tolerance limit, with a confidence of 95%. What this means is that for all future measurements, 95% of the time it expected to be true that 90% of the population will exceed the B-basis allowable.

A-Basis: This is the lower value of either the S-basis allowable or another statistically-derived number, namely the T99 lower-tolerance limit, with a confidence of 95%. What this means is that for all future measurements, 95% of the time it is expected to be true that 99 percent of the population will exceed the A-basis allowable. The T99 lower tolerance limit will by definition be lower than the T90 (B-Basis) design allowable. If the S-Basis design allowable is less than the T99 number, then it should be reported as the A basis number. If the T99 number is lower than the S-Basis number, then it is reported as the A-Basis design allowable. This assures that the A-Basis design allowable is the most conservative of the three. See Figure 2)

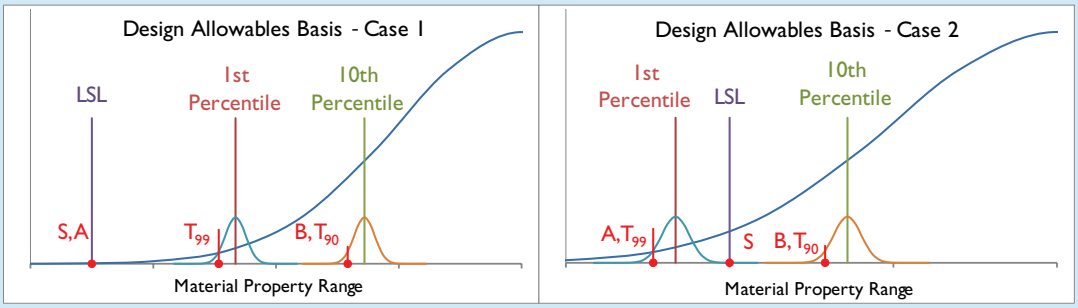

Figure 2. MMPDS A, B, and S Basis Design Allowables.

The red dots represent the lower specification limit (S), the 95% lower confidence limit on the 1st percentile (T_{99}) and the 95% lower confidence limit on the 10th percentile (T_{90} or the B Basis number). A Basis is the lower of (S) and the 95% lower confidence limit on the 1st percentile (T_{99}).

The statistically derived numbers are based on test data from a large number of production samples, typically 10 lots each from 10 heats, with up to triplicate samples from each heat. This is done for each alloy and temper listed. It is important to note that if different sizes are processed differently, then each similarly-processed size range would have its own entry. Often, you will find design allowables reported in more than one basis.

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References:

MMPDS-08
April 2013

Please contact your local sales representative for further information on material hardness or other questions pertaining to Materion or our products.

Health and Safety

Handling copper beryllium in solid form poses no special health risk. Like many industrial materials, beryllium-containing materials may pose a health risk if recommended safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in susceptible individuals. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Material Safety Data Sheet (MSDS) before working with this material. For additional information on safe handling practices or technical data on copper beryllium, contact Materion Performance Alloys or your local representative.

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