Is It in Spec ... or Not?

How to Use the Assigned Test Value for Conformance Decisions

BY ALEX T. LAU

Q: Can a product with a single inspection result that is worse than the specification limit by an amount not exceeding reproducibility (*R*) be considered as being in conformance with the specification?

A. A previous DataPoints article on how to account for test imprecision[1] and ASTM D3244, Practice for Utilization of Test Data to Determine Conformance with Specifications, spawned the above question from a reader. While the question is simple, the answer is not.

I will begin by stating a most common error, that is, use of *R* as an acceptable tolerance for judgment of a test result against a specification.

The primary purpose of *R* is not to be used for judgment of a test result against a specification. *R* is intended to be used to judge whether the difference between two single results obtained from two different labs using the same test method can be reasonably attributable to common causes that are deemed to be part of the test method, under the assumption that both labs have executed the test method correctly, and both labs tested essentially the same material.

The key word is difference. If the difference as described above exceeds *R*, we reject the notion that this difference can be attributable to common causes associated with the test method, and we look for special causes. The most frequently encountered special causes are:

- Test sample taken from the wrong batch by one of the laboratories,
- Test sample contamination, and
- Failure to properly execute the sampling protocol (such as inadequate flushing of the sample line, inadequate flushing of the sample container and use of a nonapproved container).

If the difference does not exceed *R*, we accept both results as valid single point estimates of the property in question. We can then calculate the average using both results to obtain a more precise estimate for the property. In D3244, this average is called the assigned test value (*ATV*) for the product in question. Now comes the part that is not simple: how to use this *ATV* to make the specification conformance decision.

In order to make the specification conformance decision, the receiver (consumer) and supplier (producer) will first need to agree on what value to compare this *ATV* against to make the decision. This value is referred to as the acceptance limit (*AL*) in practice D3244. The *AL* may or may not coincide with the specification limit because it is dependent on the required degree of confidence (assurance) that the product conforms to specification.

Setting the degree of confidence depends on the perspective used to make the product conformance decision. From a consumer's perspective, the decision will logically be based on minimizing consumers' risk, the risk of accepting a product based on the *ATV* meeting the *AL*, but the true value of the property is nonconforming. From a producer's perspective, the decision will logically be based on minimizing the producer's risk, the risk of rejecting a product based on the *ATV* not meeting the *AL*, but the true value of the property is conforming.

"In order to make the specification conformance decision, the receiver (consumer) and supplier (producer) will first need to agree on what value to compare this ATV against to make the decision."

Practice D3244 advocates setting the *AL* based on the probability of product acceptance if the true value of the property is exactly at the specification limit, as described below:

- For noncritical specifications, set the *AL* such that there is a 50 percent or greater probability of product acceptance if the true value of the property is exactly at the specification limit value. This is based on the producer's perspective.
- For critical specifications, set the *AL* such that there is less than a 50 percent probability of product acceptance if the true value of the property is exactly at the specification limit value. This is based on the consumer's perspective.

For critical specifications, the *AL* will be on the conforming side of the specification limit, while for noncritical specifications, the *AL* will be on the nonconforming side, except for the special case of 50 percent, where the *AL* coincides with the specification limit. Since most consumers will hesitate to accept a product with the *ATV* in the nonconforming side, the *AL* is seldom set in the nonconforming region, regardless of the statistical implications.

The following numerical example, in table form (Table 1), tabulates the *AL* at different degrees of confidence for octane (antiknock index, or *AKI*) in gasoline to illustrate the aforementioned concepts.

REFERENCE

1. Lau, A.T., "Test Method Imprecision - How to Account for It," ASTM *Standardization News*, July/Aug. 2012, pp. 16-17.

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Table 1 — Acceptance Limit at Different Degrees of Confidence for Octane

Minimum Specification, Antiknock Index *(AKI)*	Published Test Method Reproductibility *(R)*	Probability of Acceptance *(P)* *if* True Value of Product is Exactly at 93.0	Acceptance Limit *(AL)*	
93.0	0.6	5%	93.25	critical specification
93.0	0.6	10%	93.20	treatment
93.0	0.6	50%	93.00	noncritical
93.0	0.6	90%	92.80	specification treatment
93.0	0.6	95%	92.75	