An Introduction to Acceptance Sampling

What is Acceptance Sampling?

Acceptance Sampling is used to make dispositions on accepting or rejecting a lot (or batch) of product that has already been produced. A sample of product is used to determine acceptability. It is most often used to evaluate products that are received from outside sources and where it is not possible to implement Statistical Process Control. Acceptance Sampling should be considered when the testing required is destructive, 100% inspection isn't feasible due to the cost or time involved, there is a high probability of errors from 100% inspection, or if the supplier has a strong history of supplying acceptable products. An Acceptance Sampling Plan is created to define how many samples must be taken to verify the lot.

Acceptance Sampling isn't to be considered a replacement or alternative to Statistical Process Control. Statistical Process Control focuses on improving the process in order to improve future product, while Acceptance Sampling focuses on evaluation of products that have already been produced to ensure their quality.

Acceptance Sampling includes Attribute Sampling, which makes accept / reject decisions based on the number of defectives within a lot and Variable Sampling, with makes accept / reject decisions based on measurement values.

There are many methods available for acceptance testing, but Acceptance Sampling plans which take into account the Acceptable Quality Level and Lot Tolerance Percent Defective are considered to be the most statistically valid.

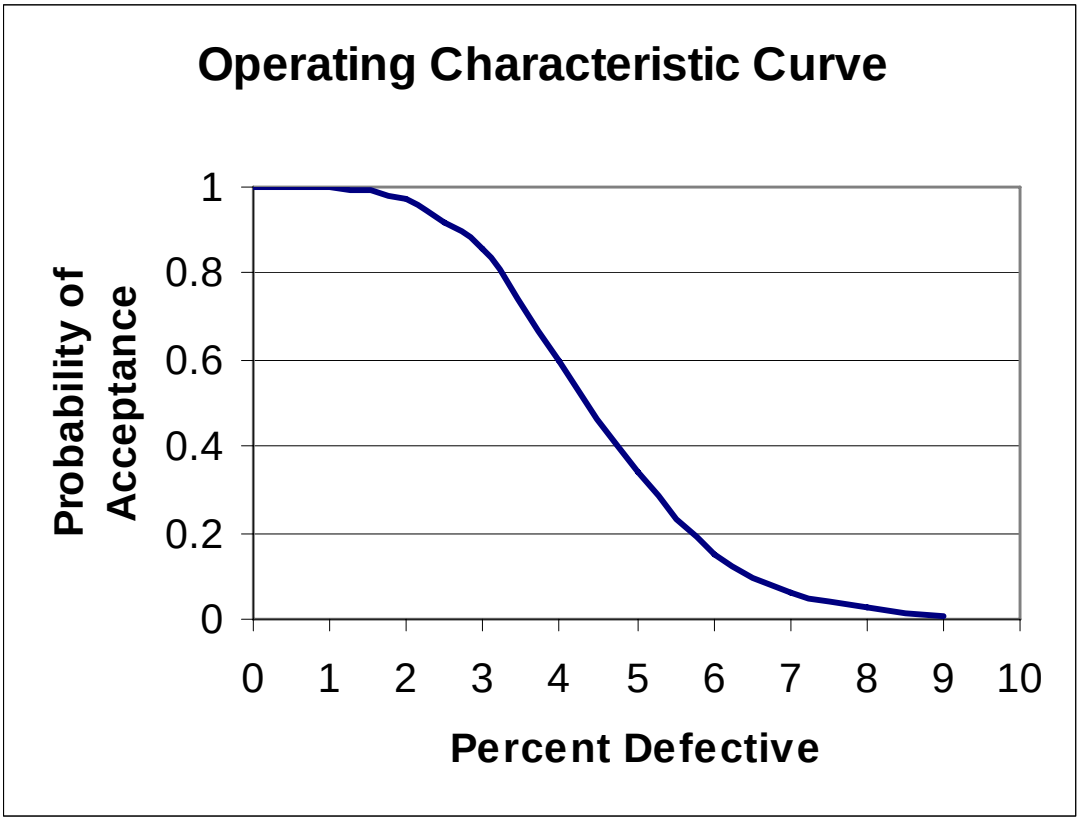
How Do Sampling Plans Work?

It would be great if we could always know that every bad lot would be rejected and that every good lot would be accepted, but since we are taking a sample of the lot there is always a risk of making the wrong decision. Sampling plans are used to control that risk. A statistically valid sampling plan tells us the probability of accepting bad lots and the probability of rejecting good lots.

A sampling plan is best understood through the *Operating Characteristic Curve*. The *Operating Characteristic Curve* or *OC curve* is a graph that shows the probability of acceptance of a lot through all possible levels of percent defective.

The *OC Curve* is created by plotting the percent defective versus the matching probabilities of acceptance. The probability of acceptance is based on the number of samples to be evaluated and the quantity of rejects that are to be allowed. The curve becomes more "sensitive", having a lower percent defective for the same probability of acceptance as the sample quantity increases.

In the following *OC Curve* we can see that with this plan, a lot with 2% defective has around a 95% probability of acceptance while a lot with 6% defective has only a 15% probability of acceptance.



The *OC Curve* is usually summarized by two points on the curve: the *Acceptable Quality Level* or *AQL* and the *Lot Tolerance Percent Defective* or *LTPD*.

The *Acceptable Quality Level (AQL)* is generally defined as the percent defectives that the plan will accept 95% of the time. Lots that are at or better than the *AQL* will be accepted 95% of the time. If the lot fails, we can say with 95% confidence that the lot quality level is worse than the *AQL*. Likewise, we can say that a lot at the *AQL* that is acceptable has a 5% chance of being rejected. The *AQL* isn't necessarily the quality level that is being produced or the quality level that is being accepted. It may not even be the quality goal. It is simply the percent defective at the *Producer's Risk (Alpha)* or the probability of rejecting the acceptable. The *Producer's Risk* is typically 5%.

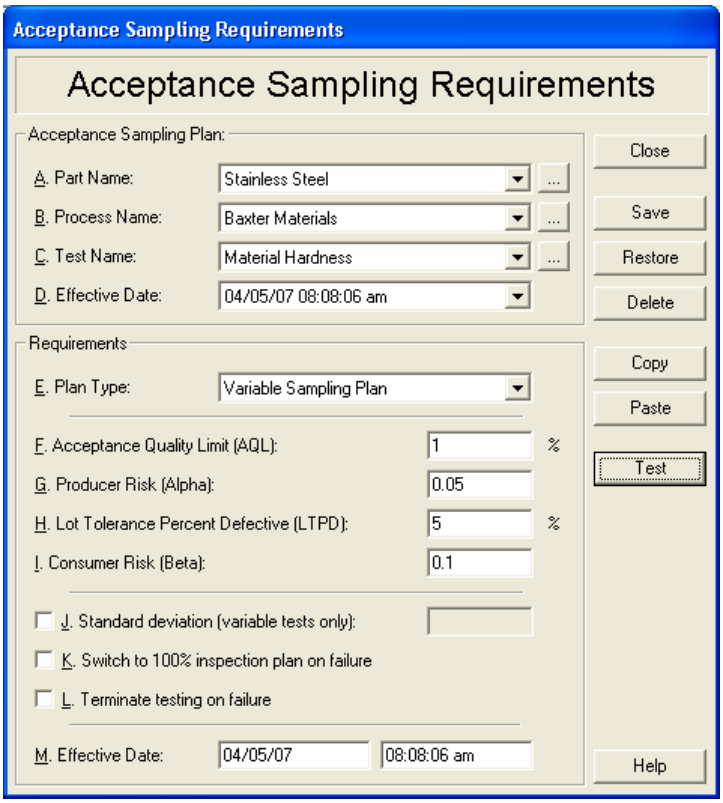
On the *OC Curve* chart above, the *AQL* would be the Percent Defective at the Probability of Acceptance of 0.95 (95%), approximately 2%.

The *Lot Tolerance Percent Defective (LTPD)* is generally defined as percent defective that the plan will reject 90% of the time. We can say that a lot at or worse than the LTPD will be rejected 90% of the time. If the lot passes, we can say with 90% confidence that the lot quality is better than the LTPD. We could also say that a lot at the *LTPD* that is defective has a 10% chance of being accepted. The LTPD is the percent defective at the *Consumer's Risk (Beta)* or the probability of accepting a defective sample. The *Consumer's Risk* is typically 10%.

On the *OC Curve* chart above, the *LTPD* would be the Percent Defective at the Probability of Acceptance of 0.10 (10%), approximately 6.5%.

How Does InfinityQS Acceptance Sampling Work?

InfinityQS creates a statistically valid sampling plan based on the *Acceptable Quality Level* and the *Lot Tolerance Percent Defective* at a user defined *Producer's Risk* and *Consumer's Risk*. The Sampling Plan is created based on these two points of the *Operating Characteristics Curve, the AQL* and the *LTPD.*



Why Does InfinityQS Acceptance Require Producer Risk and Consumer Risk?

While an *AQL* is generally defined at 95% confidence and the *LTPD* at 90% confidence, or a *Producer Risk (Alpha*) of 0.05 and a *Consumer Risk (Beta)* of 0.10, InfinityQS allows the flexibility of setting your confidence levels. If you would like a plan that reduces the chance of rejecting acceptable lots, then you may change your *Producer Risk (Alpha*) to 0.01 to create a plan with 99% confidence. This plan would have just a 1% chance of rejecting an acceptable lot at the *AQL* level. Likewise, you may desire a plan with emphasis on *Consumer Risk*. If the *Consumer Risk (Beta)* is lowered to 0.05 or 95% confidence, then the plan has a 5% chance of accepting a defective lot. Having the ability to enter your confidence intervals allows you to create a plan that matches your needs.

What options does InfinityQS Acceptance Sampling have?

InfinityQS Acceptance Sampling handles both Variable and Attribute data.

- Variable sampling plans use measurements to make acceptance decisions. They require fewer samples than attributes because they compare measured values to specifications. Variable sampling plan decisions are also based on the sample average and standard deviation. If the process being evaluated has a known standard deviation the sample quantity required is less.

- Attribute sampling plans are based on accept / reject decisions. The acceptance decision is based on counts of defectives. Attribute plans may allow a number of defectives before the lot is rejected. The number of defectives that are acceptable is based on the *Producer Risk* and *Consumer Risk.*

NOTE: InfinityQS also allows attribute sampling plans to be used with variable data.

A Zero Defective sampling option causes the lot to fail at one defective. When the Zero Defective option is utilized, only the *Lot Tolerance Percent Defective* and *Consumer Risk (Beta*) are required.

InfinityQS Acceptance Sampling also includes a 100% Inspection sampling option. This option forces 100% inspection of the lot. *Acceptable Quality Level*, *Lot Tolerance Percent Defective*, *Producer Risk* and *Consumer Risk* are not required for this option.

What other key items should I consider when using InfinityQS Acceptance Sampling?

- The protection level of the sampling plan is determined by what the plan accepts, or the *AQL* and what the plan rejects, or the *LTPD*.

- To select a statistically valid sampling plan you must start by stating the objective of the plan, selecting the appropriate *AQL* and *LTPD* and then by deciding what *Producer Risk* and *Consumer Risk* will create the desired protection.

- You must know the *AQLs* and *LTPDs* of all sampling plans. Whether you are using InfinityQS Acceptance Sampling or some other source, all *AQLs* and *LTPDs* should be known and documented.

- Acceptance Sampling is not a replacement for Statistical Process Control just as Statistical Process Control is not a replacement for Acceptance Sampling. Acceptance Sampling focuses on Product control. It is used to make accept / reject decisions on products that have already been produced. Statistical Process Control focuses on improvement of the Process. It is used to improve quality of products during production. W. Edwards Deming was believed to be in favor of elimination of Acceptance Sampling, but he really just wanted manufacturers to reduce their reliance on it. If we spend more time and resources on Acceptance Sampling than on process improvements is too reliant on Acceptance Sampling and should focus on Statistical Process Control for defect prevention and process improvement.

REFERENCES

1) Taylor, W. A., ***Guide to Acceptance Sampling***, Libertyville, IL, Taylor Enterprises, 1992
2) Smith, Gerald, ***Statistical Process Control and Quality Improvement***, Columbus, OH, Prentice Hill 1991