What You Should Know About AQL Acceptance Sampling: Producer's and Consumer's Risk

Harry B. Rowe
Rowe Quality Services
www.rowequality.com

What You Should Know About AQL Acceptance Sampling: Producer's and Consumer's Risk

In some industries it is traditional to use lot sampling or acceptance sampling to either accept or reject product at the point of shipment or receipt. In this approach, rather than testing or inspecting each item in a lot, a (usually random and assumed representative) sample of the items is selected for testing or inspection. If the number of non-conforming items in the sample exceeds a pre-determined level, the entire lot is rejected. Otherwise, the lot is accepted.

This technique is less expensive than 100% inspection or testing. It may also be necessary to use sampling techniques when testing is destructive.

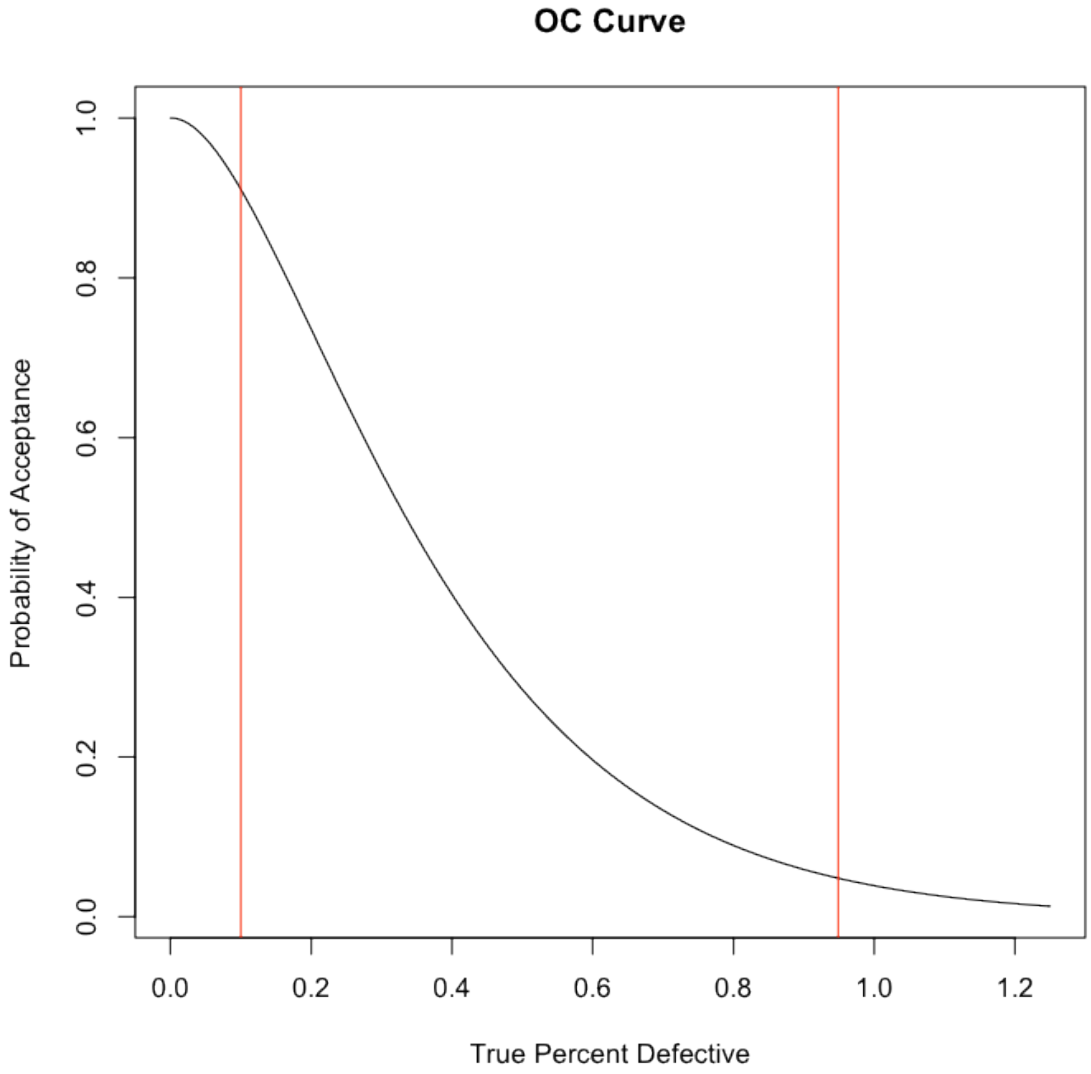
On the other hand, acceptance sampling entails some risk. Ideally, one would prefer that an acceptance procedure accept all conforming lots and reject all non-conforming lots. Unfortunately, this is impossible with acceptance sampling.

There are two types of risk: risk of accepting a "bad" lot, and risk of rejecting a "good" lot. The risk of accepting a "bad" lot is called "consumer's risk" because it can result in a negative impact on the purchaser of the product. The risk of rejecting a "good" lot is called "producers risk" because of the negative impact on the seller.

AQL is an acronym for "Acceptable Quality Level". That is defined as the maximum percent defective (or maximum number of defects per hundred units) that can be considered satisfactory as a process average. It also refers to an approach to acceptance sampling defined in a (now withdrawn) U.S. Military Standard, MIL-STD-105D. This standard provided tables for choosing sample sizes and accept/reject criteria based on acceptable quality level and lot size.

For example, for an AQL of 0.10 (one defect per thousand units) and a lot size of 40,000 units, MIL-STD-105D prescribed a sample size of 500 units. If one or fewer defective units are found, the lot is to be accepted. If two or more defectives are found, the lot is rejected.

The concern with AQL based sampling can be illustrated by plotting the operating characteristic (OC) curve for this sampling plan. The OC curve is a plot which shows, for any given "true" level of quality, the probability that the lot will be accepted under this sampling plan.



The red vertical line at the left of the OC curve is at a true percent defective of 0.1% - the chosen "Acceptable Quality Level". The corresponding probability of acceptance is 0.911. The probability that a lot with this quality level will be accepted is over 90%.

Unfortunately, the vertical red line at the right shows the percent defective at which the probability of acceptance falls to 5%. That quality level is 0.949% - almost ten times the Acceptable Quality Level. There is a high probability that a lot with twice or even three times the acceptable level of defects will not be rejected.

This illustrates the fundamental concern with AQL. It is designed to minimize the producer's risk. It does little to control the consumer's risk.

So what is a buyer to do?

One simple approach would be to demand a much lower AQL, say 0.01 instead of 0.1. In this case, the required sample size increases to 1250 and the acceptable number of defectives falls to 0.

This change will move the OC curve leftward and make it steeper. The probability of accepting a lot with more than 0.1% defectives is sharply reduced. The seller's sampling and inspection costs have sharply increased, however. The seller's risk of having a "good" lot rejected have also sharply increased; to almost 72% at 0.1% defective.

A better approach, however, is to avoid acceptance sampling completely. This means having a supplier whose production processes consistently produce a high enough level of quality that lot inspection is no longer necessary.

How? Ask your supplier to demonstrate that their manufacturing process is "in control and capable" using a control chart for p (proportion defective). To do this, however, the supplier will have to take periodic large samples (3000 units or more at an average proportion defective of 0.1%) from their production line.

A less desirable alternative is having a supplier capable of inspecting 100% of the product while maintaining a competitive price. But remember, you are paying for all that inspection.

Note: The OC curves are calculated using the cumulative hypergeometric distribution. The probability that a lot will be accepted can be computed in R using the following formula:

phyper(accept, ndef, lsize-ndef, ssize)

Where

"accept" is the largest acceptable number of defectives in the sample per the sampling plan

"ndef" is the number of defectives in a lot at the acceptable quality level

"lsize" is the lot size

"ssize" is the sample size