WHAT IS ACCEPTABLE QUALITY LEVEL?

Prof. Rajesh Bheda

AQL is one of the most frequently used terms when it comes to quality in the apparel export industry. Everyone in the industry uses this term quite liberally, assuming that they know what AQL signifies. But when a few years ago, an American apparel importer requested me to provide inputs to him and his sourcing office in India on what AQL actually was? What was the logic behind it and how to use it effectively? I realized that AQL in its true sense remains little understood among the large number of executives working in the apparel industry.

As most of the acceptance decisions of the apparel shipments for the export market are made on the basis of AQL based sampling plans, it is important that all concerned in the industry at least have a basic idea about what is AQL. In this article we shall look at fundamental concept of AQL, its origin and how to prepare an organization to meet the prescribed AQL level.

All of us know that inspection is the tool that is used for assessing the conformance of the merchandise to the agreed specifications or the requirements. Though inspection is important and it gives us an idea about the acceptance level of a product, it may not be possible to carry out 100% inspection of all the units in a particular shipment or a lot. This is mainly due to following reasons:

- It is costly.
- 100% inspection is seldom 100% accurate and dependable.
- It may be impractical and not desirable as it leads to excessive handling of goods which results in goods losing their freshness.

Having known that 100% inspection may not be the best thing to do, the next question is if not 100%, how much to inspect? There are two options available. The first option is to decide a fixed proportion of the lots that will be inspected to arrive at the acceptance decision of the whole lot or the second option is to use Acceptance Sampling procedure to arrive at a sampling plan for given AQL and make an acceptance decision. The first option is arbitrary and it does not have any scientific basis, which can tell us about the reliability of this technique. Since the acceptance decisions are important commercial decisions, it is important to have a reliable and scientific method of arriving at such decision and one should be aware of the extent of risk involved in such decisions. Acceptance sampling is a scientific technique and it also tell us the probability of making a wrong judgment while using it.

What is AQL? As Pradip V. Mehta describes, "The AQL is the maximum per cent defective that for the purpose of sampling inspection can be considered satisfactory as a process average."
In layman's language this means, when a buyer specifies a particular AQL for sampling inspection, it is an indication that as long as the percentage of defective garments in the shipments (lots) supplied by a manufacturer is lower than the AQL, most of the shipments will be accepted. Process Average

means the average percentage of defective products (percent defective) in the lots submitted for the first inspections. Assume a true percent defective level of six lots of garments is 2.3, 2.7, 2.4, 2.6, 2.8 and 2.2 respectively the process average will become 2.5% defective. The method of arriving at process average in apparel factories is provided later in this article.

Brief History of AQL and Acceptance sampling

Acceptance sampling is an important field of statistical quality control that was popularized by Dodge and Roming and originally applied by the U.S. military for the testing of bullets during World War II. If every bullet was tested in advance, no bullets would be left to ship. If, on the other hand, none were tested, malfunctions might occur in the field of battle, with potentially disastrous results.

Acceptance sampling plans help in distinguishing between the acceptable and the unacceptable lots. The basic assumption here is if the proportionate sample is randomly drawn from a lot, the sample would represent the quality level of the lot and based on this the acceptance decision can be made. Acceptance Sampling is the middle of the road approach between 100% inspection and no inspection.

Based on the extensive work by the American military during and past world war II, US Government issued the standard for sampling procedure and tables for inspection called MIL-STD-105D in 1963. This was further modified in 1989 as MIL-STD 105 E and re-designated as ANSI/ ASQC Z 1.4 in Feb 1995. For all the practical purposes MIL STD 105D and ANSI/ASQC Z 1.4 are almost similar. For the purpose of acceptance sampling inspection in the garment industry, most buyers refer to the tables from either of these standards. Though garment industry generally uses normal level on inspection, the standards also provide from reduced and tightened inspections based on the past performance of the supplier.

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Table: Acceptable Quality Level

Lot Or Batch Size			Sample Size code Letter	Sample Size	Acceptable Quality Level					
					2.5		4.0		6.5	
					Ac	Re	Ac	Re	Ac	Re
2	to	8	A	2	0	1	0	1	0	1
9	to	15	B	3	0	1	0	1	0	1
16	to	25	C	5	0	1	0	1	0	1
26	to	50	D	8	0	1	1	2	1	2
51	to	90	E	13	1	2	1	2	2	3
91	to	150	F	20	1	2	2	3	3	4
151	to	280	G	32	2	3	3	4	5	6
281	to	500	H	50	3	4	5	6	7	8
501	to	1200	J	80	5	6	7	8	10	11
1201	to	3200	K	125	7	8	10	11	14	15
3201	to	10000	L	200	10	11	14	15	21	22
10001	to	35000	M	315	14	15	21	22	21	22

From ANSI/ASQC Z 1.4 the sampling procedure and tables for inspection by attributes.

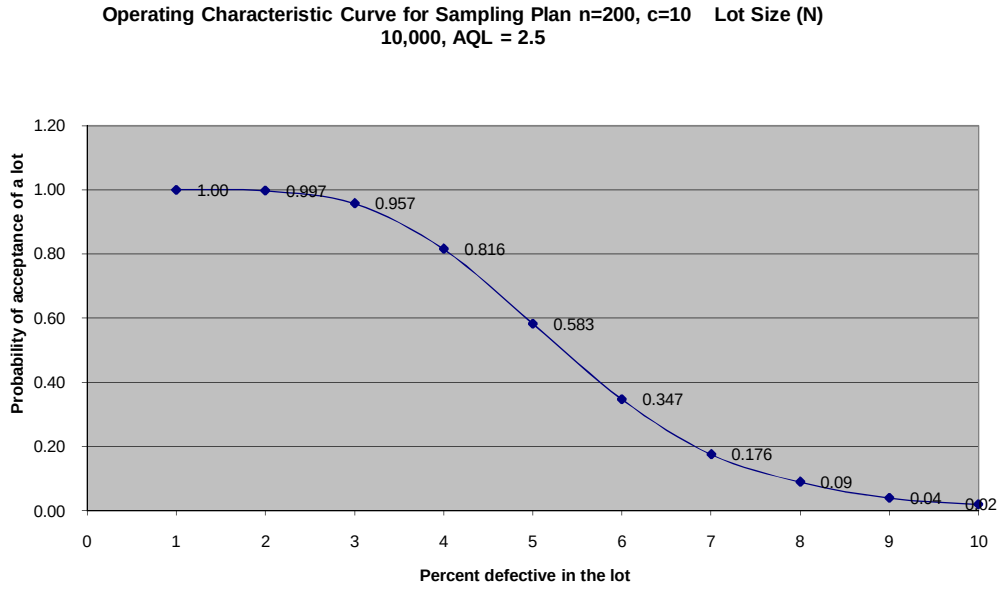
How do the Acceptance Sampling Plans Work?

The apparel industry mainly uses single sampling plans for the acceptance decisions. However, a few buyers also use double sampling procedure. In single sample based on AQL table you randomly draw a sample consisting of specified number of garments from a lot. The sample plan also provides the number maximum allowed defective pieces. If the defective pieces are less than allowed number the lot is accepted and if the number of defective pieces is greater than allowed the lot is rejected. One may say that as the acceptance sampling is scientific, ideally speaking, it must lead to 100% reliable results. In other words, it must always lead to acceptance of lots containing lower defective level than AQL and must reject all the lots that contain more defective products than AQL. But this is not possible, as the acceptance decision is made only on the basis of small sample drawn from the lot and it carries a risk of making a wrong judgment.

The acceptance decisions based on AQL based inspections contain two kinds of risks as detailed below:

1. Producer's risk: The chance of rejecting a good lot that contains equal or less percent defective than AQL.
2. The Customer's risk: The chance of accepting a bad lot that contains more defective than the largest proportion of defects that a consumer is willing to accept a very small percentage of the time. It is also known as Lot Tolerance Percent Defective (LTPD) or represented as RQL (Rejecting Quality level).

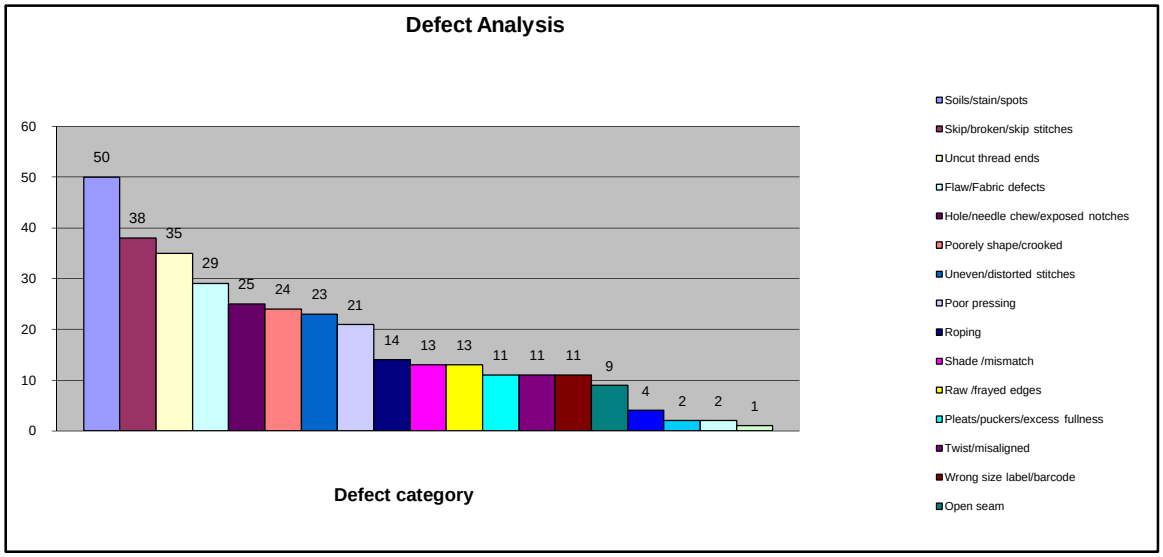
The kind of risk customer and producers faces in terms of making a wrong decision while using a acceptance sample plan can be understood by the Operating Characteristic Curve (OC Curve) of a sample plan. OC curve of a sample plan indicates the chance of acceptance or rejection of lots with varying degree of defective level. The graph 1 shows OC curve of sample plan n=200 and c= 10 for a lot size of 10,000 pieces at AQL 2.5. The Y-axis on the graph indicates the probability of acceptance of the lot, where as the X-axis indicates the percent defective level of the lots. As can be seen the lots containing 2.5% defective merchandise is likely to be accepted 95% of the time and there is a possibility of it getting rejected 5% of the time (producer risk). The readers will be surprised to know that a lot containing 5% defective (twice as the AQL) also has the chance of acceptance of 58.3 times out of 100 inspections. The customers risk with this sample plan is about 10% where a lot containing more than 8% defective may get accepted. This point beyond which the customer would not like the lots to be accepted by sampling inspections is called Lot Tolerance Percent Defective (LTPD). With a simple procedure an OC Curve for every sample plan can be drawn to understand how that plan discriminates between good and bad lots. The people who want to go further deep in the subject can specify their AQL and LTPD and find out an appropriate sample plan for their needs.



How to ensure success at AQL based inspections?

The answer to this question is very simple but difficult to achieve. Ensure that your average percent defective level is below the AQL prescribed by your buyer. What does this mean? It means the true percent defective level of the lots submitted for AQL based inspection must be less than the AQL. For this purpose an organization has to measure its current average percent defective level (process average). This can be achieved by conducting sampling inspections of the lots before the inspection by the customer. In such case, all the pieces in a sample drawn from the lot are inspected to arrive at percent defective level of respective lots. If an organization does this for about 300 consecutive lots and calculates the average of the per cent defective of all lots inspected, it would give a good idea of the 'process average'. Assuming your process average is lower than the AQL level, and then there can a very minimal chance (generally less than 5-10%) of your shipment getting rejected. If your process average is greater than AQL level, you need to work towards, if not eliminating, reducing the generation of defect level at source so that the process average becomes lower than the AQL level. In case process coverage remains higher than the AQL level the chances of your shipments failing to pass AQL based inspection are higher depending on the process average.

The best way to reduce the process average could be to analyse the kind of defects noticed in the inspection and their occurrence (frequency). A Pareto analysis as shown in graph 2 can be very useful. Once you know which are the most frequently occurring defects, it's possible to go to the source of these defects and concentrate on the elimination of these defects through cause and effect analysis and implementing remedial actions.



What AQL is not?

Having known what is AQL? How does it work? How to succeed in AQL based inspections? It is equally important to now, as indicated below, what AQL is not:

1) A permit to ship defective goods to the tune of agreed AQL level: AQL 4.0 does not mean that supplier has a right to send up to 4% defective merchandise to customer /buyer.
2) A guarantee that all shipments passed as per AQL plan will definitely contain lower percent defective than the specified AQL. There is also no guarantee that lots with higher percentage defective will not pass on AQL based inspection.

3) An indicator of the quality level achieved by a manufacturer. Let us assume that the average rate of defective garments in a manufacturer's shipment is 6%, but the AQL used by buyer for final inspection is 2.5. It is possible that the manufacturer may resort to 100% inspection of the merchandise to weed out the defective garments so that the shipment can pass the final inspection by the buyer at AQL 2.5.