Engineering Metrology
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Lecture - 49
Quality Control, critical aspects

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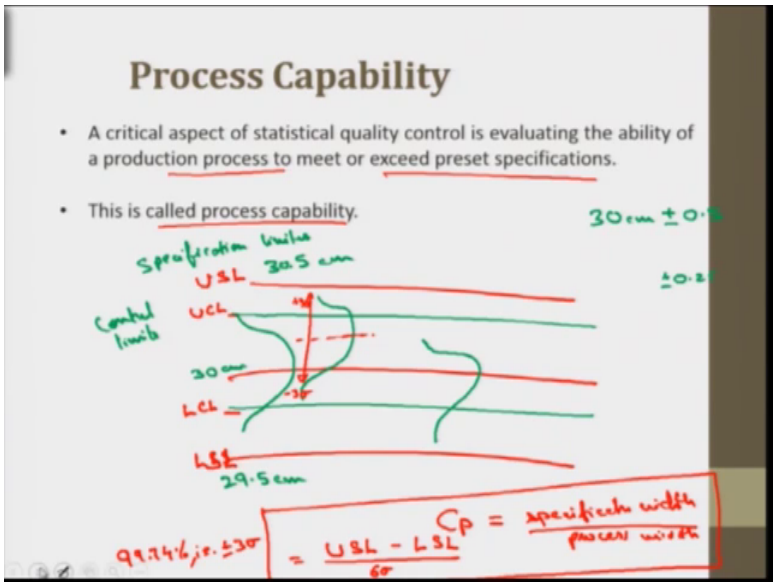

Now, next is critical aspect of statistical Quality Control is evaluating the ability of a production process to meet or exceed the preset specifications. These preset specifications is known as process capability ok, these are also sometime called as the specification limits. The specification limits are larger than the control limits. How does this work? We have some specification limit like this is a central line and we have upper specification limit and we have lower specification limit lower specification limit. And we have the upper and lower control limit within them, upper control limit and lower control limit.

So, it is such that; it is such that even if the readings or the very well experiments are done at different times and the central limit if is the central line is also varying, but the specification limits are defined which are given are also consulting known as a tolerance limits. The tolerance limits that we have seen in the measurement in the tolerance is

those are sometime called as specification limits so, within the specification limits are processes too very.

So, processes to remain within this limit. So, it is something like this so, this can be one time ok, the other day it could be like this, on the other day it could be like this ok. So, these specification limits I will put it these are specification limits and these are control limits. To understand what exactly process capability means the terms, specification needs to be understand it is the preset range beyond which the it would not a accepted actually. For instance they might be some diameter like 13 centimeters plus minus 0.5.

So, this value would be 0 point or this value would be actually 30.5; 30.5 ok. This would be 29.5 and this value is 30 centerline ok, centimeters; centimeter this is specification limits. Now, this control limits can be put such as may be 0.25 plus minus or we can define the control limits in a different way so but the thing is that within specification limits our process should like. So, simply setting up control charts to monitor whether a process is in control does not guarantee process capability. To produce an acceptable product the process must be capable and in controlled before production begins.

So, we can just say that process capability which is also termed as C p process capability is equal to specification width and process width; it is equal to specification width by process width ok. What is specification width? Specification width is the difference between the upper specification limit and lower specification limit. And the process width that we have picked here the process width here this is, what is this value? If this is central line of this process this specific process that is speaking. So, this can be plus 3 sigma this can be minus 3 sigma so, this is 3 sigma plus 3 sigma minus 3 sigma which is equal to 6 sigma so, this is process capability.

Here the value 6 is standard deviation and the reason we use 6 is that a most of processes measurement or within 99.74 percent that is within plus minus 6 sigma so, that is why this is generally used. So, the specification width, so sometimes the process variability and the specification width may vary. So, the process variability outside the specification width, well it can also be the cases, I can put 3 cases here.

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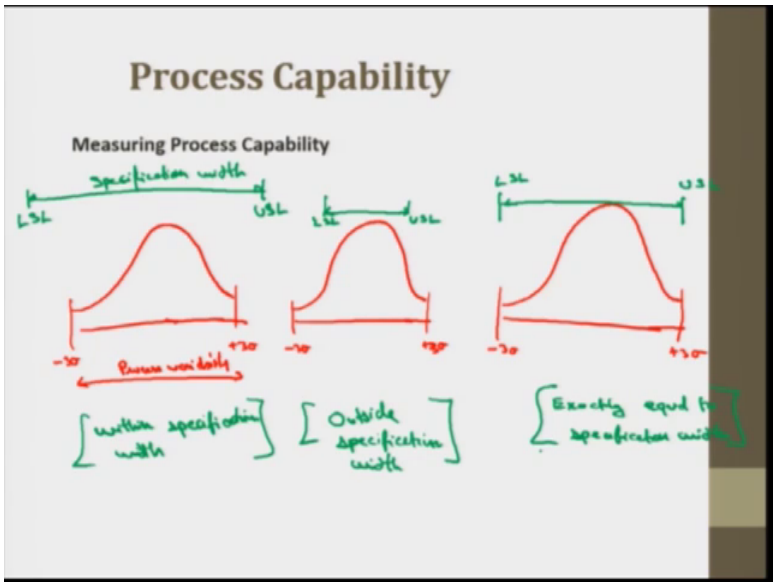

I have this process, this is this is minus 3 sigma and plus 3 sigma, minus 3 sigma and plus 3 sigma, minus 3 sigma and plus 3 sigma. So, this is my process variability ok; this is my process variability. So, the specification width can be like this. If it is like this, this is lower specification limit and this is upper specification limit and this is my specification width. Now, this means that the process variability is within my specification width process variability is lower.

In this case if specification limit is something like this it is low specification limit this is upper specification limit. This is within specification the previous my with this is specification width ok, this is outside the specification width ok. In 3rd case I can take it exactly core so, these 3 kinds of cases can exists this is lower specification limit and upper specification limit ok. So, this meets this specification limit exactly equal to specification width so, this is the process capability.

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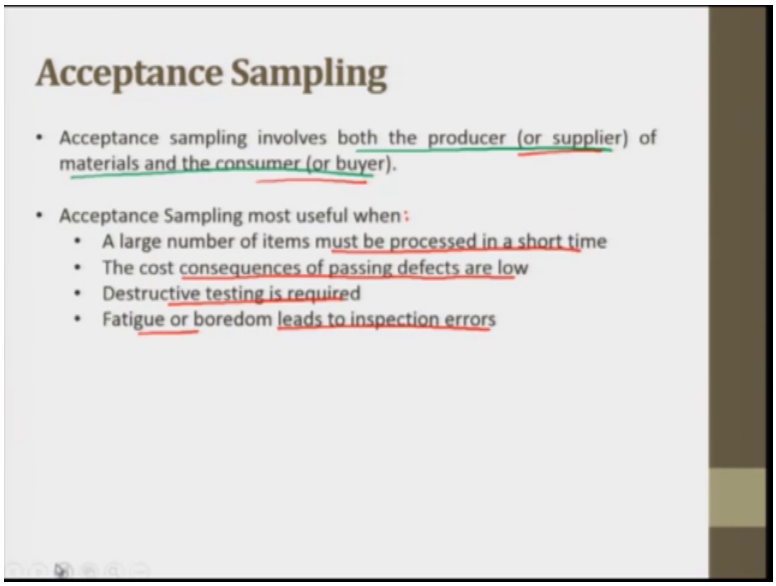

Next, I will have to talk about the acceptance sampling. Acceptance sampling involves both the producer or supplier of the material and the consumer or buyer. Acceptance sampling is the term used to select this samples out of a given population to do the inspection or to do the quality control. Acceptance sampling is most useful when a large number of items must be processed in a short time.

The cost consequences of passing defects are low; passing defects means passing the defects to the customers. Sometime acceptance sampling is there we know we have to take the sample I mean trying to represent the whole population from this sample only. And if the sample is not selected properly or if I can say I can I will just talked about the producers and the consumers risk if the sample is good, but is rejected the producer is adjust.

If the whole population is actually good but the sample that is selected is not good though because of the not good sample or the bad sample the whole population is rejected that is the producers risk the producer is at the loss. So, we can say the producers and suppliers of the loss here. The consumer can be at the loss, if the whole population or the whole lot is bad is having defected pieces but the sample it is selected is good and based on that sample this whole lot is selected and that is passed to the consumer. So, the consumer has received if bad lot, that is a consumer's risk.

So, but the cost consequence of passing defects of if they are low the acceptance sampling is helpful. Then the destructive testing is required if it is required, then acceptance sampling again helpful because, whenever we do destructive testing the sample would be then deteriorative then it cannot be passed to the customer. So, fatigue or boredom leads to inspection errors if sensors kind of inspection is done.

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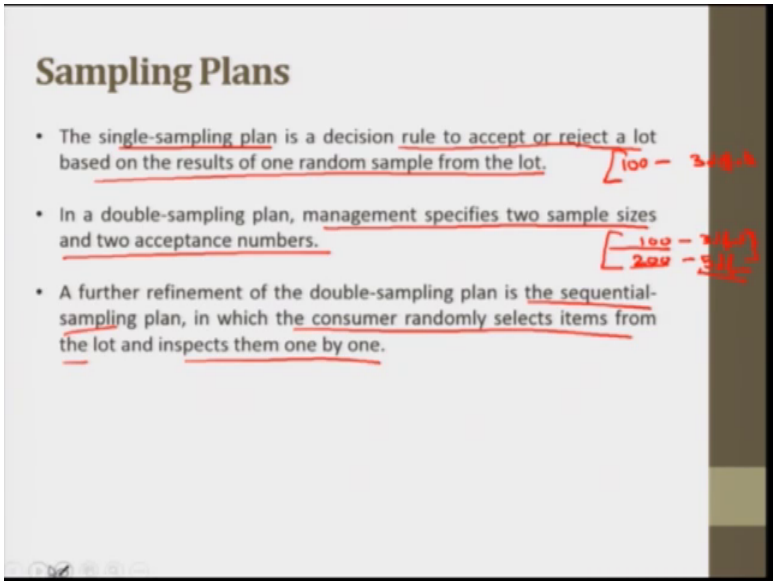

So, we can have various sampling plans; single sampling plan a decision rule to accept or reject a lot based on the resultant one random sample of the lot, one lot is selected ok. Then we just said if these many numbers of pieces are defected we will accept more than these it will be reacted this is single sampling plan. Then double sampling plan what happens two sample sizes are selected.

For instance number of defects can be selected as 3 and 5, if 3 defects are there or we can select two sample size. In this case let me let me say for selected sample size as 10 and the number of defects those are accepted are 3, if out of, I will 10 is a very small number I will just put 100, 100 out of 100, 3 defects there if those are there it would be accepted more than 3 would be rejected, this single sampling plan.

In double sampling plan what we will do I will select a sample of 200, first I will divide into two parts, if in first 100 the 3 defects are there lesser 3 defects are there the whole lot will be defected. If the defection more than 3 I respect the whole 200 and change this number I will select 5 defects. So, in the first step out of 100 if the pieces are inspected

and if defects are found then this select the other 100 pieces, ok this is cumulative a 3. So, other 100 pieces of total 200 pieces as then inspected and if more than 5 defects are found then this is lot is reacted ok. This is double sampling plan.

Further we can have a multiple sampling plans like this. So, further if I meant of the double sampling plan is sequential sampling plan that can be like we can move in sequence the management can decide whether to conduct single or double or multiple sample plans. So, in this sequential sampling plan the consumer randomly selects the items from the lot and inspects them one by one so, this can also be one of the way.

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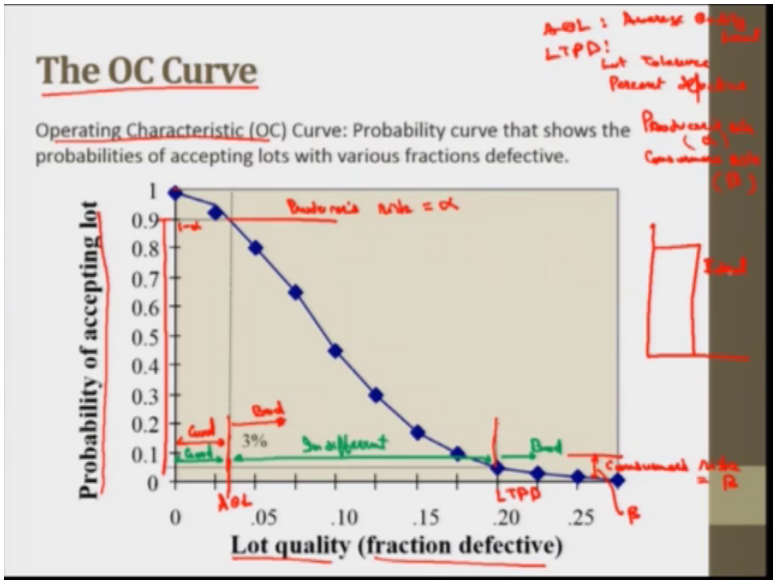

So, and important aspect in the acceptance sampling is the operating characteristic curve, OC curve that we call. So, the probability curve this probability curve shows that the probabilities of accepting lots with various fraction defectives so, we have this kind of curve here. On the left hand side we have probability of accepting a lot; probability of accepting a lot may vary from 0 to 1, 100 percent is we are sure that we accept a lot and 0 is here.

And this is lot quality that the fraction of defective so, if the fraction of defectives of more I can set a few limits here though this if I am selected 3 percent, 3 percent I have put it my acceptance level. So, I will call that if it is less than 3 percent this is my good lot, and this rest is my ok, I will put it here, this is good lot and this is my bad lot ok. So, this specific limit beyond which the lot is termed as bad lot is called as AQL, AQL which

is Acceptable Quality Level. Acceptable quality level is the percentage of defects at which consumer are willing to accept the lots as good. So, 3 percent accept of defects are accepted by the customer. Like this can vary if this is 3 percent is selected here ok.

And on this side the 20 percent is LTPD; LTPD is lot tolerance percent defective, I will just put this terms here AQL LTPD it is average quality level ok. This is Lot Tolerance Percent Defective this. This is the upper limit on the percentage of defects that a consumer is willing to accept this is upper limit maximum limit, there is a consumer risk then there is a producer risk how we can represent that on our OC curve.

So, we have two kinds of risks here the producer's risk and consumer's risk. So, these are neutral by alpha and beta. So, this is the manufacturers risk is 0 point; this is the producers risk. What is the producer's risk? Producer's risk is that the probability that a lot containing the acceptable quality level will be rejected. So, this was acceptable quality level but it is rejected that is a producer risk so, I have put a little bad here.

In case of LTPD the bad value would come here I will put it with a in other color. So, this is good if I consider LTPD this is something in between and this is bad and this is indifferent ok. So, this is producer risk that an acceptable quality level is rejected. Similarly, we can have the consumer risk, the consumer risk is when the probability that a lot contain defectives exceeding LTPD with is accepted, actually it is exceeding LTPD but it is accepted.

So, this consumer risk can be put here so, this is consumers risk ok. So, this is producer risk and consumer risk this can be termed as alpha and beta, this is alpha and this is beta. So, this value and this value is 1 minus alpha and this value, this value, this is equal to beta. So, this is OC curve so we have various points here (Refer Time: 15:51) LTPD, alpha and beta, it is ok. So, what is ideal OC curve? Ideal OC curve would be like this which actually does not exist. So, this is ideal location that this curve.

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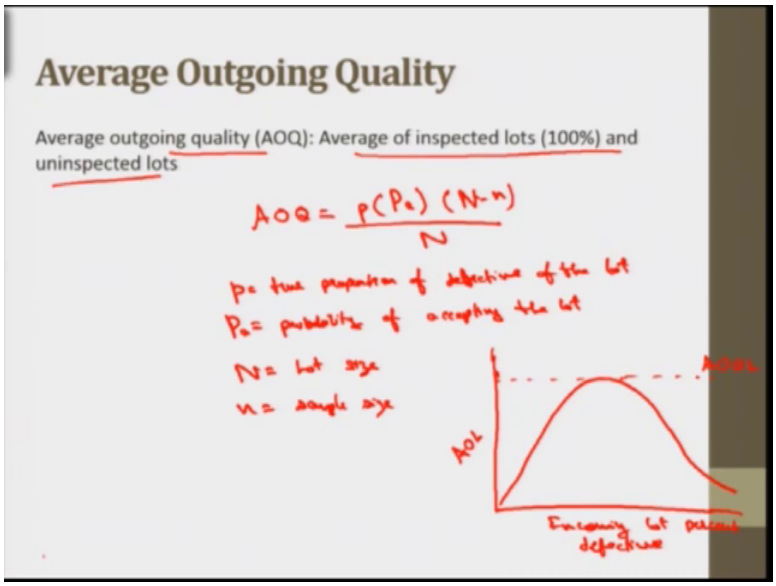

Next is average outgoing qualities; so, what is average outgoing quality? It is the average of inspected lots that is 100 percent an unexpected lots. So, average outgoing quality is I will just put it a relation here I will outgoing quality is given by p into P a into N minus n by capital N. Where what is p? P small p is true proportion of defective ok maybe of the lot. And P a is the probability of acceptance, probability of accepting the lot.

So, in capital N and small n you know capital N is the lot size and small n is the sample size. So, if I try to plot my average outgoing quality ok. This is average outgoing quality that is the percent defective and incoming lot percent defective incoming lot percent defective the curve is something like this ok. So, it should be within AOQL, it like it is my Average Outgoing Quality Level AOQL.

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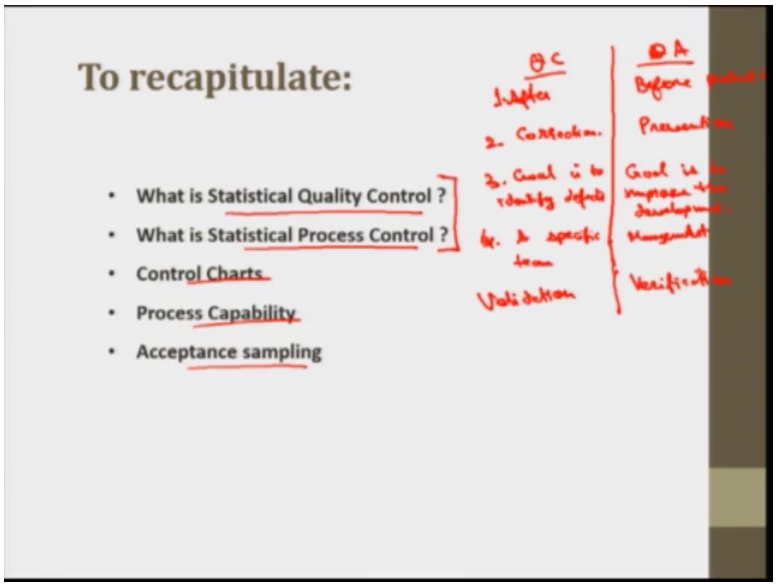

So, with this I like to conclude this lecture. So, what I discussed is what is statistical quality control and what is statistical process control. So, I just had a brief introduction about the control charts, then process capability is discuss, then acceptance sample is discussed. And also I have discussed the quality assurance, what is quality assurance I discussed in the beginning and how does quality assurance vary or differ from my quality control.

So, if I put my quality control and quality assurance here, so what is quality control? It is act of activities ensuring that quality in products that focus and identify defects when the actual products are produced. So, it is after it is generally before production, just to point out of a few differences. And quality control and so identify or correct the defects it is for correction and this is for actually prevention of the defect. Because, we do a proactive quality process is taken into account. The goal in the quality control is to identify defects.

And in the quality assurance we improve the development and test the process. The goal is here, the goal is to identify defects ok; here goal is to improve the development or the quality control process itself ok. Another difference I can put the people who are responsible here the mostly in quality control a specific team is there, an inspection team, specific team and here we have generally everyone on the team that like the whole management ok. If not like the upper management but everyone in the team is involved improvement process.

So, the quality control the activities or techniques which are used to achieve and maintain the product quality, so that is quality control. To prevention of the quality problems is our quality assurance. So, on the final note I can put that quality control is validation and quality assurance that I believe is verification ok. So, quality control is corrective tool and quality assurance is a managerial tool, this difference I would like to incorporate here.

So, with this the quality control and the quality control quality assurance and acceptance sampling, this part is over. So, we will meet in the next lecture, where we might discuss the 3D measurements and the coordinate measuring machine with that the course would be complete. And we will like to have the questions with you and please put the logical questions in the forum and will try to answer all your questions and your queries.

Thank you.