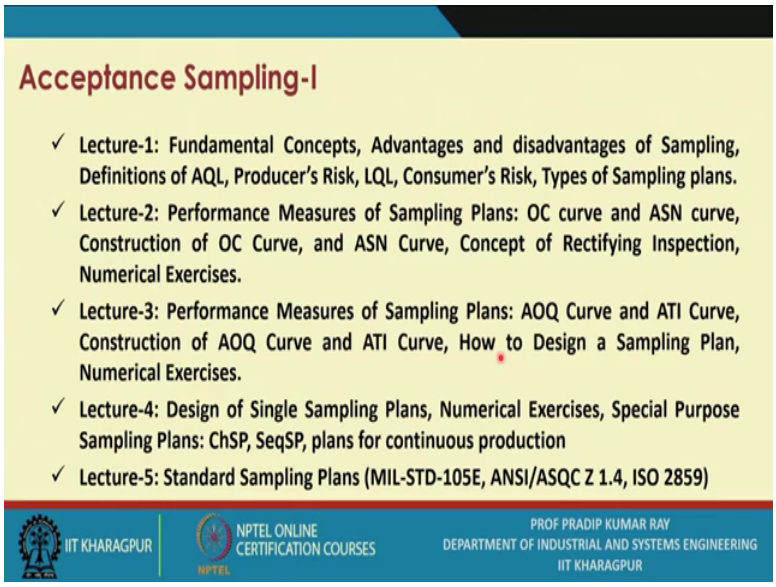
Quality Design and Control
Prof. Pradip Kumar Ray
Department of Industrial and Systems Engineering
Indian Institute of Technology, Kharagpur

Lecture – 31
Acceptance Sampling – I

So, during this week I am going to discuss an important topic in the subject quality design and control, and this particular topic is referred to as acceptance sampling. Now during this week as well as in the next week, I will be discussing on various aspects of acceptance sampling.

(Refer Slide Time: 00:46)



Now during this week there are few topics I am going to discuss, related to acceptance sampling.

So, in this lecture, I will cover the fundamental concepts in acceptance sampling advantages and disadvantages of sampling you must know in clear and specific terms, what are these advantages as well as the disadvantages. The definition of certain terms like AQL reduces risk, LQL consumer risks and we will also discuss the types of sampling plans.

In the next lecture session, I will be referring to the performance measures of sampling plans. There are different types of performance measures like OC curve we will discuss,

ASN curve we will discuss, how to construct the OC curve and the ASN curve we are going to discuss and the concept of rectifying inspection with numerical exercises we are going to discuss in the next lecture.

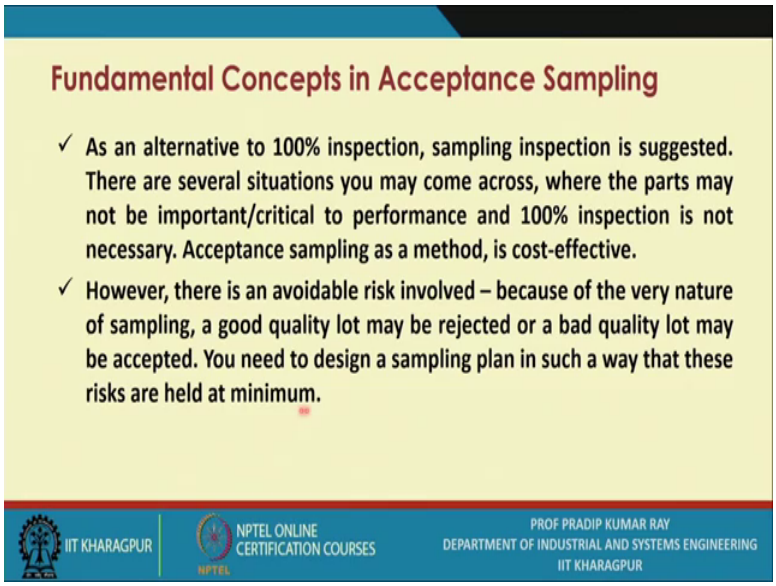
During third lecture session again we will be referring to the performance measures like say AOQ curve, and ATI curve construction of AOQ curve and ATI curve and how to design a sampling plan and numerical exercises also we will be referring to.

In lecture 4 design of single sampling plans we will explain in detail numerical exercises special purpose sampling plans like chain sampling plan, sequential sampling plans and sampling plans for continuous production. So, this will be our coverage during lecture 4 and in the lecture 5 we will be discussing in detail; the standard sampling plans like military standards 105E or equivalent ANSI SQCZ 1.4 standards or equivalent ISO 285.9 standards. So, this will be our coverage.

(Refer Slide Time: 03:08)

Now let us first talk about in this lecture session the fundamental concepts in acceptance sampling, advantages and disadvantages of sampling and we will be referring to certain terms and terminologies related to acceptance sampling, and you also must know at this stage what are the definitions of all these the terms and terminologies like AQL, LQL produces risk, consumer risks and at this stage also you must know what are the types of sampling plans you may come across now.

(Refer Slide Time: 03:49)



Acceptance sampling is considered a major component of quality control; that means, whenever you go through a topic called quality design and control or suppose the right now we are going through the subject called quality design and control. The acceptance sampling is a very important the concept you must be aware of, and among all the tools and techniques that we are going to learn or that already you have learned we will find that the acceptance sampling techniques are widely used by almost all the organizations ok.

And related to acceptance sampling there are many standards already being developed initially these standards were developed by many military organizations during the second world war days, and later on these standards with modifications for obvious reasons, where adopted by organizations are producing civilian products.

So, all these details you must know and you will find that almost majority of the cases, that the acceptance sampling the technique you have to adopt; however, you must also keep in mind that it is not considered a quality improvement tool is it. There are there are 0 aspects in quality design and control, one is definitely the controlling part; that means, whatever the quality standards you have specified and you are trying to achieve whether you are achieving those standards or not that is basically how the domain of the quality control.

Well as it is a constant endeavor on the part of management to improve the quality of a product or a process. So, what are the tools and techniques we need to use. So, like say that taguchi method or some other quality improvement tools later on we will learn. So, those definitely offline quality control, the tools and techniques you may adopt you may use for quality improvement, but here acceptance sampling is not a quality improvement tool. So, this point you also must keep in mind.

In acceptance sampling inspection is performed on a lot or a batch or a shipment of components is it. So, what is acceptance sampling, what actually are supposed to do under acceptance sampling that I am trying to explain. So, it is essentially an inspection activity, but the inspection is performed on a lot, on a batch or a shipment of components and what you are trying to do; that means, you need to take a decision suppose you receive a lot of components right.

Now, you are to take a decision whether the lot will be accepted or lot will be rejected. Based on the level of quality, that you expect of in the units of the in the lot. So, samples. So, what you try to do; that means, in the acceptance sampling, you do not the check or inspect each and every item or each and every unit in the lot. So, a sample is drawn either one sample or in certain cases more than one sample, you need to draw from the lot or the batch.

So, the samples are drawn from a lot, and a certain quality characteristics of the units are inspected is it. That is basically you know the inspection activity, a decision made is made based on the inspection of the samples; that means, when you get the sample you go for 100 percent inspection of the sample units, and then you get the inspection result. Now based on the inspection result you have to make a decision whether you are you will be going to accept the lot or you will reject the lot.

So, ultimately it is a considered to be an auditing tool or it is just as this screening technique; that means, I need to take a decisions and lot acceptance or lot rejection. So, depending on the conditions encountered now, this is the basic technique you follow in acceptance sampling now this technique you have to follow or not only in a in the same conditions, but under the different conditions.

So, depending on the conditions encountered or the situations, in which you need to apply this technique and objectives and the types of quality characteristics come across

right varieties of sampling plans can be designed and used and so, far the researchers or the practitioners they have proposed different kinds of sampling plans suitable for under you know the different conditions is it. So, the varieties of sampling plans you come across; obviously, in a textbooks on the quality or in a specific textbooks on acceptance sampling, you will come to know the classification the scheme for all these say sampling are the plans or the sampling techniques being used.

Now, whenever you say that the sampling or the acceptance sampling technique is being used; that means, it is considered to be an alternative to 100 person inspection. So, as an alternative to 100 person inspection sampling inspection is suggested; that means, your first preference may be 100 percent inspection, but in many time will find that the 100 percent inspection is not necessary. If it is very critical component like say like say the medicine and the suppose a particular medicine has been produced in large numbers also suppose it is a baby food. So, each and every say the unit you need to inspect is it ok.

So, you cannot take a chance and you must go for 100 percent inspection, is it or say the components the aircraft components each and every component is to be inspected is it; that means, even if each component is produced in large numbers, make sure that each component or the each item or each unit is inspected.

So, but barring those cases you come across several situation, where you know that the component may not be that critical. So, whenever the component is considered not critical and in actual the scenario what we will find, the such components you come across with large numbers.

What do you try to do; that means your think of alternative. So, alternative to 100 person inspection is sampling inspection or acceptance sampling. Yes there is a risk involved, but if you can design the sampling plan in such a way, that the risk is at the minimum level; obviously, you say that 100 percent inspection is not necessary for such items and the acceptance sampling is a very is maybe consider to be a very reliable say inspection tool.

So, sampling inspection is suggested under those situations, there are several situations you may come across where the parts may not be important or critical to performance. This point I have already elaborated and 100 person inspection is not necessary acceptance sampling as a method is cost effective is it ok.

That means instead of it is very clear; that means, instead of inspecting each and every item in the lot, what you are doing you are just getting a sample and sample is a representative sample and so, in many time what you find that the sample size is compared to the lot size is very very less; that means, in many a time little one we will find with examples that that the lot size is at least ten times more than the sample size.

So, but what you are trying to do; that means, you will get a sample and make sure that while you form the sample that the sample is representative of for the population or the lot and then you go for 100 percent inspection of the sample. So, the time taken for taking a decision regarding lot acceptance rejection is substantially less.

So, that is why you know it is a very cost effective method. So, certain items you know the inspection time is could be very very large. So, what you try to do; that means, you try to reduce the inspection time and; obviously, one technique could be the sampling inspection; however, there is an unavoidable risk involved; that means, this risk you cannot avoid.

Because of the very nature of sampling, a good quality lot may be rejected is it may so, happen that even if there are few number of us a nonconforming units in the lot, but when you produce when you get a sample from this lot, maybe all those nonconforming units you may find in that particular sample.

So; obviously, you know you may consider the sample quality could be extremely bad, and that is why the you may the reject the entire lot. So, what actually you are doing; that means, a good quality lot you may be rejecting and similarly alternatively a bad quality lot may be accepted; that means, in the lot there is large number of nonconforming units, but when you get a the sample because of the very nature of sampling, you may not find any number of say the nonconforming units in the sample. So, what you say that there is a sample quality is very good, you may conclude that the lot quality also may be very very good what this conclusion could be belong.

So, a bad quality lot may be accepted. So, this possibility remains. So, you need to design a sampling plan in such a way that these risk are held at minimum it is clear.

(Refer Slide Time: 15:34)

So when we discuss the sampling the design that is how to design a sampling plan, we will you refer to these points. Now it is used between 0 parties; that means, whenever you say that the acceptance sampling technique is being used, there are 0 parties involved.

So, what are these 0 parties; that means, the supplier and the manufacturing; that means, the supplier is supplying a lot or the batch of items, and he is giving it to he or she is giving it to the manufacturer and what the manufacturer decides, that as he deals with noncritical items. So, it is better to offered acceptance sampling technique is it ok.

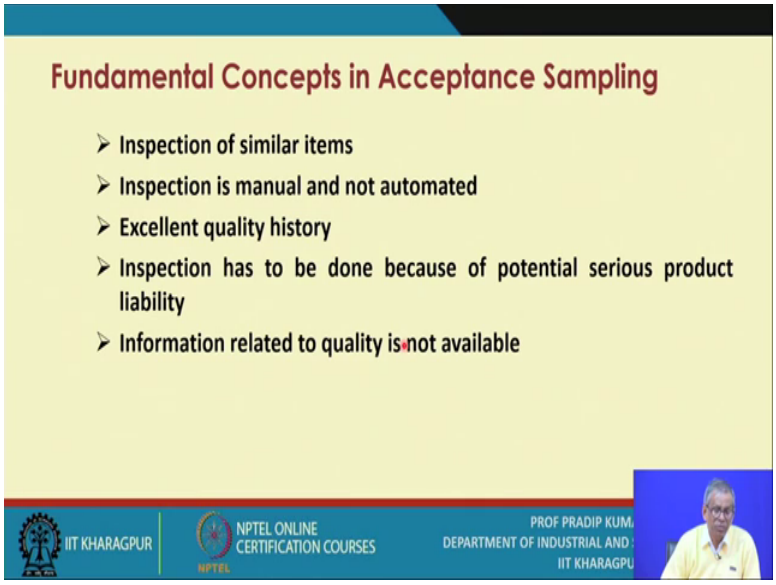
So, he applies or he say that this particular sampling plan, he is going to use. Similarly between the 0 shops say the shop a and shop b; that means, shop A is the supplier and the shop B is basically the customer; that means, the item is getting produced at shop A and before that item is used at the shop B. So, the shop B personnel may be using the sampling techniques ok.

So, whenever you say that the sampling technique is being used or acceptance sampling plan is being used, immediately you assume that there are 0 parties involved. Acceptance sampling is recommended in the following situation, testing is destructive there are many cases is it ok.

So; obviously, you cannot go for inspecting each and every item in the lot is it. So, if the testing is destructive in the process of getting the data, you will be losing all the items in the lot. So, that is not just acceptable cost of 100 percent inspection is very high compared to cost of allowing a nonconforming unit on inspected. So, this sort the data you must have in a given situation.

So; obviously, your obvious choice is why do not you go for go for sampling inspection or say acceptance sampling. 100 percent inspection is not feasible it may make the process very slow as inspection time is substantial is it. So, this is the third reason.

(Refer Slide Time: 18:17)



Inspection of similar items is it. So, when you look at the item, we will find is almost similar is it. So, why do you the test all the items is it ok.

So, it is better that will just select a sample right similar items, inspection is manual and not automated you know these days what you will find many organizations for maintaining a very reliable say inspection systems, they go for automated inspection and where the production rate is very high and 100 percent inspection is a must.

So, when the inspection is manual now if it is manual and the production rate is very high; that means, per unit of time you need to inspect a large number of items will you prefer 100 percent inspection if the inspection is manual there is a chance that there

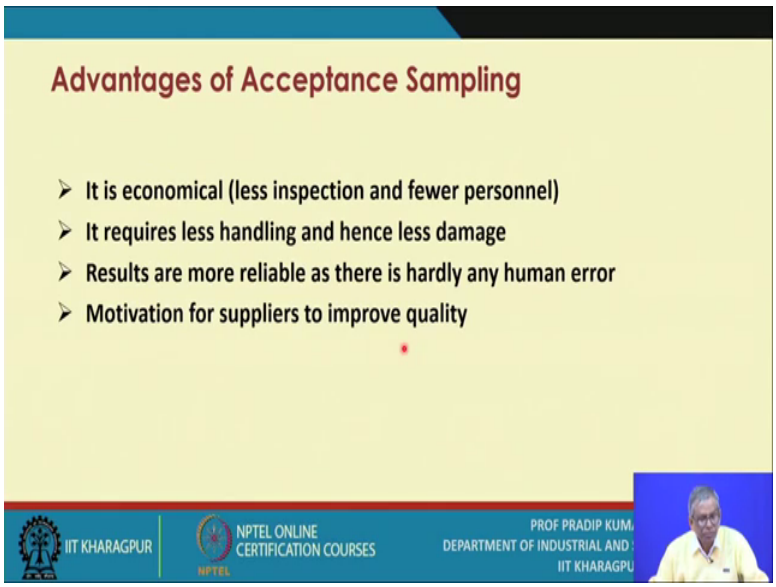
could be you know the human error and the data you will get and may not be reliable is it ok.

So, what you try to do is better, you ask as the person to inspect a fraction of the items and when while you go for inspecting a fraction of the item the total number of items; obviously, you are creating a sample excellent quality history is it. So, it is highly dependable. So, you say just you check few items from the lot and if you find these items are of acceptable quality why do not you accept the lot.

Inspection has to be done because of potential serious product liability. So, sometimes knowing fully well that the lot quality is excellent, but then again you have certain you know restrictions; that means, certain liability you have you have to show certain data to the to the regulating agencies or regulating authority.

So, what you try to do; that means, you go for a sampling inspection or accepting sampling. Information related to quality is not available is it. So, if it is not there; obviously, why do you go for you would must go for every inspection right.

(Refer Slide Time: 20:54)

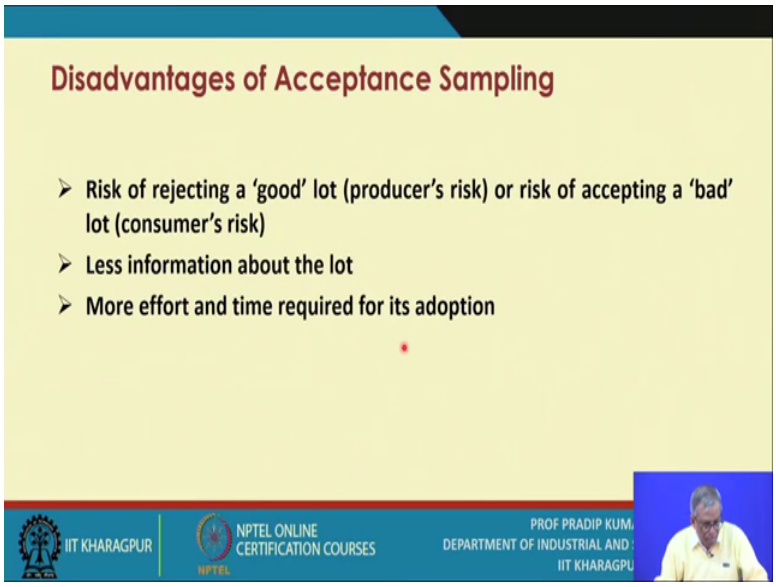


Now, what are the advantages of acceptance sampling, it is economical less inspection and fewer personnel; that means, when you find that the inspection the time is very high is it will you after inspecting each and every item in the lot probably not. So, and if you off for under even under such case such condition, suppose you opt for 100 percent

inspection of the lot the whole process becomes uneconomical. It requires less handling and hence less damage is it because you are not handling all the items in the lot you are just handling a portion of certain lot units. Results are more reliable as there is hardly any human error.

So, this is the point to be noted, I have already referred to say the human error component; that means, if human error may set in while you know while someone inspects items for a longer period of time. Motivation for suppliers to improve quality; that means, they say that there is a chance that even the good quality may be rejected is it. So, they know it very well so; obviously, we will find that if you follow the acceptance sampling technique meticulously or over period of time h there is a as a positive effect on the on the performance of the suppliers.

(Refer Slide Time: 22:33)



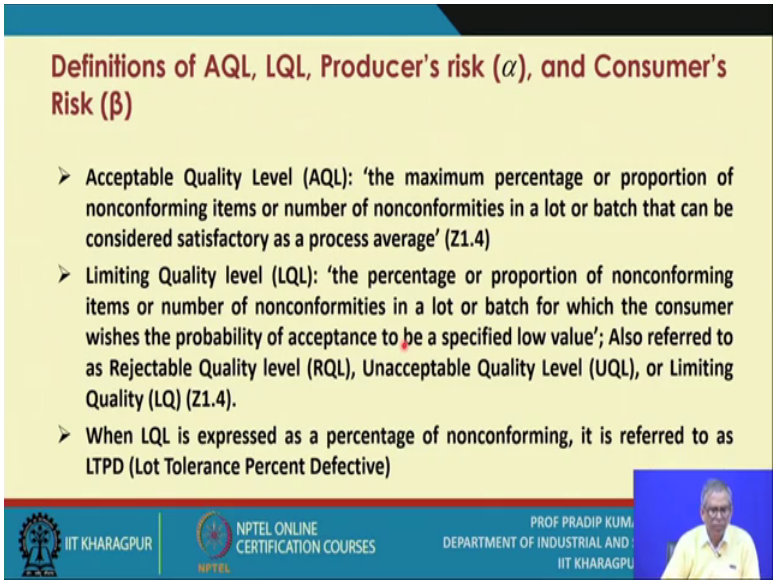
But along with these advantages there also might be certain disadvantages. So, what are those disadvantages? So, the disadvantages are few; risk of rejecting a good lot that is effort as the producers risk, this is there because of the inherent nature of sampling or risk of accepting a bad lot that is effort as the consumer risk. So, what you need to do while you design a sampling plan these are known implicitly.

So, while you design a sampling plan you make them explicit, and the you design the sampling man in such a way that the producers risk and the consumers risk here held at the minimum level. Less information about the lot; obviously, you know because if you

collect quality related data say related to all the items in the lot; obviously, your information base will be is stronger, but here what you are trying to do you have the information only on the quality of sample and this sample you have drawn from the lot. So, you have less information more effort and time required for it is adoption.

Because whenever you study a particular sampling plan, now you need to know the procedures. And in certain cases particularly when deal with the special purpose sampling plans. So, you must be well trained is it. So, there is an administrative cost associated with implementation of such a plan is it.

(Refer Slide Time: 24:18)



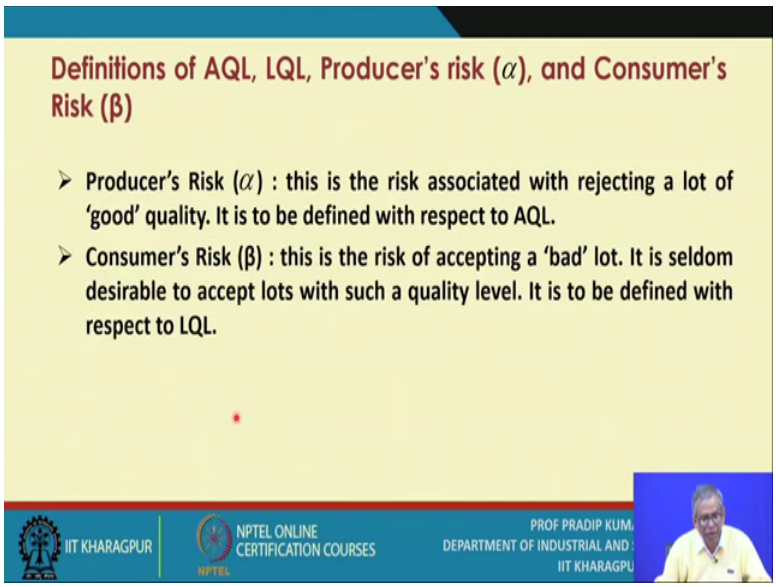
So, these are the disadvantages now, let me first the define certain terms and terminologies you come across, while you study this particular topic. So, the definitions of AQL, LQL, produces risk and consume risk. So, these 4 the terms let me first explain.

AQL stands for acceptable quality level. So, what is the definition of acceptable quality level? Acceptable quality level it is a indicates a level of quality which is considered to be very very good. The maximum percentage or proportion of nonconforming items or number of nonconformities in a lot on a batch, that can be considered satisfactory as a process average; that means, whenever you say that I have specified the value of AQL; that means, you are specifying the level of quality considered as very good and acceptable is it ok.

But this is as a process average; that means, whenever dealing with not only one lot the several lots; that means, the concept of AQL is applicable, and this definition is given as per the z 1.4 standards similarly you have the limiting quality level indicative of bad quality. The percentage of the proportion of nonconforming items or the number of nonconformities in a lot or batch for which the consumer wishes, the probability or acceptance to be a specified low value.

Also refer to as rejectable quality level different terms you use different names unacceptable quality level UQL simply limiting quality. So, this definition is also as per Z1.4 standards later on we will be discussing this particular standard, when LQL is expressed as a percentage of nonconforming it is referred to as LTPD lot tolerance percent if defect this term you will come across in the manufacturing the organizations they may not be telling you about say may not be using the term limiting quality level, but they may be using the term called LTPD not tolerance percent defective.

(Refer Slide Time: 26:55)



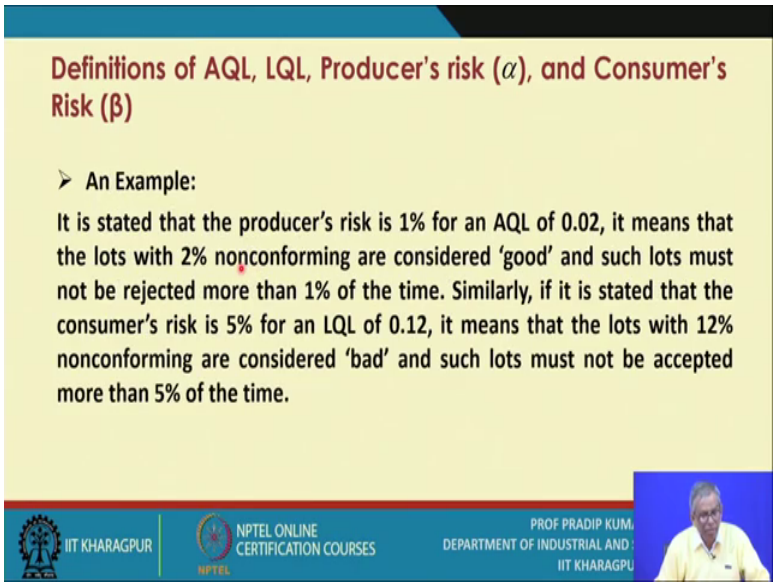
So, it is essentially a manufacturing systems the quaint terms.

Now what is producers risk, producers risks that is alpha this is the risk associated with rejecting a lot of good quality; that means, it is to be defined with respect to AQL square it is clear; that means, first you specify AQL, and then you say this is the producers risk; that means, even if the quality is at AQL or less than AQL, but the probability of it is not acceptance is alpha. Similarly you have consumer risk this is the risk of accepting a bad

lot; that means, quality is very very poor; that means, how do you specify this bad quality that is you specify by LQL.

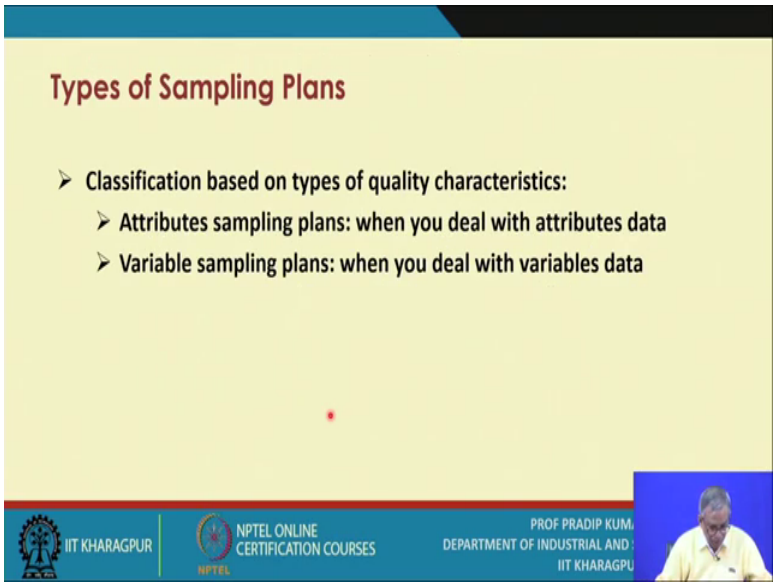
That means any value greater than or equals to LQL is considered to be very very bad. It is seldom desirable to accept lots with such a quality level it is to be defined with respect to LQL. Suppose someone explains the term alpha and beta, but he or she does not mention about AQL or LQL. So, it is. So, his definition is not complete.

(Refer Slide Time: 28:13)



So, an example it is stated that the producers risk is 1 percent, for an AQL of 0.02. It means that the lots with 2 percent nonconforming are considered good and such lots must not be rejected more than one percent of the time. Similarly if it is stated that the consumer risk is 5 percent for an LQL of 0.12 it means that the lots with 12 percent nonconforming are considered bad and such lots must not be accepted more than 5 percent of the time.

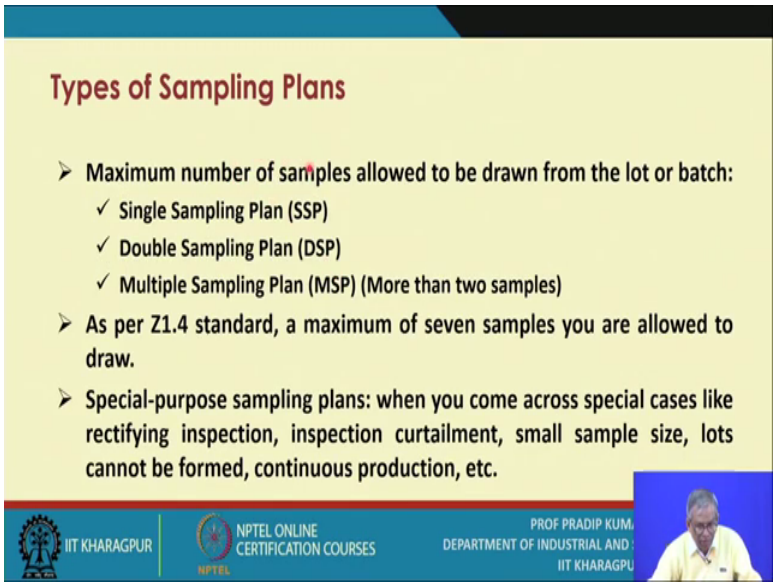
(Refer Slide Time: 28:48)



So, the types of sampling plans, there are now there are as I told have you that there are many types of the sampling plans you may you may have to use and over the years or the researchers the practitioners they have developed many types of sampling plans. Now why do you and these the types of sampling plans can be classified based on the several the criteria.

So, the first one is the classification based on types of quality characteristics, attributes sampling plans that is one type when you deal with the attributes data is it we have already mentioned when we deal with the control charting in statistical quality control or statistical the process control, similarly when you deal with the variables data you have the variable sampling plans.

(Refer Slide Time: 29:49)



So, maximum number of samples allowed to be drawn from the lot or batch, like we have single sampling plan just one sample we have to draw, double sampling plan maximum 0 numbers, and multiple sampling plan more than 0 samples you can draw as per Z 1.4 standards maximum of seven samples you are allowed to draw.

So, whenever you refer to these standards we will mention this then you have the special purpose sampling plans when you come across special cases like rectifying inspection we will define what is rectifying inspection, inspection curtailment small sample size lots cannot be formed there are cases, but you have to use the sampling plan. So, those are specifically the special purpose sampling plans and the continuous production systems.

(Refer Slide Time: 30:37)

So, this will be ah. So, the classification scheme, you must be aware of. So, along with AQL, LQL, producer risk or consumer risk we have used several other the transferring terminology in subsequent lecture sessions, we will be referring to we will be discussing those terms and terminologies.