Quality Design and Control
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Lecture – 36
Acceptance Sampling-II

So, during this week, again will be discussing acceptance sampling. In the last week if you, if you remember we are referring through mainly the attribute sampling plans and attribute sampling plans we use when you deal with attributes data. Now, the question remains that when you deal with so, the variables data and you deal with a large number of data points and you deal with large number of say the say the components or the items in a manufacturing systems. And what do you do? We that not adopt us attribute sampling plans procedures? The answer is definitely yes. So, even if you deal with the variables sampling of the variables data we can use or you should use all the acceptance sampling procedures.

Now, during this week in the next the five said the five sessions lecture sessions I will be mainly referring through for say variable sampling plans. So, why you need to develop the variable sampling plan what are the different types of variable sampling plans how to design them ok.

So, all these issues we will be discussing and we will be referring to several the numerical exercise plus what I have planned to do; that means, related to both the attribute sampling plans as well as the variable sampling plans there could be different types of the numerical problems. So, one or two sessions I will be exclusively the dealing with those the numerical problems for your understanding.

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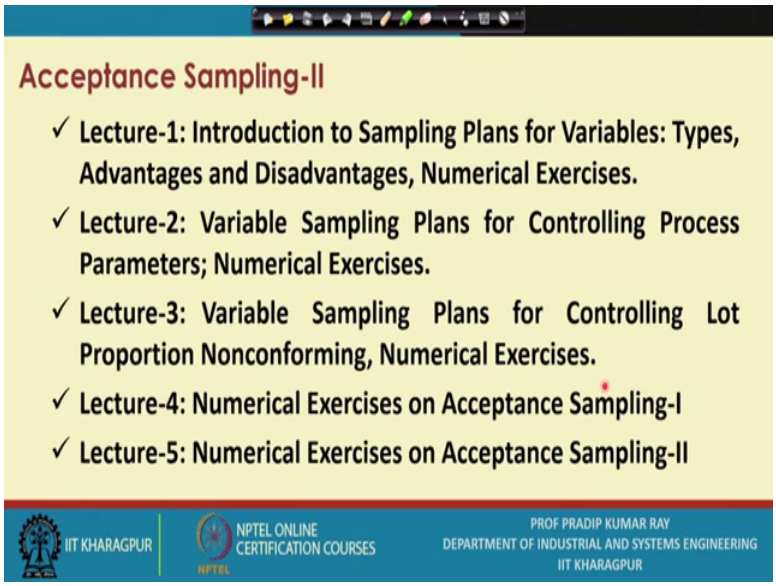

So, during this week related to acceptance sampling we will we will be dealing with several issues in the five lecture sessions

In the first lecture I will I will make some introductory remarks related to sampling plans for the variables. So, the this topic is referred to its introduction to sampling plans for the variables. What are the different types of the sampling plans you come across? Advantages and Disadvantages and if possible I will be referring to some numerical exercise mainly you know certain examples we will provide right. So, that is the coverage in lecture one, in lecture two I will be discussing variable sampling plans for controlling process parameters with numerical exercise. So, this is so the first type of variable sampling plan we will discuss how to design the how to design a variable sampling plan in this category. Lecture three will cover variable sampling plans for controlling lot proportion and confirming. And which I will take up a few numerical examples also right.

Now, here by looking at the lecture two topic and in the lecture three topic you can guess that there are two types of variable sampling plans and because there are two specific objectives of using a variable sampling plans. So, what are these two objectives?

The first objective is to control the process parameters. Now, what are these process parameters. The process parameters could be a say the mean of the quality characteristics as well as the standard deviation of the quality characteristics. How do you grade these values from the quality characteristics because you are getting this values from a process. So, sometimes so they refer to as the process parameter. So, the first objective is to control the process parameters and for which you can use the variable sampling plan. The second objective is that you need to control the lot proportion on confirming and for controlling a lot proportion non confirming again you can use the variable sampling plans. So, these are the two objectives and against each objective you have different types of sampling plans that we are going to discuss.

During lecture four and lecture five, these two sessions I will exclusively you know I will be devoting on the solving numerical problems. So, the numeral set of numerical exercise on acceptance sampling one, that is the first part and the second set of numerical exercises I will take up I am calling it a that the second set on acceptance sampling. So, this will be our coverage.

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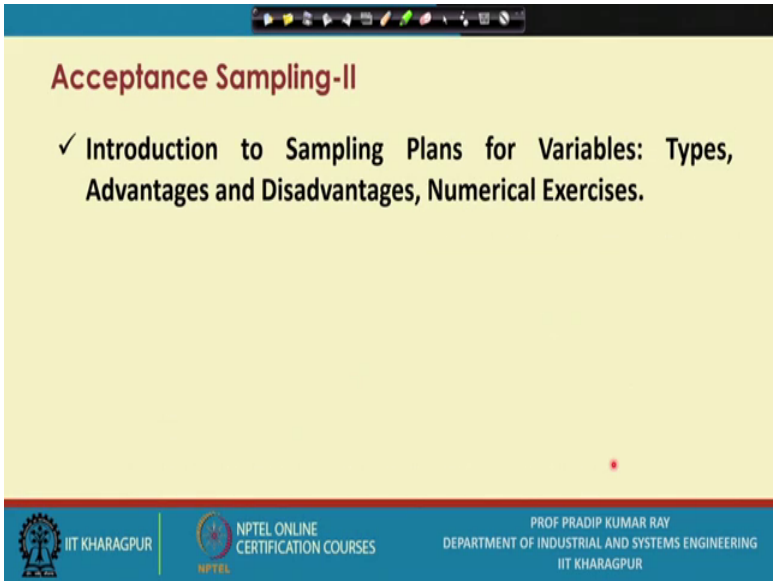

Now, so during this session I will refer to the introduction to sampling plans for the variables. What are the different types of the sampling plans you come across? What are the advantages? What are the disadvantages? And I will try to explain the concept with respect to examples by this time you may be knowing that, what is a variable?

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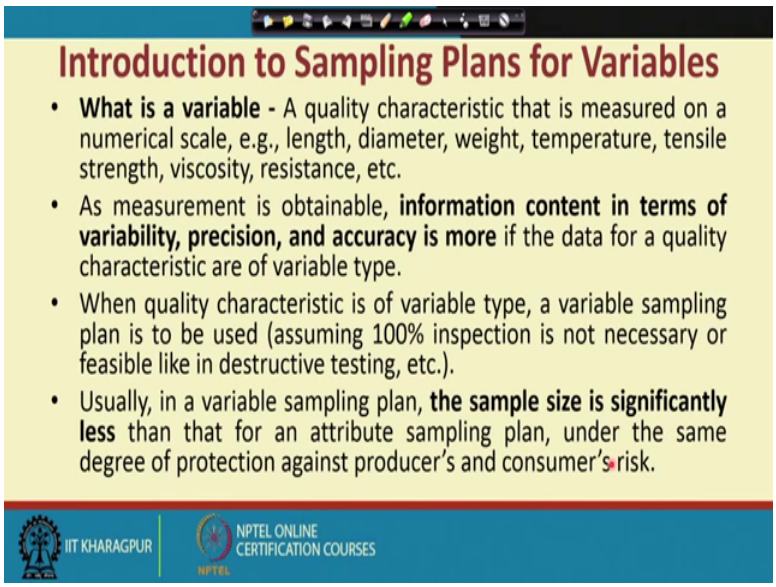

We have been saying that whenever you deal with the quality aspects in a process, in a product or in a in a system two kinds of the data you come across. Either it could be an attribute data or it could be a variable data. So, right now we are dealing with the variables data. So, you must know what is a variable so, with respect to a quality characteristic what we say that the variable when whenever you say that the quality characteristic is a variable, which say that it is measured on a numerical scale. Is it ok?

That means, there are some a numerical values addressed to it. So, there are hundreds of hundreds and thousands of examples of for the variable type quality characteristics.

So, what are these examples one is the length say diameter these are all measurable weight temperature tensile strength viscosity resistance etcetera. So, how do you get this the numerical values because you need to use some say the measurement system or say measuring instruments is it ok and related to a measuring instrument you have a say the three characteristics. One is definitely the precision of the measuring instrument, the second one is actually the accuracy and the third one is a resolution and whenever you deal with see now the numerical data or the variables data, make sure that the measurement error is at the minimum level and the concept of measurement error we have already explained and how true a propose a capability system for measurement or capability system for measurement we have already explained is it ok.

So, when you deal with when we dealt with the topic called process capability analysis. So, whenever you deal with the variables data, you please keep in mind that there could be measurement errors and you must have a system protecting against this measurement error. Now as measurement is obtainable; that means, here is a quality characteristics you have the measurement system and that is why these measurements are obtainable you can get those values. Information content in terms of variability precision and accuracy is more if the data for a quality characteristic are of variable type. Now, this point is to be noted; that means, the actual values are given.

Suppose that the diameter of a shaft now some fifteen such values you can collect say if 20.12, 20.50 say 19.95 and so on so on. So, these values you collect now from these values what you can do immediately, if you analyze this data you can get the idea about the variability, you can get the idea about the precision; that means, the repeatability and you also get an idea about the accuracy that a how the you know the mean value or the average value is different from the desired value is it. So, that is the target value.

So, that different actually is indicative of the accuracy so, what do you say that whenever you actually you generate to the variables data the information content is more; that means, your idea or your assessment of the quality characteristics will be more precise. When a quality characteristic is of a variable drive, a variable a variable sampling plan is to be used, you cannot use a attribute sampling plans.

So, what we are assuming over here again that the hundred percent inspection is not necessary or feasible likely destructive testing etcetera. So, you know what is hundred percent inspections so, hundred percent inspection in some for the critical components definitely will opt for. But there are many situations where hundred percent inspection is not necessary so, why do you end of the loose time and why do you lose you know say you know say precious time to on inspection. So, you go for inspection, but if you go for sampling inspection; obviously, you know you can take a decision; a decision is highly reliable in most of the cases ok.

So, you opt for a quality you know the variables data usually in a variable sampling plan the sample side is significantly less, than that for attribute sampling plan. This is another advantage like say when you delude the attributes the data; obviously, the information content is less, but whereas, if you deal with the variables data the information content is more, that is why now you may you may deal with the situation with the lesser number of units. That is why the sample five is significantly less so, if for an attribute sampling plan, the sample size n is equals to 50 for an equivalent you know the variable sampling plan right it may we as small as say seven or eight is it so, that is an advantage. So, under the same degree of protection against producers and consumer risk is it so, this is the point to be understood very clearly.

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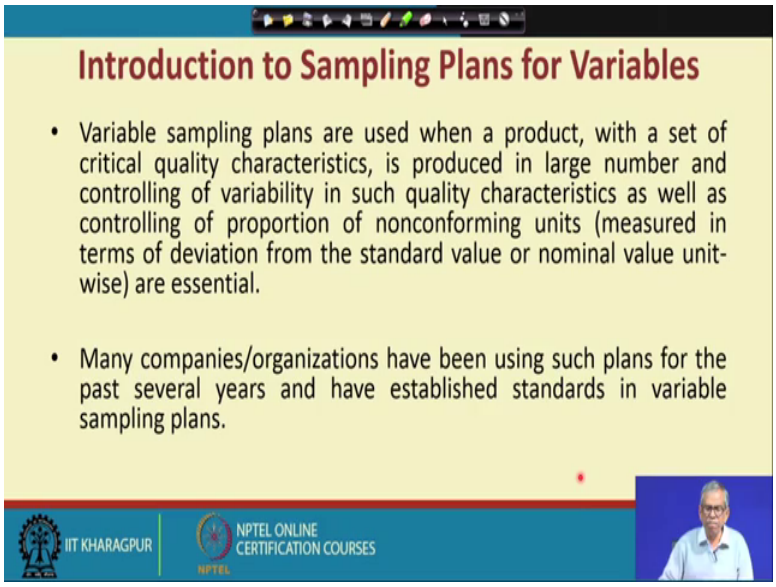

Now, the next important point is variable sampling plans are used when a product with a set of critical quality characteristics is produced in large number so, in which situation you have to adopt a variable sampling plan. So, you must have very clear understanding and controlling of variability in such quality characteristics as well as concluding of proportion of non confirming units measures in terms of deviation from the standard value or the nominal value unit wise are essential. So, that the two conditions I have specified one is that the controlling of variability

Now, how do you measure the variability or say there are different kinds of say different types of measures of the dispersion or the variability like the best possible measure is; obviously, the standard deviation or the variants so, you need to you can control this variability by using variable sampling plan. So, that is your sole objective

The second objective is as I have already pointed out by using a variable sampling plan related to a particular quality characteristics, you can you can also control the proportion on confirming related to that quality characteristics. So, how do you say that with respect to a particular unit it is non conformance; that means, you know you get a value and the

actual value is significantly different from the target value so, that is the deviation if deviation is significant you say a yes you are unable to meet the target the particular unit is unable to meet the target and that is why it is considered to be non confirming or non conformity. Many companies organizations both in manufacturing as well as you know the service sectors have been using such plans for the past several years ok.

So, if you refer to the case studies we will find in the text books we will find that the there are case studies even some 60, 70 years back on the application of say the variable sampling plans. In the, an actual manufacturing situation or in a service organization and already the standards related to variable sampling plans have already been developed.

And this is again you know whether these standards there are three equivalent the standards can opt for, One is definitely the military standards MIL STD 414 and which is the civilian standard is ANSI, ASQC, a jet 1.9, you refer to and the equivalent ISO 9000 standard is ISO 3951 is it ok. So, like we have already studied jet 1.4 standard. Similarly, if you require to study you know the standards for the variable sampling plans we always refer to this standards which already are mentioned.

Now, there are two main purposes of using variable sampling plans and these two main purposes you must know before you try to classify the existing variable sampling plans. So, whenever you try to you know the classify the variable sampling plans in a two identify what are the another types of sampling plans; you have a you can you can come across so, there are two types. So, the first type is based on for which purpose you are you are using a variable sampling plan and here the purpose is controlling a process parameter so, that is referred to is a type one variable sampling plans.

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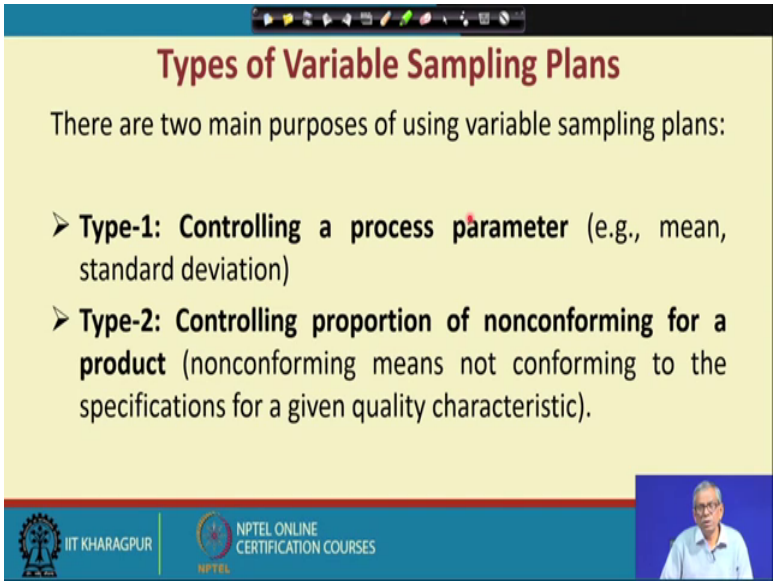

And under this there are varieties and what is the process parameter process parameter is mean all the standard deviation. So, it so among there could be other process parameters

also, but in this context we will be referring to the mean or the standard deviation. So, we will when we will we will explain with respect to some data or some numerical problems. In majority of the cases is referring to mean as a as the process parameters. Now, the second type is actually is used the type two variable sampling plan is used to control the proportion nonconfirming for a product.

And; obviously, when you say the proportion nonconfirming is defined proportions non confirming with respect to a quality characteristics. So, here what we assume that is quality characteristic used in a variable is it so, how do you define this nonconfirming? Nonconfirming means not confirming to the specifications; that means, given a particular quality characteristics you must know what is its specifications. Is it ok? Whether it is the upper specification limit or the lower specification limit or it is a double specification limits or not so, for a given quality characteristics right. So, you have type one variable sampling plan you have also type two variable sampling plan.

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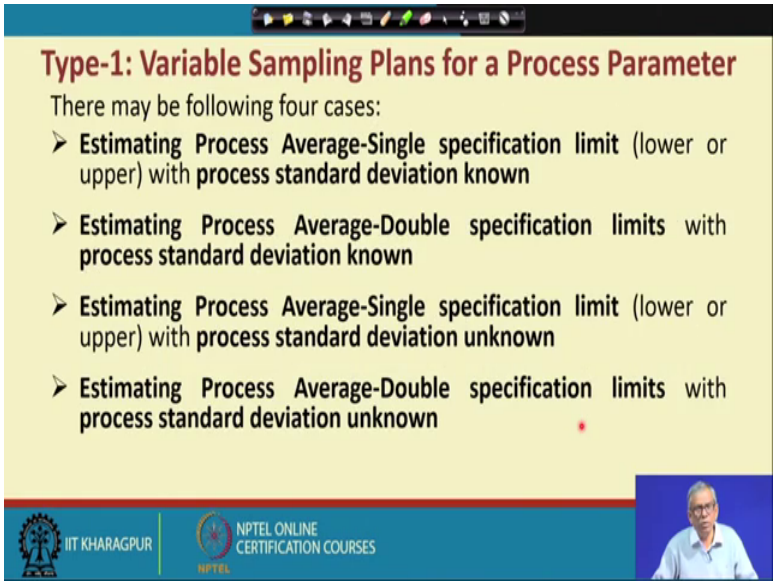

Now, under type one variable sampling plans, to control a process parameter there could be a four cases. So, let me just explain all these four cases one by one. Here you develop a sampling plan and the purpose is estimating process average. Stair has already pointed out that, among sub say you know the various the types of now the process parameters that you may come across. The first you know the process parameters which is very you know always almost always you are refer to as a process parameter and if that is as a starting process parameter that is the average or the mean.

So, estimating process average is very important and now the kinds of quality characteristics that you come across that is a single specification limit type. Either lower or the upper I have already explained. I have already given several examples of say the lower specification limit case or the upper specification limit case ok.

Like say the lower specification limit case like so, the tensile strength is it must be say at least say 3000 kg per centimeter square or a upper specification limit, that the temperature of the oven must not cross say 1200 degree celsius is it. So, there are different examples of upper specification limit as well as the lower specification limit. Now, here the next condition we will impose whether the process standard deviation is known or not so, the first case we assume that the process standard deviation is known is it. So, the sufficient say the number of data points already you have collected and you say that there is a goods estimate of the process standard deviation.

So, if you say it is in a good estimate you may assume it to be a case where the process standard deviation is known or the population standard deviation is known. The next important case is estimating process average, but you are dealing with the double specification limits. Is it ok? Like say the quality characteristic is the diameter of a shaft and you have the upper specification limit the lower specification limit. So, the tolerance the range is 20 plus minus 0.1; that means, 19 between 19.9, that is the lower specification limit and the upper specification limit is 20.1 so, this is the case you may come across and that sort of quality characteristics you are dealing with and again we assuming with the process standard deviation is known.

Now, the third case is you are estimating the process average single specification limit lower or upper its process standard deviation unknown. Now, there are cases that means, it is a absolute training situation or the process has not yet become the stable whatever may be the reasons with respect to that particular quality characteristics under consideration. So, what do you say that as of now that you know the process standard deviation is not known is it ok? So, you have to wait so, but that you have to wait to get sufficient number of data points and then only you can have a good estimate of the process standard deviation. But you know there is an urgency and if you are asked to you know the propose the variable sampling plan. So, if you face this sort of situation what do you do?

So; obviously, you are you need to refer to this particular case 3. Now, the last one is that is the case 4; that is you are suppose to estimate the process average; that means, you must have a control on the process average. The quality characteristic is a double specification limits drive and with process standard deviation unknown. So, these are the 4 cases we will be dealing with in subsequent lectures. Now, let us talk about the type 2 variable sampling plans.

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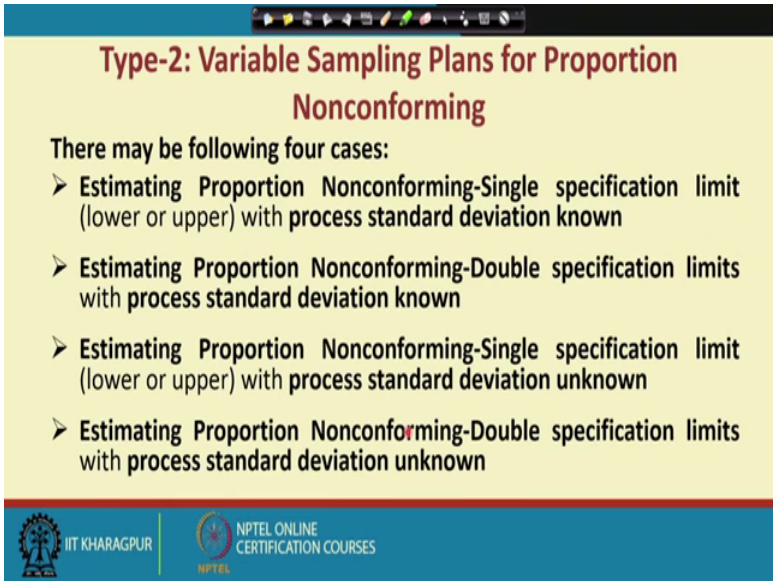

Now as I, have already pointed out that the type two variable sampling plans are used for controlling the proportion and confirming and the value of a quality characteristic or say value of a particular say the unit related to a particular quality characteristic; you measure. Then you compare it with you know the preferred value or the target value or whether that value is within the specification limit is known. Within it is lying within the specification limit or not if it lies within the specification limit; obviously, that particular limit is consider to be confirming. If it is not lying within the specification limits then; obviously, that particular limit is considered as nonconfirming. Now, when we deal with the large number of data points so, among say the all the points you say all the in the units we inspect. How many are confirming to the specifications? And how many not?

So, from this you know the data you can calculate the percent on confirming and you design the sampling plan in such a way that you can control this value so,that is the purpose. So, estimating proportion nonconfirming for controlling proportion nonconfirming single specification limit case either lower or upper with process standard deviation known. So, like the first case. What is the second one? Estimating proportion non confirming double specification limits case with processed under deviation known is it. That means, already you are running the system or the sufficient the sufficiently longer time and you have a huge database and you have very good estimate for the standard deviation.

Estimating proportion nonconfirming, but the process standard deviation unknown. So, what could be the possible reasons of the process standard deviation not known; that means, what are the possible results you must know and; obviously, you know unknown process standard deviation case is not a desirable situation. So, as quickly as possible you must adopt a good estimate for measuring a good estimate for the process standard deviation and as the situation unfolds we will be getting more number of data points and

we will be ultimately we will be reaching a condition where the process standard deviation is assume to be known ok.

So, single specification limit case, but here it is a new situation so, this problem this particular case also you come across and similarly this is a case like say estimating proportion non confirming double specification limits with process standard deviation unknown.

Now, so that means, in the first type there are four cases and similarly for the second type again you may have four cases. So, what do you trying to do; that means, when you are designing the variable sampling plan so, the this design states or the design procedure we will explain in subsequent lecture sessions minutely very elaborately we will explain and so, you will you will come to know, that the different procedures are adopted and the and there are certain the procedures which are which can be generalized. There are certain procedures which are you know the case specific so; the total you know the scenario is this.

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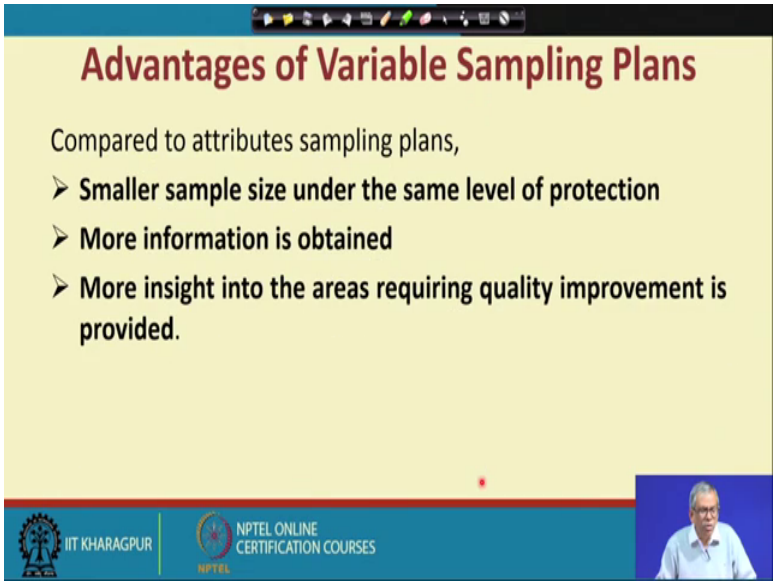

Now, I will just before I close this lecture session I will just mention, What are the advantages of a variable sampling plan? There are three main advantages compared to an attribute sampling plan right.

So, compare to an attribute sampling plan a various a variable sampling plan may have a smaller sample size because the information content is more primarily that is the that is the reason under the same level of protection so, protection against producers risk as well as the consumer risk.

The second advantage is more information is obtained because we will be getting all the all the actual values; that means, the measurements we will be getting and you can determine like said the you know the distribution of the main, the distribution of the

standard deviation, the variability accuracy. So, all these the detailed information you will have in course of time so, the more information is obtained so, you are in an advantageous position and more inside into the areas requiring quality improvement.

So, this is an important point in fact, in many time if you adopt variable sampling plan you will find, that the next step could be why do not you adopt quality improvement say the tools and techniques.

So, if we find that one particular at a one particular work place related to a few quality characteristics you know there are applications or there are say the use of the variable sampling plans. In majority of the cases it will lead to a situation where you know the quality improvement initiatives are taken is it. So, what is the basic reason; that means, you will have a more insights into the areas; that means, into the areas requiring quality improvement; that means, the causes of variations will be known and what are the you know the preventive measures or the design measures we have to take for quality improvement that you will come to know.

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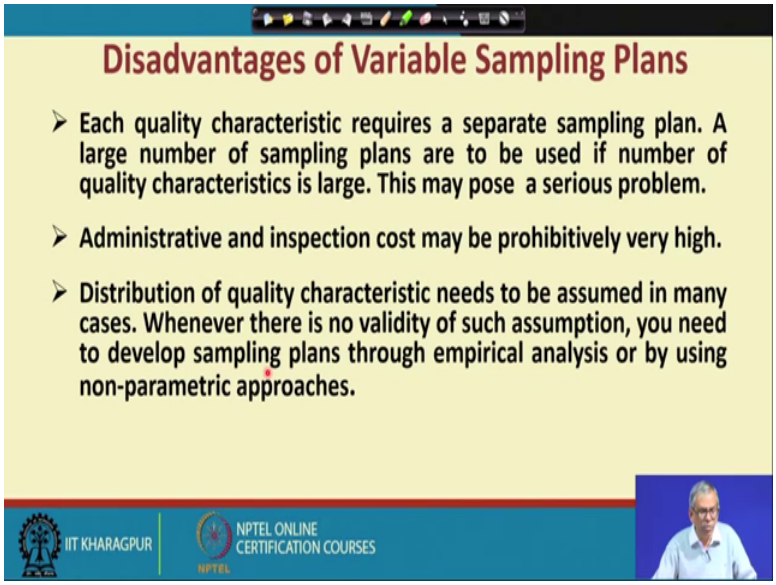

But there are certain disadvantages or demerits which we cannot avoid. Each quality characteristics requires a separate sampling plan. So, a large number of sampling plans are to be used if the number of quality characteristic is large. Since, that is most likely to happen in majority of the cases, suppose you deal with say in a repetitive manufacturing scenario like say you know the batch production scenario. What do you find? That you will be dealing with hundreds and thousands of components.

An each components we will have the different types of quality characteristics and suppose even if you 10 percent of such quality characteristics are to be are to come under the variable sampling plans. So, you can well imagine that how many you know the quality characteristics we will be dealing with so, this may this may be problematic so,

this may cause a serious problem. So, you must have sufficient man power you must have sufficient time to develop and use a variable sampling plan.

So, what do you try to do you try to focus on only the critical quality characteristics so, you have to privatize. Administrative and inspection cost may be primitively very high because we need to use the measuring instruments certain cases you know you can use certain gages, but majority of the cases you have to use and all the measuring instruments. So, the administrative and inspection cost of may be very high and when you adopt when you use a variable sampling plan; that means, you also must know what is the procedure you employ is it ok.

So, distribution of quality characteristic needs to be assumed in many cases. We will find very soon, that when you develop a variable sampling plan you assume a normality. Whenever there is no validity of such functions we need to develop a some something plans three empirical analysis or by using non parametric approaches. So, there are when you refer to the text books we will find that the variable sampling plans have been designed which the assumptions of normality; that means, quality characteristic is normal.

But in certain cases in majority of the cases may be you may come across the situation where this the normality of functions may not be may not be valid so, what do you do? Obviously, you know you may opt for different kinds of non parametric approaches.

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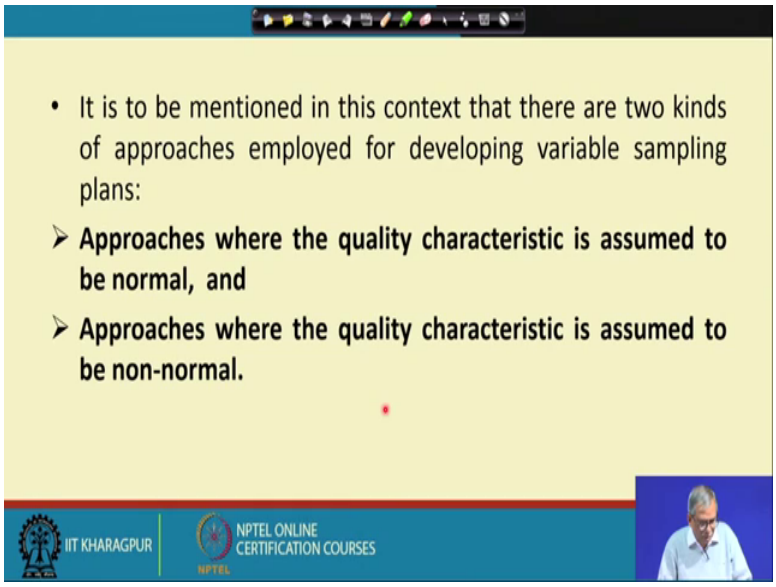

So, these are the disadvantages so, it is to be mentioned in this context. There are two kinds of approaches employed for developing variable sampling plans. Approaches where the quality characteristics assume to be normal and approaches where the quality characteristics assume to be non-normal.

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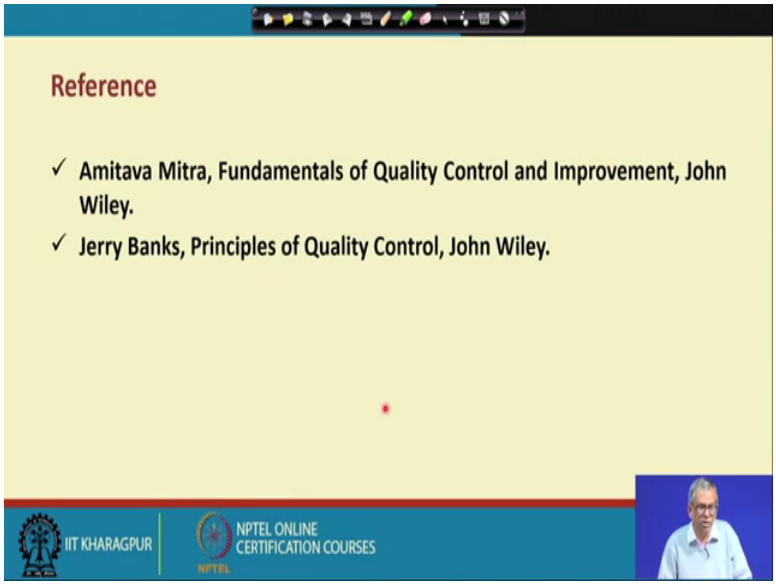

Is it ok? So, I conclude this session and in the next session I will be referring to say the variable sampling plans, but the main objective is to control the process parameter.