

## **BASIC CONCEPTS**

The basic terms and definitions which are essential to develop this dissertation are presented in Basic concepts.

### **ACCEPTANCE SAMPLING**

Acceptance sampling is the methodology that deals with procedures by which decisions to accept or not to accept are based on the results of the inspection of samples.

The following definitions are from MIL-STD-1235 C (1988)

### **MOVING PRODUCT**

Moving Product refers to product which is flowing past the inspection station. In the typical case the product moves on a conveyor belt or line; however it may be moved in tote boxes, buggies or other conveyances which are operated manually or by mobile materials handling equipment.

### **INSPECTION**

Inspection is the process of measuring, examining, testing or otherwise comparing the unit of product with the requirements.

### **ORIGINAL INSPECTION**

Original inspection is the first inspection of a particular quality of product as distinguished from the inspection of product which has been resubmitted.

## **SCREENING INSPECTION**

Screening inspection means the inspection of every unit of product for the defects concerned listed for an inspection station.

## **SAMPLING INSPECTION**

Sampling inspection means the inspection for the defects concerned where the units selected for inspection are selected by sampling.

## **CONFORMING UNIT**

Conforming unit is one which meets the acceptance criteria established for the characteristic being considered.

## **NON-CONFORMING UNIT**

Non-conforming unit is one which does not meet the acceptance criteria established for the characteristic being considered.

## **INSPECTION BY ATTRIBUTES**

Inspection by attributes is inspection where by certain characteristics of units of products are inspected and classified simply as conformity or not conforming to the specified requirements.

## **PROCESS AVERAGE**

The percent defective of product submitted by the supplier for original inspection. The phrases “process average” and “percent defective of submitted product” are used interchangeably.

## **CONTINUOUS SAMPLING INSPECTION**

Continuous sampling inspection is the examination or testing of units of product as they move past an inspection station. Only those units of product found by

the inspector or screening crew to be non-conforming are corrected or replaced with conforming units. The rest of the uninspected units as well as units found to be conforming are allowed to continue down the production line as conforming.

#### **CLEARANCE NUMBER (*i*)**

The number of consecutive conforming (defect free) units required to adjust inspection action.

#### **SAMPLING RATE (*f*)**

The desired ratio between the number of units of product randomly selected and inspected at a inspection station during period of sampling inspection. The procedure used in selecting the sampling units should give each unit of product presented during periods of sampling inspection an equal chance of being selected and inspected.

#### **AVERAGE FRACTION INSPECTED (AFI)**

The fraction of product that will be inspected in the long run if the process average is a particular value.

Definitions from American National Standards Institute / American Society for Quality Control (ANSI / ASQC) Standard A2 (1987) are the following.

#### **PROCESS QUALITY**

A statistical measure for the quality of product from a given process. The most commonly used measure of process quality is the percentage or proportion of non-conforming units in the process.

#### **ACCEPTABLE QUALITY LEVEL (AQL)**

The maximum percentage or proportion of variant units in a lot or batch that, for the purpose of acceptance sampling, can be considered satisfactory as a process

average. In this thesis, the AQL is taken as an index for designing sampling plans at which the probability of acceptance is 0.95.

### **LIMITING QUALITY LEVEL (LQL)**

The percentage or proportion of variant units in a batch or lot which, for the purpose of acceptance sampling, the consumer wishes the probability of acceptance to be restricted to a specific low value. In this thesis, the LQL is considered as an index for designing sampling plans at which the probability of acceptance is 0.10.

### **PRODUCER'S RISK ( $\alpha$ )**

For a given sampling plan, the probability of not accepting a lot the quality of which has a designated numerical value representing a level which it is generally desired to accept.

### **CONSUMER'S RISK ( $\beta$ )**

For a given sampling plan, the probability of acceptance of a lot the quality of which has a designated numerical value representing a level which it is seldom desired to accept.

### **OPERATING CHARACTERISTIC (OC) CURVE**

Associated with each sampling plan there is an OC curve which portrays the performance of the sampling plan against good and poor quality. OC curve shows graphically the interrelationship of risks, probability and qualities of a given sampling plan.

### **OC CURVE FOR CONTINUOUS SAMPLING PLAN**

The operating characteristic of a continuous sampling plan is percent of product accepted during the sampling phase as a function of the quality level of the process.

### **AVERAGE OUTGOING QUALITY (AOQ)**

The expected quality of outgoing product following the use of an acceptance sampling plan for a given value of incoming product quality.

### **AVERAGE OUTGOING QUALITY LIMIT (AOQL)**

For a given sampling plan, AOQL is defined as the maximum of AOQ over all possible levels of incoming quality.

### **AVERAGE SAMPLE NUMBER (ASN)**

The average number of sample units per lot used for making decisions (acceptance or non-acceptance).

### **SAMPLING PLAN**

An acceptance sampling plan is “a specific plan that states the sample size or sizes to be used and the associated acceptance and non-acceptance criteria”.

### **CONTINUOUS SAMPLING PLAN (CSP)**

Continuous sampling plan is a plan intended for application to a continuous flow of individual units of product that

- i. involves acceptance or non-acceptance on a unit by unit basis and
- ii. uses alternate periods of screening inspection and sampling inspection depending on the quality of the observed product.

### **SINGLE LEVEL CONTINUOUS SAMPLING PLAN**

Single level continuous sampling is sampling inspection of consecutively produced units in which sampling inspection at fixed rate alternated with screening inspection depending on the quality of the observed product.

## **MULTI-LEVEL CONTINUOUS SAMPLING PLAN**

Multi-level continuous sampling is sampling inspection of consecutively produced units in which two or more sampling rates are alternated with screening inspection, or each other depending on the quality of observed product.

## **COMBINED CONTINUOUS LOT BY LOT ACCEPTANCE SAMPLING PLAN**

Combined continuous lot by lot acceptance sampling plan is a combination of continuous sampling plan and lot by lot inspection. It includes the screening inspection of consecutively produced units alternated by the lot by lot inspection.

## **MULTIFACETED CONTINUOUS LOT BY LOT ACCEPTANCE SAMPLING PLAN**

Multifaceted continuous lot by lot acceptance sampling plan is a complex combination of continuous sampling plan, lot by lot inspection and skipping inspection. It includes the screening inspection of consecutively produced units alternated by the lot by lot inspection and skipping inspection of lots.

## **POISSON DISTRIBUTION**

The probability mass function of the Poisson distribution is

$$P(X = x | \lambda) = \frac{e^{-\lambda} \lambda^x}{x!}, \quad \text{when } x = 0, 1, 2, \dots$$

$\lambda$  is the parameter of the Poisson distribution.

## **MARKOV-CHAIN**

A stochastic process is 'a random phenomenon that arises through a process which is developing in time in a manner controlled by probabilistic laws'. A Markov process is a stochastic process which represents observations on systems satisfying the condition that, 'the probability that the physical system will be in a given state at a given time may be deduced from a knowledge of its state at any earlier time'.

## TRANSITION MATRIX

A more complete characterization of the one-step transitions of a Markov chain with their corresponding probabilities provided in a matrix form is called the transition matrix (Parzen1962).

## SEARCH PROCEDURE

This procedure based on the properties of OC function, the parameters of a sampling plan are chosen, by trial and error, by varying parameters in a uniform fashion. An example for this approach is the one followed for determining the parameters of a single and double sampling plan by Guenther (1970). The primary advantage of this approach is that sample size need not be rounded. The disadvantage of this approach is that obtaining plans need good computing facilities.

This approach is followed in designing sampling plans in this thesis.

## GLOSSARY OF SYMBOLS USED

The following is the lists of symbols which are used in this dissertation.

$p$	-	fraction non-conforming from the process
$q$	-	$1-p$ , fraction conforming from the process
$P_a$	-	Probability of acceptance during the sampling phase in multilevel plans
$P$	-	Probability of acceptance during the sampling phase of the reference plan in combined plan and multifaceted plan
$i$	-	Clearance number of screening inspection
$i_1, i_2$	-	the number of units to be found conforming successively in order that the inspection will continue to be in the sampling mode.
$l$	-	Clearance number of lots in multifaceted plan

$f$	-	Sampling(skiping) rate in multilevel plan(multifaceted plan)
$f_1, f_2, f_3$	-	sampling rates in multi-level continuous sampling plan
$p_{ij}$	-	The probability that the process from state $S_i$ to $S_j$ in one step
$N$	-	Lot size of the reference plan (single sampling plan)
$n$	-	Sample size of the reference plan (single sampling plan)
$c$	-	Acceptance number
$U$	-	The expected number of units inspected during the periods of 100 percent inspection.
$V$	-	The expected number of units inspected during the periods of sampling inspection.
$AFI$	-	The average fraction of units inspected in the long run.