# Procedure and Tables for Construction and Selection of Chain Sampling Plan with Zero – Inflated Poisson Distribution

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**Abstract- ZIP Chain sampling plans (ChSP-1) allow significant reductions in sample size under conditions of a continuing succession of lots from a stable, trusted supplier. This paper presents procedures and tables for the construction of such plans and for selection of plans by specified properties. The performance of the chain sampling plan for variable fraction defective is also discussed by determining the operating characteristic function. This paper provides a method for the selection of ZIP chain sampling plan (ChSP-1) on the basis of different combinations of entry parameter, Tables for determining the associated AQL and AOQL are also given.**

**Keywords-Acceptable Quality Level (AQL), Average Outgoing Quality Limit (AOQL), Chain Sampling Plan (ChSP-1) with Zero – Inflated Poisson distribution.**

## 1. INTRODUCTION

Dodge (1955) has proposed Chain Sampling Plan in which Chain Sampling Plan allows significant reduction in sample size and the condition for a continuing succession of lots from a stable and trusted supplier. Soundararajan (1978) has studied Chain Sampling Plan –1 involving designing of Chain Sampling Plan indexed through AQL and AOQL. The main thrust of this paper is to account for the possibility of dependence among the items of a sample. The Zero-Inflated Poisson (ZIP) distribution can be used as the appropriate probability distribution to data consisting many over dispersed zeros. ZIP distribution has been used in a wide range of disciplines such as Agriculture, Epidemiology, Econometrics, Public health, Process control, Medicine, Manufacturing, etc. Some of the applications of ZIP distribution can be found in Bohning et al. (1999) and Lambert (1992). Construction of control charts using ZIP distribution are discussed in Sim and Lim (2008). Single sampling plans by attributes under the conditions of Zero – inflated Poisson distribution are determined by Loganathan and Shalini (2013), Suresh and Latha (2002) have given a procedure and tables for the selection of Bayesian chain sampling plan-1.Palanisamy and Latha,(2018) have discuss about the Construction of Bayesian Single Sampling Plan by Attributes under the Conditions of Gamma Zero – Inflated Poisson Distribution. Palanisamy and Latha,(2018) have given the procedure for the "Construction And Selection Of Chain Sampling Plan With Zero – Inflated Poisson Distribution.

A study of construction of chain sampling plan (ChSP-1), corresponding to given value of the acceptable quality level (AQL) and the overall average outgoing quality limit (AOQL) is presented. Comparison with ChSP-1plan with Poisson model for given AQL and AOQL values.

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## II CHAIN SAMPLING PLAN (ChSP-1)

For situation in which testing is destructive or very expensive sampling plans with small sample sizes are usually selected. These small sample size plans often have acceptance number of zero. Plans with zero acceptance numbers are often undesirable, however, their OC curves are convex throughout, which means that the probability of lot acceptance begins to drop very rapidly as the lot fraction defective becomes greater than zero. This is often unfair to the producer, and in situations where rectifying inspection is used requires the consumer to screen a large number of lots which are essentially of acceptable quality.

Dodge (1955) suggested an alternate procedure, known as chain sampling that might be a substitute for ordinary single-sampling plans with zero acceptance numbers in certain circumstances. Chain sampling plans make use of the cumulative results of several preceding lots. The conditions for application and the operating procedure for the ChSP-1 plan are given as follows:

## III CONDITIONS FOR APPLICATION OF CHSP-1

The cost of destructiveness of testing is such that a relatively small sample size is necessary, although other factors make a large sample desirable.

The product to be inspected comprises a series of successive lots produced by a continuing process.

Normally lots are expected to be of essentially the same quality.

The consumer has faith in the integrity of the producer.

## IV OPERATING PROCEDURE

The plan is implemented in the following way:

1. For each lot, select a sample of n units and test each unit for conformance to the specified requirements.
2. Accept the lot if d (the observed number of defectives) is zero in the sample of n units, and reject if d > 1.
3. Accept the lot if d is equal to 1 and if no defectives are found in the immediately preceding i samples of size n.

Dodge (1955) has given the operating characteristic function of ChSP-1 as

$$Pa(p) = P0 + P1(P0)i$$

Where Pi = probability of finding i nonconforming units in a sample of n units for i = 0.1.

The Chain sampling Plan is characterized by the parameters n and i.

When i= ∞ , the OC function of a ChSP -1 plan reduces to the OC function of the Single Sampling Plan with acceptance number zero and when i = 0, the OC function of ChSP-1 plan reduces to the OC function of the Single Sampling Plan with acceptance number 1.

## V OPERATING CHARACTERISTIC FUNCTION OF ZIP MODEL

The OC function is defined as

$$P_a(p) = P[X \le c] \qquad (1)$$

Where p is the fraction defective

The numbers of defects are zero for many samples may consider Zero – inflated Poisson probability distribution. The probability mass function of the ZIP $(\varphi,\lambda)$ distribution is given by Lambert (1992) and McLachlam and peel (2000)

$$P(X = x \mid \phi,\lambda) = \phi f(x) + (1-\phi)P(X=x \mid \lambda) \qquad (2)$$

Where

$$f(x) = \begin{cases} 1, & if\ x = 0 \\ 0, & if\ x \neq 0 \end{cases}$$

and

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

The probability mass function can also be expresses as

$$P(X = x \mid \varphi, \lambda) = \begin{cases} \varphi + (1-\varphi)e^{-\lambda} & when\ \ x = 0 \\ (1-\varphi)\dfrac{e^{-\lambda}\lambda^x}{x!}, & when\ \ x = 1,2,\ldots,0 < \varphi < 1,\ \lambda > 0 \end{cases}$$

In this distribution, φ may be termed as the mixing proportion. φ and λ are the parameters of the ZIP distribution. According to McLachlan and Peel (2000), a Zip distribution is a special kind of mixture distribution.

The OC function of ZIP $(\varphi,\lambda)$ distribution can be defined as

$$P_a(p) = \sum_{x=0}^{c} P(X = x \mid \phi,\lambda)$$

$$P_a(p) = \varphi + (1-\varphi)e^{-\lambda} + \sum_{x=1}^{c}(1-\varphi)\frac{e^{-\lambda}\lambda^x}{x!},$$

$$x > 0,\ \lambda > 0, 0 < \varphi < 1). \qquad (3)$$

Where λ = np

## VI CHAIN SAMPLING PLANS (CHSP-1) WITH ZERO-INFLATED POISSON DISTRIBUTION

The probability of acceptance for chain sampling plan of type ChSP- 1 based on Zero- inflated Poisson distribution

$$P_a(p) = (\varphi + (1-\varphi)e^{-np}) + (\varphi + (1-\varphi)e^{-np})^{i+1}$$
$$+ (1-\varphi)e^{-np}\, np\, (\varphi + (1-\varphi)e^{-np})^{i} \qquad (4)$$

## VII AVERAGE OUTGOING QUALITY LIMIT (AOQL)

Average outgoing Quality, is the average quality of outgoing product including all accepted lots or batches, plus all rejected lots or batches after the rejected lots or batches have been effectively 100 percent inspected and all non-conformities replaced by non-defectives. The maximum value on the AOQ curve corresponds to the highest average percent defective or the lowest average quality for the sampling plan. It is called the Average outgoing quality limit (AOQL). Average Outgoing Quality (AOQ) is approximately obtained by $AOQ = p P_a(p)$.

For ChSP–1 with Zero – Inflated Poisson distribution

$$nAOQ = (np\varphi + np(1-\varphi)e^{-np}) + np(\varphi + (1-\varphi)e^{-np})^{i+1}$$
$$, + (1-\varphi)e^{-np}(np)^2\, (\varphi + (1-\varphi)e^{-np})^{i} \qquad (5)$$

Differentiating AOQ with respect to np and equating to 0, the value of Average Outgoing limit (AOQL) can be obtained by solving the equation.

$$\varphi + (1-\varphi)e^{-np}((\varphi + (1-\varphi)e^{-np})^{i} + np(1-\varphi)e^{-np}$$
$$(1 - np - i)\ (\varphi + (1-\varphi)e^{-np})^{i-1} - (np)^2 e^{-np}(1-\varphi)^2$$
$$i(\varphi + (1-\varphi)e^{-np} + 1)) - np(1-\varphi)e^{-np} = 0 \qquad (6)$$

From Equation (6) the values of np (=npm) can be calculated for different values of φ and i . Substituting npm in equation (5) nAOQL values are obtained.

**Table 1: Chain Sampling Plan under Zero - Inflated Poisson**

| ·· | Pa(p) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **i** | **0.99** | **0.95** | **0.50** | **0.10** | **0.05** | **0.01** |
| | 1 | 0.6343 | 0.6691 | 1.2014 | 2.5486 | 3.1605 | 4.6676 |
| | 2 | 0.4658 | 0.4937 | 0.9494 | 2.3343 | 3.0074 | 4.6156 |
| | 3 | 0.3774 | 0.4019 | 0.8334 | 2.3067 | 2.9981 | 4.6151 |
| | 4 | 0.3214 | 0.3438 | 0.7711 | 2.3038 | 2.9976 | 4.6151 |
| 0.0001 | 5 | 0.2822 | 0.3031 | 0.7361 | 2.3035 | 2.9976 | 4.6151 |
| | 6 | 0.2528 | 0.2727 | 0.7163 | 2.3034 | 2.9976 | 4.6151 |
| | 7 | 0.2299 | 0.2490 | 0.7054 | 2.3034 | 2.9976 | 4.6151 |
| | 8 | 0.2114 | 0.2299 | 0.6995 | 2.3034 | 2.9976 | 4.6151 |
| | 9 | 0.1962 | 0.2141 | 0.6964 | 2.3034 | 2.9976 | 4.6151 |
| | 1 | 0.6350 | 0.6699 | 1.2033 | 2.5583 | 3.1795 | 4.7640 |
| | 2 | 0.4663 | 0.4943 | 0.9508 | 2.3426 | 3.0248 | 4.7101 |
| | 3 | 0.3778 | 0.4023 | 0.8346 | 2.3149 | 3.0154 | 4.7095 |
| | 4 | 0.3218 | 0.3441 | 0.7722 | 2.3119 | 3.0149 | 4.7095 |
| 0.001 | 5 | 0.2825 | 0.3034 | 0.7370 | 2.3116 | 3.0149 | 4.7095 |
| | 6 | 0.2531 | 0.2730 | 0.7172 | 2.3116 | 3.0149 | 4.7095 |
| | 7 | 0.2302 | 0.2492 | 0.7063 | 2.3116 | 3.0149 | 4.7095 |
| | 8 | 0.2117 | 0.2301 | 0.7004 | 2.3116 | 3.0149 | 4.7095 |
| | 9 | 0.1964 | 0.2143 | 0.6973 | 2.3116 | 3.0149 | 4.7095 |
| | 1 | 0.6424 | 0.6779 | 1.2224 | 2.6612 | 3.3936 | 4.2822 |
| | 2 | 0.4715 | 0.4998 | 0.9646 | 2.4307 | 3.2197 | 4.1127 |
| | 3 | 0.3819 | 0.4067 | 0.8462 | 2.4013 | 3.2093 | 4.0475 |
| | 4 | 0.3251 | 0.3478 | 0.7827 | 2.3982 | 3.2088 | 4.0209 |
| 0.01 | 5 | 0.2854 | 0.3066 | 0.7469 | 2.3979 | 3.2088 | 4.0102 |
| | 6 | 0.2557 | 0.2758 | 0.7268 | 2.3978 | 3.2088 | 4.0102 |
| | 7 | 0.2325 | 0.2518 | 0.7156 | 2.3978 | 3.2088 | 4.0102 |
| | 8 | 0.2138 | 0.2324 | 0.7097 | 2.3978 | 3.2088 | 4.0102 |
| | 9 | 0.1983 | 0.2164 | 0.7065 | 2.3978 | 3.2088 | 4.0102 |
| | 1 | 0.6775 | 0.7156 | 1.3158 | 3.3414 | 3.2978 | 4.3003 |
| | 2 | 0.4961 | 0.5262 | 1.0316 | 2.9914 | 3.1290 | 4.2067 |
| | 3 | 0.4011 | 0.4274 | 0.9022 | 2.9493 | 3.0636 | 4.0598 |
| | 4 | 0.3411 | 0.3651 | 0.8331 | 2.9449 | 3.0366 | 4.0305 |
| 0.05 | 5 | 0.2992 | 0.3216 | 0.7943 | 2.9444 | 3.0258 | 4.0278 |
| | 6 | 0.2679 | 0.2891 | 0.7725 | 2.9444 | 3.0258 | 4.0265 |
| | 7 | 0.2435 | 0.2638 | 0.7605 | 2.9444 | 3.0258 | 4.0265 |
| | 8 | 0.2238 | 0.2434 | 0.7541 | 2.9444 | 3.0258 | 4.0265 |
| | 9 | 0.2076 | 0.2266 | 0.7507 | 2.9444 | 3.0258 | 4.0265 |
| | 1 | 0.7169 | 0.7580 | 1.4263 | 4.7573 | 4.3167 | 5.3193 |
| | 2 | 0.5233 | 0.5556 | 1.1095 | 4.6560 | 4.1290 | 5.1486 |
| | 3 | 0.4224 | 0.4504 | 0.9667 | 4.5253 | 4.0260 | 5.0817 |
| | 4 | 0.3588 | 0.3843 | 0.8910 | 4.5123 | 4.0235 | 5.0538 |
| 0.09 | 5 | 0.3144 | 0.3381 | 0.8486 | 4.5110 | 4.0220 | 5.0424 |
| | 6 | 0.2813 | 0.3038 | 0.8248 | 4.5108 | 4.0220 | 5.0424 |
| | 7 | 0.2555 | 0.2770 | 0.8118 | 4.5108 | 4.0220 | 5.0424 |
| | 8 | 0.2348 | 0.2555 | 0.8047 | 4.5108 | 4.0220 | 5.0424 |
| | 9 | 0.2177 | 0.2378 | 0.8011 | 4.5108 | 4.0220 | 5.0424 |

Table: 2 are used to construct chain sampling plan with ZIP through two points. The two points generally selected are ( $p_1$ ,1−~ ), ( $p_2$, ) with~ - Producer's Risk, - Consumer Risk. Table 2 in the column for the appropriate given ~ and that is equal to or just less than the desired ratio. Corresponding to the selected tabular values of $p_2 / p_1$ are $np_1$ and ***i.*** the sample size is determined by dividing $np_1$ by $p_1$ and ***i*** is read directly.

As an example, to find the chain sampling plan for $p_1$ = 0,005, ~ =0.05 and $p_2$ = 0.10, =0.10 compute $p_2/p_1$ = 0.10/0.005 = 20, enter the table 2 for ~ = 0.05 and 0.10 , and select the values of the ratio $p_2/p_1$ in the column for ~ = 0.05 and = 0.10equal to or just less than 20.the values 18.969, which has associated with a values of $np_1$ =0.2378 and the values of ·· = 0.09 ,i = 9.The sample size for the desired plan is then $np_1/p_1$ = 0.2378 / 0.005 = 47.56 which , when rounded off to the next higher integer, is 48.Hence the required plan (48,5)

**Table 2: Values of $np_1$ , ¨ and i for construction chain sampling plan, whose OC curve is required to pass Through the Two points ( $p_1$ ,$1-\sim$ ) and ( $p_2$ , )**

| | | Value of ($p_2/p_1$)for | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| .. | i | ~ = 0.05 <br> = 0.10 | ~ = 0.05 <br> = 0.10 | ~ = 0.05 <br> = 0.10 | $np_1$ | .. | i | ~ = 0.05 <br> = 0.10 | ~ = 0.05 <br> = 0.10 | ~ = 0.05 <br> = 0.10 | $np_1$ |
| | 1 | 3.809 | 4.724 | 6.976 | 0.669 | | 6 | 8.694 | 11.635 | 14.540 | 0.276 |
| | 2 | 4.728 | 6.092 | 9.349 | 0.494 | | 7 | 9.523 | 12.743 | 15.926 | 0.252 |
| | 3 | 5.739 | 7.460 | 11.483 | 0.402 | | 8 | 10.318 | 13.807 | 17.256 | 0.232 |
| | 4 | 6.701 | 8.719 | 13.424 | 0.344 | | 9 | 11.080 | 14.828 | 18.531 | 0.216 |
| 0.0001 | 5 | 7.600 | 9.890 | 15.226 | 0.303 | | 1 | 4.669 | 4.608 | 6.009 | 0.716 |
| | 6 | 8.447 | 10.992 | 16.924 | 0.273 | | 2 | 5.685 | 5.946 | 7.994 | 0.526 |
| | 7 | 9.251 | 12.039 | 18.535 | 0.249 | | 3 | 6.901 | 7.168 | 9.499 | 0.427 |
| | 8 | 10.019 | 13.039 | 20.074 | 0.230 | | 4 | 8.066 | 8.317 | 11.039 | 0.365 |
| | 9 | 10.759 | 14.001 | 21.556 | 0.214 | 0.05 | 5 | 9.155 | 9.409 | 12.524 | 0.322 |
| | 1 | 3.819 | 4.746 | 7.112 | 0.670 | | 6 | 10.185 | 10.466 | 13.928 | 0.289 |
| | 2 | 4.739 | 6.119 | 9.529 | 0.494 | | 7 | 11.161 | 11.470 | 15.263 | 0.264 |
| | 3 | 5.754 | 7.495 | 11.706 | 0.402 | | 8 | 12.097 | 12.431 | 16.543 | 0.243 |
| | 4 | 6.719 | 8.762 | 13.686 | 0.344 | | 9 | 12.994 | 13.353 | 17.769 | 0.227 |
| 0.001 | 5 | 7.619 | 9.937 | 15.522 | 0.303 | | 1 | 6.276 | 5.695 | 7.018 | 0.758 |
| | 6 | 8.467 | 11.044 | 17.251 | 0.273 | | 2 | 8.380 | 7.432 | 9.267 | 0.556 |
| | 7 | 9.276 | 12.098 | 18.898 | 0.249 | | 3 | 10.047 | 8.939 | 11.283 | 0.450 |
| | 8 | 10.046 | 13.103 | 20.467 | 0.230 | | 4 | 11.742 | 10.470 | 13.151 | 0.384 |
| | 9 | 10.787 | 14.069 | 21.976 | 0.214 | 0.09 | 5 | 13.342 | 11.896 | 14.914 | 0.338 |
| | 1 | 3.926 | 5.006 | 6.317 | 0.678 | | 6 | 14.848 | 13.239 | 16.598 | 0.304 |
| | 2 | 4.863 | 6.442 | 8.229 | 0.500 | | 7 | 16.284 | 14.520 | 18.204 | 0.277 |
| 0.01 | 3 | 5.904 | 7.891 | 9.952 | 0.407 | | 8 | 17.655 | 15.742 | 19.735 | 0.256 |
| | 4 | 6.895 | 9.226 | 11.561 | 0.348 | | 9 | 18.969 | 16.913 | 21.204 | 0.238 |
| | 5 | 7.821 | 10.466 | 13.080 | 0.307 | | | | | | |

**Table 3: Certain Parametric values Chain Sampling Plan (ChSP-1) with ZIP Model**

| .. | $i$ | $np_1$ | $np_2$ | $np_m$ | $nAOQL$ | $p_2/p_1$ | $AOQL/p_1$ | .. | $i$ | $np_1$ | $np_2$ | $np_m$ | $nAOQL$ | $p_2/p_1$ | $AOQL/p_1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0.6691 | 2.5486 | 0.8325 | 0.6508 | 3.8090 | 0.9726 | | 6 | 0.2758 | 2.3978 | 0.9788 | 0.3899 | 8.6940 | 1.4137 |
| | 2 | 0.4937 | 2.3343 | 0.7070 | 0.4935 | 4.7282 | 0.9996 | | 7 | 0.2518 | 2.3978 | 0.9822 | 0.3891 | 9.5226 | 1.5453 |
| | 3 | 0.4019 | 2.3067 | 0.7109 | 0.4201 | 5.7395 | 1.0453 | | 8 | 0.2324 | 2.3978 | 0.9983 | 0.3888 | 10.3176 | 1.6730 |
| | 4 | 0.3438 | 2.3038 | 0.8187 | 0.3860 | 6.7010 | 1.1227 | | 9 | 0.2164 | 2.3978 | 1.0674 | 0.3887 | 11.0804 | 1.7962 |
| 0.0001 | 5 | 0.3031 | 2.3035 | 0.9234 | 0.3739 | 7.5998 | 1.2336 | | 1 | 0.7156 | 3.3414 | 0.9822 | 0.7156 | 4.6694 | 1.0000 |
| | 6 | 0.2727 | 2.3034 | 0.9696 | 0.3701 | 8.4466 | 1.3572 | | 2 | 0.5262 | 2.9914 | 0.9291 | 0.5600 | 5.6849 | 1.0642 |
| | 7 | 0.2490 | 2.3034 | 0.9880 | 0.3688 | 9.2506 | 1.4811 | | 3 | 0.4274 | 2.9493 | 0.9563 | 0.5041 | 6.9006 | 1.1795 |
| | 8 | 0.2299 | 2.3034 | 0.9954 | 0.3683 | 10.0191 | 1.6020 | 0.05 | 4 | 0.3651 | 2.9449 | 0.9623 | 0.4939 | 8.0660 | 1.3528 |
| | 9 | 0.2141 | 2.3034 | 0.9985 | 0.3682 | 10.7585 | 1.7198 | | 5 | 0.3216 | 2.9444 | 0.9764 | 0.4922 | 9.1555 | 1.5305 |
| | 1 | 0.6699 | 2.5583 | 0.8347 | 0.6519 | 3.8189 | 0.9731 | | 6 | 0.2891 | 2.9444 | 0.9783 | 0.4919 | 10.1847 | 1.7015 |
| | 2 | 0.4943 | 2.3426 | 0.7097 | 0.4945 | 4.7392 | 1.0004 | | 7 | 0.2638 | 2.9444 | 0.9854 | 0.4918 | 11.1615 | 1.8643 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.001 | 3 | 0.4023 | 2.3149 | 0.7153 | 0.4212 | 5.7542 | 1.0470 | | 8 | 0.2434 | 2.9444 | 0.9930 | 0.4916 | 12.0970 | 2.0197 |
| | 4 | 0.3441 | 2.3119 | 0.8259 | 0.3874 | 6.7187 | 1.1258 | | 9 | 0.2266 | 2.9444 | 1.0620 | 0.4912 | 12.9938 | 2.1677 |
| | 5 | 0.3034 | 2.3116 | 0.9306 | 0.3738 | 7.6190 | 1.2320 | 0.09 | 1 | 0.7580 | 4.7573 | 0.9973 | 0.7877 | 6.2761 | 1.0392 |
| | 6 | 0.2730 | 2.3116 | 0.9761 | 0.3678 | 8.4674 | 1.3473 | | 2 | 0.5556 | 4.6560 | 0.9224 | 0.6255 | 8.3801 | 1.1258 |
| | 7 | 0.2492 | 2.3116 | 0.9941 | 0.3652 | 9.2761 | 1.4655 | | 3 | 0.4504 | 4.5253 | 0.9374 | 0.5667 | 10.0473 | 1.2582 |
| | 8 | 0.2301 | 2.3116 | 0.9963 | 0.3641 | 10.0461 | 1.5824 | | 4 | 0.3843 | 4.5123 | 0.9418 | 0.5437 | 11.7416 | 1.4148 |
| | 9 | 0.2143 | 2.3116 | 1.0044 | 0.3636 | 10.7867 | 1.6967 | | 5 | 0.3381 | 4.5110 | 0.9592 | 0.5412 | 13.3422 | 1.6007 |
| 0.01 | 1 | 0.6779 | 2.6612 | 0.8571 | 0.6624 | 3.9257 | 0.9771 | | 6 | 0.3038 | 4.5108 | 0.9750 | 0.5410 | 14.8479 | 1.7808 |
| | 2 | 0.4998 | 2.4307 | 0.7382 | 0.5048 | 4.8633 | 1.0100 | | 7 | 0.2770 | 4.5108 | 0.9882 | 0.5408 | 16.2845 | 1.9523 |
| | 3 | 0.4067 | 2.4013 | 0.7643 | 0.4328 | 5.9044 | 1.0642 | | 8 | 0.2555 | 4.5108 | 0.9989 | 0.5405 | 17.6548 | 2.1155 |
| | 4 | 0.3478 | 2.3982 | 0.9047 | 0.4022 | 6.8953 | 1.1564 | | 9 | 0.2378 | 4.5108 | 1.0079 | 0.5400 | 18.9689 | 2.2708 |
| | 5 | 0.3066 | 2.3979 | 0.9346 | 0.3927 | 7.8209 | 1.2808 | | | | | | | | |

## VIII SELECTION PROCEDURE of ZIP CHAIN SAMPLING PLAN-1 FOR GIVEN AOQL AND ¨

Table 4 is constructed for the selection of a ZIP chain sampling plan (ChSP-1) with given ¨ , the parameter of Zero inflated Poisson distribution and for the required AOQL. Such table can be extended for any value of ¨ and AOQL. For example, when AOQL =1%, ¨ =0.001,i=1,then plans can be (651,1),(494,2),(420,2),(386,4),(374,5),(370,6),(369,7),(368,8) or (368) one of which may be chosen according to the requirement of inspection

**Table 4: Value of sample size for given AOQL, ¨ and i**

| | | AOQL in Percent | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ¨ | i | 0.10 | 0.25 | 0.50 | 0.75 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 |
| 0.0001 | 1 | 651 | 260 | 130 | 87 | 65 | 43 | 33 | 26 | 22 | 19 | 16 | 14 | 13 | 11 | 9 | 8 | 7 | 7 |
| | 2 | 494 | 197 | 99 | 66 | 49 | 33 | 25 | 20 | 16 | 14 | 12 | 11 | 10 | 8 | 7 | 6 | 5 | 5 |
| | 3 | 420 | 168 | 84 | 56 | 42 | 28 | 21 | 17 | 14 | 12 | 11 | 9 | 8 | 7 | 6 | 5 | 5 | 4 |
| | 4 | 386 | 154 | 77 | 51 | 39 | 26 | 19 | 15 | 13 | 11 | 10 | 9 | 8 | 6 | 6 | 5 | 4 | 4 |
| | 5 | 374 | 150 | 75 | 50 | 37 | 25 | 19 | 15 | 12 | 11 | 9 | 8 | 7 | 6 | 5 | 5 | 4 | 4 |
| | 6 | 370 | 148 | 74 | 49 | 37 | 25 | 19 | 15 | 12 | 11 | 9 | 8 | 7 | 6 | 5 | 5 | 4 | 4 |
| | 7 | 369 | 148 | 74 | 49 | 37 | 25 | 18 | 15 | 12 | 11 | 9 | 8 | 7 | 6 | 5 | 5 | 4 | 4 |
| | 8 | 368 | 147 | 74 | 49 | 37 | 25 | 18 | 15 | 12 | 11 | 9 | 8 | 7 | 6 | 5 | 5 | 4 | 4 |
| | 9 | 368 | 147 | 74 | 49 | 37 | 25 | 18 | 15 | 12 | 11 | 9 | 8 | 7 | 6 | 5 | 5 | 4 | 4 |
| 0.001 | 1 | 652 | 261 | 130 | 87 | 65 | 43 | 33 | 26 | 22 | 19 | 16 | 14 | 13 | 11 | 9 | 8 | 7 | 7 |
| | 2 | 495 | 198 | 99 | 66 | 49 | 33 | 25 | 20 | 16 | 14 | 12 | 11 | 10 | 8 | 7 | 6 | 5 | 5 |
| | 3 | 421 | 168 | 84 | 56 | 42 | 28 | 21 | 17 | 14 | 12 | 11 | 9 | 8 | 7 | 6 | 5 | 5 | 4 |
| | 4 | 387 | 155 | 77 | 52 | 39 | 26 | 19 | 15 | 13 | 11 | 10 | 9 | 8 | 6 | 6 | 5 | 4 | 4 |
| | 5 | 374 | 150 | 75 | 50 | 37 | 25 | 19 | 15 | 12 | 11 | 9 | 8 | 7 | 6 | 5 | 5 | 4 | 4 |
| | 6 | 368 | 147 | 74 | 49 | 37 | 25 | 18 | 15 | 12 | 11 | 9 | 8 | 7 | 6 | 5 | 5 | 4 | 4 |
| | 7 | 365 | 146 | 73 | 49 | 37 | 24 | 18 | 15 | 12 | 10 | 9 | 8 | 7 | 6 | 5 | 5 | 4 | 4 |
| | 8 | 364 | 146 | 73 | 49 | 36 | 24 | 18 | 15 | 12 | 10 | 9 | 8 | 7 | 6 | 5 | 5 | 4 | 4 |
| | 9 | 364 | 145 | 73 | 48 | 36 | 24 | 18 | 15 | 12 | 10 | 9 | 8 | 7 | 6 | 5 | 5 | 4 | 4 |
| 0.01 | 1 | 662 | 265 | 132 | 88 | 66 | 44 | 33 | 26 | 22 | 19 | 17 | 15 | 13 | 11 | 9 | 8 | 7 | 7 |
| | 2 | 505 | 202 | 101 | 67 | 50 | 34 | 25 | 20 | 17 | 14 | 13 | 11 | 10 | 8 | 7 | 6 | 6 | 5 |
| | 3 | 433 | 173 | 87 | 58 | 43 | 29 | 22 | 17 | 14 | 12 | 11 | 10 | 9 | 7 | 6 | 5 | 5 | 4 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 402 | 161 | 80 | 54 | 40 | 27 | 20 | 16 | 13 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 4 |
| | 5 | 393 | 157 | 79 | 52 | 39 | 26 | 20 | 16 | 13 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 4 |
| | 6 | 390 | 156 | 78 | 52 | 39 | 26 | 19 | 16 | 13 | 11 | 10 | 9 | 8 | 6 | 6 | 5 | 4 | 4 |
| | 7 | 389 | 156 | 78 | 52 | 39 | 26 | 19 | 16 | 13 | 11 | 10 | 9 | 8 | 6 | 6 | 5 | 4 | 4 |
| | 8 | 389 | 156 | 78 | 52 | 39 | 26 | 19 | 16 | 13 | 11 | 10 | 9 | 8 | 6 | 6 | 5 | 4 | 4 |
| | 9 | 389 | 155 | 78 | 52 | 39 | 26 | 19 | 16 | 13 | 11 | 10 | 9 | 8 | 6 | 6 | 5 | 4 | 4 |
| | 1 | 716 | 286 | 143 | 95 | 72 | 48 | 36 | 29 | 24 | 20 | 18 | 16 | 14 | 12 | 10 | 9 | 8 | 7 |
| | 2 | 560 | 224 | 112 | 75 | 56 | 37 | 28 | 22 | 19 | 16 | 14 | 12 | 11 | 9 | 8 | 7 | 6 | 6 |
| | 3 | 504 | 202 | 101 | 67 | 50 | 34 | 25 | 20 | 17 | 14 | 13 | 11 | 10 | 8 | 7 | 6 | 6 | 5 |
| | 4 | 494 | 198 | 99 | 66 | 49 | 33 | 25 | 20 | 16 | 14 | 12 | 11 | 10 | 8 | 7 | 6 | 5 | 5 |
| 0.05 | 5 | 492 | 197 | 98 | 66 | 49 | 33 | 25 | 20 | 16 | 14 | 12 | 11 | 10 | 8 | 7 | 6 | 5 | 5 |
| | 6 | 492 | 197 | 98 | 66 | 49 | 33 | 25 | 20 | 16 | 14 | 12 | 11 | 10 | 8 | 7 | 6 | 5 | 5 |
| | 7 | 492 | 197 | 98 | 66 | 49 | 33 | 25 | 20 | 16 | 14 | 12 | 11 | 10 | 8 | 7 | 6 | 5 | 5 |
| | 8 | 492 | 197 | 98 | 66 | 49 | 33 | 25 | 20 | 16 | 14 | 12 | 11 | 10 | 8 | 7 | 6 | 5 | 5 |
| | 9 | 491 | 196 | 98 | 65 | 49 | 33 | 25 | 20 | 16 | 14 | 12 | 11 | 10 | 8 | 7 | 6 | 5 | 5 |
| | 1 | 788 | 315 | 158 | 105 | 79 | 53 | 39 | 32 | 26 | 23 | 20 | 18 | 16 | 13 | 11 | 10 | 9 | 8 |
| | 2 | 626 | 250 | 125 | 83 | 63 | 42 | 31 | 25 | 21 | 18 | 16 | 14 | 13 | 10 | 9 | 8 | 7 | 6 |
| | 3 | 567 | 227 | 113 | 76 | 57 | 38 | 28 | 23 | 19 | 16 | 14 | 13 | 11 | 9 | 8 | 7 | 6 | 6 |
| | 4 | 544 | 217 | 109 | 72 | 54 | 36 | 27 | 22 | 18 | 16 | 14 | 12 | 11 | 9 | 8 | 7 | 6 | 5 |
| 0.09 | 5 | 541 | 216 | 108 | 72 | 54 | 36 | 27 | 22 | 18 | 15 | 14 | 12 | 11 | 9 | 8 | 7 | 6 | 5 |
| | 6 | 541 | 216 | 108 | 72 | 54 | 36 | 27 | 22 | 18 | 15 | 14 | 12 | 11 | 9 | 8 | 7 | 6 | 5 |
| | 7 | 541 | 216 | 108 | 72 | 54 | 36 | 27 | 22 | 18 | 15 | 14 | 12 | 11 | 9 | 8 | 7 | 6 | 5 |
| | 8 | 541 | 216 | 108 | 72 | 54 | 36 | 27 | 22 | 18 | 15 | 14 | 12 | 11 | 9 | 8 | 7 | 6 | 5 |
| | 9 | 540 | 216 | 108 | 72 | 54 | 36 | 27 | 22 | 18 | 15 | 14 | 12 | 11 | 9 | 8 | 7 | 6 | 5 |

## IX SELECTION PROCEDURE BASED OF ZIP CHAIN SAMPLING PLAN-1 BASED ON AOQL AND AQL

Table 5 is constructed for the selection of ZIP chain sampling plan-1 for the given value of AOQL and AQL. For given values AQL and AOQL the ratio AOQL/AQL is obtained. The sample size n is obtained and hence a combination ( ,n,i) for given AOQL and AQL for the ZIP chain sampling plan is obtained.For example, when AOQL =0.1 and AQL=0.05, the table values closer to the ratio AOQL/AQL=2 is obtained as 2.1155 for which

( .i) = (0.09,8)and 2.2708, for which ( , i) = (0.09,9).

Similarly more combination of ( ,i) can be formed as per the inspection

## X COMPARISON WITH ChSP-1 PLAN WITH POISSON MODEL

The parameters of ZIP chain sampling plan- may be compared with the parameters of ChSP-1 given by Soundararajan (1978) for given AOQL and AQL. When AOQL=0.10 and AQL=0.05 percent the optimum plan is (504,1).In case of ChSP-1 with passion model. For the same combination of AOQL and AQL the appropriate plans are (492,8) and (541,8), for = 0.05,0.09 respectively. It is observed that for small values of , the optimum sample size is less and increases as increases.

The number of proceeding sample is more compared with the ChSP -1 with Poisson model. This is much favourable to the consumer.

## XI CONSTRUCTION OF AQL/ AOQL TABLE

In the Table 3, values of np1 have been calculated for p1 defined as AQL such that Pa(p) = 0.95. Also nAOQL values and the ratio AOQL/AQL are given .Given that AQL=0.15percent and AOQL is

0.25 percent, then (AOQL/AQL) = 1.6666.

From table 3, the values closer to this is 1.6020 which corresponding to a value of i=8. with i = 8, np1 = 0.2299. Hence np1 / p1 = 0.0015 = 153.26,i.e., about 0.15. Thus the ChSP-1 corresponding to given AQL=0.15 percent and AOQL is 0.25 percent is given by n = 156, = 0.01 and i = 8. In similar manner, chain sampling plan have been calculated for a wide range of AQL and AOQL values given the table.

**Table 5: Selection procedure based on AQL and AOQL**

| AQL in % | | AOQL % | |
|---|---|---|---|
| | | 0.1 | 0.25 |
| | | n, i | n, i |
| 0.05 | 0.05 | 492,8 | - |
| | 0.09 | 541,8 | |
| 0.075 | 0.0001 | 370,6 | - |
| | 0.001 | 368,6 | |
| | 0.01 | 393,5 | |
| | 0.05 | 494,4 | |
| 0.10 | 0.0001 | 494,2 | - |
| | 0.001 | 495,2 | |
| | 0.01 | 505,2 | |
| | 0.05 | 716,1 | |
| | 0.09 | 788,1 | |
| 0.15 | 0.0001 | - | 146,8 |
| | 0.001 | | 147,8 |
| | 0.01 | | 156,8 |
| | 0.09 | | 217,5 |

## XII CONCLUSION

The quality level and quality interval sampling plan possesses wider potential applicable in industry ensuring higher standard of quality attainment for product or process. Thus quality interval and quality level are good measure for defining and Designing for acceptance sampling plan which are readymade use to industrial shop-floor situations. A zero inflated model is the appropriate probability distribution to the number of non-conformities per product manufactured in such production process. The Chain sampling plan gives more pressure on the producer if the quality deteriorates. The complete Chain sampling plan gives more pressure on the producer if the quality deteriorates. These plans provide consumer an assurance regarding the outgoing quality or the quality of the lot after the inspection. Hence one can recommend this type of sampling plans for better quality control practice.

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