ISSN No:-2456-2165

Group Acceptance Sampling Plan for Truncated Life Test using Generalized Exponential-Poisson Distribution

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Abstract:- A Group Acceptance Sampling Plan (GASP) is designedto study the truncated life testplan when the lifetime of an item follows a new compound distribution called as Generalized Exponential-Poisson (GEP). In this article the design parameters are developed for the group size, its acceptance numbers, OC curve, minimum number of groups are determined through the specified consumer's confidence level and test termination ratio. Two points on the OC curve approach is incorporated to design the proposed plan. The OC values are calculated when the ratio of specified average life and the actual average life is given. The minimum mean ratio for the proposed plan are determined at the fixed producer's risk. The obtained plan parameters are illustrated with areal time example with the simulation study which are exhibited in the tables.

Keywords:- *Generalized Exponential-Poisson distribution, consumer's confidence level, producer's risk, operating characteristic function, truncated life test.*

I. INTRODUCTION

In the competitive global market, quality product always seeks more attention and demand to meet the standards prescribed by the manufactures. In industry outgoing or incoming products are widely inspected to control the quality of the products which are essential activities in industries. Statistical quality control may categorized into process control and product control. Product control plays a vital role when the product is in finished mode and helps to identify the reliable product and eliminate the manufacturing errors.The statistical techniques are usually employed to remove the defective products in the production process as an offline product control techniques at any stage of the manufacturing process as an incoming raw materials, semi-finished products or a finished products can be tested.Product control is equally important techniques however sampling plans for attributes and variables are widely studied, however sampling plan by attributes is easy to perform in industrial shop floor conditions. Acceptance sampling plan is one of the important techniques adopted in quality control towards inspection and testing the sampling units in which decision about the lot can be made. In the acceptance sampling procedure the life test plan is carried out when the quality characteristics of the product is defined by its lifetime. In particular, truncated life test is adopted at which the test will terminated at a certain point of time in the sense that observing the lifetime of the products until it fails is not possible. The truncated life test is intentionally used to save the time and cost of the experiment in such a way that life test can be studied at the specified time period.

In an attribute single sampling planbased on the truncated life testa decision of acceptance or rejection of the lot is made based on the single sample which is the traditional procedure in sentencing the lot. Epstein. B (1954) discussed truncated life test in the exponential case. Goode H.P and Kao J.H.K (1961) have studied sampling plan based on the weibull distribution. Balamuarali S. and Lee S.H (2006) discussed variable sampling plans for Weibull distribution under sudden death testing. Kaviyarasu and fawaz (2007) has studied reliability sampling plan to ensure percentiles through Weibull Poisson Distribution. Kaviyarasu, V. and Sivasankari, S. (2020) studied the Single sampling plan for life testing under the Generalized Exponential-Poisson Distribution. Every single item in the sampling units are required single tester however in practice a tester may accommodate multiple number of items simultaneously hence it saves more time and the cost of the experiment. Here the items in a tester can be regarded as a group and the number of items in the group is called as group size such as study is called as Group Acceptance Sampling Plan (GASP). In this method many items can be tested on the basis of few items are tested from the lot size of infinite. Hence this GASP elevate the ordinary plan to inspect many items with multiple tester. Also it improves the precision of the testing because various sampling units are distributed to multiple testers. In a life test experiment, a sample of size n is tested from a lot of products is put on the test when the corresponding acceptance number is fixed with the test assigned time. Probability of rejecting a good lot is called the producer's risk and probability of accepting a bad lot is called the consumer's risk. Here the confidence level is p* then the consumer risk will be 1-p*. The main objective of any acceptance sampling plan procedure is to reduce both the risk simultaneously.

Therefore many researchers prefers the GASP than any other plans and have done their researchwith various distributions such as Aslam and Jun (2009)designed the group acceptance sampling plans based on the truncated life test when the life time of products follows an Gamma Distribution and Weibull distributions. Rao (2011) introduced a hybrid group acceptance sampling plans for lifetimes based on generalized exponential distribution and log logistic distributions. Aslam et al.(2010) introduced an

ISSN No:-2456-2165

improved group sampling plan based on time truncated life tests. Kaviyarasu and Suresh (2011)proposed a new plan and designated as quick switching multiple repetitive group sampling plan of type QSMRGSP-1 in which disposition of lot is determined on the basis of normal and tightened sampling schemes. Sudamani Ramaswamy and Sutharani(2012) designed Weighted Group Sampling Plan Based on Truncated Life Tests under various distribution using Minimum Angle Method. Muhammad Aslam et al. (2013)proposed a multiple state Repetitive Group Sampling plan by considering the processloss. Aslam et al. (2015) proposed two stage group acceptance sampling plan for half normal percentiles. Rosaiah et al. (2016) developed a group acceptance sampling plan for truncated life tests when the lifetime of items follows the Type-II generalized log logistic distribution (TGLLD).

II. OPERATING PROCEDURE

Here our interest in determining the number of group's 'g' with the various values of acceptance number c and the test termination time t_0 are assumed to be specified. The operating procedure of GASP is as follows,

- Step 1: Select a random sample of size *n* from a lot of size *N* and assign *r* number of units to each of *g* groups, so that *n= r*g*
- Step 2: Fix the acceptance number *c* and the experiment time t_0.
- Step 3: Perform the experiment for the *g* groups simultaneously and record the number of failures for each group till the specified time t_0
- Step 4: Accept the lot if the number of failures from all the groups together is smaller than or equal to *c*.
- Step 5: Reject the lot whenever number of failures more than *c* as well as terminate the test before time t_0.

The quality of the product is tested with GASP on the basis of the above procedure when few items are taken from an infinite lot is tested. Here, Group Acceptance Sampling Plan (GASP) is studied under the proposed probability distribution on the truncated life test under percentile as a quality parameter when the life time of a product assumed to follow the Generalized Exponential-Poisson distribution.

III. GENERALIZED EXPONENTIAL-POISSON DISTRIBUTION

Most of the probabilistic models are studied to describe the life time of data follows a certain life time distribution. Here the failure time of an inspecting product may follows a life time distribution is modelled using a statistical distribution. Kus(2007) introduced a two parameter distribution called Exponential-Poisson distribution. Later, Wagner Barreto-Souza and Francisco Cribari-Neto (2009) derived a new distribution with three parameters known as Generalized Exponential-Poisson (GEP) Distribution. This new distribution is a compounding of an exponential and a Poisson distribution. In reality the failure item of a manufacturing product may not follow a particular distribution which may vary on the design parameters regardless on the underlying statistical distribution. The failure rate of the distribution can be decreasing or increasing and also upside-down bathtub shaped model. These applications of the proposed distribution can be seen the toys and crafts manufacturing sectors are widely used.

GEP distribution characterized by the parameter α (>0) and the random sample $Y_1 \ldots\ldots Y_\alpha$ from the EP distribution. So that X = $\max\{Y_i\}_{i=1}^{\alpha}$ is GEP distributed. Hence this model can be applicable for the maximum lifetimes of EP random samples. GEP is more suitable distribution for the physical interpretation. If the n components are connected in a parallel system, the lifetimes of the components are identically and independently GEP distributed random variables. Also the whole system lifetime follows the GEP law.The Probability density function of GEP is

$$f(x;\theta) = \frac{\alpha\lambda\beta}{(1-e^{-\lambda})^{\alpha}}\left\{1-e^{-\lambda+\lambda\exp(-\beta x)}\right\}^{\alpha-1} e^{-\lambda-\beta x+\lambda\exp(-\beta x)} \quad \text{-----(1)}$$

The Cumulative Distribution Function of the GEP is given as

$$F(x;\theta) = \left(\frac{1-e^{-\lambda+\lambda\exp(-\beta x)}}{1-e^{-\lambda}}\right)^{\alpha} \quad \text{-----(2)}$$

Where θ (>0) = (α, β, λ), α is the shape parameter, β is the scale parameter of the Exponential distribution and λ is the Poisson parameter. When α = 1, Generalized Exponential Poisson reduces to Exponential Poisson distribution. When α = 1 and λ→ 0, Exponential Poisson reduces Exponential distribution with parameter β. Let x $=\frac{t}{\beta^2}$, Then consider the CDF of the mean life product quality of GEP distribution becomes,

$$F(x;\theta) = \left(\frac{1-e^{-\lambda+\lambda\exp(-\frac{t}{\beta})}}{1-e^{-\lambda}}\right)^{\alpha}$$

t, λ,α, β > 0 -----(3)

IV. TWO POINT ON THE OPERATING CHARACTERISTIC CURVE

The two important risks involved in the acceptance sampling procedure is well known as producer's risk and the consumer's risk. The risk happening in the inspection procedures which exclusively depends with making of wrong decision such as rejecting the good lot and accepting the bad lot. Hence rejecting the good lot due to inherent nature of random sampling is the producer's risk and accepting the bad quality lot due to inherent nature of the random sample is known as consumer's risk. Both the risk have to be kept minimum for producing the reliable product. Hence it is considering the two levels Acceptable Reliability Level (ARL) and Limiting Reliability Level (LRL) to minimize the risks, which are obtained through Producer' confidence level (1-α) and the consumer's level β. The reliability sampling plan is an efficient one when both the risks are under control. Here, α ≤ 0.05 and β ≤ 0.10. Thus the probability of acceptance can be obtained for the incoming quality using the following inequality,

$$L(p_1) \geq 1-\alpha \text{ and } L(p_2) \leq \beta$$

Where p_1 is the ARL and p_2 is the LRL. The value of p_1 and p_2 obtained through $p = F\left({}^{t}/_{\beta_0} * {}^{1}/_{d}\right)$ When $d_1 = {}^{\beta}/_{\beta_0}$>1 and$d_2 = {}^{\beta}/_{\beta_0}$=1 respectively. When the actual mean lifetime of the product is similar to the specified mean lifetime, i.e., the lot quality is good enough to accept at ${}^{\beta}/_{\beta_0} = 1$ there is no chance of arising the risk. The proposed approach of finding the design parameters is to satisfy the above two inequalities for the operating characteristic function L (p)simultaneously.

V. DESIGNING OPTIMAL PLAN PARAMETERS

The sampling plan of Group Acceptance Sampling Plan is exemplified by (*rg, c,* ${}^{t}/_{\beta_0}$).For the practical use of the sampling plancan be obtaining with the smallest positive integer *n* =(*r*g*). The group acceptance sampling plan is reduced to single sampling plan when the group size r = 1. The designing plan parameters of the proposed sampling plan, minimum number of groups are determined with the assumption that the lot size is large enough to use the binomial distribution. The quality of the item is usually represented by its true life time such as mean life, median life and percentile life. It is obtained for the given values of test termination ratio ${}^{t}/_{\beta_0}$ andthe acceptance number c at the specified consumer's confidence level by using the following non-linear constraint under the percentile life is studied,

$$L(p_1) = \sum_{i=0}^{c} \binom{rg}{i} p_1^i (1-p_1)^{rg-i} \leq 1 - P^* \quad \ldots\ldots\ldots\ldots(4)$$

Where $p_1 = F(x;\theta)$ is the

$$F(x;\theta) = \left(\frac{1-e^{-\lambda+\lambda\exp(-\frac{t}{\beta})}}{1-e^{-\lambda}}\right)^{\alpha} \quad t, \lambda, \alpha, \beta > 0$$

Wherep_1 is the probability of failure of an item at time t.$p_1$depends only on${}^{t}/_{\beta_0}$Therefore the minimum group size determined using the search procedure for the various given values of P^* , c and ${}^{t}/_{\beta_0}$and tabulated. The minimum group size is determined while satisfying both the consumer and the producer by fixing the risk at certain level such as P^*= 0.75, 0.90, 0.95, 0.99.

$$L(p) = \sum_{i=0}^{c} \binom{rg}{i} p^i (1-p)^{rg-i} \quad \ldots\ldots\ldots\ldots(5)$$

The probability of acceptance of the GASP can be found out using (5) only when both the consumer's and the producer' risk are used in simulation process. The two points on the operating characteristic curve are the deciding factors in sentencing the lot to meet the necessity of both the producer and the consumer. Where$p$ is the cumulative distribution function of GEP in terms of incoming quality of ${}^{t}/_{\beta_0}$and${}^{\beta}/_{\beta_0}$Such that

$$p = F\left({}^{t}/_{\beta_0} * {}^{1}/_{d}\right) \qquad \text{Where} \quad d = {}^{\beta}/_{\beta_0} \quad \ldots\ldots\ldots\ldots\ldots(6)$$

Probability of rejecting a lot even if the lot quality is good ie.,$\beta \geq \beta_0$, the actual mean lifetime is greater than the specified mean lifetime is mentioned as producer's risk. Hence to reduce the producer's risk, one must be interested in finding the value of ${}^{\beta}/_{\beta_0}$in designing the GASP (*rg, c,*${}^{t}/_{\beta_0}$)corresponding to P*. This smallest value of the ratio ${}^{\beta}/_{\beta_0}$ can be determined under the condition that producer's risk which is kept under 0.05. Thus the proposed life testing sampling plan is studied under

$$L(p) \geq 1\text{-}\alpha \qquad \text{----------}(7)$$

Therefore the minimum mean ratio ${}^{\beta}/_{\beta_0}$of truncated life test plan can be evaluated by satisfying the following inequality,

$$\sum_{i=0}^{c} \binom{rg}{i} p^i (1-p)^{rg-i} \geq 0.95 \qquad \ldots\ldots\ldots\ldots\ldots\ldots(8)$$

wherep = F $\left({}^{t}/_{\beta_0} . {}^{\beta_0}/_{\beta}\right)$

VI. DESCRIPTION OF TABLE VALUES

- Step 1: Fix the parameters of GEP distribution α = 2, λ=2 and the test termination ratio ${}^{t}/_{\beta_0}$ = 0.5, 0.6, 0.7, 0.8, 0.9,1.0
- Step 2: Obtain $p$values in terms of the given ${}^{t}/_{\beta_0}$mentioned in (3)
- Step 3: Determine the smallest positive integer g by applying the condition that
$$L(p) = \sum_{i=0}^{c} \binom{rg}{i} p_1^i (1-p_1)^{rg-i} \leq 1 - P^*$$

Specify the appropriate consumer's confidence levels 0.75, 0.90, 0.95, 0.99 and the acceptance number 0 to 4. With the assumption of lot size is large enough to the need of binomial distribution in finding the success or failure item in the truncated life test plan and using the search procedure, the minimum group size is obtained for r =2 and exhibited in the Table-1

- Step 4: The OC values for the given incoming product quality d is evaluated as
$$L(p) = \sum_{i=0}^{c} \binom{rg}{i} p^i (1-p)^{rg-i}$$

Where p is the cumulative distribution function in terms of incoming quality of ${}^{t}/_{\beta_0}$and${}^{\beta}/_{\beta_0}$ Such that

ISSN No:-2456-2165

- $p = F\left({}^{t}/_{\beta_0} * {}^{1}/_{d}\right)$ Where $d = {}^{\beta}/_{\beta_0}$
- Step 5: Fix the ratio ${}^{t}/_{\beta_0}$ = 0.5, 0.6, 0.7, 0.8, 0.9, 1 and ${}^{\beta}/_{\beta_0}$ = 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 and 4.5 substitute in (6) and find p values. Through the value of incoming quality p, the probability of acceptance for each p value can be obtained from (5) and presented in the Table-2
- Step 6: The minimum ratio is obtained by using the inequality (7). For the given values of ${}^{t}/_{\beta_0}$, ${}^{\beta}/_{\beta_0}$, n = r * g also the acceptance number c.

Here one can obtain the minimum mean ratio which can assures that the producer's risk will not be more than 0.05 for the proposed truncated life test plan. The minimum mean ratio is obtained for the specified consumer's confidence levels 0.75, 0.90, 0.95, 0.99 and exhibited in the Table-3.

VII. OC CURVE

For the specified test termination ratio $t/t_0$with q = 0.8 and the acceptance number c =0 for the consumer's confidence level 0.99, the percentile lifetime plan is obtained from the Table-1, the minimum number of groups g = 3. Hence the plan is executed as (3, 0 and 0.8) with the minimum percentile ratio is 7.3340 from Table-3. From this obtained plan parameters one can arrive at the conclusion that the product will have the percentile life of 7 times of the specified percentile life of 1000 hours with the lot acceptance 0.99.The OC curve of the proposed plan **(n= 4*3 = 12, c= 0and $\boldsymbol{{}^{t}/_{\beta_0}}$ = 0.8)**is shown in the following figure.

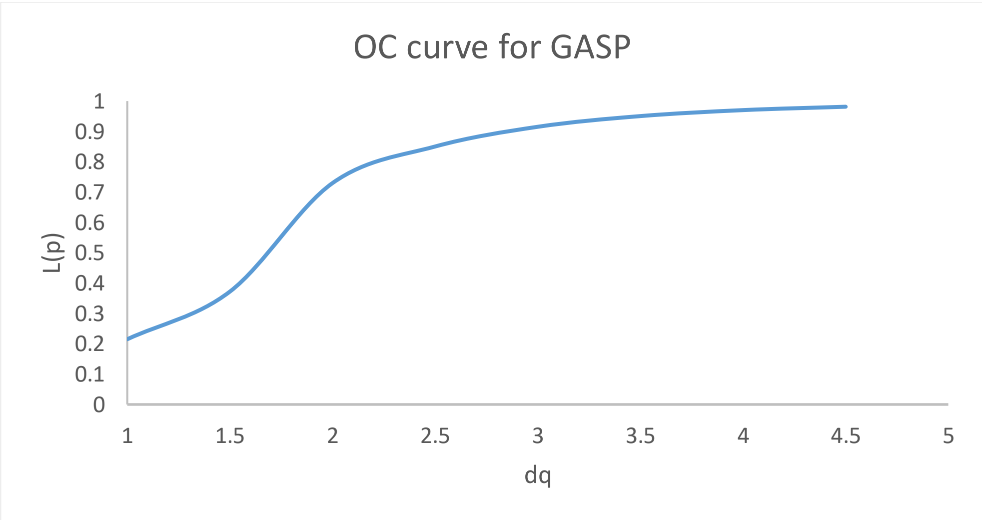

Fig. 1: OC curve of the (n= 4*3 = 12, c= 0and $\boldsymbol{{}^{t}/_{\beta_0}}$ = 0.8)

The probability of acceptance can be regarded as a function of the deviation for the specified values are given to test the percentile life. The function is called the Operating Characteristics curve of the proposed sampling plan is given. From this one can obtain the minimum sample size and interested to find the probability of lot acceptance when the quality of the item is sufficiently good under the study.

VIII. EXAMPLE

Consider an electronic toys manufacturing company wants to adopt the proposed sampling plan for life testing the electronic toys. Suppose that the quality testing engineer wants to study the lifetime of a product which may follows the Generalized Exponential-Poisson distribution, it is desired to design the GASP to test the actual lifetime is greater than 1000 hours when the test terminated at 800 hours and 2 items on each tester with allowed number of failures for each group is 2. It leads the ratio ${}^{t}/_{\beta_0}$ = 0.8 with c=1. From the Table-1theminimum number of groups for the consumer's risk 0.01 is obtained.

Thus the proposed plan is performed as the testing with 6 tester (group) with 2 items in each group simultaneously at the exact consumer's risk β = 0.0096. Accept the lot if no more than 1 failure in each of all the groups occur or else reject the lot. For this proposed electronic toy testing a sample size of 12 items are tested with g=6 and r=2 (2*6, 1, 0.8) with 12 items are tested and one may interested in finding the probability of acceptance for the method from the Table-4 when the true lifetime of the product is greater than the specified mean lifetime $\beta \geq \beta_0$ or $\frac{\beta}{\beta_0}$ can be obtained.

ISSN No:-2456-2165

β/β_0	1	1.5	2	2.5	3	3.5	4	4.5
L(p)	0.1847	0.3435	0.7221	0.8493	0.9165	0.9522	0.9717	0.9826

Table 4: OC values of (n= 2*6 = 12, c= 1and t/β_0 = 0.8)under GEP for p*=0.99

The minimum mean ratio for this proposed plan referred from the Table-3 is 5.3226 reveals that the product will have an average life of 5 times of the specified average life of 1000 hours with acceptable probability 0.99.

IX. CONCLUSIONS

This article provides a new statistical probability distribution named as Generalized Exponential-Poisson distribution to test the quality of products when acceptance sampling for life test is studied. Numerical table are developed to obtain the minimum sample size, OC values and the minimum ratio values are given when producer's risk is fixed. The proposed plan was found to be a more efficient plan for studying the percentile life as a quality parameter over the other sampling plans. Here the quality engineer can adopt the proposed sampling plan in the manufacturing sector to reach a decision regarding either to accept or not to accept the incoming / outgoing quality lots. To ensure the life quality of the products the pattern of failure can be occurred using the sampling distribution which protects both the producer and the consumer with more precision than the specified average life. Suitable illustrations under electronic toy manufacturing are given for ready made reference for the industrial shop floor conditions which provides better discrimination of accepting good lots among minimum number of groups.

p*	c	r	t/β_0					
			0.5	0.6	0.7	0.8	0.9	1
0.75	0	2	2	2	1	1	1	1
0.75	1	2	3	3	2	2	2	1
0.75	2	2	5	4	4	3	3	2
0.75	3	2	6	6	5	4	4	3
0.75	4	2	8	7	5	5	5	4
0.90	0	2	3	3	2	2	2	1
0.90	1	2	4	4	3	3	3	2
0.90	2	2	6	5	4	4	4	3
0.90	3	2	8	6	5	5	4	4
0.90	4	2	9	8	7	6	5	5
0.95	0	2	3	3	2	2	2	2
0.95	1	2	5	4	4	3	3	3
0.95	2	2	7	6	5	4	4	4
0.95	3	2	9	7	6	6	5	5
0.95	4	2	11	9	8	7	6	6
0.99	0	2	5	4	3	3	2	2
0.99	1	2	7	6	5	4	4	4
0.99	2	2	9	8	6	6	6	5
0.99	3	2	11	9	8	7	7	6
0.99	4	2	13	11	9	8	7	7

Table 1: minimum number of groups (g) for mean life under GEP Distribution for GASP

p*	t/β_0	g	β/β_0							
			1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
0.75	0.5	5	0.6878	0.896	0.9619	0.9844	0.9929	0.9965	0.9982	0.999
0.75	0.6	4	0.7275	0.8424	0.9649	0.9852	0.9931	0.9965	0.9981	0.9989
0.75	0.7	4	0.6273	0.7672	0.9396	0.9729	0.9868	0.9931	0.9962	0.9978
0.75	0.8	3	0.7882	0.8749	0.9696	0.9865	0.9935	0.9966	0.9981	0.9989
0.75	0.9	3	0.7308	0.8329	0.9550	0.9791	0.9895	0.9944	0.9968	0.9981
0.75	1	2	*	*		*	*	*	*	*
0.9	0.5	6	0.5507	0.8298	0.9335	0.9717	0.9868	0.9934	0.9965	0.998
0.9	0.6	5	0.5513	0.7154	0.9265	0.9675	0.9844	0.992	0.9956	0.9975
0.9	0.7	4	0.6273	0.7672	0.9396	0.9729	0.9868	0.9931	0.9962	0.9978
0.9	0.8	4	0.5316	0.6873	0.9071	0.9558	0.9775	0.9879	0.9931	0.9959
0.9	0.9	4	0.4446	0.6077	0.8682	0.9337	0.965	0.9805	0.9887	0.9931
0.9	1	3	0.6734	0.7882	0.9374	0.9697	0.9843	0.9914	0.995	0.997
0.95	0.5	7	0.4266	0.7554	0.8981	0.9549	0.9786	0.9891	0.9941	0.9966
0.95	0.6	6	0.3965	0.5844	0.8766	0.9427	0.9717	0.9851	0.9918	0.9952
0.95	0.7	5	0.4277	0.6051	0.878	0.9423	0.9709	0.9844	0.9912	0.9948
0.95	0.8	4	0.5316	0.6873	0.9071	0.9558	0.9775	0.9879	0.9931	0.9959
0.95	0.9	4	0.4446	0.6077	0.8682	0.9337	0.965	0.9805	0.9887	0.9931
0.95	1	4	0.3684	0.5316	0.8243	0.9071	0.949	0.9708	0.9826	0.9892
0.99	0.5	9	0.2376	0.5994	0.8115	0.9104	0.9554	0.9765	0.987	0.9925
0.99	0.6	8	0.1835	0.3571	0.7540	0.8749	0.9344	0.9642	0.9795	0.9879
0.99	0.7	6	0.2743	0.4548	0.8043	0.9015	0.9484	0.9717	0.9838	0.9903
0.99	0.8	6	0.1847	0.3435	0.7221	0.8493	0.9165	0.9522	0.9717	0.9826
0.99	0.9	6	0.1221	0.2539	0.6359	0.7885	0.8766	0.9265	0.9554	0.9717
0.99	1	5	0.1784	0.3242	0.6878	0.821	0.8969	0.9386	0.9625	0.9761

Table 2: OC values for mean life under GEP distribution when c = 2 and r=2 for GASP

p*	c	0.5	0.6	0.7	0.8	0.9	1
0.75	0	9.4413	9.6929	9.0878	10.318	11.678	12.936
0.75	1	3.8297	4.0666	4.0701	4.6574	5.248	4.6967
0.75	2	3.1326	3.2184	3.4026	3.4534	3.3427	2.356
0.75	3	2.5081	2.8247	3.0599	2.9279	2.9306	2.7986
0.75	4	2.2781	2.4534	2.3022	2.6307	2.6887	2.6636
0.90	0	11.743	12.738	13.169	15.136	16.944	12.946
0.90	1	4.5896	5.0762	5.3648	5.4389	6.124	5.8175
0.90	2	3.5241	3.7584	3.7553	3.891	4.3589	4.3077
0.90	3	2.9306	3.0048	3.059	3.228	3.2957	3.6514
0.90	4	2.5983	2.7364	3.0256	2.8573	2.9604	2.9891
0.95	0	11.73	12.813	13.259	12.852	17.039	16.226
0.95	1	4.9347	5.4847	5.9173	6.1259	6.1173	6.8047
0.95	2	3.8861	4.0066	4.3795	4.2895	4.3758	4.8652
0.95	3	3.3158	3.3596	3.5127	3.7602	3.9303	4.0357
0.95	4	2.8943	2.9972	3.1883	3.2664	3.4422	3.5721
0.99	0	14.517	16.415	16.457	17.055	17.037	18.834
0.99	1	6.3684	6.6767	6.9081	7.334	7.5843	8.4529
0.99	2	4.5596	5.0792	4.9443	5.3236	6.0006	5.8261
0.99	3	3.7727	3.9763	4.105	4.245	4.7809	4.7092

Table 3: Minimum mean ratio values for the producer's risk 0.05 under GEP distribution for GASP

ISSN No:-2456-2165

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