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Acceptance Sampling Plans for Percentiles Based on the Exponentiated Half Logistic Distribution

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Abstract

In this article, acceptance sampling plans are developed for the exponentiated half logistic distribution percentiles when the life test is truncated at a pre-specified time. The minimum sample size necessary to ensure the specified life percentile is obtained under a given customer's risk. The operating characteristic values (and curves) of the sampling plans as well as the producer's risk are presented. Two examples with real data sets are also given as illustration.

Keywords: Acceptance sampling; consumer's risk; operating characteristic function; producer's risk; truncated life tests; producer's risk

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1. Introduction

Acceptance sampling is the most popularly used sampling because it is simple for practical implementation. The decision on the lot disposition (acceptance or rejection) by acceptance sampling is based on the single inspection or life test. Today, products are produced to be of high reliability. To collect product lifetime information, products must suffer a destructive life test. Due to the fact that it could take long experimental time to observe the complete lifetime of a high reliability item, the life test must be ended within a specified schedule and such life test is called a truncated life test. Acceptance sampling plans under a truncated life test have been investigated in the past few decades by many authors for example Epstein (1954), Sobel and Tischendrof (1959), Goode and Kao (1961), Gupta and Groll (1961), Gupta (1962), Fertig and Mann (1980), Kantam and Rosaiah (1998), Kantam *et al.* (2001), Baklizi (2003), Wu and Tsai (2005), Rosaiah and Kantam (2005) and Tsai and Wu (2006).

All these authors considered the design of acceptance sampling plans based on the population mean under a truncated life test. Whereas Lio *et al*. (2009) considered acceptance sampling plans from truncated life tests based on the Birnbaum-Saunders distribution for percentiles and contend that the acceptance sampling plans based on mean may not satisfy the requirement of engineering on the specific percentile of strength or breaking stress. Where the quality of a specified low percentile is concerned, the acceptance sampling plans based on the population mean could pass a lot which has the low percentile below the required standard of consumers. Furthermore, a small decrease in the mean with a simultaneous small increase in the variance can result in a significant downward shift in small percentiles of interest. This means that a lot of products could be accepted due to a small decrease in the mean life after inspection. But the material strengths of products are deteriorated significantly and may not meet the consumer’s expectation. Therefore, engineers pay more attention to the percentiles of lifetimes than the mean life in life testing applications. Moreover, most of the employed life distributions are not symmetric. In viewing Marshall and Olkin (2007), the mean life may not be adequate to describe the central tendency of the distribution. This reduces the feasibility of acceptance sampling plans if they are developed based on the mean life of products.

Actually, percentiles provide more information regarding a life distribution than the mean life does. When the life distribution is symmetric, the 50th percentile or the median is equivalent to the mean life. Hence, developing acceptance sampling plans based on percentiles of a life distribution can be treated as a generalization of developing acceptance sampling plans based on the mean life of items. In view of this, more authors are proposing the acceptance sampling plans based on percentile, see for example, Balakrishnan *et al*. (2007), Lio *et al*. (2009, 2010), Rao and Kantam (2010), Rao *et al*. (2012) and Rao (2013a, 2013b). They argued that the sampling plans proposed at the mean life in a skewed distribution will pass out the product with lower percentiles. These reasons motivate to develop acceptance sampling plans based on the percentiles of the exponentiated half logistic distribution under a truncated life test.

The rest of the article is organized as follows. We describe the exponentiated half logistic distribution in Section 2. The proposed sampling plans are established for the exponentiated half logistic percentiles under a truncated life test, along with the operating characteristic (OC) and some relevant tables are given in Section 3. Two examples based on real fatigue life data sets are provided for the illustration in Section 4 and some conclusions are made in Section 5.

2. The Exponentiated Half Logistic Distribution

The class of distributions $\left[F_T(.)\right]^{\alpha}$ can be defined as the exponentiated class of distributions with base distribution $F_T(.)$ where α is a positive real number. On similar lines Gupta and Kundu (1999) proposed a new model called generalized exponential distribution or exponentiated exponential distribution. In this paper, we stick to the terminology of Mudholkar and Srivastava (1993) as the exponentiated half logistic distribution with base distribution consider as half logistic distribution.

Half logistic model obtained as the distribution of absolute standard logistic variate is a probability model of recent origin (Balakrishnan, 1985). The probability density function, cumulative distribution function and hazard function with scale parameter σ are given by

$$f(t;\sigma)=\frac{2e^{-t/\sigma}}{\sigma(1+e^{-t/\sigma})^{2}}; \quad t\geq 0 \tag{1}$$

$$F(t;\sigma)=\left(\frac{1-e^{-t/\sigma}}{1+e^{-t/\sigma}}\right); \quad t\geq 0 \tag{2}$$

and

$$h(t;\sigma)=\frac{1}{1+e^{-t/\sigma}}; \quad t\geq 0 \tag{3}$$

As this model is free from any shape parameter with IFR nature, it would be more useful in reliability studies and survival analysis. This model is parallel to half normal distribution also. If α is a positive real number, the cumulative distribution function (cdf) of exponentiated half logistic distribution is given by

$$F(t;\alpha,\sigma)=\left[F(t;\sigma)\right]^{\alpha}=\left(\frac{1-e^{-t/\sigma}}{1+e^{-t/\sigma}}\right)^{\alpha}; \quad t\geq 0 \tag{4}$$

and the probability density function (pdf) of exponentiated half logistic distribution (EHLD) with $\alpha > 0$ and $\sigma > 0$ is given by

$$f(t;\sigma,\alpha)=\frac{2\alpha(1-e^{-t/\sigma})^{\alpha-1}e^{-t/\sigma}}{\sigma(1+e^{-t/\sigma})^{\alpha+1}}; \quad t\geq 0\,. \tag{5}$$

The hazard function is given by

$$h(t;\sigma,\alpha)=\frac{2\alpha(1-e^{-t/\sigma})^{\alpha-1}e^{-t/\sigma}}{\sigma(1+e^{-t/\sigma})\left[(1+e^{-t/\sigma})^{\alpha}-(1-e^{-t/\sigma})^{\alpha}\right]}; \quad t\geq 0. \tag{6}$$

Here, α and σ are the shape and scale parameters respectively. Given $0<q<1$ the $100q^{th}$ percentile (or the q^{th} quantile) is given by

$$t_q = \sigma\left[-\ln\left(\frac{1-q^{1/\alpha}}{1+q^{1/\alpha}}\right)\right]. \tag{7}$$

The t_q is increases as q increases. Let $\eta = -\ln\left(\frac{1-q^{1/\alpha}}{1+q^{1/\alpha}}\right)$. Then, Equation (7) implies that

$$\sigma = t_q/\eta. \tag{8}$$

To develop acceptance sampling plans for the exponentiated half logistic percentiles, the scale parameter σ in the exponentiated half logistic cdf is replaced by Equation (8) and the exponentiated half logistic cdf is rewritten as

$$F(t) = \left(\frac{1-e^{-t/(t_q/\eta)}}{1+e^{-t/(t_q/\eta)}}\right)^{\alpha}; \quad t>0.$$

Letting $\delta = t/t_q$, F(t) can be rewritten emphasizing its dependence on δ as

$$F(t;\alpha,\delta) = \left(\frac{1-e^{-\delta\eta}}{1+e^{-\delta\eta}}\right)^{\alpha}; \quad t>0. \tag{9}$$

Taking partial derivative with respect to δ, we have

$$\frac{\partial F(t;\delta)}{\partial \delta} = 2\alpha\eta e^{-\delta\eta}\frac{(1-e^{-\delta\eta})^{\alpha-1}}{(1+e^{-\delta\eta})^{\alpha+1}}; \quad t>0.$$

3. Acceptance Sampling Plans

A common practice in life testing is to terminate the life test by a pre-determined time *t*, the probability of rejecting a bad lot be at least p^*, and the maximum number of allowable bad items to accept the lot be *c*. The acceptance sampling plan for percentiles under a truncated life test is to set up the minimum sample size *n* for this given acceptance number *c* such that the consumer's risk, the probability of accepting a bad lot, does not exceed 1- p^*. A bad lot means that the true $100q^{th}$ percentile, t_q, is below the specified percentile, t_q^0. Thus, the probability p^* is a confidence level in the sense that the chance of rejecting a bad lot with $t_q < t_q^0$ is at least equal to p^*. Therefore, for a given p^*, the proposed acceptance sampling plan can be characterized by the triplet $(n, c, t/t_q^0)$.

3.1. Minimum Sample Size

For a fixed p^* our sampling plan is characterized by $(n, c, t/t_q^0)$. Here, we consider sufficiently large sized lots so that the binomial distribution can be applied. The problem is to determine for given values of p^* ($0 < p^* < 1$), t_q^0 and c, the smallest positive integer, n required to assert that $t_q > t_q^0$ must satisfy

$$\sum_{i=0}^{c} \binom{n}{i} p_0^i \left(1-p_0\right)^{(n-i)} \leq (1-p^*), \tag{10}$$

where $p = F(t;\delta_0)$ is the probability of a failure during the time t given a specified $100q^{th}$ percentile of lifetime t_q^0 and depends only on $\delta_0 = t/t_q^0$, since $\partial F(t;\delta)/\partial\delta > 0$, $F(t;\delta)$ is a nondecreasing function of δ. Accordingly, we have

$$F(t,\,\delta) < F(t,\,\delta_0) \Leftrightarrow \delta \leq \delta_0,$$

or equivalently,

$$F(t,\,\delta) \leq F(t,\,\delta_0) \Leftrightarrow t_q \geq t_q^0.$$

The smallest sample size n satisfying the inequality (10) can be obtained for any given q, t/t_q^0, p^*. To save space, only the results of small sample sizes for q = 0.1, t/t_q^0 =0.7, 0.9, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5; p^* =0.75, 0.90, 0.95, 0.99; c = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and $\alpha = 2$ are reported in Table 1.

If $p = F(t;\delta_0)$ is small and n is large the binomial probability may be approximated by Poisson probability with parameter $\lambda = np$ so that the left side of (10) can be written as

$$\sum_{i=0}^{c} \frac{\lambda^i e^{-\lambda}}{i\,!} \leq 1 - p^*, \tag{11}$$

where $\lambda = n\,F(t;\delta_0)$. The minimum values of n satisfying (11) are obtained for the same combination of q, t/t_q^0 and p^* values as those used for (10). The results are reported in Table 2.

3.2. Operating Characteristic of the Sampling Plan $(n, c, t/t_q^0)$

The operating characteristic (OC) function of the sampling plan $(n, c, t/t_q^0)$ is the probability of accepting a lot. It is given as

$$L(p) = \sum_{i=0}^{c} \binom{n}{i} p^i (1-p)^{(n-i)} , \tag{12}$$

where $p = F(t;\delta)$. It should be noticed that $F(t;\delta)$ can be represented as a function of $\delta = t/t_q$. Therefore, $p = F(\frac{t}{t_q^0}\frac{1}{d_q})$ where $d_q = t_q/t_q^0$. Using Eq. (12), the OC values and OC curves can be obtained for any sampling plan $(n, c, t/t_q^0)$. To save space, we present Table 3 to show the OC values for the sampling plan $(n, c = 5, t/t_{0.1}^0)$. Figure1 shows the OC curves for the sampling plan $(n, c, t/t_{0.1}^0)$ with $\alpha = 2$ and p^* =0.90 for $\delta_0 = 1$, where c = 0,1,2,3,4,5,6,7,8,9,10.

3.3. Producer's Risk

The producer's risk is defined as the probability of rejecting of the lot when $t_q > t_q^0$. For the sampling plan under consideration and a given value for the producer's risk, say γ, one may be interested in knowing the value of d_q that will ensure the producer's risk to be at most γ. The sampling plan $(n, c, t/t_q^0)$ is developed at a specified confidence level p^*. Based on (9), the probability $p = F(t;\delta)$, with fixed α, F(.) may be obtained as function of d_q, that is, $p = F(\frac{t}{t_q^0}\frac{1}{d_q})$, $d_q = t_q/t_q^0$. Then, d_q is the smallest positive number for which $p = F(\frac{t}{t_q^0}\frac{1}{d_q})$ satisfies the inequality

$$\sum_{i=0}^{c} \binom{n}{i} p^i (1-p)^{(n-i)} \geq (1-\gamma) . \tag{13}$$

To save space, based on sampling plans $(n, c, t/t_q^0)$ established in Tables 1 the minimum ratios of $d_{0.1}$ for the acceptability of a lot at the producer's risk of γ =0.05 are presented in Table 4.

4. Illustrative Examples and Discussion

In this section, two examples with real data sets are given to illustrate the proposed acceptance sampling plans. The first data set is of the data given arisen in tests on endurance of deep groove ball bearings (Lawless (1982), p.228). The data are the number of million revolutions before failure for each of the 23 ball bearings in life test and they are: 17.88, 28.92, 33.00, 41.52, 42.12, 45.60, 48.80, 51.84, 51.96, 54.12, 55.56, 67.80, 68.44, 68.64, 68.88, 84.12, 93.12, 98.64, 105.12, 105.84, 127.92, 128.04 and 173.40. The second data set regarding the software reliability was presented by Wood (1996), analyzed via the acceptance sampling viewpoint by Rosaiah and

Kantam (2005), Balakrishnan *et al.* (2007), Lio *et al.* (2009) and Rao and Kantam (2010). The software reliability data set was reported in hours as 519, 968, 1430, 1893, 2490, 3058, 3625, 4422, and 5218. As the confidence level is assured by this acceptance sampling plan only if the lifetimes are from the exponentiated half logistic distribution. Then, we should check if it is reasonable to admit that the given sample comes from the exponentiated half logistic distribution by the goodness of fit test and model selection criteria.

The first data set was used by Sultan (2007) to demonstrate the goodness of fit for generalized exponential distribution and Gupta and Kundu (1999) fitted for extended exponential distribution. However, the acceptance sampling plans under the truncated life test based on the exponentiated half logistic distribution for percentiles has not yet been developed. Balakrishnan *et al.* (2007) compared the goodness of fits among the Rayleigh, generalized BS, and BS distributions for the software reliability data set presented here using probability plots and showed that the generalized BS model (R-square (RS) = 0.97) was slightly better than the BS model (RS = 0.96) and both models were much better than the Rayleigh model (RS = 0.87). We have applied QQ plot and RS method to test the goodness of fit for both data sets for exponentiated half logistic distribution and we got RS = 0.9809 for first data set and RS=0.9909 for second data set. Therefore, it is clear that exponentiated half logistic model fits quite well to both the data sets.

4.1. Example 1.

Assume that the lifetime distribution is exponentiated half logistic distribution and that the experimenter is interested to establish the true unknown 10th percentile lifetime for the ball bearings to be at least 20 million revolutions with confidence p^* =0.75 and the life test would be ended at 40 million revolutions, which should have led to the ratio $t/t_{0.1}^0$ = 2.0. Thus, for an acceptance number c =5 and the confidence level p^* =0.75, the required sample size n found from Table 1 should be at least 23. Therefore, in this case, the acceptance sampling plan from truncated life tests for the exponentiated half logistic distribution 10th percentile should be $(n, c, t/t_q^0)$ = (23, 5, 2.0). Based on the ball bearings data, the experimenter must have decided whether to accept or reject the lot. The lot should be accepted only if the number of items of which lifetimes were less than or equal to the scheduled test lifetime, 40 million revolutions, was at most 5 among the first 23 observations. Since there were 3 items with a failure time less than or equal to 40 million revolutions in the given sample of n =23 observations, the experimenter would accept the lot, assuming the 10th percentile lifetime $t_{0.1}$ of at least 20 million revolutions with a confidence level of p^* =0.75. The OC values for the acceptance sampling plan $(n, c, t/t_q^0)$ = (23,5,2.0) and confidence level p^* =0.75 under exponentiated half logistic distribution from Table 3 is as follows:

$t_{0.1}/t_{0.1}^0$	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75
OC	0.2140	0.6001	0.8464	0.9468	0.9818	0.9936	0.9976	0.9991

This shows that if the true 10^{th} percentile is equal to the required 10^{th} percentile ($t_{0.1}/t_{0.1}^0$ = 2.00) the producer's risk is approximately 0.7860 (=1- 0.2140). The producer's risk is almost equal to zero when the true 10^{th} percentile is greater than or equal to 2.50 times the specified 10^{th} percentile.

From Table 4, the experimenter could get the values of $d_{0.1}$ for different choices of c and $t/t_{0.1}^0$ in order to assert that the producer's risk was less than 0.05. In this example, the value of $d_{0.1}$ should be 1.7489 for c = 5, $t/t_{0.1}^0$ =2.0 and p^* =0.75. This means the product can have a 10^{th} percentile life of 1.7489 times the required 10^{th} percentile lifetime in order that under the above acceptance sampling plan the product is accepted with probability of at least 0.95.

Alternatively, assume that products have an exponentiated half logistic distribution and consumers wish to reject a bad lot with probability of p^* =0.75. What should the true 10^{th} percentile life of products be so that the producer's risk is 0.05 if the acceptance sampling plan is based on an acceptance number c =5 and $t/t_{0.1}^0$ =0.7. From Table 4, we can find that the entry for p^* =0.75, c = 5, and $t/t_{0.1}^0$ =0.7 is $d_{0.1}$ = 1.7030. Thus, the manufacturer's product should have a 10^{th} percentile life at least 1.7030 times the specified 10^{th} percentile life in order for the products to be accepted with probability 0.75 under the above acceptance sampling plan. Table 1 indicates that the number of products required to be tested is n = 56 so that the sampling plan is $(n, c, t/t_{0.1}^0)$ = (146, 5, 0.7).

4.2. Example 2.

Suppose an experimenter would like to establish the true unknown 10^{th} percentile lifetime for the software mentioned above to be at least 100h and the life test would be ended at 250 h, which should have led to the ratio $t/t_{0.1}^0$ =2.5. The goodness of fit test for these nine observations were verified and showed that exponentiated half logistic model as a reasonable goodness of fit for these nine observations. Thus, with c = 1 and p^* =0.95, the experimenter should find from Table 1 the sample size n must be at least 9 and the sampling plan to be $(n, c, t/t_{0.1}^0)$ = (9, 1, 2.5). Since there were no items with a failure time less than or equal to 250h in the given sample of n =9 observations, the experimenter would accept the lot, assuming the 10^{th} percentile lifetime $t_{0.1}$ of at least 100h with a confidence level of p^* =0.95.

The acceptance sampling plans based on the exponentiated half logistic population mean could have less chance to report a failure than the acceptance sampling plans based on 10^{th} percentile. The acceptance sampling plans based on population mean could accept the lot of bad quality of the 10^{th} percentiles. The minimum sample sizes are reported in Table 1 of this article for the 10^{th} percentiles are compared with the minimum sample sizes are reported in Table 1 of Lio *et al*. (2009) and Rao and Kantam (2010). It shows that the minimum sample sizes using exponentiated half logistic population are smaller than those reported in Tables 1 of Lio *et al*. (2010) whereas, the minimum sample sizes using exponentiated half logistic population are very close to those reported in Tables 1 of Rao and Kantam (2010) for the 10^{th} percentile.

5. Conclusions

This article has inferred the acceptance sampling plans based on the exponentiated half logistic percentiles when the life test is truncated at a pre-fixed time. The procedure is provided to construct the proposed sampling plans for the percentiles of the exponentiated half logistic distribution with known parameter α =2. To ensure that the life quality of products exceeds a specified one in terms of the life percentile, the acceptance sampling plans based on percentiles should be used. Some useful tables are provided and applied to establish acceptance sampling plans for two examples.

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Table 1. Minimum sample sizes necessary to assert the 10th percentile to exceed a given values, $t_{0.1}^{0}$, with probability p^* and the corresponding acceptance number, *c*, for the exponentiated half logistic distribution using the binomial approximation with $\alpha = 2$.

p^*	c	$t/t_{0.1}^{0}$							
		0.7	0.9	1.0	1.5	2.0	2.5	3.0	3.5
0.75	0	27	17	14	6	4	3	2	2
0.75	1	53	32	27	13	8	5	4	4
0.75	2	77	47	39	18	11	8	6	5
0.75	3	100	62	51	24	15	11	8	7
0.75	4	123	76	62	30	18	13	10	9
0.75	5	146	90	73	35	23	15	12	10
0.75	6	168	103	85	40	25	18	14	12
0.75	7	190	117	96	46	28	20	16	13
0.75	8	212	131	107	51	32	23	18	15
0.75	9	234	144	118	56	35	25	20	17
0.75	10	256	158	129	62	38	27	22	18
0.90	0	45	27	22	10	6	4	3	3
0.90	1	76	46	38	18	11	7	6	5
0.90	2	104	64	52	24	15	10	8	7
0.90	3	130	80	65	31	19	13	10	8
0.90	4	156	96	78	37	23	16	12	10
0.90	5	181	111	91	43	26	19	14	12
0.90	6	206	127	104	49	30	21	16	14
0.90	7	230	142	116	55	34	24	18	15
0.90	8	254	156	128	61	37	26	20	17
0.90	9	278	171	140	66	41	29	22	19
0.90	10	301	186	152	72	44	31	24	20
0.95	0	58	35	29	13	8	5	4	3
0.95	1	92	56	46	21	13	9	7	5
0.95	2	122	75	61	29	17	12	9	7
0.95	3	151	93	76	35	21	15	11	9
0.95	4	178	109	89	42	25	18	14	11
0.95	5	205	126	103	48	29	21	16	13
0.95	6	231	142	116	55	33	23	18	15
0.95	7	256	158	129	61	37	26	20	17
0.95	8	282	173	142	67	41	29	22	18
0.95	9	307	188	154	73	44	31	24	20
0.95	10	331	204	167	79	48	34	26	22
0.99	0	89	54	44	20	12	8	6	5
0.99	1	128	79	64	30	18	12	9	7
0.99	2	163	100	81	38	22	15	12	9
0.99	3	195	119	97	45	27	19	14	11
0.99	4	225	138	113	53	32	22	17	13
0.99	5	255	156	127	60	36	25	19	15
0.99	6	283	174	142	66	40	28	21	17
0.99	7	311	191	156	73	44	31	23	19
0.99	8	339	208	170	80	48	34	26	21
0.99	9	366	224	183	86	52	36	28	23
0.99	10	392	241	197	92	56	39	30	25

Table 2. Minimum sample sizes necessary to assert the 10th percentile to exceed a given values, $t_{0.1}^{0}$, with probability p^{*} and the corresponding acceptance number, c, for the exponentiated half logistic distribution using the Poisson approximation with $\alpha = 2$.

p^*	c	$t/t_{0.1}^{0}$							
		0.7	0.9	1.0	1.5	2.0	2.5	3.0	3.5
0.75	0	28	17	14	7	5	4	3	3
0.75	1	45	28	23	11	7	5	4	4
0.75	2	75	47	38	19	12	9	7	6
0.75	3	100	62	51	25	16	12	9	8
0.75	4	124	77	63	31	19	14	12	10
0.75	5	147	91	75	36	23	17	14	12
0.75	6	169	105	86	42	26	19	16	13
0.75	7	191	119	97	47	30	22	18	15
0.75	8	213	132	109	53	33	24	19	17
0.75	9	235	146	120	58	37	27	21	18
0.75	10	257	159	131	63	40	29	23	20
0.90	0	46	29	24	12	7	6	5	4
0.90	1	71	44	36	18	11	8	7	6
0.90	2	104	64	53	26	16	12	10	8
0.90	3	132	82	67	33	21	15	12	10
0.90	4	158	98	80	39	25	18	15	12
0.90	5	183	114	93	45	29	21	17	14
0.90	6	208	129	106	51	32	24	19	16
0.90	7	232	144	118	57	36	26	21	18
0.90	8	257	159	130	63	40	29	23	20
0.90	9	280	174	143	69	43	32	25	22
0.90	10	304	188	155	75	47	34	28	24
0.95	0	60	37	30	15	10	7	6	5
0.95	1	89	55	46	22	14	10	8	7
0.95	2	124	77	63	31	19	14	11	10
0.95	3	153	95	78	38	24	18	14	12
0.95	4	181	112	92	45	28	21	17	14
0.95	5	208	129	106	51	32	24	19	16
0.95	6	234	145	119	58	36	27	21	18
0.95	7	260	161	132	64	40	29	24	20
0.95	8	285	176	145	70	44	32	26	22
0.95	9	310	192	158	76	48	35	28	24
0.95	10	335	207	170	82	52	38	30	26
0.99	0	91	57	47	23	14	11	9	7
0.99	1	128	79	65	32	20	15	12	10
0.99	2	166	103	84	41	26	19	15	13
0.99	3	198	123	101	49	31	23	18	16
0.99	4	229	142	117	57	36	26	21	18
0.99	5	259	160	132	64	40	29	24	20
0.99	6	288	178	146	71	45	33	26	22
0.99	7	316	195	160	78	49	36	29	25
0.99	8	343	213	175	85	53	39	31	27
0.99	9	371	229	188	91	57	42	34	29
0.99	10	397	246	202	98	61	45	36	31

Table 3. Operating characteristic values of the sampling plan $(n, c = 5, t / t_{0.1}^{0})$ for a given p^* Under exponentiated half logistic distribution with $\alpha = 2$.

p^*	n	$t / t_{0.1}^{0}$	$t_{0.1} / t_{0.1}^{0}$							
			1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75
0.75	146	0.70	0.2499	0.6543	0.8790	0.9610	0.9874	0.9957	0.9985	0.9994
0.75	90	0.90	0.2390	0.6366	0.8684	0.9565	0.9856	0.9950	0.9982	0.9993
0.75	73	1.00	0.2140	0.6001	0.8464	0.9468	0.9818	0.9936	0.9976	0.9991
0.75	35	1.50	0.2489	0.6272	0.8574	0.9505	0.9829	0.9939	0.9978	0.9991
0.75	22	2.00	0.2193	0.5821	0.8277	0.9364	0.9771	0.9916	0.9968	0.9987
0.75	15	2.50	0.2133	0.5608	0.8093	0.9262	0.9723	0.9895	0.9959	0.9983
0.75	12	3.00	0.0988	0.4508	0.7610	0.9106	0.9679	0.9883	0.9956	0.9982
0.75	10	3.50	0.0993	0.4498	0.7595	0.9097	0.9674	0.9881	0.9955	0.9982
0.90	181	0.70	0.0976	0.4452	0.7559	0.9078	0.9666	0.9878	0.9953	0.9982
0.90	111	0.90	0.0944	0.4316	0.7431	0.9007	0.9634	0.9864	0.9948	0.9979
0.90	91	1.00	0.0948	0.4227	0.7324	0.8941	0.9601	0.9849	0.9941	0.9976
0.90	43	1.50	0.0719	0.3614	0.6778	0.8631	0.9456	0.9786	0.9914	0.9964
0.90	26	2.00	0.0927	0.3935	0.6977	0.8717	0.9488	0.9798	0.9918	0.9966
0.90	19	2.50	0.0665	0.3221	0.6274	0.8277	0.9265	0.9693	0.9871	0.9944
0.90	14	3.00	0.0490	0.3309	0.6667	0.8623	0.9469	0.9796	0.9920	0.9967
0.90	12	3.50	0.0483	0.3269	0.6622	0.8595	0.9455	0.9790	0.9917	0.9966
0.95	205	0.70	0.0479	0.3247	0.6596	0.8579	0.9447	0.9787	0.9916	0.9966
0.95	126	0.90	0.0491	0.3213	0.6531	0.8530	0.9421	0.9774	0.9910	0.9963
0.95	103	1.00	0.0481	0.3091	0.6368	0.8419	0.9363	0.9747	0.9898	0.9958
0.95	48	1.50	0.0355	0.2572	0.5779	0.8032	0.9163	0.9653	0.9856	0.9938
0.95	29	2.00	0.0351	0.2446	0.5564	0.7857	0.9060	0.9601	0.9830	0.9926
0.95	21	2.50	0.0347	0.2315	0.5328	0.7655	0.8935	0.9534	0.9797	0.9910
0.95	16	3.00	0.0097	0.1540	0.4663	0.7334	0.8818	0.9498	0.9787	0.9908
0.95	13	3.50	0.0098	0.1532	0.4640	0.7313	0.8804	0.9491	0.9784	0.9906
0.99	255	0.70	0.0100	0.1537	0.4642	0.7311	0.8802	0.9489	0.9783	0.9906
0.99	156	0.90	0.0086	0.1387	0.4372	0.7084	0.8665	0.9419	0.9749	0.9890
0.99	127	1.00	0.0083	0.1299	0.4176	0.6899	0.8546	0.9354	0.9717	0.9874
0.99	60	1.50	0.0076	0.1175	0.3901	0.6631	0.8368	0.9255	0.9666	0.9849
0.99	36	2.00	0.0070	0.1057	0.3614	0.6332	0.8158	0.9134	0.9602	0.9816
0.99	25	2.50	0.0085	0.1099	0.3605	0.6272	0.8095	0.9089	0.9575	0.9802
0.99	19	3.00	0.2499	0.6543	0.8790	0.9610	0.9874	0.9957	0.9985	0.9994
0.99	15	3.50	0.2390	0.6366	0.8684	0.9565	0.9856	0.9950	0.9982	0.9993

Table 4. Minimum ratio of true $d_{0.1}$ for the acceptability of a lot for the exponentiated half logistic distribution for producer's risk of 0.05 when $\alpha = 2$.

p^*	c	$t/t_{0.1}^0$							
		0.7	0.9	1.0	1.5	2.0	2.5	3.0	3.5
0.75	0	5.3639	5.4086	5.3107	5.7800	6.2531	6.1226	7.1423	8.1619
0.75	1	2.7732	2.8249	2.9061	3.0021	2.8877	3.0423	3.5537	4.0617
0.75	2	2.2075	2.2292	2.2292	2.2738	2.3624	2.3810	2.4649	2.8161
0.75	3	1.9600	1.9685	1.9857	2.0392	2.1249	2.0859	2.2237	2.5407
0.75	4	1.8044	1.8044	1.8409	1.8447	1.8986	1.9186	2.0812	2.3810
0.75	5	1.7030	1.6966	1.7191	1.7658	1.7489	1.8116	1.8522	2.1151
0.75	6	1.6239	1.6327	1.6356	1.6717	1.7094	1.7322	1.8080	2.0670
0.75	7	1.5706	1.5733	1.5926	1.5982	1.6239	1.6748	1.6717	1.9106
0.75	8	1.5284	1.5284	1.5413	1.5733	1.6038	1.6297	1.6565	1.8947
0.75	9	1.4908	1.4932	1.5006	1.5258	1.5466	1.5926	1.6415	1.8790
0.75	10	1.4643	1.4620	1.4786	1.4883	1.4981	1.5598	1.5598	1.7832
0.90	0	6.7650	6.7852	6.8568	7.0811	7.2218	7.5081	8.7596	10.0030
0.90	1	3.3445	3.3693	3.4459	3.5537	3.4855	3.8388	4.0437	4.6189
0.90	2	2.5840	2.5840	2.5988	2.6991	2.6911	2.8425	3.0525	3.4990
0.90	3	2.2346	2.2292	2.2738	2.3261	2.3502	2.4062	2.4384	2.7816
0.90	4	2.0346	2.0300	2.0623	2.1200	2.1501	2.1654	2.2401	2.5621
0.90	5	1.8986	1.9026	1.9227	1.9433	2.0255	2.0076	2.1151	2.4125
0.90	6	1.8080	1.8116	1.8262	1.8560	1.8790	1.8986	2.0210	2.3143
0.90	7	1.7355	1.7355	1.7556	1.7902	1.8225	1.8152	1.8636	2.1299
0.90	8	1.6748	1.6779	1.6998	1.7126	1.7322	1.7522	1.8225	2.0859
0.90	9	1.6297	1.6327	1.6415	1.6748	1.6998	1.7030	1.7902	2.0437
0.90	10	1.5926	1.5926	1.6067	1.6210	1.6385	1.6595	1.6966	1.9391
0.95	0	7.6988	7.7912	7.8180	8.1766	8.0821	8.6678	8.7596	10.0030
0.95	1	3.6832	3.7133	3.7286	3.8880	3.9904	4.1929	4.0437	4.6189
0.95	2	2.8074	2.8074	2.8694	2.8877	2.9824	3.0423	3.0525	3.4990
0.95	3	2.4125	2.4190	2.4254	2.4582	2.5478	2.5549	2.6288	3.0021
0.95	4	2.1706	2.1758	2.2075	2.2237	2.3084	2.3810	2.3872	2.7315
0.95	5	2.0255	2.0300	2.0392	2.0670	2.1501	2.1863	2.2292	2.5478
0.95	6	1.9146	1.9186	1.9433	1.9600	1.9857	2.0483	2.1200	2.4254
0.95	7	1.8335	1.8335	1.8560	1.8790	1.9106	1.9474	2.0392	2.3321
0.95	8	1.7658	1.7727	1.7902	1.8188	1.8522	1.8674	1.9026	2.1706
0.95	9	1.7126	1.7159	1.7355	1.7455	1.7727	1.8044	1.8560	2.1249
0.95	10	1.6717	1.6748	1.6903	1.7062	1.7388	1.7556	1.8225	2.0812
0.99	0	9.5712	9.5914	9.7040	10.0140	10.2281	10.6225	11.3097	12.9349
0.99	1	4.3956	4.3956	4.4823	4.5956	4.6425	4.7893	4.8924	5.5835
0.99	2	3.2489	3.2373	3.3080	3.3080	3.3693	3.5817	3.5537	4.0617
0.99	3	2.7315	2.7397	2.7647	2.8161	2.9155	2.9438	2.9727	3.4072
0.99	4	2.4516	2.4582	2.4919	2.5407	2.5840	2.6752	2.6596	3.0321
0.99	5	2.2568	2.2568	2.2967	2.3321	2.3747	2.4319	2.6518	3.0321
0.99	6	2.1249	2.1299	2.1450	2.1810	2.2292	2.2568	2.3084	2.6364
0.99	7	2.0210	2.0255	2.0437	2.0717	2.1249	2.1299	2.1968	2.5126
0.99	8	1.9391	1.9433	1.9685	1.9857	2.0392	2.0812	2.1151	2.4190
0.99	9	1.8713	1.8751	1.8947	1.9186	1.9391	1.9944	2.0483	2.3381
0.99	10	1.8188	1.8225	1.8335	1.8636	1.8868	1.9268	1.9944	2.2795

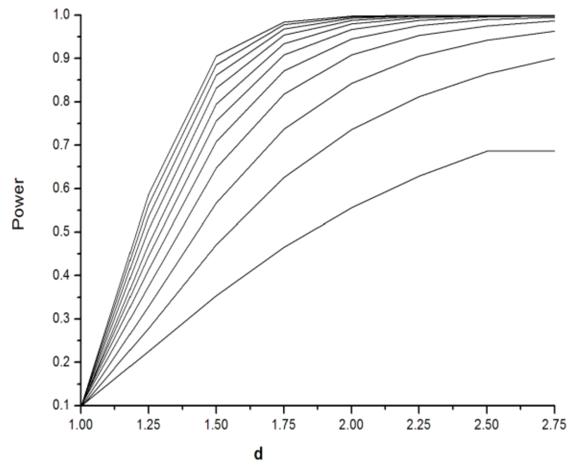

Figure 1. OC curves for c = 0,1,2,3,4,5,6,7,8,9,10, respectively under p^*=0.90, $\delta_0 = 1$ based on the 10th percentile, $d = d_{0.1}$, of exponentiated half logistic distribution with $\alpha = 2$.