Truncated Life Test Plan under Generalized Log-Logistic Distribution

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Abstract

This paper proposes combined continuous lot by lot acceptance sampling plan for the truncated life test based on generalized log-logistic distribution. For the proposed sampling plan, the minimum sample sizes necessary to ensure the specified average lifetime are obtained at the given consumer's confidence level. The operating characteristic values are analysed with ratios of various true average lifetime two the specified life time of the product. The minimum ratios of the true population average lifetime to the specified lifetime are also obtained at the specified producer's risk. Selection and application of combined continuous lot by lot truncated life test sampling plan is illustrated with a numerical example. The advantage of proposed plan is analysed with single sampling truncated life test plan under generalized log-logistic distribution using numerical values.

***Keywords*: combined continuous lot by lot acceptance sampling plan, consumer's confidence level, producer risk, operating characteristic values and binomial model.**

1. INTRODUCTION

Acceptance sampling is an inspection procedure used to determine whether to accept or reject a specific quantity of material. More firms initiate total quality management programs and work closely with suppliers to ensure high levels of quality. The total quality management concept is that no defects should be passed from a producer to a customer, whether the customer is an external or internal member. However, in reality, many firms still rely on checking their material input and output.

For production process, involving very low fraction non confirming Pesotchinsky (1987) devised a scheme that includes both the strategies of continuous plan of Dodge (1943) and lot by lot inspection plan formed together with certain criteria for switching between the strategies. The scheme proposed by Pesotchinsky (1987) is complex and difficult to implement. As an alternative to Pesotchinsky's complex scheme Govindaraju and Bebbington (2000) recommended a simple combined continuous lot by lot plan. Subhalakshmi and Muthulakshmi (2015) presented designing of combined continuous lot by lot acceptance sampling plan. This plan promotes confidence to consumers in buying the product due to inspection of lot by lot following individual units. Generalised log-logistic distribution is a continuous probability distribution for a non negative random variable which is a generalisation of log-logistic distribution.

Several truncated life test sampling plan are available in the literature following Epstein (1954) and Gupta and Groll (1961) with various life time distributions. Log-logistic model is used in survival analysis as a parametric model for events whose rate increases initially and decreases later and also used as a basis of a failure model. This renders the generalised log-logistic distribution, the general form of log-logistic distribution suitable for studying situations like mortality from cancer following treatment, stream flow and precipitation in hydrology, survival data. Kantam and Rosaiah (1988) developed life test plans under half- logistic distribution. Kantam et.al (2001) developed acceptance sampling plan for truncated life test under log-logistic model. Kantam et.al (2006) developed test plans using log-logistic distribution and shown its superiority. Aslam and Jun (2010) proposed A double acceptance sampling plan for generalized log-logistic distributions with known shape parameters. Srinivasan Rao et.al. (2013) presented an economic reliability test plan generalized log-logistic distribution. Gomathi and Muthulakshmi (2014) proposed truncated life test plan using skip lot plan sampling plans based on generalized log-logistic model. Theerthana and Muthulakshmi (2016) designed truncated life test plan under log-logistic distribution with combined lot by lot acceptance sampling plan. This motivated the investigator to design truncated life test plan under generalised log-logistic distribution using the continuous lot by lot sampling plan.

This paper presents the designing of a combined continuous lot by lot acceptance sampling truncated life test plan under generalised log-logistic distribution. The minimum sample size necessary to ensure the specified average life time is obtained at the given consumer's confidence level, acceptance number, termination ratio and clearance number. The operating characteristic values are analysed with various ratios of the true average lifetime to the specified average lifetime of the product. The minimum ratios of the average lifetime to the specified average lifetime are obtained at the specified producer's risk. Selection and application of sampling plan is illustrated with an example. A comparatively study is carried out with single sampling truncated life test plan under generalized log-logistic distribution.

2. Generalized log-logistic distributions

The lifetime of a product is assumed to have the generalized log-logistic distribution, whose probability density function and cumulative distribution function are given respectively as

$$f(t;\sigma,\theta,\gamma)=\left((\theta/\sigma)\ (t/\sigma)^{\theta-1}\left(1+(t/\sigma)^{\theta}\right)^{-2}\right)^{\gamma},$$

$t \geq 0,\ \sigma > 0,\ \theta > 0,\ \gamma > 0$ (1) and

$$F(t;\sigma,\theta,\gamma)=\left((t/\sigma)^{\theta}\left(1+(t/\sigma)^{\theta}\right)^{-1}\right)^{\gamma},\quad t \geq 0,\ \sigma > 0,$$

$\theta > 0, \gamma\ 0$ (2)

where t is a lifetime variant , σ is the scale parameter and θ, γ are shape parameters.

The generalized log-logistic distribution is considered to analyze the system reliability. since the failure probability of a parallel system with θ items having a log-logistic distributed lifetime is represented through cumulative distribution function.

In this the probability of failer is defined by

$$p=\left((t/\sigma)^{\theta}\left(1+(t/\sigma)^{\theta}\right)^{-1}\right)^{\gamma}$$

In a generalized log-logistic distribution the failure rate function is decreasing when $\theta \leq 1$ but increasing to certain level and then decreasing over time when $\theta > 1$. Due to its versatile failure rate pattern this distribution is an adopted as a lifetime model in this chapter. Therefore a combined continuous lot by lot acceptance sampling plan for truncated life test under the generalized log-logistic distribution using average lifetime is proposed.

3. Combined continuous lot by lot acceptance sampling plan

The operating procedure of combined continuous lot by lot acceptance sampling plan consists of the following steps. When the units are offered for inspection from a production process

Step 1: Start with the screening inspection of the units consecutively until i units in succession are conforming.

Step 2: When i units in succession are found conforming discontinue 100% inspection and form lot of desired size and inspect lot by lot by applying single sampling inspection plan as reference plan.

Step 3**:** If a lot is rejected revert to screening inspection of units otherwise, continue with lot by lot inspection.

Therefore combined continuous lot by lot acceptance sampling truncated life test plan denoted by (n, c, i, t/σ_0). It is defined in terms of the clearance number, i on test, the number of units n, on test, an acceptance number c and experiment time ratio t/σ_0. At the consumer's confidence level P^*, the probability of accepting a lot when the true average lifetime (σ) is below the specified lifetime(σ_0) not to exceed $(1-P^*)$. Here, we consider a lot of infinitely large size so that the binomial distribution may be applied to find the probability of acceptance. For given P^* $(0 < P^* < 1)$, t/σ_0, acceptance number c and clearance number i we want to find a smallest positive integer n such that

$$L(p) = \frac{Pq^i p}{D} \leq 1 - P^*$$

where $P = \sum_{i=0}^{c} \binom{n}{i} p^i (1-p)^{n-i}$ and

$$D = (1-P)(1-q^i) + pq^i$$

and $$p=\left((t/\sigma)^{\theta}\left(1+(t/\sigma)^{\theta}\right)^{-1}\right)^{\gamma}$$

at time t_0 it depends only on the ratio t/σ_0 . Therefore the experimenter needs to specify this ratio to design the plan.

If the number of observed failures is less than or equal to c, from equation (3) one may make the confidence statement that

$$P[F(t;\sigma)] \leq P[F(t;\sigma_0)]=P^* \Rightarrow P(\sigma \geq \sigma_0) = P^*$$

The minimum values of n satisfying inequality (3) are calculated for θ (=2), γ (=2, 3), t/σ_0 (= 0.315, 0.472, 0.629, 0.786, 1.180, 1.573, 1.966, 2.359) and i (=5), P^* (= 0.75, 0.90, 0.95, 0.99) for combined continuous lot by lot acceptance sampling truncated life test plan under generalized log-logistic distribution using equation (3) and presented in Tables 1 and 2. The values of t/σ_0 are considered from Srinivasa Rao et al. (2013).

The tabulated values reveal that minimum sample size

i. increases for increase in c for fixed i, θ, P^*, γ and t/σ_0
ii. increases for increase in P^* for fixed i, θ, c, γ and t/σ_0
iii. decreases for increase in P^* for fixed i, θ, c, γ and t/σ_0
iv. increases for increase in γ for fixed i, θ, c, P^* and t/σ_0

Table 1 Minimum size for combined continuous lot by lot truncated life test plan under generalised log-logistic distribution for θ=2, γ = 2 and i=5

P*	t/σ_0 \ c	0.315	0.472	0.629	0.786	1.180	1.573	1.966	2.359
0.75	0	49	12	5	2	1	1	1	1
	1	145	35	14	7	3	2	2	2
	2	248	60	24	12	5	3	3	3
	3	356	86	34	18	7	4	4	4
	4	465	112	45	24	9	6	5	5
	5	576	139	56	30	11	7	6	6
	6	687	167	67	36	14	9	7	7
	7	800	194	78	42	16	10	8	8
	8	913	222	90	48	19	12	9	9
	9	1027	249	101	54	21	13	11	10
	10	1141	277	112	60	24	15	12	11
0.90	0	111	26	10	5	1	1	1	1
	1	246	59	23	12	4	2	2	2
	2	378	91	36	18	6	3	3	3
	3	509	122	49	25	9	5	4	4
	4	639	154	61	32	11	7	5	5
	5	768	185	74	39	14	8	6	6
	6	897	217	87	46	17	10	7	7
	7	1025	248	99	52	19	11	9	8
	8	1153	279	112	59	22	13	10	9
	9	1280	310	125	66	25	15	11	10
	10	1408	341	137	73	28	17	13	11
0.95	0	173	41	16	8	2	1	1	1
	1	334	80	31	16	5	2	2	2
	2	486	116	46	24	8	4	3	3
	3	632	152	60	31	11	6	4	4
	4	776	187	74	39	14	7	5	5
	5	917	221	88	46	16	9	7	6
	6	1057	255	102	54	19	11	8	7
	7	1195	289	116	61	22	13	9	8
	8	1333	323	130	68	25	14	11	9
	9	1470	356	143	76	28	16	12	10
	10	1606	389	157	83	31	18	13	11
0.99	0	348	83	32	16	5	2	1	1
	1	558	134	53	27	9	4	2	2
	2	745	179	71	37	12	6	4	3
	3	921	222	88	46	16	8	5	4
	4	1091	263	105	55	19	10	7	5
	5	1256	303	121	64	23	12	8	6
	6	1417	343	137	72	26	14	10	8
	7	1575	381	153	81	30	16	11	9
	8	1731	419	169	89	33	18	13	10
	9	1886	457	184	98	36	20	14	11
	10	2038	494	199	106	40	22	16	13

Table 2 Minimum sample size for combined continuous lot by lot truncated life test plan under generalised log-logistic distribution for θ =2, γ = 3 and i =5

P^*	c \ t/σ_0	0.315	0.472	0.628	0.786	1.180	1.573	1.966	2.359
0.75	0	551	67	17	7	2	1	1	1
	1	1615	195	51	20	5	2	2	2
	2	2768	335	88	35	9	4	3	3
	3	3959	480	126	50	13	6	4	4
	4	5172	627	165	66	17	8	6	5
	5	6401	776	204	82	21	11	7	6
	6	7641	927	244	98	26	13	9	7
	7	8891	1079	284	114	30	15	10	8
	8	10147	1231	324	131	34	17	12	10
	9	11409	1384	365	147	39	20	13	11
	10	12676	1538	406	164	43	22	15	12
0.90	0	1244	150	39	15	3	1	1	1
	1	2747	332	87	34	8	3	2	2
	2	4219	511	133	53	13	6	3	3
	3	5673	687	180	72	18	8	5	4
	4	7116	862	226	90	23	10	7	5
	5	8550	1036	272	109	28	13	8	6
	6	9978	1210	318	127	32	15	10	8
	7	11402	1382	363	146	37	18	12	9
	8	12821	1555	409	164	42	20	13	10
	9	14237	1727	454	183	47	23	15	12
	10	15650	1898	500	201	52	26	17	13
0.95	0	1938	234	61	23	5	2	1	1
	1	3734	451	118	46	11	4	2	2
	2	5417	656	171	68	16	7	4	3
	3	7045	853	223	89	22	10	6	4
	4	8638	1047	274	110	27	12	8	6
	5	10210	1237	325	130	33	15	9	7
	6	11762	1426	375	150	38	18	11	8
	7	13301	1613	424	170	43	20	13	10
	8	14828	1798	473	190	49	23	15	11
	9	16346	1982	522	210	54	26	16	13
	10	17856	2166	570	229	59	29	18	14
0.99	0	3888	470	122	48	11	4	2	1
	1	6225	753	197	78	19	8	4	2
	2	8305	1006	263	105	26	11	6	4
	3	10262	1243	326	130	32	14	8	6
	4	12144	1472	386	154	39	18	10	7
	5	13973	1694	445	178	45	21	12	9
	6	15762	1911	502	201	51	24	14	10
	7	17520	2125	559	224	58	27	17	12
	8	19254	2335	614	247	64	30	19	13
	9	20966	2543	669	269	70	33	21	15
	10	22661	2749	724	291	76	36	23	18

4. Operating characteristics values

The performance of the sampling plan according to the submitted quality of the product is represented by the operating characteristic values. The probability of the acceptance will increase if the true lifetime increases beyond the specified lifetime. Therefore, we need to know the operating characteristic values for the proposed plan according to the ratio of the true average lifetime to the specified lifetime σ/σ_0 , Obviously, a plan will be more desirable if its operating characteristic values increase more sharply to one. The probability of acceptance for combined continuous lot by lot acceptance sampling truncated life test plan is

$$L(p) = \frac{Pq^i p}{D} \qquad (4)$$

Equation (4) gives the operating characteristic value as a function of the ratio σ/σ_0, P^*, t/σ_0 and θ. when i= 0 equation (4) reduces to the probability acceptance of single acceptance truncated life test plan. The operating characteristic values satisfying inequality (7) are calculated for P^* (= 0.75, 0.90, 0.95, 0.99), σ/σ_0 (=2, 4, 6, 8, 10, 12), t/σ_0(= 0.315, 0.472, 0.629, 0.786, 1.180, 1.573, 1.966, 2.359), i (= 5), γ (= 2,3) and θ (= 2) and presented in Tables 3 and 4.

From numerical values presented in Tables 3 and 4 it is seen that the operating characteristic value increases to one more rapidly as we move from a lower value to a higher value of the ratio σ/σ_0. It is also seen that operating characteristic value

i. decreases for increase in confidence level with given ratio σ/σ_0
ii. decreases for increase in confidence level with given t/σ_0
iii. increases for increase in the ratio σ/σ_0 for any given t/σ_0 and P^*
iv. increases for increase in shape parameter for σ/σ_0 , c and P^*.

Table 3 Operating Characteristic for combined continuous lot by lot truncated life test plan under generalised-log-logistic distribution for i = 5, γ = 2 and θ = 2

P^*	n	c	σ/σ_0 / t/σ_0	2	4	6	8	10	12
0.75	248	2	0.315	0.9973	1.0000	1.0000	1.0000	1.0000	1.0000
	60	2	0.472	0.9961	1.0000	1.0000	1.0000	1.0000	1.0000
	24	2	0.628	0.9942	1.0000	1.0000	1.0000	1.0000	1.0000
	12	2	0.786	0.9930	1.0000	1.0000	1.0000	1.0000	1.0000
	5	2	1.180	0.9811	1.0000	1.0000	1.0000	1.0000	1.0000
	3	2	1.573	0.9720	1.0000	1.0000	1.0000	1.0000	1.0000
	3	2	1.966	0.8398	0.9996	1.0000	1.0000	1.0000	1.0000
	3	2	2.359	0.5370	0.9979	1.0000	1.0000	1.0000	1.0000
0.90	378	2	0.315	0.9909	1.0000	1.0000	1.0000	1.0000	1.0000
	91	2	0.472	0.9870	1.0000	1.0000	1.0000	1.0000	1.0000
	36	2	0.628	0.9813	1.0000	1.0000	1.0000	1.0000	1.0000
	18	2	0.786	0.9765	1.0000	1.0000	1.0000	1.0000	1.0000
	6	2	1.180	0.9646	1.0000	1.0000	1.0000	1.0000	1.0000
	3	2	1.573	0.9720	1.0000	1.0000	1.0000	1.0000	1.0000
	3	2	1.966	0.8398	0.9996	1.0000	1.0000	1.0000	1.0000
	3	2	2.359	0.5370	0.9979	1.0000	1.0000	1.0000	1.0000
0.95	486	2	0.315	0.9817	1.0000	1.0000	1.0000	1.0000	1.0000
	116	2	0.472	0.9744	1.0000	1.0000	1.0000	1.0000	1.0000
	46	2	0.628	0.9631	1.0000	1.0000	1.0000	1.0000	1.0000
	24	2	0.786	0.9474	1.0000	1.0000	1.0000	1.0000	1.0000
	8	2	1.180	0.9144	0.9999	1.0000	1.0000	1.0000	1.0000
	4	2	1.573	0.9061	0.9999	1.0000	1.0000	1.0000	1.0000
	3	2	1.966	0.8398	0.9996	1.0000	1.0000	1.0000	1.0000
	3	2	2.359	0.5370	0.9979	1.0000	1.0000	1.0000	1.0000
0.99	745	2	0.315	0.9428	1.0000	1.0000	1.0000	1.0000	1.0000
	179	2	0.472	0.9205	1.0000	1.0000	1.0000	1.0000	1.0000
	71	2	0.628	0.8879	0.9999	1.0000	1.0000	1.0000	1.0000
	37	2	0.786	0.8452	0.9999	1.0000	1.0000	1.0000	1.0000
	12	2	1.180	0.7634	0.9997	1.0000	1.0000	1.0000	1.0000
	6	2	1.573	0.7012	0.9993	1.0000	1.0000	1.0000	1.0000
	4	2	1.966	0.6076	0.9986	1.0000	1.0000	1.0000	1.0000
	3	2	2.359	0.5370	0.9979	1.0000	1.0000	1.0000	1.0000

Table 4 Operating Characteristic for combined continuous lot by lot truncated life test plan under generalised-log-logistic distribution for i=5, γ=3 and θ =2

P^*	n	c	t/σ_0 \ σ/σ_0	2	4	6	8	10	12
0.75	2768	2	0.315	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
	335	2	0.472	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
	88	2	0.628	0.9998	1.0000	1.0000	1.0000	1.0000	1.0000
	35	2	0.786	0.9995	1.0000	1.0000	1.0000	1.0000	1.0000
	9	2	1.180	0.9975	1.0000	1.0000	1.0000	1.0000	1.0000
	4	2	1.573	0.9954	1.0000	1.0000	1.0000	1.0000	1.0000
	3	2	1.966	0.9861	1.0000	1.0000	1.0000	1.0000	1.0000
	3	2	2.359	0.9211	1.0000	1.0000	1.0000	1.0000	1.0000
0.90	4219	2	0.315	0.9997	1.0000	1.0000	1.0000	1.0000	1.0000
	511	2	0.472	0.9996	1.0000	1.0000	1.0000	1.0000	1.0000
	133	2	0.628	0.9992	1.0000	1.0000	1.0000	1.0000	1.0000
	53	2	0.786	0.9982	1.0000	1.0000	1.0000	1.0000	1.0000
	13	2	1.180	0.9920	1.0000	1.0000	1.0000	1.0000	1.0000
	6	2	1.573	0.9791	1.0000	1.0000	1.0000	1.0000	1.0000
	3	2	1.966	0.9861	1.0000	1.0000	1.0000	1.0000	1.0000
	3	2	2.359	0.9211	1.0000	1.0000	1.0000	1.0000	1.0000
0.95	5417	2	0.315	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
	656	2	0.472	0.9992	1.0000	1.0000	1.0000	1.0000	1.0000
	171	2	0.628	0.9983	1.0000	1.0000	1.0000	1.0000	1.0000
	68	2	0.786	0.9963	1.0000	1.0000	1.0000	1.0000	1.0000
	16	2	1.180	0.9850	1.0000	1.0000	1.0000	1.0000	1.0000
	7	2	1.573	0.9653	1.0000	1.0000	1.0000	1.0000	1.0000
	4	2	1.966	0.9509	1.0000	1.0000	1.0000	1.0000	1.0000
	3	2	2.359	0.9211	1.0000	1.0000	1.0000	1.0000	1.0000
0.99	8305	2	0.315	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
	1006	2	0.472	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
	263	2	0.628	0.9994	1.0000	1.0000	1.0000	1.0000	1.0000
	105	2	0.786	0.9872	1.0000	1.0000	1.0000	1.0000	1.0000
	26	2	1.180	0.9420	1.0000	1.0000	1.0000	1.0000	1.0000
	11	2	1.573	0.8731	1.0000	1.0000	1.0000	1.0000	1.0000
	6	2	1.966	0.8205	1.0000	1.0000	1.0000	1.0000	1.0000
	4	2	2.359	0.7707	1.0000	1.0000	1.0000	1.0000	1.0000

5. Minimum ratios

Producer wants to know what will be the minimum product quality level to be maintained in order to keep the producer's risk at the specified level. At the producer's risk α, the minimum ratio σ/σ_0 may be obtained by solving

$$L(p) \geq 1-\alpha \qquad (5)$$

where L(p) is given in (5) for combined continuous acceptance sampling plan and p is given in (2). The minimum ratios satisfying inequality (5) are calculated for γ (=2, 3), i (= 5), θ (= 2), P^* (= 0.75, 0.90, 0.95, 0.99), t/σ_0 (= 0.315, 0.472, 0.629, 0.786, 1.180, 1.573, 1.966, 2.359) and c(=0,1,2,3,4,5,6,7,8,9,10) for combined continuous lot by lot acceptance sampling truncated life test plans under generalised log-logistic distribution and presented in Tables 5 and 6.

Numerical values in the Tables 5 and 6 reveal that minimum ratio

i. increases for increase in P^* for fixed i, $\boldsymbol{\theta}, \boldsymbol{\gamma}$ and c
ii. decreases for increase in c for fixed i, $\boldsymbol{\theta}$, $\boldsymbol{\gamma}$ and P^*
iii. decreases for increase $\boldsymbol{\gamma}$ in for fixed i,c, $\boldsymbol{\theta}$ and P^* (by comparing table 5 and 6)

Table 5 Minimum ratio for combined continuous lot by lot truncated life test plan under generalised-log-logistic distribution for $\theta = 2$, i = 5 and $\gamma = 2$

P*	t/σ0 / c	0.315	0.472	0.629	0.786	1.180	1.573	1.966	2.359
0.75	0	2.71	2.84	3.02	2.97	3.71	4.94	6.17	7.40
	1	1.77	1.82	1.89	1.93	2.19	2.47	3.09	3.71
	2	1.53	1.57	1.61	1.63	1.79	1.87	2.34	2.80
	3	1.42	1.45	1.48	1.52	1.60	1.58	1.98	2.37
	4	1.36	1.38	1.41	1.44	1.49	1.61	1.76	2.11
	5	1.31	1.33	1.36	1.39	1.41	1.46	1.61	1.93
	6	1.28	1.30	1.33	1.35	1.40	1.47	1.50	1.80
	7	1.26	1.28	1.30	1.32	1.35	1.38	1.41	1.69
	8	1.24	1.26	1.28	1.30	1.34	1.39	1.34	1.61
	9	1.22	1.24	1.26	1.28	1.31	1.32	1.43	1.54
	10	1.21	1.23	1.24	1.26	1.30	1.33	1.37	1.48
0.90	0	3.33	3.46	3.61	3.77	3.71	4.94	6.17	7.40
	1	2.03	2.10	2.17	2.26	2.42	2.47	3.09	3.71
	2	1.71	1.76	1.81	1.85	1.93	1.87	2.34	2.80
	3	1.56	1.60	1.65	1.68	1.78	1.82	1.98	2.37
	4	1.47	1.51	1.54	1.58	1.62	1.75	1.76	2.11
	5	1.42	1.45	1.48	1.52	1.57	1.59	1.61	1.93
	6	1.37	1.40	1.43	1.47	1.53	1.57	1.50	1.80
	7	1.32	1.37	1.40	1.42	1.46	1.47	1.59	1.69
	8	1.32	1.34	1.37	1.39	1.44	1.46	1.50	1.61
	9	1.30	1.32	1.35	1.37	1.42	1.45	1.43	1.54
	10	1.28	1.30	1.32	1.35	1.40	1.44	1.48	1.48
0.95	0	3.73	3.88	4.07	4.26	4.46	4.94	6.17	7.40
	1	2.19	2.27	2.35	2.45	2.60	2.47	3.09	3.71
	2	1.82	1.88	1.94	2.02	2.14	2.17	2.34	2.80
	3	1.65	1.70	1.75	1.80	1.92	1.99	1.98	2.37
	4	1.55	1.59	1.63	1.69	1.79	1.75	1.76	2.11
	5	1.48	1.52	1.56	1.60	1.66	1.70	1.82	1.93
	6	1.43	1.47	1.50	1.55	1.60	1.66	1.69	1.80
	7	1.40	1.43	1.46	1.50	1.56	1.62	1.59	1.69
	8	1.37	1.40	1.43	1.46	1.52	1.53	1.63	1.61
	9	1.34	1.37	1.40	1.43	1.49	1.51	1.55	1.54
	10	1.32	1.35	1.38	1.41	1.46	1.49	1.48	1.48
0.99	0	4.44	4.64	4.86	5.09	5.66	5.94	6.17	7.40
	1	2.50	2.60	2.71	2.83	3.12	3.22	3.09	3.71
	2	2.03	2.10	2.19	2.28	2.45	2.57	2.71	2.80
	3	1.82	1.88	1.95	2.02	2.19	2.26	2.27	2.37
	4	1.69	1.74	1.81	1.87	2.00	2.08	2.19	2.11
	5	1.61	1.65	1.71	1.77	1.90	1.96	1.99	1.93
	6	1.55	1.59	1.64	1.69	1.81	1.87	1.96	2.03
	7	1.50	1.54	1.59	1.64	1.76	1.80	1.83	1.90
	8	1.46	1.50	1.55	1.59	1.70	1.74	1.82	1.80
	9	1.43	1.47	1.51	1.56	1.65	1.70	1.73	1.72
	10	1.41	1.44	1.48	1.52	1.63	1.66	1.73	1.78

Table 6 Minimum ratio for combined continuous lot by lot truncated life test plan under generalised log-logistic distribution for θ = 2, i = 5 and γ = 3

P^*	c \ t/σ_0	0.315	0.472	0.628	0.786	1.180	1.573	1.966	2.359
0.75	0	1.97	2.05	2.14	2.27	2.68	3.11	3.89	4.66
	1	1.47	1.51	1.57	1.62	1.77	1.79	2.24	2.68
	2	1.34	1.37	1.41	1.45	1.56	1.60	1.76	2.11
	3	1.27	1.29	1.33	1.36	1.45	1.49	1.52	1.82
	4	1.23	1.25	1.28	1.31	1.38	1.41	1.54	1.64
	5	1.20	1.22	1.25	1.27	1.33	1.41	1.41	1.51
	6	1.18	1.20	1.22	1.25	1.31	1.36	1.42	1.41
	7	1.17	1.18	1.21	1.23	1.28	1.32	1.34	1.33
	8	1.16	1.17	1.19	1.21	1.26	1.29	1.34	1.41
	9	1.15	1.16	1.18	1.20	1.25	1.29	1.28	1.35
	10	1.14	1.15	1.17	1.19	1.23	1.27	1.29	1.30
0.90	0	2.26	2.36	2.48	2.61	2.9	3.11	3.89	4.66
	1	1.61	1.67	1.74	1.81	1.99	2.05	2.24	2.68
	2	1.44	1.48	1.53	1.58	1.72	1.85	1.76	2.11
	3	1.35	1.38	1.43	1.47	1.59	1.66	1.72	1.82
	4	1.30	1.33	1.36	1.40	1.51	1.54	1.66	1.64
	5	1.27	1.29	1.32	1.36	1.45	1.51	1.52	1.51
	6	1.24	1.26	1.29	1.32	1.40	1.45	1.50	1.58
	7	1.22	1.24	1.27	1.30	1.37	1.43	1.49	1.49
	8	1.21	1.23	1.25	1.28	1.34	1.38	1.41	1.41
	9	1.19	1.21	1.23	1.26	1.32	1.37	1.40	1.45
	10	1.18	1.20	1.22	1.25	1.31	1.36	1.39	1.40
0.95	0	2.44	2.54	2.68	2.82	3.2	3.57	3.89	4.66
	1	1.70	1.76	1.84	1.92	2.14	2.23	2.24	2.68
	2	1.50	1.55	1.60	1.67	1.81	1.94	2.00	2.11
	3	1.40	1.44	1.49	1.54	1.68	1.79	1.86	1.82
	4	1.35	1.38	1.42	1.47	1.58	1.65	1.76	1.84
	5	1.31	1.33	1.37	1.41	1.52	1.59	1.62	1.69
	6	1.28	1.30	1.34	1.37	1.47	1.55	1.58	1.58
	7	1.25	1.28	1.31	1.35	1.43	1.49	1.55	1.60
	8	1.24	1.26	1.29	1.32	1.41	1.46	1.52	1.52
	9	1.22	1.24	1.27	1.3	1.38	1.44	1.45	1.54
	10	1.21	1.23	1.26	1.29	1.36	1.42	1.44	1.48
0.99	0	2.74	2.87	3.03	3.21	3.70	4.08	4.46	4.66
	1	1.86	1.93	2.02	2.12	2.41	2.65	2.78	2.68
	2	1.62	1.67	1.74	1.82	2.03	2.20	2.31	2.40
	3	1.50	1.54	1.60	1.67	1.84	1.98	2.07	2.23
	4	1.43	1.47	1.52	1.57	1.73	1.87	1.93	1.99
	5	1.38	1.42	1.46	1.51	1.65	1.78	1.83	1.94
	6	1.34	1.38	1.42	1.47	1.59	1.71	1.76	1.80
	7	1.32	1.35	1.39	1.43	1.55	1.65	1.74	1.78
	8	1.30	1.32	1.36	1.40	1.52	1.61	1.69	1.69
	9	1.28	1.30	1.34	1.38	1.49	1.57	1.65	1.68
	10	1.26	1.29	1.32	1.36	1.46	1.54	1.62	1.61

6. Selection of plans

Suppose that one wishes to apply combined continuous lot by lot acceptance sampling truncated life test plan with shape parameter θ = 2, γ = 3 clearance number i =5 and acceptance number c = 2. The experimenter is interested in accepting the lot of products if the true unknown average lifetime of product is at least 1000 hours with a consumer's confidence level of 0.75. The experimenter wants to truncate the experiment at 315 hours. This leads to the experimental termination ratio t/σ_0 = 0.315.From the constructed Table 2 one obtains the required plan (n, c, i, t/σ_0) as (2768, 2, 5, 0.315).The application of selected plan is done as follows:

Start with the screening inspection of units submitted in the order of production. If 5 units in succession are found to be conforming, form lots and choose a sample size n = 2768 from the lot and put on test and count the number of defectives. If the number of defectives is less than or equal to

2 accept the lot and continue with lot by lot inspection otherwise terminate the test at once and reject the lot. if 5 units in succession are lot found to be conforming continue screening inspection and util and 5 units are

For this plan, the operating characteristic values are given in the following table which and obtained from Table 4.

σ/σ_0	2	4	6	8	10	12
OC value	0.9999	1	1	1	1	1

From the above tabulated values it is seen that the producer's risk tends to decrease for the higher values of the average ratios.

By considering various choices of c , one may get the smallest value of σ/σ_0 to claim that producer's risk is less than or equal to 0.05 from Table 6. In particular the smallest value of σ/σ_0 is 1.34 for c = 2, $P^* = 0.75$, $t/\sigma_0 = 0.315$. This means that the item should have an average lifetime of at least 1340 hours in order to accept the lot with probability 0.75.

7. Comparative analysis

A comparative analysis is carried out with single sampling truncated life test plan under generalized log logistic distribution. Table 7 is prepared for minimum sample size relating to truncated life test single sampling plan for θ = (2), γ = (2, 3), P* = 0.95 and t/σ_0 (= 0.315, 0.472, 0.629, 0.786, 1.180, 1.573, 1.966, 2.359) from the analysis of the value from tables 1 and 2 with 7 it is seen that the minimum sample size required for the proposed plan – combined continuous lot by lot truncated life test plan is lower than that of single sampling truncated life test plan**.** This leads to minimum cost and time in inspection.

Table 7 minimum sample size of single sampling truncated life test plan

P*	t/σ_0 / c	$\gamma = 2$								$\gamma = 3$							
		0.315	0.472	0.629	0.786	1.180	1.573	1.966	2.359	0.315	0.472	0.629	0.786	1.180	1.573	1.966	2.359
0.95	0	367	89	36	20	8	5	4	3	4072	494	130	53	14	7	5	4
	1	581	142	58	31	12	8	6	5	6448	783	207	84	23	12	8	6
	2	771	188	77	41	17	10	8	7	8558	1039	275	111	30	16	11	8
	3	950	232	95	51	21	13	10	8	10540	1280	338	137	37	19	13	10
	4	1121	274	112	61	25	16	12	10	12443	1511	400	162	44	23	16	13
	5	1288	314	129	70	29	18	14	12	14291	1736	459	186	51	27	18	15
	6	1451	354	145	79	32	21	16	13	16098	1956	517	210	58	30	21	16
	7	1611	393	161	87	36	23	18	15	17873	2171	575	233	64	34	23	18
	8	1769	432	177	96	40	25	20	17	19622	2384	631	256	70	37	26	20
	9	1925	470	193	105	43	28	21	18	21349	2594	687	279	77	40	28	22
	10	2079	508	208	113	47	30	23	20	23058	2802	742	302	83	44	30	24

7. Conclusion

In this chapter, designing of combined continuous lot by lot acceptance sampling truncated life test plans under generalised log-logistic lifetime distribution using average lifetime. Tables are provided for minimum sample size, operating characteristic values and minimum ratios.

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