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Time truncated acceptance sampling plans for generalized inverted exponential distribution

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In this paper, the problem of acceptance sampling with truncated test at a pre-assigned time is studied. The generalized inverted exponential distribution is appointed as a model for a life time random variable. The minimum sample sizes required to assure a specified mean life time are obtained. The operating characteristic function values of the sampling plans are presented and the producer's risk is also inspected. Some useful tables of the ratio of the true mean life to specified mean life that asserts acceptance with a pre-assigned probability are presented.

Keywords: Truncated life tests, Acceptance sampling plan, Operating characteristics, Producer's risk, Generalized inverted exponential distribution.

1 Introduction

Acceptance sampling is known as a tool in the statistical quality control to make a decision either to accept or reject a lot of product that has already obtained. In acceptance sampling, accept or reject decision can be taken based on the number of defective items within a lot. Since we select our sample from a lot which contains bad lot and good lot, then there is always a risk of making a wrong decision. A statistically valid sampling plan is used to control the risk and give the probability of rejecting good lots and the probability of accepting bad lots.

In this study, our problem is to find a minimum sample size n that is necessary to assure a certain average life when the life test is terminated at a pre-assigned time t and

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when the observed number of failures does not exceed a given acceptance number c. The decision procedure is to accept a lot only if the specified average life can be established with a pre-assigned high probability P^*, which provides the protection to the consumer.

Extensive works have been done on the acceptance sampling plans. Epstein (1954) was the first who considered the acceptance sampling plans based on truncated life tests in the exponential distribution. Gupta and Groll (1961) studied the acceptance sampling plans for the gamma distribution. Rosaiah and Kantam (2005) investigated the acceptance sampling plans for the inverse Rayleigh distribution. Acceptance sampling plans for the generalized Birnbaum-Saunders distribution is considered by Balakrishnan and Lpez (2007). Kantam and Rao (2001) considered truncated life tests for log-logistic distribution. Rao (2010) investigated a group acceptance sampling plans based on truncated life tests for Marshall-Olkin extended Lomax distribution. Rao (2009) examined a group acceptance sampling plans for lifetimes following a generalized exponential distribution. Aslam and Ahmad (2010) considered time truncated acceptance sampling plans for generalized exponential distribution. Baklizi (2003) provided acceptance sampling plans based on truncated life tests in the Pareto distribution of the second kind. Rao (2011) considered double acceptance sampling plans based on truncated life tests for Marshall-Olkin extended exponential distribution. Single sampling plan without power based on the hypergeometric, binomial and Poisson distributions is investigated by Sathakathulla and Murthy (2005). Al-Nasser and Al-Omari (2013) developed an acceptance sampling plan based on truncated life tests for exponentiated Frechet distribution.

The rest of this paper is arranged as follows: in Section 2, the generalized inverted exponential distribution and its properties are presented. The suggested acceptance sampling plans, operating characteristic and their properties are established in Section 3. In Section 4, examples for illustration are discussed. Finally, Section 5 is devoted for conclusions.

2 A Generalized Inverted Exponential Distribution

A generalization of inverted exponential distribution is considered as a lifetime model by Abouammoh and Alshingiti (2009). The probability density function of the generalized inverted exponential distribution (GIED) is defined as

$$f(x) = \frac{\alpha\,\lambda}{x^2} \exp\left(-\frac{\lambda}{x}\right)\left[1-\exp\left(-\frac{\lambda}{x}\right)\right]^{\alpha-1},\ x \geq 0,\ \alpha, \lambda > 0, \tag{1}$$

and the cumulative distribution function is

$$F(x) = 1 - \left[1-\exp\left(-\frac{\lambda}{x}\right)\right]^{\alpha}, \quad \alpha,\, \lambda > 0. \tag{2}$$

The reliability function or the survival function and the hazard rate of the GIED are

$$R(x) = \exp\left[1-\exp\left(-\frac{\lambda}{x}\right)\right]^{\alpha}, \quad x \geq 0,\, \alpha,\, \lambda > 0, \tag{3}$$

and

$$h(x) = \frac{f(x)}{R(x)} = \frac{\alpha\,\lambda}{x^2} \exp\left(-\frac{\lambda}{x}\left[1 - \exp\left(-\frac{\lambda}{x}\right)\right]^{-1}\right), \tag{4}$$

respectively. The mean and median of the GIED are

$$\mu = \int_0^{\infty} \left[1 - \exp\left(-\frac{\lambda}{x}\right)\right]^{\alpha} dx, \tag{5}$$

and

$$t^0 = -\frac{\lambda}{\ln\left(1 - (0.5)^{1/\alpha}\right)}, \tag{6}$$

where the mean is converges if $\alpha > 1$.

3 Acceptance sampling plans

In this section, we will introduce acceptance sampling plans based on the assumption that life time distribution follows a GIED. An acceptance sampling plan consists of:

- The number of units n on test.
- The acceptance number c, where the lot is accepted if at most c failures out of n observed at the end of the predetermined time t.
- A ratio t/σ_0, where σ_0 is the specified average life.

The consumer's risk is defined as the probability of accepting a bad lot and is fixed in this study not to exceed $1 - P^*$. That is the one for which the true average life is below the specified life σ_0. When $\sigma > \sigma_0$, the probability of rejecting a good lot is known as the producer's risk.

Assume that the lot size is sufficiently large to compute the probability of accepting a lot by the binomial cumulative distribution function up to c for given values of P^* $(0 < P^* < 1)$. Then, we aim to find the smallest sample size n such that

$$\sum_{i=0}^{c} \binom{n}{i} p^i (1-p)^{n-i} \leq 1 - P^*, \tag{7}$$

where $p = F(t; \sigma_0)$ is the probability of a failure observed during the time t which depends only on the ratio t/σ_o. The minimum values of n satisfying Inequality (7) are obtained and presented in Tables 1 and 4 when $\alpha = 1, 2$, respectively for $P^* = 0.75$, 0.90, 0.95, 0.99, and $t/\sigma_o = 0.3$, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 1.5, 2. If the number of observed failures before the time t is less than or equal to the acceptance number c, then from (7) we can make the confidence statement

$$F\left(t; \sigma\right) \leq F\left(t; \sigma_0\right) \; iff \; \sigma \geq \sigma_0. \tag{8}$$

The operating characteristic (OC) function of the sampling plan (n, c, t/σ_0) gives the probability $L(p)$ of acceptance the lot. The OC of this acceptance sampling plan is

$$L(p) = P(\text{Accepting a lot}) = \sum_{i=0}^{c} \binom{n}{i} p^i (1-p)^{n-i}, \tag{9}$$

where $p = F(t;\sigma)$ is considered as a function of σ (the lot quality parameter). The operating characteristic function values as a function of σ/σ_0 are given in Tables 2 and 5 for $\alpha = 1, 2$, respectively.

The producer's risk is the probability of rejecting the lot when $\sigma > \sigma_0$. Based on the considered sampling plan and a given value of the producer's risk, say 0.05, one may be interested in knowing what value of σ/σ_0 will ensure the producer's risk less than or equal to 0.05 if the sampling plan under study is adopted. The value of σ/σ_0 is the smallest positive number for which $p = F\left(\frac{t}{\sigma_0}\frac{\sigma_0}{\sigma}\right)$ satisfies the inequality

$$\sum_{i=0}^{c} \binom{n}{i} p^i (1-p)^{n-i} \geq 0.95. \tag{10}$$

For a given sampling plan (n, c, t/σ_0) at specified confidence level P^*, the minimum values of σ/σ_0 satisfying Inequality (10) are summarized in Tables 3 and 6 for $\alpha = 1, 2$, respectively.

4 Results and descriptive example

In this section, some computations are obtained for $\alpha = 1$ and 2 when the underlying model is the GIED. In Tables 1,2,3 the results are obtained when $\alpha = 1$ while for $\alpha = 2$ the results are presented in Tables 4,5,6. For $\alpha = 1$, assume that an experimenter wants to establish the true unknown average life to be at least 1000 hours with confidence $P^* = 0.90$. It is desired to stop the experiment at $t = 500$ hours when the acceptance number $c = 2$, then the required n from Table 1 is $n = 38$. Now, the 38 units have to be put on test. If during 1000 hours no more than 2 failures out of 38 units are observed, then the experimenter can assert with confidence 0.90 that the average life is at least 1000 hours.

For the sampling plan ($n = 38, c = 2, t/\sigma_0 = 0.500$) the operating characteristic values from Table 2 are

σ/σ_0	1	2	3	4	5	6	7	8	9	10
O.C.	0.09627	0.96780	0.99988	1	1	1	1	1	1	1

This means that if the true mean life is twice the specified mean life ($\sigma/\sigma_0 = 2$) the producer's risk is about 0.0322. The producer's risk is approximately zero when the true mean life is 4 times or more than the specified mean life ($\sigma/\sigma_0 \geq 4$).

From Table 3, we can get the value of σ/σ_0 for various choices of c, t/σ_0 such that the producer's risk may not exceed 0.05. Thus, in the above example, the value of σ/σ_0 is

2.00718 for $c = 2$, $t/\sigma_0 = 0.7$, and $P^* = 0.75$. This means that the product should have an average life of 2.00718 times the specified average life of 1000 hours in order that, the product be accepted lot with probability at least 0.95.

We can conclude that the results are depending on the parameter α of the distribution. For example the minimum sample sizes for $\alpha = 1$ and 2 are 10 and 5, respectively, when $P^* = 0.75$, $c = 0$ and $t/\sigma_0 = 0.5$.

5 Conclusion

In this article, an acceptance sampling plan is developed based on truncated life test when the life distribution of the test items is the generalized inverted exponential distribution. Some important tables are reported so that the practitioners can use the suggested acceptance sampling plans comfortably.

Table 1: Minimum sample sizes necessary to ensure the average life exceeds a given value σ_0 with probability P^* and the corresponding acceptance number c when $\alpha = 1$.

		t/σ_0									
P^*	c	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.5	2
0.75	0	38	16	10	7	5	4	3	3	2	1
	1	75	32	19	13	10	9	7	6	4	3
	2	109	47	28	20	15	13	11	10	7	5
	3	142	61	37	26	20	17	14	13	9	7
	4	175	75	45	32	25	21	18	16	11	9
	5	207	89	54	38	30	25	21	19	13	11
	6	239	103	62	44	34	29	25	22	15	13
	7	270	117	70	50	39	32	28	25	17	14
	8	301	130	78	56	44	36	31	28	19	16
	9	332	144	87	62	48	40	35	31	22	18
	10	263	157	95	67	53	44	38	34	24	20
0.90	0	63	27	16	11	8	7	6	5	3	2
	1	108	46	27	19	15	12	10	9	6	5
	2	148	63	38	26	20	17	14	13	8	7
	3	185	80	47	33	26	21	18	16	11	9
	4	222	95	57	40	31	26	22	20	13	11
	5	258	111	66	47	36	30	26	23	16	13
	6	293	126	75	53	41	34	30	26	18	15
	7	328	141	85	60	47	39	33	29	20	17
	8	362	156	93	66	52	43	37	33	22	18
	9	396	170	102	73	57	47	40	36	25	20
	10	429	185	111	79	61	51	44	39	27	22
0.95	0	82	35	21	14	11	9	8	7	4	3
	1	131	56	33	23	18	15	12	11	7	6
	2	174	75	44	31	24	20	17	15	10	8
	3	215	92	55	39	30	25	21	18	12	10
	4	254	109	65	46	35	29	25	22	15	12
	5	292	125	75	53	41	34	29	26	17	14
	6	329	141	85	60	46	38	33	29	20	16
	7	365	157	94	66	52	43	37	32	22	18
	8	401	173	103	73	57	47	40	36	24	20
	9	437	188	113	80	62	51	44	39	27	22
	10	472	203	122	86	67	55	48	42	29	24
0.99	0	127	54	32	22	17	14	12	10	6	5
	1	183	78	46	32	25	20	17	15	10	8
	2	232	99	59	41	32	26	22	19	13	10
	3	278	119	71	50	38	31	27	23	16	12
	4	321	138	82	57	44	36	31	27	18	15
	5	363	156	93	65	50	41	35	31	21	17
	6	404	173	103	73	56	46	40	35	24	19
	7	444	190	114	80	62	51	44	39	26	21
	8	483	207	124	87	68	56	48	42	29	23
	9	522	224	134	94	73	60	52	46	31	25
	10	560	240	144	101	79	65	56	49	33	27

Table 2: Operating characteristic values for the sampling plan $(n, c, t/\sigma_0)$ for a given probability P^* with acceptance number $c = 2$ when $\alpha = 1$.

			σ/σ_0									
P^*	n	t/σ_0	1	2	3	4	5	6	7	8	9	10
0.75	109	0.3	0.24961	0.99961	1	1	1	1	1	1	1	1
	47	0.4	0.24723	0.99602	1	1	1	1	1	1	1	1
	28	0.5	0.24966	0.98570	0.99995	1	1	1	1	1	1	1
	20	0.6	0.24253	0.96713	0.99968	1	1	1	1	1	1	1
	15	0.7	0.26522	0.94871	0.99895	0.99998	1	1	1	1	1	1
	13	0.8	0.23344	0.91508	0.99688	0.99992	1	1	1	1	1	1
	11	0.9	0.24311	0.89180	0.99396	0.99975	0.99999	1	1	1	1	1
	10	1	0.22471	0.85675	0.98863	0.99933	0.99996	1	1	1	1	1
	7	1.5	0.20515	0.72769	0.94316	0.99051	0.99857	0.99980	0.99997	1	1	1
	5	2	0.30622	0.73644	0.92277	0.97997	0.99513	0.99886	0.99974	0.99994	0.99999	1
0.9	148	0.3	0.09880	0.99905	1	1	1	1	1	1	1	1
	63	0.4	0.10091	0.99101	0.99999	1	1	1	1	1	1	1
	38	0.5	0.09627	0.96780	0.99988	1	1	1	1	1	1	1
	26	0.6	0.10680	0.93589	0.99929	0.99999	1	1	1	1	1	1
	20	0.7	0.10920	0.89585	0.99751	0.99996	1	1	1	1	1	1
	17	0.8	0.09577	0.84117	0.99309	0.99981	1	1	1	1	1	1
	14	0.9	0.11127	0.81208	0.98770	0.99946	0.99998	1	1	1	1	1
	13	1	0.09001	0.74685	0.97576	0.99847	0.99992	1	1	1	1	1
	8	1.5	0.12763	0.64440	0.91801	0.98560	0.99778	0.99968	0.99996	0.99999	1	1
	7	2	0.09007	0.49145	0.80999	0.94316	0.98496	0.99629	0.99912	0.99980	0.99995	0.99999
0.95	174	0.3	0.05043	0.99849	1	1	1	1	1	1	1	1
	75	0.4	0.04851	0.98559	0.99999	1	1	1	1	1	1	1
	44	0.5	0.05170	0.95334	0.99981	1	1	1	1	1	1	1
	31	0.6	0.05080	0.90257	0.99881	0.99999	1	1	1	1	1	1
	24	0.7	0.05017	0.84326	0.99575	0.99993	1	1	1	1	1	1
	20	0.8	0.04637	0.77681	0.98901	0.99968	0.99999	1	1	1	1	1
	17	0.9	0.04747	0.72211	0.97878	0.99903	0.99996	1	1	1	1	1
	15	1	0.04656	0.66841	0.96419	0.99763	0.99987	0.99999	1	1	1	
	10	1.5	0.04587	0.48518	0.85675	0.97220	0.99549	0.99933	0.99991	0.99999	1	1
	8	2	0.04588	0.38593	0.74398	0.91801	0.97739	0.99428	0.99862	0.99968	0.99993	0.99998
0.99	232	0.3	0.01012	0.99659	1	1	1	1	1	1	1	1
	99	0.4	0.01010	0.97026	0.99997	1	1	1	1	1	1	1
	59	0.5	0.00980	0.90599	0.99955	1	1	1	1	1	1	1
	41	0.6	0.01030	0.82064	0.99731	0.99998	1	1	1	1	1	1
	32	0.7	0.00940	0.72186	0.99040	0.99983	1	1	1	1	1	1
	26	0.8	0.00985	0.63897	0.97741	0.99929	0.99998	1	1	1	1	1
	22	0.9	0.01033	0.56819	0.95786	0.99789	0.99992	1	1	1	1	1
	19	1	0.01149	0.51517	0.93413	0.99522	0.99973	0.99999	1	1	1	1
	13	1.5	0.00870	0.29305	0.74685	0.94329	0.99008	0.99847	0.99978	0.99997	1	1
	10	2	0.01097	0.22471	0.60730	0.85675	0.95720	0.98863	0.99718	0.99933	0.99984	0.99996

Table 3: Minimum value of the true mean life to specified mean life for the acceptability of a lot with producer's risk of 0.05 when $\alpha = 1$.

		t/σ_0									
P^*	c	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.5	2
0.75	0	1.98254	2.29775	2.63767	2.95186	3.20933	3.49032	3.66961	4.07734	5.51421	5.99146
	1	1.60433	1.79604	1.98079	2.14419	2.31212	2.55489	2.63736	2.76701	3.49014	3.99978
	2	1.46615	1.61544	1.75583	1.89964	2.00718	2.17388	2.28653	2.43881	3.07475	3.32932
	3	1.39137	1.51404	1.63799	1.74781	1.84807	1.97543	2.03662	2.18333	2.66900	2.98045
	4	1.34425	1.45023	1.55260	1.65259	1.74825	1.85137	1.93545	2.02411	2.41734	2.76168
	5	1.30992	1.40578	1.50280	1.58644	1.67880	1.76541	1.81941	1.91413	2.24446	2.60943
	6	1.28438	1.37272	1.45750	1.53737	1.60598	1.70177	1.77288	1.83295	2.11756	2.49620
	7	1.26339	1.34700	1.42233	1.49927	1.56852	1.62646	1.70232	1.77017	2.01995	2.24768
	8	1.24651	1.32320	1.39410	1.46866	1.53829	1.58975	1.64589	1.71994	1.94224	2.19698
	9	1.23258	1.30642	1.37677	1.44343	1.49822	1.55946	1.62734	1.67867	1.95672	2.15410
	10	1.22086	1.28970	1.35672	1.41303	1.47850	1.53396	1.58634	1.64406	1.89688	2.11726
0.9	0	2.13412	2.50679	2.87219	3.22225	3.53699	3.93581	4.28960	4.58476	6.11602	7.35228
	1	1.71413	1.94247	2.15913	2.37694	2.60424	2.79307	2.97273	3.19362	4.15051	5.14249
	2	1.55834	1.73396	1.91146	2.06149	2.21624	2.39822	2.51568	2.71735	3.29582	4.09967
	3	1.47114	1.62382	1.76010	1.89521	2.03911	2.15288	2.27659	2.40514	3.00288	3.55867
	4	1.41599	1.54596	1.67332	1.79063	1.90500	2.03079	2.12697	2.26259	2.69673	3.22312
	5	1.37634	1.49524	1.60528	1.71793	1.81165	1.91862	2.02332	2.11848	2.59093	2.99262
	6	1.34581	1.45435	1.55470	1.65248	1.7599	1.8354	1.94664	2.01160	2.42203	2.82341
	7	1.32207	1.42255	1.52144	1.61198	1.70433	1.79259	1.85897	1.92881	2.29131	2.69327
	8	1.30215	1.39701	1.48387	1.57019	1.65979	1.73885	1.81444	1.89520	2.18685	2.46748
	9	1.28573	1.37360	1.45791	1.54429	1.62317	1.69468	1.75439	1.83804	2.16852	2.39496
	10	1.27123	1.35611	1.43610	1.51476	1.58067	1.65764	1.72570	1.79015	2.09189	2.33423
0.95	0	2.21317	2.61051	3.00797	3.36665	3.75929	4.13621	4.54756	4.91977	6.54434	8.15469
	1	1.77220	2.02166	2.26060	2.49345	2.73455	2.97627	3.14220	3.40162	4.39561	5.53401
	2	1.60707	1.80431	1.98587	2.16937	2.34762	2.53285	2.69799	2.86739	3.65822	4.39442
	3	1.51641	1.68027	1.84001	1.99790	2.14249	2.29793	2.42199	2.52954	3.14518	3.79386
	4	1.45656	1.60152	1.74015	1.87663	1.99284	2.12178	2.24775	2.36330	2.93145	3.41824
	5	1.41364	1.54325	1.67034	1.79188	1.90581	2.02299	2.12653	2.24813	2.69038	3.15905
	6	1.38073	1.49981	1.61841	1.72885	1.82576	1.9282	2.03671	2.12721	2.59478	2.96833
	7	1.35427	1.46600	1.57266	1.67065	1.77750	1.87397	1.96712	2.03307	2.44781	2.82149
	8	1.33298	1.43882	1.53585	1.63224	1.72623	1.81299	1.88813	1.98718	2.32983	2.70455
	9	1.31542	1.41428	1.51002	1.60063	1.68400	1.76275	1.84446	1.92265	2.29444	2.60896
	10	1.30001	1.39363	1.48417	1.56698	1.64854	1.72055	1.80784	1.86847	2.20882	2.52918
0.99	0	2.34438	2.78386	3.21837	3.63744	4.06344	4.48887	4.91151	5.27534	7.14934	9.16952
	1	1.87270	2.15487	2.42808	2.69406	2.96821	3.21101	3.46340	3.72034	4.95455	6.14137
	2	1.69363	1.91615	2.13432	2.34006	2.5536	2.74866	2.93787	3.11306	4.07602	4.87762
	3	1.59377	1.78403	1.96943	2.1499	2.31228	2.47556	2.65683	2.78587	3.60772	4.19357
	4	1.52705	1.69668	1.85800	2.00799	2.15753	2.30077	2.44929	2.57786	3.22575	3.90859
	5	1.47918	1.63264	1.77950	1.91699	2.04872	2.17807	2.30296	2.43253	3.03235	3.58717
	6	1.44257	1.58235	1.71591	1.84911	1.96748	2.08658	2.21719	2.32454	2.88945	3.34791
	7	1.41328	1.54300	1.67059	1.78865	1.90421	2.01539	2.12972	2.24074	2.71842	3.16219
	8	1.38901	1.51123	1.63006	1.73985	1.85335	1.95821	2.05931	2.14898	2.63634	3.01344
	9	1.36894	1.48499	1.59655	1.69953	1.80167	1.89749	2.00125	2.09589	2.51801	2.89136
	10	1.35149	1.46120	1.56833	1.66558	1.76721	1.85902	1.95247	2.03027	2.41809	2.78918

Table 4: Minimum sample sizes necessary to ensure the average life exceeds a given value σ_0 with probability P^* and the corresponding acceptance number c when $\alpha = 2$.

		t/σ_0									
P^*	c	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.5	2
0.75	0	19	8	5	3	3	2	2	2	1	1
	1	38	16	10	7	5	4	4	4	2	2
	2	55	24	15	10	8	7	6	5	4	3
	3	72	31	19	14	11	9	8	7	5	5
	4	88	39	24	17	14	12	10	9	7	6
	5	105	46	28	20	16	14	12	11	8	7
	6	121	53	33	24	19	16	14	13	10	8
	7	137	60	37	27	21	18	16	15	11	10
	8	153	67	41	30	24	20	18	16	12	11
	9	169	74	46	33	27	23	20	18	14	12
	10	184	81	50	36	29	25	22	20	15	13
0.90	0	32	13	8	6	4	3	3	3	2	1
	1	54	23	14	10	8	6	5	5	3	3
	2	74	32	19	14	11	9	8	7	5	4
	3	93	41	25	18	14	12	10	9	6	5
	4	112	49	30	21	17	14	12	11	8	7
	5	130	57	34	25	20	16	14	13	10	8
	6	148	65	39	28	22	19	17	15	11	9
	7	166	72	44	32	25	21	19	17	12	11
	8	183	80	49	35	28	24	21	19	14	12
	9	200	88	54	39	31	26	23	21	15	13
	10	217	95	58	42	34	28	25	22	17	15
0.95	0	41	17	10	7	5	4	4	3	2	2
	1	66	28	17	12	9	8	6	6	4	3
	2	88	38	23	16	13	10	9	8	6	5
	3	108	47	28	20	16	13	11	10	7	6
	4	128	55	34	24	19	16	14	12	9	7
	5	147	64	39	28	22	18	16	14	10	9
	6	166	72	44	31	25	21	18	16	12	10
	7	185	80	49	35	28	23	20	18	13	11
	8	203	88	54	39	31	26	23	20	15	13
	9	221	96	59	42	34	28	25	22	16	14
	10	239	104	64	46	36	31	27	24	18	15
0.99	0	63	27	16	11	8	7	6	5	3	2
	1	92	39	23	16	13	10	9	8	5	4
	2	117	50	30	21	16	14	12	10	7	6
	3	140	60	36	26	20	17	14	13	9	7
	4	162	70	42	30	23	19	17	15	10	9
	5	183	79	48	34	27	22	19	17	12	10
	6	204	88	35	38	30	25	22	19	14	12
	7	224	97	59	42	33	28	24	21	15	13
	8	244	106	64	46	36	30	26	23	17	14
	9	263	114	69	50	39	33	28	26	18	16
	10	282	123	74	53	42	35	31	28	20	17

Table 5: Operating characteristic values for the sampling plan $(n, c, t/\sigma_0)$ for a given probability P^* with acceptance number $c = 2$ when $\alpha = 2$.

Text

			σ/σ_0									
P^*	n	t/σ_0	1	2	3	4	5	6	7	8	9	10
0.75	55	0.3	0.24971	0.99961	1	1	1	1	1	1	1	1
	24	0.4	0.24778	0.99603	1	1	1	1	1	1	1	1
	15	0.5	0.22978	0.98432	0.99995	1	1	1	1	1	1	1
	10	0.6	0.27908	0.97158	0.99973	1	1	1	1	1	1	1
	8	0.7	0.27140	0.94948	0.99897	0.99998	1	1	1	1	1	1
	7	0.8	0.24172	0.91678	0.99695	0.99992	1	1	1	1	1	1
	6	0.9	0.25523	0.89489	0.99414	0.99976	0.99999	1	1	1	1	1
	5	1	0.31671	0.89399	0.99213	0.99955	0.99998	1	1	1	1	1
	4	1.5	0.23959	0.74811	0.94788	0.99132	0.99870	0.99981	0.99997	1	1	1
	3	2	0.39626	0.78354	0.93768	0.98393	0.99610	0.99908	0.99979	0.99995	0.99999	1
0.90	74	0.3	0.10136	0.99907	1	1	1	1	1	1	1	1
	32	0.4	0.10113	0.99102	0.99999	1	1	1	1	1	1	1
	19	0.5	0.10712	0.97001	0.99989	1	1	1	1	1	1	1
	14	0.6	0.09362	0.93002	0.99921	0.99999	1	1	1	1	1	1
	11	0.7	0.09239	0.88426	0.99714	0.99995	1	1	1	1	1	1
	9	0.8	0.09911	0.84289	0.99317	0.99981	1	1	1	1	1	1
	8	0.9	0.08844	0.78582	0.98526	0.99935	0.99998	1	1	1	1	1
	7	1	0.09585	0.75150	0.97626	0.99850	0.99992	1	1	1	1	1
	5	1.5	0.09005	0.57891	0.89399	0.98046	0.99691	0.99955	0.99994	0.99999	1	1
	4	2	0.11585	0.52407	0.82484	0.94788	0.98624	0.99661	0.99920	0.99981	0.99996	0.99999
0.95	88	0.3	0.04912	0.99846	1	1	1	1	1	1	1	1
	38	0.4	0.04862	0.98560	0.99999	1	1	1	1	1	1	1
	23	0.5	0.04678	0.95074	0.99980	1	1	1	1	1	1	1
	16	0.6	0.05147	0.90288	0.99881	0.99999	1	1	1	1	1	1
	13	0.7	0.04193	0.82984	0.99524	0.99992	1	1	1	1	1	1
	10	0.8	0.06136	0.80055	0.99058	0.99973	0.99999	1	1	1	1	1
	9	0.9	0.04976	0.72493	0.97903	0.99904	0.99996	1	1	1	1	1
	8	1	0.04955	0.67267	0.96473	0.99767	0.99987	0.99999	1	1	1	1
	6	1.5	0.03104	0.42599	0.82682	0.96479	0.99414	0.99912	0.99987	0.99998	1	1
	5	2	0.02902	0.31671	0.68864	0.89399	0.96961	0.99213	0.99808	0.99955	0.9999	0.99998
0.99	117	0.3	0.00984	0.99655	1	1	1	1	1	1	1	1
	50	0.4	0.01013	0.97027	0.99997	1	1	1	1	1	1	1
	30	0.5	0.00986	0.90607	0.99955	1	1	1	1	1	1	1
	21	0.6	0.01044	0.82095	0.99731	0.99998	1	1	1	1	1	1
	16	0.7	0.01193	0.73847	0.99124	0.99985	1	1	1	1	1	1
	14	0.8	0.00778	0.61734	0.97514	0.99921	0.99998	1	1	1	1	1
	12	0.9	0.00788	0.54072	0.95308	0.99761	0.99990	1	1	1	1	1
	10	1	0.01220	0.51853	0.93472	0.99526	0.99973	0.99999	1	1	1	1
	7	1.5	0.01008	0.30160	0.75150	0.94444	0.99028	0.99850	0.99978	0.99997	1	1
	6	2	0.00662	0.17861	0.55163	0.82682	0.94628	0.98539	0.99633	0.99912	0.99979	0.99995

Table 6: Minimum value of the true mean life to specified mean life for the acceptability of a lot with producer's risk of 0.05 when $\alpha = 2$.

		t/σ_0									
P^*	c	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.5	2
0.75	0	1.98254	2.29775	2.63767	2.85974	3.33636	3.49032	3.92660	4.36289	5.51421	7.35228
	1	1.60631	1.78950	1.99343	2.16596	2.27130	2.59577	2.69510	2.99456	3.19461	4.25948
	2	1.46611	1.61521	1.77301	1.86564	2.00294	2.16729	2.27584	2.30673	3.02420	3.16686
	3	1.39240	1.51043	1.63006	1.75738	1.86161	1.38973	2.05791	2.12158	2.49748	3.32998
	4	1.34248	1.45531	1.56285	1.64999	1.77222	1.88287	1.92179	2.00423	2.50400	2.87737
	5	1.31060	1.40774	1.49691	1.57535	1.66089	1.24417	1.82748	1.92188	2.23346	2.55737
	6	1.28434	1.37239	1.46454	1.54851	1.62158	1.69209	1.75766	1.86024	2.26344	2.31711
	7	1.26390	1.34492	1.42474	1.50245	1.55282	1.62914	1.70352	1.81197	2.08695	2.48938
	8	1.24746	1.32284	1.39280	1.46551	1.53209	1.57872	1.66009	1.69539	1.94289	2.31436
	9	1.23389	1.30463	1.37839	1.43512	1.51452	1.58008	1.62431	1.67150	1.99119	2.16880
	10	1.22081	1.28931	1.35536	1.40962	1.47188	1.54199	1.59424	1.65092	1.88116	2.04547
0.9	0	2.13884	2.49171	2.87219	3.16521	3.53699	3.81298	4.2896	4.76623	6.54434	7.35228
	1	1.71272	1.93798	2.16813	2.39212	2.62642	2.75525	2.92024	3.24471	3.98601	5.31468
	2	1.55628	1.73383	1.89745	2.08362	2.24939	2.39451	2.57521	2.70912	3.46009	4.03227
	3	1.47030	1.62618	1.77555	1.92129	2.05028	1.38973	2.29524	2.42734	2.88229	3.32998
	4	1.41596	1.55002	1.68156	1.78901	1.92499	2.02539	2.11823	2.25060	2.77789	3.33866
	5	1.37573	1.49686	1.60066	1.72271	1.83791	1.24417	1.99498	2.12808	2.48603	2.97795
	6	1.34578	1.45732	1.55390	1.65050	1.73843	1.85323	1.96829	2.03745	2.46250	2.70478
	7	1.32249	1.42088	1.51759	1.61505	1.69241	1.77465	1.89082	1.96730	2.27442	2.78260
	8	1.30212	1.39676	1.48843	1.56796	1.65548	1.75096	1.82869	1.91114	2.27638	2.59051
	9	1.28532	1.37689	1.46442	1.54624	1.62506	1.69583	1.77759	1.86500	2.14003	2.43016
	10	1.27119	1.35583	1.43512	1.51235	1.59948	1.64941	1.73474	1.77138	2.15178	2.50821
0.95	0	2.21317	2.59892	2.98360	3.36665	3.69274	4.04227	4.54756	4.76623	6.54434	8.72579
	1	1.77334	2.01800	2.26800	2.50607	2.71344	3.00162	3.09965	3.44406	4.49184	5.31468
	2	1.60879	1.80423	1.99696	2.16858	2.37549	2.48751	2.69382	2.86134	3.79307	4.61346
	3	1.51569	1.68234	1.83496	1.98895	2.15245	2.27763	2.39350	2.55027	3.18237	3.84305
	4	1.45654	1.59766	1.74742	1.87541	2.01081	2.14597	2.27857	2.35359	3.00634	3.33866
	5	1.41310	1.54470	1.67316	1.79629	1.91187	2.00580	2.13543	2.21664	2.69857	3.31470
	6	1.38071	1.49963	1.61779	1.71694	1.83832	1.94473	2.02852	2.11511	2.63607	3.01793
	7	1.35548	1.46452	1.57469	1.67361	1.78120	1.85847	1.94524	2.03642	2.43869	2.78260
	8	1.33370	1.43627	1.54004	1.63885	1.73537	1.82464	1.92527	1.9734	2.41620	2.82705
	9	1.31573	1.41298	1.51151	1.59486	1.69767	1.76442	1.86653	1.92163	2.27376	2.65492
	10	1.30061	1.39340	1.48752	1.57212	1.64455	1.74378	1.81714	1.87823	2.26877	2.50821
0.99	0	2.34200	2.78386	3.21837	3.63744	4.02107	4.48887	4.91151	5.27534	7.14934	8.72579
	1	1.87352	2.15226	2.42248	2.68425	2.98179	3.18949	3.48871	3.75203	4.86706	5.98912
	2	1.69492	1.91610	2.13414	2.33962	2.53001	2.77816	2.97681	3.10939	4.06367	5.05743
	3	1.59430	1.78226	1.96560	2.15538	2.32044	2.51246	2.63607	2.84704	3.64101	4.24317
	4	1.52797	1.6966	1.85769	2.01787	2.15598	2.29807	2.47499	2.60998	3.20298	4.00845
	5	1.47958	1.63125	1.78186	1.92079	2.06822	2.18499	2.31137	2.44228	3.0458	3.59809
	6	1.44330	1.58224	1.71549	1.84809	1.97821	2.10093	2.23513	2.31654	2.92944	3.51476
	7	1.41360	1.54393	1.67236	1.79133	1.90775	2.03565	2.13439	2.21831	2.71796	3.25158
	8	1.38961	1.51304	1.62955	1.74563	1.85091	1.95401	2.05272	2.13919	2.65937	3.03517
	9	1.36863	1.48393	1.59411	1.70792	1.80394	1.91349	1.98498	2.11979	2.50725	3.03169
	10	1.35093	1.46272	1.56421	1.66414	1.76440	1.85415	1.96175	2.06176	2.47638	2.86904

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