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Original Article

Repetitive acceptance sampling plan for type-ii generalized half logistic distribution based on truncated life test

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Abstract

In this article, we present a new repetitive acceptance sampling plan for attributes based on considering the Type-II generalized half-logisticl distribution (GHLD) with known shape parameters. The plan parameters such as sample size and acceptance number are formulated by considering the median lifetime of test as a quality parameter. The objective function to be mimimized is the average sample number(ASN), whereas the constraints are related to the lot acceptance probalilities at the acceptable and limiting quality levels. The authors compare the average sample number (ASN) of the proposed repetative acceptance sampling plan and the ordinary single sampling plan. Tables are constructed for various values of shape parameter. The results are demonstrated with the help of real- life data.

Keywords: Type-II generalized half-logistic distribution, producer's risk, consumer's risk, median life, repetitive acceptance sampling plan

1. Introduction

Type-I and Type-II censoring are two types of censoring are commonly used in medical sciences and in life testing experiments. Type-I censoring scheme fixes the test duration and Type-II censoring scheme fixes the number of failures. But today in life testing, time truncated scheme is preferred. Generally, in life testing, the author truncates the experiment when pre-defined experimental time in reached. This scheme is more convenient than censoring schemes to minimize the time and cost of the experiment to reach the final decision.

There are various types of sampling plans such as attributes sampling plan, variable sampling plan, group sampling plan, accelerated sampling plan and progressively sampling plan. But, the main intention of these plans is to make a decision on submitted lot with minimum sample size by providing the protection to producer and consumer. It is a very important feature, both for the producer and the consumer. Whatever acceptance sampling plans are implemented, the producer's and consumer's risk is always associated with the lot decision. Therefore, there is a chance to accept a bad lot (or) to reject a good lot. The probability of rejecting a good lot is called producer's risk (α) and the probability of acceptance of a bad lot is called consumer's risk (β). So, the purpose of sampling scheme is to minimize these risks with the minimum number of sample size. Many researchers have done studies on the time truncated life test for various distributions, including Kantam, Rosaiah and Rao (2001), Tsai and Wu (2006), Balakrishnan, Leiva and Lopez (2007), Lio, Tsai and Wu (2010a), Lio, Tsai and Wu (2010b), and Aslam, Azam, and Jun (2013).

Even though a number of sampling plans has been planned for lot character, a plan which needs minimum sample size is often called the ideal design for inspection. As a consequence of minimum sample size, the cost of inspection is reduced and such plans are called economical sampling plans. The main purpose of designing of the repetitive group acceptance sampling plan is to reduce the ASN. A repetitive group acceptance sampling plan based on attribute repetitive group sampling for a normal distribution was proposed by

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Sherman (1965). According to him, the developed repetitive group acceptance sampling plan gives anminimize sample size corresponding to the consumer's risk. Numerous authors considered the repetitive sampling plans for various distributions; for more details see Balamurali, Park, Jun, Kim and Lee (2005), Balamurali and Jun (2006), Aslam, Niaki, Rasool and Fallahnezhad (2012), Aslam, Lio and Jun (2013), Lee, Aslam and Jun (2012), Aslam, Jun, Fernandez, Ahmad and Rasool (2014), Singh, Singh and Kaur (2018) and Singh, Singh and Kaur (2018).

In this article, we have developed the attribute repetitive acceptance sampling plan based on Type-II generalized half-logistic distribution. The rest of the paper is organized as follows. Section 2 presents an introduction to the Type-II generalized half-logistic distribution. In Section 3, we developed an attributes repetitive acceptance sampling plan for truncated life tests assuming that the lifetime of product follows the Type-II GHLD with known shape parameter. The proposed methodology with real life data is given in Section 4. In Section 5, the ASN of the proposed attributes repetitive acceptance sampling plan is compared with the single sampling plan. Finally, the results are demonstrated with a real life data set in Section 6.

2. The Type-II Generalized Half Logistic Distribution (GHLD)

In this paper, we discuss proposed attribute repetitive acceptance sampling plan for when life time of product follows Type-II generalized half logistic distribution (GHLD) proposed by Kantam, Ramakrishna and Ravikumar (2014). The probability density function and cumulative distribution function of this distribution is given by

$$f(t;\theta)=\frac{2^{\theta}\theta e^{t}}{\left(1+e^{t}\right)^{\theta+1}};\qquad t>0\ and\ \theta>0\ . \tag{1}$$

and

$$F(t;\theta)=1-\frac{2^{\theta}}{\left(1+e^{t}\right)^{\theta}}\ ;\quad t>0\ and\ \theta>0 \tag{2}$$

If we introduce a scale parameter in the above standard distribution, then the resultant distribution may be called a two-parameter Type-II GHLD, whose probability density function and cumulative distribution function are respectively given by

$$f(t;\sigma,\theta)=\frac{2^{\theta}\theta e^{t/\sigma}}{\sigma\left(1+e^{t/\sigma}\right)^{\theta+1}};\qquad t>0,\quad \sigma,\theta>0\ . \tag{3}$$

$$F(t;\sigma,\theta)=1-\frac{2^{\theta}}{\left(1+e^{t/\sigma}\right)^{\theta}}\ ;\qquad t>0,\quad \sigma,\theta>0\ . \tag{4}$$

Where σ is a scale parameter and θ is the shape parameter. When $\theta=1$, the Type-II generalized half-logistic distribution converts to half logistic distribution.

The 100q-th percentile of the Type-II GHLD is given as

$$t_q=\sigma\eta_q,\qquad \text{where } \eta_q=\ln\left(2(1-q)^{-1/\theta}-1\right). \tag{5}$$

Where q ranges is (0.0, 1.0).

The median lifetime is 50th percentile of the Type-II GHLD, given by

$$t_{0.5}=\sigma\left[\ln\left(2(1-0.5)^{-1/\theta}-1\right)\right]. \tag{6}$$

By assuming the parameter θ is known, the 50th percentile lifetime given equation (6) is the function of the scale parameter σ only.

3. Design of Attributes Repetitive Acceptance Sampling Plan

The proposed plan attributes repetitive acceptance sampling plan under truncated life test can be delineated as follows:

Step-1: Draw a random sample of size n from a lot and put them on a life test for fixed time t_0.

Step-2: Accept the lot if the number of failures (D) is smaller than (or) equal to C_1 (first acceptance number). Truncate the test and the lot as soon as number of defective exceeds C_2, where $C_2 \geq C_1$.

Step-3: If $C_1 < D \leq C_2$, then go to step-1. Repeat the above experiment.

The proposed plan parameters are n, C_1 and C_2. The attributes repetitive acceptance sampling plan is a generalization of the single sampling plan and the above specified plan is reduced to a single sampling plan. The probability of acceptance lot is decided by using the operating characteristic (OC) function, which is derived to be:

$$P_A(p)=\frac{P_a}{P_a+P_r};\ \ 0<p<1 \tag{7}$$

Where P_a is the probability of acceptance of a submitted lot with fraction defective P based on a given sample.

$$P_a=\Pr\left(D\leq c_1\mid p\right)=\sum_{i=0}^{c_1}\left(\binom{n}{i}p^i\left(1-p\right)^{n-i}\right) \tag{8}$$

Whereas, P_r is the corresponding probability of lot rejection

$$P_r=\Pr\left(D>c_2\mid p\right)=1-\left(\sum_{i=0}^{c_2}\binom{n}{i}p^i\left(1-p\right)^{n-i}\right) \tag{9}$$

Then the operating characteristic define in equation (7) can be rewritten as

$$P_A(p)=\frac{\sum_{i=0}^{c_1}\binom{n}{i}p^i\left(1-p\right)^{n-i}}{\sum_{i=0}^{c_1}\binom{n}{i}p^i\left(1-p\right)^{n-i}+1-\sum_{i=0}^{c_2}\binom{n}{i}p^i\left(1-p\right)^{n-i}}\ ;\ 0<p<1 \tag{10}$$

The design parameters n, C_1 and C_2 of the proposed repetitive acceptance sampling plan, as stated by Aslam and Jun (2009), it would be easiest to express the termination time

t_0, as a multiple of the specified length δ_q^0. Accordingly, we will consider that $t_0 = \delta_q t_q^0$ for a constant δ_q and the targeted 100q-th lifetime percentile, t_q^0, thus, $\frac{t_0}{\sigma} = \frac{\delta_q^0 \eta_q}{\left(t_q / t_q^0\right)}$. We prefer the approach based on two points on the OC curve by considering the consumer's risk and producer's risk. Many authors put their effects to develop the sampling plan using this view point, including Fertig and Mann (1980) and Aslam and Jun (2009). In this approach, the quality level is measured as a ratio of its life time to the specified value δ_q / δ_q^0. From the producers required probability of lot acceptance of at least $1-\alpha$ at the Acceptance Quality Level (AQL), let p_1 be probability of a failure corresponding to the producer's risk (α) at AQL, say $t_q / t_q^0 = 2,4,6,8$ and 10. On other hand, form consumer's perspective, the lot rejection probability at most β at the limiting Quality Level (LQL), let p_2 be the probability of a corresponding to the consumer's risk (β) at LQL, say $t_q / t_q^0 = 1$. The repetitive acceptance sampling plan parameters n, c_1 and c_2, the following two inequalities should be satisfied.

$$P_A(p_1) = \frac{\sum_{i=0}^{c_1} \binom{n}{i} p_1^i (1-p_1)^{n-i}}{\sum_{i=0}^{c_1} \binom{n}{i} p^i (1-p)^{n-i} + 1 - \sum_{i=0}^{c_2} \binom{n}{i} p^i (1-p)^{n-i}} \geq 1\text{-}\alpha \tag{11}$$

$$P_A(p_2) = \frac{\sum_{i=0}^{c_1} \binom{n}{i} p_2^i (1-p_2)^{n-i}}{\sum_{i=0}^{c_1} \binom{n}{i} p^i (1-p)^{n-i} + 1 - \sum_{i=0}^{c_2} \binom{n}{i} p^i (1-p)^{n-i}} \leq \beta \tag{12}$$

where p_1 and p_2 are

$$p_1 = 1 - \frac{2^\theta}{\left(1 + \exp\left(\frac{\eta_q \delta_q^0}{\left(t_q / t_q^0\right)}\right)\right)^\theta} \tag{13}$$

And

$$p_2 = 1 - \frac{2^\theta}{\left(1 + \exp\left(\eta_q \delta_q^0\right)\right)^\theta} \tag{14}$$

The proposed repetitive acceptance sampling plan parameters should be chosen to minimize the Average sample Number (ASN) at the Limiting Quality Level. The Average Sample Number of the proposed plan when p is the true fraction defective P is derived to be.

$$ASN(p) = \frac{n}{P_a + P_r}. \tag{15}$$

Therefore, the proposed plan parameters n, c_1 and c_2 can be obtained by solving the following optimization problem.

Minimize $ASN(p_2)$

Subject to $P_A(p_1) \geq 1-\alpha$

$P_A(p_2) \leq \beta$

where n is an integer.

Given the producer's risk $\alpha = 0.05$ and its percentile ratio t_q / t_q^0, with $\delta_q^0 = 0.5$ to 1.0, there are three parameters n, c_1 and c_2 in this proposed repetitive acceptance sampling plan under the truncated life test at the specified time t_0, with $\theta = 1.5, 2.0$ and 2.5 obtained according to the consumer's confidence levels $\beta = 0.25, 0.10, 0.05$ and 0.01 for 50th percentile lifetime. The Average Sample Number (ASN) is also reported and finally, the probability of acceptance is also reported. The results are presented in Table 1 to 3. The Type- II GHLD estimated parameters value $\hat{\theta}$ =0.6809 for the 50th percentile estimated lifetimes the sampling parameters are presented in Table 4.

Form these tables; we noticed form Tables 1-4 that the constant δ_q^0 increase from 0.5 to 1.0, the sample size n decreases, for fixing all other values, when the shape parameter changes from 1.5 to 2.5. The tables are also equipped with the probability of acceptance p_a and the ASN for the optimal acceptance plans.It means that, as the producer increases the quality level of their product, the producer's risk decreases.

4. Application of the Proposed Repetitive Acceptance Sampling Plan with Real Data Set

In this section, the proposed Type-II GHLD is illustrated with following real lifetime data on clean up gradient ground-water monitoring wells in $(\mu g / L)$ from vinyl chloride data and it is taken from Bhaumik and Gibbons (2006) and Krishanamoorty, Mathew and Mukhejee (2008).

0.1, 0.1, 0.2, 0.2, 0.4, 0.4, 0.4 , 0.5, 0.5, 0.5, 0.6, 0.6, 0.8, 0.9, 0.9, 1.0, 1.1, 1.2, 1.2, 1.3, 1.8, 2.0, 2.0, 2.3, 2.4, 2.5, 2.7, 2.9, 3.2, 4.0, 5.1, 5.3, 6.8, 8.0.

Assume that the data set follows the Type-II Generalized half logistic distribution. The MLEs of the parameters are obtained as $\hat{\theta} = 0.6809$. To test the goodness of fit we apply the Kolmogorov-Smirnov test, it is observed that for the data set Kolmogorov-Smirnov statistic is 0.15704 with p-value is 0.4224. Thus, the data set is reasonably fitted for Type-II GHLD. Figure 1 displays Superimposed Empirical, Theoretical Density plots and Q-Q Plot, which show that Type-II GHLD is well fitted for this data set.

Table 1. Design parameters of the proposed plan for the Type-II GHLD with $\theta = 1.5$

	$\delta_q^0 = 0.5$						$\delta_q^0 = 1.0$				
β	t_q/t_q^0	c_1	c_2	n	$P_A(p_1)$	ASN	c_1	c_2	n	$P_A(p_1)$	ASN
0.25	2	3	6	22	0.9570	43.53	5	7	15	0.9642	23.05
	4	1	2	11	0.9537	14.32	1	2	6	0.9513	7.84
	6	0	1	6	0.9605	8.98	0	1	3	0.9666	4.8
	8	0	1	6	0.9782	8.98	0	1	3	0.9818	4.8
	10	0	1	6	0.9863	8.98	0	1	3	0.9887	4.8
0.10	2	4	18	31	0.9573	58.32	8	10	24	0.9529	29.81
	4	2	3	19	0.9514	21.58	0	2	5	0.9535	9.41
	6	1	2	14	0.9691	16.42	1	2	7	0.9744	8.37
	8	1	2	14	0.9861	16.42	0	1	4	0.9634	5.33
	10	0	1	9	0.9667	11.13	0	1	4	0.9771	5.33
0.05	2	7	11	48	0.9509	66.39	4	8	17	0.9558	32.41
	4	1	3	17	0.9562	22.46	1	3	9	0.9574	11.96
	6	0	2	11	0.9769	17.06	0	2	6	0.9752	8393
	8	0	2	11	0.9907	17.06	0	2	6	0.9902	8.93
	10	0	1	10	0.9583	11.82	0	1	5	0.9617	5.93
0.01	2	7	13	56	0.9535	79.17	7	12	28	0.9533	38.86
	4	1	4	23	0.9585	28.69	1	4	12	0.9617	14.83
	6	0	3	19	0.9825	23.32	0	3	9	0.9829	12.03
	8	0	2	15	0.9737	18.08	0	2	8	0.9721	9.31
	10	0	2	15	0.9869	18.08	0	2	8	0.9863	9.31

Table 2. Design parameters of the proposed plan for the Type-II GHLD with $\theta = 2.0$

	$\delta_q^0 = 0.5$						$\delta_q^0 = 1.0$				
β	t_q/t_q^0	c_1	c_2	n	$P_A(p_1)$	ASN	c_1	c_2	n	$P_A(p_1)$	ASN
0.25	2	5	7	28	0.9509	39.92	5	7	15	0.9611	23.05
	4	0	2	9	0.9538	17.02	2	8	3	0.9794	10.24
	6	0	1	6	09579	8.93	0	1	3	0.9646	4.8
	8	0	1	6	0.9767	8.93	0	1	3	0.9807	4.8
	10	0	1	6	0.9853	8.93	0	1	3	0.9879	4.8
0.10	2	5	9	36	0.9529	59.94	6	9	20	0.9607	30.97
	4	1	3	15	0.9705	21.93	1	3	9	0.9533	11.76
	6	1	2	14	0.9664	16.32	1	2	7	0.9723	8.37
	8	0	1	8	0.9563	10.37	0	1	4	0.9612	5.33
	10	0	1	8	0.9723	10.37	0	1	4	0.9756	5.33
0.05	2	7	11	47	0.9506	65.86	4	8	17	0.9508	32.41
	4	1	3	17	0.9513	22.21	1	3	9	0.9523	11.75
	6	0	2	11	0.9745	16.83	0	2	6	0.9729	8.93
	8	0	2	11	0.9897	16.83	0	2	6	0.9893	8.93
	10	0	2	11	0.9555	16.83	0	1	5	0.9592	5.93
0.01	2	7	13	55	0.9516	78.53	9	4	33	0.9626	43.23
	4	1	4	22	0.619	28.25	1	4	12	0.9571	14.83
	6	0	3	17	0.9800	22.99	0	3	9	0.9808	12.03
	8	0	2	15	0.9709	17.92	0	2	8	0.9694	9.31
	10	0	2	15	0.9855	17.92	0	2	8	0.9849	9.31

Table 3. Design parameters of the proposed plan for the Type-II GHLD with $\theta = 2.5$

		$\delta_q^0 = 0.5$					$\delta_q^0 = 1.0$				
β	t_q/t_q^0	c_1	c_2	n	$P_A(p_1)$	ASN	c_1	c_2	n	$P_A(p_1)$	ASN
0.25	2	3	6	21	0.9599	42.96	5	7	15	0.9587	23.05
	4	2	1	10	0.9601	13.43	2	3	8	0.9783	10.00
	6	0	1	6	0.9561	8.89	0	1	3	0.9632	4.8
	8	0	1	6	0.9757	8.89	0	1	3	0.9799	4.8
	10	0	1	6	0.9846	8.89	0	1	3	0.9874	4.8
0.10	2	4	8	13	0.9563	57.74	6	9	20	0.9579	30.97
	4	0	2	9	0.9509	16.86	1	3	9	0.9504	11.76
	6	1	2	14	0.9644	16.26	1	2	7	0.9709	8.37
	8	0	1	8	0.9544	10.33	0	1	4	0.9596	5.23
	10	0	1	8	0.9711	10.33	0	1	4	0.9746	5.23
0.05	2	7	11	46	0.9534	16.85	11	8	26	0.9514	34.25
	4	0	3	14	0.9501	23.73	1	3	9	0.9504	11.76
	6	0	2	11	0.9728	16.68	0	2	6	0.9713	8.93
	8	0	2	11	0.9889	16.68	0	2	6	0.9886	8.93
	10	0	1	10	0.9583	11.71	0	1	5	0.9575	5.93
0.01	2	8	4	59	0.9579	81.91	9	14	33	0.9587	43.23
	4	1	4	22	0.9583	27.99	1	4	12	0.9536	14.83
	6	1	3	17	0.9782	22.78	0	3	9	0.9792	12.03
	8	0	2	15	0.9687	17.82	0	2	8	0.9674	9.31
	10	0	2	15	0.9845	17.82	0	2	8	0.9839	9.31

Table 4. Design parameters of the proposed plan for the Type-II GHLD with $\hat{\theta} = 0.6809$

		$\delta_q^0 = 0.5$					$\delta_q^0 = 1.0$				
β	t_q/t_q^0	c_1	c_2	n	$P_A(p_1)$	ASN	c_1	c_2	n	$P_A(p_1)$	ASN
0.25	2	5	7	30	0.9576	42.17	4	6	13	0.9600	20.52
	4	1	2	11	0.9648	14.56	1	2	6	0.9610	7.83
	6	0	1	6	0.9684	9.14	0	1	3	0.9725	4.8
	8	0	1	6	0.9827	9.14	0	1	3	0.9853	4.8
	10	0	1	6	0.9891	9.14	0	1	3	0.9909	4.8
0.10	2	3	7	28	0.9531	55.69	7	9	22	0.9514	27.32
	4	0	2	10	0.9560	17.86	0	2	5	0.9641	9.41
	6	1	2	15	0.9719	17.39	1	2	7	0.9803	8.37
	8	0	1	9	0.9581	11.34	0	1	4	0.9704	5.23
	10	0	1	9	0.9737	11.34	0	1	4	0.9816	5.23
0.05	2	6	10	45	0.9564	64.78	7	10	24	0.9592	31.52
	4	1	3	18	0.9621	23.48	1	3	9	0.9685	11.75
	6	0	2	12	0.9779	17.81	0	2	6	0.9817	8.93
	8	0	2	12	0.9912	17.81	0	1	5	0.9505	5.93
	10	0	1	11	0.9596	12.75	0	1	5	0.9692	5.93
0.01	2	5	11	48	0.9527	75.01	5	10	23	0.9504	34.51
	4	1	4	24	0.9673	29.93	0	3	8	0.9603	12.49
	6	0	3	18	0.9856	24.32	0	3	9	0.9886	12.03
	8	0	2	16	0.9771	19.04	0	2	8	0.9797	9.31
	10	0	2	16	0.9887	19.04	0	2	8	0.9902	9.31

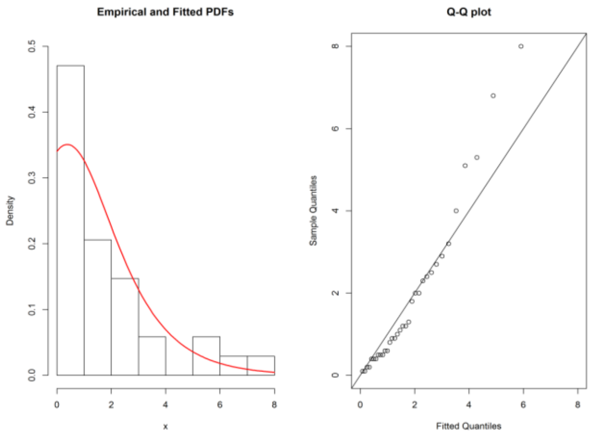

Figure 1. Superimposed empirical, theoretical density plots and Q-Q plot of the fitted Type- II GHLD for vinyl chloride data

Suppose that lifetime of the products follows Type-II Generalized half-logistic distribution. So, let us assume that $\hat{\theta}$=0.6809 now. Assuming that $\alpha=0.05$, $\beta=0.25$ and t_q/t_q^0=2, from Table 4 we note that the optimal design parameters are n=30, c_1=5 and c_2=7. Thus, the sampling plan can be implemented as follows: Take a random sample of size 30 from the lot. Reject the lot if the number of failures reaches 8 and terminate the test. Accept the lot if 5 failures occur before 0.6 gradient ground-water monitoring wells in $(\mu g/L)$. If the number of failures is 5 to 7, the experiments should be repeated. From data, it is clear that ten failure within 0.6 $\mu g/L$. Hence, the quality professional decision is to reject the submitted lot.

5. Comparison Study

Obviously, in terms of required sample size, an attributes repetitive acceptance sampling plan based on truncated life tests is preferable to the corresponding single sampling plan developed by Rao, Jilani, Rao, Bhanuprakash (2019). Table 5 and Table 6 present the ASN of the proposed attributes repetitive acceptance sampling plan and sample size required for the single sampling plan when producer's risk $\alpha=0.05$, $\delta_q=0.5$ and $\delta_q=1.0$, consumer's confidence level $\beta=0.25, 0.10, 0.05$ and 0.01 and $t_q/t_q^0=2,4,6,8$ and 10. From Table 5, we observed that the proposed plan needed a smaller sample size than the single acceptance sampling plan. For example, $\beta=0.05$, $t_q/t_q^0=2$, $\delta_q^0=1.0$ and $\theta=2.5$, the ASN of the proposed plan is 34.25, whereas the single sampling plan 53. In Table 6, for example $\beta=0.10$, $t_q/t_q^0=2$, $\delta_q^0=1.0$ and $\theta=2.0$, the ASN of the proposed plan is 30.97, whereas the single sampling plan 44.

6. Conclusions

In this article, the attributes repetitive acceptance sampling plan based on the time truncated life test under Type-II Generalized half-logistic distribution. In the proposed sampling plan, the parameters *n*, C_1 and $C_2$are determined by the two-point method approach considering the producer's and consumer's risk are both satisfied at the same time. Comparing between the ASN of the proposed repetitive group sampling plan and the ordinary single acceptance sampling plan, we observe that the proposed plan is more economical that the existing one as it provides smaller sample size then the ordinary single acceptance sampling plan. From this study, it is concluded that proposed plan will be effective in reducing the inspection cost and time.

Table 5. Sample sizes of the proposed plans and single sampling plans for the Type-II GHLD when $\alpha=0.05$ and $\delta_q^0=0.5$

β	t_q/t_q^0	$\theta=1.5$		$\theta=2.0$		$\theta=2.5$	
		Proposed(ASN)	Single	Proposed(ASN)	Single	Proposed(ASN)	Single
0.25	2	43.53	50	39.92	54	42.96	49
	4	14.32	18	17.02	18	13.43	18
	6	8.98	14	8.93	14	8.89	14
	8	8.98	9	8.93	9	8.89	9
	10	8.98	9	8.93	9	8.89	9
0.10	2	58.32	79	59.94	82	57.74	81
	4	21.58	28	21.93	27	16.86	27
	6	16.42	23	16.32	23	16.26	22
	8	16.42	18	10.37	18	10.33	18
	10	11.13	18	10.37	18	10.33	18
0.05	2	66.39	102	65.86	--	16.85	--
	4	22.46	36	22.21	36	23.73	35
	6	17.06	26	16.83	26	16.68	26
	8	17.06	21	16.83	21	16.68	21
	10	11.82	21	16.83	21	11.71	21
0.01	2	79.17	--	78.53	--	81.91	--
	4	28.69	54	28.25	53	27.99	53
	6	23.32	39	22.99	38	22.78	38
	8	18.08	34	17.92	33	17.82	33
	10	18.08	28	17.92	27	17.82	27

Table 6. Sample sizes of the proposed plans and single sampling plans for the Type-II GHLD when $\alpha = 0.05$ and $\delta_q^0 = 1.0$

β	t_q/t_q^0	$\theta = 1.5$		$\theta = 2.0$		$\theta = 2.5$	
		Proposed(ASN)	Single	Proposed(ASN)	Single	Proposed(ASN)	Single
0.25	2	23.05	27	23.05	27	23.05	27
	4	7.84	10	10.24	10	10.00	10
	6	4.80	7	4.80	7	4.80	7
	8	4.80	5	4.80	5	4.80	5
	10	4.80	5	4.80	5	4.80	5
0.10	2	29.81	39	30.97	44	30.97	44
	4	9.41	14	11.76	14	11.76	14
	6	8.37	9	8.37	12	8.37	12
	8	5.33	9	5.33	9	5.23	9
	10	5.33	9	5.33	9	5.23	9
0.05	2	32.41	51	32.41	51	34.25	53
	4	11.96	18	11.75	18	11.76	18
	6	8393	13	8.93	13	8.93	13
	8	8.93	11	8.93	11	8.93	11
	10	5.93	11	5.93	11	5.93	11
0.01	2	38.86	--	43.23	--	43.23	--
	4	14.83	27	14.83	27	14.83	27
	6	12.03	19	12.03	19	12.03	19
	8	9.31	17	9.31	17	9.31	17
	10	9.31	14	9.31	14	9.31	14

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