
Designing Double Sampling Plan for Truncated Life Tests Using Minimum Angle Method

3.1 Introduction

Acceptance sampling procedures play an important role in improving quality. The basic aim of all companies is to improve the quality of their products. A high quality product has a higher probability of acceptance. In a time- truncated sampling plan, a random sample is selected from a lot of products and put on the test where the number of failures is recorded until the pre-specified time. If the number of failures observed is not greater than the specified acceptance number, then the lot will be accepted.

The priority of every sampling plan is the reduction in time and cost, which depends on the sample size. In a single sampling plan, a decision regarding rejection and acceptance of the lot is taken on the basis of a single sample, whereas in case of Double sampling plan two different sample sizes are involved to decide on the quality of the sample which obviously increases the probability of acceptance. The Double sampling plan can be used to reduce the average sample number and also it is expected to reduce the producer's risk and consumer's risk simultaneously. Another advantage of this plan is to improve the operating characteristics as compared to a Single sampling plan.

The life tests for DASP are discussed by many authors, Aslam (2007 b), presented Double sampling plan based on truncated life tests for Rayleigh distribution. Srinivasa Rao (2012 a), presented Double sampling plan based on truncated life tests for the Marshall – Olkin Extended Exponential distribution.

Sudamani and Priya (2012 a,b), presented Double sampling plan based on truncated life tests for the Generalized Exponential distribution. In this chapter minimum angle and optimum design parameters for DASP, $c_1 = 0$ and $c_2 = 2$ by keeping the producer's risk below 5 percent and the consumer's risk below 10 percent were provided. The Double sampling plan is characterized by the parameters $n_1, n_2, c_1, c_2, r_1, r_2$ and designated as DASP ($n_1, n_2, c_1, c_2, r_1, r_2$) where $r_1 = r_2 = c_2 + 1$. Here n_1 and n_2 are the sample sizes c_1, c_2 are the acceptance number and r_1, r_2 are the rejection numbers.

In this chapter a new approach of designing Double sampling plans for truncated life test using minimum angle method, is proposed when the life time of the items follows different distributions. The distributions considered in this chapter are Rayleigh distribution, Generalized Exponential distribution, Weibull distribution, Gamma distribution and Marshall - Olkin Extended Lomax distribution. The test termination time and mean ratio time are specified. The acceptance numbers are specified as $c_1 = 0$ and $c_2 = 2$. The design parameter is obtained such that it satisfies both the producer's risk and consumer's risk simultaneously and at the same time it minimizes the sum of risks. The tables of design parameter are provided for easy selection of the plan parameter. The results are analyzed with the help of tables and examples.

3.2 Operating Procedure for Double sampling plan

- 1) From a lot, take a first sample of size n_1 and observe the number of nonconforming units, d_1 .
- 2) (i) If $d_1 \leq c_1$, accept the lot; if $d_1 \geq c_2$, reject the lot.
(ii) If $c_1 < d_1 < c_2$ take a second sample of size n_2 and observe the number of nonconforming units, d_2 .
- 3) If $d_1 + d_2 \leq c_2$, accept the lot; otherwise reject the lot.

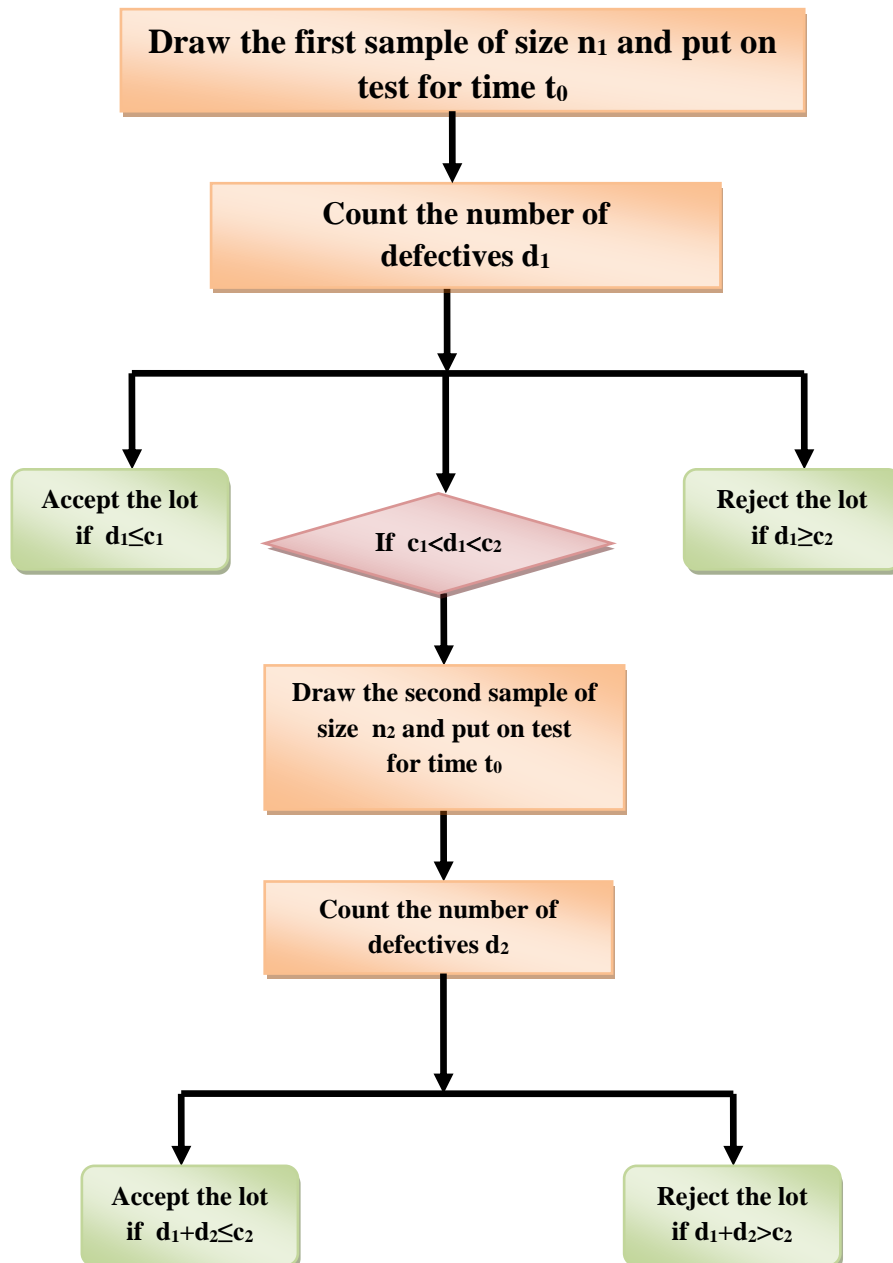
3.3 Operating Procedure of Double sampling plan for truncated life test

The following is the procedure presented by Aslam (2007 b), for the Double sampling plan based on truncated life test.

1. Draw the first sample of size n_1 and put them on test during time t_0
2. Accept the lot if there are no more than c_1 failures. Reject the lot and terminate the test if there are more than c_2 failures.
3. If the number of failures is between c_1 and c_2 , then draw the second sample of size n_2 and put them on test during time t_0 .
4. Accept the lot if the total number of failures is not more than c_2 during the time t_0 , Otherwise, reject the lot and terminate the test.

The following is the operating procedure for Double sampling plan for life test in the form of a flow chart.

Flow-Chart



3.4 Distributions

The following are the different life time distributions used in this chapter.

3.4.1 Rayleigh distribution

The cumulative distribution Function (cdf) of the Rayleigh distribution is given by,

$$F(t, \lambda) = 1 - e^{-\frac{1}{2}\left(\frac{t}{\lambda}\right)^2}, \quad t > 0, \lambda > 0 \quad (3.1)$$

where λ is the scale parameter,

3.4.2 Generalized Exponential distribution

The cumulative distribution function (cdf) of the Generalized Exponential distribution is given by

$$F(t, \lambda) = \left(1 - e^{-\frac{t}{\lambda}}\right)^\alpha, \quad t > 0, \lambda > 0 \quad (3.2)$$

where λ is the scale parameter and α is the shape parameter and it is fixed as 2

3.4.3 Weibull distribution

The cumulative distribution function (cdf) of the Weibull distribution is given by,

$$F(t, \lambda) = 1 - e^{-\left(\frac{t}{\lambda}\right)^m}, \quad t > 0, \lambda > 0 \quad (3.3)$$

Where λ is the scale parameter and m is the shape parameter and it is fixed as 2.

3.4.4 Gamma distribution

The cumulative distribution function (cdf) of the Gamma distribution is given by ,

$$F(t, \lambda) = 1 - e^{-\frac{t}{\lambda}} \sum_{j=0}^{\gamma-1} \left(\frac{t}{\lambda}\right)^j / j!, \quad t > 0, \lambda > 0 \quad (3.4)$$

where λ is the scale parameter and $\gamma > 0$ is the shape parameter and it is fixed as 2.

3.4.5 Marshall - Olkin Extended Lomax distribution

The cumulative distribution function of the Marshall -- Olkin Extended Lomax distribution are given by ,

$$F(t, \lambda) = \frac{(1+t/\lambda)^\theta - 1}{(1+t/\lambda)^\theta - \bar{\gamma}}, \quad t > 0, \lambda > 0 \quad (3.5)$$

where $\bar{\gamma} = 1 - \gamma$ and $\gamma > 0$ is the shape parameter and let us assume $\gamma = 2$, λ is scale parameter and θ is shape parameter.

3.5 Construction of Tables

It is assumed that the lot size is large enough to use the binomial distribution to find the probability of lot acceptance. The acceptance numbers are fixed as $c_1 = 0$ and $c_2 = 2$. Probability of acceptance for DASP is given by $P(A) = P(\text{no failure occur in sample 1}) + P(1 \text{ failure occur in sample 1 and } 0, 1 \text{ failure occur in sample 2}) + P(2 \text{ failures occur in sample 1 and } 0 \text{ failure occurs in sample 2})$.

The probability of acceptance $L(p)$ for Double sampling plan is calculated using the following equation

$$L(p) = \binom{n_1}{0} p^0 q^{n_1} + \binom{n_1}{1} p^1 q^{n_1-1} \left[\sum_{i=0}^1 \binom{n_2}{i} p^i q^{n_2-i} \right] + \binom{n_1}{2} p^2 q^{n_1-2} \left[\binom{n_2}{0} p^0 q^{n_2} \right] \quad (3.6)$$

The time termination ratio t/λ_0 values are fixed as 0.628, 0.912, 1.257, 1.571, 2.356, 3.141, 3.927 and 4.712, and the mean ratio λ/λ_0 values are fixed as 4, 6, 8, 10 and 12 and $c_1 = 0$, $c_2 = 2$. The failure probability p is obtained such that it satisfies the following inequality at worst case $\lambda = \lambda_0$, $L(p) \leq \beta$ where β is less

than 0.10. The parameter value n is obtained using minimum angle method for predetermined values of acceptance numbers and satisfying the conditions $L(p_1) \geq 0.95$ and $L(p_2) \leq 0.10$ and at the same time it minimizes sum of the risks for Rayleigh distribution, Generalized Exponential distribution, Weibull distribution and Gamma distribution. The results are presented in Table 3.1, Table 3.2, Table 3.3 and Table 3.4 respectively. The value of θ and $\tan\theta$ are also provided in each table. The parameters can be selected corresponding to the minimum value of θ .

Table-3.1 The sample size and probability of acceptance for Minimum angle method Double sampling plan ($c_1 = 0, c_2 = 2$) when the life time of the items follows Rayleigh distribution

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
0.628	4	15	18	0.993478	0.083341	1.071839	46.98588
		14	18	0.99412	0.098354	1.089035	47.44048
		16	18	0.992804	0.070609	1.057825	46.60959
		17	18	0.992097	0.059813	1.046377	46.29826
		15	20	0.992526	0.074524	1.062656	46.7399
		14	20	0.993238	0.088528	1.078268	47.15676
		18	20	0.990192	0.044459	1.031496	45.88824
		16	20	0.991781	0.062737	1.050025	46.39786
		14	23	0.991828	0.078574	1.06818	46.88815
		15	23	0.991006	0.065608	1.054162	46.51038
		16	23	0.990151	0.054788	1.042932	46.20389
		19	23	0.987383	0.031925	1.020997	45.59525
		16	28	0.987204	0.047799	1.038444	46.08045
		22	28	0.980196	0.015397	1.011113	45.3166
		19	28	0.983854	0.027117	1.019632	45.55694
	13	28	0.990246	0.084331	1.076834	47.11873	
	14	33	0.986474	0.065977	1.059775	46.66227	
	18	33	0.981401	0.030407	1.02579	45.72939	
	26	33	0.969628	0.006475	1.01284	45.3655	
	15	33	0.985257	0.054357	1.047932	46.34077	
	20	37	0.97528	0.019995	1.021182	45.60044	
	25	37	0.967018	0.007532	1.016711	45.47475	
	30	37	0.957947	0.002839	1.021372	45.60576	
	12	37	0.986772	0.095487	1.09451	47.58359	
	18	37	0.978354	0.029553	1.028161	45.7955	
	6	16	24	0.998893	0.052933	1.045577	46.27639
		20	24	0.998445	0.025547	1.016627	45.47238
		15	24	0.998993	0.063524	1.057303	46.59548
		18	24	0.998678	0.036766	1.028237	45.79762
		15	28	0.998735	0.05779	1.051149	46.42849
	13	28	0.998961	0.08438	1.081451	47.24094	
	17	28	0.99849	0.039596	1.031473	45.8876	

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		25	28	0.997306	0.008759	1.000534	45.01529
		18	40	0.997234	0.02923	1.021766	45.61682
		24	40	0.995915	0.009015	1.002203	45.06303
		30	40	0.994379	0.002782	0.997455	44.92701
		35	40	0.992927	0.001045	0.997168	44.91877
	8	13	22	0.999873	0.097286	1.101262	47.75901
		15	22	0.999843	0.068163	1.066875	46.85318
		18	22	0.999791	0.040004	1.035631	46.00278
		20	22	0.999752	0.02805	1.022933	45.64949
		21	27	0.999646	0.019122	1.013729	45.39062
		25	27	0.999531	0.009051	1.003538	45.10119
		17	27	0.999743	0.040459	1.036173	46.01777
		14	27	0.999806	0.071056	1.070239	46.94319
		22	37	0.999403	0.013542	1.00824	45.23508
		17	37	0.999584	0.035956	1.031502	45.8884
		28	37	0.999146	0.004199	0.999033	44.97228
		32	37	0.998949	0.001925	0.996952	44.91254
	10	14	17	0.999972	0.104615	1.112472	48.04766
		15	17	0.999969	0.088966	1.093366	47.55376
		18	23	0.999936	0.038252	1.035746	46.00595
		16	23	0.999946	0.05483	1.053902	46.5033
		20	23	0.999924	0.026695	1.023459	45.66424
		25	27	0.999863	0.009051	1.005297	45.15134
		23	27	0.999881	0.013154	1.009459	45.26969
		20	27	0.999905	0.023059	1.01967	45.558
		17	27	0.999926	0.040459	1.038139	46.07204
	12	21	24	0.99997	0.021298	1.018997	45.53909
		17	24	0.999979	0.044112	1.043309	46.21423
		13	24	0.999986	0.091524	1.09775	47.66791
		12	24	0.999987	0.109881	1.120387	48.24955
		25	27	0.999953	0.009051	1.006421	45.18334
		22	27	0.999962	0.015859	1.013374	45.38058
		18	27	0.999972	0.033541	1.031904	45.89956
		14	27	0.999981	0.071056	1.073568	47.03194
		35	39	0.999867	0.001052	0.998447	44.95549

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		31	39	0.999891	0.002301	0.999674	44.99065
		26	39	0.999917	0.006122	1.003491	45.09984
		22	39	0.999935	0.013397	1.010873	45.30979
		17	20	0.999984	0.052856	1.052936	46.47706
		13	20	0.999989	0.105233	1.114565	48.10119
		15	20	0.999987	0.074578	1.077647	47.14031
		19	20	0.99998	0.037459	1.036095	46.01561
0.942	4	12	19	0.958175	0.004977	0.991716	44.7617
		10	19	0.966781	0.012037	0.990111	44.71529
		8	19	0.974747	0.02912	0.999656	44.99014
		7	19	0.978486	0.045297	1.01298	45.36945
		12	21	0.95276	0.004919	0.997321	44.92316
		9	21	0.966696	0.018566	0.997018	44.91443
		7	21	0.975221	0.045016	1.01623	45.46122
		6	21	0.979246	0.070099	1.039767	46.1169
		15	17	0.950566	0.00137	0.995897	44.88222
		13	17	0.959308	0.003293	0.988794	44.67716
		9	17	0.974857	0.019067	0.989027	44.6839
		11	17	0.967412	0.007922	0.985213	44.57323
	6	18	22	0.988949	0.000344	0.986746	44.61777
		14	22	0.992294	0.002021	0.985084	44.5695
		17	22	0.989836	0.000535	0.986052	44.59763
		16	22	0.990689	0.000833	0.9855	44.58157
		15	29	0.987647	0.001288	0.988993	44.68293
		18	29	0.984274	0.00034	0.99143	44.75344
		13	29	0.989724	0.003128	0.988754	44.67602
		24	29	0.976601	0.0001	0.998899	44.96843
		21	37	0.973644	0.0001	1.002	45.05725
		25	37	0.966958	0.0001	1.008852	45.25248
		30	37	0.957871	0.0001	1.018408	45.52253
		28	37	0.961601	0.0001	1.01446	45.41126
	8	9	18	0.999382	0.01886	1.005773	45.16491
		12	18	0.999065	0.005029	0.992099	44.77277
		15	18	0.998683	0.001342	0.988811	44.67766
		13	22	0.998591	0.003148	0.990697	44.73224
		16	22	0.99809	0.000833	0.988895	44.6801
		8	22	0.999271	0.028853	1.016244	45.46161
		11	22	0.998886	0.007636	0.994888	44.85318

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		17	28	0.997075	0.00053	0.989601	44.70054
		12	28	0.998182	0.004875	0.992827	44.79377
		21	28	0.996027	0.0001	0.990205	44.71802
		25	28	0.994826	0.0001	0.991326	44.75042
		22	37	0.993808	0.0001	0.992384	44.78099
		17	37	0.99562	0.00053	0.991048	44.7424
		9	37	0.998009	0.018442	1.006753	45.1928
		30	37	0.990374	0.0001	0.995769	44.87854
		28	37	0.991295	0.0001	0.994846	44.85196
		7	15	0.999674	0.04728	1.035477	45.99854
		11	15	0.999369	0.008324	0.995092	44.85906
		9	15	0.999534	0.019827	1.006609	45.18872
		10	15	0.997195	0.000371	0.978572	44.37952
		8	15	0.99796	0.001802	0.979226	44.39865
		5	15	0.998907	0.01927	0.99574	44.87771
		12	15	0.996316	0.0001	0.979147	44.39632
		14	23	0.991777	0.0001	0.983567	44.52534
		17	23	0.989197	0.0001	0.986119	44.59955
		8	23	0.996044	0.0018	0.981111	44.45372
		17	23	0.989197	0.0001	0.986119	44.59955
		19	35	0.978331	0.0001	0.99707	44.91593
		13	35	0.986488	0.0001	0.98886	44.67907
		26	35	0.967281	0.0001	1.00846	45.24133
		12	35	0.987729	0.0001	0.987659	44.64427
		10	19	0.986854	0.0001	0.974622	44.26368
		7	19	0.991647	0.000177	0.970081	44.12993
		15	19	0.977191	0.0001	0.984256	44.54541
		12	19	0.983241	0.0001	0.9782	44.36861
		14	25	0.970718	0.0001	0.990819	44.73578
		9	25	0.983009	0.0001	0.978446	44.37581
		11	25	0.978335	0.0001	0.983106	44.51191
		18	25	0.95945	0.0001	1.002455	45.07026
		20	25	0.953353	0.0001	1.008866	45.25288
10		14	21	0.999591	0.002029	0.993568	44.81514
		12	21	0.999675	0.004919	0.996371	44.89585
		8	21	0.999814	0.028909	1.020848	45.59107
		18	21	0.999397	0.000345	0.992087	44.77242
		15	21	0.999546	0.001303	0.99289	44.7956

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		20	27	0.998998	0.00014	0.992279	44.77796
		17	27	0.999214	0.000531	0.992453	44.78297
		14	27	0.999405	0.002008	0.993733	44.8199
		24	27	0.998669	0.0001	0.99249	44.78406
	12	18	21	0.99979	0.000345	0.9944	44.83912
		16	21	0.999826	0.000837	0.994854	44.85219
		11	21	0.999901	0.007658	1.001618	45.04631
		8	21	0.999936	0.028909	1.023502	45.66544
		24	26	0.999555	0.0001	0.994314	44.83666
		20	26	0.999667	0.00014	0.994318	44.83677
		17	26	0.999741	0.000531	0.994634	44.84587
		13	26	0.999824	0.003131	0.997145	44.91809
		30	37	0.998987	0.0001	0.994857	44.85229
		26	37	0.999186	0.0001	0.994667	44.84682
		22	37	0.999364	0.0001	0.994538	44.84311
		15	37	0.999625	0.001287	0.995503	44.87087
		9	37	0.999803	0.018442	1.012724	45.3622
1.257	4	4	18	0.956538	0.042425	0.988549	44.67008
		3	18	0.967933	0.093479	1.033384	45.94058
		5	13	0.964292	0.019329	0.956277	43.71964
		6	13	0.95569	0.00878	0.95431	43.66073
	6	9	18	0.985087	0.000817	0.971876	44.18286
		13	18	0.975675	0.0001	0.980472	44.43507
		16	18	0.967484	0.0001	0.988741	44.67563
		11	18	0.980598	0.000168	0.975683	44.29483
		16	20	0.963315	0.0001	0.99302	44.79934
		8	20	0.996836	0.028994	1.007915	45.22585
		12	20	0.975039	0.0001	0.981153	44.45496
		14	20	0.969386	0.0001	0.986813	44.61973
		6	20	0.989436	0.008738	0.975415	44.28697
		7	25	0.982363	0.003965	0.977709	44.35423
		12	25	0.966688	0.0001	0.98963	44.70139
		15	25	0.956095	0.0001	1.000524	45.01499
		10	25	0.994076	0.011851	0.993156	44.80325
		8	17	0.963225	0.0001	0.968262	44.07619
		6	17	0.973891	0.000609	0.958205	43.77729
		4	17	0.983589	0.007183	0.955139	43.68558
		11	14	0.956572	0.0001	0.974946	44.27318

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		5	14	0.984123	0.002091	0.949668	43.5212
		7	14	0.975958	0.000177	0.955752	43.70392
		5	7	0.994322	0.002194	0.940004	43.22866
		3	7	0.997249	0.025327	0.959546	43.81732
	10	18	21	0.996902	0.0001	0.987322	44.63448
		13	21	0.998096	0.0001	0.986174	44.60115
		8	21	0.999019	0.0018	0.987006	44.62532
		5	21	0.999454	0.019253	1.004143	45.11843
		22	28	0.993908	0.0001	0.990295	44.72061
		17	28	0.995801	0.0001	0.988414	44.66615
		12	28	0.99738	0.0001	0.986923	44.62292
		9	28	0.998183	0.000817	0.986861	44.62111
		30	37	0.986386	0.0001	0.997846	44.93823
		27	37	0.988294	0.0001	0.995921	44.8829
		23	37	0.99064	0.0001	0.993562	44.81496
		16	37	0.994217	0.0001	0.989991	44.71182
		11	37	0.99637	0.000168	0.988015	44.65459
		8	37	0.997507	0.0018	0.988506	44.66881
	12	16	20	0.999138	0.0001	0.989915	44.70961
		13	20	0.999372	0.0001	0.989714	44.7038
		8	20	0.999682	0.0018	0.991157	44.74553
		4	20	0.999866	0.042422	1.033019	45.93049
		23	26	0.997841	0.0001	0.991198	44.74672
		19	26	0.998392	0.0001	0.990651	44.73092
		14	26	0.998968	0.0001	0.990095	44.71484
		6	26	0.999654	0.008737	0.998125	44.94623
		27	35	0.995942	0.0001	0.993088	44.8013
		20	35	0.997368	0.0001	0.991668	44.76031
		15	35	0.998217	0.0001	0.990832	44.73614
		8	35	0.999184	0.0018	0.991652	44.75984
1.571	10	17	19	0.991512	0.0001	0.983823	44.53278
		14	19	0.993651	0.0001	0.981705	44.47105
		10	19	0.996053	0.0001	0.979342	44.40203
		8	19	0.997069	0.0001	0.978391	44.3742
		22	25	0.982613	0.0001	0.992732	44.79104
		19	25	0.985936	0.0001	0.989387	44.69434
		14	25	0.990785	0.0001	0.984545	44.5538
		12	25	0.992487	0.0001	0.982857	44.50465

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		7	25	0.996165	0.000177	0.979402	44.40378
		25	34	0.970035	0.0001	1.005605	45.16013
		21	34	0.976248	0.0001	0.999205	44.97722
		17	34	0.981921	0.0001	0.993432	44.81122
		8	34	0.992697	0.0001	0.982699	44.50006
		15	17	0.993901	0.0001	0.981458	44.46384
		12	17	0.99564	0.0001	0.979744	44.41379
		7	17	0.997933	0.000177	0.977666	44.35299
		4	17	0.99897	0.007183	0.983549	44.52482
	12	16	20	0.996959	0.0001	0.985932	44.59413
		13	20	0.997769	0.0001	0.985132	44.57088
		9	20	0.998665	0.0001	0.984263	44.54559
		21	25	0.993863	0.0001	0.989004	44.68324
		18	25	0.99512	0.0001	0.987754	44.64702
		12	25	0.997233	0.0001	0.985661	44.58627
		6	25	0.998844	0.000609	0.984672	44.5575
		25	30	0.989996	0.0001	0.992866	44.7949
		21	30	0.992236	0.0001	0.990625	44.73017
		15	30	0.995118	0.0001	0.987756	44.64708
		8	30	0.997789	0.0001	0.985163	44.57178
		4	30	0.999001	0.007183	0.991043	44.74224
2.356	4	2	4	0.9547	0.004006	0.716845	35.63465
		2	3	0.971501	0.005403	0.705415	35.19972
	6	4	8	0.958511	0.0001	0.888481	41.62049
		3	8	0.97075	0.000242	0.877485	41.26645
	8	9	12	0.951088	0.0001	0.962187	43.89599
		6	12	0.971022	0.0001	0.942434	43.30248
		4	12	0.982324	0.0001	0.931606	42.97211
		10	12	0.943684	0.0001	0.969735	44.11973
		5	15	0.968295	0.0001	0.945089	43.38294
		6	15	0.960832	0.0001	0.952429	43.60426
		4	15	0.975394	0.0001	0.938224	43.17447
		3	15	0.98212	0.000242	0.932014	42.98465
		5	20	0.953085	0.0001	0.960171	43.83597
		3	20	0.972693	0.000242	0.941049	43.26042
	10	12	21	0.952663	0.0001	0.992225	44.77639
		8	21	0.970975	0.0001	0.973512	44.23103
		5	21	0.983075	0.0001	0.961531	43.87647

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		6	15	0.987308	0.0001	0.957407	43.75346
		4	15	0.992212	0.0001	0.95269	43.61209
		9	15	0.978657	0.0001	0.96587	44.00539
		4	10	0.995954	0.0001	0.94911	43.50439
		3	10	0.997187	0.000242	0.948153	43.47553
	12	9	12	0.993979	0.0001	0.967649	44.05805
		6	12	0.996619	0.0001	0.965085	43.98209
		3	12	0.998605	0.000242	0.9634	43.93205
		14	18	0.980652	0.0001	0.980798	44.44459
		11	18	0.986152	0.0001	0.975328	44.28442
		7	18	0.992313	0.0001	0.969273	44.10607
		4	18	0.996074	0.0001	0.965627	43.99818
		19	21	0.964258	0.0001	0.997474	44.92755
		16	21	0.971882	0.0001	0.989649	44.70193
		12	21	0.980896	0.0001	0.980554	44.43747
		7	21	0.99029	0.0001	0.971253	44.1645
3.141	12	9	12	0.972634	0.0001	0.958889	43.79771
		6	12	0.984108	0.0001	0.947709	43.46213
		4	12	0.990438	0.0001	0.941652	43.27874
		11	15	0.953011	0.0001	0.978633	44.38128
		8	15	0.968841	0.0001	0.962643	43.90955
		3	15	0.990235	0.0001	0.941846	43.28462

Table-3.2 The sample size and probability of acceptance for Minimum angle method Double sampling plan ($c_1 = 0, c_2 = 2$) when the life time of the items follows Generalized Exponential Distribution

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ		
0.628	4	15	18	0.972346	0.035394	0.209577	11.83659		
		14	18	0.974901	0.044157	0.210975	11.91327		
		16	18	0.96969	0.028373	0.208606	11.78325		
		17	18	0.966932	0.022747	0.207972	11.74843		
		15	20	0.968671	0.031901	0.209618	11.83881		
		14	20	0.971466	0.040071	0.210828	11.90519		
		18	20	0.959695	0.016109	0.208104	11.75569		
		16	20	0.965777	0.0254	0.208814	11.79468		
		14	23	0.966094	0.036387	0.21121	11.92619		
		15	23	0.962935	0.028755	0.210199	11.87072		
		16	23	0.95968	0.022727	0.209577	11.83657		
		19	21	0.954155	0.012182	0.20846	11.77525		
		6	15	33	0.991662	0.025653	0.214904	12.12862	
			20	37	0.98581	0.007478	0.212197	11.98031	
			25	37	0.980899	0.0022	0.212118	11.97594	
			30	37	0.975432	0.000648	0.212969	12.02263	
			12	37	0.992516	0.052979	0.220959	12.45983	
			18	37	0.987619	0.0122	0.212831	12.01504	
			12	19	0.997215	0.065726	0.222868	12.56408	
			10	20	0.997673	0.099946	0.23125	13.02076	
			8	19	0.998407	0.162078	0.248227	13.94059	
			7	17	0.998882	0.215137	0.264881	14.83587	
			12	21	0.996784	0.061251	0.221905	12.51148	
			11	26	0.99607	0.070743	0.224352	12.64507	
			8	17	21	0.998861	0.01931	0.216196	12.19935
				15	17	0.999297	0.037758	0.220246	12.42084
				13	17	0.99944	0.058299	0.225019	12.68143
				19	26	0.998194	0.010386	0.214389	12.10039
		11		17	0.999566	0.090038	0.23284	13.10724	
		10	14	18	0.999805	0.044157	0.223691	12.60897	

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		13	16	0.999853	0.062217	0.227988	12.84323
		11	19	0.999854	0.082336	0.232987	13.11521
		12	31	0.999641	0.053699	0.225986	12.73416
		15	26	0.999629	0.027085	0.219805	12.39675
		11	16	0.999887	0.095206	0.236293	13.29474
	12	11	17	0.999956	0.090038	0.236148	13.28685
		14	25	0.999888	0.034948	0.222682	12.55393
		12	16	0.999954	0.076964	0.232803	13.10521
		16	24	0.999871	0.022152	0.219772	12.39494
		20	24	0.999818	0.008593	0.216777	12.23119
		15	24	0.999883	0.028077	0.221109	12.46801
0.942	4	5	16	0.962026	0.099416	0.380543	20.83396
		8	12	0.95413	0.028467	0.354621	19.52559
		9	11	0.951616	0.019896	0.352316	19.40818
	6	17	18	0.966932	0.000379	0.363327	19.96747
		15	20	0.968671	0.000938	0.362884	19.94505
		14	20	0.971466	0.001493	0.362046	19.9026
		18	20	0.959695	0.000233	0.366013	20.10327
		16	20	0.965777	0.00059	0.363841	19.99349
		15	23	0.962935	0.000929	0.365045	20.05436
		16	23	0.95968	0.000583	0.366152	20.11031
		19	22	0.951771	0.000145	0.369026	20.2554
		5	16	0.994439	0.099416	0.392365	21.42328
	8	15	33	0.995165	0.000926	0.366315	20.11852
		5	15	0.999672	0.10042	0.405009	22.04837
		8	16	0.999315	0.024939	0.373782	20.49485
		12	37	0.995658	0.003742	0.367173	20.16185
		18	37	0.992757	0.000229	0.366946	20.15041
		12	19	0.998418	0.003802	0.366176	20.11151
		10	20	0.99868	0.009577	0.368217	20.21454
		8	19	0.9991	0.02434	0.373635	20.48745
		7	17	0.999371	0.039148	0.379292	20.77131
		12	21	0.998169	0.003768	0.366255	20.11551
		11	26	0.997752	0.005966	0.367221	20.16428
	10	15	33	0.995165	0.000926	0.366315	20.11852
		5	15	0.999672	0.10042	0.405009	22.04837
		8	16	0.999315	0.024939	0.373782	20.49485
		12	37	0.995658	0.003742	0.367173	20.16185

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		18	37	0.992757	0.000229	0.366946	20.15041
		12	19	0.998418	0.003802	0.366176	20.11151
		10	20	0.99868	0.009577	0.368217	20.21454
		8	19	0.9991	0.02434	0.373635	20.48745
		7	17	0.999371	0.039148	0.379292	20.77131
		12	21	0.998169	0.003768	0.366255	20.11551
	12	17	21	0.998861	0.000368	0.36714	20.16019
		14	18	0.999319	0.001518	0.367394	20.17304
		15	17	0.999297	0.000971	0.367201	20.16329
		13	17	0.99944	0.002446	0.367691	20.18805
		19	26	0.998194	0.000144	0.367302	20.16841
		11	17	0.999566	0.006161	0.36902	20.25507
		5	16	0.999867	0.099416	0.407114	22.15193
		8	13	0.99982	0.027002	0.376829	20.64787
		9	14	0.99976	0.016521	0.372835	20.44724
1.257	4	4	8	0.960566	0.06515	0.490513	26.12853
		5	7	0.955894	0.037699	0.478344	25.56385
	6	8	17	0.957519	0.003223	0.499013	26.5198
		4	9	0.992854	0.061239	0.511162	27.07441
		5	8	0.991898	0.033068	0.496654	26.41148
		6	8	0.989448	0.016808	0.489602	26.08646
		9	16	0.95458	0.001575	0.499689	26.55079
	8	10	19	0.982818	0.000767	0.49976	26.55404
		14	23	0.96597	0.000014	0.508102	26.93523
		15	23	0.962799	0.000012	0.509764	27.01084
		16	23	0.959534	0.000011	0.511493	27.08942
		11	14	0.99706	0.00017	0.53556	28.1719
		11	20	0.97917	0.000374	0.501422	26.63018
		4	8	0.998647	0.06515	0.525753	27.7333
		5	12	0.996473	0.028111	0.506824	26.877
		6	14	0.994311	0.013585	0.500435	26.58497
	10	8	11	0.998142	0.003384	0.500603	26.59268
		18	33	0.973984	0.000012	0.511282	27.07983
		26	33	0.957945	0.000017	0.519841	27.46725
		15	33	0.979297	0.000012	0.508517	26.95413
		20	37	0.965656	0.000015	0.51569	27.27971
		4	8	0.999593	0.06515	0.532915	28.05383
		5	12	0.998912	0.028111	0.512957	27.15587

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		6	15	0.998009	0.013552	0.505841	26.83217
		8	18	0.996138	0.003222	0.501531	26.6352
		10	20	0.993929	0.000767	0.501407	26.62953
	12	8	19	0.9984	0.003221	0.504473	26.76971
		7	17	0.998877	0.006603	0.50595	26.83712
		12	21	0.996771	0.000183	0.50376	26.73713
		11	26	0.996053	0.000374	0.50422	26.75814
		17	21	0.994647	0.000015	0.504745	26.78214
		14	18	0.996742	0.000014	0.503704	26.73458
		15	17	0.996638	0.000012	0.503745	26.73646
		13	17	0.997304	0.000018	0.503443	26.72265
		5	10	0.999702	0.029209	0.517305	27.35275
		4	8	0.999851	0.06515	0.537114	28.24086
		6	18	0.998989	0.013522	0.509444	26.99631
		7	16	0.998981	0.006608	0.505899	26.83481
1.571	4	3	6	0.952542	0.060601	0.585268	30.33909
	6	3	6	0.992392	0.060601	0.616507	31.65412
		4	8	0.982592	0.020066	0.596821	30.82965
		5	10	0.968209	0.007236	0.597785	30.87036
		6	11	0.954716	0.002683	0.603399	31.10675
	8	7	12	0.983281	0.000997	0.606477	31.23584
		4	8	0.995706	0.020066	0.610607	31.40853
		3	6	0.998206	0.060601	0.635377	32.43092
		5	7	0.995173	0.008141	0.603559	31.11347
		6	9	0.990953	0.002746	0.602842	31.08333
		8	11	0.982116	0.000373	0.606811	31.24983
		9	11	0.978837	0.000139	0.608699	31.32884
		10	12	0.972625	0.000015	0.612532	31.48881
	10	3	7	0.999277	0.055439	0.642468	32.71946
		3	6	0.999448	0.060601	0.645884	32.85776
		4	7	0.998913	0.021226	0.620225	31.80822
		4	8	0.998648	0.020066	0.619658	31.78475
		4	6	0.999152	0.023972	0.62182	31.87417
		5	7	0.998479	0.008141	0.612302	31.47923
		6	8	0.997544	0.002858	0.609625	31.36755
		6	9	0.997084	0.002746	0.60984	31.37649
		9	12	0.992041	0.000138	0.611336	31.43896
		9	11	0.992909	0.000139	0.610802	31.41668

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		11	13	0.988108	0.000019	0.613696	31.53728
	12	3	6	0.999795	0.060601	0.652117	33.10905
		3	7	0.999731	0.055439	0.648597	32.96731
		4	8	0.999492	0.020066	0.62533	32.01898
		4	7	0.999593	0.021226	0.626006	32.04683
		7	17	0.996328	0.000995	0.615336	31.60547
		9	13	0.996517	0.000138	0.61469	31.57863
		9	11	0.997236	0.000139	0.614247	31.56021
2.356	6	3	5	0.963402	0.006326	0.745949	36.72106
		3	6	0.952584	0.005983	0.754203	37.0237
		2	7	0.963147	0.032685	0.767285	37.49848
		2	5	0.97835	0.034096	0.756078	37.09212
	8	2	7	0.98511	0.039365	0.754886	37.04864
		2	8	0.95968	0.092878	0.119855	6.834584
		3	6	0.960372	0.042878	0.214022	12.08032
	10	2	5	0.97607	0.03262	0.821803	39.41347
		2	6	0.969011	0.03262	0.827999	39.62471
		3	7	0.953483	0.005892	0.818211	39.29041
		3	8	0.953483	0.005892	0.818211	39.29041
		3	6	0.953483	0.005892	0.818211	39.29041
	12	2	4	0.99952	0.039365	0.820296	39.36191
		2	5	0.999267	0.034096	0.816035	39.21563
		3	5	0.998684	0.006326	0.793678	38.43825
	3	6	0.998208	0.005983	0.793783	38.44196	
3.141	8	2	4	0.985117	0.007553	0.828538	39.64305
		3	4	0.973492	0.000661	0.832569	39.77973
		3	5	0.963418	0.000611	0.841237	40.07178
		2	5	0.97836	0.007199	0.834001	39.82813
	10	2	3	0.9969	0.010805	0.854615	40.5177
		2	4	0.994758	0.007553	0.853653	40.48584
		3	4	0.990413	0.000661	0.851457	40.41298
		3	5	0.986467	0.000611	0.854822	40.52457
	12	2	3	0.998758	0.010805	0.87287	41.11672
		2	4	0.997871	0.007553	0.870785	41.04886
		3	4	0.996045	0.000661	0.866354	40.90414
	3	5	0.994341	0.000611	0.867796	40.95131	
3.927	8	2	3	0.975615	0.001911	0.832397	39.77391
		2	4	0.960993	0.001542	0.844763	40.18989

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
	10	2	3	0.990983	0.001911	0.86496	40.8585
		2	4	0.985104	0.001542	0.869806	41.01694
		3	4	0.973469	0.000016	0.878878	41.31154
		3	5	0.963389	0.000015	0.888075	41.60746
	12	3	5	0.983647	0.001911	0.899517	41.97191
		2	4	0.993617	0.001542	0.890143	41.67364
		3	4	0.988373	0.000012	0.893531	41.78178
		3	5	0.983647	0.000011	0.897824	41.91824
4.712	10	2	3	0.979556	0.000359	0.858787	40.65554
		2	4	0.967077	0.000321	0.869838	41.01798
		3	4	0.953064	0.000015	0.891696	41.72325
	12	2	3	0.990987	0.000359	0.884941	41.50694
		2	4	0.98511	0.000321	0.890188	41.6751
		3	4	0.973479	0.000012	0.900535	42.00415
		3	5	0.963402	0.000011	0.909955	42.30078

Table-3.3 The sample size and probability of acceptance for Minimum angle method Double sampling plan ($c_1 = 0, c_2 = 2$) when the life time of the items follows Weibull distribution

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ					
0.628	4	15	18	0.9604	0.002908	0.314937	17.48116					
		14	18	0.963973	0.004288	0.314218	17.44364					
		16	18	0.956699	0.001973	0.31585	17.5287					
		17	18	0.952872	0.001338	0.316909	17.5839					
	6	15	20	20	0.95532	0.0028	0.316581	17.56681				
			6	20	0.985695	0.004141	0.307217	17.07785				
			7	13	0.990823	0.074349	0.329033	18.2129				
			8	11	0.991242	0.05989	0.323777	17.94074				
		8	9	11	11	0.998898	0.042217	0.329274	18.22537			
				7	10	0.999351	0.093459	0.347734	19.17432			
				11	13	0.998097	0.017059	0.321099	17.80175			
				12	13	0.997813	0.011817	0.319484	17.71786			
			10	13	15	15	0.997007	0.007056	0.318208	17.65147		
					13	16	0.996741	0.006723	0.318186	17.65035		
					7	12	0.999838	0.078803	0.347174	19.1457		
					7	11	0.999859	0.08497	0.349507	19.26487		
				12	8	13	13	0.999777	0.051424	0.337174	18.63277	
						8	14	0.99975	0.048879	0.336281	18.58684	
						9	13	0.999733	0.035585	0.33165	18.34811	
						10	13	0.999914	0.024634	0.330121	18.26912	
					12	9	13	13	0.999927	0.035585	0.333865	18.46234
							8	12	0.999946	0.05497	0.340707	18.81433
							7	11	0.999962	0.08497	0.351872	19.38554
							8	10	0.999986	0.066687	0.346255	19.09869
	12	7	11	11	0.999987	0.08497	0.353174	19.45188				
			7	10	0.999989	0.093465	0.356483	19.62027				
			8	11	0.999984	0.05989	0.343753	18.97056				
			4	11	0.971089	0.028919	0.567106	29.55782				
0.942		4	3	9	0.984808	0.071358	0.584936	30.3249				
			4	9	0.978385	0.029634	0.563172	29.387				
			5	12	0.957568	0.011876	0.564993	29.46616				

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		5	11	0.962264	0.011929	0.562233	29.34615
		6	11	0.952831	0.004921	0.563672	29.40872
	6	7	9	0.994541	0.00213	0.568224	29.60628
		6	8	0.996341	0.005424	0.569081	29.6434
		5	7	0.997723	0.014184	0.57335	29.82781
		4	6	0.998724	0.038116	0.587036	30.41448
		4	5	0.99904	0.048734	0.5934	30.6849
		7	8	0.995348	0.002283	0.56785	29.59009
	8	7	12	0.99833	0.002017	0.576616	29.96843
		7	11	0.998535	0.00203	0.576505	29.96367
		7	10	0.998728	0.002061	0.576411	29.95963
		6	9	0.99914	0.00512	0.577946	30.02559
		6	8	0.99928	0.005424	0.578042	30.02971
		5	8	0.999456	0.012901	0.582319	30.21306
		5	7	0.999558	0.014184	0.583017	30.2429
	10	6	10	0.999721	0.004983	0.58249	30.2206
		5	9	0.99982	0.012314	0.586761	30.40275
		4	8	0.999893	0.030717	0.597858	30.87345
		7	10	0.999647	0.002061	0.580832	30.14939
		7	9	0.999699	0.00213	0.580842	30.14983
	12	6	10	0.999904	0.004983	0.585092	30.33154
		5	10	0.999926	0.012048	0.589263	30.50927
		5	9	0.999938	0.012314	0.589415	30.51572
		4	9	0.999955	0.029634	0.599925	30.9606
1.257	6	5	7	0.988944	0.000375	0.759779	37.22681
		4	7	0.991965	0.001814	0.758565	37.1827
		3	5	0.996883	0.009641	0.760801	37.2639
		4	6	0.993637	0.001863	0.757324	37.13751
		4	5	0.995151	0.002068	0.756325	37.10113
		5	6	0.991077	0.000388	0.758153	37.1677
	8	5	7	0.997711	0.000375	0.771695	37.6572
		5	6	0.998176	0.000388	0.771346	37.64466
		4	6	0.998718	0.001863	0.772068	37.67059
		3	5	0.999389	0.009642	0.777613	37.8691
		3	4	0.999581	0.012426	0.779654	37.94191
		3	6	0.999164	0.008954	0.77725	37.85612
		2	3	0.999874	0.083846	0.840193	40.03673
	10	4	7	0.999542	0.001815	0.780123	37.95861

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
		5	9	0.999046	0.000371	0.779383	37.93223
		5	8	0.999208	0.000372	0.779257	37.92774
		6	8	0.998952	0.000017	0.779226	37.92665
		6	9	0.998751	0.000017	0.779383	37.93223
	12	4	9	0.999757	0.001801	0.784723	38.12211
		4	8	0.999801	0.001803	0.784691	38.12095
		3	7	0.999895	0.008789	0.790147	38.31392
		3	6	0.999921	0.008954	0.790259	38.31786
		3	5	0.999943	0.009642	0.79079	38.3366
1.571	4	2	5	0.951788	0.007224	0.817631	39.27051
		2	4	0.965971	0.00758	0.805835	38.86308
	6	3	4	0.992588	0.000665	0.855903	40.56032
		3	5	0.989491	0.000614	0.85854	40.64742
		4	6	0.97927	0.000015	0.867008	40.92554
		4	5	0.983951	0.000015	0.862884	40.79038
		5	7	0.965176	0.000014	0.879626	41.33569
	8	2	3	0.999539	0.010846	0.887455	41.58761
		3	4	0.998498	0.000665	0.879325	41.32598
		3	5	0.997828	0.000614	0.879871	41.34362
		4	5	0.996608	0.000015	0.880452	41.36237
		4	6	0.995534	0.000015	0.881402	41.39302
		5	6	0.993712	0.000014	0.882976	41.44373
	10	4	7	0.998363	0.000015	0.892377	41.74499
		4	8	0.997968	0.000015	0.89273	41.75625
		5	7	0.997714	0.000014	0.892915	41.76215
		6	8	0.996327	0.000013	0.894155	41.80163
		5	8	0.997205	0.000014	0.893371	41.77669
	12	3	5	0.999788	0.000614	0.899003	41.95564
		3	6	0.999708	0.000609	0.89907	41.95777
		4	6	0.99955	0.000015	0.898711	41.94638
		4	5	0.999663	0.000015	0.89861	41.94317
		5	7	0.999188	0.000014	0.898994	41.95535
2.356	4	8	9	0.99931	0.076016	0.341181	18.83864
		14	18	0.995735	0.004288	0.317727	17.62648
		15	17	0.9956	0.002999	0.317358	17.60726
		13	17	0.996466	0.006488	0.318199	17.65102
		19	26	0.98921	0.00056	0.318626	17.67326
		11	17	0.99724	0.01405	0.320396	17.76525

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
	6	2	4	0.966006	0.000015	0.883266	41.45306
		2	3	0.978865	0.000011	0.871663	41.07746
	8	4	7	0.953954	0.000012	0.957111	43.74459
		4	6	0.96255	0.000012	0.948564	43.48792
		3	7	0.967843	0.000015	0.943376	43.33106
		2	5	0.988696	0.000011	0.923493	42.72226
		3	8	0.960967	0.000015	0.950127	43.53501
	10	5	7	0.979569	0.000018	0.961781	43.88391
		4	8	0.981776	0.000012	0.959618	43.81947
		4	9	0.978343	0.000012	0.962985	43.91974
		6	8	0.968543	0.000013	0.972729	44.20799
		5	8	0.975503	0.000018	0.965789	44.00297
	12	3	5	0.997832	0.000015	0.960393	43.84256
		3	4	0.9985	0.000015	0.959749	43.82339
		4	5	0.996613	0.000012	0.961566	43.87753
		4	6	0.99554	0.000012	0.962603	43.90837
		5	7	0.992193	0.000018	0.96585	44.00479
3.141	8	2	3	0.978877	0.000012	0.875585	41.20491
		3	4	0.9926	0.000011	0.940691	43.24955
	10	3	5	0.989508	0.000011	0.943631	43.33878
		2	4	0.995975	0.000012	0.937503	43.15249
	12	2	3	0.99763	0.000012	0.935948	43.10503
		4	5	0.983976	0.000016	0.948936	43.49913

Table-3.4 The sample size and probability of acceptance for Minimum angle method Double sampling plan ($c_1 = 0, c_2 = 2$) when the life time of the items follows Gamma distribution

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
0.628	4	21	22	0.989277	0.09586	0.134425	7.656069
	4	21	23	0.988695	0.091108	0.1338	7.620928
	6	20	24	0.998714	0.097597	0.139932	7.965771
	6	20	25	0.998642	0.093482	0.139307	7.930639
	8	20	24	0.999743	0.097597	0.142195	8.092895
	8	20	25	0.999728	0.093482	0.141551	8.056754
	10	20	24	0.999928	0.097597	0.14331	8.155552
	10	20	25	0.999924	0.093482	0.14266	8.119053
	12	20	24	0.999975	0.097597	0.143933	8.190517
	12	20	25	0.999974	0.093482	0.14328	8.153843
0.942	4	15	16	0.967471	0.022616	0.23197	13.05995
	4	14	15	0.972646	0.03142	0.232865	13.10856
	6	10	13	0.998268	0.097113	0.257236	14.42576
	6	10	14	0.998078	0.089845	0.255231	14.31797
	8	10	13	0.999643	0.097113	0.262047	14.68399
	8	10	14	0.999603	0.089845	0.259965	14.57231
	10	10	13	0.999899	0.097113	0.264458	14.8132
	10	10	14	0.999887	0.089845	0.262349	14.70021
	12	10	13	0.999964	0.097113	0.265816	14.88588
	12	10	14	0.99996	0.089845	0.263694	14.77229
1.257	4	7	9	0.978911	0.070075	0.349584	19.2688
	4	7	8	0.981837	0.081212	0.352771	19.43135
	6	7	8	0.997646	0.081212	0.369652	20.28693
	6	7	9	0.997228	0.070075	0.365378	20.07121
	8	7	8	0.999502	0.081212	0.377599	20.68649
	10	7	8	0.999856	0.081212	0.381651	20.88938
	10	7	9	0.999829	0.070075	0.37709	20.66096
	12	7	8	0.999949	0.081212	0.383953	21.00444
	12	7	8	0.999949	0.081212	0.383953	21.00444
	12	7	9	0.999939	0.070075	0.379358	20.77466
1.571	4	5	6	0.978368	0.078787	0.451357	24.29235
	4	5	7	0.973493	0.064443	0.446655	24.06816
	6	5	6	0.997061	0.078787	0.475682	25.4396

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
	6	5	7	0.996324	0.064443	0.468737	25.11422
	8	5	6	0.999362	0.078787	0.487431	25.98602
	8	5	7	0.999196	0.064443	0.480038	25.64276
	10	5	6	0.999813	0.078787	0.493503	26.26649
	10	5	7	0.999763	0.064443	0.485961	25.91796
	12	5	6	0.999933	0.078787	0.496982	26.42656
	12	5	7	0.999915	0.064443	0.489371	26.07581
2.356	4	3	4	0.964029	0.057052	0.621364	31.85534
	6	3	5	0.992162	0.041554	0.654591	33.20838
	6	3	4	0.994497	0.057052	0.663782	33.57549
	8	3	4	0.998727	0.057052	0.686154	34.4561
	8	3	4	0.998727	0.057052	0.686154	34.4561
	10	3	4	0.999612	0.057052	0.698204	34.9229
	10	3	5	0.999434	0.041554	0.687037	34.4905
	12	3	4	0.999857	0.060831	0.856225	40.57097
	12	3	5	0.99979	0.060831	0.708155	35.3044
3.141	4	2	3	0.956586	0.060831	0.708932	35.33404
	6	2	3	0.992807	0.060831	0.776342	37.82368
	6	2	4	0.98805	0.060831	0.780325	37.96582
	8	2	4	0.997025	0.060831	0.81325	39.11973
	8	2	3	0.998256	0.060831	0.812181	39.08286
	10	2	3	0.999452	0.060831	0.831884	39.75653
	10	2	3	0.999452	0.060831	0.831884	39.75653
	12	2	3	0.999793	0.060831	0.84361	40.15132
	12	2	3	0.999793	0.060831	0.84361	40.15132
3.972	6	2	3	0.978938	0.013633	0.791086	38.34703
	6	2	4	0.96612	0.009352	0.798145	38.59495
	8	2	3	0.994417	0.013633	0.833215	39.80158
	8	2	4	0.99067	0.009352	0.832762	39.78626
	10	2	3	0.99815	0.013633	0.858843	40.65741
	10	2	4	0.996847	0.009352	0.856254	40.57192
	12	2	3	0.999278	0.013633	0.874838	41.18068
	12	2	4	0.998755	0.009352	0.871516	41.07267
4.712	6	2	3	0.956567	0.0035	0.800282	38.66965
	8	2	3	0.987532	0.0035	0.84385	40.15933
	8	2	4	0.97959	0.002692	0.850012	40.36493
	10	2	3	0.995668	0.0035	0.873913	41.15062
	10	2	4	0.992722	0.002692	0.8758	41.21186
	12	2	3	0.998255	0.0035	0.893759	41.78903
	12	2	4	0.997023	0.002692	0.89414	41.80117

Table-3.5 The sample size and probability of acceptance for Minimum angle method Double sampling plan ($c_1 = 0, c_2 = 2$) when the life time of the items follows Marshall – Olkin extended lomax Distribution

t/λ_0	λ/λ_0	n_1	n_2	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
0.628	10	4	10	0.965756	0.097713	0.450761	24.264
	10	5	10	0.955185	0.054782	0.434561	23.4879
	12	4	10	0.978258	0.097713	0.455566	24.49239
	12	4	9	0.981385	0.102896	0.456632	24.54295
	12	5	12	0.963165	0.077579	0.452972	24.36922
	14	4	11	0.983099	0.094603	0.459496	24.67857
	14	5	13	0.971826	0.050462	0.443104	23.89831
	14	6	15	0.95754	0.027298	0.438875	23.69547
	14	8	12	0.954577	0.00866	0.431603	23.34515
0.942	10	3	8	0.95259	0.102323	0.476584	25.48173
	12	3	8	0.969485	0.077579	0.566657	29.53834
	12	4	8	0.956759	0.033181	0.547224	28.68855
	12	3	9	0.963765	0.075465	0.568957	29.63803
	14	4	10	0.959512	0.031356	0.555732	29.06232
	14	3	8	0.979254	0.077579	0.572053	29.77184
	14	5	9	0.953935	0.013522	0.548489	28.74426
1.257	12	2	5	0.9816	0.039507	0.607711	31.28749
	12	3	6	0.95933	0.039507	0.622424	31.89913
	12	3	5	0.968738	0.046326	0.620677	31.82694
	14	2	8	0.973385	0.1088	0.677829	34.13057
	14	3	9	0.950105	0.035554	0.640797	32.65162
	14	4	7	0.950128	0.012318	0.624904	32.00141
1.571	12	2	6	0.9573	0.071525	0.694057	34.76284
	12	2	5	0.967803	0.07705	0.690178	34.61259
	14	3	6	0.952021	0.019191	0.676689	34.08577

3.6 Example

Assume that an experimenter wants to establish that the lifetime of the electrical devices produced in the factory ensures that the true unknown mean life is at least 1000 hours when the ratio of the unknown average life is $\lambda/\lambda_0 = 4$. and acceptance numbers $c_1 = 0$ and $c_2 = 2$. Following are the results obtained when the lifetime of the test items follows the Rayleigh distribution, Generalized Exponential distribution, Weibull distribution and Gamma distribution

3.6.1 Rayleigh distribution

Suppose that the life time of a product follows the Rayleigh distribution. For the above example, from the Table 3.1, the sample sizes required are obtained as $n_1 = 22$ and $n_2 = 28$ and one can observe that the minimum angle is $\theta = 45.3166^\circ$ and also $\alpha = 0.0198$ and $\beta = 0.0153$ which is very much less than the specified risk. The lot is accepted if during 628 hours no failure is observed in the first sample of size 22 or not more than 2 failures occur in the second sample of size 28 which satisfies the condition of the producer's risk and consumer's risk $\alpha \leq 0.05$, $\beta \leq 0.10$. Thus the required Double sampling plan has parameters (22, 28, 0, 2). For the same conditions when the time of experiment is 2356 hours, the probability of acceptance is 0.971501, the producer's risk is 0.028499 and consumer's risk 0.005403. The sample size are $n_1 = 2$ and $n_2 = 3$ which is very much less. Thus it is clear that as the time of experiment increases, the sample size decreases. When the ratio of unknown average life to specified life as 12, there is slight change in the sample size but there is increase in the probability of acceptance as 0.9998 which is almost equal to 1 and the consumer's risk is 0.001052 which shows that there is a reduction in consumer's risk.

3.6.2 Generalized Exponential distribution

Suppose that the life time of a product follows the Generalized Exponential distribution. For the above example, from Table 3.2, the sample sizes required are obtained as $n_1 = 17$ and $n_2 = 18$ and one can observe that the minimum angle is $\theta = 11.74843^\circ$ and also $\alpha = 0.033$ and $\beta = 0.0227$ which is very much less than the

specified risk. The lot is accepted if during 628 hours no failure is observed in the first sample of size 17 or not more than 2 failures occur in the second sample of size 18 which satisfies the condition of the producer's risk and consumer's risk $\alpha \leq 0.05$, $\beta \leq 0.10$. Thus the required Double sampling plan has parameters (17, 18, 0, 2). For the same conditions when the time of experiment is 1571 hours, the probability of acceptance is 0.952542, the producer's risk is 0.047458 and consumer's risk 0.060601. The sample size are $n_1 = 3$ and $n_2 = 6$ which is very much less. Thus it is clear that as the time of experiment increases, the sample size decreases. When the ratio of unknown average life to specified life as 12, there is slight change in the sample size but there is increase in the probability of acceptance as 0.9998 which is almost equal to 1 and the consumer's risk is 0.008593 which shows that there is a reduction in consumer's risk.

3.6.3 Weibull distribution

Suppose that the life time of a product follows the Weibull distribution. For the above example, from Table 3.3, the sample sizes required are obtained as $n_1 = 6$ and $n_2 = 20$ and one can observe that the minimum angle is $\theta = 17.07785^\circ$ and also $\alpha = 0.0143$ and $\beta = 0.0041$ which is very much less than the specified risk. The lot is accepted if during 628 hours no failure is observed in the first sample of size 6 or not more than 2 failures occur in the second sample of size 20 which satisfies the condition of the producer's risk and consumer's risk $\alpha \leq 0.05$, $\beta \leq 0.10$. Thus the required sampling plan has parameters (6, 20, 0, 2). For the same conditions when the time of experiment is 2356 hours, the probability of acceptance is 0.9956, the producer's risk is 0.0044 and consumer's risk 0.00299. The sample size are $n_1 = 15$ and $n_2 = 17$ which is very much less. Thus it is clear that as the time of experiment increases, the sample size decreases. When the ratio of unknown average life to specified life as 12, there is slight change in the sample size but there is increase in the probability of acceptance as 0.99998 which is almost equal to 1 and consumer's risk is 0.05989 which shows that there is a reduction in consumer's risk.

3.6.4 Gamma distribution

Suppose that the life time of a product follows the Gamma distribution. For the above example, from Table 3.4, the sample sizes required are obtained as $n_1 = 21$ and $n_2 = 23$ and one can observe that the minimum angle is $\theta = 7.620928^\circ$ and also $\alpha = 0.0113$ and $\beta = 0.0911$ which is very much less than the specified risk. The lot is accepted if during 628 hours no failure is observed in the first sample of size 21 or not more than 2 failures occur in the second sample of size 23 which satisfies the condition of the producer's risk and consumer's risk $\alpha \leq 0.05$, $\beta \leq 0.10$. Thus the required sampling plan has parameters (21, 23, 0, 2). For the same conditions when the time of experiment is 3141 hours, the probability of acceptance is 0.9565; the producer's risk is 0.0434 and consumer's risk 0.060831. The sample size are $n_1 = 2$ and $n_2 = 3$ which is very much less. Thus it is clear that as the time of experiment increases, the sample size decreases. When the ratio of unknown average life to specified life as 12, there is slight change in the sample size but there is increase in the probability of acceptance as 0.99997 which is almost equal to 1 and consumer's risk is 0.093482 which shows that there is a reduction in consumer's risk.

Comparison of the results of Producer's risk, Consumer's risk and sample size for Double sampling plan when the life time of the items follows different distributions provided in Table 3.6.

Table-3.6 Comparison of results of Producer's risk, Consumer's risk and sample size for Double sampling plan when the life time of the items follows different distributions ($t/\lambda_0=0.628$)

S.No.	λ/λ_0	Distribution	Producer's risk	Consumer's risk	n_1	n_2
1	4	Rayleigh	0.0198	0.0153	22	28
		Generalized Exponential	0.0330	0.0227	17	18
		Weibull	0.0143	0.0041	6	20
		Gamma	0.0113	0.0911	21	23
2	6	Rayleigh	0.0070	0.0010	35	40
		Generalized Exponential	0.0191	0.0022	25	37
		Weibull	0.0033	0.0067	13	16
		Gamma	0.0013	0.0934	20	25
3	8	Rayleigh	0.0010	0.0019	32	37
		Generalized Exponential	0.0018	0.0103	19	26
		Weibull	0.0002	0.0355	9	13
		Gamma	0.0002	0.0934	20	25
4	10	Rayleigh	0.0001	0.0091	25	27
		Generalized Exponential	0.0004	0.0270	15	26
		Weibull	0.0001	0.0246	10	13
		Gamma	0.0001	0.0934	20	25
5	12	Rayleigh	0.0001	0.0010	35	39
		Generalized Exponential	0.0001	0.0086	20	24
		Weibull	0.0001	0.0598	8	11
		Gamma	0.0001	0.0934	20	25

**Figure 3.1 OC Curve for The Double Sampling Plan when the lifetime of the Items follows different distributions
($t/\lambda_0 = 0.628$ hrs)**



From Table 3.6 one can conclude that when the Weibull distribution is followed, the sample size is very much less than the sample size of all other distribution. And at the same time the producer's risk and consumer's risk are less and the sum of the risks is also very much less for Weibull distribution. Figure 3.1 shows the OC curves of all four distributions. From the figure, one can observe that probability of acceptance is more for Weibull distribution and Gamma distribution than any other distributions. It can be seen that minimum angle method minimizes simultaneously the consumer's risk and producer's risk. Thus minimum angle method plan provides better discrimination of accepting good lots.