4

Designing Special Purpose Double Sampling Plan of Type DSP(0,1) for Truncated Life Tests Using Minimum Angle Method

4.1 Introduction

An acceptance sampling plan involves quality contracting on product orders between the producers and the consumers. It is an essential tool in Statistical Quality Control. In most of the statistical quality control experiment, it is not possible to perform hundred percent inspection, due to various reasons. A plan in which management specifies two sample sizes and two acceptance numbers of the quality of the lots is very good or very bad, the consumer can make a decision, to accept or reject the lot on the basis of the first sample, which is smaller than the Single sampling plan.

From Cameron table (1952), one can observe a jump between the operating ratios of c = 0 and c = 1 and slow reduction of operating ratios for other values of c. It may also be seen that, in between the OC curves of c = 0 and c = 1 plans , there is vast gap to be filled which leads one to access the possibility of designing plans having OC curves lying between the OC curves of c = 0, and c = 1 plans. To overcome such situation, Hald (1981), has proposed Double sampling plan with acceptance number 0 and 1 and rejection number 2.

In this chapter a new approach of designing Special purpose Double sampling plan of type DSP (0,1) 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 and Gamma distribution. The test termination time and mean ratio time are specified. The design parameter is obtained such that it satisfies both producer's risk and consumer's risk simultaneously. 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.

4.2 Operating Procedure of Special Purpose Double Sampling plan of type DSP (0, 1)

According to Hald (1981), the operating procedure for DSP (0,1) is as follows :

1) From a lot, select a sample size n_1, and observe the number of defectives d_1.
2) If $d_1 = 0$, accept the lot.
   If $d_1 > 1$, reject the lot.
3) If $d_1 = 1$, select a second sample of size n_2 and observe d_2.
   If $d_2 = 0$, accept the lot. Otherwise reject the lot.

4.3 Operating Procedure of Special Purpose Double Sampling Plan of type DSP (0, 1) for life tests

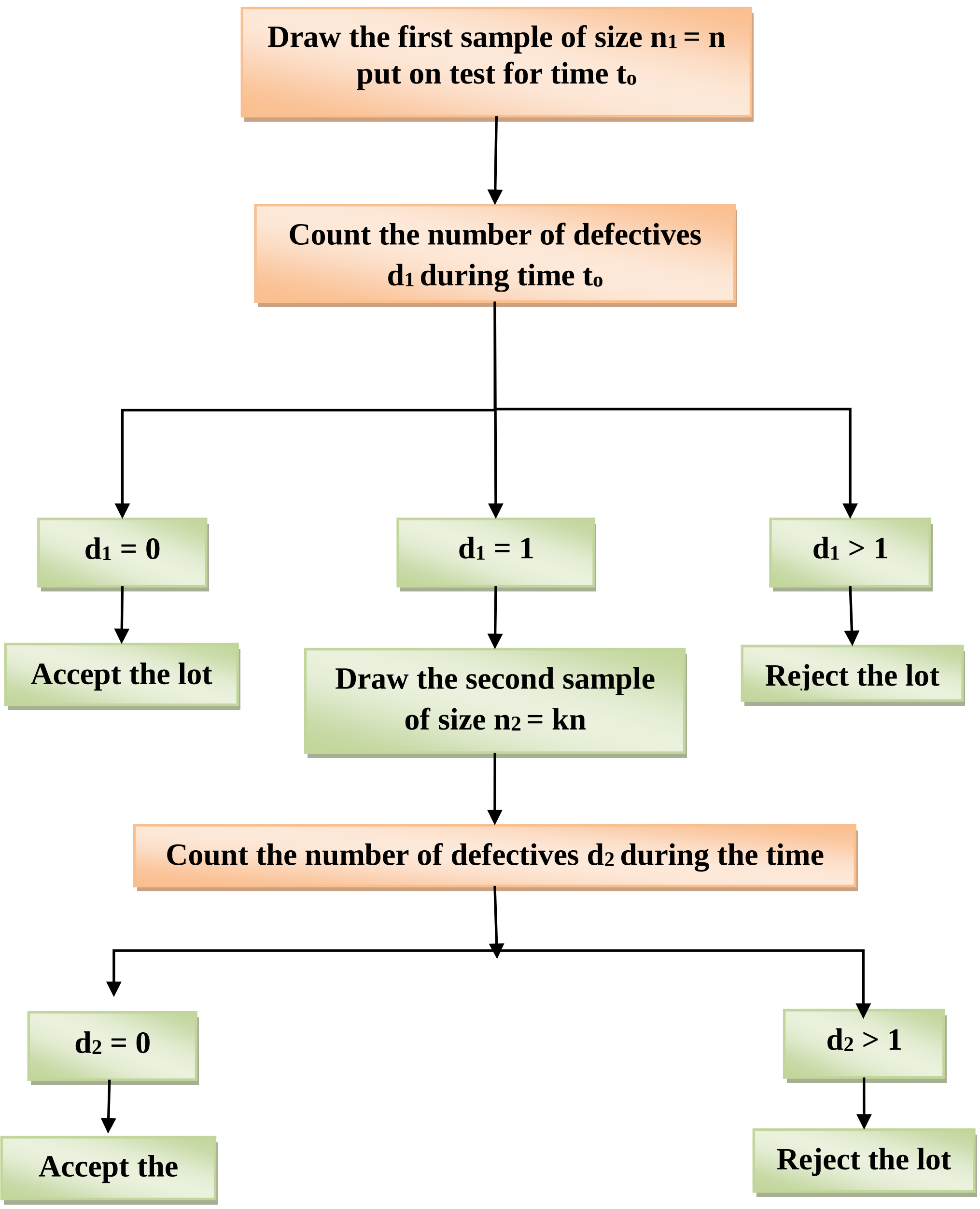
(i) From a lot, select a sample size n_1 , and observe the number of defectives d_1, during the time t_0.

(ii) If $d_1 = 0$, accept the lot.
If $d_1 > 1$, reject the lot.

(iii) If $d_1 = 1$, select a second sample of size n_2 and observe d_2 during the time t_0.
If $d_2 = 0$, accept the lot. Otherwise reject the lot.

The following is the operating procedure for DSP (0,1) for life test in the form of a flow chart.

Flow-Chart



Draw the first sample of size n1 = n put on test for time to
Count the number of defectives d1 during time to
d1 = 0
d1 = 1
d1 > 1
Accept the lot
Draw the second sample of size n2 = kn
Reject the lot
Count the number of defectives d2 during the time
d2 = 0
d2 > 1
Accept the
Reject the lot

4.4 Distributions

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

4.4.1 Rayleigh distribution

The cumulative distribution function (cdf) of the Rayleigh distribution is given as,

$$F(t,\lambda) = 1 - e^{-\frac{1}{2}\left(\frac{t}{\lambda}\right)^2}, \qquad t>0, \lambda>0 \qquad (4.1)$$

where, λ is the scale parameter

4.4.2 Generalized Exponential distribution

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

$$F(t,\lambda) = \left(1 - e^{-\frac{t}{\lambda}}\right)^{\alpha}, \qquad t>0, \lambda>0 \qquad (4.2)$$

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

4.4.3 Weibull distribution

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

$$F(t,\lambda) = 1 -- e^{-\left(\frac{t}{\lambda}\right)^{m}}, \qquad t>0, \lambda>0 \qquad (4.3)$$

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

4.4.4 Gamma distribution

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

$$F(t,\lambda) = 1 - e^{-\frac{t}{\lambda}} \sum_{j=0}^{\gamma-1} \left(\frac{t}{\lambda}\right)^{j} / j!, \qquad t>0, \lambda>0 \qquad (4.4)$$

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

4.5 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. Probability of acceptance for Special purpose Double sampling plan of type DSP –(0,1) is given by P (A) = P (no failure occur in sample 1) + P (1 failure occur in sample 1 and 0 failure occur in sample 2). Under the conditions for application of the binomial model the probability of acceptance for Special purpose Double sampling plan of type DSP (0,1) is given by,

$$L(p) = (1-p)^{n_1} + n_1 p\ (1-p)^{(n_1+n_2-1)} \quad (4.5)$$

The usual practice is to choose the second sample size that equals to some constant (k) multiple of first sample size which facilitates sample administration of the Special purpose Double sampling plan of type DSP(0,1) sampling plan.

Taking $n_1 = n$ and $n_2 = kn$

$$L(p) = (1-p)^{n} + np\,(1-p)^{(n(k+1)-1)} \quad (4.6)$$

The failure probability of an item by time t_0 is given by

$$P = F(t_0, \lambda) \quad (4.7)$$

The Tables are constructed using OC function for Special purpose Double sampling plan of type DSP (0, 1) sampling plans under various distributions. The test 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 4,6,8,10,12. For various time ratios t/λ_0 and mean ratios $\boldsymbol{\lambda}/\lambda_0$ the parameter values $n_1 = n$ and $n_2 = kn$ are obtained and satisfying $L(p_1) \geq 0.95$ and $L(p_2) \leq 0.10$ for various distribution and are provided in Table 4.1 to Table 4.4. The value θ and tanθ values are also provided in each table. The parameters can be selected such that the angle is minimum.

Table - 4.1 Sample size and the probability of acceptance for DSP (0, 1) using Minimum angle method when the life time of the items follows Rayleigh distribution

t/λ_0	λ/λ_0	k	n	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
0.628	4	2	15	0.956604	0.057872	0.185504	10.50913
	4	1	20	0.972999	0.088719	0.188536	10.67696
	4	3	12	0.954543	0.095023	0.193967	10.97715
	6	1	20	0.994152	0.088719	0.191626	10.84785
	6	2	15	0.990264	0.057872	0.186085	10.54134
	6	3	12	0.989616	0.095023	0.193948	10.97612
	8	1	20	0.998088	0.088719	0.19342	10.94699
	8	2	13	0.997538	0.088371	0.193464	10.94538
	8	3	12	0.996539	0.095023	0.195105	11.04002
	10	1	20	0.999205	0.088719	0.194398	11.00099
	10	2	13	0.998973	0.088371	0.194374	10.99963
	10	3	12	0.998548	0.095023	0.195896	11.08366
	12	1	20	0.999613	0.088719	0.194972	11.03264
	12	2	13	0.9995	0.088371	0.194921	11.02987
	12	3	12	0.99929	0.095023	0.1964	11.11149
0.942	4	1	10	0.965085	0.054237	0.363377	19.96997
	4	2	6	0.961153	0.076524	0.374147	20.51319
	6	1	9	0.993676	0.077916	0.377918	20.70246
	6	2	6	0.991334	0.076524	0.37831	20.72212
	8	1	9	0.99793	0.077916	0.381975	20.90559
	8	2	6	0.997137	0.076524	0.381726	20.89316
	8	3	6	0.995343	0.070103	0.379817	20.79764
	10	1	9	0.999139	0.077916	0.384167	21.01514
	10	2	6	0.998804	0.076524	0.383727	20.99315
	10	3	6	0.998037	0.070103	0.381389	20.87629
	12	1	9	0.999581	0.077916	0.385448	21.07907
	12	2	6	0.999417	0.076524	0.384935	21.05348
	12	3	6	0.999038	0.070103	0.382432	20.92843
1.257	4	1	5	0.969421	0.071827	0.554805	29.02171
	4	2	3	0.964615	0.099971	0.575947	29.93966
	6	1	5	0.993332	0.071827	0.569135	29.6457

t/ λ_0	λ/λ_0	k	n	L(p1)	L(p2)	tanθ	θ
	6	2	3	0.99213	0.099971	0.587855	30.44935
	6	3	3	0.987437	0.093749	0.586849	30.40652
	8	1	5	0.997815	0.071827	0.576571	29.96651
	8	2	3	0.997403	0.099971	0.594918	30.74916
	8	3	3	0.995777	0.093749	0.591887	30.62074
	10	1	5	0.99909	0.071827	0.580523	30.13613
	10	2	3	0.998915	0.099971	0.59881	30.91362
	10	3	3	0.99822	0.093749	0.595152	30.75906
	12	1	5	0.999557	0.071827	0.582815	30.23427
	12	2	3	0.999471	0.099971	0.601106	31.01033
	12	3	3	0.999128	0.093749	0.597203	30.84578
1.571	4	1	4	0.952636	0.027549	0.686047	34.45195
	4	2	3	0.950221	0.025049	0.706606	35.24525
	6	1	3	0.993489	0.077142	0.73682	36.38354
	6	2	3	0.981802	0.025049	0.705703	35.21072
	8	1	3	0.997867	0.077142	0.749174	36.83961
	8	2	4	0.989991	0.007225	0.70188	35.06424
	10	1	3	0.999112	0.077142	0.755573	37.07372
	10	2	4	0.995738	0.007225	0.704711	35.17277
	10	3	2	0.997845	0.077142	0.756614	37.11165
	12	1	3	0.999568	0.025049	0.71866	35.70328
	12	2	3	0.998727	0.025049	0.71928	35.72672
2.356	6	1	2	0.984301	0.003886	0.880726	41.3712
	6	2	2	0.958039	0.01117	0.911928	42.36257
	8	1	2	0.99475	0.000242	0.900179	41.99288
	8	2	2	0.985256	0.000019	0.964629	43.96856
	10	1	2	0.997793	0.01117	0.922643	42.69596
	10	2	2	0.993656	0.003886	0.91971	42.60507
	12	1	2	0.998921	0.01117	0.929976	42.92208
	12	2	3	0.993859	0.000242	0.924486	42.75295
3.141	6	1	2	0.955007	0.000155	0.905629	42.16491
	6	2	1	0.956838	0.007206	0.910607	42.32122
	8	1	1	0.994497	0.014359	0.937228	43.14409
	8	2	1	0.984686	0.007206	0.939777	43.22174
	10	1	1	0.997683	0.014359	0.960682	43.85119
	10	2	1	0.993379	0.007206	0.957907	43.76839
	10	3	2	0.970927	0.000019	0.973001	44.21599

t/λ_0	λ/λ_0	k	n	$L(p_1)$	$L(p_2)$	tanθ	θ
	12	1	1	0.998866	0.014359	0.974212	44.25161
	12	2	1	0.996711	0.007206	0.969291	44.1066
3.927	6	1	1	0.962828	0.000896	0.838678	39.98581
	8	1	1	0.987117	0.000896	0.898427	41.93738
	8	2	1	0.965571	0.000448	0.918067	42.55401
	10	1	1	0.994493	0.000896	0.931306	42.96293
	10	2	1	0.984675	0.000448	0.940173	43.23378
	10	3	1	0.97626	0.000448	0.94828	43.47937
	12	1	1	0.997282	0.000896	0.950851	43.55681
	12	2	2	0.978225	0.000001	0.968503	44.08332
4.712	8	1	1	0.97464	0.000002	0.862638	40.78231
	10	1	1	0.988959	0.000002	0.904929	42.14285
	10	2	1	0.970236	0.000051	0.922378	42.68775
	12	1	1	0.994495	0.000002	0.930941	42.95173
	12	2	1	0.98468	0.000051	0.940207	43.23482
	12	3	1	0.976267	0.000051	0.948309	43.48022

Table - 4.2 Sample size and Probability of acceptance for DSP (0,1) using Minimum angle method when the life time of the items follows Generalized Exponential distribution

t/λ_0	λ/λ_0	k	n	$L(p_1)$	$L(p_2)$	tanθ	θ
0.628	4	1	16	0.950865	0.088555	0.227718	12.82855
	6	1	16	0.987981	0.088555	0.230813	12.99701
	6	2	10	0.985696	0.098711	0.23405	13.17298
	6	3	10	0.977404	0.086946	0.233138	13.12339
	8	1	16	0.995826	0.088555	0.23342	13.13871
	8	2	10	0.994992	0.098711	0.236282	13.29412
	8	3	10	0.991912	0.086946	0.234014	13.17102
	10	1	16	0.998201	0.088555	0.235003	13.22473
	10	2	10	0.997833	0.098711	0.237754	13.37398
	10	3	10	0.996462	0.086946	0.235037	13.22655
	12	1	16	0.999104	0.088555	0.235984	13.27796
	12	2	10	0.998919	0.098711	0.238695	13.425
	12	3	10	0.998224	0.086946	0.235795	13.26772
0.942	6	1	8	0.985463	0.095894	0.39477	21.54261
	6	2	6	0.975817	0.066422	0.386163	21.11474
	8	1	8	0.994826	0.095894	0.400416	21.82197
	8	2	6	0.991211	0.066422	0.38922	21.26701
	8	3	5	0.989764	0.098135	0.403696	21.98373
	10	1	8	0.997736	0.095894	0.403845	21.99107
	10	2	6	0.996114	0.066422	0.391747	21.39261
	10	3	5	0.995441	0.098135	0.405886	22.09157
	12	1	8	0.998861	0.095894	0.40598	22.09614
	12	2	6	0.998034	0.066422	0.393496	21.47946
	12	3	5	0.997684	0.098135	0.407522	22.17199
1.257	6	1	5	0.982608	0.098585	0.538681	28.31052
	6	2	4	0.967578	0.059963	0.524679	27.68504
	6	3	4	0.950448	0.056834	0.532899	28.05312
	8	1	5	0.993664	0.098585	0.54832	28.73682
	8	2	4	0.987849	0.059963	0.528933	27.87583
	8	3	4	0.980778	0.056834	0.531189	27.97675

	10	1	5	0.997187	0.098585	0.554171	28.99395
	10	2	4	0.994528	0.059963	0.532846	28.05072
	10	3	4	0.991191	0.056834	0.532964	28.056
	12	1	5	0.998571	0.098585	0.557832	29.15419
	12	2	4	0.997198	0.059963	0.535662	28.17625
	12	3	4	0.995444	0.056834	0.534877	28.1413
1.571	6	1	4	0.974711	0.067565	0.633256	32.34427
	6	2	3	0.957787	0.05355	0.635294	32.42753
	8	1	4	0.990522	0.067565	0.645461	32.84066
	8	2	3	0.983698	0.05355	0.640471	32.63838
	10	1	4	0.995719	0.067565	0.653325	33.15759
	10	2	3	0.992524	0.05355	0.645797	32.85424
	10	3	3	0.988052	0.051714	0.647614	32.92767
	12	1	4	0.9978	0.067565	0.658397	33.36079
	12	2	3	0.996125	0.05355	0.649778	33.01492
2.356	6	1	2	0.96898	0.086077	0.808616	38.95956
	8	1	2	0.987847	0.086077	0.836483	39.91192
	8	2	2	0.967053	0.032935	0.807517	38.92146
	10	1	2	0.994347	0.086077	0.853634	40.4852
	10	2	2	0.984166	0.032935	0.815081	39.18282
	12	1	2	0.997035	0.086077	0.864598	40.84664
	12	2	2	0.991534	0.032935	0.821629	39.40751
3.141	8	1	1	0.988882	0.16206	0.979593	44.40937
	8	2	1	0.970039	0.085164	0.915325	42.46865
	10	1	1	0.994721	0.10206	1.012095	45.3444
	10	2	1	0.985285	0.085164	0.936242	43.11401
	10	3	1	0.97717	0.084613	0.944176	43.35531
	12	1	1	0.997187	0.10206	1.032602	45.91893
	12	2	1	0.992001	0.085164	0.950947	43.55971
3.927	8	1	1	0.977358	0.076512	0.89972	41.97836
	10	1	1	0.988875	0.076512	0.937684	43.158
	10	2	1	0.970022	0.039074	0.918965	42.58192
	10	3	1	0.954936	0.039017	0.934044	43.04682
	12	1	1	0.993932	0.076512	0.962577	43.90761
	12	2	2	0.954136	0.001523	0.927016	42.83101

4.712	8	1	1	0.960744	0.035465	0.847287	40.27418
	10	1	1	0.980067	0.035465	0.89024	41.67674
	12	1	1	0.988878	0.035465	0.919483	42.59802
	12	2	1	0.97003	0.017898	0.920721	42.63642
	12	3	1	0.954947	0.017893	0.935535	43.09242

Table - 4.3 Sample size and probability of acceptance for DSP (0, 1) using Minimum angle method when the life time of the items follows Weibull distribution

t/λ_0	λ/λ_0	k	n	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
0.628	4	2	7	0.959278	0.0694	0.338875	18.72023
	4	1	10	0.971826	0.082513	0.33909	18.73129
	4	3	6	0.951752	0.094561	0.351797	19.3817
	6	1	10	0.993884	0.082513	0.345644	19.06738
	6	2	7	0.990891	0.0694	0.341848	18.87288
	6	3	6	0.988892	0.094561	0.352229	19.40374
	8	1	10	0.997999	0.082513	0.349281	19.25332
	8	2	7	0.996988	0.0694	0.344724	19.02029
	8	3	6	0.996287	0.094561	0.35461	19.52503
	10	1	10	0.999168	0.082513	0.351243	19.35349
	10	2	7	0.998741	0.0694	0.346449	19.10858
	10	3	6	0.99844	0.094561	0.356208	19.60629
	12	1	10	0.999595	0.082513	0.352389	19.41191
	12	2	7	0.999386	0.0694	0.3475	19.16233
	12	3	6	0.999237	0.094561	0.357221	19.65782
0.942	4	1	4	0.973909	0.096367	0.608871	31.33604
	4	2	3	0.956501	0.073342	0.604999	31.17389
	6	1	4	0.994355	0.096367	0.627973	32.12773
	6	2	3	0.990188	0.073342	0.615057	31.59389
	8	1	4	0.998156	0.096367	0.637057	32.49947
	8	2	3	0.996745	0.073342	0.622145	31.88762
	8	3	3	0.994723	0.069904	0.621193	31.84825
	10	1	4	0.999233	0.096367	0.641763	32.69085
	10	2	3	0.998637	0.073342	0.626207	32.05508
	10	3	3	0.997769	0.069904	0.624472	31.98364
	12	1	4	0.999627	0.096367	0.644462	32.80026
	12	2	3	0.999335	0.073342	0.628641	32.15516
	12	3	3	0.998905	0.069904	0.626605	32.07147
1.257	4	1	3	0.953363	0.029551	0.757731	37.15233
	6	1	3	0.98956	0.029551	0.782382	38.039
	6	2	2	0.984922	0.04301	0.797415	38.56937
	6	3	2	0.976414	0.042427	0.80418	38.80555
	8	1	3	0.996547	0.029551	0.795917	38.51689

t/ λ_0	λ/λ_0	k	n	L(p1)	L(p2)	tanθ	θ
	8	2	2	0.994931	0.04301	0.808522	38.95631
	8	3	2	0.991854	0.042427	0.810646	39.02981
	10	1	3	0.998556	0.029551	0.803255	38.77335
	10	2	2	0.997864	0.04301	0.81516	39.18554
	10	3	2	0.996523	0.042427	0.815807	39.20782
	12	1	3	0.999296	0.029551	0.807555	38.92278
	12	2	2	0.998954	0.04301	0.819214	39.32481
	12	3	2	0.998285	0.042427	0.819287	39.32732
1.571	6	1	2	0.987411	0.020331	0.87789	41.27956
	6	2	1	0.987682	0.085308	0.94084	43.25406
	8	1	2	0.995815	0.020331	0.899471	41.97047
	8	2	1	0.995867	0.085308	0.963606	43.93818
	10	1	2	0.998246	0.020331	0.91099	42.3332
	10	2	1	0.99826	0.085308	0.975813	44.29865
	10	3	1	0.99717	0.020331	0.911993	42.36461
	12	1	2	0.999144	0.085308	0.982952	44.50741
	12	2	1	0.999148	0.085308	0.982946	44.50726
2.356	6	1	1	0.979583	0.007754	0.87796	41.28185
	8	1	1	0.993098	0.007754	0.92662	42.81881
	8	2	1	0.980968	0.003885	0.934455	43.05938
	10	1	1	0.997085	0.007754	0.952281	43.59981
	10	2	1	0.991717	0.003885	0.953725	43.64316
	12	1	1	0.99857	0.007754	0.967185	44.04432
	12	2	1	0.995871	0.003885	0.966044	44.01053
3.141	8	1	1	0.979591	0.000104	0.875037	41.18714
	10	1	1	0.991174	0.000104	0.914163	42.43241
	10	2	1	0.975931	0.000019	0.928394	42.87343
	10	3	1	0.963418	0.000019	0.940453	43.2423
	12	1	1	0.995615	0.000104	0.93794	43.16579
	12	2	1	0.987697	0.000019	0.94541	43.39264
3.927	8	1	1	0.95415	0.000001	0.823638	39.47617
	10	1	1	0.979577	0.000001	0.874959	41.1846
	12	1	1	0.989686	0.000001	0.907806	42.23335
	12	2	1	0.972094	0.000001	0.924234	42.74516

Table - 4.4 Sample size and probability of acceptance for DSP (0, 1) using Minimum angle method when the life time of the items follows Gamma distribution

t/λ_0	λ/λ_0	k	n	$L(p_1)$	$L(p_2)$	$\tan\theta$	θ
0.628	4	2	18	0.950122	0.092504	0.140036	7.971624
	4	1	28	0.958916	0.091065	0.138385	7.87882
	6	1	28	0.990327	0.091065	0.14022	7.981991
	6	2	18	0.988006	0.092504	0.140809	8.015064
	6	3	17	0.982806	0.092828	0.141683	8.064164
	8	1	28	0.996705	0.091065	0.141646	8.062078
	8	2	18	0.995882	0.092504	0.142	8.081996
	8	3	17	0.993998	0.092828	0.142349	8.10154
	10	1	28	0.998596	0.091065	0.142489	8.109444
	10	2	18	0.998239	0.092504	0.142772	8.125309
	10	3	17	0.997413	0.092828	0.142953	8.135509
	12	1	28	0.999307	0.091065	0.143004	8.138349
	12	2	18	0.999128	0.092504	0.143259	8.152669
	12	3	17	0.998713	0.092828	0.143376	8.159233
0.942	4	1	14	0.951792	0.089443	0.254165	14.2606
	6	1	14	0.988232	0.089443	0.257913	14.46213
	6	2	9	0.985213	0.092765	0.259745	14.56054
	6	3	9	0.976669	0.089443	0.261274	14.64258
	8	1	14	0.995917	0.092765	0.261866	14.67433
	8	2	9	0.99482	0.092765	0.262185	14.6914
	8	3	9	0.991638	0.082397	0.260112	14.58024
	10	1	14	0.998241	0.089443	0.262708	14.71947
	10	2	9	0.997758	0.092765	0.263813	14.77865
	10	3	9	0.99634	0.082397	0.261229	14.64016
	12	1	14	0.999124	0.089443	0.26382	14.77903
	12	2	9	0.998881	0.092765	0.264858	14.83462
	12	3	9	0.998163	0.082397	0.262067	14.68509
1.257	6	2	6	0.979907	0.07688	0.37514	20.56306
	6	1	9	0.985163	0.078344	0.373571	20.48425
	6	3	6	0.968636	0.070409	0.377144	20.66367
	8	1	9	0.994752	0.078344	0.378374	20.72535
	8	2	6	0.992795	0.07688	0.378578	20.73555
	8	3	6	0.988449	0.070409	0.377702	20.69163

t/ λ_0	λ/λ_0	k	n	L(p1)	L(p2)	tanθ	θ
	10	1	9	0.997713	0.078344	0.38135	20.87433
	10	2	6	0.996839	0.07688	0.381105	20.86209
	10	3	6	0.994864	0.070409	0.379251	20.76929
	12	1	9	0.998853	0.078344	0.383214	20.96752
	12	2	6	0.998409	0.07688	0.382789	20.94632
	12	3	6	0.997395	0.070409	0.380536	20.83361
1.571	6	1	6	0.984138	0.088316	0.487605	25.99408
	6	2	4	0.978179	0.088142	0.490774	26.14061
	6	3	4	0.96611	0.081815	0.493961	26.28757
	8	1	6	0.99431	0.081815	0.491747	26.18553
	8	2	4	0.99205	0.088316	0.496514	26.40503
	8	3	4	0.987296	0.081815	0.495556	26.361
	10	1	6	0.997498	0.088316	0.499933	26.56197
	10	2	4	0.996477	0.088142	0.500399	26.58332
	10	3	4	0.99429	0.088316	0.501703	26.64305
	12	1	6	0.998737	0.088142	0.502741	26.69055
	12	2	4	0.998215	0.088142	0.50303	26.70375
2.356	6	1	3	0.980345	0.098071	0.70529	35.19494
	8	1	3	0.992703	0.098071	0.722234	35.83809
	8	2	3	0.979692	0.032876	0.682428	34.31072
	10	1	3	0.99672	0.098071	0.73232	36.21608
	10	2	3	0.99064	0.032876	0.68712	34.49375
	12	1	3	0.998319	0.098071	0.738606	36.44979
	12	2	3	0.995135	0.032876	0.691008	34.64479
3.141	6	1	2	0.973381	0.084701	0.814165	39.15128
	8	1	2	0.989772	0.032363	0.795229	38.49275
	8	2	2	0.972033	0.032363	0.810242	39.01583
	10	1	2	0.9953	0.084701	0.857484	40.61255
	10	2	2	0.986754	0.032363	0.818139	39.28793
	10	3	2	0.979195	0.032062	0.824408	39.50245
	12	1	2	0.997555	0.084701	0.867738	40.94942
	12	2	2	0.992987	0.032062	0.82433	39.49977
	12	3	2	0.988802	0.032062	0.827935	39.62255
3.927	8	1	2	0.978395	0.026441	0.856633	40.58445
	10	1	2	0.989765	0.026441	0.875427	41.19977
	10	2	2	0.972015	0.009439	0.876107	41.22183
	12	1	2	0.994567	0.026441	0.88805	41.60667
	12	2	2	0.984761	0.009439	0.881498	41.3961

t/ λ_0	λ/λ_0	k	n	L(p_1)	L(p_2)	tanθ	θ
	12	2	2	0.984761	0.009439	0.881498	41.3961
4.712	8	1	2	0.961331	0.007635	0.870691	41.04579
	10	1	2	0.981111	0.007635	0.890692	41.6912
	10	2	2	0.950089	0.002636	0.915156	42.46339
	12	1	2	0.989768	0.007635	0.905244	42.15279
	12	2	2	0.972023	0.002636	0.917147	42.52541

4.6 Example

Assume that an experimenter wants to establish that the lifetime of the electrical devices produced in the factory ensures the true unknown mean life as at least 1000 hours when the ratio of the unknown average life is $\lambda/\lambda_0 = 6$. Following are the results obtained when the lifetime of the test items follows the Rayleigh distribution, Generalized Exponential distribution, Weibull distribution and Gamma distribution respectively.

4.6.1 Rayleigh distribution

Suppose that the life time of a product follows the Rayleigh distribution. For the above example from Table 4.1, the sample size required is obtained as $n_1 = 15$, $n_2 = 30$ and one can observe that the minimum angle is $\theta = 10.54134°$ and also $\alpha = 0.0097$ and $\beta = 0.0578$ 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 15 or not more than 1 failure occurs in the second sample of size 30 which satisfies the condition of the producer's risk and consumer's risk $\alpha \leq 0.05$, $\beta \leq 0.10$. Thus the required special purpose Double sampling plan of type DSP (0,1) sampling plan has sample sizes (15, 30). For the same conditions when the time of experiment is 3141 hours, the probability of acceptance is 0.956838; the producer's risk is 0.0431 and consumer's risk 0.0072. The sample size is $n = 1$ 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 is specified life as 12, there is a slight change in the sample size but there is increase in the probability of acceptance. The probability of acceptance as 0.9995 which is almost equal to 1 and the consumer's risk is 0.0883 which shows that there is a reduction in consumer's risk.

4.6.2 Generalized Exponential distribution

Suppose that the life time of a product follows the Generalized Exponential distribution. For the above example from Table 4.2, the sample size required is obtained as $n_1 = 16$, $n_2 = 16$ and one can observe that the minimum angle is $\theta = 12.99701°$ and also $\alpha = 0.0120$ and $\beta = 0.0885$ 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 16 or not more than 1 failure occurs in the second sample of size 16 which satisfies the condition of producer's risk and consumer's risk $\alpha \leq 0.05$, $\beta \leq 0.10$. Thus the required special purpose Double sampling plan of type DSP (0,1) sampling plan has sample sizes (16, 16). For the same conditions when the time of experiment is 1571 hours, the probability of acceptance is 0.9747, the producer's risk is 0.0252 and consumer's risk 0.0675. The sample size is n = 4 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 no change in the sample size but there is increase in the probability of acceptance. The probability of acceptance as 0.9991 which is almost equal to 1 and the consumer's risk is 0.0885 which shows that there is a reduction in consumer's risk.

4.6.3 Weibull distribution

Suppose that the life time of a product follows the Weibull distribution. For the above example from Table 4.3 the sample size required is obtained as $n_1 = 7$, $n_2 = 14$ and one can observe that the minimum angle is $\theta = 18.8728°$ and also $\alpha = 0.0091$ and $\beta = 0.0694$ 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 7 or not more than 1 failure occurs in the second sample of size 14 which satisfies the condition of producer's risk and consumer's risk $\alpha \leq 0.05$, $\beta \leq 0.10$. Thus the required special purpose Double sampling plan of type DSP (0,1) sampling plan has sample sizes (7, 14). For the same conditions when the time of experiment is 1257 hours, the probability of acceptance is 0.9849, the producer's risk is 0.0151 and consumer's risk 0.04301. The sample size is n = 2 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 no change in the sample size but there is increase in the probability of acceptance. The probability of acceptance as 0.9993 which is almost equal to 1 and the consumer's risk is 0.0694 which shows that there is a reduction in consumer's risk.

4.6.4 Gamma distribution

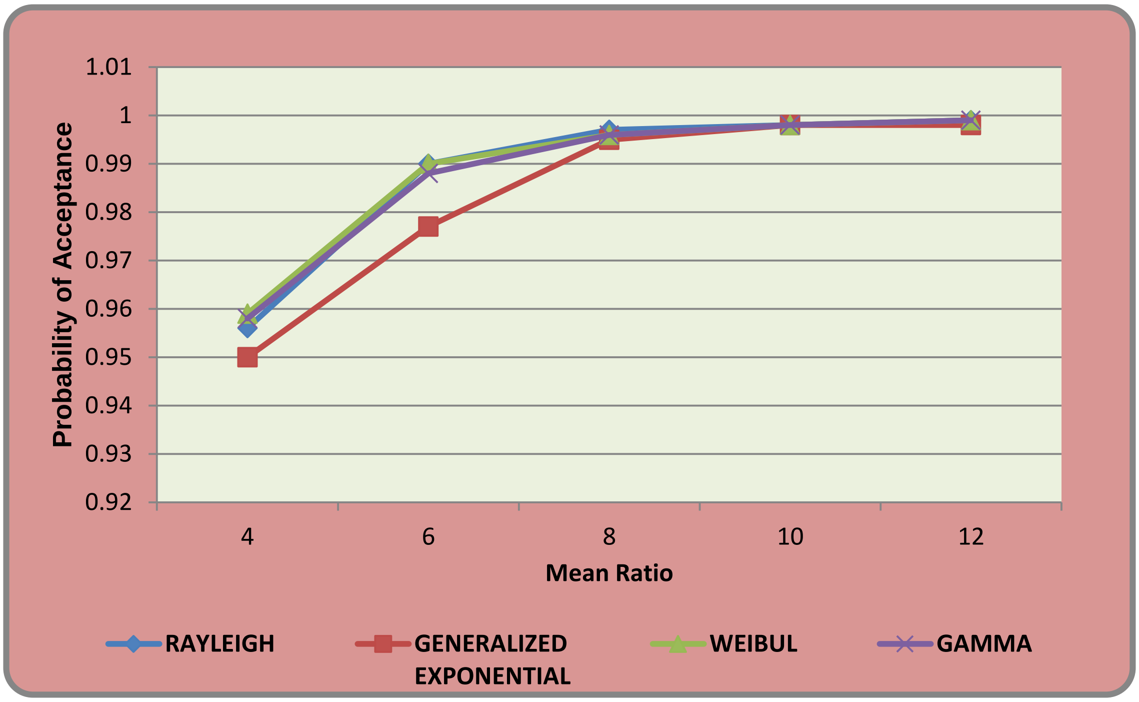
Suppose that the life time of a product follows the Gamma distribution. For the above example from Table 4.4, the sample size required is obtained as n_1 = 28, n_2 = 28 and one can observe that the minimum angle is θ = 7.98199° and also α = 0.0096 and β = 0.0910 which is very much less than the specified risk. The lot is accepted if during 628 hours no failure is observed in the first sample of size 28 or not more than 1 failure occurs in the second sample of size 28 which satisfies the condition of producer's risk and consumer's risk α ≤ 0.05, β ≤ 0.10. Thus the required special purpose Double sampling plan of type DSP (0,1) sampling plan has sample sizes (28,28). For the same conditions when the time of experiment is 1571 hours, the probability of acceptance is 0.9841; the producer's risk is 0.0159 and consumer's risk 0.0883. The sample size is n = 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 not change in the sample size but there is increase in the probability of acceptance. The probability of acceptance as 0.9993 which is almost equal to 1 and the consumer's risk is 0.0910 which shows that there is a reduction in consumer's risk.

Comparison of results of Producer's risk, Consumer's risk and sample size for special purpose of DSP-(0,1) sampling plan when the life time of the items follows different distributions is provided in Table 4.5.

Table-4.5 Comparison of results of Producer's risk, Consumer's risk and sample size for Special purpose Double sampling Plan of type DSP (0,1) when the life time of the items follows different distributions (t/λ_0=0.628)

S.No.	λ/λ_0	Distribution	Produicer's risk	Consumer's risk	k	n
1	4	Rayleigh	0.0433	0.0578	2	15
		Generalized Exponential	0.0491	0.0885	1	16
		Weibull	0.0407	0.0694	2	7
		Gamma	0.0410	0.0910	1	28
2	6	Rayleigh	0.0097	0.0578	2	15
		Generalized Exponential	0.0121	0.0885	1	16
		Weibul	0.0091	0.0694	2	7
		Gamma	0.0097	0.0910	1	28
3	8	Rayleigh	0.0024	0.0883	2	13
		Generalized Exponential	0.0041	0.0885	1	16
		Weibull	0.0030	0.0694	2	7
		Gamma	0.0033	0.0910	1	28
4	10	Rayleigh	0.0011	0.0883	2	13
		Generalized Exponential	0.0018	0.0885	1	16
		Weibull	0.0013	0.0694	2	7
		Gamma	0.0015	0.0910	1	28
5	12	Rayleigh	0.0006	0.0883	2	13
		Generalized Exponential	0.0009	0.0885	1	16
		Weibull	0.0006	0.0694	2	7
		Gamma	0.0007	0.0910	1	28

Figure 4.1 OC Curve for Special Purpose Double Sampling Plan DSP (0,1) when the lifetime of the Items follows different distributions (t/λ_0 = 0.628 hrs)



From a comparison of the table values (Table 4.1 to Table 4.4) one can see that when the Weibull distribution is followed, the sample size is very much less than the sample size of all other distributions. And at the same time the producer's risk and consumer's risk is also less and the sum of the risks is also very much less for Weibull distribution. Figure 4.1 shows the OC curves of all four distributions. From the figure, one can observe that probability of acceptance is more for Weibull distribution than any other distributions. It can be seen that by applying minimum angle method one can obtain parameters which minimizes simultaneously the consumer's risk and producer's risk. This minimum angle method plan provides better discrimination of accepting good lots.