CHAPTER IV
TWO-LEVEL SKIP-LOT PLANS

SECTION - 4.1
TWO-LEVEL SKIP-LOT PLAN (PLAN 2L.1)

- In section 4.1, a designing method is provided for the selection of Two-Level Skip-Lot Sampling Plan, designated Plan 2L.1 with chain sampling ChSP-1 plan as reference plan. Under the conditions for application of Poisson model for OC curve, tables are constructed using which one can select Plan 2L.1 under various sets of incoming and outgoing qualities. Conversion of a given set of parameters to the other sets of parameters is discussed through an example which provides information in the related parameters.

TWO-LEVEL SKIP-LOT PLAN (PLAN 2L.1)

Perry (1970, 1973) has also developed three two-level skip-lot plans and designated them as Plan 2L.1, Plan 2L.2 and Plan 2L.3.

OPERATING PROCEDURE

Plan 2L.1 is based on the multi-level continuous sampling plans of Lieberman and Solomon (1955) which is operated as follows:

5. Start with normal inspection, using the reference sampling plan.
6. When i consecutive lots are accepted on normal inspection, switch to skipping inspection at rate $f_1$.
7. During skipping inspection at rate $f_1$:
   (a) When i consecutively inspected lots are accepted, switch to skipping inspection at rate $f_2$.
   (b) When lot is rejected, switch to normal inspection.
8. During skipping inspection at rate $f_2$, when lot is rejected, switch to skipping inspection at $f_1$. 

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OPERATING CHARACTERISTIC FUNCTION

Perry has derived the OC function of Plan 2L.1 as

\[ P_{a_{2L.1}} = \frac{f_2 [P^i + f_1 [(P(1-P^i) - P^i(1-P^{i+1})]) + (f_1 - f_2)P^{2i}]}{f_2 [P^i + f_1(1-P^i)^2] + (f_1 - f_2)P^{2i}} \]  (4.1)

where \( P \) is the probability of acceptance of the reference plan.

The values of \( i, f_1 \) and \( f_2 \) are the skipping parameters of 2L.1 plan. Here the only restriction on the skipping rates \( f_1 \) and \( f_2 \) is that \( f_1 > f_2 \). In general, \( 0 < f_2 < 1 \), \( 0 < f_2 < 1 \) and \( i \) is a positive integer.

SELECTION OF PLANS

Selection procedures of Plan 2L.1 with ChSP-1 as reference plan will now be indicated under the conditions for application of Poisson model for OC curve. Tables 4.1, 4.2 and 4.3 have been constructed for various parametric values indexed by \( i_c, f_1, f_2, i \), which can be used for selection of such plans.

Designing plans for Given AQL and LQL

Column 5, 6 and 10 of Table 4.1 is used to design plans for a given AQL and LQL.

For example, for given \( p_1 = 0.005 \) and \( p_2 = 0.055 \), one can compute \( \frac{p_2}{p_1} = 0.055/0.005 = 11 \).

The value closest to 11 in the \( \frac{p_2}{p_1} \) column of Table 4.1 is 11.024.

This corresponds to \( i_c, f_1, f_2, i \) and np values of 2, 1/2, 1/3, 12 and 0.210 respectively.

Now one can calculate \( n = np_1 / p_1 = 0.210 / 0.005 = 42 \).

Rounding \( n \) to the nearest integer one obtains a sample size of 42.

Thus, the desired plan can be specified by \( n = 42, i_c = 2, f_1 = 1/2, f_2 = 1/3 \) and \( i = 12 \).
Designing Plans for Given AQL and IQL

The entries in Column 5, 7 and 11 of Table 4.1 can be used to design plans for given AQL and IQL.

For example, for given $p_1 = 0.007$ and $p_0 = 0.020$, one scans the column 11 for the value closest to $p_0 / p_1 = 0.020 / 0.007 = 2.857$, which is 2.869.

The $i_c$, $f_1$, $f_2$, $i$ and $np_1$ values corresponding to this value are 2, 1/5, 1/6, 6 and 0.305 respectively.

Now the sample size $n = np_1 / p_1 = 0.305 / 0.007 = 43.57 = 44$.

Thus, the desired plan can be specified by $n = 44$, $i_c = 2$, $f_1 = 1/5$, $f_2 = 1/6$ and $i = 6$.

Designing plans for Given AQL and MAPD

Column 5, 9 and 12 of Table 4.1 is used to design plans for a given AQL and MAPD.

For example, for given $p_1 = 0.008$ and $p^* = 0.015$, one can compute $p^* / p_1 = 0.015 / 0.008 = 1.875$.

The value closest to 4.1 in the $p^* / p_1$ column of Table 4.1 is 1.902.

This value corresponds to $i_c$, $f_1$, $f_2$, $i$ and $np_1$ values of 2, 1/2, 1/3, 8 and 0.225 respectively.

Now one can calculate $n = np_1 / p_1 = 0.225 / 0.008 = 28.125$.

Rounding $n$ to the nearest integer one obtains a sample size of 28.

Thus, the desired plan can be specified by $n = 28$, $i_c = 2$, $f_1 = 1/2$, $f_2 = 1/3$ and $i = 8$.

Designing plans for Given AQL ($p_1$) and AOQL ($p_L$)

Columns 5, 6 and 9 of Table 4.2 can be used to design plans for a given point $p_1$ on the OC curve and $p_L$. 
For example, for given $p_1 = 0.01$ and $p_L = 0.019$ one can compute

$$p_L / p_1 = 0.019 / 0.01 = 1.9.$$  

The value closest to 1.9 under the column headed by $p_L / p_1$ of Table 4.2 is 1.900, which corresponds to $i_c, f_1, f_2$ and $i$ values of 2, $1/3$, $1/4$ and 12 respectively.

Corresponding to $i_c = 2, f_1 = 1/3, f_2 = 1/4$ and $i = 12$ in Table 4.2, one finds $np_1 = 0.229$.

From this value, one can calculate $np_1 / p_1 = 0.229 / 0.01 = 22.9$.

Rounding $n$ to the nearest integer can obtains a sample size of 23.

Thus, the desired plan can be specified by $n = 23, i_c = 2, f_1 = 1/3, f_2 = 1/4$ and $i = 12$.

**Designing plans for Given AQL ($p_1$) and MAAOQ ($p_M$)**

Columns 5, 8 and 10 of Table 4.2 are used to design plans for given AQL and MAAOQ.

For example, for given $p_1 = 0.01$ and $p_M = 0.012$, one can compute

$$p_M / p_1 = 0.012 / 0.01 = 1.2.$$  

The value closest to this in the $p_M / p_1$ column of Table 4.2 is 1.217.

This value corresponds to $i_c, f_1, f_2, i$ and $np_1$ values of 2, $1/4$, $1/5$, 4 and 0.313 respectively.

From $np_1$ value, one can calculate $n = np_1 / p_1 = 0.313 / 0.01 = 31.3$, that is $n = 31$.

Thus, the desired plan can be specified by $n = 31, i_c = 2, f_1 = 1/4, f_2 = 1/5$ and $i = 4$.

**Designing plans for Given MAPD ($p_*$) and AOQL ($p_L$)**

The entries in Column 6, 7 and 11 of Table 4.2 can be used to design plans for given MAPD and AOQL.

For example, for given $p_* = 0.014$ and $p_L = 0.015$, one scans the column 11 for the value closest to $p_L / p_* = 0.015 / 0.014 = 1.071$, which is 1.077.
The \( i_c, f_1, f_2, i \) and \( np^* \) values corresponding to this value are 2, 2/3, 1/2, 12 and 0.390 respectively.

Now the sample size \( n = np^* / p_* = 0.390 / 0.014 = 27.857 = 28 \).

Thus, the desired plan can be specified by \( n = 28, i_c = 2, f_1 = 2/3, f_2 = 1/2 \) and \( i = 12 \).

**Designing plans for Given MAPD \( (p_*) \) and MAAOQ \( (p_M) \)**

The entries in Columns 7, 8 and 12 of Table 4.2 can be used to design plans for given MAPD and MAAOQ.

For example, for given \( p_* = 0.011 \) and \( p_M = 0.009 \), one scans the column 12 for the value closest to \( p_M / p_* = 0.009 / 0.011 = 0.818 \), which is 0.843.

The \( i_c, f_1, f_2, i \) and \( np^* \) values corresponding to this value are 5, 2/3, 1/2, 12 and 0.396.

From \( n_{MAPD} \) value, calculate the \( n = np^* / p_* = 0.396 / 0.011 = 36 \).

Thus, the desired plan can be specified by \( n = 36, i_c = 5, f_1 = 2/3, f_2 = 1/2 \) and \( i = 12 \).

**Designing plans for Given \( (p_1, h_1) \)**

Column 5 and 9 of Table 4.3 is used to design plans for a given \( p_1 \) and \( h_1 \).

For example, for given \( p_1 = 0.005 \) and \( h_1 = 0.10 \), from Table 4.3 under column headed \( h_1 \), locate the value equal to or just greater than specified \( h_1 \), which is 0.101.

Corresponding to this \( h_1 \), the \( i_c, f_1, f_2, i \), and \( np_1 \) values associated are 4, 2/3, 1/2, 4 and 0.167 respectively.

From this one can obtain the sample size \( n=np_1 / p_1 = 0.167 / 0.005 = 33.4 = 33 \).

Thus the selected parameters for Plan 2L.1 are \( n = 33, i_c = 4, f_1 = 2/3, f_2 = 1/2 \) and \( i = 4 \).
**Designing plans for Given (p₂, h₂)**

Column 6 and 10 of Table 4.3 is used to design plans for a given p₂ and h₂.

For example, for given p₂ = 0.14 and h₂ = 2.4, from Table 4.3 under column headed h₂, locate the value equal to or just greater than specified h₂, which is 2.418.

Corresponding to this h₂, the i_c, f₁, f₂, i, and np₂ values associated are 2, 1/5, 1/6, 6 and 2.316 respectively.

From this one can obtain the sample size n = np₂ / p₂ = 2.316 / 0.14 = 16.54 = 17.

Thus the selected parameters for Plan 2L.1 are n = 17, i_c = 2, f₁ = 1/5, f₂ = 1/6 and i = 6.

**Designing plans for Given (p₀, h₀)**

Columns 7 and 11 of Table 4.3 can be used to design plan for a given p₀ and h₀.

For example, for given p₀ = 0.025 and h₀ = 0.9, from Table 4.3 under column headed h₀, locate the value equal to or just greater than specified h₀, which is 0.905.

Corresponding to this h₀, the i_c, f₁, f₂, i, and np₀ values associated are 2, 1/2, 1/3, 6 and 0.840 respectively.

From this one can obtain the sample size n = np₀ / p₀ = 0.840 / 0.025 = 33.6 = 34.

Thus the selected parameters for Plan 2L.1 are n = 34, i_c = 2, f₁ = 1/2, f₂ = 1/3 and i = 6.

**Designing plans for Given (p*, h*)**

Columns 8 and 12 of Table 4.3 can be used to design plan for a given p* and h*.

For example, for given p* = 0.010 and h* = 0.7, from Table 4.3 under column headed h*, locate the value equal to or just greater than specified h*, which is 0.700.

Corresponding to this h*, the i_c, f₁, f₂, i, and np₀ values associated are 3, 2/3, 1/2, 6 and 0.519 respectively.

From this one can obtain the sample size n = np* / p* = 0.519 / 0.010 = 51.9 = 52.

Thus the selected parameters for Plan 2L.1 are n = 52, i_c = 3, f₁ = 2/3, f₂ = 1/2 and i = 6.
Designing plans through the Ratio of Relative slope $h_2 / h_1$

Column 5 and 13 of Table 4.3 is used to design plans for specified AQL with the ratio of relative slopes $h_2/h_1$.

For example, for given $p_1 = 0.012$ and the ratio of $h_2/h_1 = 19.5$.

By using Table 4.3, under column headed $h_2/h_1$ one can locate the value equal to or just greater than desired ratio, which are 19.508.

Corresponding to this located value, one can find $i_c$, $f_1$, $f_2$, $i$, and $np_1$ values as 2, 1/2, 1/3, 8 and 0.225 respectively.

From this one can obtain the sample size $n = np_1 / p_1 = 0.225 / 0.012 = 18.75 = 19$.

Thus the selected parameters for the plan are $n = 19$, $i_c = 2$, $f_1 = 1/2$, $f_2 = 1/3$ and $i = 8$.

Designing plans through the Ratio of Relative slope $h^*/h_0$

Column 7 and 14 of Table 4.3 is used to design plans for specified AQL with the ratio of relative slopes $h^*/h_0$.

For example, for given $p_1 = 0.022$ and the ratio of $h^*/h_0 = 1.2$.

By using Table 4.2, under column headed $h^*/h_0$ one can locate the value equal to or just greater than desired ratio, which are 1.200.

Corresponding to this located value, one can find $i_c$, $f_1$, $f_2$, $i$, and $np_0$ values as 2, 2/3, 1/2, 4 and 0.809 respectively.

From this one can obtain the sample size $n = np_0 / p_0 = 0.809 / 0.022 = 36.773 = 37$.

Thus the selected parameters for the plan are $n = 37$, $i_c = 2$, $f_1 = 2/3$, $f_2 = 1/2$ and $i = 4$.

CONVERSION OF PARAMETERS

Now converting a given set of parameters to the other set of equivalent (resulting plans having nearly identical OC curves) parameters will be discussed through an example.
For example \( p^* = 0.03, p_L = 0.03, p^*/p_L = 0.03/0.03 = 1 \), which corresponds to the table value of 1.010 from Table 4.1. Now, \( n = np^*/p^* = 0.415/0.03 = 13.833 \). The parameters of Plan 2L.1 satisfying the requirements are found from Table 4.1 as \( n = 14, i_c = 2, f_1 = 1/3, f_2 = 1/2, i = 10 \).

The other measure can be calculated from Table 4.1, 4.2 and 4.3 as

\[
\begin{align*}
p_1 &= np_1 / p_1 = 0.217 / 14 = 0.016 \\
p_2 &= np_2 / p_2 = 2.315 / 14 = 0.165 \\
p_0 &= np_0 / n = 0.840 / 14 = 0.06 \\
p_M &= np_M / n = 0.371 / 14 = 0.027 \\
h_1 &= 0.127 \\
h_2 &= 2.419 \\
h_0 &= 0.929 \\
h^* &= 0.782
\end{align*}
\]

The other similar sets of parameters can be specified as

\[
\begin{align*}
(AQL, MAPD) &= (0.016, 0.03) \\
(AQL, IQL) &= (0.016, 0.06) \\
(AQL, AOQL) &= (0.016, 0.030) \\
(AQL, MAAOQ) &= (0.016, 0.027) \\
(AOQL, MAAOQ) &= (0.030, 0.027) \\
(p_0, h_0) &= (0.06, 0.929) \\
(p^*, h^*) &= (0.030, 0.782) \\
(p_1, h_1) &= (0.016, 0.127)
\end{align*}
\]

**CONSTRUCTION OF TABLES 4.1, 4.2 AND 4.3**

Perry has derived the OC function of Plan 2L.1 as

\[
P_{a2L.1} = \frac{[f_2 [P^i + f_1 [P(1-P^i) - P^i(1-P^{i+1})]] + (f_1 - f_2)P^{2i}]}{[f_2 [P^i + f_1 (1-P^i)^2] + (f_1 - f_2)P^{2i}]} \quad (4.1)
\]

where \( P \) is the probability of acceptance of the reference plan.
Here, \[ P = e^{-np} + (np) e^{-np(ic + 1)} \],
which is the OC function for ChSP-1 reference plan having parameters \( n \) and \( i_c \), as derived by Dodge (1955a), under the conditions for application of Poisson model for OC curve.

For given values of \( i_c, f_1, f_2, i \) and \( P_a(p) \), equation (4.1) can be solved for \( np \) by the method of iterations. The entries of the columns \( np_1, np_2 \) and \( np_0 \) of Table 4.1 provides such \( np \) values with \( P_a(p) = 0.95, 0.10 \) and \( 0.50 \) respectively for given \( i_c, f_1, f_2, i \) and \( P_a(p) \).

Assuming \( n\text{AOQ} = np \ P_a(p) \), for given values of \( i_c, f_1, f_2 \) and \( i \), the values of \( np_m \) that maximizes \( n\text{AOQ} \), can be obtained from equation (4.1) and are tabulated in Table 4.1. Values of \( n\text{AOQL} \) are obtained using \( np_L = np_m \ P_a(p_m) \) and are tabulated in Table 4.2.

The values of the column \( np^* \) of Table 4.3 are such values of \( np \) which are obtained by equating the second derivative of \( P_a(p) \) to 0 for given values of \( i_c, f_1, f_2, i \) and \( P_a(p) \).

The entries of column \( h_1, h_2, h_0 \) and \( h^* \) of Table 4.3 are calculated through the expression
\[ h = - \left( \frac{p}{P_a(p)} \right) \left( \frac{d P_a(p)}{dp} \right), \] for \( p = p_1, p_2, p_0 \) and \( p^* \).

The remaining columns of the tables of 4.1, 4.2 and 4.3 are the ratios of corresponding parametric values.
SECTION - 4.2

TWO-LEVEL SKIP-LOT PLAN (PLAN 2L.2)

- In section 4.2, various incoming and outgoing quality levels are considered for selection of Two-Level Skip-Lot Sampling Plan, designated Plan 2L.2, with chain sampling ChSP-1 plan as reference plan. Tables are constructed under the conditions for application of Poisson model for OC curve using which one can select Plan 2L.2 under various sets of incoming and outgoing qualities. Also conversion from one set of parameters to the other sets of parameters is discussed through an example.

TWO-LEVEL SKIP-LOT PLAN (PLAN 2L.2)

Plan 2L.2 is based on the tightened multi-level continuous sampling plans of Derman, Littauer and Solomon (1957), which is operated as follows:

OPERATING PROCEDURE

1. Start with normal inspection using the reference plan.
2. When i consecutive lots are accepted on normal inspection level, switch to skipping inspection at rate $f_1$.
3. When i consecutive lots are accepted on skipping inspection at rate $f_1$, switch to skipping inspection at rate $f_2$.
4. When a lot is rejected on either skipping inspection level, switch to normal inspection.

The parameters of Plan 2L.2 are $f_1$, $f_2$ and i. The restriction on $f_1$ and $f_2$ is that $f_1 > f_2$. In general $0 < f_1 < 1$, $0 < f_2 < 1$ and $i < \infty$. 

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OPERATING CHARACTERISTIC FUNCTION

According to Perry (1973), the OC function of Plan 2L.2 is

\[
P_a^{2L.2} = \frac{f_2 \left[ P^i + f_1 (P - P^i) \right] + (f_1 - f_2) P^{2i}}{f_2 \left[ P^i + f_1 (1-P^i) \right] + (f_1 - f_2) P^{2i}}
\]  

(4.2)

where \( P \) is the probability of acceptance of the reference plan.

The values of \( i, f_1 \) and \( f_2 \) are the skipping parameters of 2L.2 plan. Here the only restriction on the skipping rates \( f_1 \) and \( f_2 \) is that \( f_1 > f_2 \). In general, \( 0 < f_2 < 1, \ 0 < f_2 < 1 \) and \( i \) is a positive integer.

SELECTION OF PLANS

Selection procedures of Plan 2L.2 with ChSP-1 as reference plan will now be indicated under the conditions for application of Poisson model for OC curve. Tables 4.4, 4.5 and 4.6 have been constructed for various parametric values indexed by \( i_c, f_1, f_2, i \), which can be used for selection of such plans.

Designing plans for Given AQL and LQL

Column 5, 6 and 10 of Table 4.4 is used to design plans for a given AQL and LQL.

For example, for given AQL = 0.007 and LQL = 0.07, one can compute \( \frac{LQL}{AQL} = \frac{0.07}{0.007} = 10 \).

The value closest to 10 in the \( p_2 / p_1 \) column of Table 4.4 is 10.006.

This corresponds to \( i_c, f_1, f_2, i \) and \( np_1 \) values of 3, 1/3, 1/4, 6 and 0.228 respectively.

Now one can calculate \( n = np_1 / p_1 = 0.228 / 0.007 = 32.57 \).

Rounding \( n \) to the nearest integer one obtains a sample size of 33.

Thus, the desired plan can be specified by \( n = 33, i_c = 3, f_1 = 1/3, f_2 = 1/4 \) and \( i = 6 \).
Designing Plans for Given AQL and IQL

The entries in Column 5, 7 and 11 of Table 4.4 can be used to design plans for given AQL and IQL.

For example, for given AQL = 0.006 and IQL = 0.027, one scans the column 10 for the value closest to $p_0 / p_1 = 0.027 / 0.006 = 4.5$, which is 4.525.

The $i_c$, $f_1$, $f_2$, $i$ and $n p_1$ values corresponding to this value are 4, 1/2, 1/3, 12 and 0.162 respectively.

Now the sample size $n = n p_1 / p_1 = 0.162 / 0.006 = 27$.

Thus, the desired plan can be specified by $n = 27$, $i_c = 4$, $f_1 = 1/2$, $f_2 = 1/3$ and $i = 12$.

Designing plans for Given AQL and MAPD

Column 5, 9 and 12 of Table 4.4 is used to design plans for a given AQL and MAPD.

For example, for given AQL = 0.008 and MAPD = 0.016, one can compute $\text{MAPD} / \text{AQL} = 0.016 / 0.008 = 2$.

The value closest to 2 in the MAPD / AQL column of Table 4.4 is 2.000.

This value corresponds to $i_c$, $f_1$, $f_2$, $i$ and $n p_1$ values of 5, 1/2, 1/3, 4 and 0.181 respectively.

Now one can calculate $n = n p_1 / p_1 = 0.181 / 0.008 = 22.625$.

Rounding $n$ to the nearest integer one obtains a sample size of 23.

Thus, the desired plan can be specified by $n = 23$, $i_c = 5$, $f_1 = 1/2$, $f_2 = 1/3$ and $i = 4$. 
**Designing plans for Given AQL and AOQL**

Columns 5, 6 and 9 of Table 4.5 can be used to design plans for a given point on the OC curve and AOQL.

For example, for given \( p_1 = 0.007 \) and \( p_L = 0.015 \) one can compute
\[
p_L / p_1 = 0.015 / 0.007 = 2.142.
\]

The value closest to 2.142 under the column headed by \( p_L / p_1 \) of Table 4.5 is 2.143, which corresponds to \( i_c, f_1, f_2 \) and \( i \) values of 2, 2/3, 1/2 and 10 respectively.

Corresponding to \( i_c = 2, f_1 = 2/3, f_2 = 1/2 \) and \( i = 4 \) in Table 4.5, one finds \( n_{p_1} = 0.196 \).

From this value, one can calculate \( n_{p_1} / p_1 = 0.196 / 0.007 = 28 \).

Rounding \( n \) to the nearest integer can obtain a sample size of 28.

Thus, the desired plan can be specified by \( n = 28, i_c = 2, f_1 = 2/3, f_2 = 1/2 \) and \( i = 10 \).

**Designing plans for Given AQL (\( p_1 \)) and MAAOQ (\( p_M \))**

Columns 5, 8 and 10 of Table 4.5 are used to design plans for given AQL and MAAOQ.

For example, for given \( p_1 = 0.010 \) and \( p_M = 0.019 \), one can compute
\[
p_M / p_1 = 0.019 / 0.010 = 1.9.
\]

The value closest to this in the \( p_m / p_1 \) column of Table 4.5 is 1.970.

This value corresponds to \( i_c, f_1, f_2, i \) and \( n_{p_1} \) values of 4, 1/2, 1/3, 10 and 0.167 respectively.

From \( n_{p_1} \) value, one can calculate \( n = n_{p_1} / p_1 = 0.167 / 0.010 = 16.7 \), that is \( n = 17 \).

Thus, the desired plan can be specified by \( n = 17, i_c = 4, f_1 = 1/2, f_2 = 1/3 \) and \( i = 10 \).
Designing plans for Given MAPD ($p_*$) and AOQL ($p_L$)

The entries in Columns 6, 7 and 11 of Table 4.5 can be used to design plans for given MAPD and AOQL.

For example, for given $p_* = 0.018$ and $p_L = 0.019$, one scans the column 11 for the value closest to $p_L / p_* = 0.019 / 0.018 = 1.055$, which is 1.050.

The $i_c$, $f$, $i$ and $n_{p*}$ values corresponding to this value are 3, $1/5$, $1/6$, 12 and 0.424 respectively.

Now the sample size $n = n_{p*} / p_* = 0.424 / 0.018 = 23.55 = 24$.

Thus, the desired plan can be specified by $n = 24$, $i_c = 3$, $f_1 = 1/5$, $f_2 = 1/6$ and $i = 12$.

Designing plans for Given MAPD ($p_*$) and MAAOQ ($p_M$)

The entries in Columns 7, 8 and 12 of Table 4.5 can be used to design plans for given MAPD and MAAOQ.

For example, for given $p_* = 0.011$ and $p_M = 0.007$, one scans the column 12 for the value closest to $p_M / p_* = 0.007 / 0.011 = 0.636$, which is 0.642.

The $i_c$, $f$, $i$ and $n_{MAPD}$ values corresponding to this value are 2, $1/5$, $1/6$, 8 and 0.520.

From $n_{p*}$ value, calculate the $n = n_{p*} / p_* = 0.520 / 0.011 = 47.27$.

Rounding to the nearest integer the sample size of 47 is obtained.

Thus, the desired plan can be specified by $n = 47$, $i_c = 2$, $f_1 = 1/5$, $f_2 = 1/6$ and $i = 8$.

Designing plans for Given ($p_1$, $h_1$)

Column 5 and 9 of Table 4.6 is used to design plans for a given $p_1$ and $h_1$.

For example, for given $p_1 = 0.04$ and $h_1 = 0.13$, from Table 4.6 under column headed $h_1$, locate the value equal to or just greater than specified $h_1$, which is 0.132.
Corresponding to this $h_1$, the $i_c$, $f_1$, $f_2$, $i$, and $n p_1$ values associated are 2, $1/4$, $1/5$, 6 and 0.286 respectively.

From this one can obtain the sample size $n = n p_1 / p_1 = 0.286 / 0.04 = 7.15 = 7$.

Thus the selected parameters for Plan 2L.2 are $n = 7$, $i_c = 2$, $f_1 = 1/4$, $f_2 = 1/5$ and $i = 6$.

**Designing plans for Given ($p_2$, $h_2$)**

Column 6 and 10 of Table 4.6 is used to design plans for a given $p_2$ and $h_2$.

For example, for given $p_2 = 0.4$ and $h_2 = 2.32$, from Table 4.4 under column headed $h_2$, locate the value equal to or just greater than specified $h_2$, which is 2.320.

Corresponding to this $h_2$, the $i_c$, $f_1$, $f_2$, $i$, and $n p_2$ values associated are 4, $2/3$, $1/2$, 4 and 2.294 respectively.

From this one can obtain the sample size $n = n p_2 / p_2 = 2.294 / 0.4 = 5.735 = 6$.

Thus the selected parameters for Plan 2L.2 are $n = 6$, $i_c = 4$, $f_1 = 2/3$, $f_2 = 1/2$ and $i = 4$.

**Designing plans for Given ($p_0$, $h_0$)**

Columns 7 and 11 of Table 4.6 can be used to design plan for a given $p_0$ and $h_0$.

For example, for given $p_0 = 0.06$ and $h_0 = 0.77$, from Table 4.4 under column headed $h_0$, locate the value equal to or just greater than specified $h_0$, which is 0.771.

Corresponding to this $h_0$, the $i_c$, $f_1$, $f_2$, $i$, and $n p_0$ values associated are 5, $1/2$, $1/3$, 10 and 0.715 respectively.

From this one can obtain the sample size $n = n p_0 / p_0 = 0.715 / 0.06 = 11.916 = 12$.

Thus the selected parameters for Plan 2L.2 are $n = 12$, $i_c = 5$, $f_1 = 1/2$, $f_2 = 1/3$ and $i = 10$. 

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**Designing plans for Given \((p_1, h_2 / h_1)\)**

Column 5 and 13 of Table 4.6 is used to design plans for specified AQL with the ratio of relative slopes \(h_2/h_1\).

For example, for given \(p_1 = 0.05\) and the ration of \(h_2/h_1 = 16.3\).

By using Table 4.6, under column headed \(h_2/h_1\) one can locate the value equal to or just greater than desired ratio, which are 16.308.

Corresponding to this located value, one can find \(i_c, f_1, f_2, i\) and \(np_1\) values as 3, 1/4, 1/5, 12 and 0.210 respectively.

From this one can obtain the sample size \(n = np_1 / p_1 = 0.210 / 0.05 = 4.2 = 4\).

Thus the selected parameters for the plan are \(n = 4, i_c = 3, f_1 = 1/4, f_2 = 1/5\) and \(i = 12\).

**Designing plans for Given \((p_0, h^* / h_0)\)**

Column 7 and 14 of Table 4.6 is used to design plans for specified IQL with the ratio of relative slopes \(h^*/h_0\).

For example, for given \(p_0 = 0.07\) and the ration of \(h^*/h_0 = 0.6\).

By using Table 4.6, under column headed \(h^*/h_0\) one can locate the value equal to or just greater than desired ratio, which are 0.607.

Corresponding to this located value, one can find \(i_c, f_1, f_2, i\) and \(np_0\) values as 2, 1/2, 1/3, 10 and 0.841 respectively.

From this one can obtain the sample size \(n = np_0 / p_0 = 0.841 / 0.07 = 12.01 = 12\).

Thus the selected parameters for the plan are \(n = 12, i_c = 2, f_1 = 1/2, f_2 = 1/3\) and \(i = 10\).
CONVERSION OF PARAMETERS

One may be interested in converting the given set of parameters into other familiar sets which provide information in the related parameters. For example when $p_0 = 0.077$, $h_0 = 0.88$ are specified, the other equivalent set of parameters are found using the Tables 4.4, 4.5 and 4.6.

Corresponding to $h_0 = 0.88$, one finds tabulated $h_0 = 0.883$. The $np_0$ value associated to this $h_0$ is 0.772. Now $n = np_0 / p_0 = 0.772 / 0.077 = 10.025 = 10$. The other associated values are

- $p_1 = np_1 / n = 0.194 / 10 = 0.019$
- $p_2 = np_2 / n = 2.295 / 10 = 0.229$
- $p* = np* / n = 0.444 / 10 = 0.044$
- $p_m = np_m / n = 0.991 / 10 = 0.099$
- $p_L = np_L / n = 0.387 / 10 = 0.039$
- $p_M = np_M / n = 0.327 / 10 = 0.033$
- $h_1 = 0.122$
- $h_2 = 2.332$
- $h* = 0.535$

Thus, when $p_0 = 0.077$ and $h_0 = 0.88$, the other sets of parameters are

- $(AQL, LQL) = (0.019, 0.229)$
- $(AQL, MAPD) = (0.019, 0.044)$
- $(AQL, IQL) = (0.019, 0.077)$
- $(AQL, AOQL) = (0.019, 0.039)$
- $(AQL, MAAOQ) = (0.019, 0.033)$
- $(AOQL, MAPD) = (0.039, 0.044)$
- $(AOQL, MAAOQ) = (0.039, 0.033)$
- $(MAPD, MAAOQ) = (0.044, 0.033)$
- $(p_1, h_1) = (0.019, 0.122)$
- $(p_2, h_2) = (0.229, 2.332)$
- $(p*, h*) = (0.044, 0.535)$
CONSTRUCTION OF TABLES 4.4, 4.5 AND 4.6

According to Perry (1973), the OC function of Plan 2L.2 is

\[
P_a^{2L.2} = \frac{\left[ f_2 \left[ P^i + f_1 ( P - P^i) \right] + (f_1 - f_2) P^{2i} \right]}{\left[ f_2 \left[ P^i + f_1 (1 - P^i) \right] + (f_1 - f_2) P^{2i} \right]}
\]

where \( P \) is the probability of acceptance of the reference plan.

Here, \( P = e^{-np} + (np) e^{-np(ic + 1)} \),

which is the OC function for ChSP-1 reference plan having parameters \( n \) and \( ic \), as derived by Dodge (1955a), under the conditions for application of Poisson model for OC curve.

For given values of \( ic, f_1, f_2, i \) and \( P_a(p) \), equation (4.4) can be solved for \( np \) by the method of iterations. The entries of the columns \( np_1, np_2 \) and \( np_0 \) of Table 4.4 provides such \( np \) values with \( P_a(p) = 0.95, 0.10 \) and 0.50 respectively for given \( ic, f_1, f_2, i \) and \( P_a(p) \).

Assuming \( nAOQ = np P_a(p) \), for given values of \( ic, f_1, f_2 \) and \( i \), the values of \( np_m \) that maximizes \( nAOQ \), can be obtained from equation (4.4) and are tabulated in Table 4.4. Values of \( nAOQL \) are obtained using \( np_L = np_m P_a(p_m) \) and are tabulated in Table 4.5.

The values of \( np^* \), tabulated in Table 4.5, such values of \( np \) which are obtained by equating the second derivative of \( P_a(p) \) to 0 for given values of \( ic, f_1, f_2, i \) and \( P_a(p) \).

The entries of column \( h_1, h_2, h_0 \) and \( h^* \) in Table 4.6 are calculated through the expression

\[
h = - \frac{\left( p / P_a(p) \right)}{\left( d P_a(p) / d p \right)}, \text{ for } p = p_1, p_2, p_0 \text{ and } p^*.
\]

The remaining columns of the tables of 4.4, 4.5 and 4.6 are the ratios of corresponding parametric values.