DODGE AND ROMIG'S SAMPLING INSPECTION PLAN TABLES

Semester IV **STAT CC410**

Unit 3

- Dodge and Romig's Sampling Inspection Plan Tables
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- Dodge and Romig Tables based on AOQL and LTPD

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Dodge and Romig's Sampling Inspection Plan Tables

- H. F. Dodge and H. G. Romig developed a set of sampling inspection tables for lot-by-lot inspection of product by attributes using two types of sampling plans, plans for lot tolerance percent defective (LTPD) protection and plans that provide a specified average outgoing quality limit (AOQL).
- For each of these approaches to sampling plan design, there are tables for single and double sampling.
- Sampling plans that emphasize LTPD protection, such as the Dodge-Romig plans, are often preferred to AQL oriented sampling plans, such as those in MIL STD 105E, particularly for critical components and parts.
- Many manufacturers believe that they have relied too much on AOQLs in the past, and they have now emphasizing other measures of performance, such as defective parts per million (ppm).

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- Consider the following table:

AQL	Defective Parts per Million
10%	100,000
1%	10,000
0.1%	1000
0.01%	100
0.001%	10
0.0001%	1

- Thus, from the above table it is clear that even very small AQLs imply large numbers of defective ppm. In complex products, the effect of this can be devastating.
- For example, suppose that a printed circuit board contains 100 elements, each manufactured by a process operating at 0.5% defective. If the AQLs for these elements are 0.5% and if all elements on the printed circuit board must operate for the card to function properly, then the probability that a board work is

$$P[\text{Circuit board function properly}] = (0.995)^{100} = 0.6058$$

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- Thus, there is an obvious need for sampling plans that emphasize LTPD protection, even when the process average fallout is low. The Dodge and Romig plans are often useful in these situations.
- The Dodge and Romig AOQL plans are designed so that the average total inspection for a given AOQL, and a specified process average '*p*' will be minimized.
- Similarly, the LTPD plans are designed so that the average total inspection is minimum. This makes the Dodge and Romig plans very useful for in-plant inspection of semi finished product.

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- The Dodge and Romig plans apply only to programs that submit rejected lots to 100% inspection. Unless rectifying inspection is used, the AOQL concept is meaningless.
- Furthermore, to use the plans, we must know the process average – that is, the average fraction nonconforming of the incoming product.
- When a supplier is relatively new, we usually do not know its process fallout. Sometimes this may be estimated from a preliminary sample or from data provided by the supplier.
- Alternatively, the largest possible process average in the table can be used until enough information has been generated to provide a more accurate estimate of the supplier's process fallout.
- Obtaining a more accurate estimate of the incoming fraction nonconforming or process average will allow a more appropriate sampling plan to be adopted.
- It is not uncommon to find that sampling inspection begins with one plan, and after sufficient information is generated to reestimate the supplier's process fallout, a new plan is adopted.

AOQL Plans

- The Dodge and Romig (1959) tables give AOQL sampling plans for AOQL values of 0.1%, 0.25%, 0.5%, 0.75%, 1%, 1.5%, 2%, 2.5%, 3%, 4%, 5%, 7%, and 10%. For each of these AOQL values, six classes of values for the process average are specified.
- Tables are provided for both single and double sampling plans. These plans have been designed so that the average total inspection at the given AOQL and process average is approximately a minimum.
- An example of the Dodge and Romig sampling plans is shown in the table 1.
- To illustrate the use of the Dodge and Romig AOQL tables, suppose that we are inspecting LSI memory elements for a personal computer and that the elements are shipped in lots of size $N = 5000$. Supplier's process average fallout is 1% nonconforming. We wish to find a single sampling plan with an AOQL = 3%. From the table 1, we find that the plan is

$$n = 65, \qquad c = 3$$

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- Table 1 also indicates that the LTPD for this sampling plans is 10.3%. This is the point on the OC curve for which P_a = 0.10. Therefore, the sampling plan n = 65, c = 3 gives an AOQL of 3% nonconforming and provide assurance that 90% of incoming lots that are as bad as 10.3% defective will be rejected.
- Assuming that incoming quality is equal to the process average and that the probability of lot acceptance at this level of quality is P_a = 0.9957, we find that the average total inspection for this plan is

$$\begin{aligned} \text{ATI} &= n + (1 - P_a)(N - \text{n}) \\ &= 65 + (1 - 0.9957)(5000 - 65) \\ &= 86.22 \end{aligned}$$

Thus, we will inspect approximately 86 units, on the average, in order to accept or reject a lot.

LTPD Plans

- The Dodge and Romig LTPD tables are designed so that the probability of lot acceptance at the LTPD is 0.1. Tables are provided for LTPD values of 0.5%, 1%, 2%, 3%, 4%, 5%, 7%, and 10%. Table 2 for an LTPD of 1% is representative of these Dodge and Romig tables.
- To illustrate the use of these tables, suppose that LSI memory elements for a personal computer are shipped from the supplier in lots of size $N = 5000$. The supplier's process average fallout is 0.25% nonconforming, we wish to use a single sampling plan with an LTPD of 1%. From inspection of table 2, the sampling plan that should be used is

$$n = 770, \qquad c = 4$$

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- If we assumed that rejected lot are screened 100% and that defective items are replaced with good ones, the AOQL for this plan is approximately 0.28%.
- Note from inspection of the Dodge and Romig LTPD tables that values of the process average cover the interval from zero to one-half the LTPD.
- Provision for larger process average is unnecessary, since 100% inspection is more economically efficient than inspection sampling when the process average exceeds one-half the desired LTPD.

Table 1

Table 1. Dodge-Romig Single Sampling Lot Inspection Table.

Based on Average Outgoing Quality Limit (AOQL) = 3.0 %.

LOT SIZE	PROCESS AVERAGE (%)																	
	0.00 - 0.06			0.07 - 0.60			0.61 - 1.20			1.21 - 1.80			1.81 - 2.40			2.41 - 3.00		
	n	*c*	LQL (%)	*n*	*c*	LQL (%)	*n*	*c*	LQL (%)	*n*	*c*	LQL (%)	*n*	*c*	LQL (%)	*n*	*c*	LQL (%)
1 - 10	All	0	-	All	0	-	All	0	-	All	0	-	All	0	-	All	0	-
11 - 50	10	0	19.0	10	0	19.0	10	0	19.0	10	0	19.0	10	0	19.0	10	0	19.0
51 - 100	11	0	18.0	11	0	18.0	11	0	18.0	11	0	18.0	11	0	18.0	22	1	16.4
101 - 200	12	0	17.0	12	0	17.0	12	0	17.0	25	1	15.1	25	1	15.1	25	1	15.1
201 - 300	12	0	17.0	12	0	17.0	26	1	14.6	26	1	14.6	26	1	14.6	40	2	12.8
301 - 400	12	0	17.1	12	0	17.1	26	1	14.7	26	1	14.7	41	2	12.7	41	2	12.7
401 - 500	12	0	17.2	27	1	14.1	27	1	14.1	42	2	12.4	42	2	12.4	42	2	12.4
501 - 600	12	0	17.3	27	1	14.2	27	1	14.2	42	2	12.4	42	2	12.4	60	3	10.8
601 - 800	12	0	17.3	27	1	14.2	27	1	14.2	43	2	12.1	60	3	10.9	60	3	10.9
801 - 1000	12	0	17.4	27	1	14.2	44	2	11.8	44	2	11.8	60	3	11.0	80	4	9.8
1001 - 2000	12	0	17.5	28	1	13.8	45	2	11.7	65	3	10.2	80	4	9.8	100	5	9.1
2001 - 3000	12	0	17.5	28	1	13.8	45	2	11.7	65	3	10.2	100	5	9.1	140	7	8.2
3001 - 4000	12	0	17.5	28	1	13.8	65	3	10.3	85	4	9.5	125	6	8.4	165	8	7.8
4001 - 5000	28	1	13.8	28	1	13.8	65	3	10.3	85	4	9.5	125	6	8.4	210	10	7.4
5001 - 7000	28	1	13.8	45	2	11.8	65	3	10.3	105	5	8.8	145	7	8.1	235	11	7.1
7001 - 10000	28	1	13.9	46	2	11.6	65	3	10.3	105	5	8.8	170	8	7.6	280	13	6.8
10001 - 20000	28	1	13.9	46	2	11.7	85	4	9.5	125	6	8.4	215	10	7.2	380	17	6.2
20001 - 50000	28	1	13.9	65	3	10.3	105	5	8.8	170	8	7.6	310	14	6.5	560	24	5.7
50001 - 100000	28	1	13.9	65	3	10.3	125	6	8.4	215	10	7.2	385	17	6.2	690	29	5.4

n : size of sample; entry of "All" indicates that each piece in lot is to be inspected.

c : acceptance number for sample.

LQL : limiting quality level corresponding to a consumer's risk (β) = 0.10.

Table 2

Table 2. Dodge and Romig Single Sampling Lot Inspection Table.
Based on Stated Value of Lot Tolerance Per Cent Defective (LTPD) = 1.0 % and Consumer's Risk = 0.10.

LOT SIZE	PROCESS AVERAGE (%)																	
	0 - 0.010			0.011 - 0.10			0.11 - 0.20			0.21 - 0.30			0.31 - 0.40			0.41 - 0.50		
	n	*c*	AOQL (%)	*n*	*c*	AOQL (%)	*n*	*c*	AOQL (%)	*n*	*c*	AOQL (%)	*n*	*c*	AOQL (%)	*n*	*c*	AOQL (%)
1 - 120	All	0	0.00	All	0	0.00	All	0	0.00	All	0	0.00	All	0	0.00	All	0	0.00
121 - 150	120	0	0.06	120	0	0.06	120	0	0.06	120	0	0.06	120	0	0.06	120	0	0.06
151 - 200	140	0	0.08	140	0	0.08	140	0	0.08	140	0	0.08	140	0	0.08	140	0	0.08
201 - 300	165	0	0.10	165	0	0.10	165	0	0.10	165	0	0.10	165	0	0.10	165	0	0.10
301 - 400	175	0	0.12	175	0	0.12	175	0	0.12	175	0	0.12	175	0	0.12	175	0	0.12
401 - 500	180	0	0.13	180	0	0.13	180	0	0.13	180	0	0.13	180	0	0.13	180	0	0.13
501 - 600	190	0	0.13	190	0	0.13	190	0	0.13	190	0	0.13	190	0	0.13	305	1	0.14
601 - 800	200	0	0.14	200	0	0.14	200	0	0.14	330	1	0.15	330	1	0.15	330	1	0.15
801 - 1000	205	0	0.14	205	0	0.14	205	0	0.14	335	1	0.17	335	1	0.17	335	1	0.17
1001 - 2000	220	0	0.15	220	0	0.15	360	1	0.19	490	2	0.21	490	2	0.21	610	3	0.22
2001 - 3000	220	0	0.15	375	1	0.20	505	2	0.23	630	3	0.24	745	4	0.26	870	5	0.26
3001 - 4000	225	0	0.15	380	1	0.20	510	2	0.24	645	3	0.25	880	5	0.28	1000	6	0.29
4001 - 5000	225	0	0.16	380	1	0.20	520	2	0.24	770	4	0.28	895	5	0.29	1120	7	0.31
5001 - 7000	230	0	0.16	385	1	0.21	655	3	0.27	780	4	0.29	1020	6	0.32	1260	8	0.34
7001 - 10000	230	0	0.16	520	2	0.25	660	3	0.28	910	5	0.32	1150	7	0.34	1500	10	0.37
10001 - 20000	390	1	0.21	525	2	0.26	785	4	0.31	1040	6	0.35	1400	9	0.39	1980	14	0.43
20001 - 50000	390	1	0.21	530	2	0.26	920	5	0.34	1300	8	0.39	1890	13	0.44	2570	19	0.48
50001 - 100000	390	1	0.21	670	3	0.29	1040	6	0.36	1420	9	0.41	2120	15	0.47	3150	23	0.50

n : size of sample; entry of "All" indicates that each piece in lot is to be inspected.

c : acceptance number for sample.

AOQL : average outgoing quality limit.