Sandia Corporation

REPRINT

ACCEPTANCE SAMPLING CRITERIA FOR THE CONSUMER

by
Allen F. Hurford

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ACCEPTANCE SAMPLING CRITERIA FOR THE CONSUMER

THE CONSUMER'S "RISK"

The specification of attributes sampling plans by reference to MIL-STD-105A has the distinct disadvantage to the consumer in that the probability of lot acceptance is determined not only by the specified AQL but also by the lot size. (Note: This criticism also applies to certain variables sampling plans.) Consequently, the protection afforded by a specified AQL is directly proportional to the lot size. An examination of the OC curves in MIL-STD-105A in this regard indicates that the LTPD may vary by a factor of two within a relatively small range of lot sizes for a fixed AQL.

LTPD AND MIL-STD-105A

This dependence on lot size may be avoided through the use of a maximum allowable LTPD value in the consumer's quality specification. As a matter of convenience for the supplier it is also desirable to specify a maximum allowable AQL since the majority of available sampling plans are designed around AQL tables. This method of specifying acceptance criteria, in effect, defines quality limits for both the producer and consumer risks.

MIL-STD-105A may be used in conjunction with the specified maximum AQL and LTPD by selecting a sampling plan whose AQL and LTPD do not exceed the specified values. This procedure should be applied without regard to lot size and is reasonably accurate except in those cases of relatively small lot sizes--in which case the hypergeometric distribution should be used to compute the actual OC curve.¹

Table I is presented as a convenient means of selecting the appropriate sampling plan since it avoids the necessity of comparing the various OC curves in MIL-STD-105A. The use of this table is illustrated for the case where AQL = 0.25 per cent maximum and LTPD = 2.5 per cent maximum. In this case, either of the following plans satisfies these acceptance criteria: $N = 225$, $c = 2$ or $N = 110$, $c = 0$. The choice in this case would be determined by the inspection agency with due regard to the process average for the test requirement.

¹Wiesen, J. M., Extension of Existing Tables of Attributes Sampling Plans, Sandia Corporation Technical Memorandum 146-56-51, July 5, 1956.

Selecting the LTPD

Since the LTPD corresponds to a 10-per cent probability of lot acceptance, it is a quality level which is acceptable for 10 per cent of the lots. The selection of the LTPD, therefore, should be related to the criticality of the test requirement and its desired reliability. The difficulty in selecting a value of LTPD to provide an economical sampling plan arises from the consumer's lack of information regarding reliability values and the supplier's process average for each test requirement. On the other hand, since the criticality of test requirements has been associated with AQL values, the selection of the AQL is usually straightforward (if not quite arbitrary!)--although not necessarily related to process averages or reliability values.

Assuming there is no information available which can be used to qualify the value of the LTPD, it is recommended that the LTPD be selected at ten times the specified AQL value. The use of a 10:1 discrimination ratio is based on the following:

If the process average equals the AQL, the average outgoing quality (AOQ) will be:

$$\underline{AOQ \approx 0.95 \times AQL} \quad (1)$$

(Note: In this case, it is assumed that the AQL is the quality level for which the probability of lot acceptance is 95 per cent.)

In the case of Equation 1, this value of AOQ may be termed the "acceptable average outgoing quality" or "AAOQ" since it corresponds to the acceptable quality level (AQL).

On the other hand, if the process average equals the LTPD, the AOQ will be:

$$AOQ \approx 0.10 \times LTPD \quad (2)$$

In order that the value of AOQ in Equation 2 may also be "acceptable", i. e., equal to the "AAOQ" (although not necessarily as economical), Equation 2 is equated to Equation 1 with the result that the LTPD to provide this condition should be:

$$LTPD = 9.5 \times AQL \quad (3)$$

Since the probability of lot acceptance varies from 80 to 98 per cent for the AQL in MIL-STD-105A, Equation 3 can be modified to provide a 10:1 ratio as a matter of convenience in using MIL-STD-105A.

Example of LTPD versus Lot Size Control on AOQ

Figure 1 presents a comparison of AOQ curves to illustrate the effect of different discrimination ratios upon the AOQ. In this case, the Δ AOQ is the absolute difference in average outgoing quality between the AQL and LTPD. In the case of Curve 1, where the $LTPD = 10 \times AQL$, the Δ AOQ is relatively small. By comparison, Curve 2 shows the effect of an uncontrolled discrimination ratio upon the Δ AOQ. Under "normal" use, Curve 2 would be applicable to MIL-STD-105A for an AQL = 0.25 per cent, Inspection Level II, normal inspection, for lot sizes through 800. On the other hand, Curve 1 normally would not apply until the actual lot size reached 3201 to 8000. (Note: These AOQ curves are only approximate since they were computed directly from OC curves in MIL-STD-105A.)

If it is possible to specify the LTPD in terms of the maximum amount of unreliability, the AQL should be set at 1/10 of the LTPD. In cases where the LTPD is less than 1 per cent,

it may not be possible to maintain this ratio. In this case, the AQL should be set at the process average (assuming it is less than the LTPD).

The use of a 10:1 discrimination ratio is suggested only as a guide and should not be used without due regard to its effect on the resulting amount of sampling required. For example, if the AQL is 0.25 per cent and the LTPD is set at 2.5 per cent, a sample of 225 would be required per Table I. On the other hand, if we allow the LTPD to equal 2.6 per cent, the sample size would decrease to 150--an appreciable savings for one tenth of a per cent!

THE CONSUMER'S NEED

The sampling plans available in MIL-STD-105 are not necessarily the most economical for applying the preceding acceptance criteria since the amount of sampling usually will be greater than necessary. Excess sampling can be avoided by use of plans designed to meet exactly the specified acceptance requirements. In this and other respects, MIL-STD-105A continues to be of less value to the consumer of components required for reliable military end-use. The need for a MIL-STD sampling plan which reflects not only the producer's ability but also the consumer's need for a controlled discrimination ratio is apparent.

ALLEN F. HURFORD - 1451-1

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August 8, 1957

TABLE I
SINGLE SAMPLING BY ATTRIBUTES (MIL-STD-105A)

n	AQL%		AQL%		AQL%		AQL%		AQL%		AQL%		AQL%		AQL%		AQL%		AQL%	
	0.10		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10.0	
	c	LTPD	c	LTPD	c	LTPD	c	LTPD	c	LTPD	c	LTPD	c	LTPD	c	LTPD	c	LTPD	c	LTPD
2																			0	70.0
3																			0	55.0
5															0	38.0				
7													0	28.0					1	45.0
10									0	13.0							1	35.0	2	45.0
15								0	9.0						1	25.0	2	32.0	3	40.0
25					0	6.0					1	10.5	2	12.8	3	18.0	5	25.0	7	32.0
35			0	4.5					1	7.8	2	10.3	3	12.7	4	16.0	6	22.0	9	28.0
50							1	5.2	2	7.0	3	8.8	4	10.3	6	13.0	9	19.0	13	25.0
75	0	2.1			1	3.5	2	4.8	3	6.0	4	7.5	6	9.3	8	12.0	12	16.3	18	22.5
110			1	2.6	2	3.5	3	4.4	4	5.5	5	6.2	8	8.9	11	11.0	17	15.8	24	21.0
150			2	2.5	3	3.0	4	3.6	5	4.0	8	5.9	11	7.5	17	10.2	24	14.0	34	19.0
225	1	1.25	3	2.3	4	2.7	5	3.1	7	3.8	10	5.0	14	6.8	20	9.2	32	13.6	44	18.0
300	2	1.20	4	1.8	5	2.0	7	2.6	10	3.5	14	4.6	20	6.1	29	8.3	43	11.8	62	16.4
450	3	0.90	6	1.4	8	1.7	11	2.3	15	2.7	20	3.6	31	5.3	45	7.4	68	10.7	98	14.9
750	5	0.65	9	1.2	13	1.3	18	1.7	25	2.2	35	2.9	56	4.8	81	6.3	124	9.4	184	13.6

↓ = Use First Sample and LTPD Below Arrow.

↑ = Use First Sample and LTPD Above Arrow.

n = Size of the Sample.

c = Acceptance Number.

LTPD Values in Per Cent.

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