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Agricultural Marketing Service

Specialty Crops Program

Specialty Crops Inspection Division

AIM Management Series

Cumulative Sum Sampling Plan (CUSUM) Attributes Standards Only

October 2017

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Cumulative Sum Sampling Plan (CUSUM) Attributes Standards Only
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INTRODUCTION

This document is designed as a reference document to give guidance to Specialty Crops Inspection Division personnel of the United States Department of Agriculture (USDA) in applying the Cumulative Sum Sampling Plan (CUSUM) for Attributes Standards Only in on-line inspection applications.

Compliance with the Agricultural Marketing Service (AMS) guidelines does not excuse failure to comply with the Food, Drug, and Cosmetic Act or any other applicable Federal or State laws or regulations. SCI Division of the Specialty Crops Programs (SCP), AMS is responsible for grading/inspecting, audits and standardization programs of fresh and/or processed fruits and vegetables and related products. The legal authority for grading, auditing, and standardization activities are the Agricultural Marketing Acts of 1936 and 1946, as amended.

Applicants may obtain inspections of any fresh and/or processed fruit and vegetable and related products for which they have a financial interest. The inspection service is voluntary and self-supporting, and is offered on a fee-for-service basis.

GUIDE FOR ELECTRONIC USAGE

The AIM system of instructional manuals is available electronically in Adobe Acrobat Portable Document Format (PDF) at the following intranet address: https://ems-team.usda.gov/sites/AMS/AMS-SCI/AIM/SitePages/Home.aspx.

When accessed electronically, AIM materials have hyperlinks and hypertext (visible as underlined blue text) available to the PDF user. Clicking on a hyperlink takes the reader to a web site with information relating to the subject. Hypertext links the reader to a different page within the current manual, or a different manual, with information relating to the subject. For example, the hypertext in the Table of Contents allows a reader to go directly to the section of interest in the manual by clicking on the section title.

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- A series of options will become available,
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STATISTICAL EXPLANATION OF ON-LINE SAMPLING PROCEDURES

A “lot” is never formed under an on-line inspection situation. Instead, production is divided into separate portions (e.g., tote bins, period codes, sub-codes, etc.). Each portion is inspected and assigned a grade as it is produced. The grade is final. This procedure frees the producer to ship directly off the line. The Cumulative Sum (CuSum) Sampling Plan was developed to handle on-line inspection.

CuSum is designed to maintain a constant good quality, rather than to screen out poor quality-after it has been produced. Therefore, the producer is requested to establish the desired quality level for production. CuSum will tell only whether the production meets or fails the intended grade. It is not structured to discern between different quality levels.

The producer is provided with step-by-step reporting as each sample unit is graded. This information may be used to help the producer control the process. Positive CuSum values (in excess of zero (0)) provide evidence of worsening quality. This signals the need for improvement. The ability to abuse the CuSum sampling plan by intentionally producing poorer quality, after establishing a history of good quality, is limited.

CuSum sampling plans

A CuSum sampling plan is defined by three numbers, denoted by the letters “T,” “L,” and “S.” These values are chosen for each AQL and sample unit size to pass 95% of the production produced at the Acceptable Quality level (AQL). Individual portions of production will have, at most, a 98 percent to 99.5% chance of passing when the CuSum value is zero (0).

Sample unit tolerance (“T”)

The “T” value is the sample unit tolerance. A portion of production represented by a sample unit having “T” or less defects will always pass the intended grade. Only the number of defects that exceed “T” are counted and accumulated by the CuSum plan. If the number of defects is less than “T,” the CuSum accumulation will be decreased.

Acceptance limit (“L”)

Some sample units may have more than “T” defects, even though the producer has good quality. This will occur due to sample variation. However, when the CuSum value exceeds “L,” the production quality is probably below the intended grade. Only those portions of production represented by sample units whose CuSum value exceeds 'L' are rejected for the designated grade.

There may be portions of production with good quality that fail the designated grade. This risk will be present with any sampling plan because of sampling variation. Also, poor production may be passed for the intended grade because our sample information does not provide sufficient proof that the quality is poor. This is also due to sampling variation.

Starting value ("S")

At the start of a CuSum value, no prior information is available about the production quality. To give production approximately a 95% chance of passing at the start of each plan, the CuSum value is set equal to "S." Starting the CuSum value at any value other than "S," would make the sampling plan either too tight or too loose for the first portions of production produced at the AQL.

CuSum sampling plans are designed to be continuous sampling plans with infrequent restarts. There is no need to restart a CuSum sampling plan unless there is a distinct break in production or a re-designation of the grade. A CuSum sampling plan does not necessarily need to be restarted at the beginning of each shift or each day's production.

Resetting to zero (0)

Whenever the CuSum value is less than zero, it is reset equal to zero. This rule prevents the buildup of too much good history, which would permit the acceptance of poorer quality later in a production run. If negative CuSum values were maintained, the number of defects that would be permitted in subsequent sample units would be large. There is no specific absolute limit (AL) given for any individual sample unit by the CuSum sampling plan. By always resetting to zero (0), when the CuSum is negative, the maximum allowance for any sample unit becomes "T" plus "L."

Resetting to "L"

The CuSum value is reset to "L," when it exceeds "L." This requires the next sample unit to meet the tolerance ("T" or less defects) for production to pass the designated grade. By resetting to "L," the producer is also assured that all portions of production will pass the designated grade if the sample unit has "T" or less defects.

Production which fails the designated grade

When a portion of production fails the designated grade, it is necessary to assign a lower grade. A single sampling plan is used to determine the lower grade. The same sample unit results are used without recalculations. The sample size is the sample unit size for the CuSum sampling plan. The acceptance number is the sum, "T" plus "L," for the next lower grade. If the number of defects in the sample unit does not exceed "T" plus "L," the production is assigned that lower grade. Usually, when production fails the designated grade, it will pass the next lower grade.

Two (2) consecutive sample unit failure rule

Small sample sizes are used to make grading decisions for on-line inspection, due to time and costs of inspection. Thus, the CuSum sampling plan may allow some poorer quality to pass for the designated grade. The single sampling plan is even looser than the CuSum sampling plan. It permits the maximum number ("T" plus "L") of defects in each sample unit. This creates a situation where production is designated grade A, but quality is actually grade B or worse. The

single sampling plan gives production even a greater chance of passing. In this situation a producer could take advantage of the CuSum sampling plan for the designated grade, and the single sampling plan for the lower grades.

To improve the accuracy of the on-line sampling procedure, and to discourage possible intentional abuse, a two (2) consecutive failure rule has been added to the on-line plan. When two successive portions of production have failed the designated grade, the quality level has probably dropped below the designated grade. If production is at the AQL, the probability of two consecutive failures is less than 1.0%. This rule will seldom be used unless production quality has actually slipped below the designated grade.

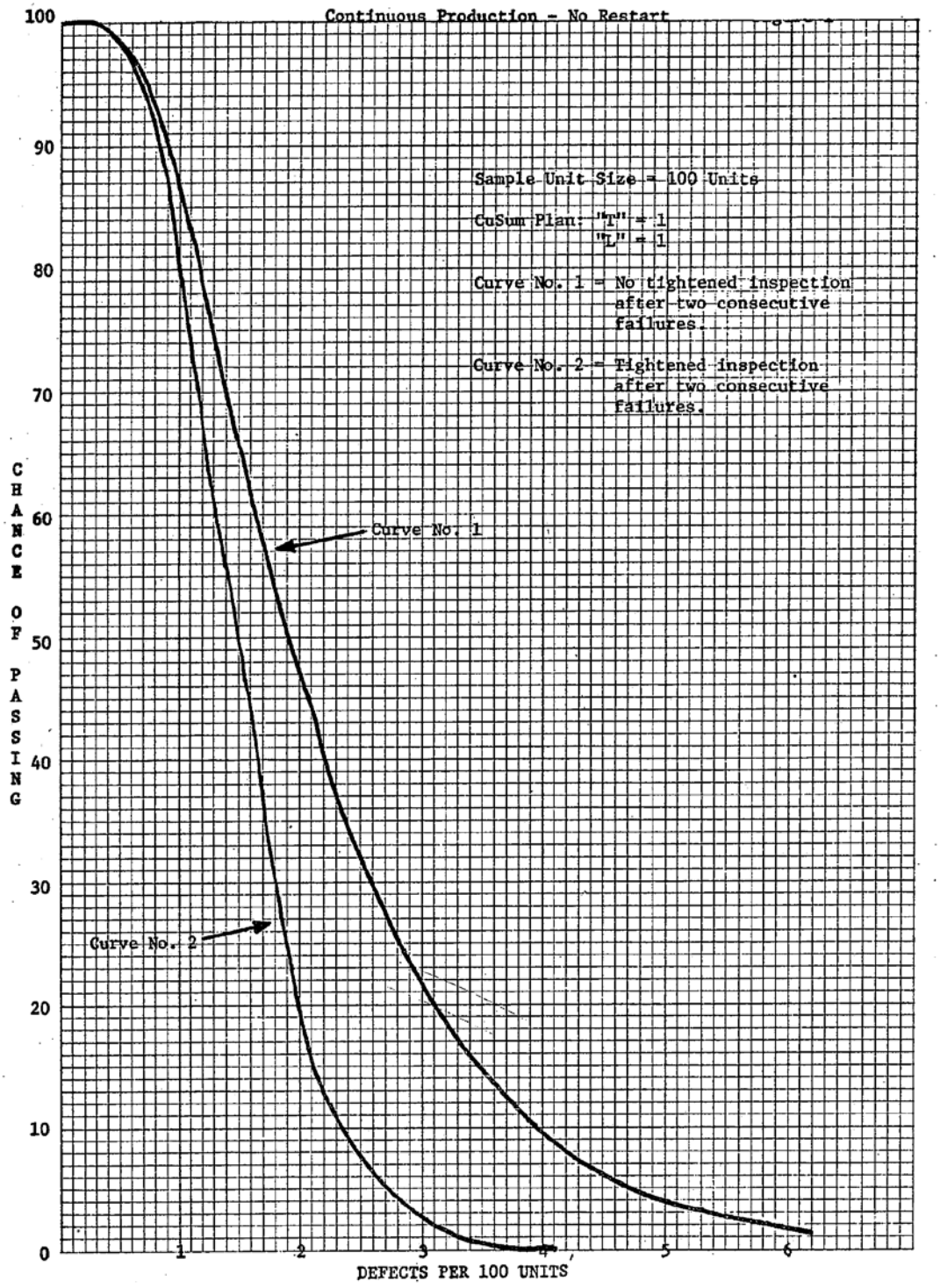
Inspection for the designated grade may resume when three consecutive sample units meet the sample tolerance, "T," for each class of defects in the designated grade and the CuSum value is zero "O" in the lower grade. This requirement is similar to the CuSum sampling plan, where the sample unit following a failure must meet the tolerance, for the production to pass the designated grade. In most situations, the production represented by the three consecutive sample units within the tolerance may be recovered for the designated grade (see Appendix I, step A).

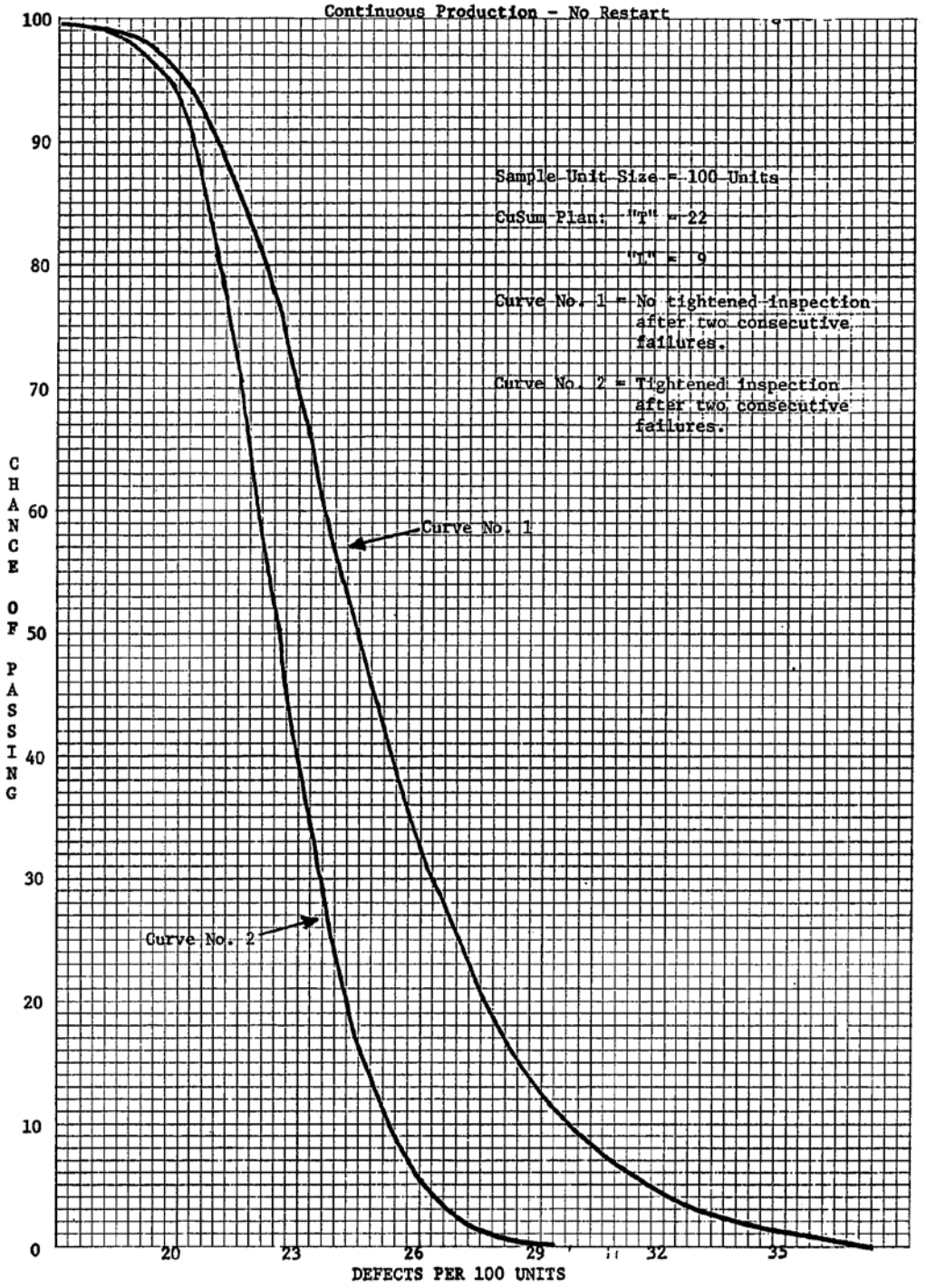
The effect of the two consecutive failure rule on the CuSum sampling plan being used for the designated grade is illustrated in the OC curves shown in the graphs in this manual. The OC curves show comparison of the CuSum sampling plan with the two consecutive failure rule for a small AQL (1 defect per 100 units) and a larger AQL (20 defects per 100 units). This rule tightens the CuSum sampling plan on quality levels which exceed the AQL. The chance of passing at the AQL has only a small decrease. The two consecutive failure rule reduces the chance of accepting poor quality for the designated grade with a minimal chance at the AQL.

Assigning a grade to production

In a true on-line inspection situation, each portion of production which is represented by a sample unit is separately identifiable. The on-line sampling procedures assign a grade to each portion of production. However, in our on-line inspection, each portion of production will often not be separately identified due to the costs and time loss in changing codes. All production with the same code must be assigned the same grade, since the portions that are graded differently cannot be identified. All production that is similarly coded must receive the lowest grade assigned to any portion of production using that code. This is to protect the buyer or consumer.

The producer would obtain the greatest benefit from the CuSum sampling plan by separately identifying each portion of production. If the code is not changed for each portion of production, the risks of failing the designated grade are increased. Each producer must weigh these increased risks against the costs to determine how frequently codes should be changed.


Continuous Production - No Restart
Sample Unit Size = 100 Units
CuSum Plan: "h" = 1
"L" = 1
Curve No. 1 = No tightened inspection after two consecutive failures.
Curve No. 2 = Tightened inspection after two consecutive failures.
Curve No. 1
Curve No. 2
CHANCE OF PASSING
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
DEFECTS PER 100 UNITS


Continuous Production - No Restart
Sample Unit Size = 100 Units
CuSum Plan: "r" = 22
"h" = 9
Curve No. 1 = No tightened inspection after two consecutive failures.
Curve No. 2 = Tightened inspection after two consecutive failures.
Curve No. 1
Curve No. 2
CHANCE OF PASSING
100
90
80
70
60
50
40
30
20
10
0
20
23
26
29
32
35
DEFECTS PER 100 UNITS

HOW TO CHOOSE THE APPROPRIATE CUSUM SAMPLING PLANS

A. Use the U.S. standards or other applicable specifications for the product.

Example: "U.S. Standards for Grades of Canned Clingstone Peaches"

or

"_____ Foods, Inc., Product Specifications for Canned Clingstone Peach Halves, effective _____."

B. Use the applicable AQLs for the designated grade.

Example:

	U.S. GRADE B			
	TOTAL	MAJOR	SEVERE	CRITICAL
AQL[1]	20.0	12.5	5.0	1.0

or

"_____ Foods, First Label Canned Clingstone Peach Halves will conform to the effective U.S. Standards for Grades of Canned Clingstone Peaches with the following modifications:"

	TOTAL	MAJOR	SEVERE	CRITICAL
AQL[1]	15.0	10.0	5.0	1.0

[1] AQLs expressed as defects per 100 units.

Example:

	Defect Action Level					
	5	10	12	15	20	25
	Positive Fields					
S	0	1	0	1	0	1
T	1	2	3	3	5	6
L	1	3	2	3	2	3
AQL[2]	2.5	6.5	8.5	10.0	15.0	20.0

C. Use the applicable standard sample unit size.

Example: "7 CFR 52.38b Recommended Sample Unit Sizes.

Halves; Quarters -- 25 units"

or

"_____ Foods, Inc., Specification.

SAMPLE UNIT SIZE:

Draw 25 halves at 30 minute intervals."

D. Select the CuSum values ("S," "T," "L") from the Regulations 7 CFR 52.38a which may be found at the following internet address: http://www.access.gpo.gov/nara/cfr/cfr-table-search.html#page1 or other procedures that match the AQL and the standard sample unit size.[3]

[2] AQLs expressed as percent defective.
[3] CuSum values will usually be preprinted on the defect tally sheets.

Example:

TABLE VII
CUSUM SAMPLING PLANS

STANDARD SAMPLE UNIT SIZE = 25

AQL	S	T	L	Quality Levels Pa=50%	Pa=10%
QUALITY LEVELS EXPRESSED AS DEFECTS PER HUNDRED UNITS OR PERCENT DEFECTIVE					
* * *					
---------Critical					
-- 1.0	0	0.5	0.5	4.0	10.0
* * *					
---------Severe					
-- 5.0	1.5	1.5	3	9.1	16.3
* * *					
QUALITY LEVELS EXPRESSED AS DEFECTS PER HUNDRED UNITS ONLY					
* * *					
---------Major					
-- 12.5	1	4	3	21.0	32.4
* * *					
---------Total					
-- 20.0	1	6	4	29.7	42.7
* * *					

E. If the AQL specified in the U.S. standards or other specification is not available in the "Regulations," do the following:

Use the next AQL in the "Regulations" that is on the restrictive side of the designated grade (or designated AQL).

Example:

	U.S. GRADE B			
	TOTAL	MAJOR	SEVERE	CRITICAL
AQL[4]	26.0	11.0	3.0	0.75

adjust to the following AQLs

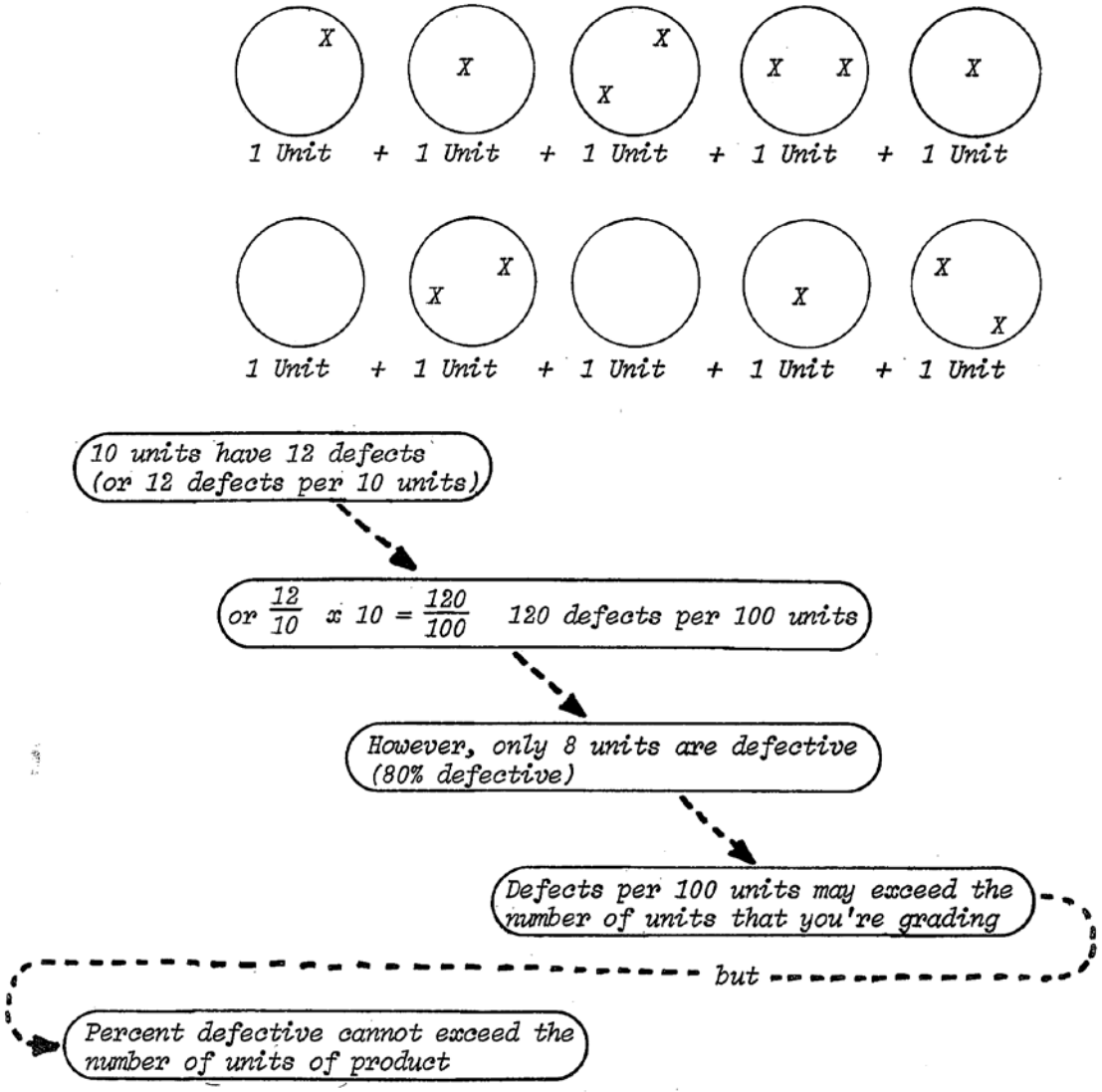
	U.S. GRADE B			
	TOTAL	MAJOR	SEVERE	CRITICAL
AQL[4]	25.0	10.0	2.5	0.65

Accept or reject based on the adjusted AQLs.

[4] AQLs expressed as defects per 100 units.

HOW TO DETERMINE THE DIFFERENCE BETWEEN DEFECTS PER HUNDRED UNITS AND PERCENT DEFECTIVE

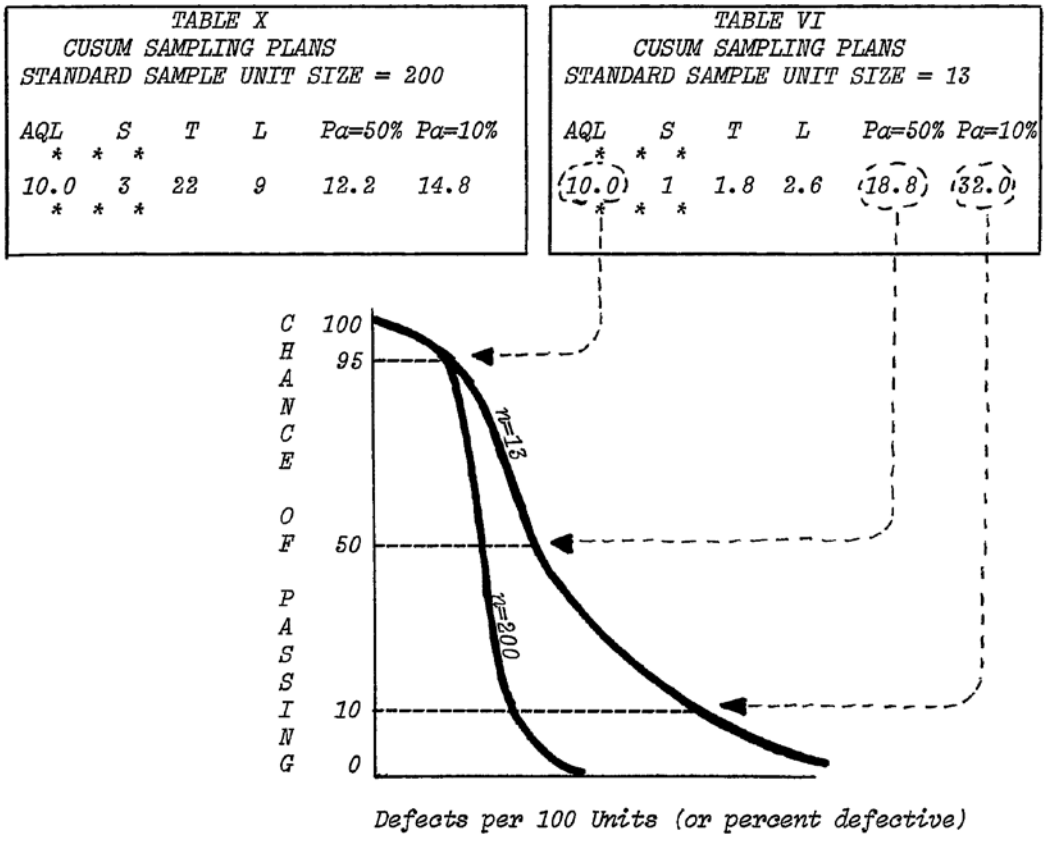
Example: (each X represents one defect)



HOW TO USE THE PROBABILITY OF ACCEPTANCE ("PA")

The CuSum sampling plans in the Code of Federal Regulation give the probability of acceptance (Pa) at the 50/50 level and at the 10/90 level in defects per 100 units (or percent defective) for each indexed AQL. The probability of acceptance will change if the standard sample unit size is increased or decreased. The larger the sample unit size, the better the protection against poorer quality production. However, the larger sample unit sizes increase the time and costs of inspection. The U.S. standards will recommend which sample unit size to use.

Example: Relationship of Pa to the OC Curve



HOW TO COMPUTE CUSUM VALUES

At the beginning of the basic inspection period, set the CuSum value equal to the Starting value ("S") for each class of defects ("critical," "severe," "major," and "total all classes") of the designated grade. Compute the CuSum value for each sample unit as follows:

A. Add the number of defects (or defectives) in the sample unit that you're working with to the CuSum value (carry over) from the previous sample unit.

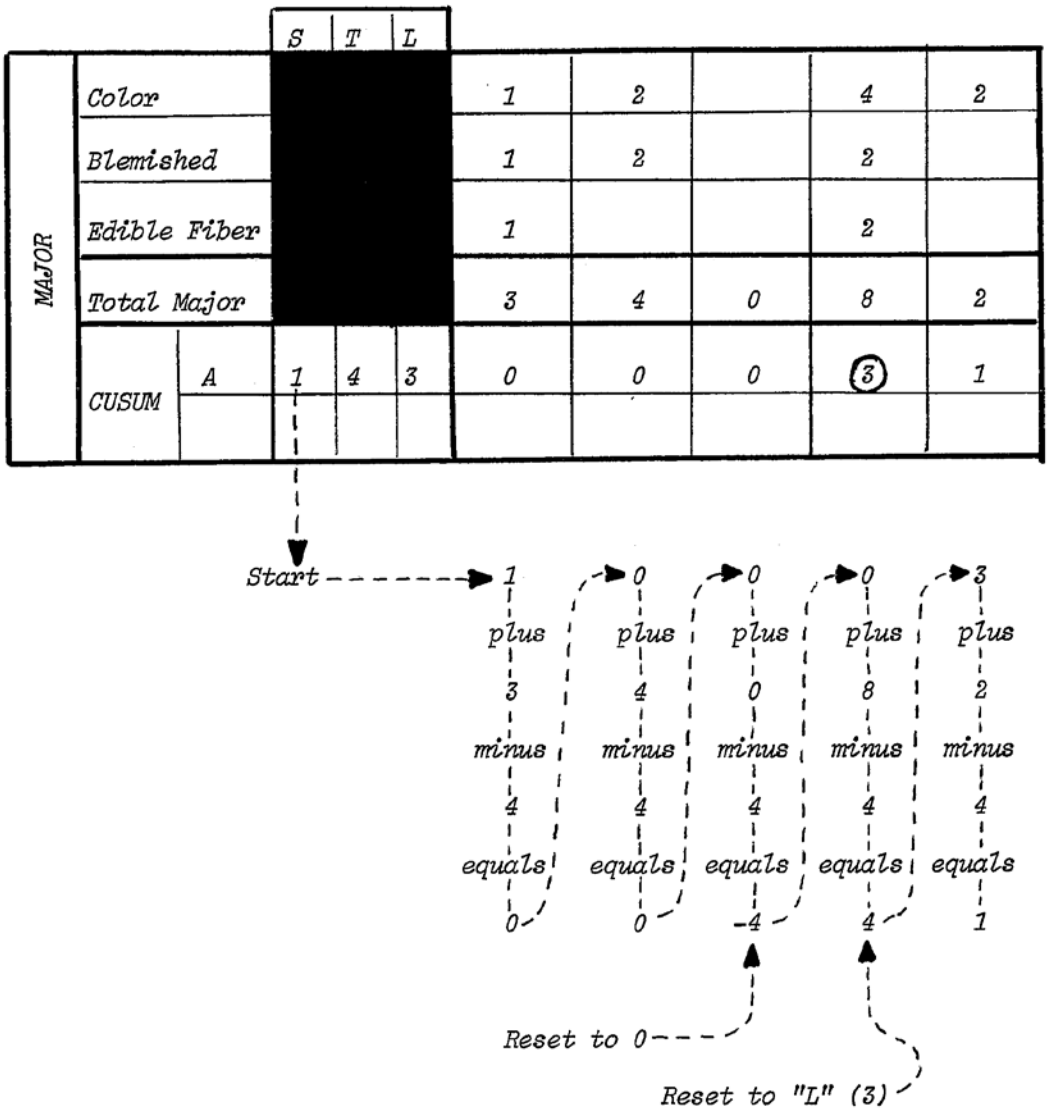
B. Subtract the Sample Unit Tolerance ("T").

Reset the CuSum value in the following situations:

1. When the CuSum value is less than zero (0), reset the CuSum value to zero (0).

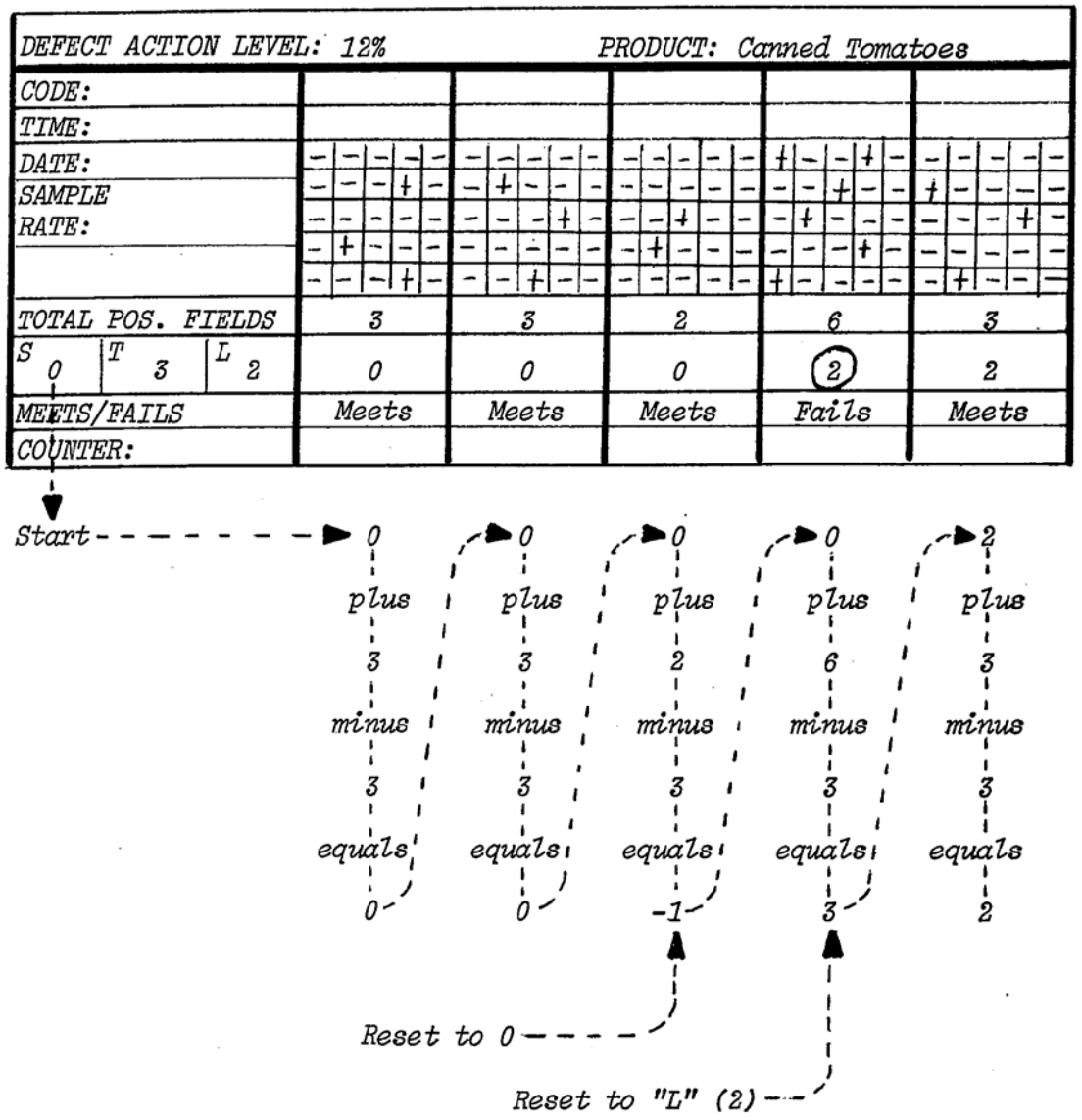
2. When the CuSum value exceeds the Acceptance Limit ("L"), reset the CuSum value to ("L").

Example 1: (showing only major defects)



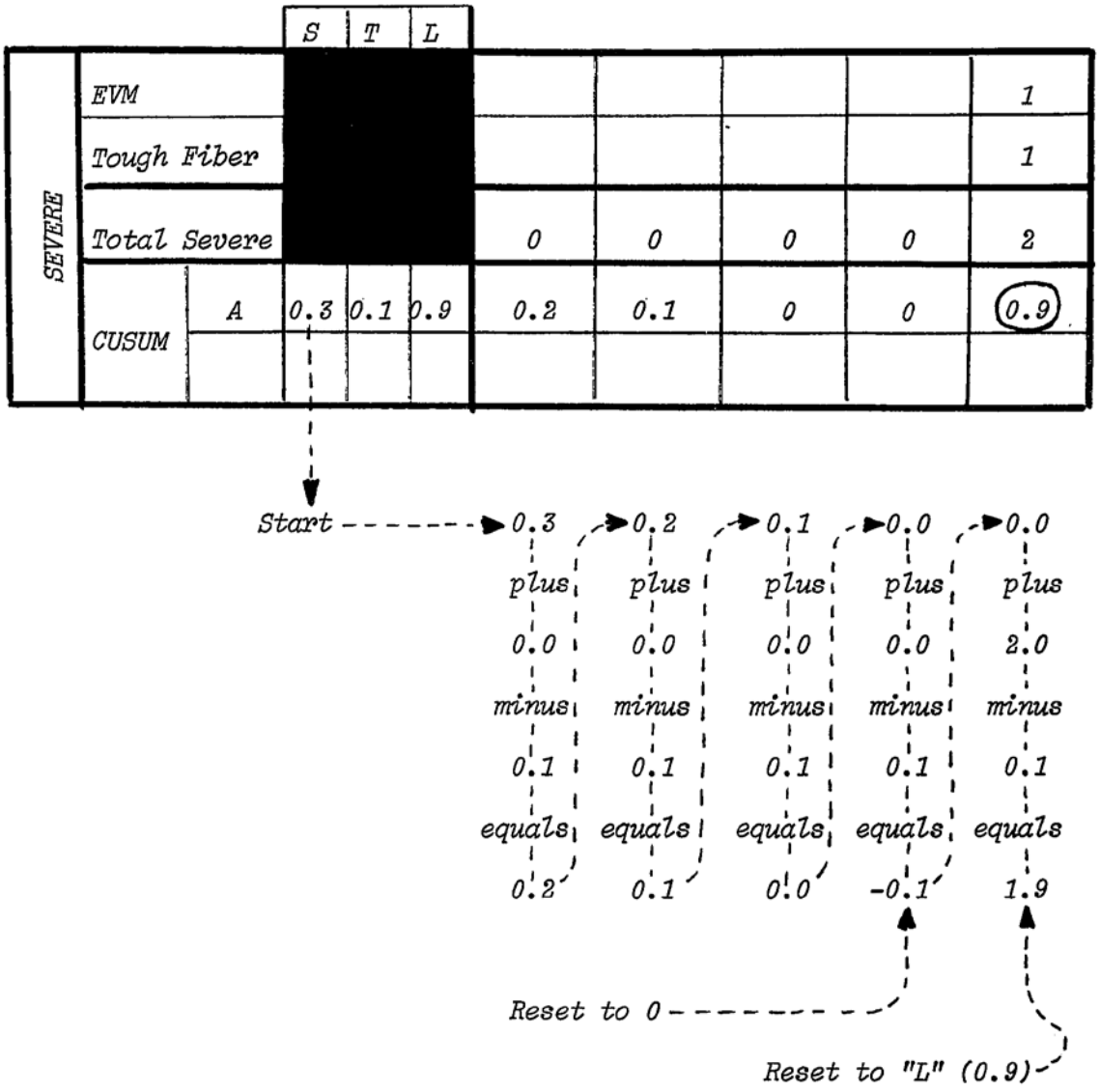
FORMULA: Carry Over (Old CuSum) + Defects - Tolerance = New CuSum

Example 2: showing only mold count record



FORMULA: Carry Over (Old CuSum) + Defects - Tolerance = New CuSum

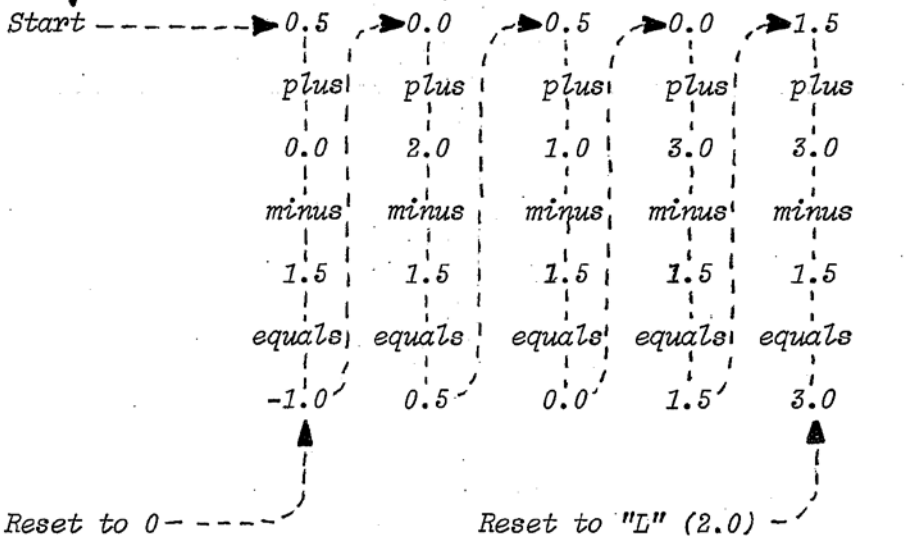
Example 3: decimal fractions showing only severe defects



FORMULA: Carry Over (Old CuSum) + Defects - Tolerance = New CuSum

Example 4: decimal compound fractions showing only major defects

			S	T	L					
MAJOR	Blemished						1	1	1	1
	Off-suture								1	1
	Gouge						1		1	1
	Total Major					0	2	1	3	3
	CUSUM	A	0.5	1.5	2.0	0	0.5	0	1.5	2.0



FORMULA: Carry Over (Old CuSum) + Defects - Tolerance = New CuSum

Example 5: showing all classes of defects

			S	T	L						
CRITICAL	Pit Material							1	1		2
	Total Critical					0	0	1	1	0	2
	CUSUM	A	0.5	0.5	1.5	0	0	0.5	1	0.5	1.5
SEVERE	Color						1	1			
	Blemished							1		1	
	Total Severe					0	1	2	0	1	0
	CUSUM	A	1	1	2	0	0	1	0	0	0
MAJOR	Character					2			2	1	4
	Gouge					1		2	1	1	4
	Total Major					3	0	2	3	2	8
	CUSUM	A	1	4	3	0	0	0	0	0	3
MINOR	Off-suture					3	1	2	6	1	
	Short Stem					2	3	4	4	4	
	Total Minor					5	4	6	10	5	0
TOTAL	Total All Classes					8	5	11	14	8	10
	CUSUM	A	1	9	4	0	0	2	4	3	4

Reset to "L"

FORMULA: Carry Over (Old CuSum) + Defects - Tolerance = New CuSum

HOW FREQUENTLY TO DRAW THE STANDARD SAMPLE UNIT SIZE FOR INSPECTION

Use the time sampling plan outlined in the AIM Instruction Series, Sampling Manual. Draw the sample unit so that only the inspector can predict the actual time of sampling. Do not fall into a predictable time-frame sampling.

Acceptable sampling frequencies are: high volume, medium volume, low volume, optional rate, pallet by pallet, and tote by tote inspection. See also Appendix I, section B, Tote bin inspection (or other large units such as drums), steps B and D, tote by tote inspection and modification of sampling frequency.

HOW TO EVALUATE A SAMPLE UNIT

Prerequisite quality factors.

Evaluate and record each prerequisite quality factor which is applicable for the product (overall appearance, flavor and odor, etc.). Prerequisites are recorded as either "A," "B," "C" or Substandard.[5]

Classified defects

A. Determine and record the number of defects of each kind and class in the appropriate boxes indicated for the defects;

B. Count the total number of classified defects for each class (minor, major, severe, and critical);

C. Record the number of defects in each class in the appropriate boxes opposite "Total Critical," "Total Severe," "Total Major," and "Total minor";

D. Add the total number of classified defects found in all classes in the sample unit and record this number opposite "Total All Classes."

Other defects, if any

Some U.S. standards may have defects that are not classified as minor, major, severe, or critical. Count and record these defects as instructed by the grading manual for each product.

[5] Consider prerequisites independently of the classified defects. Therefore, record the prerequisites as the actual grade that they are assigned and not the designated grade. This is important if tally sheets are later reevaluated to determine if production has met a special specification, such as a buyer's spec.

How to inspect production

Step 1. Meets designated grade

If the CuSum value is less than or equal to the Acceptance Limit ("L") for all classes of defects, the portion of production represented by that sample unit meets the requirements of the designated grade.

Example 1: Designated grade A showing only critical defects

			S	T	L					
CRITICAL	Pit Material						1			
	Total Critical					0	1	0	0	0
	CUSUM	A	0.2	0.2	0.8	0	0.8	0.6	0.4	0.2
		B	0.5	0.5	1.5					

Meets →

Example 2: Designated grade B showing only total defects

			S	T	L					
TOTAL	Total All Classes					10	14	0	16	10
	CUSUM	A	1	8	3					
		B	2	12	5	0	2	0	4	2

Meets →

Example 3: Designated grade B showing all classes of defects

			S	T	L						
CRITICAL	EVM					1			3		1
	Total Critical					1	0	0	3	0	1
	CUSUM	A	0	1	1						
		B	1	2	2	0	0	0	1	0	0
		C	1	3	3						
SEVERE	Tough Fiber						1	2			1
	Blemished						1	1	1	1	
	Total Severe					0	2	3	1	1	1
	CUSUM	A	0.5	1.5	2						
		B	1	3	3	0	0	0	0	0	0
		C	1	5	3						
MAJOR	Edible Fiber					1	2	2		2	1
	Blemished						2	2	1	2	1
	Total Major					1	4	4	1	4	2
	CUSUM	A	1	3	3						
		B	1	5	3	0	0	0	0	0	0
		C	1	6	4						
MINOR	Damaged					2	4	4	3	1	1
	Blemished					2	4	2	2	1	1
	Total Minor					4	8	6	5	2	2
	Total All Classes					6	14	13	10	7	6
TOTAL	CUSUM	A	1	6	4						
		B	2	12	5	0	2	3	1	0	0
		C	2	17	7						
						Meets					

Step 2. Fails designated grade

If the CuSum value exceeds the Acceptance Limit ("L") for one of more classes of defects, the portion of production represented by that sample unit fails requirements of the designated grade.

A. Determine if the sample units meets or fails lower grades:

1. Do not recalculate CuSum; and

2. Use the sum of T+L, applicable to the lower grade, as the acceptance number for the failed sample unit (maximum number of defects permitted).

Example 1: Designated grade A showing only major defects

			S	T	L	Fails	Meets			Fails
MAJOR	Color					5	2	1	1	12
	Gouge					3	1	1		
	Total Major					8	3	2	1	12
	CUSUM	A	1	3	3	**3**	3	2	0	**3**
		B	1	6	4	**B**				
		C	1	9	4					**C**

Meets grade B (T+L=10) Meets grade C (T+L=13)

Example 2: Designated grade A showing only severe defects

			S	T	L	Meets				Fails
MAJOR	EVM					1				3
	Uncolored							1		2
	Total Severe					1	0	1	0	5
	CUSUM	A	0	0.5	0.5	0.5	0	0.5	0	0.5
		B	0.4	0.8	1.6					
		C	1.5	1.5	1.5	3				

SSTD

Fails grade B (T+L=2.4) Fails grade C (T+L=4.5)

Example 3: (Designated grade B showing all classes of defects)

			S	T	L						
CRITICAL	EVM					2	2	1	1	5	1
	Total Critical					2	2	1	1	5	1
	CUSUM	A	0	1	1						
		B	1	2	2	1	1	0	0	(2)	1
		C	1	3	3					**C**	
SEVERE	Tough Fiber					1	4	1	1	1	1
	Blemished						3	1	1	1	
	Total Severe					1	7	2	2	2	1
	CUSUM	A	0.5	1.5	2.0						
		B	1	3	3	0	(3)	2	1	0	0
		C	1	5	3		C				
MAJOR	Edible Fiber					2	3	2	3	3	2
	Blemished					2	2	2	2	2	2
	Total Major					4	5	4	5	5	4
	CUSUM	A	1	3	3						
		B	1	5	3	0	0	0	0	0	0
		C	1	6	4						
MINOR	Damaged					1	1		4	4	2
	Blemished					1	1	1		4	2
	Total Minor					2	2	1	4	8	4
TOTAL	Total All Classes					9	16	8	12	20	10
	CUSUM	A	1	6	4						
		B	2	12	5	0	4	0	0	(5)	3
		C	2	17	7					**C**	
						Meets	Fails	Meets		Fails	Meets

Step 3. Two (2) sample units in a row fail the designated grade.

If the CuSum value for 2 sample units in a row exceeds a specified Acceptance Limit ("L") of the designated grade for any class of defects:

A. Inspect subsequent production at the lowest grade of the two consecutive failing sample units;

1. Start CuSum equal to "S" of the lower grade for all classes of defects;

2. Calculate CuSum at the lower grade for all classes of defects;

B. Resume inspection for the designated grade only when three (3) consecutive sample units;[6]

1. Are zero (0) CuSum value in the lower grade;

2. And the number of defects in each sample unit is less than or equal to the tolerance ("T") of the designated grade for all classes of defects;

C. Restart CuSum equal to "S" of the designated grade for any production which follows the three consecutive sample units that meet.

Exception: Step 3 does not apply to prerequisites.

Example 1: (does not count as 2 in a row)

Sample Unit Number----------	1	2	3	4	5	6
Prerequisites:						
Overall appearance	A	B	A	A	B	A
Flavor and odor	A	A	A	A	A	B
Classified defects: (After computing the CuSum value and assigning a grade)	A	A	B	A	A	A
Sample Unit Grade	A	B	B	A	B	B

[6] See also Appendix I, step 1of this manual (recovery of step 3 failure)

Example 2: Designated grade A showing only severe defects

			S	T	L						
SEVERE	Total Severe					2	2	0	0	0	0
	CUSUM	A	0	0.5	0.5	0.5	0.5				0
		B	0.4	0.8	1.6	B	B	0	0	0	
		C	1.5	1.5	3.0						

2 in a row fail grade A

Start CuSum at "S" of grade B

3 in a row meet (0) CuSum at the lower grade and defects do not exceed "T" of the designated grade

Start CuSum at "S" of the designated grade and resume inspection at grade A for all following production.

Example 3: (Designated grade B showing total all classes of defects)

			S	T	L									
SEVERE	Total All Classes					17	24	20	18	16	17	15	16	17
	CUSUM	A	2	12	5	Fails B								
		B	2	17	7	2	7	7					1	1
		C	3	22	9		C	C	0	0	0	0		

2 in a row fail grade B

Start CuSum at "S" of grade C

3 in a row meet (0) CuSum at the lower grade and defects do not exceed "T" of the designated grade.

Start CuSum at "S" of the designated grade and resume inspection at grade B for all following production.

Example 4: Designated grade A showing only major defects

			S	T	L									
MAJOR	Total Major					9	8	14	28	10	8	8	6	9
	CUSUM	A	1	8	4	2	2	4	4					2
		B	2	12	5			B		B				
		C	2	17	7									

Fails A

SSTD

2 in a row fail grade A

Inspect at the lowest grade of the 2 sample unit failures.
Ignore computations for SSTD

3 in a row do not exceed "T" of the designated grade

Start CuSum at "S" of the designated grade and resume inspection at grade A for all following production

Example 5: Designated grade A showing all classes of defects

Production Code															
PRE.	Overall Color				A	A	A	A	A	A	A	A	A		
	Flavor and Odor				A	A	A	A	A	A	A	A	A		
	Peel (Area)				A	A	A	A	A	A	A	A	A		
			S	T	L										
CRITICAL	Pit Material								1						
	Total Critical				0	0	0	1	0	0	0	0	0		
	CUSUM	A	0.3	0.1	0.9	0.2	0.1	0					0.2	0.1	
		B	0	0.5	0.5				0.5	0	0	0			
		C	0	1	1										
SEVERE	EVM					1	1								
	Off-suture												1		
	Total Severe					1	1	0	0	0	0	0	1	0	
	CUSUM	A	0	0.5	0.5	0.5	0.5	0					0.5	0	
		B	0	1	1		B		0	0	0	0			
		C	0.5	1.5	2.0										
MAJOR	Color					1	1	2			1				
	Gouge					1		2					1		
	Total Major					2	1	4	0	0	1	0	1	0	
	CUSUM	A	0	1	1	1	1	1					0	0	
		B	1.5	1.5	3.0			B	0	0	0	0			
		C	0	3	2										
MINOR	Short Stems								1						
	Blemished					1			1	1	1			1	
	Total Minor					1	0	0	2	1	1	0	0	1	
TOTAL	Total All Classes					4	2	4	3	1	2	0	2	1	
	CUSUM	A	1	2	3	3	3	3					1	0	
		B	1	3	3			B	1	0	0	0			
		C	1	5	3										
Sample Unit Grade						← Fails →									
Production Grade															

D. Re-designation of production grade

If the grade of production is re-designated:

1. To a higher grade;

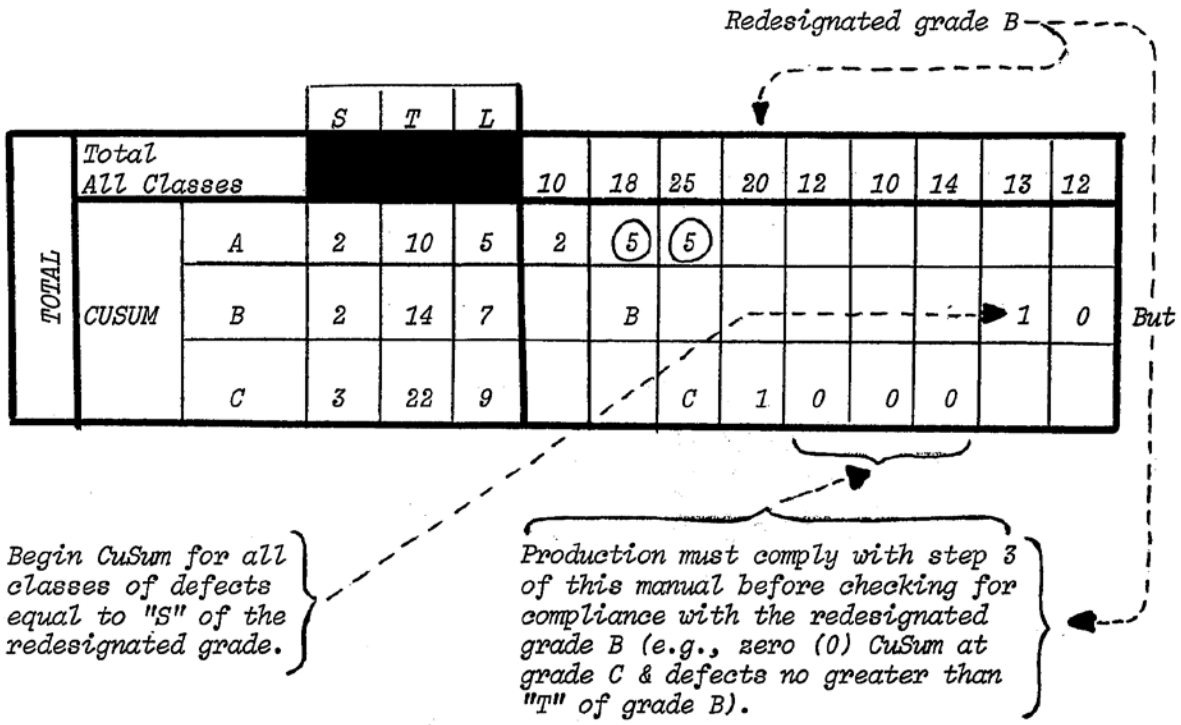
   a. Begin CuSum for all classes of defects at the “S” value of the higher grade;

2. To a lower grade;

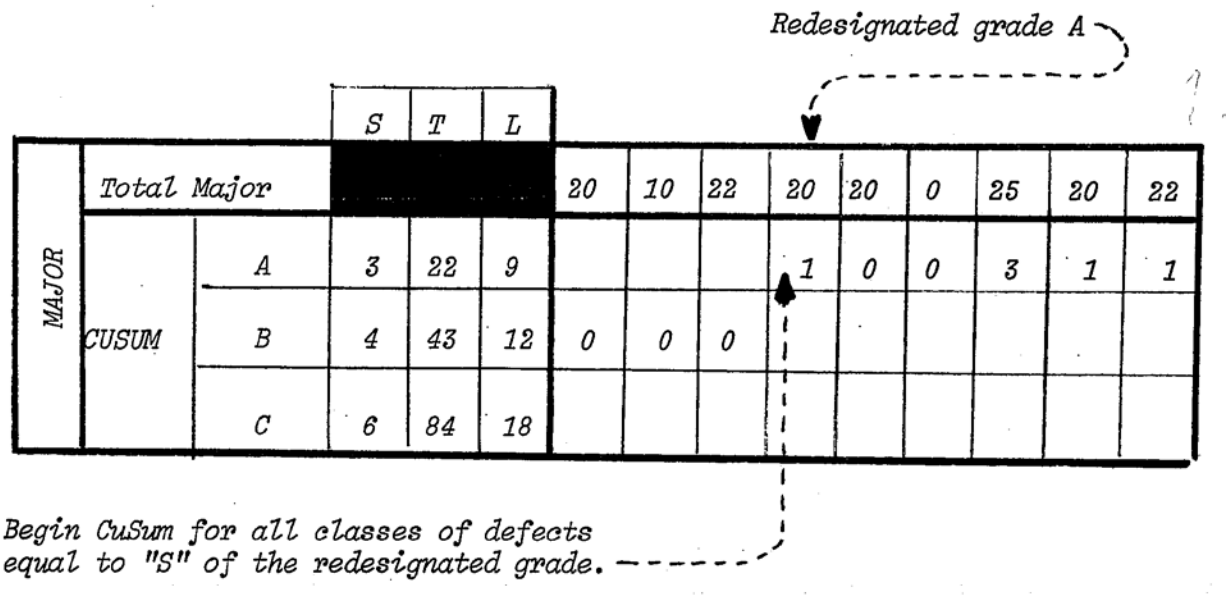
   a. Begin CuSum for all classes of defects at the “S” value of the lower grade.

Re-designation of the production grade does not remove the restrictions placed on production by step 3.

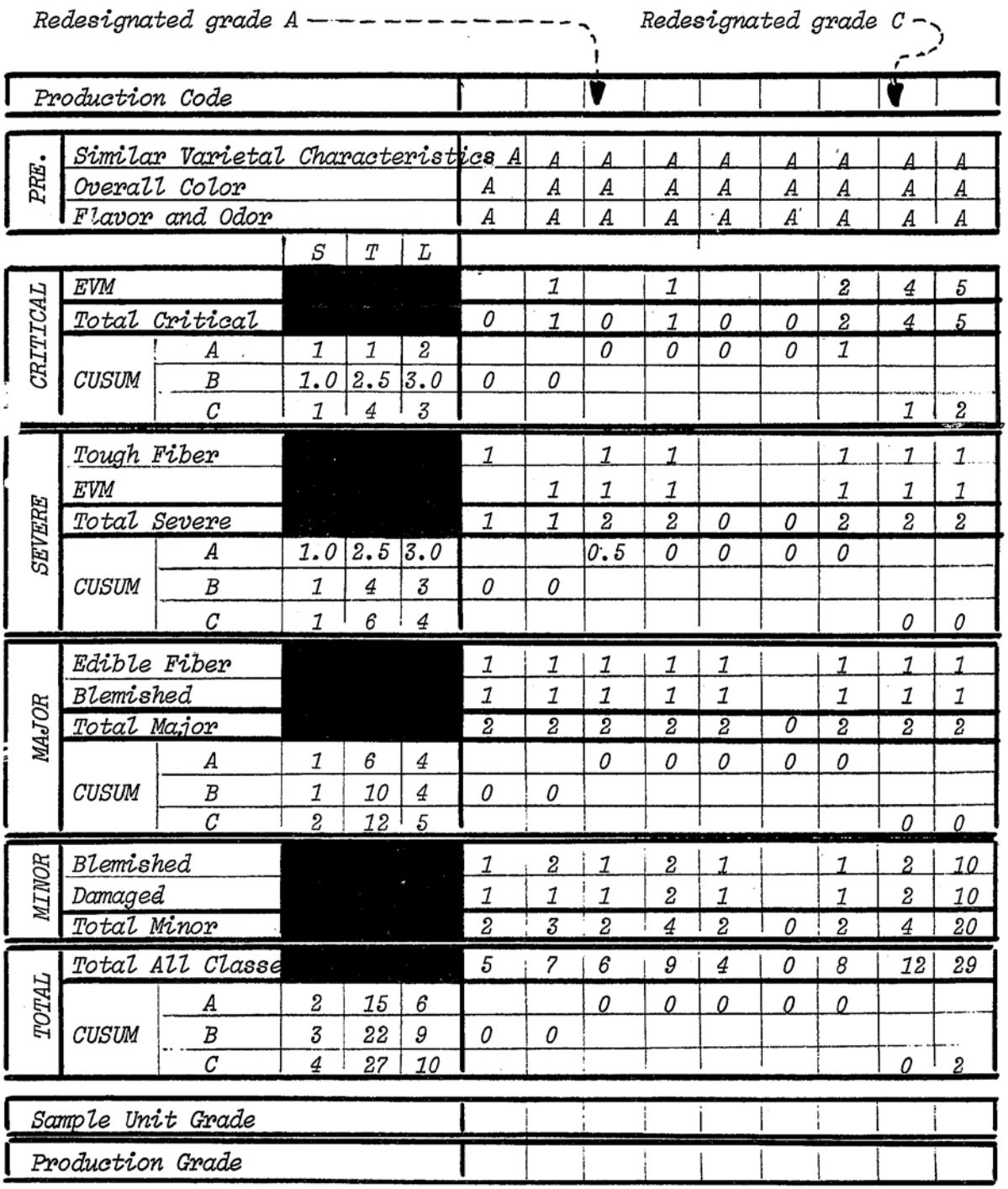
Example 1: Re-designated grade B showing total all classes of defects.



Example 2: Re-designated grade A showing only major defects.



Example 3: Re-designation of grade showing all classes of defects.



			S	T	L									
Production Code														
PRE.	Similar Varietal Characteristics					A	A	A	A	A	A	A	A	A
	Overall Color					A	A	A	A	A	A	A	A	A
	Flavor and Odor					A	A	A	A	A	A	A	A	A
CRITICAL	EVM						1		1			2	4	5
	Total Critical					0	1	0	1	0	0	2	4	5
	CUSUM	A	1	1	2			0	0	0	0	1		
		B	1.0	2.5	3.0	0	0							
		C	1	4	3								1	2
SEVERE	Tough Fiber					1		1	1			1	1	1
	EVM						1	1	1			1	1	1
	Total Severe					1	1	2	2	0	0	2	2	2
	CUSUM	A	1.0	2.5	3.0			0.5	0	0	0	0		
		B	1	4	3	0	0							
		C	1	6	4								0	0
MAJOR	Edible Fiber					1	1	1	1	1		1	1	1
	Blemished					1	1	1	1	1		1	1	1
	Total Major					2	2	2	2	2	0	2	2	2
	CUSUM	A	1	6	4			0	0	0	0	0		
		B	1	10	4	0	0							
		C	2	12	5								0	0
MINOR	Blemished					1	2	1	2	1		1	2	10
	Damaged					1	1	1	2	1		1	2	10
	Total Minor					2	3	2	4	2	0	2	4	20
TOTAL	Total All Classe					5	7	6	9	4	0	8	12	29
	CUSUM	A	2	15	6			0	0	0	0	0		
		B	3	22	9	0	0							
		C	4	27	10								0	2
Sample Unit Grade														
Production Grade														

E. Assigning a grade to production

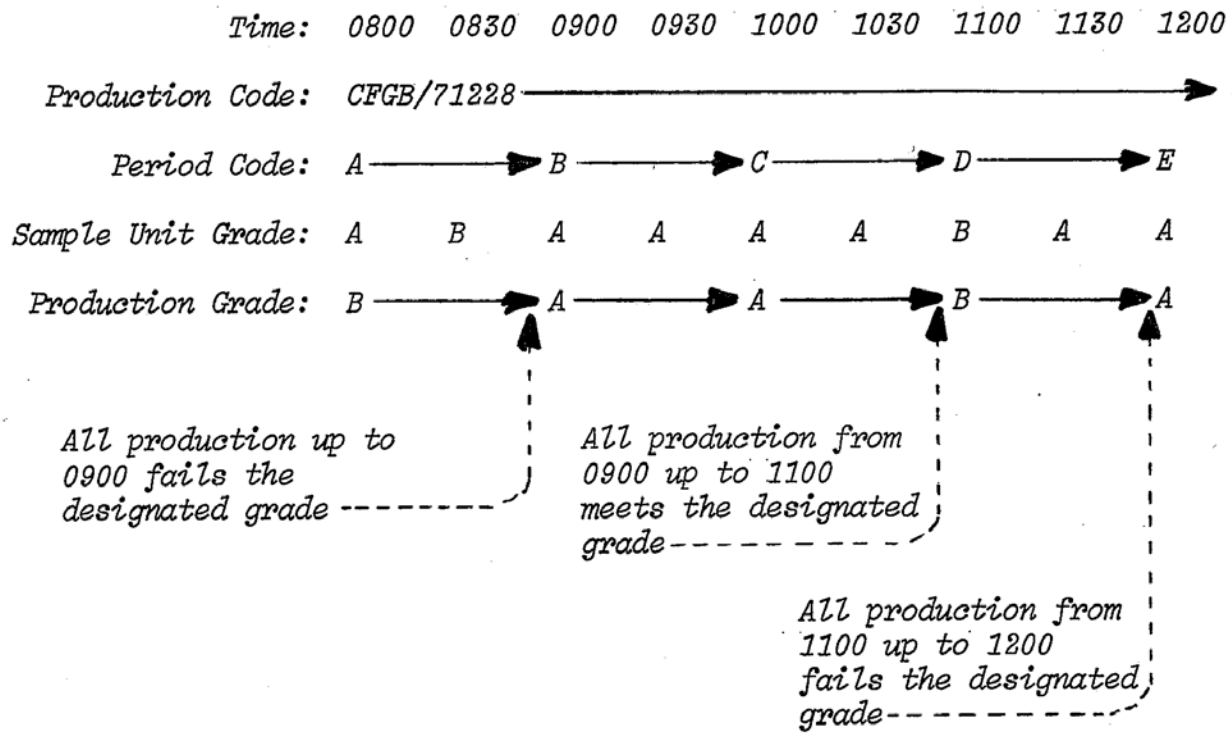
When similarly coded production is represented by more than one sample unit, the grade for that production is determined as follows:

1. If each portion of production (period code, sub-code, tote bin, pallet, label, drum, etc.) is acceptable for the designated grade, all of the production is accepted for the designated grade.

2. If any portion of production is not acceptable for the designated grade, all of that portion of production fails the designated grade.

3. A portion of production may be accepted by one sample unit grade.

Example 1: Designated grade A showing only code segregation policy.



Example 2: Designated grade A showing all classes of defects

Production Code					A →			B →			C →			
PRE.	Overall Color				A	A	A	A	A	(B)	A	A	A
	Flavor and Odor				A	A	A	A	A	A	A	A	A
	Peel (Area)				A	A	A	A	A	A	A	A	A
			S	T	L									
CRITICAL	Pit Material									1				
	Total Critical					0	0	0	0	0	1	0	0	0
	CUSUM	A	0.3	0.1	0.9	0.2	0.1	0	0	0	0.9	0.8	0.7	0.6
		B	0	0.5	0.5									
		C	0	1	1									
SEVERE	EVM							1						
	Off-suture									1				
	Total Severe					0	0	1	0	1	0	0	0	0
	CUSUM	A	0	0.5	0.5	0	0	0.5	0	0.5	0	0	0	0
		B	0	1	1									
		C	0.5	1.5	2									
MAJOR	Color							1						
	Gouge						1	1				1		
	Total Major					0	1	2	0	0	0	1	0	0
	CUSUM	A	0	1	1	0	0	1	0	0	0	0	0	0
		B	1.5	1.5	3									
		C	0	3	2									
MINOR	Short Stems					1			1					1
	Blemished					1	1	1	2	1	1	0	1	1
	Total Minor					2	1	1	3	1	1	0	1	2
TOTAL	Total All Classes					2	2	4	3	2	2	1	1	2
	CUSUM	A	1	2	3	1	1	3	(3)	3	3	2	1	1
		B	1	3	3				B					
		C	1	5	3									
Sample Unit Grade						A-	A	A	B	A	B	A	A	A
Production Grade						A →			B →			A →		

Example 3: Designated grade B showing all classes of defects

Redesignated grade A ---------- Redesignated grade C

			S	T	L	X1	X2	X3	X4	X5	X6	X7	X8	X9
Production Code						X1	X2	X3	X4	X5	X6	X7	X8	X9
PRE.	Similar Varietal Characteristics					A	A	A	A	A	A	A	A	A
	Overall Color					A	A	A	A	A	(B)	A	A	A
	Flavor and Odor					A	A	A	A	A	A	A	A	A
CRITICAL	EVM					1		1		1		1		6
	Total Critical					1	0	1	0	1	0	1	0	6
	CUSUM	A	1	1	2			1	0	0	0	0	0	
		B	1.0	2.5	3	0	0							
		C	1	4	3									3
SEVERE	Tough Fiber					1						1	1	2
	EVM					1		1	1			1		5
	Total Severe					2	0	1	1	0	0	2	1	7
	CUSUM	A	1.0	2.5	3			0	0	0	0	0	0	
		B	1	4	3	0	0							
		C	1	6	4									2
MAJOR	Edible Fiber					1		1	1			1	2	
	Blemished					1		1	1			4	2	2
	Total Major					2	0	2	2	0	0	5	4	2
	CUSUM	A	1	6	4			0	0	0	0	0	0	
		B	1	10	4	0	0							
		C	2	12	5									0
MINOR	Blemished					3		1	2	2	2	1	1	1
	Damaged					2		1	2	2	2	1	1	1
	Total Minor					5	0	2	4	4	4	2	2	2
TOTAL	Total All Classes					10	0	6	7	5	4	10	7	17
	CUSUM	A	2	15	6			0	0	0	0	0	0	
		B	3	22	9	0	0							
		C	4	27	10	-								0
Sample Unit Grade						B	B	A	A	A	B	A	A	C
Production Grade						B →		A →			B	A →		C

APPENDIX I

A. Recovery of production which follows a step 3 failure.

When production fails the designated grade for 2 sample units in a row, inspection cannot be resumed for the designated grade until 3 consecutive sample units are zero (0) CuSum value at the lower grade and defects do not exceed "T" of the designated grade (see step C of this manual, page 23).

Production represented by the 3 consecutive sample units that meet may be recovered and assigned the designated grade, provided, that:

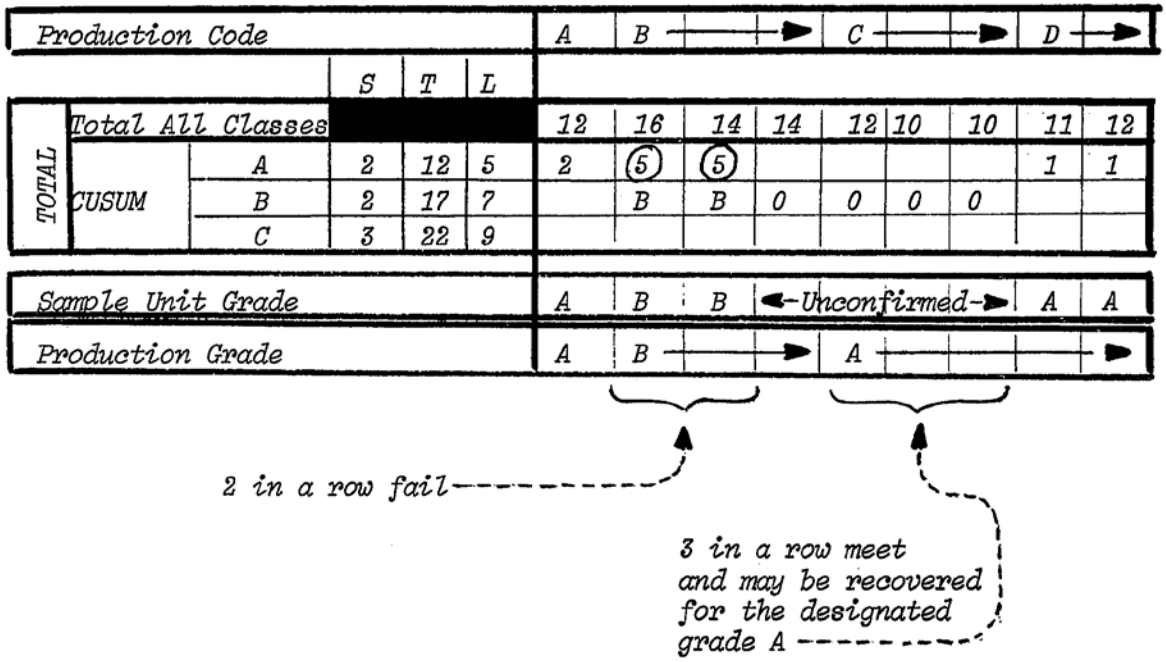
1. The code (period code, sub-code, tote, pallet, label, drum, etc.) is changed often enough to separate passing production from failing production;

2. The production in question is capable of being recovered and is not buried in the warehouse or freezer storage (e.g., frozen peas stored in silos probably cannot be recovered);

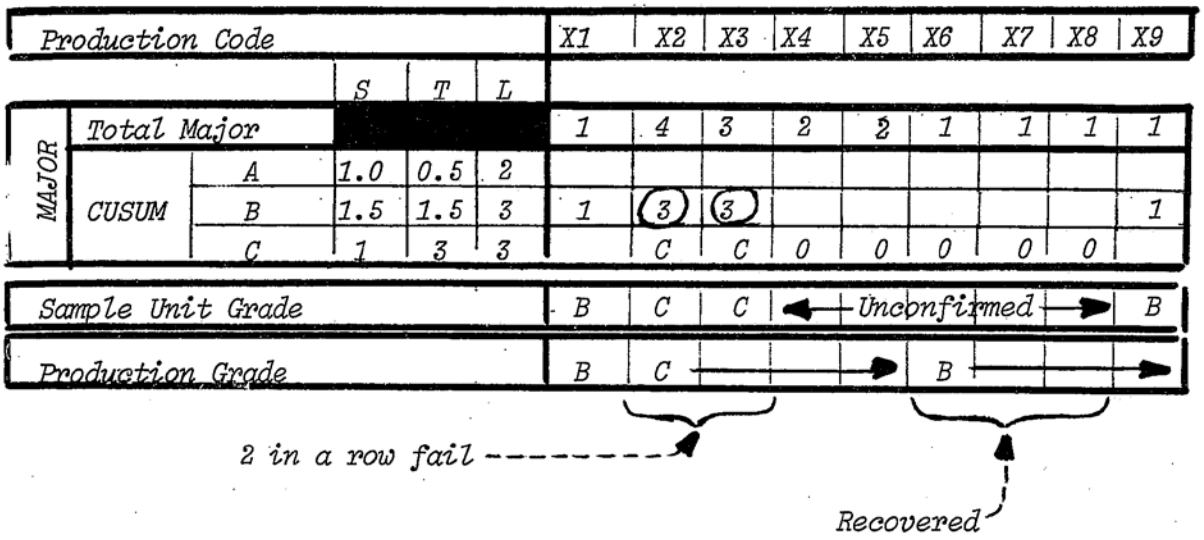
3. The tally sheet is recorded in a manner which will verify that the production may be recovered; and

4. The production meets step C of this manual, page 23.

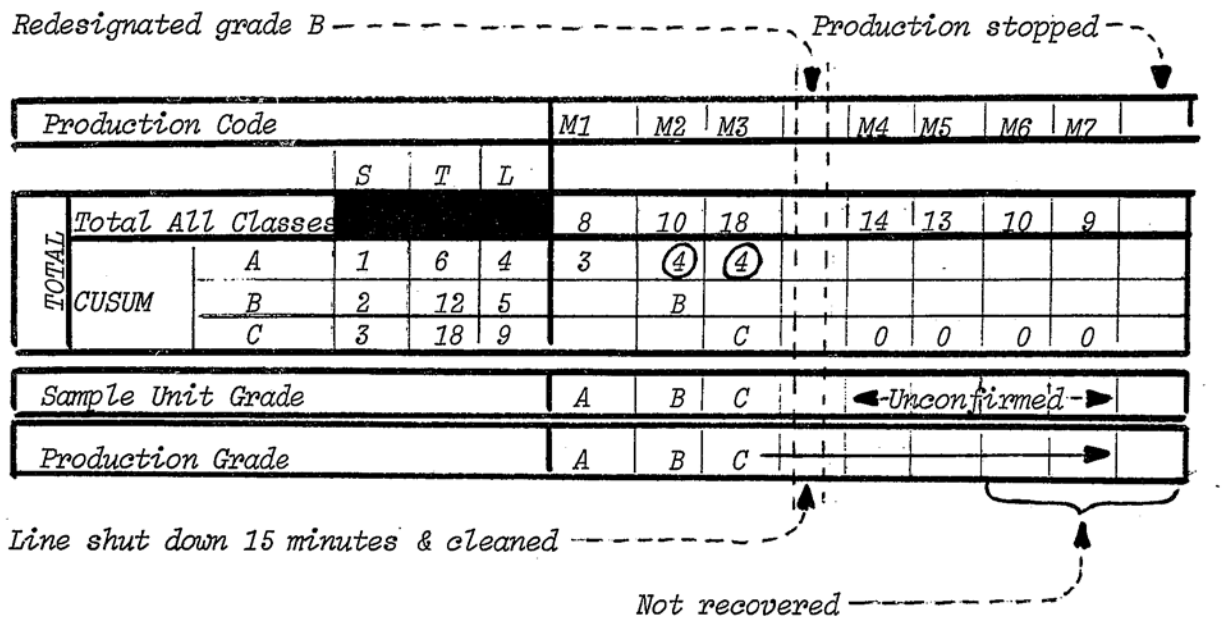
Example 1: (Designated grade A showing only total defects)



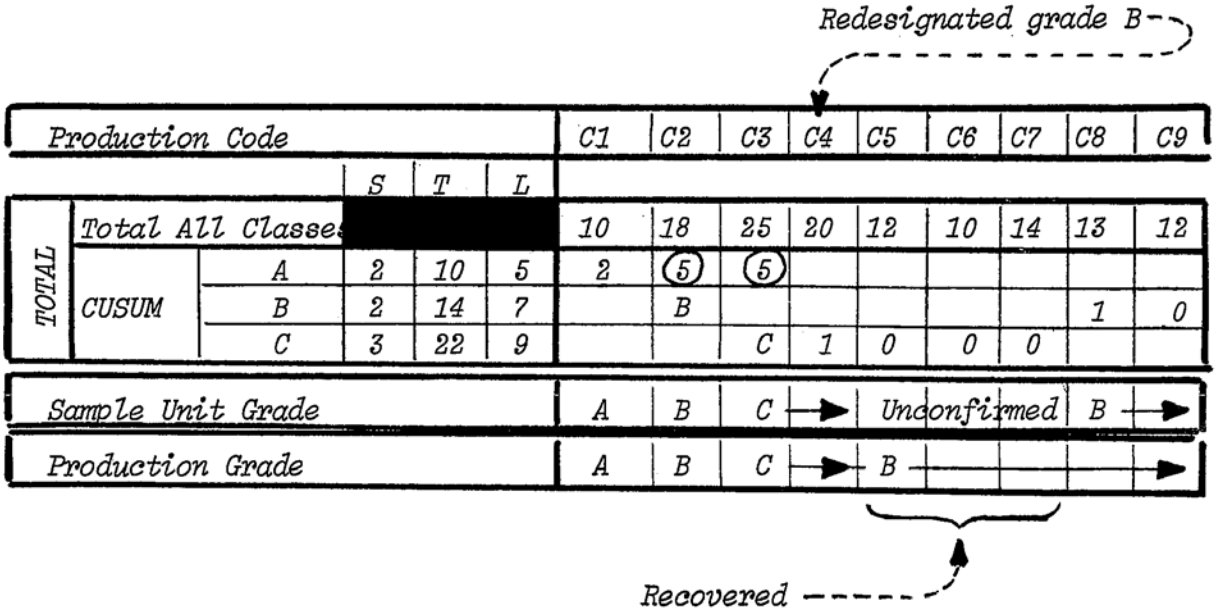
Example 2: Designated grade B showing only major defects.



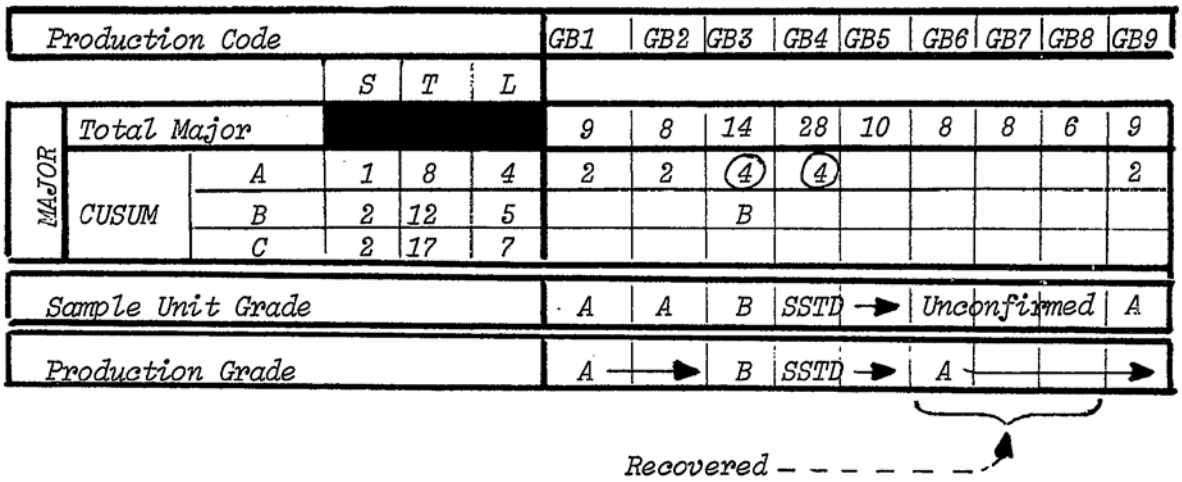
Example 3: Designated grade A showing only total defects



Example 4: Re-designated grade B following 2 failures in a row.



Example 5: Recovery of Substandard



B. Tote bin inspection (or other large units such as drums).

For tote bin inspection or drum inspection, use the procedure as described in this manual (steps 1 through 5, and Appendix I). Totes and drums may be inspected on a unit-by-unit basis, if the applicant desires.

The standard sample unit size (200 green beans, 50 peas, 100 strawberries, etc.) may be drawn at random from the container or a composite may be drawn from each unit selected for sampling.

1	1/3 of sample unit from top tier	1
tote	1/3 of sample unit from mid-tier	sample
or drum	1/3 of sample unit from bottom tier	unit

Tote-by-tote or drum-by-drum inspection does not change the requirements for production as outlined under step 3 of this manual. If two totes in a row fail the designated grade, 3 units in a row must comply with step 3 before production may be returned to the designated grade.

Example 2: Designated grade A showing only total defects.

Tote Bin or Drum No.	BK1	BK2	BK3	BK4	BK5	BK6	BK 7	BK8	BK9

			S	T	L									
TOTAL	Total All Classes					10	10	5	8	25	5	8	7	35
	CUSUM	A	1	8	4	3	4	1	1	4	1	1	0	4
		B	2	14	7			B						
		C	3	22	9			C						

Sample Unit Grade	A	B	A	---	C	A	---	---	SSTD

Production Grade	A	B	A	----	C	A	---	---	SSTD

Example 3: Designated grade A showing only total defects

Tote Bin or Drum No.	C5	C10	C15	C20	C25	C30	C35	C40	C45

			S	T	L									
TOTAL	Total All Classes					6	12	12	6	5	0	6	4	5
	CUSUM	A	1	6	4	1	(4)	(4)				1	0	0
		B	2	12	5		B	B	0	0	0			
		C	3	18	9									

Sample Unit Grade	A	B	B	UNCONFIRMED			A	A	A

Production Grade	A	B	B	A	A	A	A	A	A

Sample unit drawn every 5th container. Thus, 10 thru 19 are grade B.

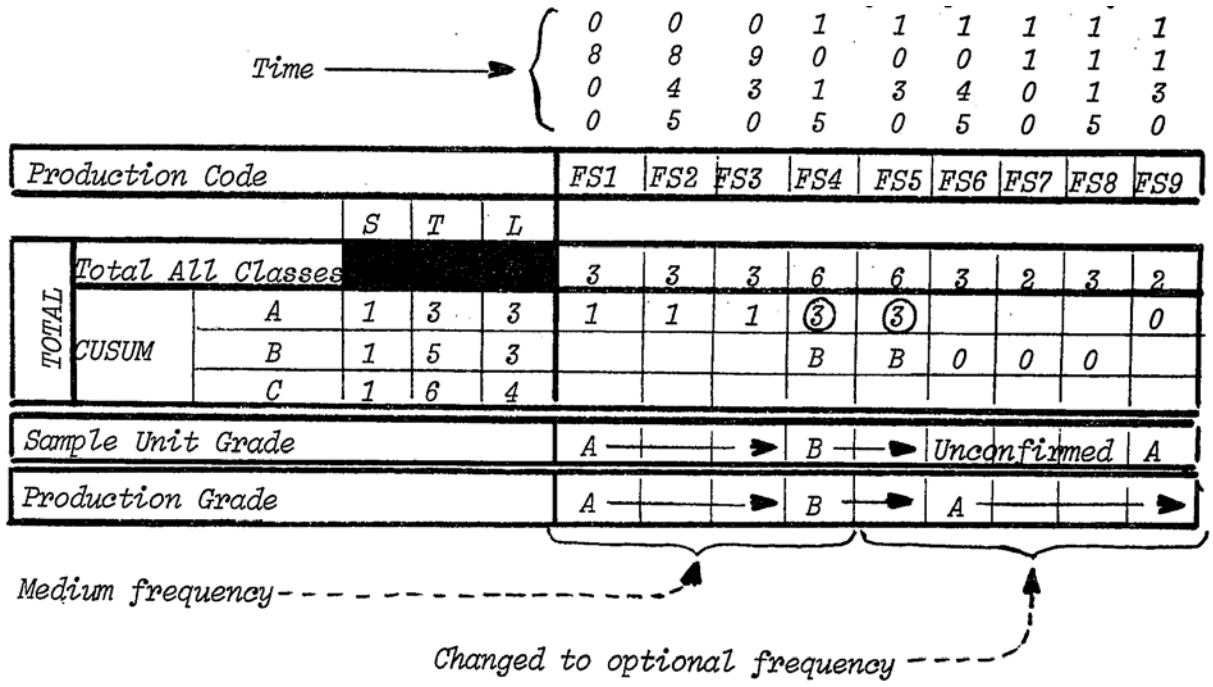
C. Re-inspection of failed production.

Failed production or any portion of production may be accepted as a lot on its own or with other production of the same grade (quality level) and is considered the grade assigned at the time of production. Any request for re-inspection of production failed under the CuSum plan must be accomplished as an appeal lot inspection. However, the product may be reexamined at any time to update certification or verify for condition.

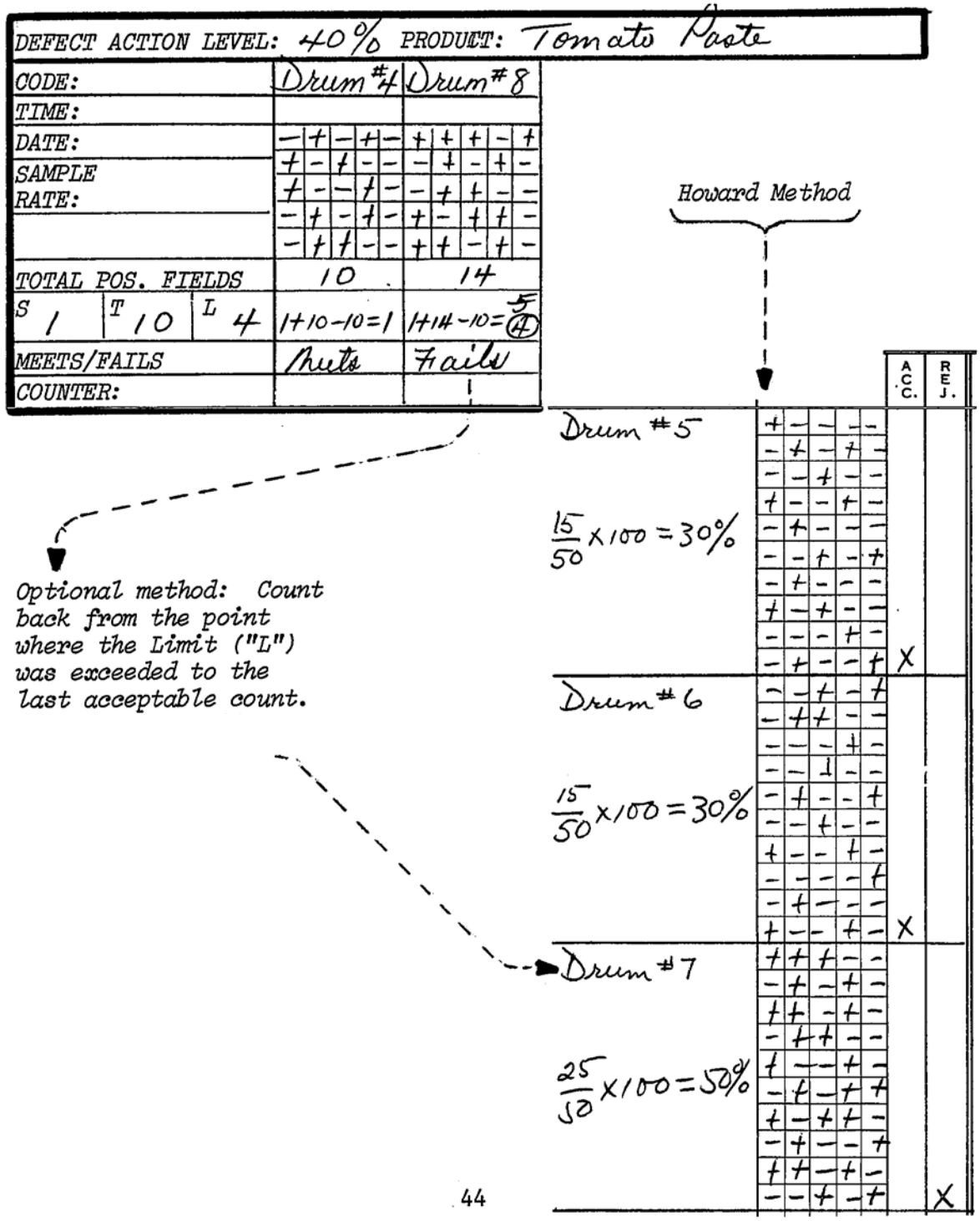
D. Modification of sampling frequency.

The time sampling frequency may be adjusted, if it is necessary, following a production failure to meet the designated grade. This is important if production is being sampled at a low or medium frequency. Otherwise, a severe penalty would be imposed on the producer by just a small pocket of lower quality production. However, it is your responsibility to never allow this flexibility of sampling frequency to be abused.

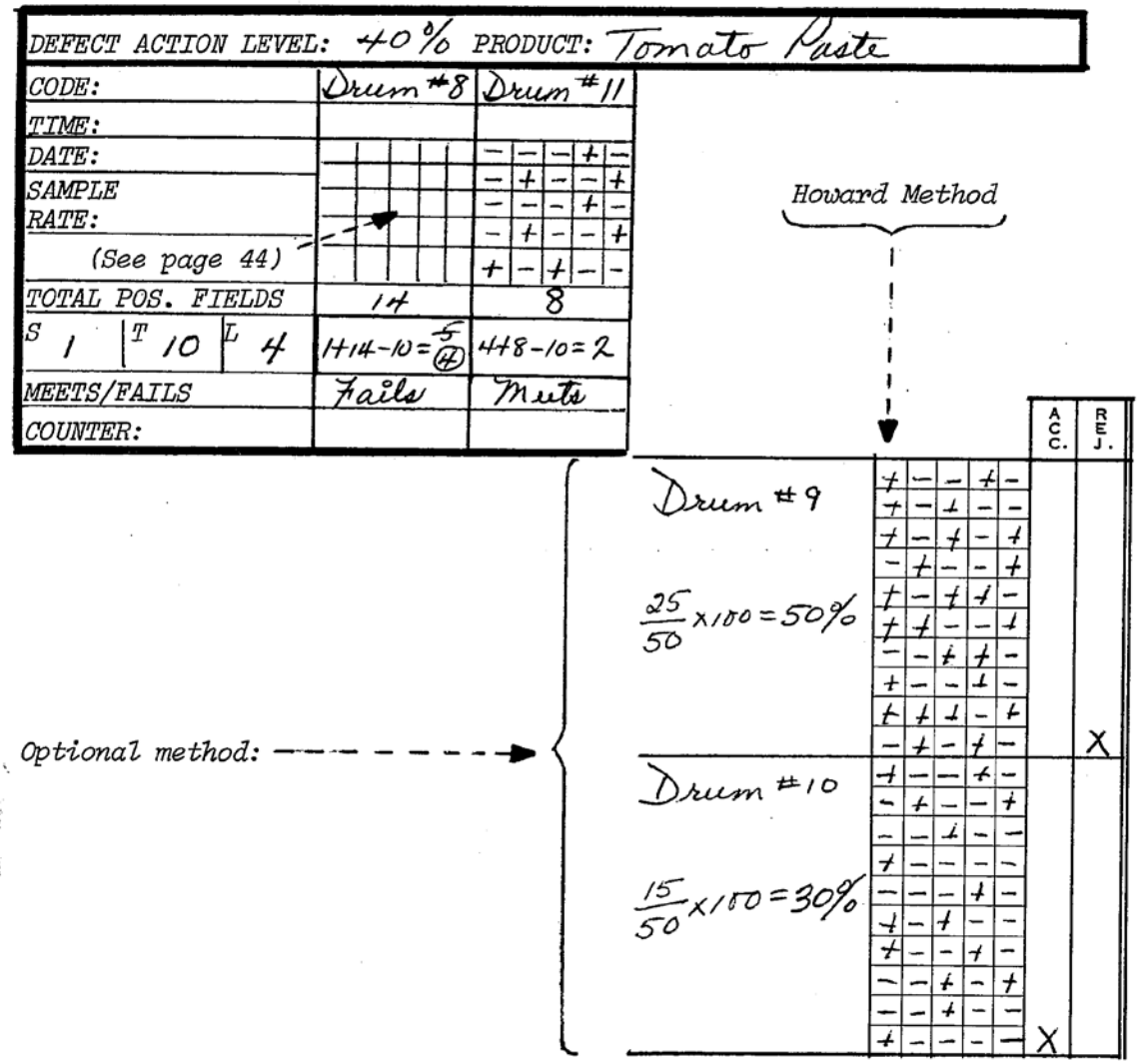
Example 1: Designated grade A showing only total defects


Time
0 0 0 1 1 1 1 1 1
8 8 9 0 0 0 1 1 1
0 4 3 1 3 4 0 1 3
0 5 0 5 0 5 0 5 0
Production Code
FS1 FS2 FS3 FS4 FS5 FS6 FS7 FS8 FS9
S T L
TOTAL
Total All Classes
3 3 3 6 6 3 2 3 2
CUSUM
A 1 3 3 1 1 1 3 3 0
B 1 5 3 B B 0 0 0
C 1 6 4
Sample Unit Grade
A B Unconfirmed A
Production Grade
A B A
Medium frequency
Changed to optional frequency

E. Mold counting example



Mold counting example (continued)



F. How to convert to tighter AQLs.

Some persons (processors, private label buyers, quality assurance personnel, etc.) have in the past required that production be better than a minimum grade limit as defined in the U.S. standards (such as bottom grade A). These persons developed their own specifications.

With the CuSum plan, a limit may be placed on production so that a minimum grade level is clearly unacceptable. The easiest way to do this is to tighten the specified AQL. The CuSum plan offers this flexibility and also indicates the chances of passing a level of defects worse than the AQL. Also, the selection of the appropriate plan (13, 25, 50, 100 or 200) may reduce the chances of accepting bad quality.

With the CuSum plan, the larger the standard sample unit size, the better the protection against poorer quality. However, there is a "trade-off." Large sample unit sizes increase the time and costs of inspection. Ensure the desired protection is practical.

1. Use as a base of operation, the AQLs that are applicable for the designated grade in the U.S. standards.

   Example:

U.S. GRADE B				
AQL[7]	Total	Major	Severe	Critical
	20.0	10.0	2.5	0.65

2. Use the standard sample unit size applicable for the product. If the sample unit size is changed, the protection against poorer quality would change. However, the sample unit size may be changed, if desired.

   Example: 7 CFR52.38b Recommended Sample Unit Sizes.

   Halves; Quarters -- 25 Units"

3. Refer to the appropriate CuSum table that you're using.

   Example:

TABLE VII
CUSUM SAMPLING PLANS

STANDARD SAMPLE UNIT SIZE = 25

AQL	S	T	L	QUALITY LEVELS Pa=50%	QUALITY LEVELS Pa=10%
QUALITY LEVELS EXPRESSED AS DEFECTS PER HUNDRED UNITS OR PERCENT DEFECTIVE					
* * *					
QUALITY LEVELS EXPRESSED AS DEFECTS PER HUNDRED UNITS ONLY					
* * *					
20.0	1	6	4	29.7	42.7
* * *					

[7] AQL expressed as defects per 100 units.

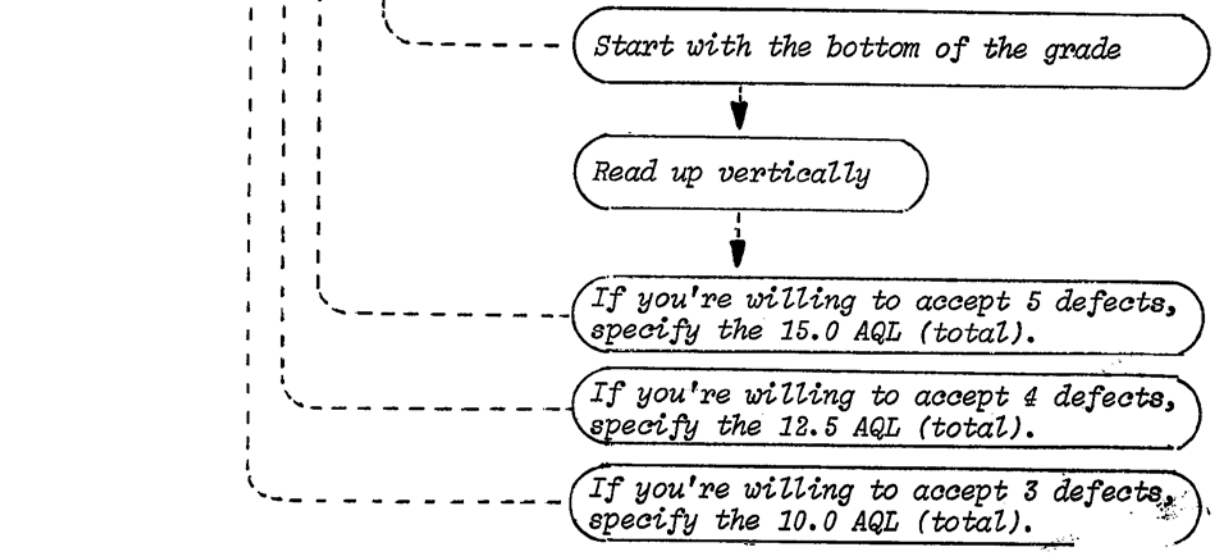
4. Tolerance ("T") method: Use the tolerance ("T") as the number of defects that you are willing to accept.

Example:

TABLE VII
CUSUM SAMPLING PLANS

STANDARD SAMPLE UNIT SIZE = 25

AQL	S	T	L	Quality Levels Pa=50%	Pa=10%
QUALITY LEVELS EXPRESSED AS DEFECTS PER HUNDRED UNITS OR PERCENT DEFECTIVE					
* * *					
10.0	1	3	3	16.7	27.1
QUALITY LEVELS EXPRESSED AS DEFECTS PER HUNDRED UNITS ONLY					
12.5	1	4	3	21.0	32.4
15.0	1	5	3	25.2	37.6
20.0	1	6	4	29.7	42.7
* * *					



5. AQL method: Use the AQL as the number of defects that you are willing to accept in 100 units.

Example:

TABLE VII
CUSUM SAMPLING PLANS

STANDARD SAMPLE UNIT SIZE = 25

AQL	S	T	L	QUALITY LEVELS Pa=50%	QUALITY LEVELS Pa=10%
QUALITY LEVELS EXPRESSED AS DEFECTS PER HUNDRED UNITS OR PERCENT DEFECTIVE					
* * *					
5.0	1.5	1.5	3	9.1	16.3
6.5	1	2	3	12.2	21.5
8.5	0	3	2	16.4	27.1
10.0s	1	3	3	16.7	27.1
* * *					

Start with the bottom of the grade

Read up vertically

If you're willing to accept 8.5 defects per 100 units, specify the 8.5 AQL (major).

If you're willing to accept 6.5 defects per 100 units, specify the 6.5 AQL (major).

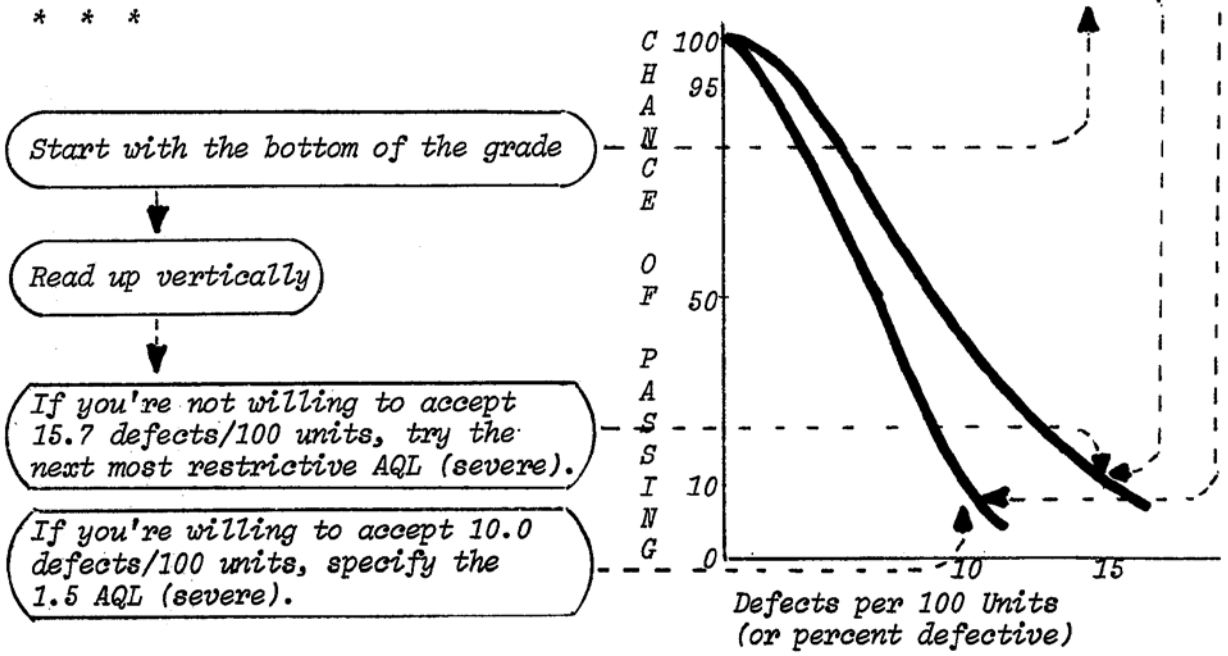
6. Limiting quality method (Pa=10%): Use the Pa=10% as a guide to the worst quality that you are willing to accept.

   Example:

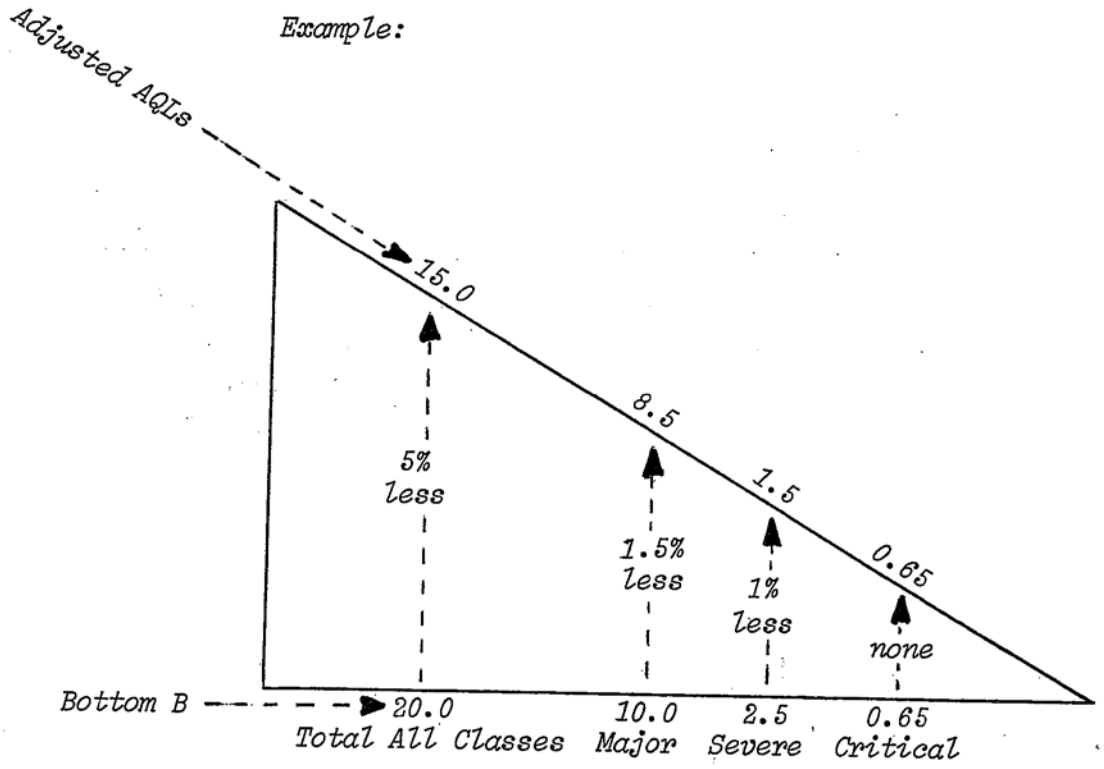
TABLE VII
CUSUM SAMPLING PLANS

STANDARD SAMPLE UNIT SIZE = 25

AQL	S	T	L	Quality Levels Pa=50%	Quality Levels Pa=10%
QUALITY LEVELS EXPRESSED AS DEFECTS PER HUNDRED UNITS OR PERCENT DEFECTIVE					
* * *					
1.0	0	0.5	0.5	4.0	10.0
1.5	1	0.5	2	7.5	10.0
2.5	0	1	1	9.0	15.7
* * *					



7. From a practical standpoint, AQLs for the more serious defects (major, severe and critical) should be tightened less than the AQLs for the less serious defects (total all classes).



8. If you change the standard sample unit size, the protection against acceptance of poorer quality would also change.

TABLE VII
CUSUM SAMPLING PLANS

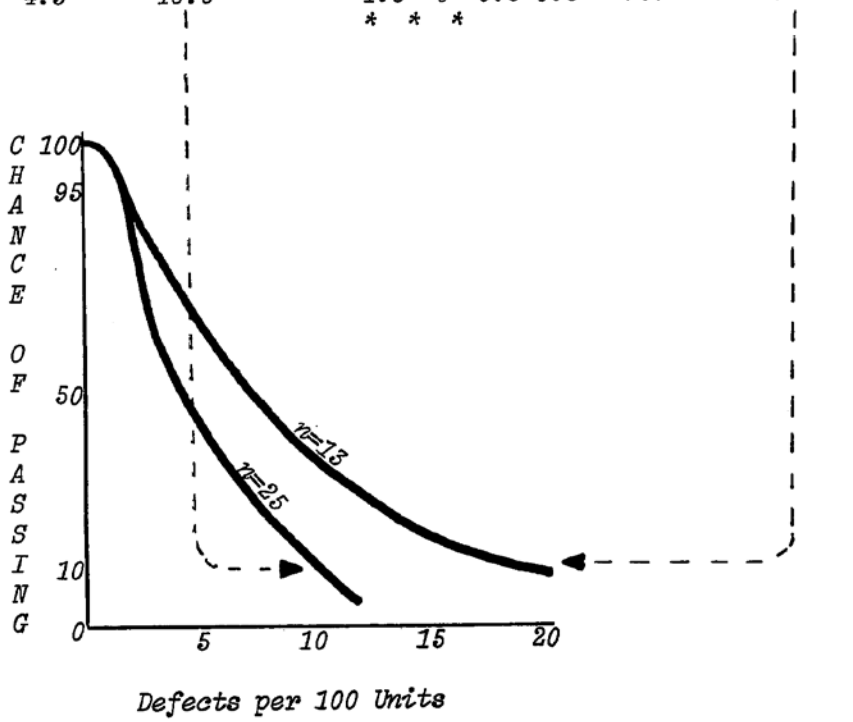
STANDARD SAMPLE UNIT SIZE = 25

AQL	S	T	L	Pa=50%	Pa=10%
*	*	*			
1.5	1	0.5	2	4.3	10.0
*	*	*			

TABLE VI
CUSUM SAMPLING PLANS

STANDARD SAMPLE UNIT SIZE = 13

AQL	S	T	L	Pa=50%	Pa=10%
*	*	*			
1.5	0	0.5	0.5	7.7	19.2
*	*	*			



G. How to reevaluate a defect tally sheet.

It is possible to reevaluate a previously filled in defect tally sheet to determine if past production would meet a specification not used at the time of the original grading. This situation could occur if production was sold several months after packing.

The defect tally sheet is a history of production. It contains the order of production, the number of units examined, the number of classified defects, and the record of prerequisite quality factors.

Normally, a buyer's specification would be expected to place a limitation on specific defects other than what the product was originally graded against.

The defect tally sheet may be reevaluated by transposing to a new tally sheet or superimposing on the old tally sheet. If there is any information on the old tally sheet which would reveal another buyer's position, complete a new tally sheet.

There is a “trap” in revaluating a defect tally sheet -- that is failed production. It must be considered because the order of production would influence acceptance or rejection of portions of production. In reevaluating a defect tally sheet, do not bypass failed production even though that production may have been removed from the lot.

The example on the next page of this manual shows the reevaluation of a defect tally sheet by superimposing a buyer's AQLs on the old tally sheet.

Example: Designated grade B showing all classes of defects

Production Code					CYC1 →			CYC2 →		CYC3 →		CYC4 →	
PRE	Overall Color (Bar letter)				A	A	A	A	A	A	A	A	A
	Flavor and Odor				A	A	A	A	A	A	A	A	A
	Peel				A	B	A	A	A	A	B	B	A
		S	T	L	25	25	25	25	25	25	25	25	25
CRIT	Pit Material							1					
	Total Critical				0	0	0	1	0	0	0	0	0
	CUSUM 0.65 A	0.3	0.1	0.9	0.3	0.1	0	0.8	0.6	0.4	0.2	0	0
	CUSUM 0.65 B	0	0.5	0.5	0	0	0	0.5	0	0	0	0	0
	CUSUM 0.65 C	0	1	1									
SEVERE	EVM												
	Off-suture				1			1	1				
	Total Severe				1	0	0	1	1	0	0	0	0
	CUSUM (Bar letter) A	0	0.5	0.5									
	CUSUM (Bar letter) B	0	1	1	0	0	0	0	0	0	0	0	0
	CUSUM (Bar letter) C	0.5	1.5	2									
MAJOR	Color												
	Gouge				1		1	1	1	1	1	1	1
	Total Major				1	0	1	1	1	1	1	1	1
	CUSUM (Bar letters) A	0	1	1									
	CUSUM (Bar letters) B	1.5	1.5	3	1	0	0	0	0	0	0	0	0
	CUSUM (Bar letters) C	0	3	2									
MIN	Short Stems												
	Blemished				1	1	1	4	1	1	1	1	1
	Total Minor				1	1	1	4	1	1	1	1	1
TOTAL	Total All Classes				3	1	2	7	3	2	2	2	2
	CUSUM 6.5 A	1	2	3	2	1	1	3	3	3	3	3	3
	CUSUM 6.5 B	1	3	3	1	0	0	3	3	2	1	0	0
	CUSUM 6.5 C	1	5	3				C	◄	- -	- -	- -	- -
Sample Unit Grade					B →			C	B →				
Production Grade					B →			C →		B →			

Note: Two-in-row rule, step 3, does not apply to reevaluated tally sheet.

H. How to use the verification sampling plans.

It is possible to evaluate a small sample to indicate the reliability of the original evaluation of a larger sample; or, to indicate if there has been a change in quality since the original evaluation; or, to audit another grader.

The advantage of the verification sampling plan is to reduce the time required for re-grading a small sample could be graded faster than a large sample. Then, if the verification sample indicates the original evaluation is unreliable, other methods could be used to reevaluate the quality of the lot (such as re-grading at the full sample size).

As with all sampling plans, the verification sampling plan is subject to sampling risks (or sampling variation).

The purpose of this instruction is to show how to use the verification sampling plan. This instruction does not give guidelines for the circumstances under which the plan may be used.

To use the verification sampling plan, the procedure is as follows:

1. Obtain the original grading record (tally sheet).

   Example:

   "TALLY SHEET FOR CANNED _____"

2. Determine the standard sample unit size that was used for the original inspection.

   Example 1:

"TALLY SHEET FOR CANNED _____ - SAMPLE UNIT SIZE = 25 HALVES"

Example 2:

"TALLY SHEET FOR FROZEN _____ - SAMPLE UNIT SIZE = 1000 g"

3. Determine the defects per 100 units for each class of defects (total, major, severe and critical) that were found in the original inspection.

Example 1: defects by count

* * *

25 + 25 + 25 + 25 + 25 + 25 + 25 + 25 = 200

MAJOR	Color						1				1		
	Blemish				1		1	1	1		1	1	
	Total Major				1	1	1	1	1	1	1	1	= 8
	CUSUM	A	0	1	1								
		B	1.5	1.5	3	1	0.5	0	0	0	0	0	0
		C	0	3	2								

* * *

8 sample units X 25 units =

200 / 8.00 .04 X 100 = 4 defects/100 units.

Determine the defects per 100 units for each class of defects (total, major, severe and critical) that were found in the original inspection (continuation).

Example 2: defects by weight/40 g increments

* * *

MAJOR	Color						1				1		
	Blemished				1		1	1	1		1	1	
	Total Major				1	1	1	1	1	1	1	1	= 8
	CUSUM	A	0	1	1								
		B	1.5	1.5	3	1	0.5	0	0	0	0	0	0
		C	0	3	2								

8 sample units X 1000 g =

$\frac{8000}{40}$ g = 200 / 8.00 X 100 = 4 defects/100 units. (-.04)

Each 40 g increment equals 1 defect

Example 3: defects by weight/8 g increments

$$\frac{\text{8 sample units X 200 g}}{\text{-.04}} =$$

$$\frac{1600 \text{ g}}{8} = 200 / 8.00 \text{ X } 100 = 4 \text{ defects/100 units.}$$

Each 8 g increment equals 1 defect

4. Select the verification sampling plan that matches the appropriate standard sample unit size used for the original inspection. There are 5 tables of verification plans.

Example:

" TABLE I
VERIFICATION SAMPLING PLANS
ON-LINE SAMPLE UNIT SIZE = 13
VERIFICATION SAMPLE SIZE = 6 X 13 "

" TABLE II
VERIFICATION SAMPLING PLANS
ON-LINE SAMPLE UNIT SIZE = 25
VERIFICATION SAMPLE SIZE = 6 X 13 "

" TABLE III
VERIFICATION SAMPLING PLANS
ON-LINE SAMPLE UNIT SIZE = 50
VERIFICATION SAMPLE SIZE = 6 X 25 "

" TABLE IV
VERIFICATION SAMPLING PLANS
ON-LINE SAMPLE UNIT SIZE = 100
VERIFICATION SAMPLE SIZE = 6 X 50 "

" TABLE V
VERIFICATION SAMPLING PLANS
ON-LINE SAMPLE UNIT SIZE = 200
VERIFICATION SAMPLE SIZE = 6 X 100 "

5. Perform the inspection of the verification sample that you have drawn. Evaluate all prerequisite quality factors and all classified quality factors (total, major, severe and critical).

6. Check the defects per 100 units that were found in the original inspection against the number of defects you have found in the verification sample for all classes of defects (total, major, severe and critical).

   Example:

   Original inspection:

25 + 25 + 25 + 25 + 25 + 25 + 25 + 25

MAJOR	Color							1				1		
	Blemished					1		1	1	1		1	1	=4/100
	Total Major					1	1	1	1	1	1	1	1	
	CUSUM	A	0	1	1									
		B	1.5	1.5	3	1	0.5	0	0	0	0	0	0	
		C	0	3	2									

Verification inspection:

13 + 13 + 13 + 13 + 13 + 13

MAJOR	Color							1		1				
	Blemished					1	1		1					
	Total Major					1	1	1	1	1	0			=5
	CUSUM	A	0	1	1									
		B	1.5	1.5	3									
		C	0	3	2									

7. Accept or reject the verification sample based on the results of the check between the original inspection and the verification sample.

Example:

Original inspection:

MAJOR	Color						1				1		
	Blemished					1		1	1	1		1	1
	Total Major					1	1	1	1	1	1	1	1
	CUSUM	A	0	1	1								
		B	1.5	1.5	3	1	0.5	0	0	0	0	0	0
		C	0	3	2								

=4/100

TABLE II
VERIFICATION SAMPLING PLANS
ON-LINE SAMPLE UNIT SIZE = 25
VERIFICATION SAMPLE SIZE = 6 X 13

DEFECTS/100 UNITS IN ON-LINE SAMPLE	MAXIMUM NUMBER OF DEFECTS IN VERIFICATION SAMPLE
0.00 - 0.2	1
0.21 - 0.7	2
0.71 - 1.2	3
1.21 - 1.9	4
1.91 - 2.7	5
2.71 - 3.6	6
3.61 - 4.4	(7) → Meets

Verification inspection:

MAJOR	Color						1		1				
	Blemished				1	1		1					
	Total Major				1	1	1	1	1	0			
	CUSUM	A	0	1	1								
		B	1.5	1.5	3								
		C	0	3	2								

=5

TABLE I
VERIFICATION SAMPLING PLAN
ON-LINE SAMPLE UNIT SIZE = 13
VERIFICATION SAMPLE SIZE = 6 X 13

DEFECTS/100 UNITS IN ON-LINE SAMPLE	MAXIMUM NO. OF DEFECTS IN VERIFICATION SAMPLE	DEFECTS/100 UNITS IN ON-LINE SAMPLE	MAXIMUM NO. OF DEFECTS IN VERIFICATION SAMPLE
0.00 - 0.5	2	75.01 - 77.0	76
0.51 - 0.9	3	77.01 - 80.0	78
0.91 - 1.7	4	80.01 - 83.0	81
1.71 - 2.4	5	83.01 - 87.0	84
2.41 - 3.1	6	87.01 - 90.0	87
3.11 - 3.8	7	90.01 - 94.0	90
3.81 - 4.8	8	94.01 - 97.0	93
4.81 - 5.6	9	97.01 - 100.0	96
5.61 - 6.5	10	100.01 - 104.0	99
6.51 - 7.4	11	104.01 - 107.0	102
7.41 - 8.2	12	107.01 - 111.0	105
8.21 - 9.2	13	111.01 - 114.0	108
9.21 - 10.0	14	114.01 - 118.0	111
10.01 - 11.0	15	118.01 - 121.0	114
11.01 - 12.0	16	121.01 - 125.0	117
12.01 - 13.0	17	125.01 - 128.0	120
13.01 - 14.0	18	128.01 - 132.5	123
14.01 - 15.0	19	132.51 - 137.0	127
15.01 - 16.0	20	137.01 - 141.5	131
16.01 - 17.0	21	141.51 - 146.5	135
17.01 - 18.0	22	146.51 - 151.0	139
18.01 - 19.0	23	151.01 - 156.0	143
19.01 - 20.0	24	156.01 - 160.0	147
20.01 - 21.0	25	160.01 - 165.0	151
21.01 - 22.0	26	165.01 - 170.0	155
22.01 - 23.0	27	170.01 - 174.0	159
23.01 - 24.0	28	174.01 - 179.0	163
24.01 - 25.0	29	179.01 - 184.0	167
25.01 - 26.0	30	184.01 - 188.0	171
26.01 - 27.0	31	188.01 - 193.5	175
27.01 - 28.0	32	193.51 - 198.0	179
28.01 - 29.0	33	198.01 - 203.0	183
29.01 - 31.0	34	203.01 - 207.0	187
31.01 - 33.0	36	207.01 - 213.0	191
33.01 - 35.0	38	213.01 - 217.5	195
35.01 - 37.0	40	217.51 - 222.0	199
37.01 - 39.2	42	222.01 - 226.1	203
39.21 - 42.0	44	226.11 - 232.0	207
42.01 - 43.0	46	232.01 - 237.0	212
43.01 - 45.7	48	237.01 - 242.0	216
45.71 - 48.0	50	242.01 - 247.0	220
48.01 - 50.0	52	247.01 - 251.0	224
50.01 - 52.5	54	251.01 - 257.0	228
52.51 - 55.0	56	257.01 - 263.0	233
55.01 - 57.0	58	263.01 - 268.0	238
57.01 - 59.0	60	268.01 - 274.9	243
59.01 - 61.0	62	274.91 - 281.0	248
61.01 - 64.0	64	281.01 - 288.0	253
64.01 - 66.0	66	288.01 - 293.5	259
66.01 - 68.0	68	293.51 - 300.0	264
68.01 - 70.0	70	300.01 - 306.0	269
70.01 - 73.0	72	-	
73.01 - 75.0	74		

TABLE II
VERIFICATION SAMPLING PLAN
ON-LINE SAMPLE UNIT SIZE = 25
VERIFICATION SAMPLE SIZE = 6 X 13

DEFECTS/100 UNITS IN ON-LINE SAMPLE	MAXIMUM NO. OF DEFECTS IN VERIFICATION SAMPLE	DEFECTS/100 UNITS IN ON-LINE SAMPLE	MAXIMUM NO. OF DEFECTS IN VERIFICATION SAMPLE
0.00 - 0.2	1	55.01 - 58.0	57
0.21 - 0.7	2	58.01 - 61.0	60
0.71 - 1.2	3	61.01 - 64.9	63
1.21 - 1.9	4	64.91 - 68.0	66
1.91 - 2.7	5	68.01 - 71.2	69
2.71 - 3.6	6	71.21 - 75.0	72
3.61 - 4.4	7	75.01 - 78.0	75
4.41 - 5.3	8	78.01 - 81.9	78
5.31 - 6.1	9	81.91 - 85.0	81
6.11 - 7.1	10	85.01 - 88.9	84
7.11 - 7.9	11	88.91 - 92.0	87
7.91 - 8.9	12	92.01 - 96.0	90
8.91 - 9.9	13	96.01 - 99.0	93
9.91 - 10.8	14	99.01 - 103.0	96
10.81 - 11.5	15	103.01 - 106.0	99
11.51 - 12.8	16	106.01 - 110.0	102
12.81 - 13.5	17	110.01 - 113.0	105
13.51 - 15.0	18	113.01 - 117.0	108
15.01 - 15.5	19	117.01 - 122.0	112
15.51 - 17.0	20	122.01 - 126.0	116
17.01 - 17.5	21	126.01 - 131.0	120
17.51 - 19.0	22	-	
19.01 - 20.0	23		
20.01 - 21.0	24		
21.01 - 22.0	25		
22.01 - 23.0	26		
23.01 - 24.0	27		
24.01 - 25.0	28		
25.01 - 26.0	29		
26.01 - 27.0	30		
27.01 - 28.5	31		
28.51 - 29.0	32		
29.01 - 30.9	33		
30.91 - 33.0	35		
33.01 - 35.0	37		
35.01 - 37.5	39		
37.51 - 39.5	41		
39.81 - 42.0	43		
42.01 - 44.0	45		
44.01 - 46.0	47		
46.01 - 48.8	49		
48.81 - 50.2	51		
50.21 - 53.0	53		
53.01 - 55.0	55		

TABLE III
VERIFICATION SAMPLING PLAN
ON-LINE SAMPLE UNIT SIZE = 50
VERIFICATION SAMPLE SIZE = 6 X 25

DEFECTS/100 UNITS IN ON-LINE SAMPLE	MAXIMUM NO. OF DEFECTS IN VERIFICATION SAMPLE	DEFECTS/100 UNITS IN ON-LINE SAMPLE	MAXIMUM NO. OF DEFECTS IN VERIFICATION SAMPLE
0.00 - 0.1	1	40.81 - 42.4	78
0.11 - 0.35	2	42.41 - 44.5	81
0.36 - 0.65	3	44.51 - 46.0	84
0.66 - 1.05	4	46.01 - 48.0	87
1.06 - 1.45	5	48.01 - 49.8	90
1.46 - 1.9	6	49.81 - 52.0	93
1.91 - 2.3	7	52.01 - 54.0	97
2.31 - 2.7	8	54.01 - 56.6	101
2.71 - 3.2	9	56.61 - 59.0	105
3.21 - 3.7	10	59.01 - 61.5	109
3.71 - 4.1	11	61.51 - 64.0	113
4.11 - 4.7	12	64.01 - 66.0	117
4.71 - 5.1	13	66.01 - 69.0	121
5.11 - 5.7	14	69.01 - 71.0	125
5.71 - 6.1	15	71.01 - 73.5	129
6.11 - 6.7	16	73.51 - 76.0	133
6.71 - 7.2	17	76.01 - 79.0	137
7.21 - 7.7	18	79.01 - 82.0	142
7.71 - 8.3	19	82.01 - 85.0	147
8.31 - 8.8	20	85.01 - 88.0	152
8.81 - 9.3	21	88.01 - 91.0	157
9.31 - 9.9	22	91.01 - 94.0	162
9.91 - 10.3	23	94.01 - 98.0	167
10.31 - 11.0	24	98.01 - 101.0	173
11.01 - 11.5	25	101.01 - 105.0	179
11.51 - 12.0	26		
12.01 - 12.5	27		
12.51 - 13.0	28		
13.01 - 13.5	29		
13.51 - 14.4	30		
14.41 - 15.5	32		
15.51 - 16.5	34		
16.51 - 17.8	36		
17.81 - 18.9	38		
18.91 - 20.0	40		
20.01 - 21.1	42		
21.11 - 22.4	44		
22.41 - 23.5	46		
23.51 - 24.5	48		
24.51 - 26.0	50		
26.01 - 27.0	52		
27.01 - 28.0	54		
28.01 - 29.0	56		
29.01 - 30.6	58		
30.61 - 32.0	60		
32.01 - 33.7	63		
33.71 - 35.4	66		
35.41 - 37.0	69		
37.01 - 39.0	72		
39.01 - 40.8	75		

TABLE IV
VERIFICATION SAMPLING PLAN
ON-LINE SAMPLE UNIT SIZE = 100
VERIFICATION SAMPLE SIZE = 6 X 50

DEFECTS/100 UNITS IN ON-LINE SAMPLE	MAXIMUM NO. OF DEFECTS IN VERIFICATION SAMPLE	DEFECTS/100 UNITS IN ON-LINE SAMPLE	MAXIMUM NO. OF DEFECTS IN VERIFICATION SAMPLE
0.00 - 0.05	1	21.21 - 22.2	81
0.06 - 0.17	2	22.21 - 23.0	84
0.18 - 0.33	3	23.01 - 24.0	87
0.34 - 0.5	4	24.01 - 24.8	90
0.51 - 0.7	5	24.81 - 25.7	93
0.71 - 0.95	6	25.71 - 26.8	96
0.96 - 1.15	7	26.81 - 28.0	100
1.16 - 1.35	8	28.01 - 29.2	104
1.36 - 1.6	9	29.21 - 30.4	108
1.61 - 1.8	10	30.41 - 31.7	112
1.81 - 2.1	11	31.71 - 32.8	116
2.11 - 2.3	12	32.81 - 34.0	120
2.31 - 2.6	13	34.01 - 35.5	124
2.61 - 2.8	14	35.51 - 36.8	128
2.81 - 3.1	15	36.81 - 38.2	133
3.11 - 3.3	16	38.21 - 39.7	138
3.31 - 3.6	17	39.71 - 41.0	143
3.61 - 3.9	18	41.01 - 42.5	147
3.91 - 4.1	19	42.51 - 43.8	151
4.11 - 4.4	20	43.81 - 45.0	156
4.41 - 4.7	21	45.01 - 46.6	160
4.71 - 4.9	22	46.61 - 48.0	165
4.91 - 5.2	23	48.01 - 49.5	170
5.21 - 5.5	24	49.51 - 51.2	175
5.51 - 5.7	25	51.21 - 52.7	180
5.71 - 6.0	26	52.71 - 54.0	185
6.01 - 6.3	27	54.01 - 55.8	190
6.31 - 6.6	28	55.81 - 57.3	195
6.61 - 6.8	29	57.31 - 59.0	200
6.81 - 7.1	30	59.01 - 60.4	205
7.11 - 7.4	31	60.41 - 62.0	210
7.41 - 7.7	32	62.01 - 63.8	215
7.71 - 7.9	33	63.81 - 65.2	220
7.91 - 8.3	34	65.21 - 66.8	225
8.31 - 8.9	36	-	
8.91 - 9.4	38		
9.41 - 10.0	40		
10.01 - 10.6	42		
10.61 - 11.2	44		
11.21 - 11.7	46		
11.71 - 12.5	48		
12.51 - 13.3	51		
13.31 - 14.0	54		
14.01 - 14.5	56		
14.51 - 15.3	58		
15.31 - 16.0	60		
16.01 - 16.8	63		
16.81 - 17.7	66		
17.71 - 18.5	69		
18.51 - 19.5	72		
19.51 - 20.3	75		
20.31 - 21.2	78		

TABLE V
VERIFICATION SAMPLING PLAN
ON-LINE SAMPLE UNIT SIZE = 200
VERIFICATION SAMPLE SIZE = 6 X 100

DEFECTS/100 UNITS IN ON-LINE SAMPLE	MAXIMUM NO. OF DEFECTS IN VERIFICATION SAMPLE	DEFECTS/100 UNITS IN ON-LINE SAMPLE	MAXIMUM NO. OF DEFECTS IN VERIFICATION SAMPLE
0.00 - 0.025	1	14.01 - 14.6	104
0.026 - 0.09	2	14.61 - 15.2	108
0.091 - 0.165	3	15.21 - 15.8	112
0.166 - 0.255	4	15.81 - 16.4	116
0.256 - 0.36	5	16.41 - 17.0	120
0.361 - 0.45	6	17.01 - 17.7	124
0.46 - 0.55	7	17.71 - 18.3	128
0.56 - 0.7	8	18.31 - 19.0	133
0.71 - 0.8	9	19.01 - 19.7	138
0.81 - 0.9	10	19.71 - 20.5	143
0.91 - 1.05	11	20.51 - 21.2	147
1.06 - 1.15	12	21.21 - 21.9	151
1.16 - 1.3	13	21.91 - 22.5	156
1.31 - 1.4	14	22.51 - 23.3	160
1.41 - 1.5	15	23.31 - 24.0	165
1.51 - 1.7	16	24.01 - 24.8	170
1.71 - 1.8	17	24.81 - 25.6	175
1.81 - 1.9	18	25.61 - 26.4	180
1.91 - 2.1	19	26.41 - 27.0	185
2.11 - 2.2	20	27.01 - 27.9	190
2.21 - 2.3	21	27.91 - 28.6	195
2.31 - 2.45	22	28.61 - 29.4	200
2.46 - 2.6	23	29.41 - 30.2	205
2.61 - 2.7	24	30.21 - 31.0	210
2.71 - 2.9	25	31.01 - 31.8	215
2.91 - 3.0	26	31.81 - 32.5	220
3.01 - 3.1	27	32.51 - 33.4	225
3.11 - 3.3	28	33.41 - 34.2	231
3.31 - 3.4	29	34.21 - 35.2	236
3.41 - 3.6	30	35.21 - 36.0	241
3.61 - 3.7	31	36.01 - 36.6	246
3.71 - 3.8	32	36.61 - 37.4	251
3.81 - 4.0	33	37.41 - 38.3	256
4.01 - 4.3	35	38.31 - 39.0	262
4.31 - 4.6	37	39.01 - 39.9	267
4.61 - 4.9	39	39.91 - 40.7	272
4.91 - 5.2	41	40.71 - 41.6	277
5.21 - 5.4	43	41.61 - 42.2	282
5.41 - 5.8	45	42.21 - 43.0	287
5.81 - 6.0	47	43.01 - 44.0	292
6.01 - 6.3	49	44.01 - 44.7	298
6.31 - 6.6	51	44.71 - 45.8	304
6.61 - 6.9	53	45.81 - 47.0	311
6.91 - 7.2	55	47.01 - 48.2	318
7.21 - 7.5	57	48.21 - 49.0	325
7.51 - 7.8	59	49.01 - 50.3	332
7.81 - 8.1	61	50.31 - 51.4	339
8.11 - 8.6	64	51.41 - 52.5	346
8.61 - 9.0	67	52.51 - 53.6	354
9.01 - 9.4	70	53.61 - 54.9	361
9.41 - 9.9	73	54.91 - 56.2	368
9.91 - 10.3	76	56.21 - 57.3	376
10.31 - 10.8	79	57.31 - 58.8	384
10.81 - 11.2	82	58.81 - 60.0	393
11.21 - 11.7	85	60.01 - 61.4	401
11.71 - 12.2	88	61.41 - 63.0	410
12.21 - 12.6	91	63.01 - 64.0	420
12.61 - 13.1	94	64.01 - 65.0	428
13.11 - 13.5	97	65.01 - 66.0	436
13.51 - 14.0	100		