Topic 2

SINGLE SAMPLING PLAN FOR NORMAL, TIGHT AND REDUCED INSPECTION USING MIL-STD 105D

Topic 2-

Setting up Single Sampling Plan

Course Objectives

01

Parameters need to setup Single Sampling Plan

- Understand the basic parameters to setup single sampling plan

02

Reading Table MIL-STD-105D for Single Sampling Plan

- Reading the MIL-STD-105D table to setup Single sampling plan for Normal, Tightened and Reduced Inspection

SETTING UP

(1)
For sampling plan involving attributes in the group, usually the industry will use MIL-STD 105D table

(2)
The 3 basic parameters that decide the plan are lot size, AQL, and inspection level.

(3)

Based on the parameters, reading the table will help identify the sample size, n and the acceptance and reject value (Ac and Re).

(4)

Identify these value for 3 different inspection plan (normal, tightened and reduced).

(5)

Sampling Plan then provides the specific instructions for inspecting a lot based on the value found in tables within MIL-STD-105D.

The Parameters needed

Lot Size

Definition: The total number of units in a group of items that is inspected at once.

Purpose: It determines the sample size required for inspection.

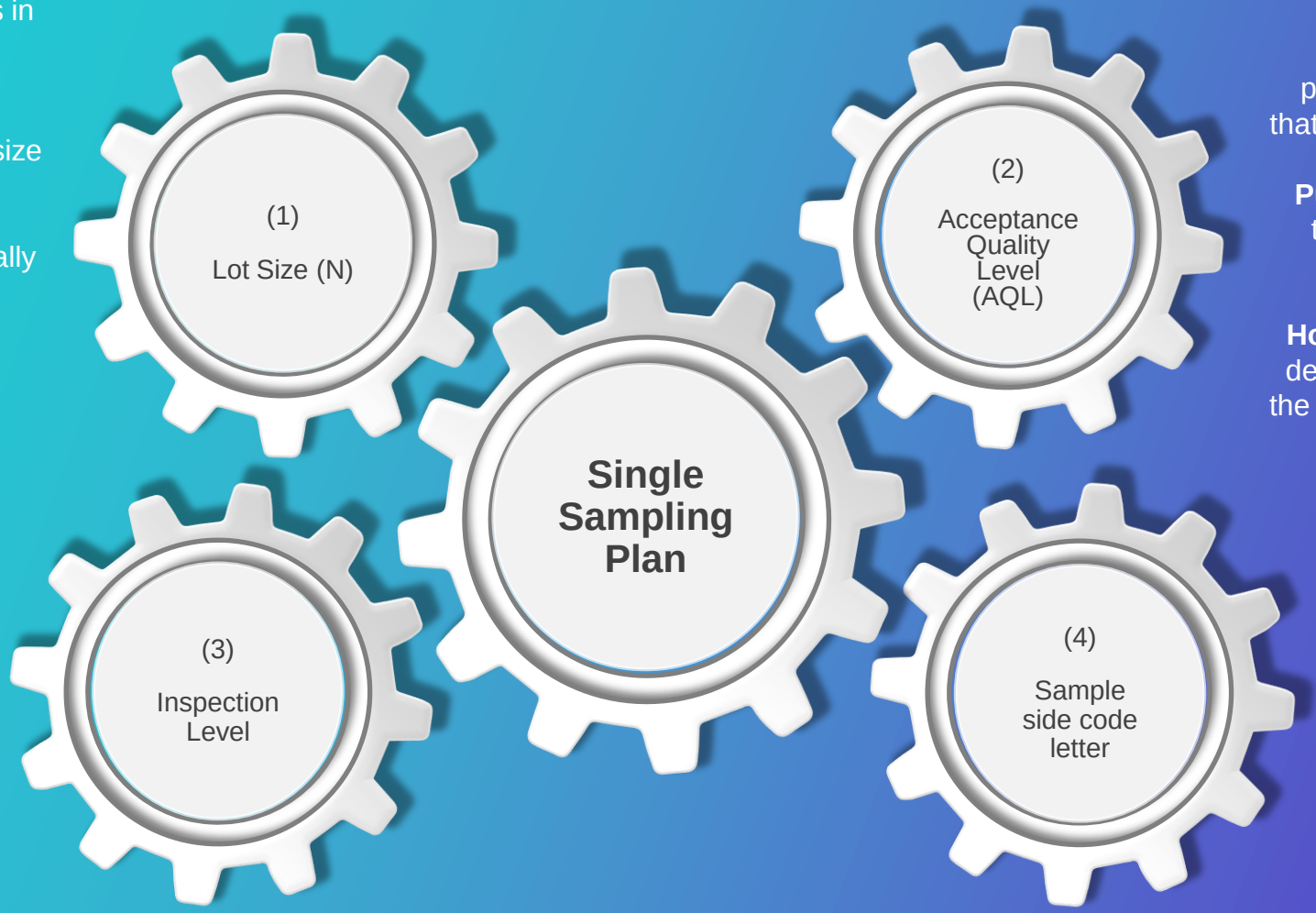
How to Determine: Lot size is typically specified by the manufacturer or purchaser.

Inspection Level

Definition: A numerical value that indicates the stringency of the inspection.

Purpose: It affects the sample size and the probability of accepting a lot with a given percentage of nonconforming units.

How to Determine: Inspection level is typically chosen based on the criticality of the product and the desired level of risk..



Acceptable Quality Level (AQL)

Definition: This is the maximum percentage of nonconforming units that is considered acceptable in a lot.

Purpose: It sets the level of quality that is deemed satisfactory for the product or service.

How to Determine: AQL is typically determined based on the severity of the nonconformities and the intended use of the product.

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Inspection Type

Definition: The method used to inspect the units, such as single, double, or multiple sampling.

Purpose: It determines the number of samples drawn and the acceptance/rejection criteria.

How to Determine: Inspection type is often specified in the product's specifications or contract

WHAT IS INSPECTION LEVEL?

LEVEL I

level of inspection that uses the lowest cost. It focuses on examining minor and low-interest inspection only. Minor damage will not interfere with the usability of the product. Not taking into account the safety of consumers.
Example: to check the smooth face of the table.

LEVEL II

Major damage will cause the product does not work, but not harmful to consumers if does not work. For example, the connection wiring inside the watch. Level II is used for regular inspection of the product is usually not expensive.

LEVEL III

a check for products that can cause critical damage and harm consumers if it is not working properly. The cost of testing was highest among the three levels. For example, testing of the accuracy of the drill bit gripping assembly.

LEVEL S-I

Used only if the cost of testing is too high. Minor damage will not interfere with the usability of the product. Not taking into account the safety of consumers.
Example: A4 color discoloration.

LEVEL S-II

Used only if involving low. Minor damage will not interfere with the usability of the product. Not taking into account the safety of consumers.
Example: binding wire / cable (cable tie)..

LEVEL S-III

Used to from the aspect of high importance. Major damage will cause the product does not work, but not harmful to consumers if does not work. For example, usability of blank compact discs (CD-R).

LEVEL S-IV

A check for products that can cause critical damage and harm consumers if it is not working properly. For example, testing the composition of medicines.

STEP-BY-STEP GUIDE FOR USING MIL-STD-105D

1. Determine AQL:

- **Define the acceptable level of nonconforming units:** This is typically decided based on product criticality and customer requirements.

2. Determine Lot Size:

Identify the total number of units in a lot: This is usually specified in the product's specifications or contract

3. Select Inspection Level:

- **Choose the desired level of inspection stringency:** MIL-STD-105D offers several levels (I, II, III, IV) based on the criticality of the product.

4. Find the Corresponding Table:

- **Refer to the appropriate table in MIL-STD-105D:** Locate the table that matches your chosen inspection level.

5. Identify the AQL Column:

Find the column in the table that corresponds to your AQL: The AQL values are listed horizontally across the top of the table

6. Locate the Lot Size Row:

- **Find the row in the table that corresponds to your lot size:** Lot sizes are listed vertically down the left side of the table.

7. Determine the Sample Size and Acceptance Number:

- **Intersect the AQL column and lot size row:** The value at this intersection provides the sample size (n) and the acceptance number (c).

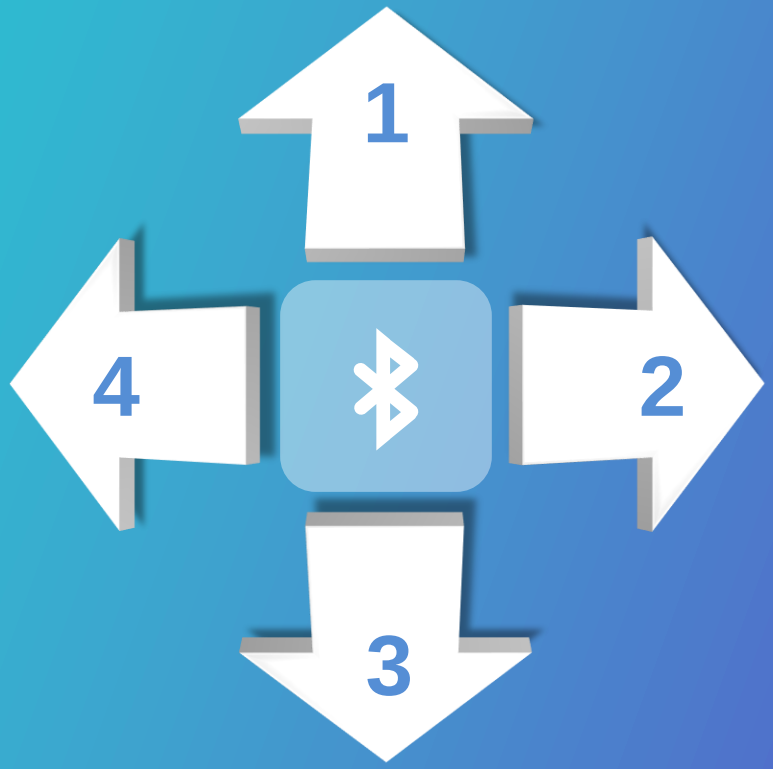
8. Apply the Sampling Plan:

- **Inspect the specified number of units:** If the number of nonconforming units found is less than or equal to the acceptance number (c), accept the lot. Otherwise, reject the lot.

READING MIL-STD-105D

Step 1: Identify the Inspection Level:

- Determine the desired level of inspection stringency based on the criticality of the product.
- Choose from Levels I, II, III, or IV



Step 2: Locate the Appropriate Table:

- Find the table in MIL-STD-105D that corresponds to the selected inspection level

Step 3: Determine the AQL and Lot Size

- **AQL:** Define the acceptable level of nonconforming units.
- **Lot Size:** Identify the total number of units in a lot.

Step 4: Find the Sample Size and Acceptance Number:

- **Intersect the AQL column and lot size row:** The value at this intersection provides the sample size (n) and the acceptance number (c).
- **Use the sample size to inspect the lot.**
- **If the number of nonconforming units is less than or equal to the acceptance number, accept the lot; otherwise, reject it.**

LET’S SET THE SAMPLING PLAN

Example 2 Suppose an electronic company produces earbuds in lots of 15000 in a month. To identify the single sampling plan for this product, the AQL level is 0.65% and the inspection level is Level II as minor defect will cause the earbuds not to function well.

Solution: To gain the value of the sample, n, acceptance value, Ac and the reject value, Re, you need to read 4 tables to identify all 3 set of single sampling plan (normal inspection, tightened inspection and reduced inspection).

HERE IS HOW WE READ THE TALES

The first table tell us the code letter for the lot.
Reading from the “Sample size code letters” table, knowing that the lot size is 15000, it falls in the “Lot or batch size”= 10,001 to 35,000.

Solution: Therefore reading under inspection level II, we found code letter “**M**”

Lot or batch size			Special Inspection Levels				General Inspection Levels		
			S-1	S-2	S-3	S-4	I	II	III
2	to	8	A	A	A	A	A	A	B
9	to	15	A	A	A	A	A	B	C
16	to	25	A	A	B	B	B	C	D
26	to	50	A	B	B	C	C	D	E
51	to	90	B	B	C	C	C	E	F
91	to	150	B	B	C	D	D	F	G
151	to	280	B	C	D	E	E	G	H
281	to	500	B	C	D	E	F	H	J
501	to	1,200	C	C	E	F	G	J	K
1,201	to	3,200	C	D	E	G	H	K	L
3,201	to	10,000	C	D	F	G	J	L	M
10,001	to	35,000	C	D	F	H	K	M	N
35,001	to	150,000	D	E	G	J	L	N	P
150,001	to	500,000	D	E	G	J	M	P	Q
500,001	and	over	D	E	H	K	N	Q	R

NOW TO THE SECOND TABLE

The 2nd table tell us the the value of n, Ac & Re.

Reading from the "Single Sampling Plan for *Normal Inspection*" table, knowing that the code letter is **M, with AQL = 0.65%.**

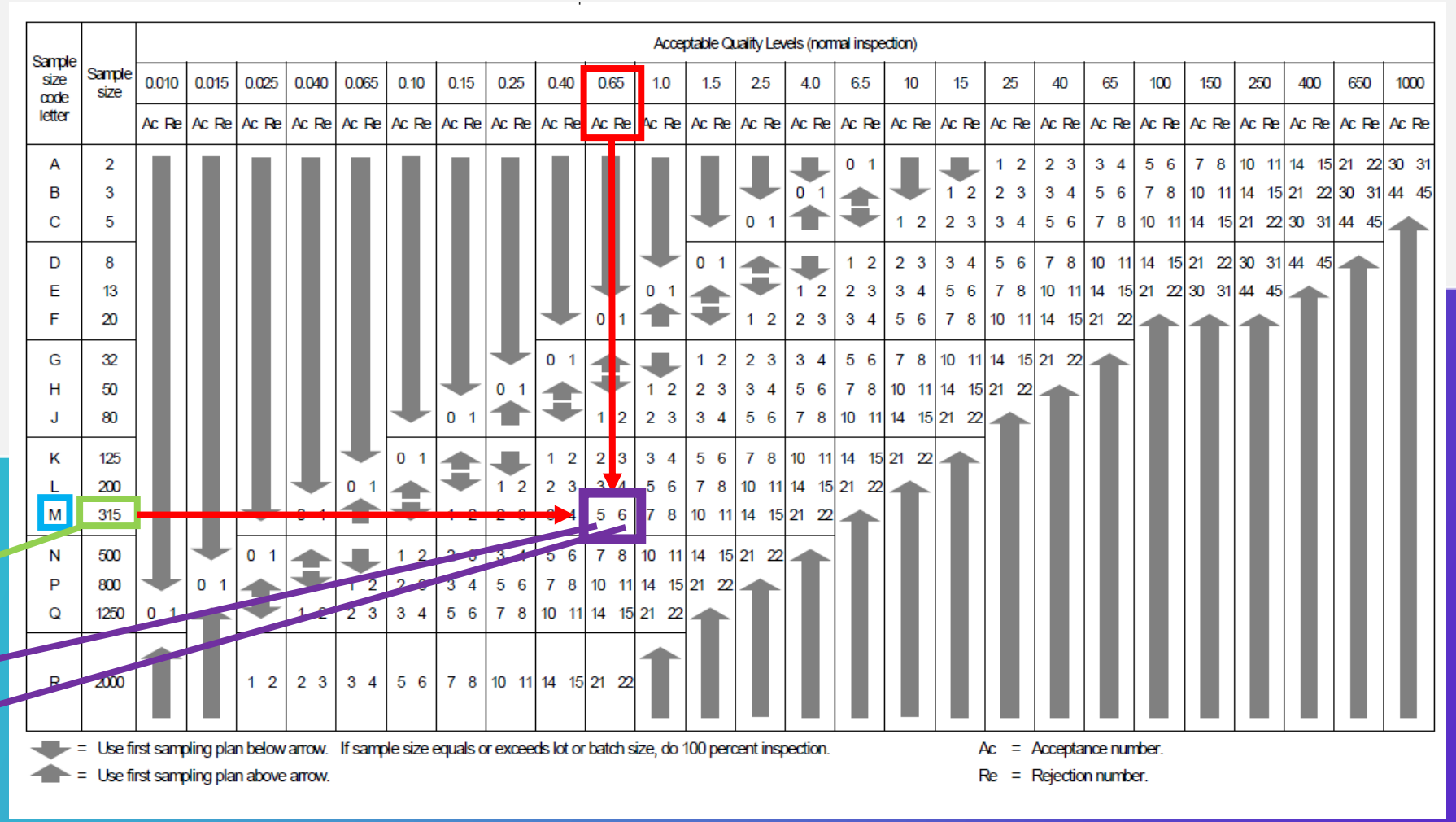
Solution: Therefore,

n =**315**

Ac= **5**

Re= **6**

Single Sampling Plan for *Normal Inspection*



Sample size code letter	Sample size	Acceptable Quality Levels (normal inspection)																															
		0.010	0.015	0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10	15	25	40	65	100	150	250	400	650	1000							
		Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re							
A	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↓	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31							
B	3	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↑	↓	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45							
C	5	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↑	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓							
D	8	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓	↓							
E	13	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓	↓	↓							
F	20	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↓	↓	↓	↓	↓	↓							
G	32	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↓	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↓	↓	↓	↓	↓	↓	↓							
H	50	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↑	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↓	↓	↓	↓	↓	↓	↓	↓							
J	80	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↓	↓	↓	↓	↓	↓	↓	↓	↓							
K	125	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							
L	200	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							
M	315	↓	↓	↓	↓	↑	↓	↑	↓	↑	5 6	7 8	10 11	14 15	21 22	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							
N	500	↓	↓	0 1	↓	↓	1 2	↓	3 4	↓	7 8	10 11	14 15	21 22	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							
P	800	↓	0 1	↑	↓	1 2	↓	3 4	↓	7 8	10 11	14 15	21 22	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							
Q	1250	0 1	↓	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							
R	2000	↑	↑	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑							

↓ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.

↑ = Use first sampling plan above arrow.

Ac = Acceptance number.

Re = Rejection number.

NOW TO THE THIRD TABLE

Single Sampling Plan for *Tightened Inspection*

The 3rd table tell us the the value of n, Ac & Re.

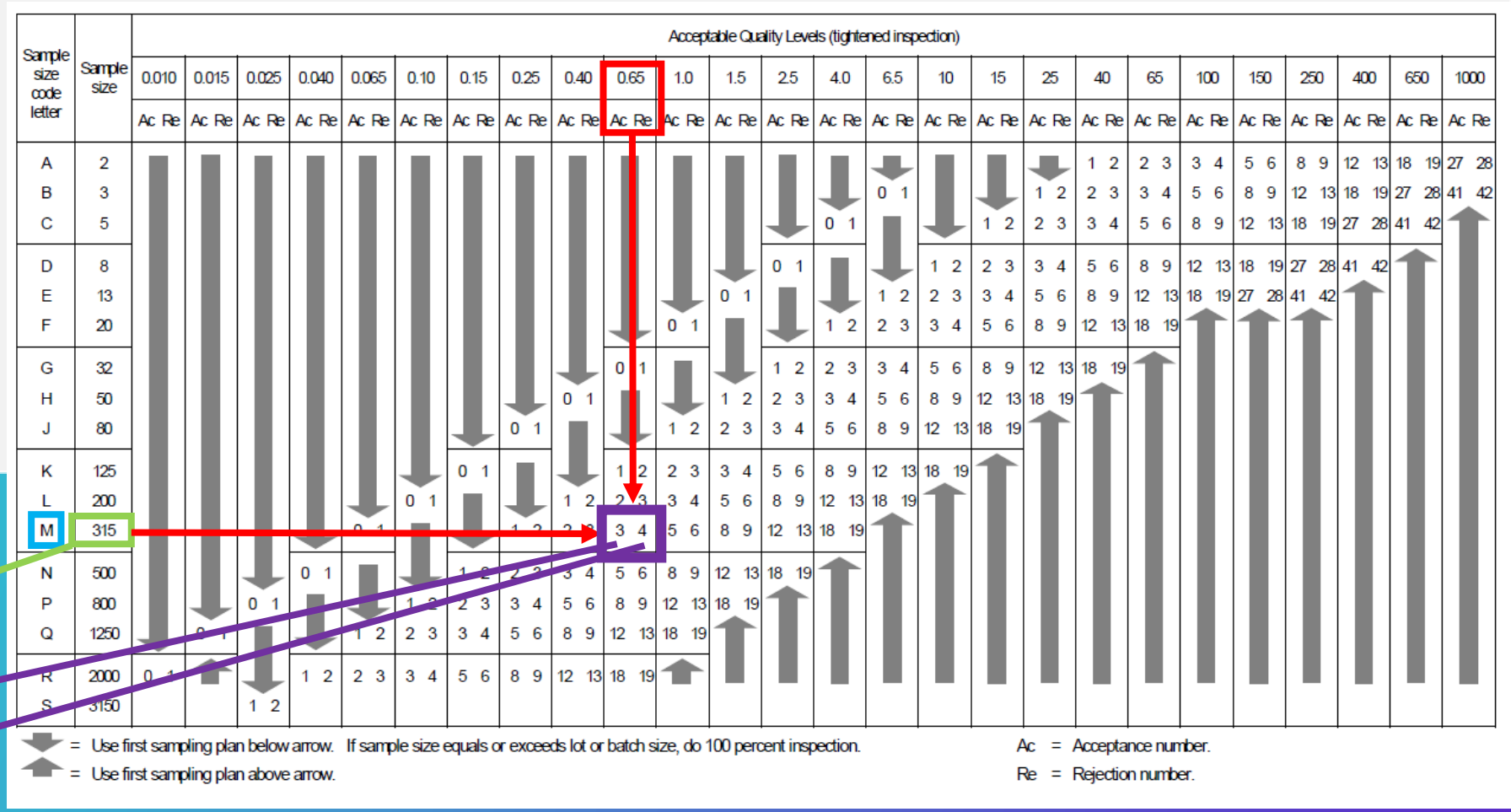
Reading from the "Single Sampling Plan for *Tightened Inspection*" table, withcode letter is **M, with AQL = 0.65%.**

Solution: Therefore,

n =**315**

Ac= **3**

Re= **4**



Sample size code letter	Sample size	Acceptable Quality Levels (tightened inspection)																															
		0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2																																
B	3																																
C	5																									0	1					1	2
D	8																							0	1								
E	13																					0	1					1	2				
F	20																									1	2	2	3				
G	32																			0	1			1	2			3	4				
H	50																	0	1			1	2	2	3	3	4	5	6				
J	80															0	1					1	2	2	3	3	4	5	6	8	9		
K	125													0	1					1	2	2	3	3	4	5	6	8	9	12	13	18	19
L	200											0	1					1	2	2	3	3	4	5	6	8	9	12	13	18	19		
M	315									0	1					1	2	2	3	3	4	5	6	8	9	12	13	18	19				
N	500							0	1			1	2	2	3	3	4	5	6	8	9	12	13	18	19								
P	800					0	1			1	2	2	3	3	4	5	6	8	9	12	13	18	19										
Q	1250							1	2	2	3	3	4	5	6	8	9	12	13	18	19												
R	2000					1	2	2	3	3	4	5	6	8	9	12	13	18	19														
S	3150																																

= Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.

= Use first sampling plan above arrow.

Ac = Acceptance number.

Re = Rejection number.

NOW TO THE FOURTH TABLE

The 4TH table tell us the the value of n, Ac & Re.

Reading from the "Single Sampling Plan for *Reduced Inspection*" table, withcode letter is **M, with AQL = 0.65%.**

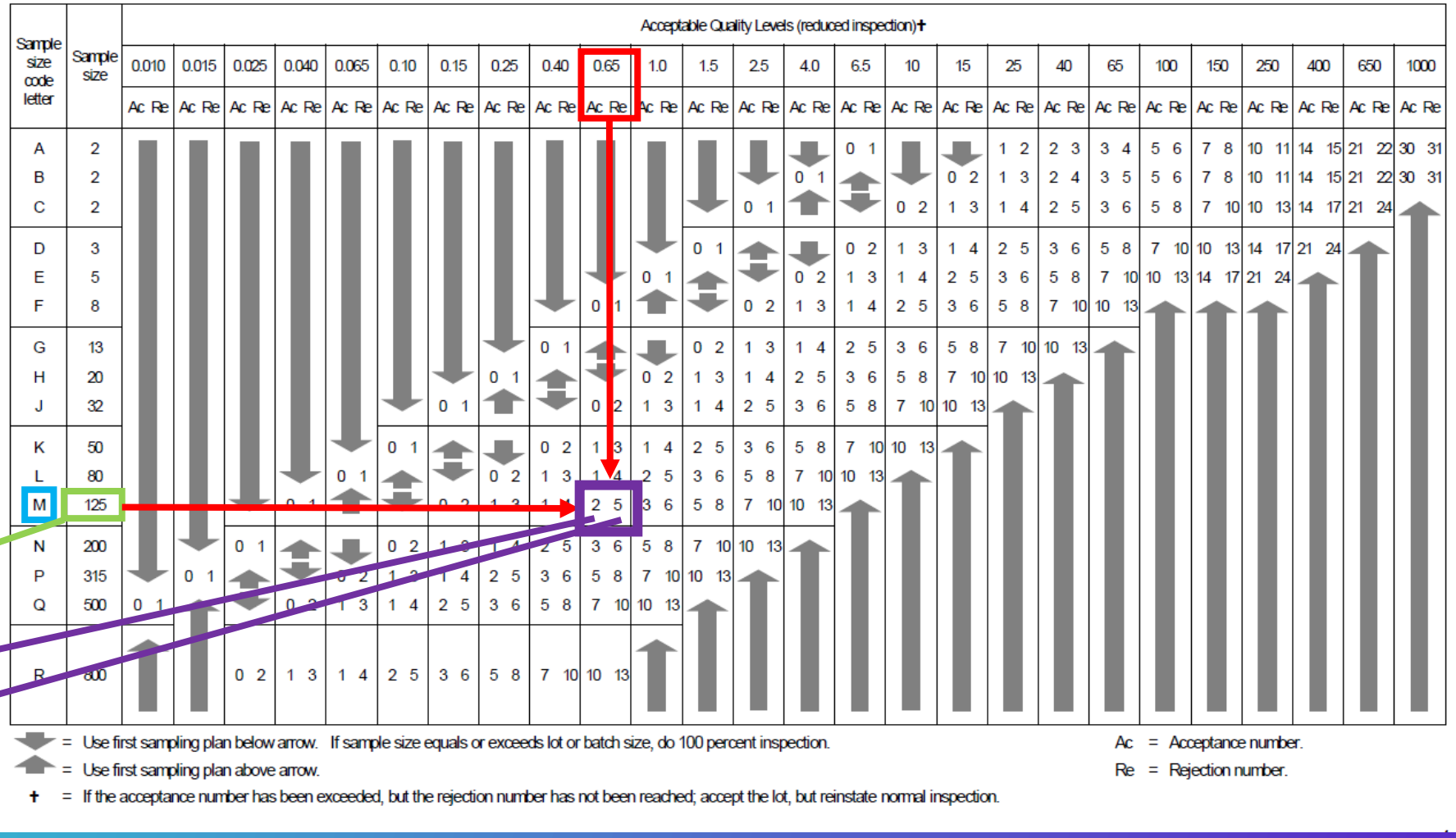
Solution: Therefore,

n =**125**

Ac= **2**

Re= **5**

Single Sampling Plan for *Reduced Inspection*



Sample size code letter	Sample size	Acceptable Quality Levels (reduced inspection)†																													
		0.010	0.015	0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10	15	25	40	65	100	150	250	400	650	1000
		Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re
A	2													0 1	⇩	0 1		0 2		1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	
B	2														0 1	⇧		1 3		2 4	3 5	5 6	7 8	10 11	14 15	21 22	30 31		
C	2													0 1	⇧		0 2	1 3		1 4	2 5	3 6	5 8	7 10	10 13	14 17	21 24			
D	3												0 1	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	14 17	21 24						
E	5											0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	14 17	21 24						
F	8										0 1	⇧	⇧	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13									
G	13									0 1	⇩	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13										
H	20								0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13											
J	32							0 1	⇧	⇧	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13												
K	50						0 1	⇩	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13													
L	80					0 1	⇧	⇧	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13														
M	125				0 1	⇧	⇧	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13															
N	200			0 1	⇩	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇩															
P	315		0 1	⇧	⇩	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧															
Q	500	0 1	⇧	⇧	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧	⇧	⇧															
R	800	⇧	⇧	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧

⇩ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.

⇧ = Use first sampling plan above arrow.

† = If the acceptance number has been exceeded, but the rejection number has not been reached; accept the lot, but reinstate normal inspection.

Ac = Acceptance number.

Re = Rejection number.

WHY NORMAL, TIGHTENED & REDUCE INSPECTION?

Why?

The different inspection levels in a single sampling plan (normal, tightened, and reduced) are used to adjust the probability of accepting or rejecting a lot based on the quality history of the incoming material. This helps to maintain a balance between minimizing the risk of accepting defective lots and avoiding unnecessary inspections.

However, this level is only used under strict conditions to ensure that quality does not deteriorate.

The specific criteria for switching between inspection levels are defined in the sampling plan. This can be based on the number of consecutive lots that meet or exceed the specified quality criteria.

Overall, the use of different inspection levels in a single sampling plan helps to maintain a balance between quality assurance and cost-effectiveness. By adjusting the inspection level based on the quality history of the incoming material, it is possible to minimize the risk of accepting defective lots while avoiding unnecessary inspections.

Here's a breakdown of each level:

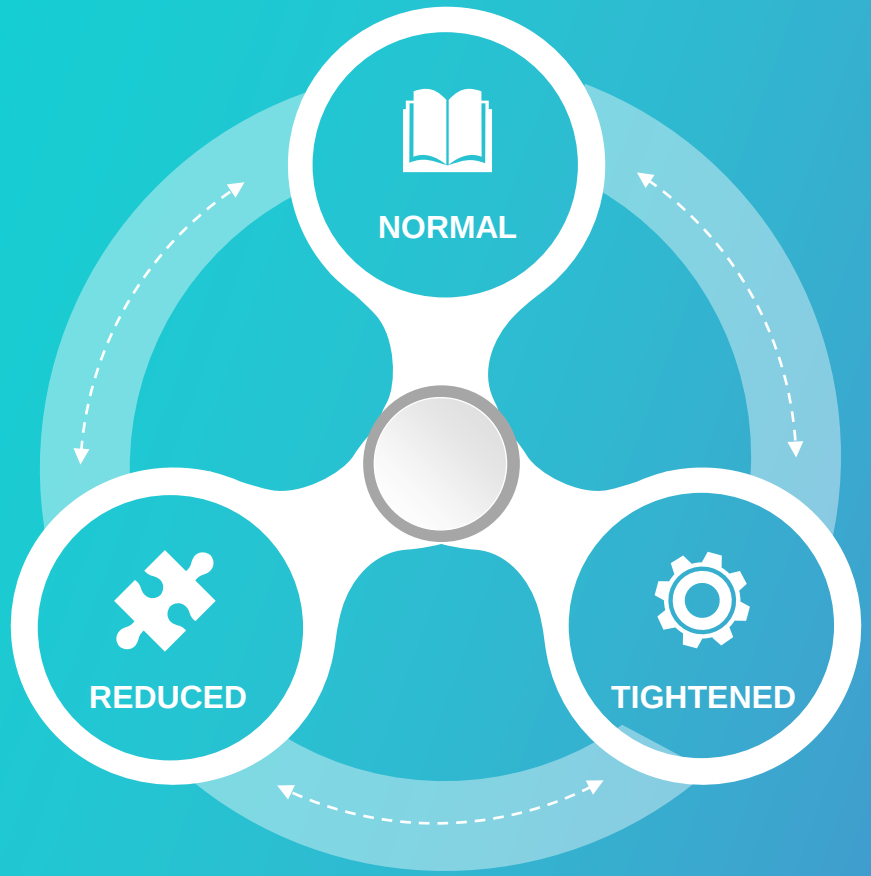
Normal inspection: This is the standard inspection level used when the quality of the incoming material is considered to be acceptable. The sample size and acceptance number are determined based on the desired level of quality assurance.

Tightened inspection: This level is used when the quality of the incoming material has deteriorated. The sample size and acceptance number are increased to reduce the risk of accepting defective lots. This is done to encourage the supplier to improve their quality.

Reduced inspection: This level is used when the quality of the incoming material has consistently been better than the specified requirements. The sample size and acceptance number are decreased to reduce the cost of inspection..

SWITCHING CRITERIA

The switching criteria in a single sampling plan determine when to change from one inspection level (normal, tightened, or reduced) to another based on the quality history of incoming lots. These criteria are typically based on the number of consecutive lots that meet or exceed specific quality criteria.



01 **Normal to Tightened**

- **Condition:** A specified number of consecutive lots are rejected.
- **Example:** If 2 out of 5 consecutive lots are rejected, the inspection level is switched from normal to tightened.

02 **Tightened to Normal**

- **Condition:** A specified number of consecutive lots are accepted.
- **Example:** If 5 consecutive lots are accepted under tightened inspection, the inspection level is switched back to normal.

03 **Normal to Reduced**

- **Condition:** A specified number of consecutive lots meet or exceed a predetermined quality level.
- **Example:** If 10 consecutive lots have zero defects under normal inspection, the inspection level can be switched to reduced.

04 **Reduced to Normal Switching Criteria**

- **Condition:** A specified number of consecutive lots are rejected or lots fall between the acceptance and reject value.
- **Example:** If 2 out of 10 consecutive lots contain defects under reduced inspection, the inspection level is switched back to normal.

05 Discontinue Criteria for Tightened Inspection

- **Condition:** 10 consecutive lots are maintained under tightened inspection.
- **Example:** The production may be discontinued if these factors are not beneficial to the company: severity of quality issue, financial impact, regulatory compliance, and customer satisfaction.

SIMPLE EXAMPLE

Example 3 Suppose an electronic company produces earbuds in lots of 15000 in a month. After running 10 consecutive *normal inspection* cycle using single sampling plan on the produce, what inspection type will be suitable for the 11^{th} time?

Solution: The company may switch to **Single Sampling Plan *Reduced Inspection*** . This will help the company to save cost on the number of sample inspected in terms of time, inspection material, or other resources involved.

Well done

Now that you have a good idea on how to identify the value of n (Sample), c (Acceptance) and r (Reject) in the sampling plan, do remember that switching criteria always applies to help save cost or improve the quality of the product.