Design and Manufacturing of Combine Inspection Gauge for Silencer Cover (059 & 845) of Vacuum Pump

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Abstract - *A Gauge is a tool used to determine and assess or judge the actual dimension, strength, and quantity. There is a huge range of inspection Gauges and instruments that serve these purposes, ranging from small pieces of material that can be measured against measurements to complicated pieces of machinery. This paper deals with the Design and manufacturing of combine inspection gauge for Cover 059 & 845 which both are male & female parts.*

***Key Words*: Combine Inspection Gauge, Receiving Gauge, Gauge for Vacuum Pump, RPN Number, Flush Pin, Pin and Locator, Flow Chart of Receiving Gauge**

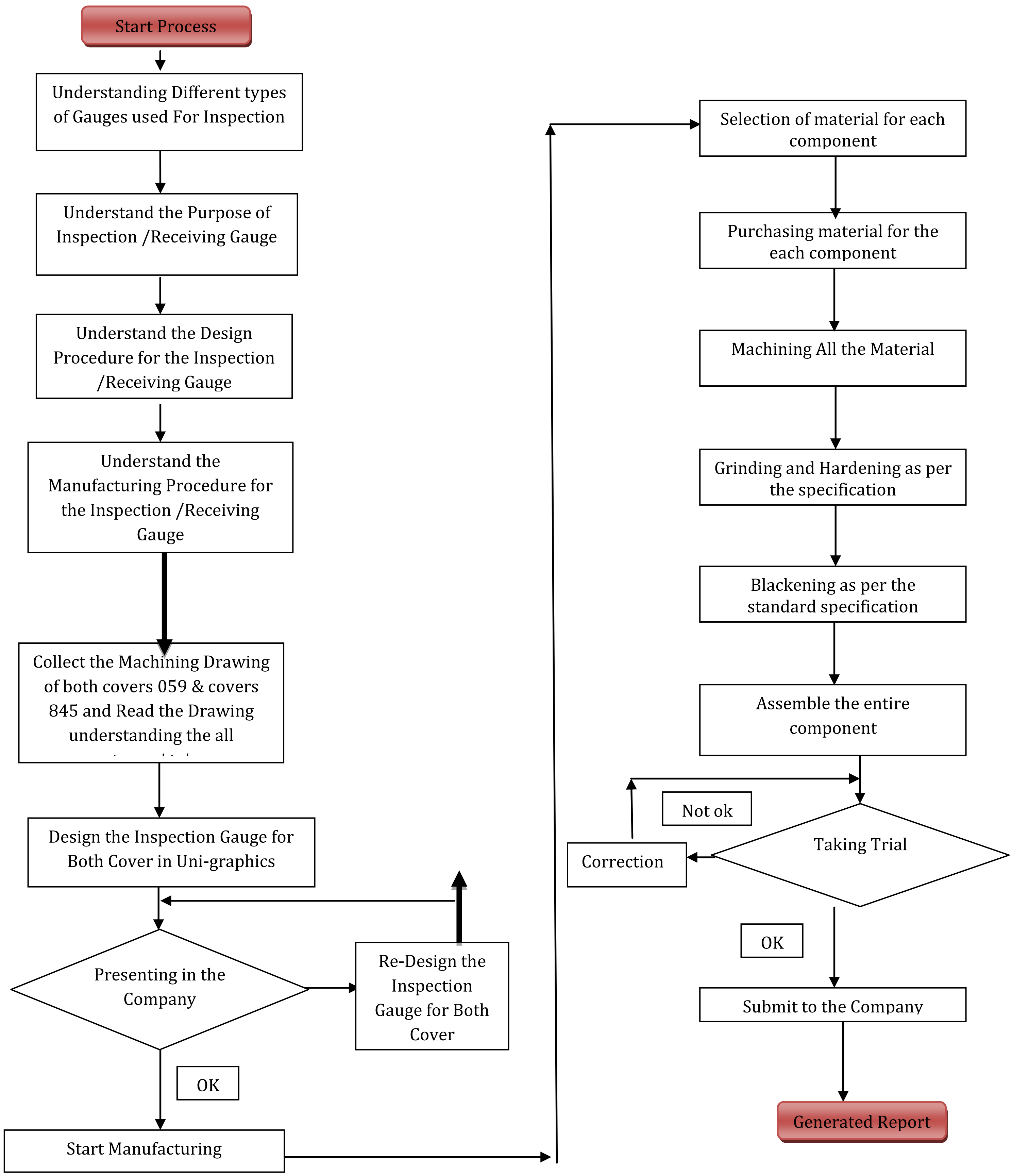
1. INTRODUCTION OF THE PART

The part photos are shown in bellow. For the photos it's shown that there is 9 holes are available for the mating purpose so the base of our inspection gauges to measure the co-ordinates of the 9 holes as well as Remaining machining holes.

Silencer cover 059

Silencer cover 845

2. FLOW CHART FOR DESIGN AND MANUFACTURING OF RECEIVING GAUGE



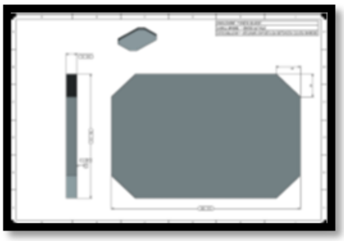
3. DESIGN AND MANUFACTURING OF COMPONENT OF THE RECEIVING GAUGE

3.1 List Of Components of the Receiving Gauge

I. Design of Base Plate
II. Design Liners for 059 & 845 cover.
III. Design Flush Pin for 059 & 845 cover.
IV. Design Locator for 059 & 845 cover.

3.2 Design of Components of the Receiving Gauge

3.2.1 Design of Base Plate

DESCRIPTION	DIMENSION	MATERIAL	MACHINING	DRAWING
A base plate does have a flat, precise undersurface, and forms the top portion on which various parts are mounted.	From the Machining Drawing we Understand that the length of each cover is 320±2.5mm & width of both cover 217±2.5mm.	Mild Steel	Machining on the lathe and making The Width of 20mm with flatness of 0.1mm	

3.2.2 Co-Ordinate Drilling

For cover 059 for drill Dia. is Ø22$H7^{+0.021}_{0}$ for which it is referred as the Press Fit Tolerances.

A. Co-Ordinate for the Cover 059

After the Base plate Machining Drill Co-ordinate of the as per the cover 059 & cover 845

1. Co-ordinate for Tap Hole

Sr. No.	X Co-ordinate	Y Co-ordinate
1	0	0
2	-126	0
3	-238	0
4	36	-103.5
5	-108.4	-103.5
6	274	-103.5
7	0	-207
8	-126	-207
9	-238	-207

2. Co-ordinate for There is 1 Ø35 Bore

Sr. No.	X Co-ordinate	Y Co-ordinate
1	-130	-151

3. Ø9 Drill Are Available in the 059

In the 059 cover there are 4 drills of Ø9. Which are equispaced of 40mm pitch circle diameter with the center of ø35 bore.

4. Drawing

B. Co-Ordinate for the Cover 845

1. Co-ordinate for Drill Hole

In the 845 Cover There are 9 holes of Ø6 which are available which is Spread on the Distance with a reference of dowel hole and which is mirror image of silencer cover 059 so we did not ream this Hole for 845 cover inspection.

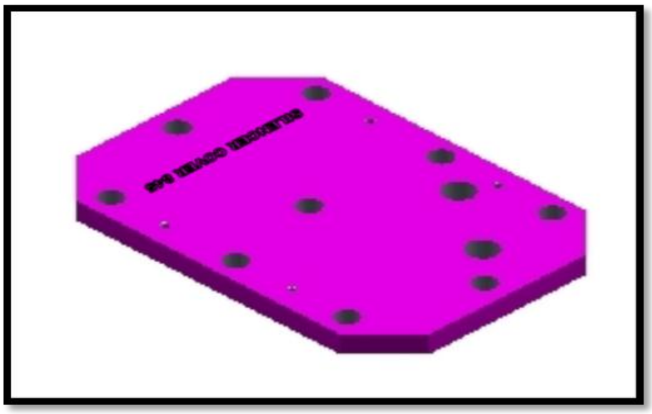
2. Co-ordinate for G1̍ Tap Hole

Sr. No.	X Co-ordinate	Y Co-ordinate
1	169	182

3. Co-ordinate for G2" Tap Hole

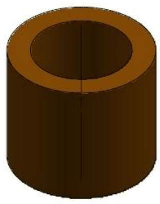
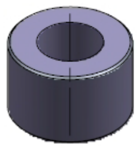
Sr. No.	X Co-ordinate	Y Co-ordinate
1	239	136

4. DRAWING



3.2.3 Design Liners for 059 & 845 Cover

Description: Liner bushings are permanently installed bushings used to hold flush pin. The liner's inner dia. has a precise sliding fit with the flush pin outer dia. and liner's outer dia. has a precise press fit with the reaming inner dia.

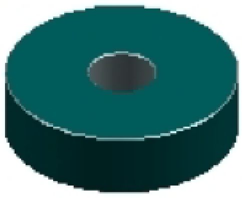
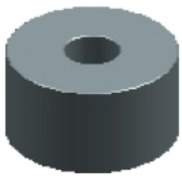
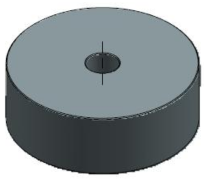
Sr. No.	SPECIFICATION	DIMENTION		FITMENT		MATERIAL	PART PHOTO
		Inner Dia.	Outer Dia.	Inner Dia.	Outer Dia.		
1	Liners for 059 cover for tap and drill hole	$Ø22s6^{-0.031}_{-0.044}$	$Ø15H7^{+0.021}_{0}$	Slide Fit	Press Fit	Carbon steel	
2	Liners for 845 cover for g1′ & g2′	$Ø28s6^{-0.031}_{-0.044}$	$Ø15H7^{+0.021}_{0}$	Slide Fit	Press Fit	Carbon steel	

3.2.4 Design of Flush Pin

Description: Flush pin is sliding through liners and locates the proper co-ordinate of the hole, which is used to check. There are 3 steeped flush pin were used for this receiving gauge.

SR. NO.	SPECIFICATION	DIMENSION			FITMENT IN THE LINER			MATERIAL	PART PHOTO
		1st step	2nd step	3rd step	1st step	2nd step	3rd step		
1	Design Flush Pin For Tap Hole Of 059 And Drill Hole For 845	L=50mm D=Ø25mm Knurling of 0.2mm.	L=35 Mm D= $Ø15g6_{-0.016}^{-0.007}$	L=18 Mm D= 6.6	Transits	Slide	Loose	Carbon Steel	
2	Flush Pin For Drill Hole Of 845 Cover	L=50mm D=Ø25mm Knurling of 0.2mm.	L=35 Mm D= $Ø15g6_{-0.016}^{-0.007}$	L=35 Mm D= 6.8	Transits	Slide	Loose	Carbon Steel	
3	Design Flush Pin For Ø9 Hole For 059.	L=50mm D=Ø25mm Knurling of 0.2mm.	L=144.5 Mm D= $Ø15g6_{-0.016}^{-0.007}$	L=20 Mm D= 9	Transits	Slide	Loose	Carbon Steel	
4	Design Of Flush Pin Ø35 Bore Hole For 059.	L=50mm D=Ø25mm Knurling of 0.2mm.	L=148.5 Mm D= $Ø15g6_{-0.016}^{-0.007}$	L=20 Mm D= $Ø10h6_{-0.021}^{+0.000}$	Transits	Slide	Loose	Carbon Steel	
5	Design Flush Pin For Tap G1'' And Tap G2'' For 845.	L=50mm D=Ø25mm Knurling of 0.2mm.	L=148.5 Mm D= $Ø21g6_{-0.016}^{-0.007}$.	L=20 Mm D $Ø10h6_{-0.021}^{+0.000}$	Transits	Slide	Loose	Carbon Steel	

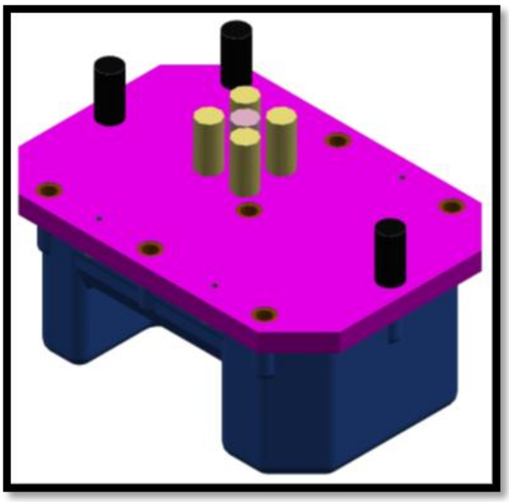
3.2.5 Design of the Locators

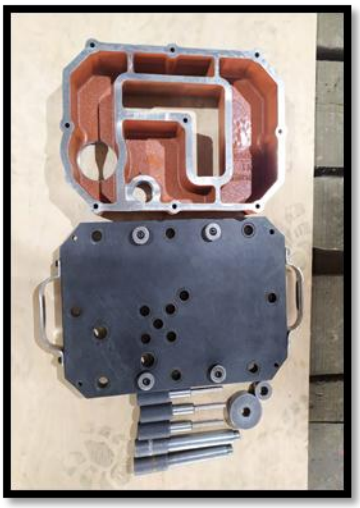
SR. NO	SPECIFICATION	DIMENSION		FITMENT IN FLUSH PIN		MATERIAL	PART PHOTO
		Inner Dia.	Outer Dia.	Inner Dia.	Outer Dia.		
1	Locator For Ø35 Bore Hole for 059	$\varnothing 10H7^{+0.000}_{+0.180}$	Ø35mm	Push Fit	Slide Fit	Carbon Steel	
2	Locator for Tap G1''	$\varnothing 10H7^{+0.000}_{+0.180}$	Ø30.75mm	Push Fit	Slide Fit	Carbon Steel	
3	Locator For Tap G2''	$\varnothing 10H7^{+0.000}_{+0.180}$	Ø56.5mm	Push Fit	Slide Fit	Carbon Steel	

3.2.6 Manufacturing and Assembly

Silencer Cover 845

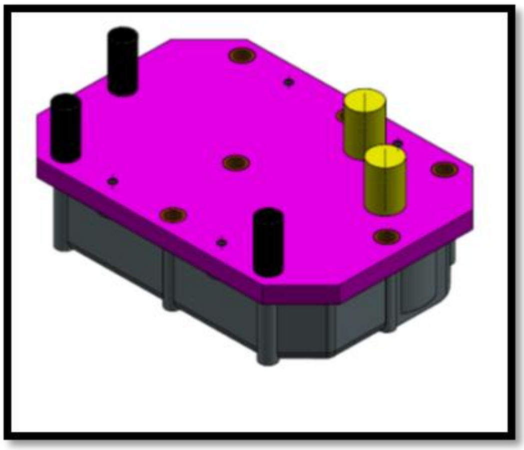
Unigraphics Assembly **Actual Assembly**

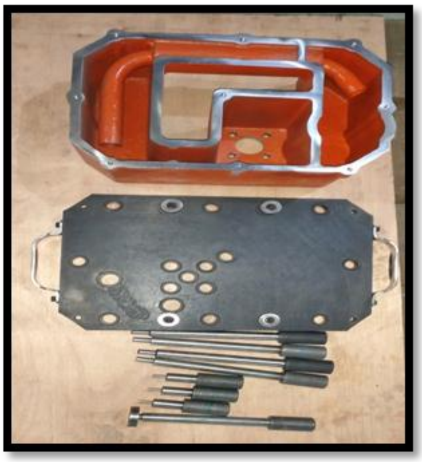




Silencer Cover 059

Unigraphics Assembly **Actual Assembly**





4. IMPLIMENTATION EFFECT ON SHOP FLOOR

4.1 Study of RPN Number

Failure Modes and Effects Analysis (FMEA) is a constructive approach and systematic way of evaluation the operation. Every mode of failure has a quantified statistical score;

(a) The probable risk of failure occur (Occurrence)

(b) The probable risk of failure or loss detection and not being detected (Detection)

(c) The harm or damage done to equipment by the breakdown mode (Severity).

For this mode of failure, the consequence of the three (a, b, c) scores is the risk priority number (RPN). For the failure modes, the number of RPNs is the cumulative loop RPN.

4.2 Terminology

Risk Priority number (RPN) refers to a numeric risk assessment for each process or phase of process in which a team assigns numerical values to any failed mode to quantify likelihood of occurrence, detection frequency and effect intensity. The risk Priority number is the number of the failure risk evaluation process or steps in the FMEA process.

4.3 Risk Priority Number (RPN).

1. O = Failure mode of the rank of occurrence.
2. S = Failure mode of rank of severity
3. D = The chance of the malfunction being detected before the end user / customer is met by the Device.
4. All ranks are displayed on 1-10 scale
5. RPN = O * S * D is specified.
6. The smaller RPN is better and larger is the worse.

4.4 Ranking of Severity

OCCURANCE	FAILURE RATE	CRITERIA	RANK
Very High	> 1 In 2	Failure Is Almost Invertible	10
	1 In 3		9
High	1 In 8	Repeated Failures	8
	1 In 20		7
Moderate	1 In 80	Occassional Failures	6
	1 In 400		5
	1 In 2000		4
Low	1 In 15000	Relatively Few Failures	3
	1 In 150000		2
Remote	< 1 In 15,00,000	Failure Is Unlikely	1

4.5 Ranking of Severity

CRITERIA FOR RANKING SAVERITY	EFFECT	RANK
Failure occurs without warning	Deadly	10
Failure occurs with warning	Hazardous	9
Product inoperable, with loss of function	Very serious	8
Product operable but with loss of performance	Serious	7
Product operable but with loss of comfort	Moderate	6
Product operable, with low effect on performance	Low	5
Noticeable effect by most customers	Very low	4
Noticeable effect by average customers	Minor	3
Noticeable effect by discriminating customers	Very minor	2
No effect	None	1

4.6 Ranking of Detection

CHANCES OF DETECTION OF FAILURE MODE	RANK
No known controls available	10
Very remote chances of detection	9
remote chances of detection	8
Very Low chances of detection	7
Low chances of detection	6
Moderate chances of detection	5
Moderately high chances of detection	4
High chances of detection	3
Very high chances of detection	2
Almost certain to detect	1

4.7 Decreasing RPN number

Risk Priority before Receiving Gauge

Value	Status	Number
Severity	Very High	8
Occurrence	High	8
Detection	Remote	8

RPN before Receiving Gauge

8x8x8

=512

Risk Priority after Receiving Gauge

Value	Status	Number
Severity	Very High	8
Occurrence	High	8
Detection	Very Low	7

RPN before Receiving Gauge

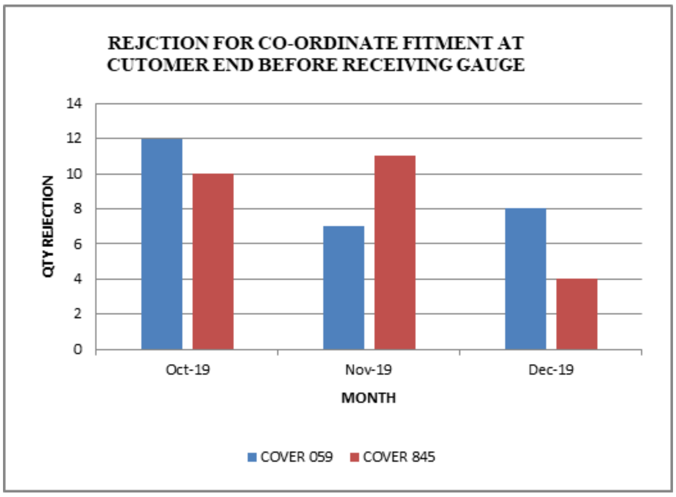
8x8x7

=448

4.8 Rejection Analysis at Shop Floor and At Customer End

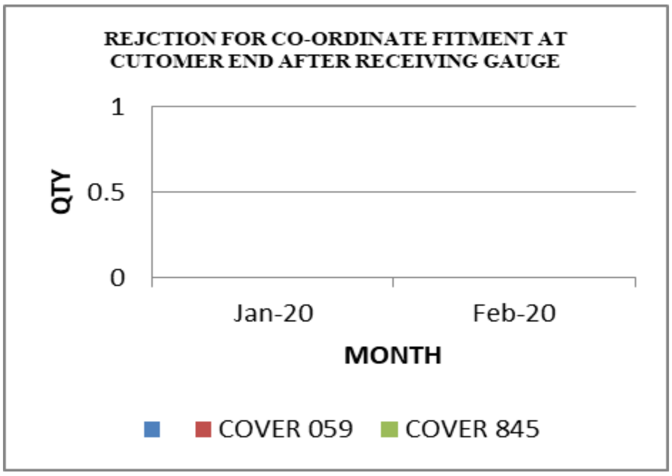
REJCTION FOR CO-ORDINATE FITMENT AT CUSTOMER END BEFORE RECEIVING GAUGE

MONTH/PART	Oct-19	Nov-19	Dec-19
COVER 059	12	7	8
COVER 845	10	11	4



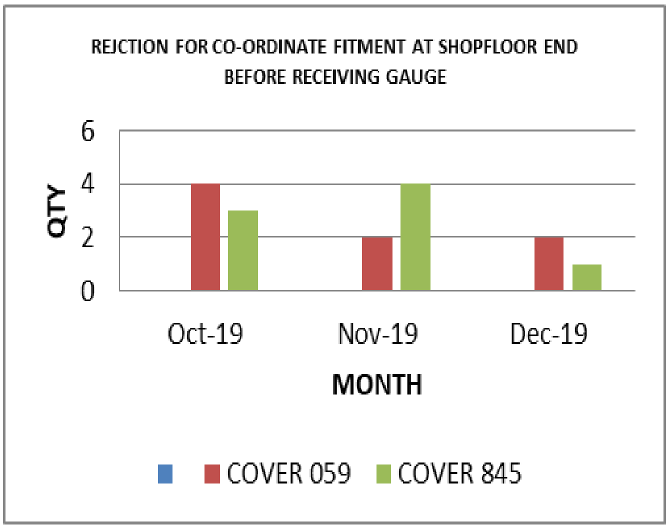
REJCTION FOR CO-ORDINATE FITMENT AT CUTOMER END AFTER RECEIVING GAUGE

MONTH/PART	Jan-20	Feb-20
COVER 059	0	0
COVER 845	0	0

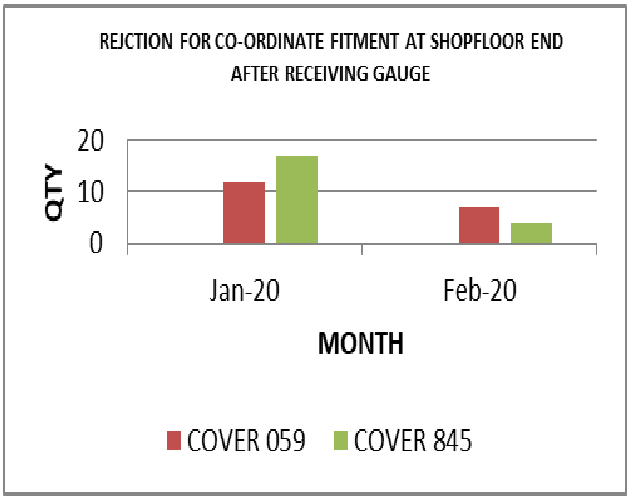


REJCTION FOR CO-ORDINATE FITMENT AT SHOPFLOOR END BEFORE RECEIVING GAUGE

MONTH/PART	Oct-19	Nov-19	Dec-19
COVER 059	4	2	2
COVER 845	3	4	1



REJCTION FOR CO-ORDINATE FITMENT AT SHOPFLOOR END AFTER RECEIVING GAUGE		
MONTH/PART	Jan-20	Feb-20
COVER 059	12	7
COVER 845	17	4



5. CONCLUSION

From the Both Graph We understand that the Rejection the customer end is reduce to zero and the detection of the not ok part at the shop floor is increases. That means the increasing productivity of ok parts as well as increasing customer satisfaction so the receiving gauge is used for decreasing the risk of not ok part send to Customer.

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BIOGRAPHIES

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