A
MAJOR PROJECT REPORT
ON

"TPM APPROACH FOR ANALYSIS AND REDUCTION IN ENGINE LEAKAGE FROM STATOR PLATE"

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT
FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY
(PRODUCTION & INDUSTRIAL ENGINEERING)

Submitted by:
ASHISH VASHISTHA
UNIVERSITY ROLL NO: 2K11/PIE/02

Under the esteemed Guidance of:
Dr. QASIM MURTAZA (Associate Professor)
Dr. SAURABH AGGARWAL (Associate Professor)

DEPARTMENT OF MECHANICAL ENGINEERING

DELHI TECHNOLOGICAL UNIVERSITY

BAWANA ROAD, DELHI.

ACKNOWLEDGEMENT

It is distinct pleasure to express my deep sense of gratitude and indebtedness to my supervisor **Dr. QASIM MURTAZA** Professor, **Department of Mechanical Engineering,** Delhi Technological University**,** (Formerly Delhi College of Engineering), for his invaluable guidance, encouragement and patient reviews. His continuous inspiration only has made me complete this minor project. Without his help and guidance, this minor project would have been impossible. He remained a pillar of help throughout the project.

I am also grateful to Dr. **Saurabh Aggarwal, Department of Mechanical Engineering**, for providing the experimental facilities in various labs of the Department.

I express my sincere gratitude to the faculty and non teaching staff of Mechanical engineering department and the library of Delhi Technological University, (Formerly Delhi College of Engineering) for providing the relevant information and help when needed during the course of my project work.

I am also thankful to my classmates and my friends for their unconditional support and motivation during this work.

(ASHISH VASHISTHA)

(2K11/PIE/02)

M.TECH-FINAL YEAR

CERTIFICATE

Dated :

This is to certify that report entitled **"TPM APPROACH FOR ANALYSIS AND REDUCTION IN ENGINE LEAKAGE FROM STATOR PLATE"** by **Mr. Ashish Vashistha,** is the requirement of the partial fulfilment for the award of **Degree of Master of Technology (M.Tech) in Production & Industrial Engineering at Delhi Technological University**. This work was completed under our supervision and guidance. He has completed his work with utmost sincerely and diligence. The work embodied in this project has not been submitted for the award of any other degree to the best of my knowledge.

(Supervisor)

Dr. QASIM MURTAZA

(ASSOCIATE PROFESSOR)

(Co-Supervisor)

Dr. SAURABH AGGARWAL

(ASSOCIATE PROFESSOR)

Department of Mechanical Engineering

Delhi Technological University, (Formerly Delhi College Of Engineering), Delhi – 110042

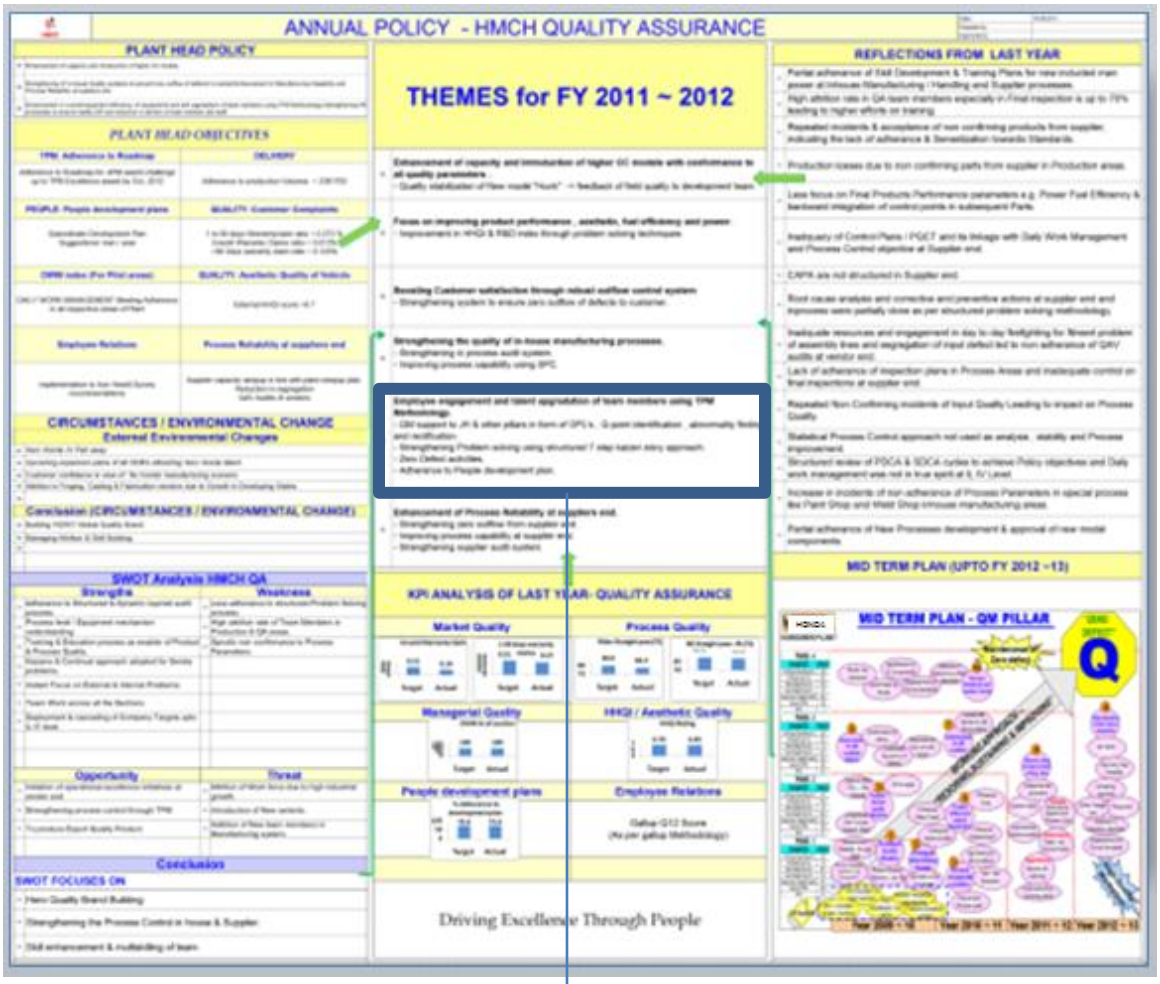
Session 11~13

CONTENTS **PAGES**

1. SELECTION OF THEME

SELECTION OF THEME IS BASED ON THE ANNUAL POLICY (2012 ~ 2013) OF HONDA MOTORCYCLE AND SCOOTER INDIA PVT LTD.

AS PER ANNUAL POLICY

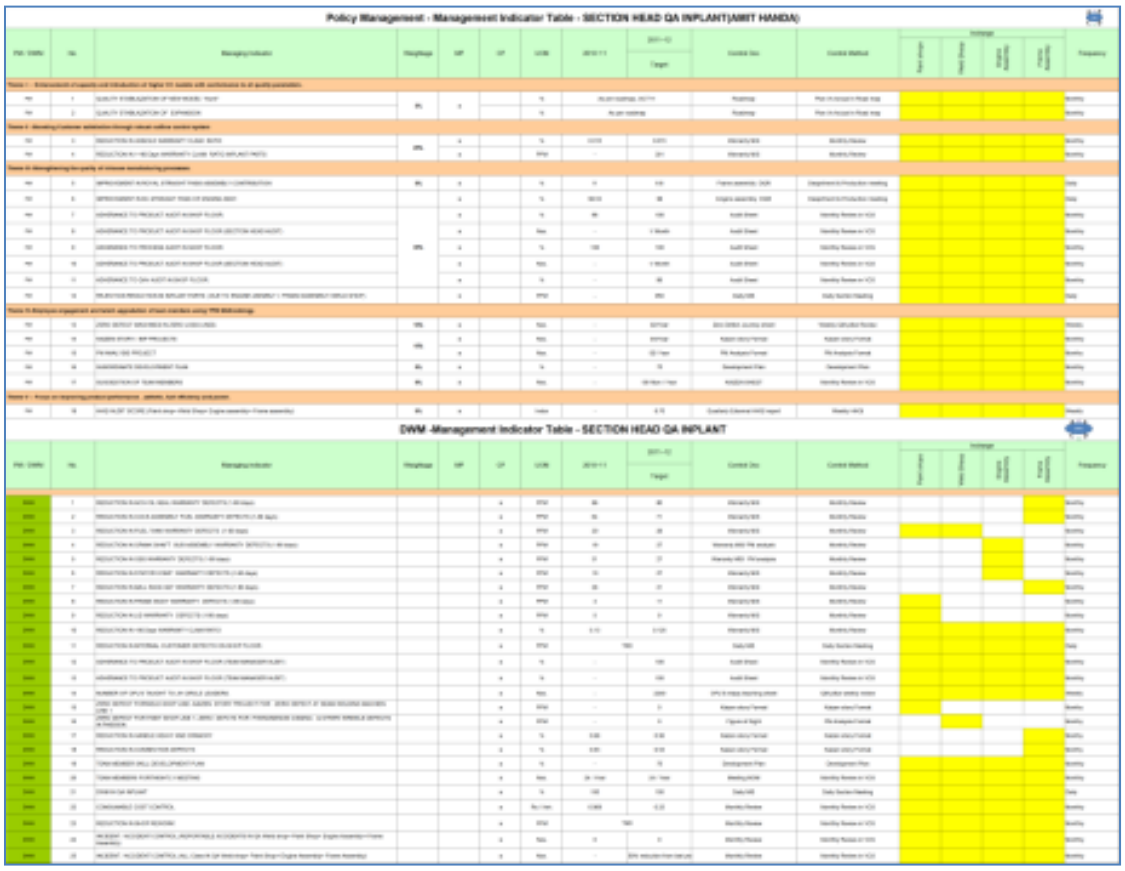


1. Boosting Customer satisfaction through robust outflow control system
2. Strengthening system to ensure zero outflow of defects to customer.
3. Strengthening Problem solving using structured 7 step kaizen story approach.
4. Zero Defect activities

Under this policy, department policy developed and after that Department Manager policy will introduced.

MANAGEMENT INDICATOR: DEPARTMENT MANAGER POLICY:

According to this policy:-



Policy Management - Management Indicator Table - SECTION HEAD QA INPLANT(AMIT HANDA)

DWM -Management Indicator Table - SECTION HEAD QA INPLANT

1. Increase engine straight pass.
2. Zero defect machine in zero loss line.
3. Pm analysis project.
4. Kaizen story / IMP projects.
5. Team suggestions
6. Subordinate development.

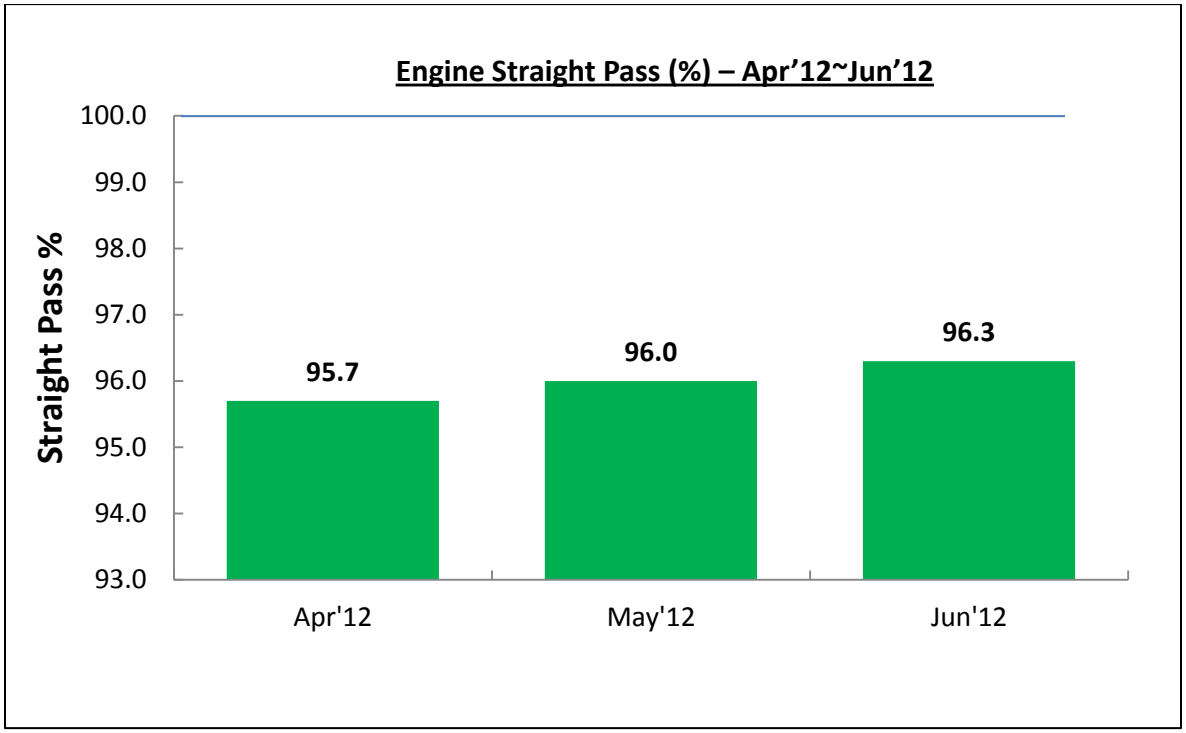
HMSI QUALITY POLICY : POLICY FOCUSED ON DEFECT REDUCTION BY STRUCTURED 7 STEP KAIZEN STORY APPROACH

1.1 IDENTIFY THE PROBLEM

To identify the problem we take the data of engine straight pass of three months.
Before moving forward it is necessary to know the straight pass.
yttStraight means the percentage of engine produced without any defect.

Straight pass = No. of defective engine / No of total engine produced * 100 %

Here I am showing the bar graph of 3 months of Engine straight pass.

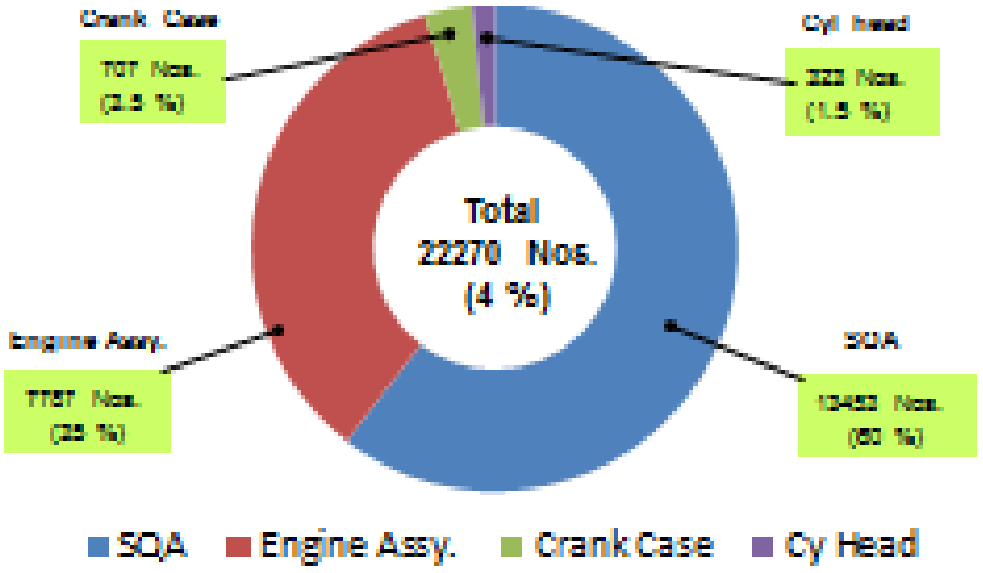


By this graph we can say that the average engine straight pass for the month of April, may, june is nearby 96 % which is 4 % less than the target i.e 100 %.

Now the defect contribution for this 4 % department wise is given below.

There are total 4 departments who feed the engine assembly and these 4 departments contribute for the engine straight pass.

SECTION WISE CONTRIBUTION FOR (APRIL '12 ~ JUNE '12)



By this graph we can easily identify that the percentage contribution for the 4 % defect section wise are :-

35 % contribution of engine assembly

3.5 % contribution of crank case.

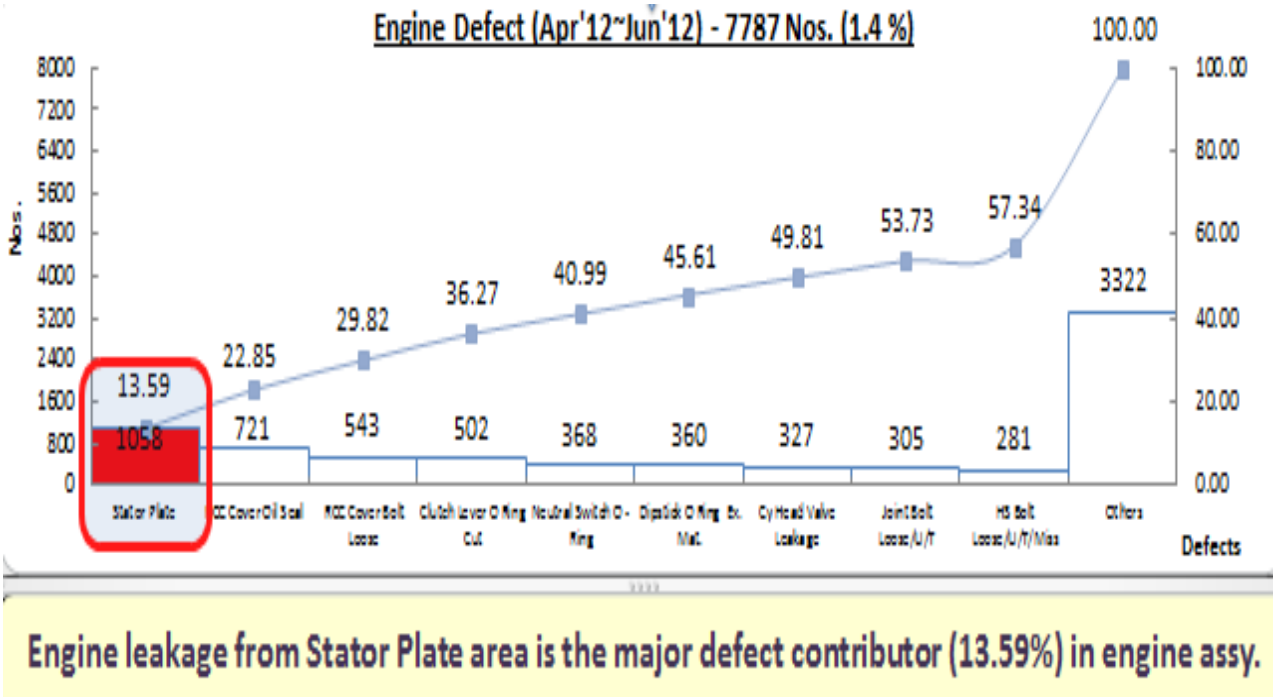
60 % contribution of Supplier (SQA).

1.5 % contribution of cylinder head department

Now we can say that the top 2 contributing department area engine assembly and SQA.

So for selection of theme and identify the problem I am taking engine assembly defect as an

Improvement project which will be a step towards accomplish our company QA policy.



Engine leakage from Stator Plate area is the major defect contributor (13.59%) in engine assy.

By doing the parato Analysis we have taken top 10 defects and their contribution. Here we found that

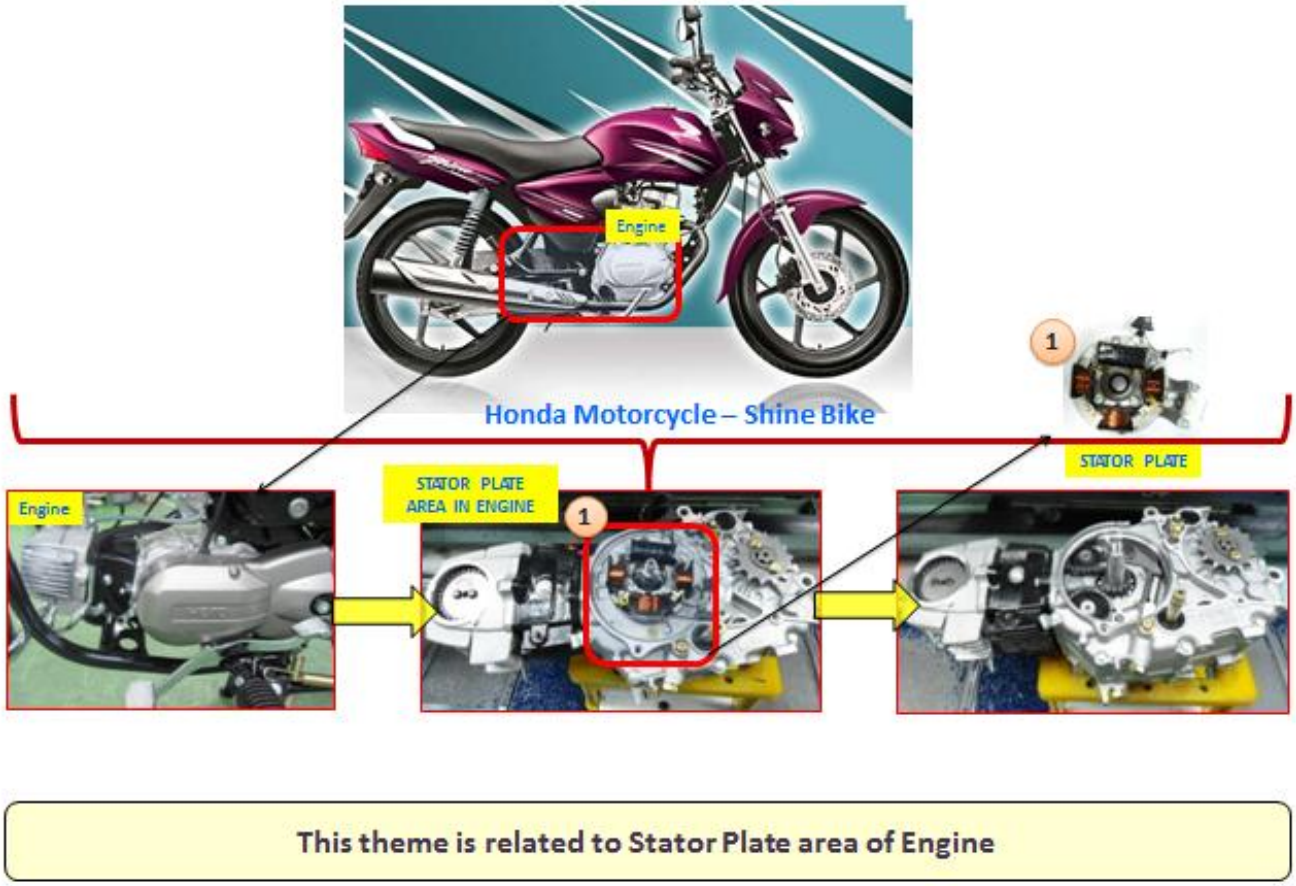
The stator plate leakage is the top most defects and having the contribution of 13.59 percent.

By doing this analysis I have selected my theme of this project which is STATOR PLATE LEAKAGE

FROM ENGINE.

2. UNDERSTANDING CURRENT SITUATION AND TARGET SETTING :-

2.1 UNDERSTANDING CURRENT SITUATION:-



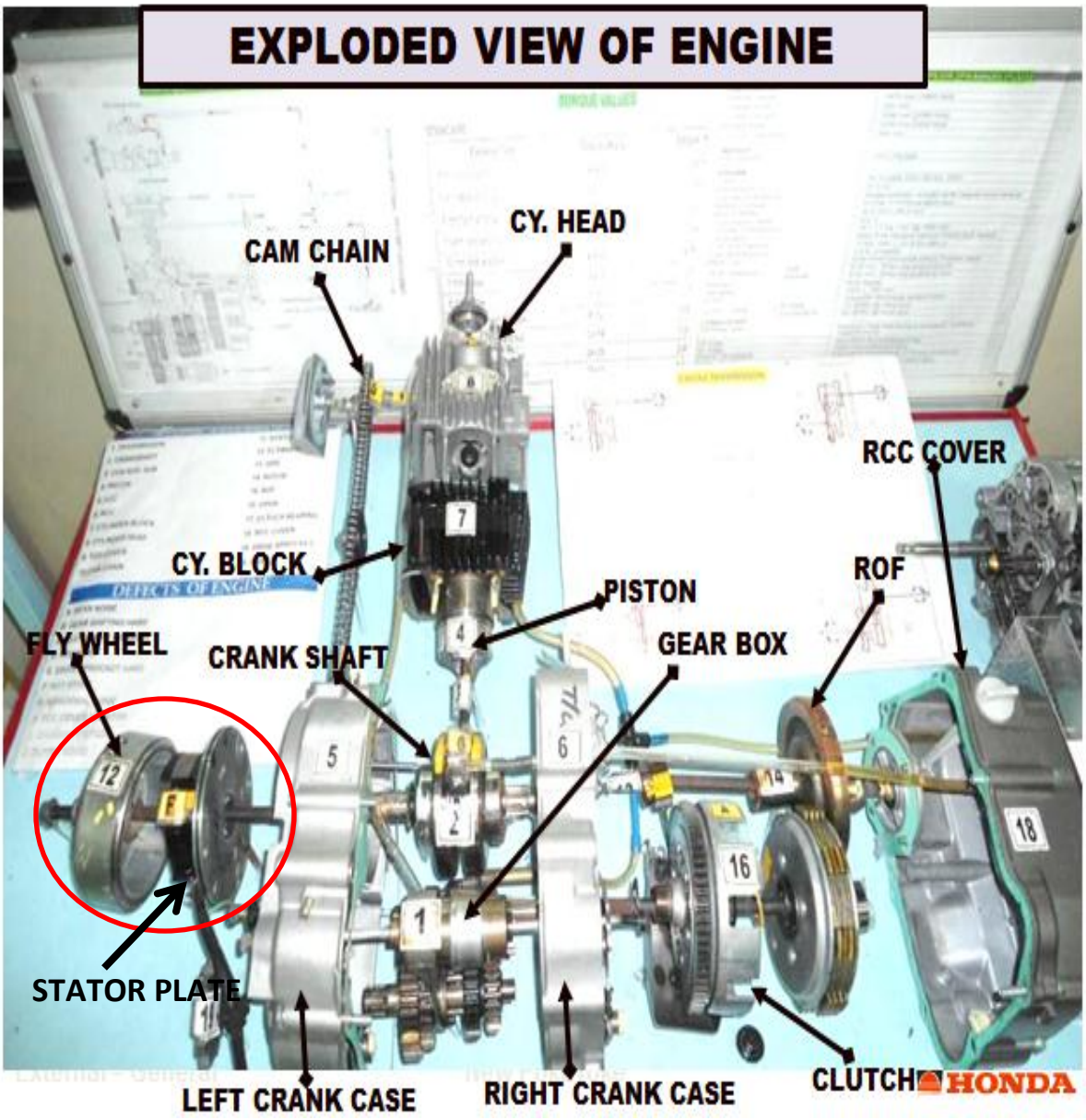
Some of the major components of engine assy are given below.

1. Crankcase right
2. Crankcase left
3. Cylinder head
4. Cylinder block
5. ACG (alternative current generator)

ACG consist of 2 parts. One is stator plate and second is flywheel or rotor.

The function of this ACG is to provide the current for spark plug and various electrical circuits. The stator plate is stationary having the coils and rotor or flywheel is rotary.

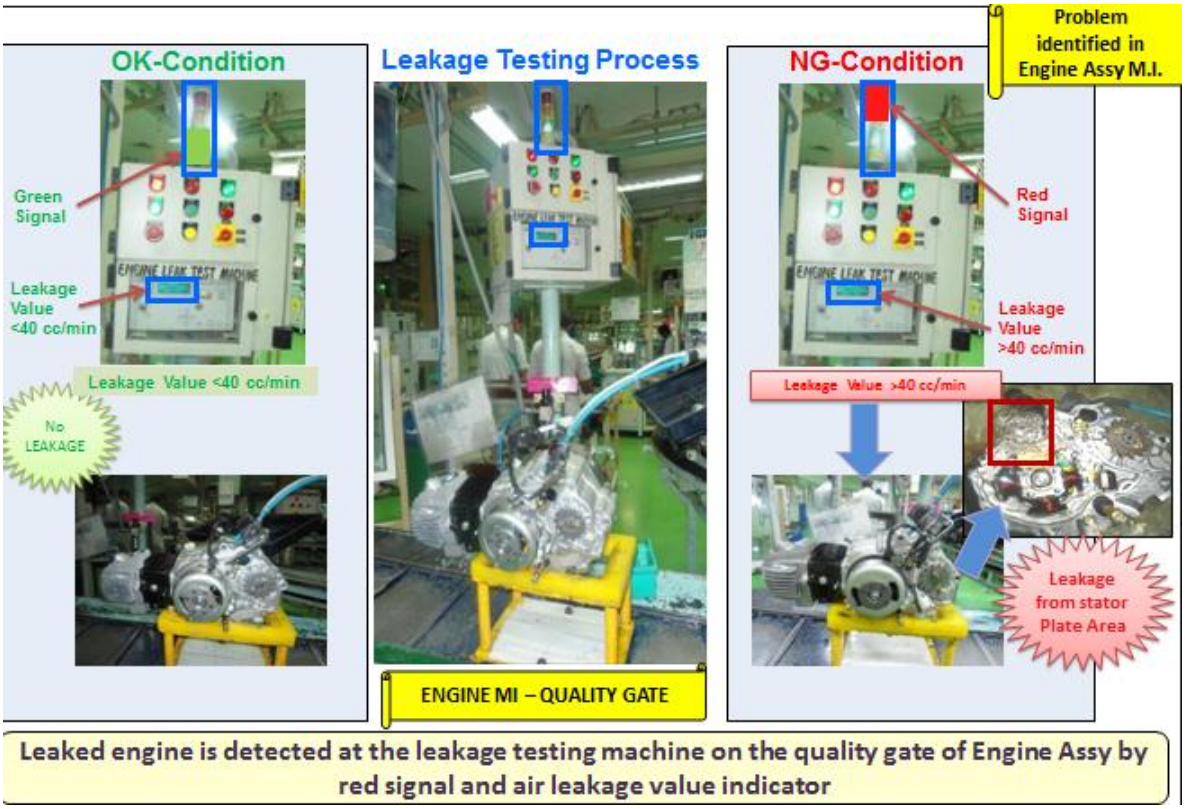
Now here i am showing the exploded view of engine to clear the component and assembly of engine.



In this exploded view you can easily understand that the assembly of stator plate is on the left crankshaft in left crank case.

This stator plate is fixed with two screws in left crank case on left crankshaft, after that flywheel or rotor is mounted on crankshaft in such a manner so that it can cover the coil.

ENGINE LEAKAGE TESTING MACHINE AND PROCESS :-



After complete assembly of engine , engine is tested, we called it leakage testing.
Leakage testing machine principle is based on the comparison of master engine (Completely OK engine)with the leakage engine.
We insert the air in both the engine at 0.2 bar. Then there is a stabilization time after filling the air.

If there is any leakage in the engine then the air in the master engine travel or moves towards the leakage one. The flow rate of the leakage or we can say that the flow rate of air from master engine to leakage engine is the leakage value.

As per standard the leakage value is 40 cc/min.

There is a provision on the machine that if there is any leakage engine detected than machine will give red light with buzzer.

In the same fashion, if there is any ok engine , machine will give green light with signal as shown in fig

STATIFICATION OF STATOR PLATE LEAKAGE MODEL, LINE, MONTH AND VENDOR WISE

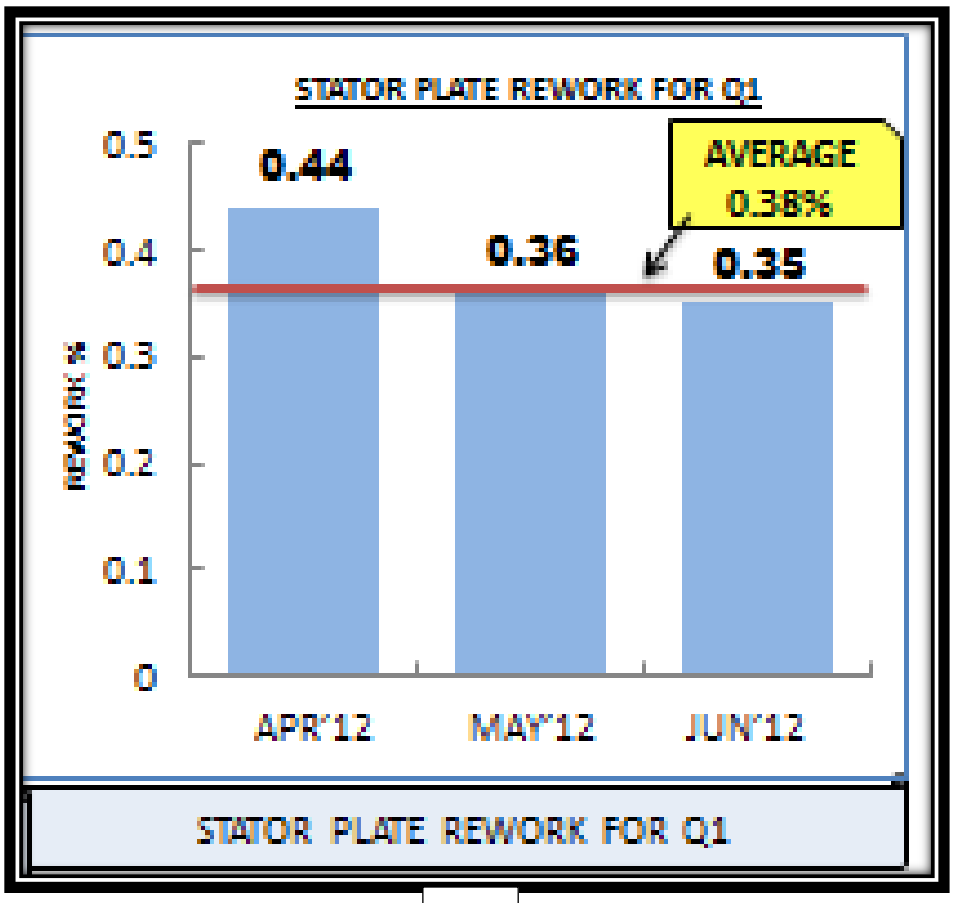


Fig 1

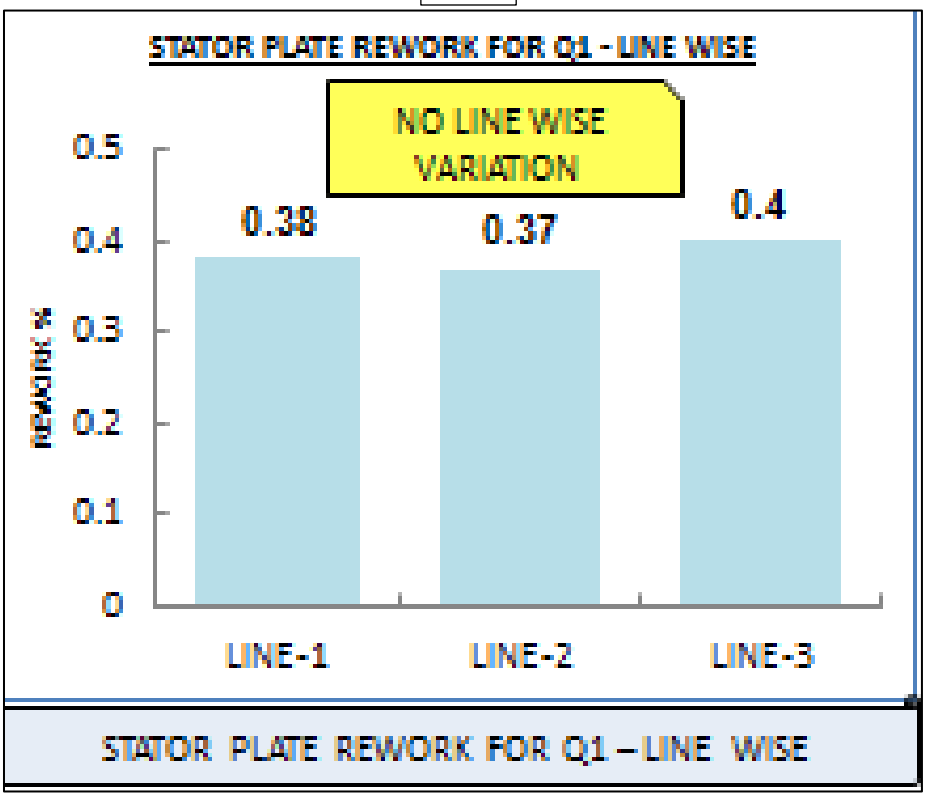


Fig 2

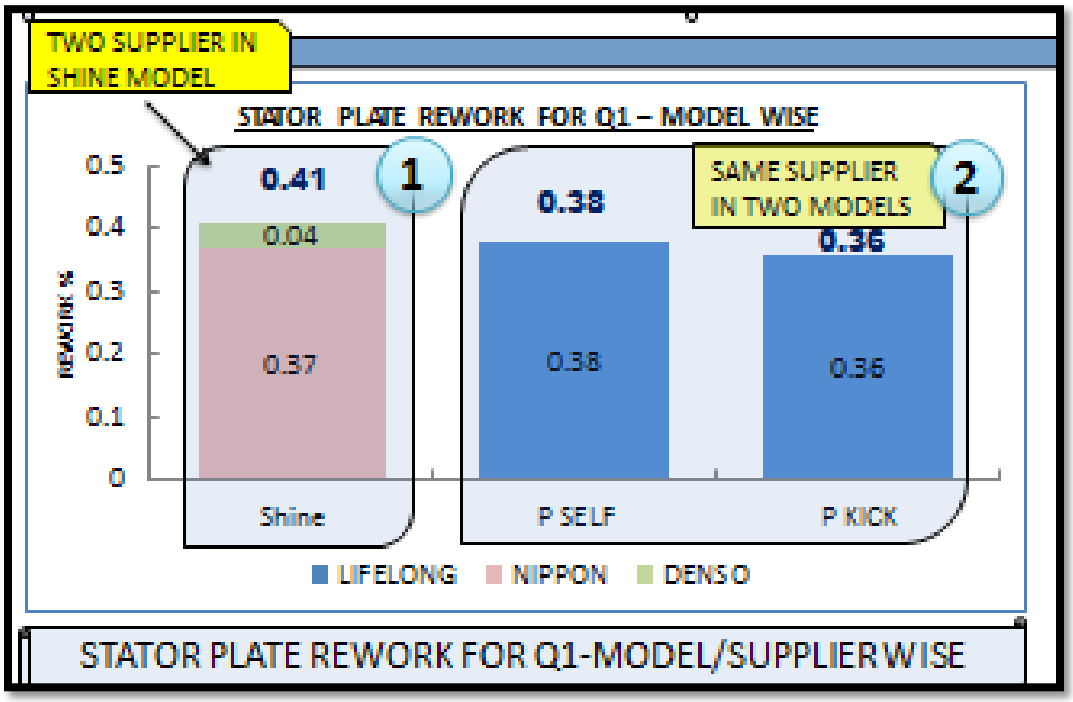

TWO SUPPLIER IN SHINE MODEL
STATOR PLATE REWORK FOR Q1 – MODEL WISE
0.41
1
0.04
0.37
0.38
SAME SUPPLIER IN TWO MODELS
2
0.36
0.38
0.36
0.5
0.4
0.3
0.2
0.1
0
Shine
P SELF
P KICK
LIFELONG
NIPPON
DENSO
STATOR PLATE REWORK FOR Q1-MODEL/SUPPLIER WISE

Fig 3

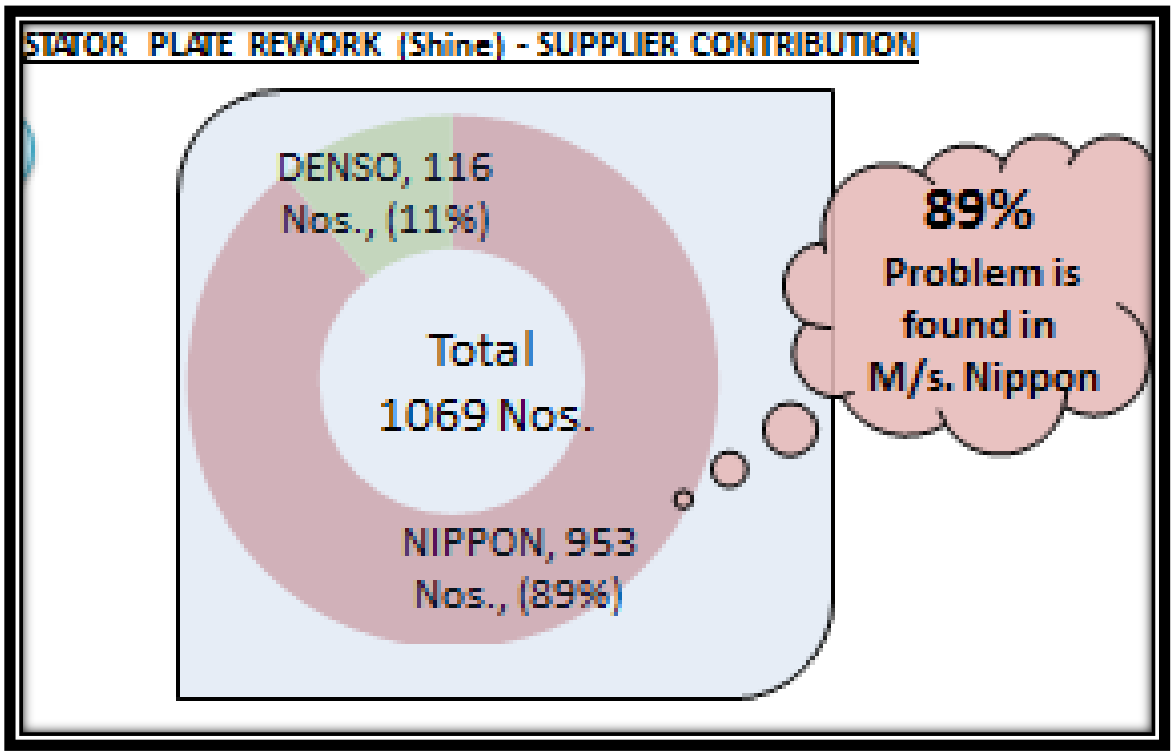

STATOR PLATE REWORK (Shine) - SUPPLIER CONTRIBUTION
DENSO, 116 Nos., (11%)
Total 1069 Nos.
NIPPON, 953 Nos., (89%)
89% Problem is found in M/s. Nippon

Fig 4

In first graph, it shows the percentage of stator plate defect in the month of April , May, June 2012. The Average of stator plate defect of these 3 months is 0.38 % in Quarter 1.

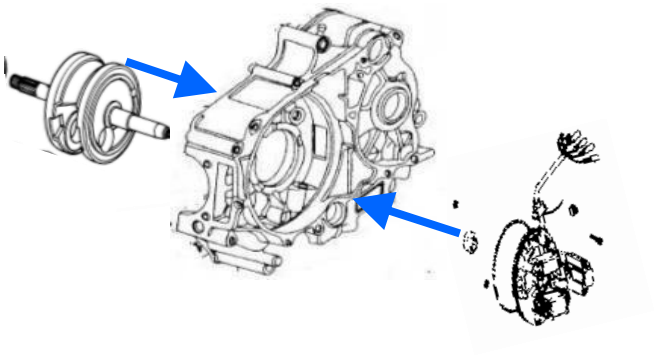
In second graph, it shows the stator plate defect of Quarter 1 line wise. In this graph it is very clear that the defect is coming on each line and almost in equal proportion.

Third Graph Shows the stator plate defect vehicle model wise. First one is for shine mode using two different vendors. Nipon and Denso are the two vendors who provides stator plate for the shine model. For shine model 0.41 % contribution of nipon vendor and 0.04% contribution of denso vendor.

The volume of shine model is very high as comparatively then the other 2 models so we are considering only for the shine model.

In the last graph we can see clearly that for particular shine model, 89% leakage contribution is by nipon stator plate and only 11 % contribution is from denso stator plate.

ASSEMBLY VIEW OF STATOR PLATE AREA



CONTRIBUTING PARTS IN STATOR PLATE LEAKAGE :

1. CRANK CASE LEFT (INHOUSE PART)

2. CRANKSHAFT LEFT

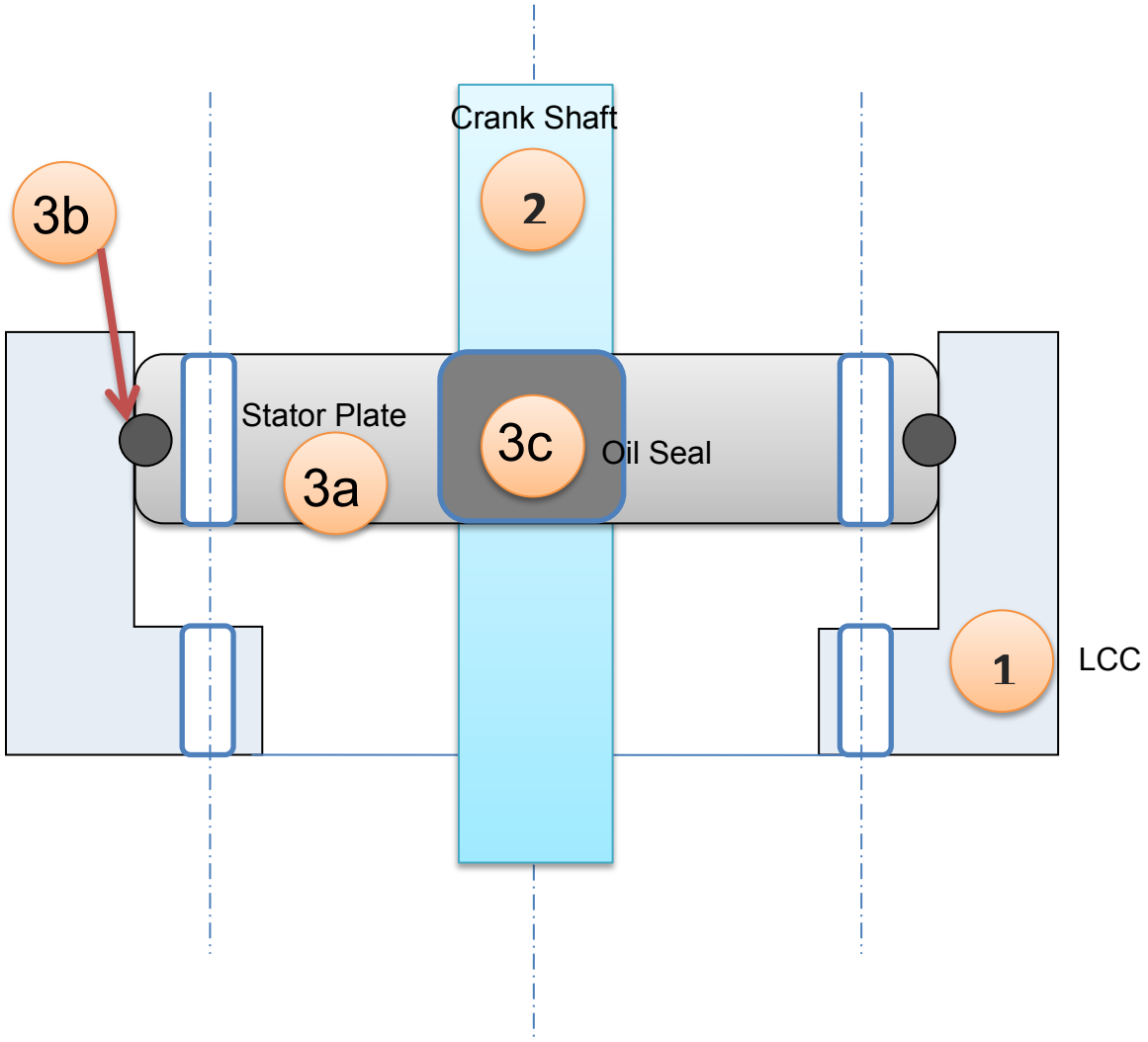
3. STATOR PLATE ASSEMBLY (SUPPLIER)

3a. Stator plate

3b. O'Ring

3c. Oil Seal

MECHANISM UNDERSTANDING OF STATOR PLATE LEAKAGE



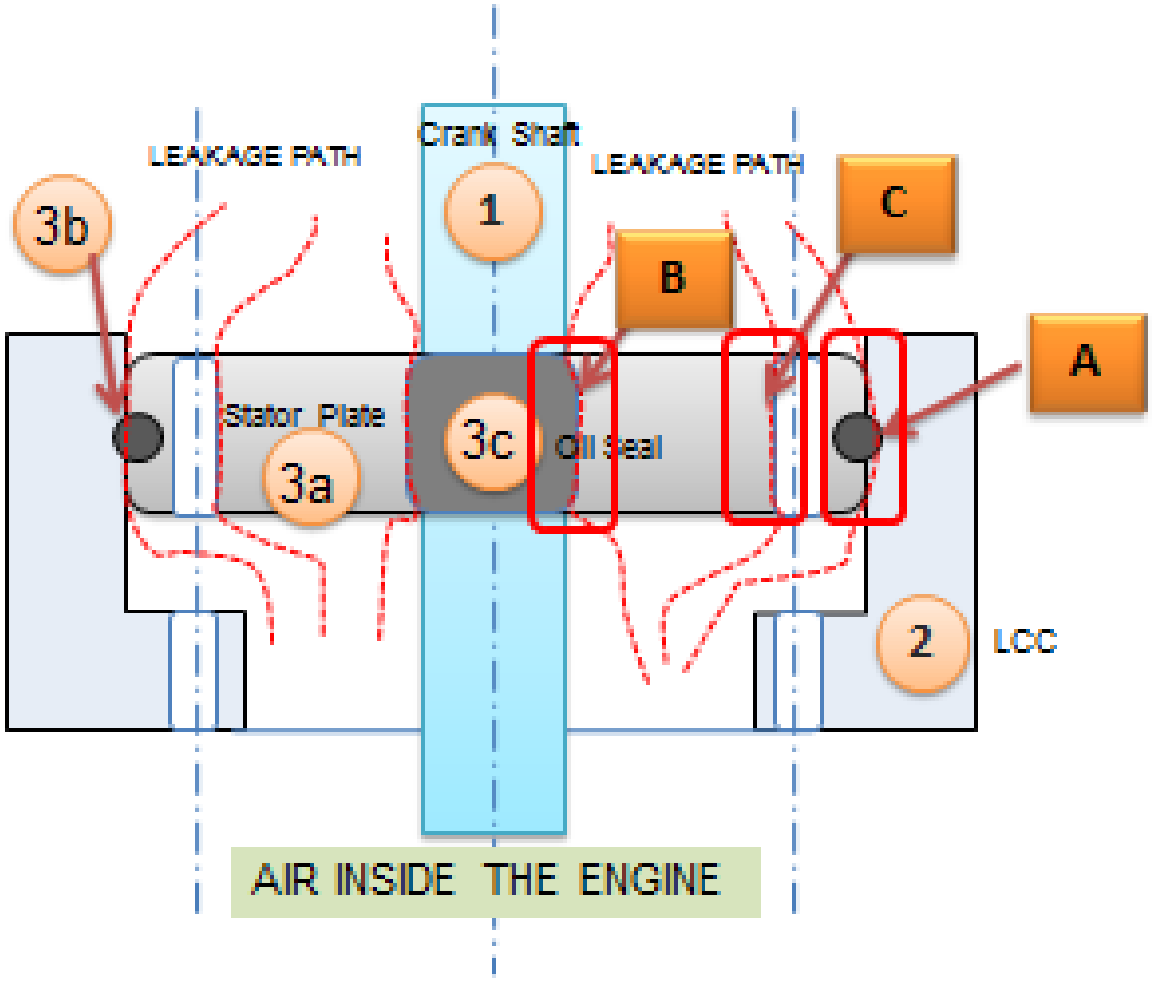
This figure shows the assembly of stator plate with crankcase and crankshaft including there child parts of stator plate.

Stator plate consisting of three parts : First is O'Ring on the outer side of the stator plate in the groove. Second is the oil seal in the inner dia of stator plate.

This Stator plate rests in the crankcase left with a slightly interference fit. The inner side of the stator plate which is having oil seal slides over the crankshaft.

In the figure. 3a shows the stator plate. 3b shows the o'ring between crankcase and stator plate. 3c shows the oil seal over the crankshaft.

BREAK UP OF 1069 Nos. (0.68%) LEAKGAE ENGINE IN SUPPLIER M/s NIPPON BASED ON SEALING SURFACES



SEALING SURFACES – STATOR PLATE AREA

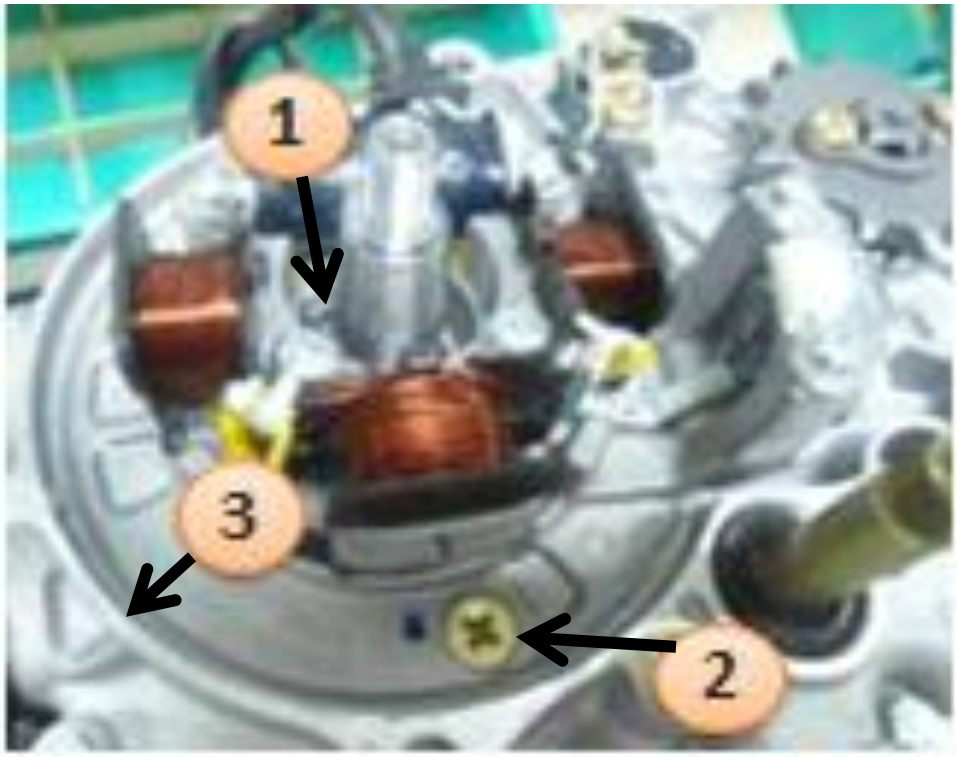
A O ring and LCC interface

B Oil seal and crank shaft left interface

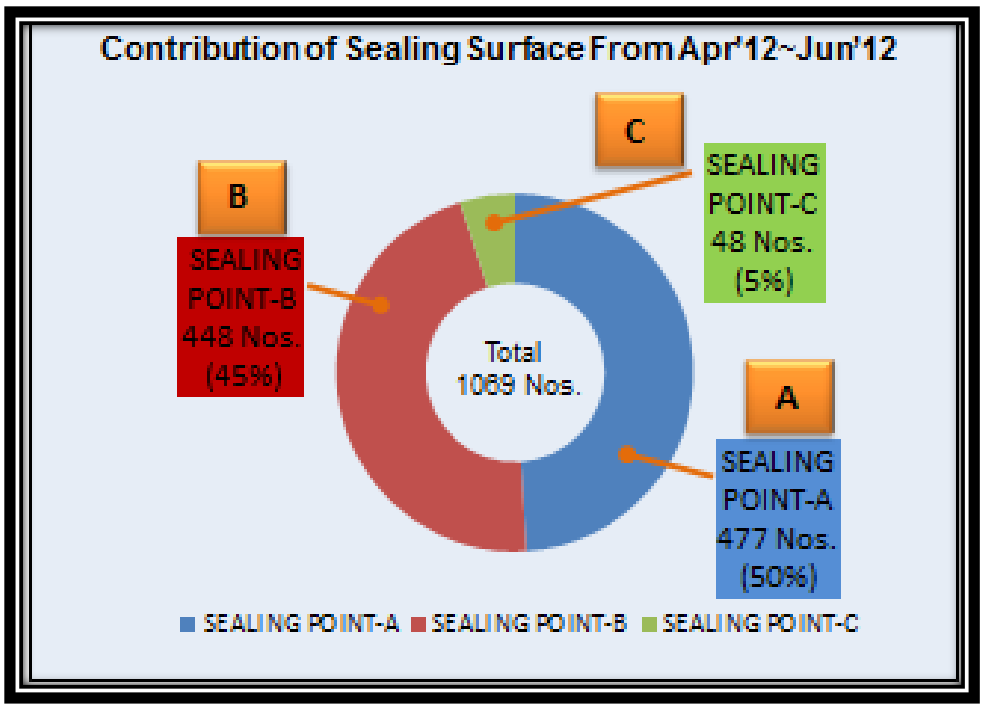
C Mounting and LCC interface

This fig. shows the sealing surface of stator plate area. There are three points in this figure A, B, C. A represent the sealing surface between O'ring and LCC interface. B represent the sealing surface between oil seal and crankshaft left interface.

C represents the sealing surface between mounting bolt of stator plate and LCC interface.



1. Represent the crankshaft and oil seal interface.
2. Represent the mounting bolt and lcc interface.
3. O’ring and LCC (left crak case) interface.



BREAKUP OF LEAKAGE FROM THE VARIOUS SEALING SURFACE

FROM THE SEALING PONIT A 50 % OF LEAKAGE OBSERVED.
FROM THE SEALING POINT B 45 % OF LEAKAGE OBSERVED.
FROM THE SEALING POINT C 05 % OF LEAKAGE OBSERVED.

THIS DATA SHOWS THAT THE MAXIMUM LEAGAGE OBSERBEVED FROM THE O'RING AND LCC INTERFACE.

Contributing parts for Leakage From Stator Plate Area Model - Shine : -

S.No	Parts		Part Supplied from		Remark
1.	Crank Case Left		In-house Manufacturing (Receiving From M/c Shop)		Eliminated for Supplier Difference
2.	Crank Shaft		In-house Manufacturing (Receiving From M/c Shop)		Eliminated for Supplier Difference
3.	Stator Plate Assy.		M/s. Nippon	M/s. Denso	Complete Stator Plate Assembly Supplied
a.)	- Stator Plate		M/s. Nippon	M/s. Denso	Assembly Child Part
b.)	- Oil Seal		M/s. Nippon	M/s. Denso	Assembly Child Part
c.)	- O Ring		M/s. Nippon	M/s. Denso	Assembly Child Part

CHILD PARTS OF STATOR PLATE ASSEMBLY

LCC and Crank Shaft are common parts & Stator Plate Assembly is received from two supplier

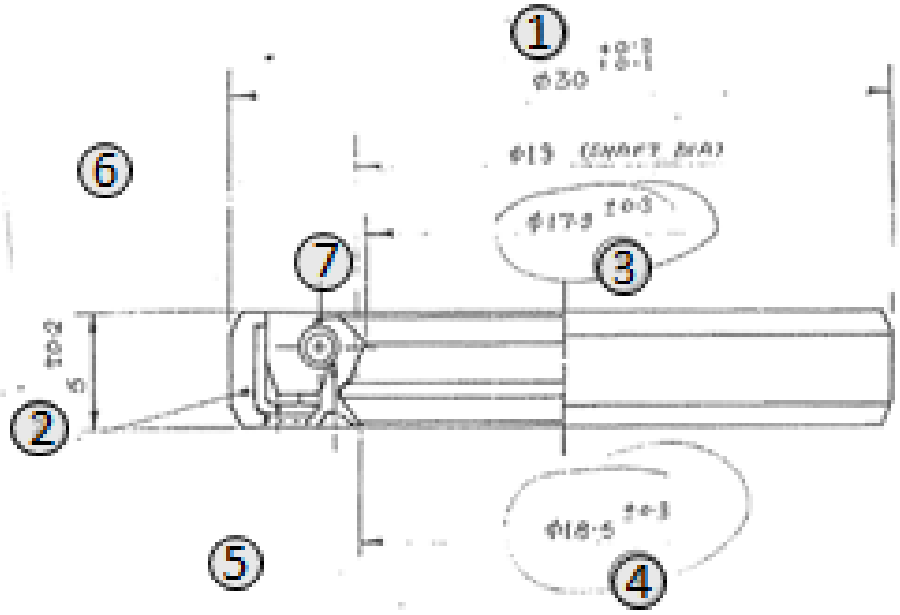
Crankcase left and crankshaft left with stator plate are the contributing parts.

There are two suppliers of stator plate: M/s Nippon & M/s Denso.

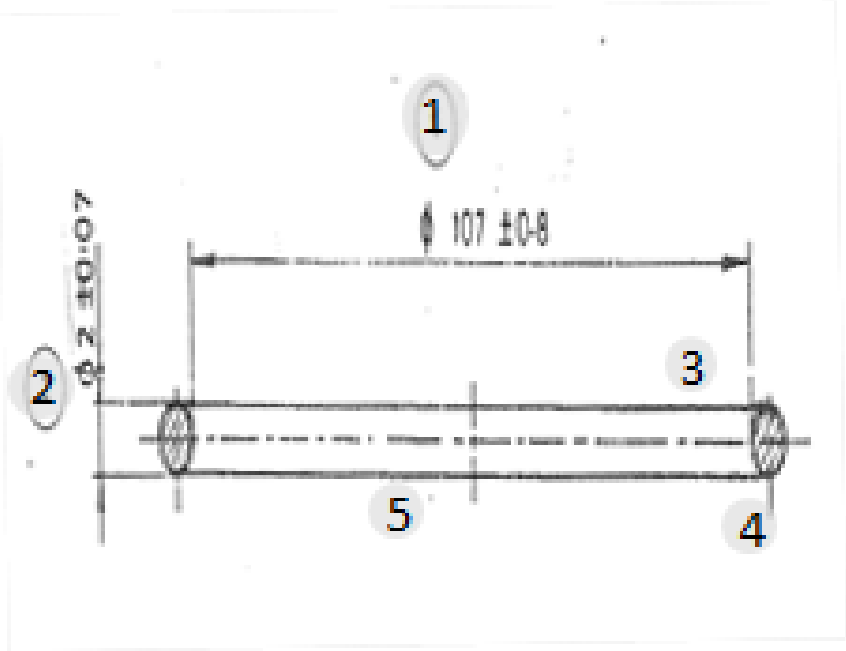
Crankcase and crankshaft are common parts and manufactured in house.

CONTRIBUTING PARTS FOR LEAKAGE FROM STATOR PLATE ASSEMBLY :

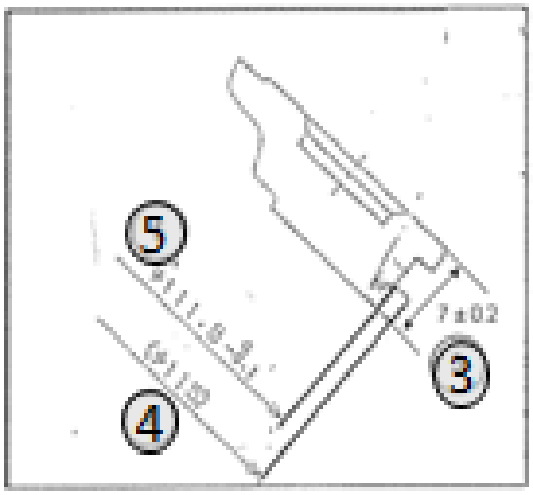
Part	Dimension	Specification	Remarks
Oil Seal	Oil Seal OD	30/+0.10/+0.30	①
	Thickness of Oil Seal	5±0.20	②
	Oil Seal ID	17.90±0.30	③
	Inner Dia1	18.5±0.30	④
	Oil Seal Cut and flashes	Shouldn't have cut and flashes	⑤
	Extra Material in Oil Seal	Shouldn't have Extra material at Oil Seal.	⑥
	Greasing of Oil Seal	Greasing application	⑦

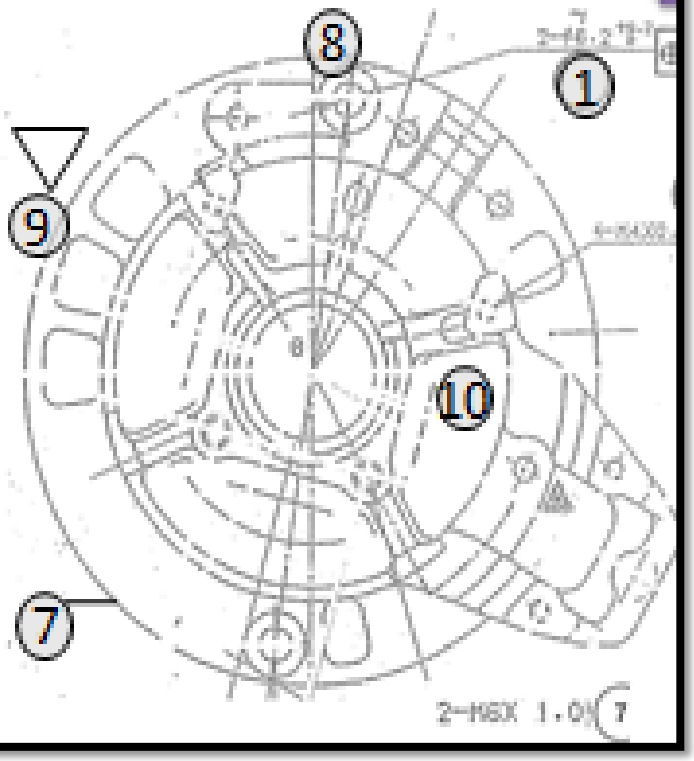


Part	Dimension with tolerance	Specification	Remarks
O Ring	Diameter	107±0.8	①
	Thickness	2±0.07	②
	Parting Lines and Flashes on O ring	Shouldn't have deep parting lines, cut and flashes	③
	Extra Material at O ring	Shouldn't have Extra material at O ring	④
	Oiling of O ring	Oiling application	⑤

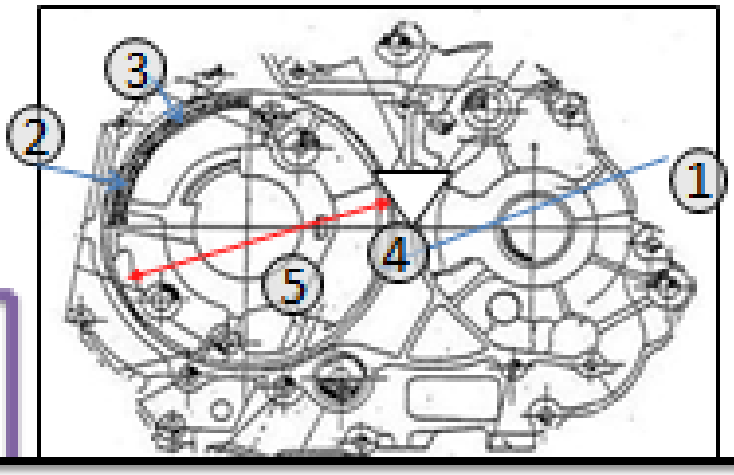


Part	Dimension with tolerance	Specification	Remarks
Stator Plate	Mounting Holes(X2)	6.2+0.20	1
	Position of Holes Ø 6.2	⌖ Ø0.1 A B	2
	Thickness	7.0±0.2	3
	Outer Diameter	115/-0.36/-0.71	4
	O-Ring groove diameter	111.8/-0.2	5
	Thread(X2)	M6X1.0	6
	Extra material and dust	Shouldn't be available	7
	Chamfer	0.5X45°	8
	Ø 115 Finish	12.5 Ra	9
	Appearance	No dent and damage	10



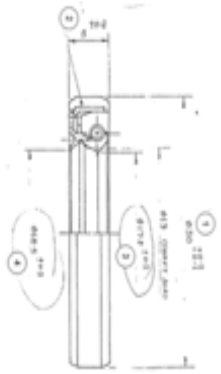
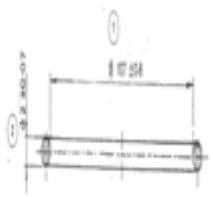


Part	Dimension with tolerance	Specification	Result
CCL	Ø 115	115+0.035	1
	Ovality in Ø 115	0.011	2
	Chamfer	20°	3
	Ø 115 Finish	12.5 Ra	4
	Appearance	No dent and damage	5



Part	Dimension with tolerance	Specification
Crank Shaft	Ø19.00	19.00/-0.0.26/-0.007
	Appearance	No dent and Damage

CONTRIBUTING DIAMETER COMPARISION:

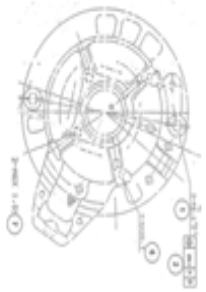
Part	Dimension with tolerance	Specification (Unit-mm)	Contributing Dimension comparison					
			M/s. Nippon(Leaked Engine)			M/s. Nippon(OK Engine)		
Oil Seal 	Oil Seal OD	30/+0.10/+0.30	30.23	30.19		30.21	30.24	
	Thickness of Oil Seal	5±0.20	5.01	5.02		5.09	5.06	
	Oil Seal ID	17.90±0.30	17.74	17.79		17.81	17.84	
	Inner Dia1	18.5±0.30	18.65	18.64		18.69	18.71	
	Oil Seal Cut and flashes	Shouldn't have cut and flashes	OK	OK		OK	OK	
	Foreign Material in Oil Seal	Shouldn't have Foreign material at Oil Seal.	foreign Mat Available	foreign Mat Available		OK	OK	
	Greasing of oil seal	Should be done	OK	OK		OK	OK	
O ring 	Diameter	107±0.8	107.45	107.52		107.39	107.42	
	Thickness	2±0.07	1.88	1.90		1.94	1.95	
	Parting Lines and Flashes on O ring	Shouldn't have deep parting lines, cut and flashes	Flashes	Flashes		OK	OK	
	Foreign Material at O ring	Shouldn't have foreign material at O ring	foreign Mat Available	foreign Mat Available		OK	OK	
	Oiling of O Ring	Oiling Should be done	OK	OK		OK	OK	
Crank Shaft 	Diameter	19.00/-0.0.26/-0.007	18.989	18.987		18.987	18.989	
	Appearance	No dent and Damage	OK	OK		OK	OK	

After doing analysis of all the parameter of oil seal we found Foreign material in and under the oil seal.

In the same way after analyzing the O-ring parameter we found that the Thickness which should be 2(+- 0.07) actual found 1.88 and 1.90.

Moreover in O-Ring we found flashes on the surface of O-Ring. In O-Ring also there are some foreign material found.

Rest of all the parameter are within the specification.

Part	Dimension with tolerance	Specification (Unit-mm)	Contributing Dimension comparison					
			M/s. Nippon(Leaked Engine)			M/s. Nippon(OK Engine)		
Stator Plate  	Mounting Holes(X2)	6.2+0.20	6.31	6.29		6.34	6.30	
	Position of Holes Ø 6.2	⌖ Ø0.1 A B	0.06	0.06		0.04	0.03	
	Thickness	7.0±0.2	7.04~7.06	7.06~7.14		7.09~7.12	7.08~7.14	
	Outer Diameter	115/-0.36/-0.71	114.944~ 114.955	114.930~ 114.944		14.932~ 14.948	14.934~ 14.949	
	O-Ring groove diameter	111.8/-0.2	111.640~ 111.650	111.680~ 111.690		111.720~ 111.740	111.710~ 111.730	
	Thread(X2)	M6X1.0	OK	OK		OK	OK	
	Foreign mat. and dust	Shouldn't be available	Foreign mat/Chips	Foreign mat/Chips		OK	OK	
	Stator Plate Chamfer	0.5X45°	OK	OK		OK	OK	
	Ø 115 Finish	12.5 Ra	8.5 Ra	7.2 Ra		9.1 Ra	8.6 Ra	
	Appearance	No dent and damage	OK	OK		OK	OK	
CCL 	Ø 115	115+0.035	115.008	115.007		115.009	115.014	
	Ovality in Ø 115	0.011	0.007	0.006		0.007	0.009	
	Dia 115 Chamfer	20°	OK	OK		OK	OK	
	Ø 19.00	19.000/-0.026/0.007	18.991	18.989		18.986	18.987	
	Ø 115 Finish	12.5 Ra	6.5 Ra	7.2 Ra		7.1 Ra	6.9 Ra	
	Appearance	No dent and damage	OK	OK		OK	OK	

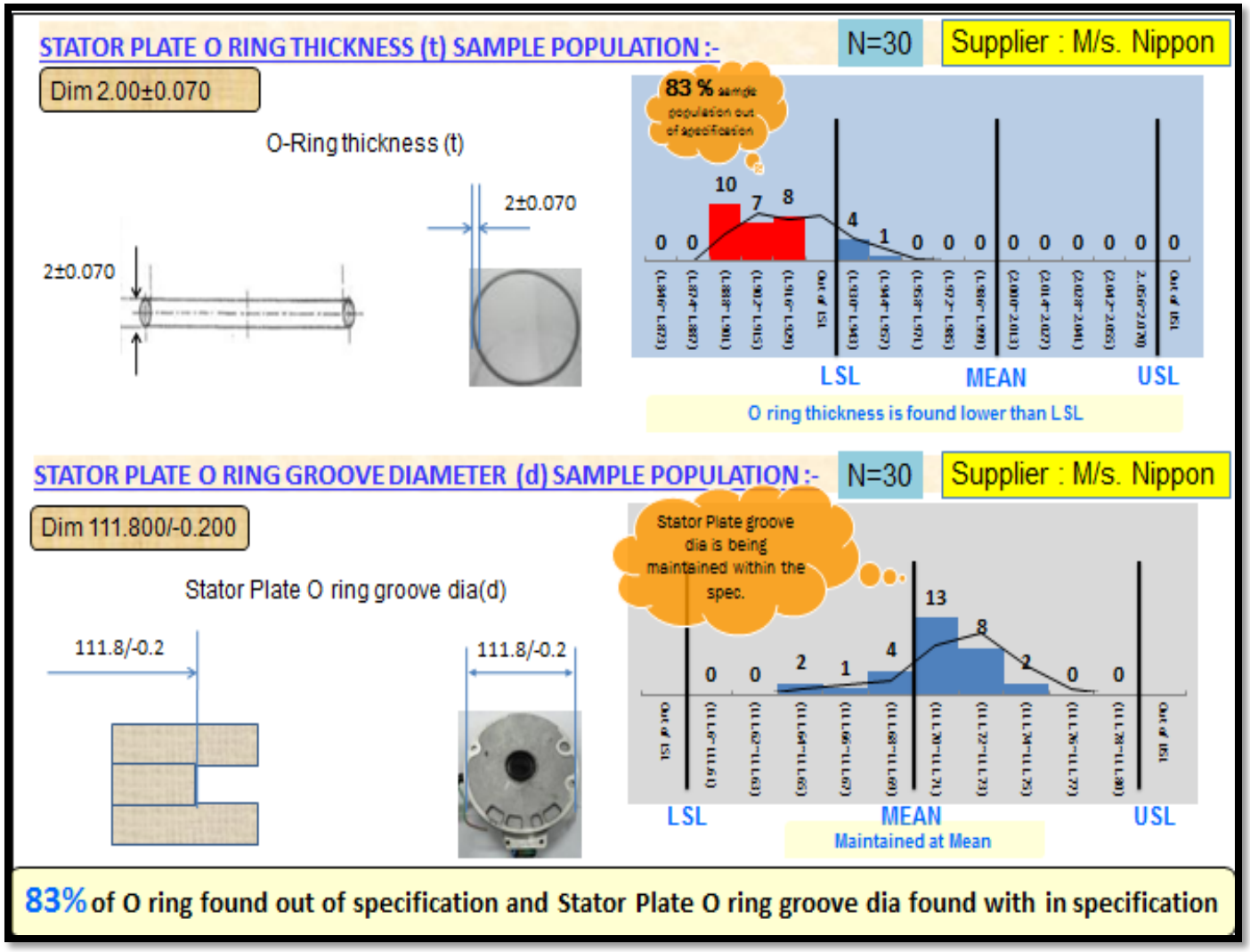
Total 05 parameters were found out of specification

Out of ten parameter of stator plate, there is only one parameter which is out of specification.

Foreign material and dust found in stator plate

Total five parameters were found out of specification, listed below

1. Foreign material in oil seal.
2. Foreign material in o-ring.
3. Foreign material in stator plate .
4. Flashes in o ring in parting line
5. Thickness of o ring undersize.

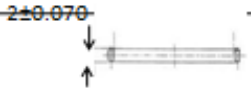


Now to ensure the o ring thickness we prepared a graph of O ring thickness and take sample population of O'Ring thickness.

By measuring the o ring thickness of 30 nos we observed that out of 30, total 25 o ring diameter are out of specification. Lower than the lower limit.

It means 83% sample population are out of specification.

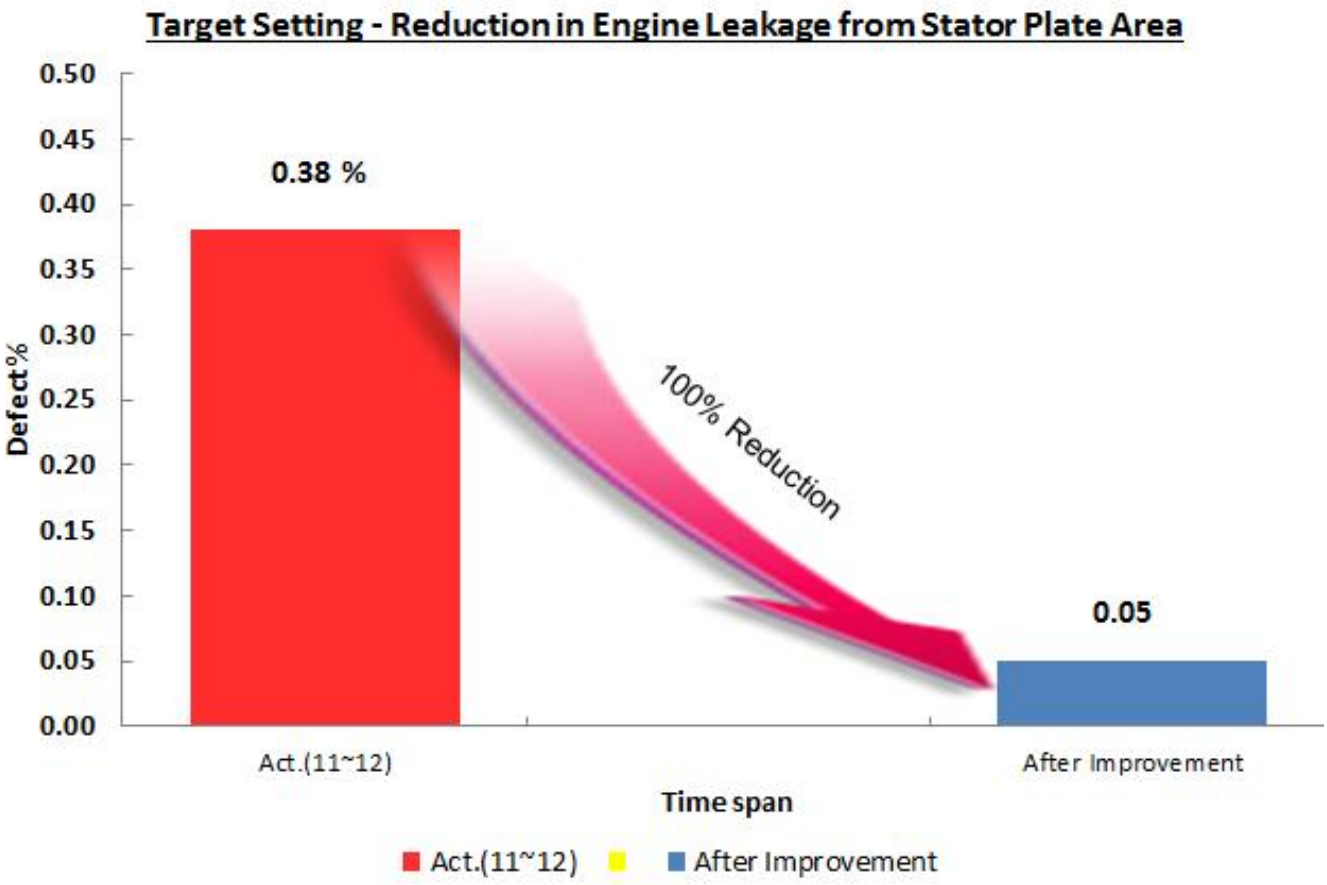
We also checked the stator plate o ring groove dia by take the sample population of 30 nos. all the 30 nos found within the specification.

S.No	Component name	Characteristics	Specification	Sketch	Observation
1.)	Oil Seal	Contamination	Foreign Material not allowed		Foreign material in oil seal.
2.)	O Ring	Parting lines and Flashes	Deep parting lines and flashes not allowed		Flashes on O ring
3.)	O Ring	Contamination	Foreign material not allowed		Foreign material on O ring
4.)	Stator Plate	Contamination	Foreign material not allowed.		Foreign material /Chips on stator plate O ring groove.
5.)	O Ring	Thickness	2±0.07		Found undersize.

Now there are total 5 parameter on which we have to work.

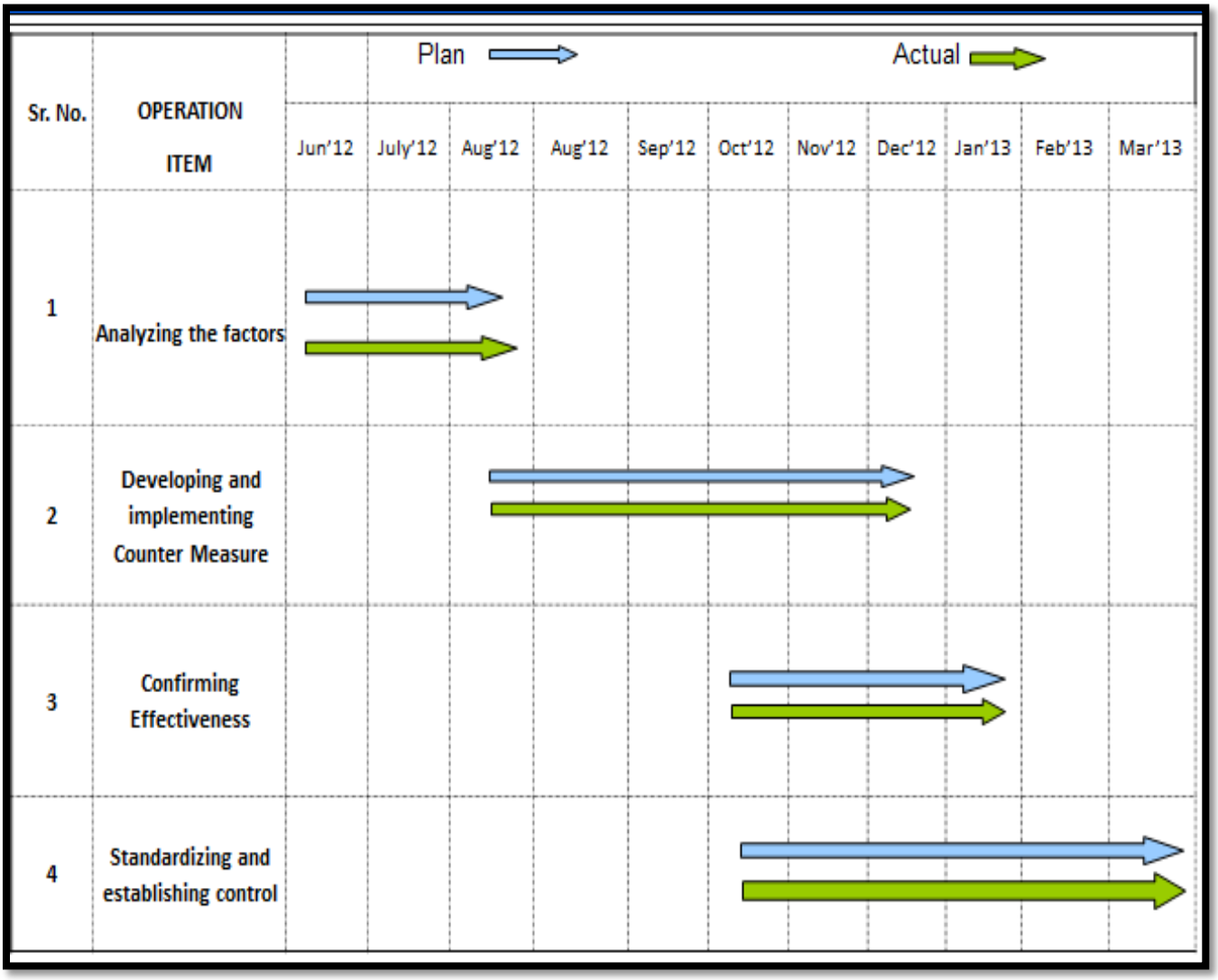
1. Oil Seal contamination
2. O Ring Parting line and flashes.
3. O Ring Contamination.
4. Stator Plate Contamination
5. O Riong Thickness.

TARGET SETTING:



The current status of Engine leakage is 0.38% which we have to reduce up to 0.05%.

PLAN OF ACTION :



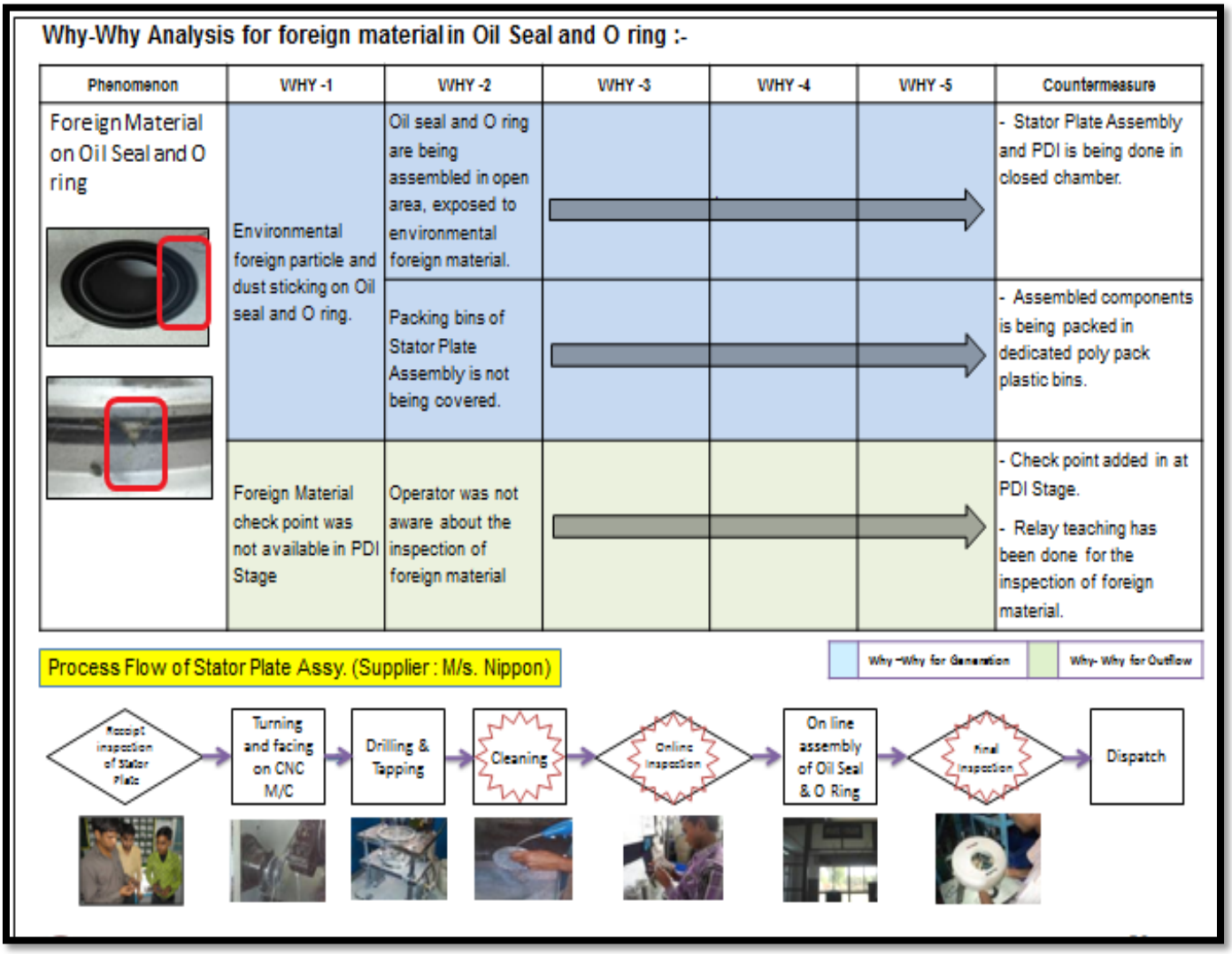
In this I am showing my plan of action. I am doing this in 4 phases.

First one is analyzing the factor, after that developing and implementing countermeasure against the engine leakage.

Then confirm effectiveness. Whatever the countermeasure will be taken to eliminate the engine leakage, we have to check the effective of those countermeasure.

And if those countermeasure are ok to eliminate the engine leakage then we have to standardize those countermeasure in the Standard Operating Procedure.

ANALYSING THE FACTOR :



For the foreign material in oil seal and o ring, we have done why why analysis and found that oil seal and o ring are being assembled in open area, exposed to environmental foreign material.

The second thing is packing bins of stator plate assembly is not being covered.

And the third is operator was not aware about the inspection of foreign material.

As a countermeasure of all these 3 reasons we have started stator plate assembly and inspection in closed chamber. Assembled component started packing in closed plastic bins. Check point for inspection is added in PDI Stage. Relay teaching has been started for the inspection of foreign material.

Why-Why Analysis for foreign material/chips on stator plate O ring groove :-

Phenomenon	WHY -1	WHY -2	WHY -3	WHY -4	WHY -5	Countermeasure
Foreign Material/Chips on Stator Plate O ring groove 	Loose aluminum chips stick on Stator Plate O ring groove.	Chips sticks on the stator plate from the packing bins	Packing bins are having foreign material and loose chips.	Packing bins are not being cleaned regularly.	→	- Packing bins cleaning system started after each usage cycle.
		Loose chips didn't cleaned from stator plate completely after machining	Air cleaning process doesn't ensures chips free Stator plate to the next process	→	→	- Compressed air cleaning for the removal of loose chips on Stator Plate.
	Packing bin was not being inspected for foreign material before packing	No check point for the inspection of Packed components for foreign material	→	→	→	- Check point added. - Relay teaching has been done for the inspection of foreign Material in packing bins at PDI stage.

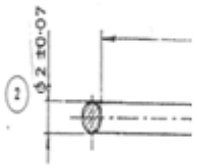
Why -Why for Generation | Why- Why for Outflow

Process Flow of Stator Plate (Supplier : M/s. Nippon)

Foreign Material/Chips on stator plate o ring groove is the another observation. After doing analysis we found that packing bins are not being cleaned regularly. Air cleaning processes doesn't ensures chips free stator plate to the next process.no check point fot the inspection of packed component for foreign material.

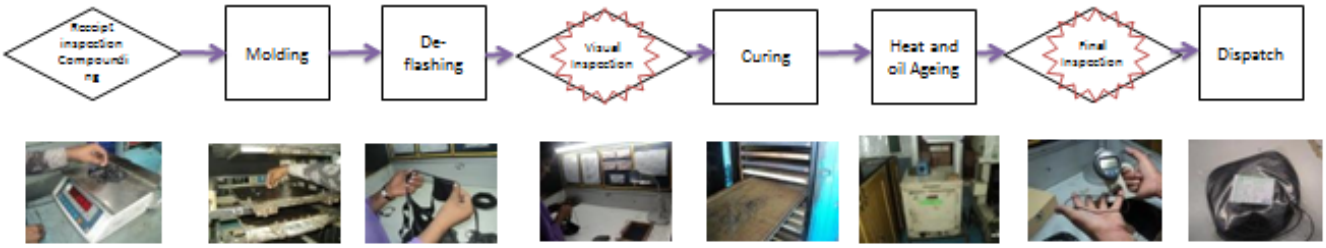
As a countermeasure of all these , packing bins cleaning system started after each usage cycle. Compressed air used for cleaning/removal of loose chips on stator plate. Relay teaching has been done for the inspection of foreign material in packing bins at PDI stage.

Why-Why Analysis for O ring thickness less :-

Phenomenon	WHY -1	WHY -2	WHY -3	WHY -4	WHY -5	Countermeasure
O ring thickness less 	Material run radius is less in mould.	Foreign particle sticks on the surface of mould	Mould Cleaning and Polishing is not being done regularly.	→	→	- Polishing/Cleaning done and frequency fixed and being adhered.
	O ring thickness inspection was being done after a specified time duration	Mould/Cavity wise inspection was missing	→	→	→	Mould/Cavity , batch wise inspection started.

Why -Why for Generation | Why- Why for Outflow

Process Flow of O Ring (Supplier : M/s. Nippon)



Against the phenomenon of O ring thickness less, when we have done why why analysis, we found that mould cleaning and polishing is not being done regularly. The second thing is Mould/cavity wise inspection was missing. As a countermeasure polishing/cleaning done and frequency of cleaning fixed and being adhered.

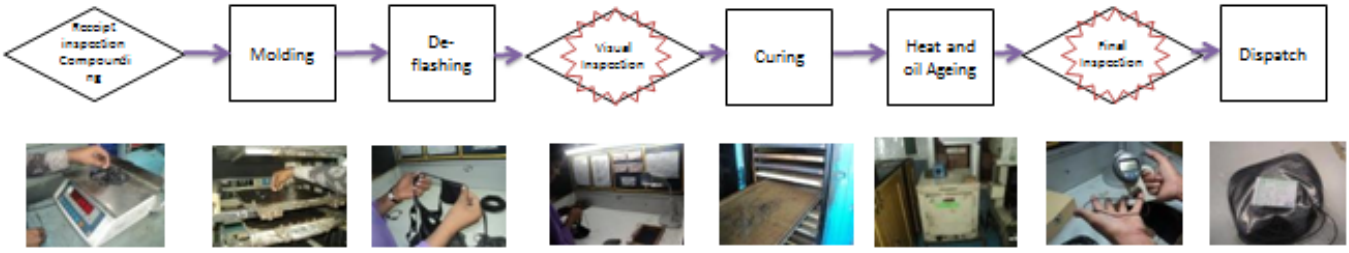
Mould /cavity, batch wise inspection started.

Why-Why Analysis for flashes on O ring :-

Phenomenon	WHY -1	WHY -2	WHY -3	WHY -4	WHY -5	Countermeasure
Flashes on O ring. 	Flashes didn't tear off completely.	O ring parting line area thickness is more.	Mould notches worn out.	Notch and tool maintenance frequency not fixed.	→	Tool notches re-shaped and its maintenance schedule fixed.
	De-flashing was not being done completely	Operator was not able to detect minor flashes by naked eyes.	→	→	→	Magnifying glass provided for the visual inspection of O ring

Why –Why for Generation | Why- Why for Outflow

Process Flow of O Ring (Supplier : M/s. Nippon)

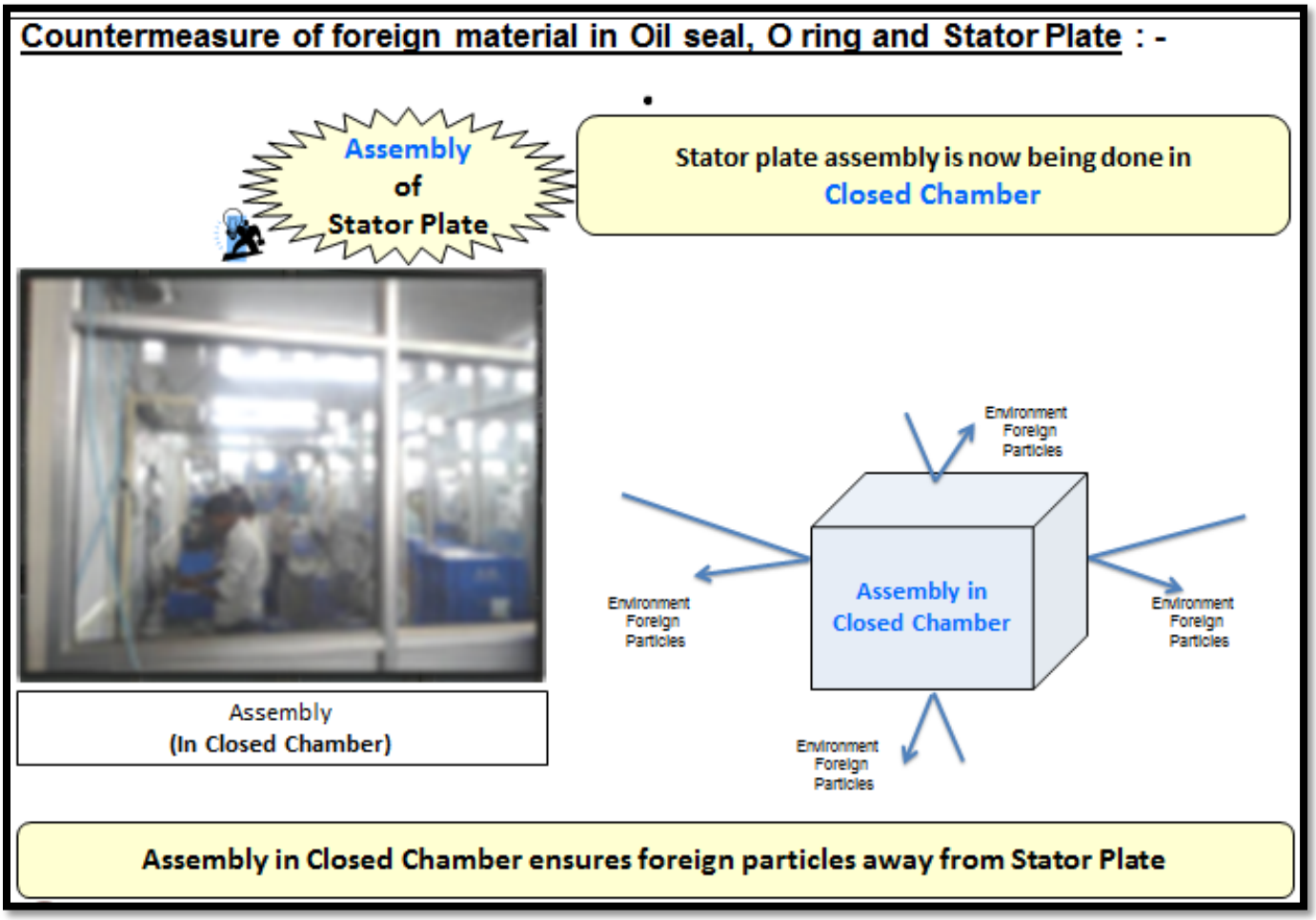


Now we have done why why for flashes on o ring. We found that notch and tool maintenance frequency not fixed. Operator was not able to detected minor flashes by naked eyes.

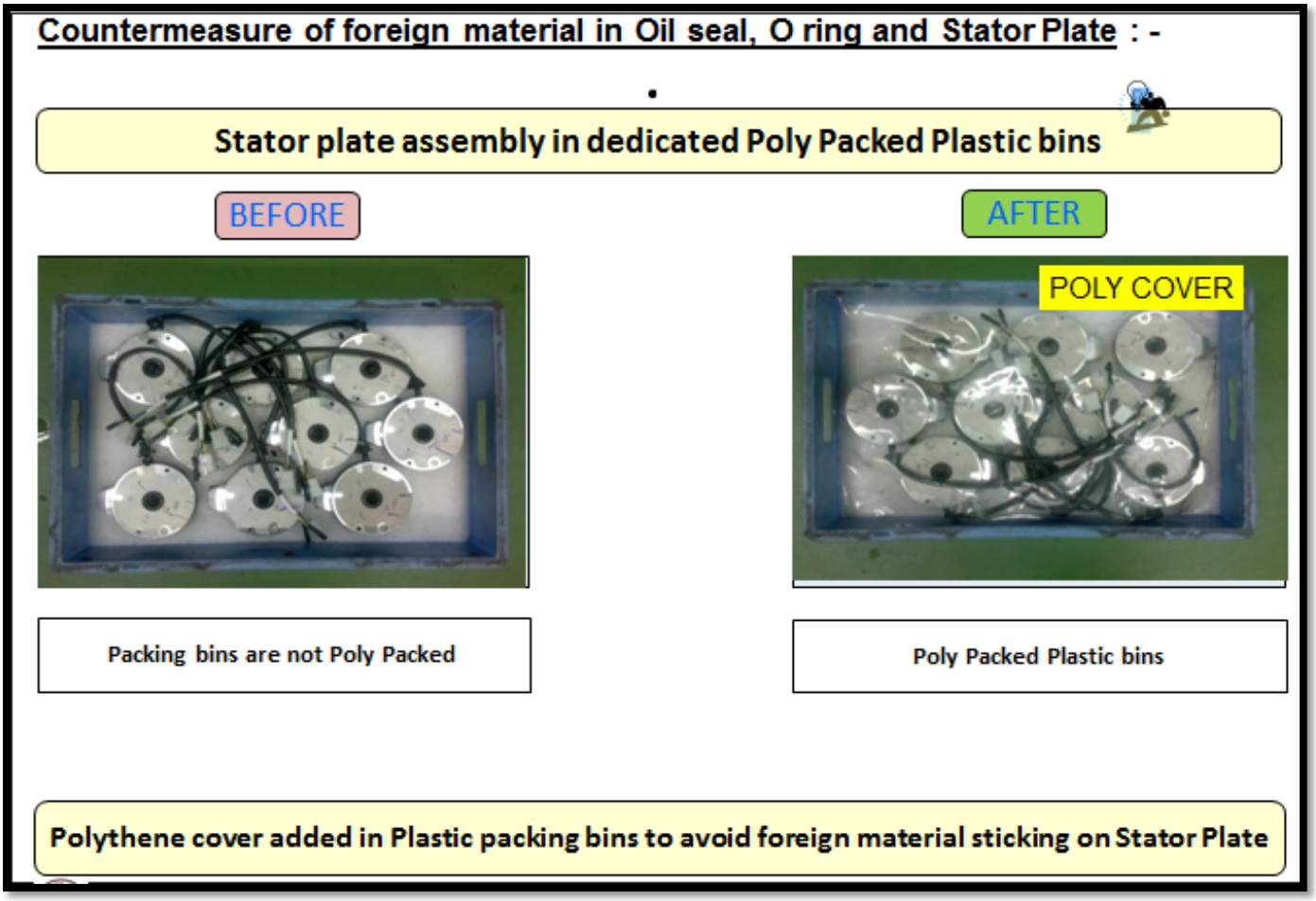
The first countermeasure is tool notches reshaped and its maintenance schedule fixed.

The second countermeasure is magnifying glass provided for the visual inspection of O'ring.

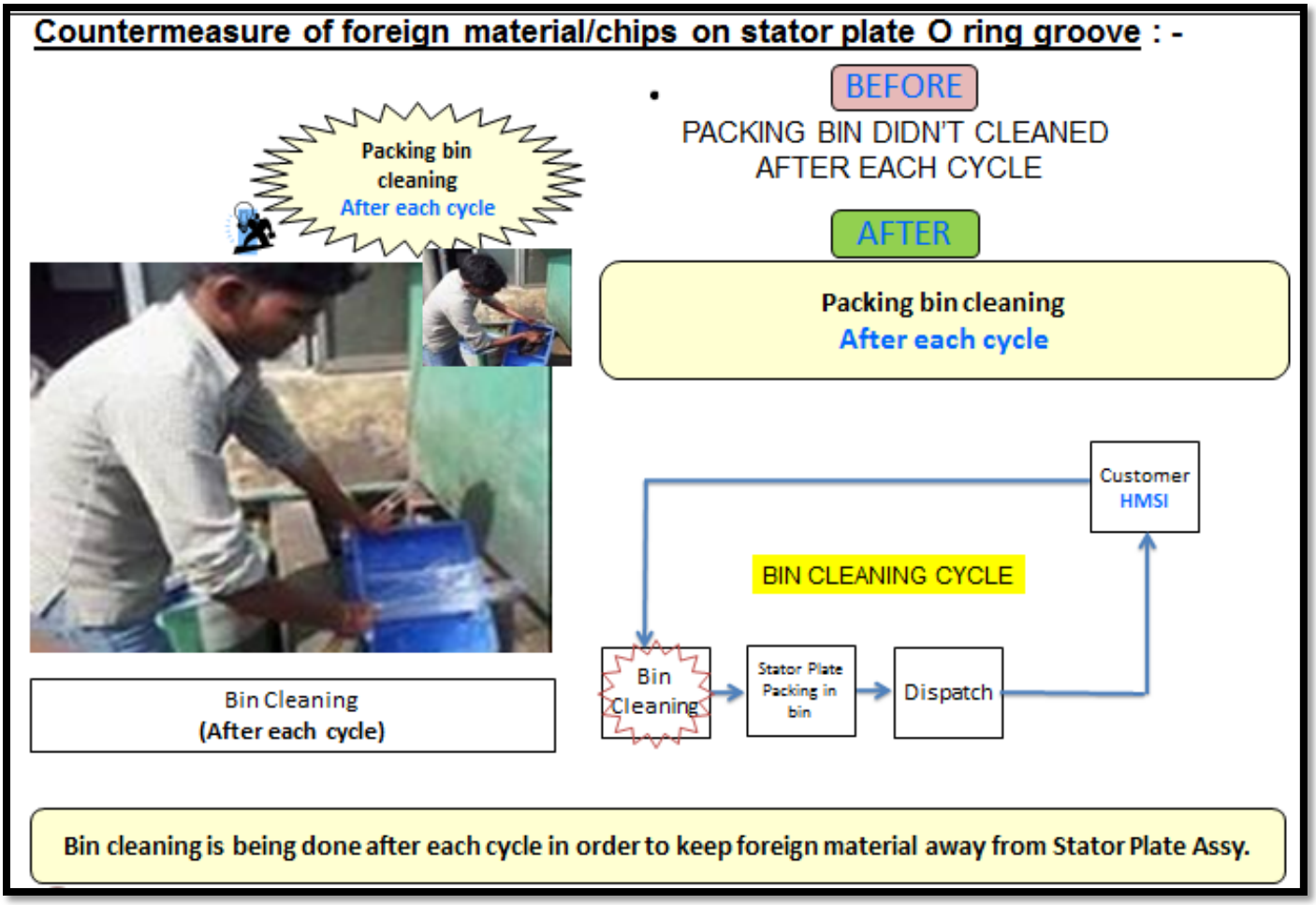
DEVELOPING AND IMPLEMENTING COUNTERMEASURES :



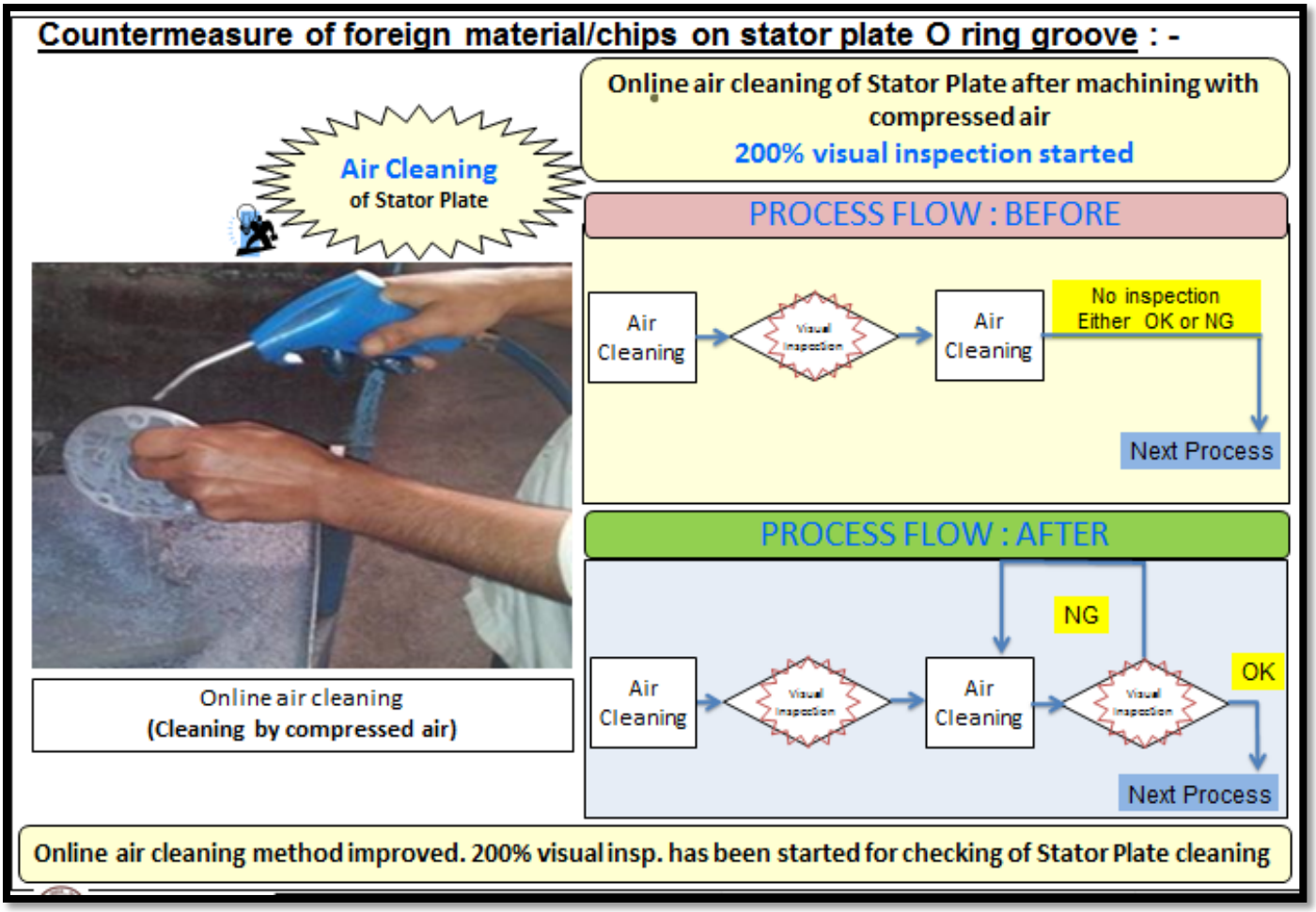
By this figure I am trying to show the close chamber of stator plate assembly , due to which o ring, oil seal and stator plate will be free from any type of foreign material.



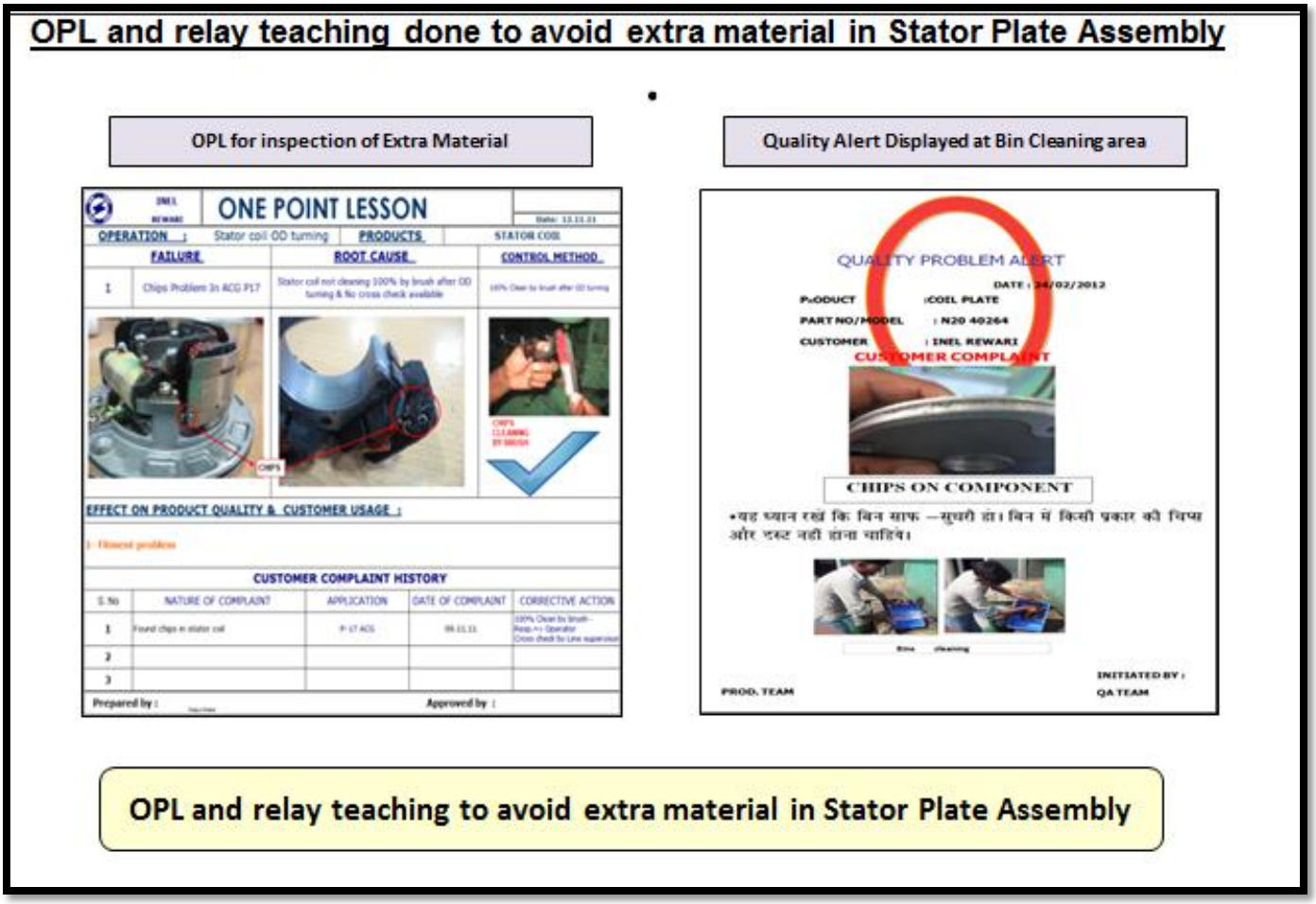
This picture shows the poly packed plastic bins to avoid foreign material in o ring, oil seal and stator plate.



This picture shows the packing bin cleaning after each cycle. Flow chart of this process is also shown in this picture. As per flowchart after getting empty bin from vendor, bin has to be cleaned with water before feeding or packing the new stator plate. After washing the bins, stator plate is going to pack in washed bins and then move for dispatch to the customer.



Now as a part of countermeasure of foreign material/chips on stator plate o ring groove we started compressed airspray in the groove so that the possibility of stuck chips inside the o ring will be zero.



For the teaching purpose of man we prepared OPL (one point lesson) in which we have shown that what thing a person has to ensure before assembly.

In this OPL person has to ensure the cleaning of chips from stator plate by using brush.

Countermeasure of O ring thickness less : -

O Ring Injection Moulding Machine
Polishing/Cleaning and tool notches re-shaped

ACTIONS :-

1. Flash rest groove cleaned and polished to maintain material run radius.
2. Tool and its notches re-shaped to cut away the flashes from O ring.
3. Batch/Mould/Cavity wise inspection started to monitor the parameters within specifications.

Moulding Machine

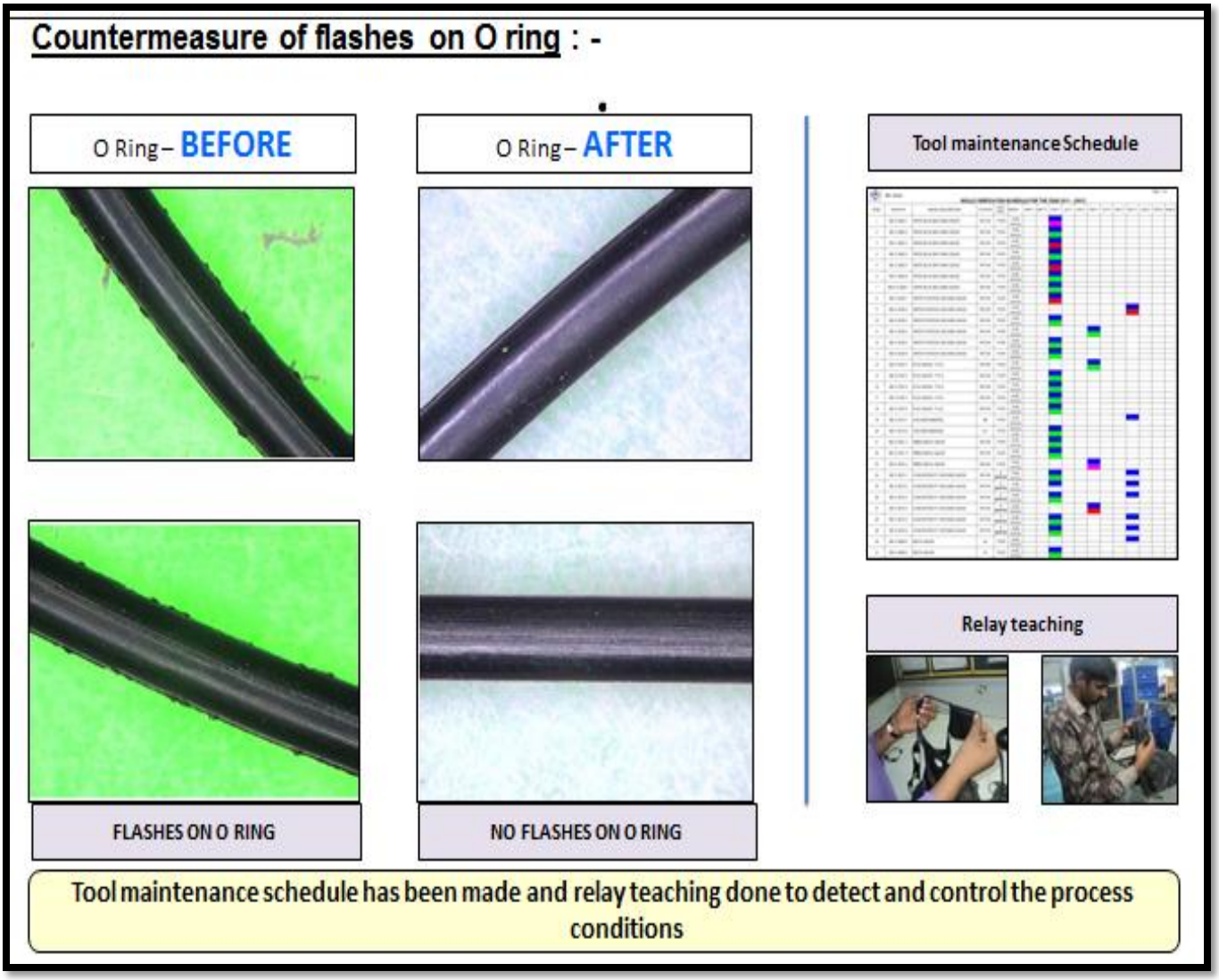
Inspection Process

Injection moulding tool's cleaning and polishing done & Batch/Mould/Cavity wise inspection started.

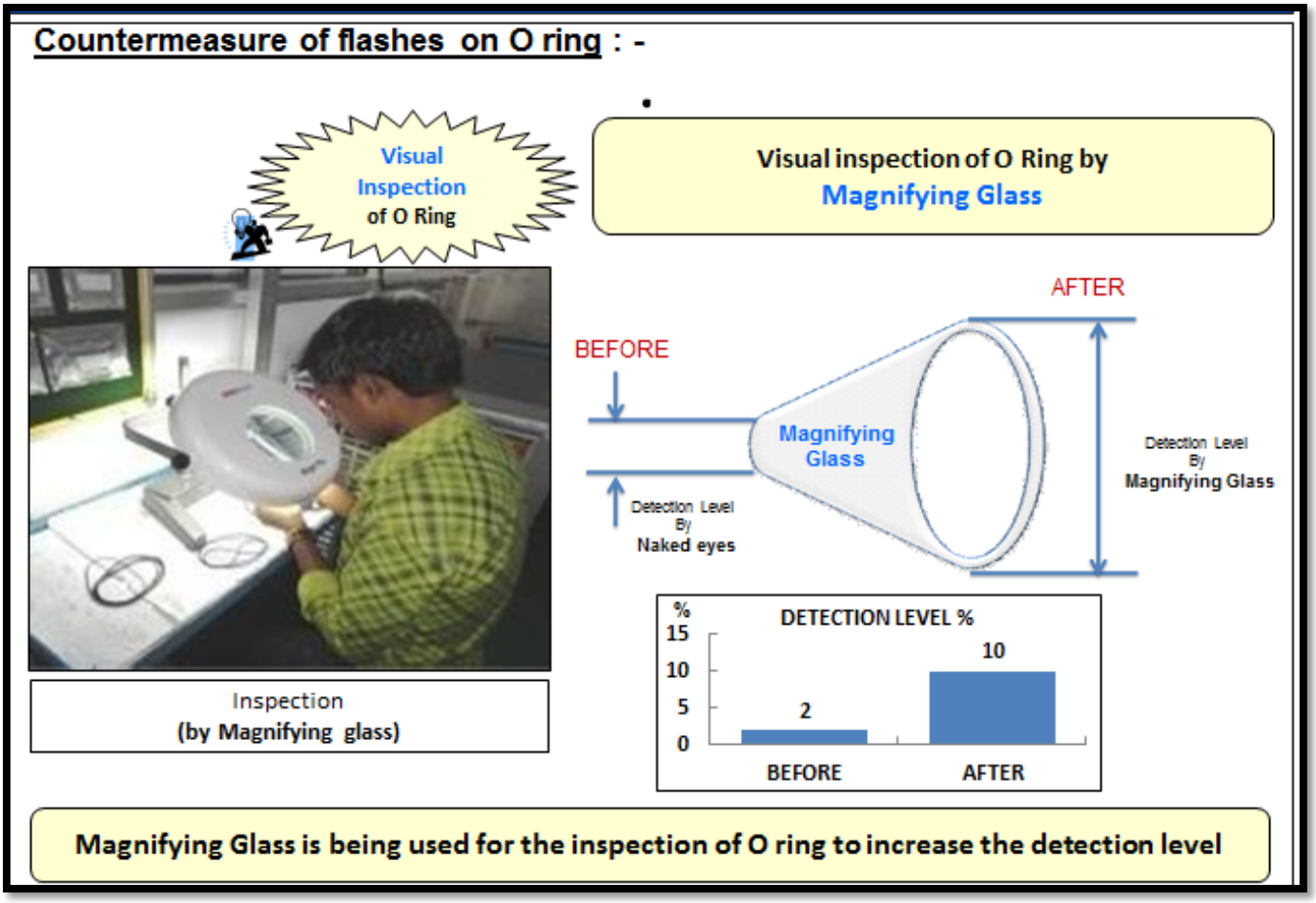
As a countermeasure of O ring thickness we have started cleaning and polishing of mould to maintain material run radius.

Tool and its notches reshaped to cut away the flashes from O'ring.

Batch/Mould/Cavity wise inspection started to monitor the parameter within the specifications.



Tool Life and its maintenance schedule has been made to control the process condition. In this figure we can easily understand that after sharpening the tool the generation of flashes is completely removed.



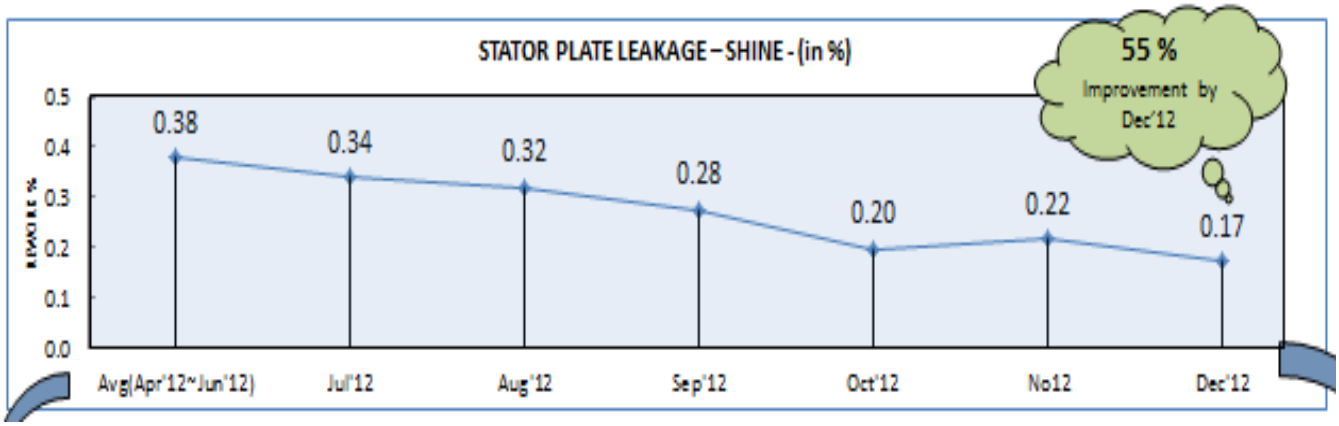
We have started visual inspection of o ring by using magnifying glass to arrest the flashes of o ring.

Summary of Countermeasures for Engine leakage from Stator Plate Area :-

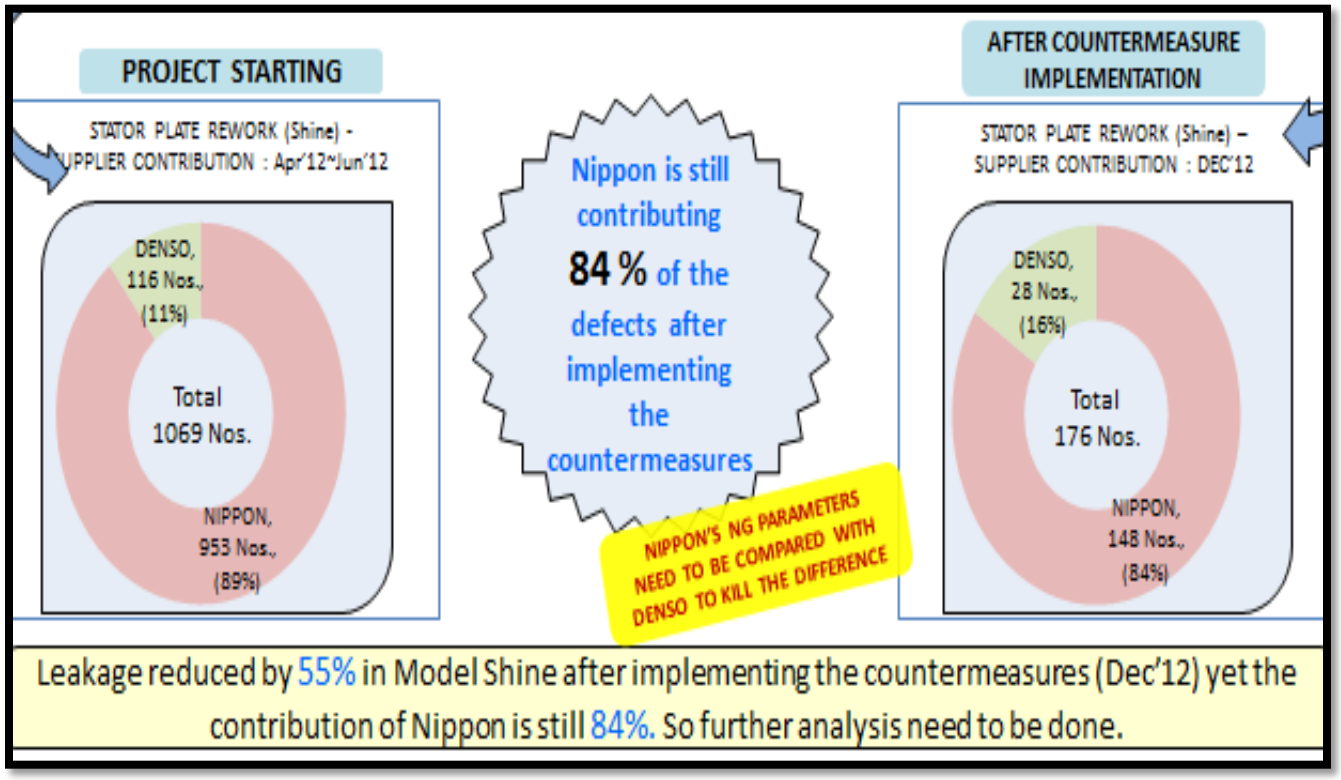
Phenomenon	Root Cause	Countermeasure	Status
Foreign Material on Oil Seal and O ring	Oil seal and O ring are being assembled in open area, exposed to environmental foreign material. Packing bins of Stator Plate Assembly is not being covered properly Operator was not aware about the inspection of foreign material	-Stator Plate Assembly and PDI will now being done in closed chamber -Assembled components would be Packed in dedicated poly pack plastic bins - Check point added in at PDI Stage. - Relay teaching has been done for the inspection of foreign Material.	
Foreign Material/Chips on Stator Plate O ring groove	Packing bins are not being cleaned regularly. Air cleaning process doesn't ensures chips free Stator plate to the next process No check point for the inspection of Packed components for foreign material	- Packing bins cleaning system started after each usage cycle. -Compressed air cleaning for the removal of loose chips on Stator Plate until the plate is completely cleaned -Check point added. -Relay teaching has been done for the inspection of foreign Material in packing bins at PDI stage.	
O ring thickness less	Mould Cleaning and Polishing is not being done regularly. Mould/Cavity wise inspection was missing	-Polishing/Cleaning done and frequency fixed and being adhered. -Mould/Cavity , batch wise inspection started.	
Flashes on O ring.	Notch and tool maintenance frequency not fixed. Operator was not able to detect minor loose flashes by naked eyes.	-Tool notches re-shaped and its maintenance schedule fixed. Magnifying glass provided for the visual inspection of O ring	

CONFIRMING EFFECTIVENESS:

Effectiveness of : Model Shine – After Implementing the Countermeasures



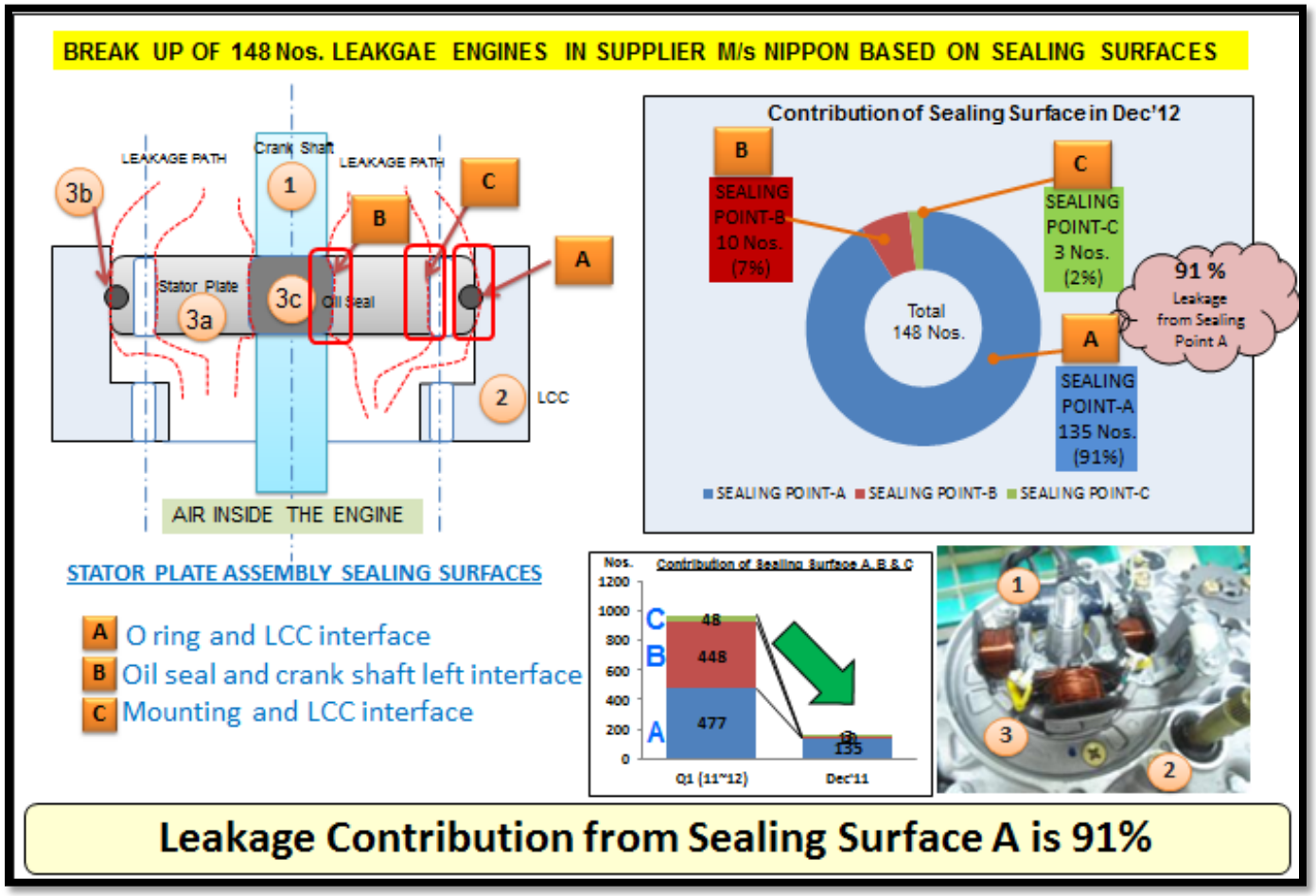
After taking these countermeasure we achieved 55% of improvement till the end of Dec'12.



Leakage reduced by 55% in model shine after implementing the countermeasure (Dec'12) yet the contribution of Nippon is still 84%.

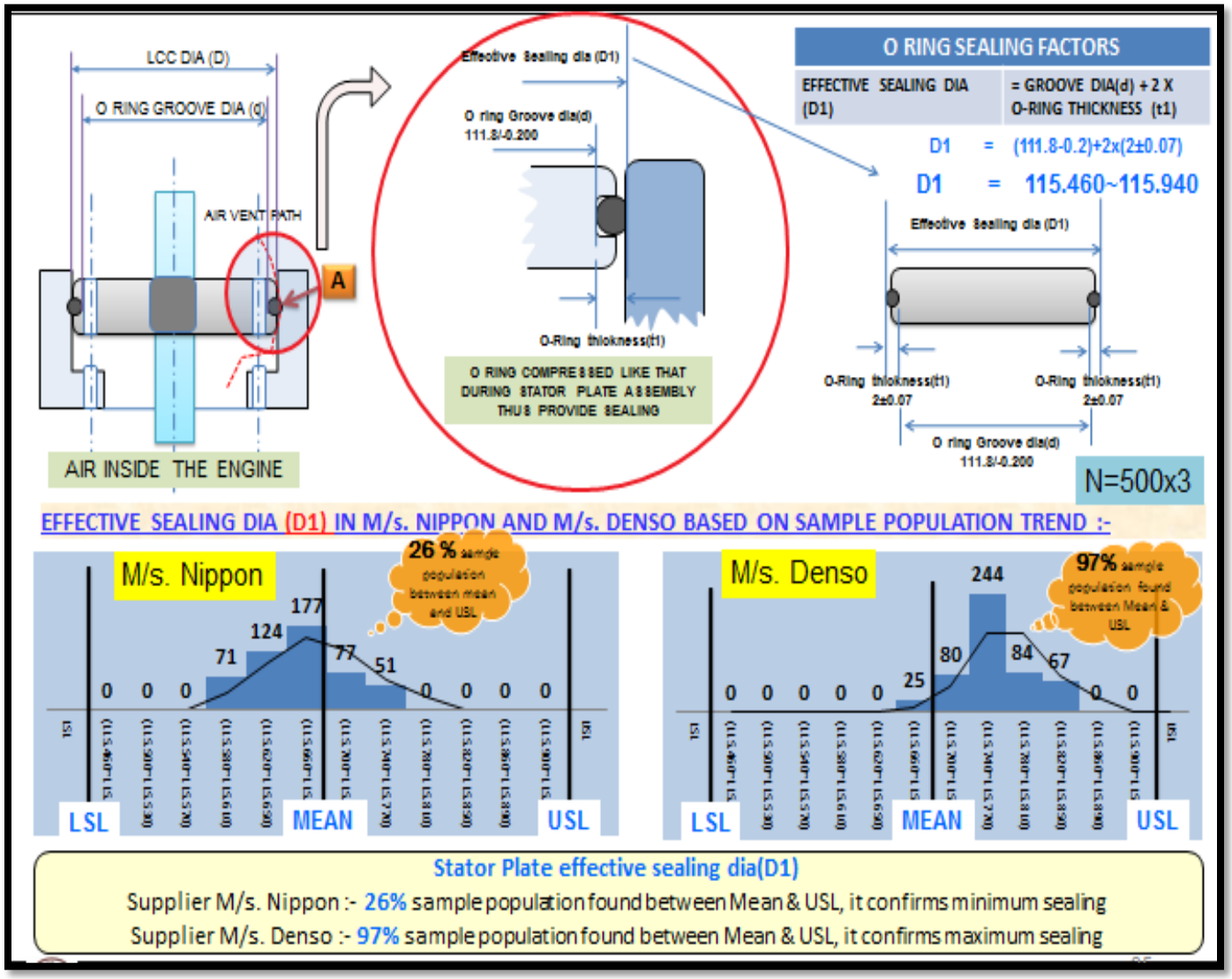
So further analysis is required to achieve zero defect.

ANALYSING THE FACTOR:



After doing further analysis of total 148 nos of defect, we found that leakage contribution from the sealing surface A is the highest which is 91%. Point C is having 2% of leakage which is from mounting and LCC interface. And 7% leakage is found from oil seal and crankshaft interface.

INVESTIGATE CHARACTERISTICS VALUE AND CURRENT SITUATION:



O ring between stator plate groove and crankcase interface provide sealing in such a manner so that there must be no leakage.

After doing comparision of two vendors Nippon and Denso based on the sample population trend we found that 26% sample population are found between Mean and USL in Nippon supplier.it confirm minimum sealing

In Denso vendor 97% sample population found between mean & USL. It confirm maximum sealing.

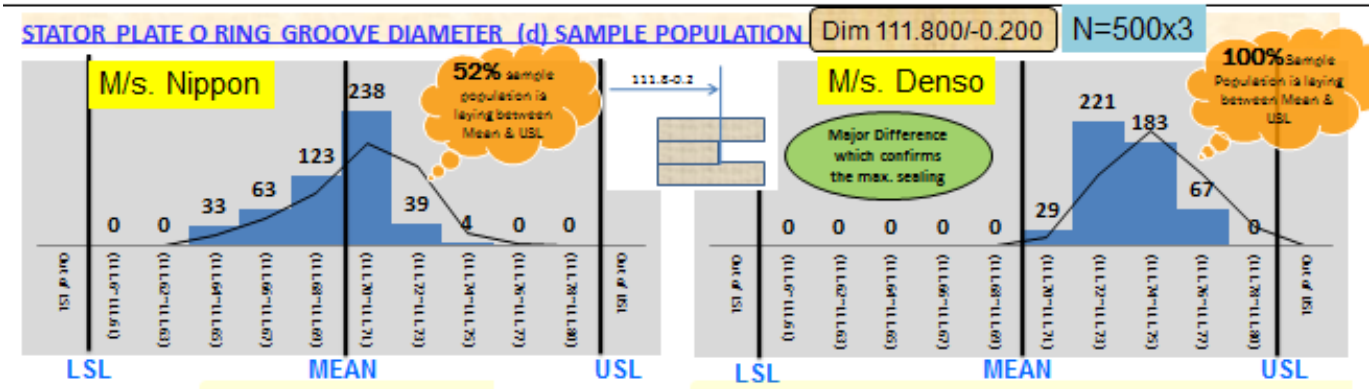
Part	Dimension with tolerance	Specification (Unit-mm)	Contributing Dimension comparison in both vendors For sealing Surface (A)								
			M/s. Nippon (Leaked Engine)			M/s. Nippon (OK Engine)			M/s. Denso (OK Engine)		
O ring 	Diameter	107±0.8	107.45	107.52		107.44	107.50		107.41	107.38	
	Thickness	2±0.07	1.98	2.01		2.01	2.00		2.02	2.00	
Stator Plate 	O-Ring groove diameter	111.8/-0.2	DIFFERENCE IN THE DIMENSION RANGE								
			111.630~ 111.640	111.640~ 111.660		111.730~ 111.760	111.740~ 111.770		111.740~ 111.750	111.750~ 111.770	
	Outer Diameter	115/-0.36/-0.71	114.942~ 114.951	114.928~ 114.939		114.943~ 114.950	114.927~ 114.937		14.942~ 14.949	14.937~ 14.945	
LCC 	Ø 115	115+0.035	115.008	115.007		115.007	115.006		115.009	115.014	
	Ovality in Ø 115	0.011	0.007	0.006		0.004	0.008		0.007	0.009	
	Dia 115 Chamfer	20°	OK	OK		OK	OK		OK	OK	

All contributing parameters found within specification & the difference observed between the range of Stator Plate O ring Groove Dia. in Leaked and OK engine

After comparison of Stator plate, o ring and Crankcase dimension we found difference in the dimension of o ring groove. The difference observed between the range of stator plate o ring Groove dia in leaked and OK engine. It is observed that the dimension which is coming out in leakage engine is on the lower side. but in ok engine it is found that the dimension lie between USL and mean.

STATOR PLATE O RING GROOVE DIAMETER (d) SAMPLE POPULATION

Dim 111.800/-0.200 N=500x3

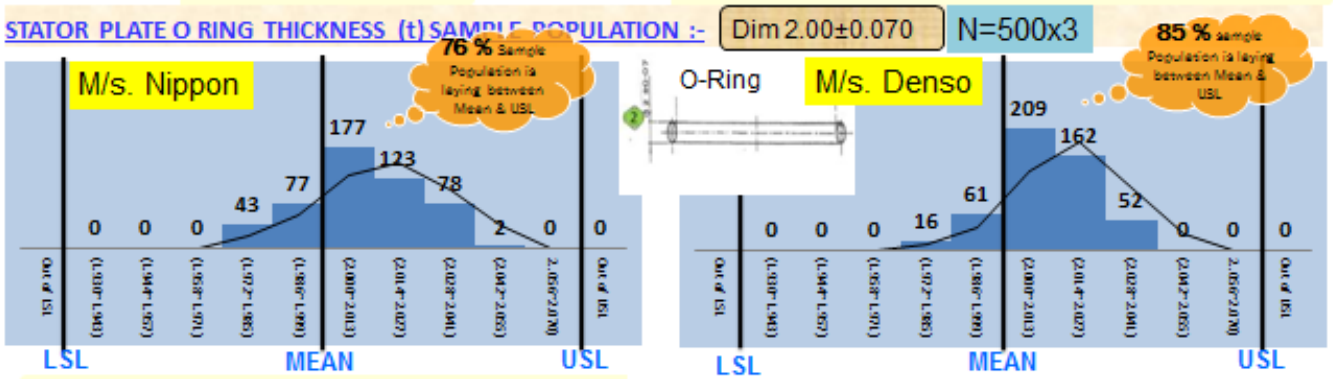


Maintained at Mean

Maintained between USL and mean

STATOR PLATE O RING THICKNESS (t) SAMPLE POPULATION :-

Dim 2.00±0.070 N=500x3



O ring diameter is found lower than LSL

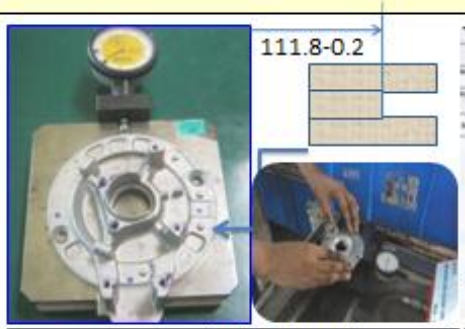
O ring diameter is being maintained at mean

No Major Observation in O Ring Thickness in both the supplier
In Stator Plate O ring Groove Dia. 52% Population of M/s Nippon Lying between Mean & USL

5. Developing & Implementing Countermeasures — 5.1 Develop Countermeasures

M/s. Nippon (Supplier) visit done to study the capability of machine for Stator Plate O ring groove diameter

M/s. NIPPON – SUPPLIER VISIT



Gauge to check groove dia

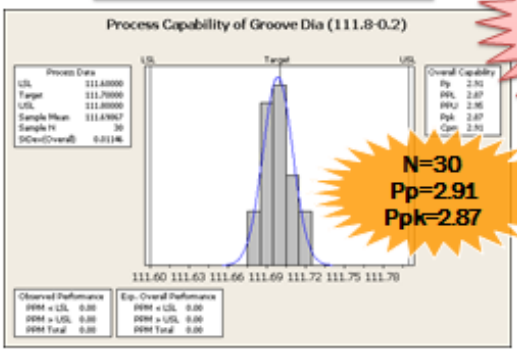
MOM with Supplier

Stator Plate Groove diameter turning and facing on CNC Machine

Supplier M/s. Nippon is having two production lines in which two CNC turning machines are there, We did the capability study for these machines.

Short Term Process Capability Study of CNC Turning M/C-For Groove diameter 111.80-0.2

SPC - M/C- 1, GROOVE DIAMETER

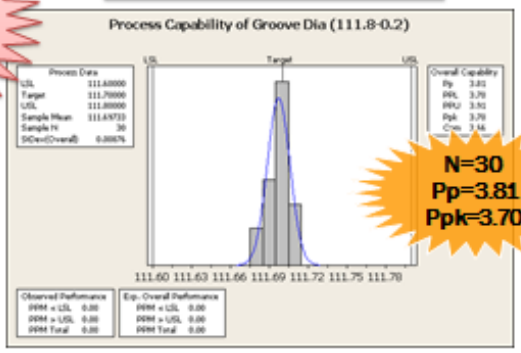


Short Term SPC for continuous 30 Pieces

N=30
Pp=2.91
Ppk=2.87

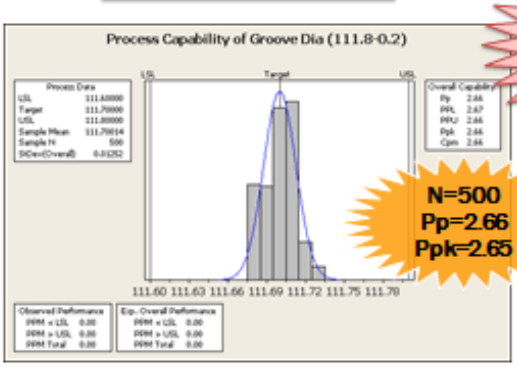
111.8-0.2

SPC - M/C- 2, GROOVE DIAMATER



N=30
Pp=3.81
Ppk=3.70

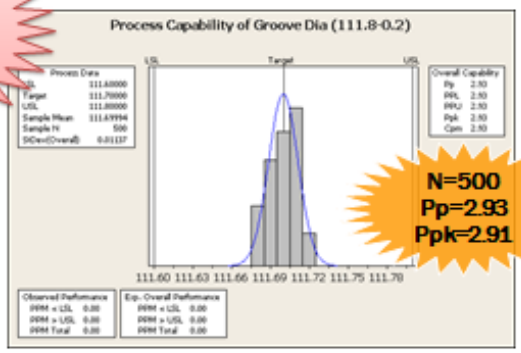
SPC - M/C- 1, GROOVE DIAMETER



Short Term SPC for continuous 500 Pieces

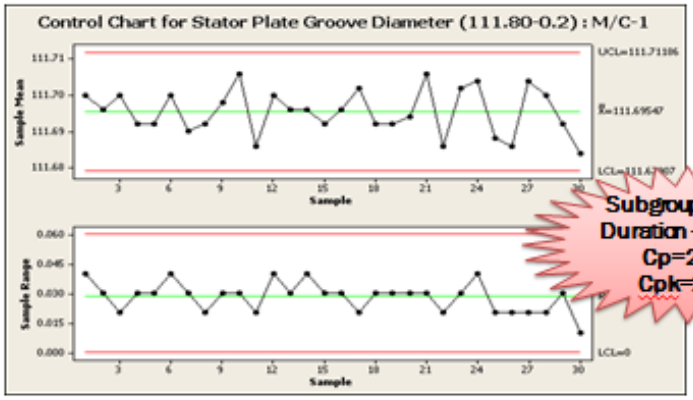
N=500
Pp=2.66
Ppk=2.65

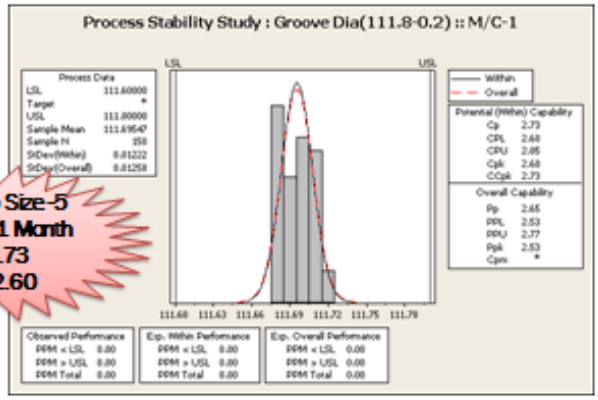
SPC - M/C- 2, GROOVE DIAMATER



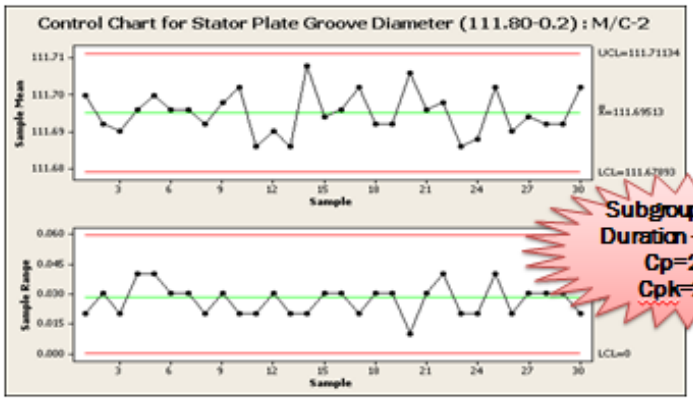
N=500
Pp=2.93
Ppk=2.91

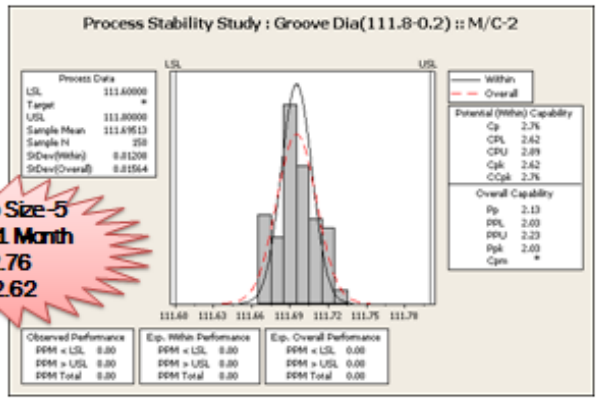
Long Term Process Capability Study of CNC Turning M/C-For Groove diameter 111.80-0.2





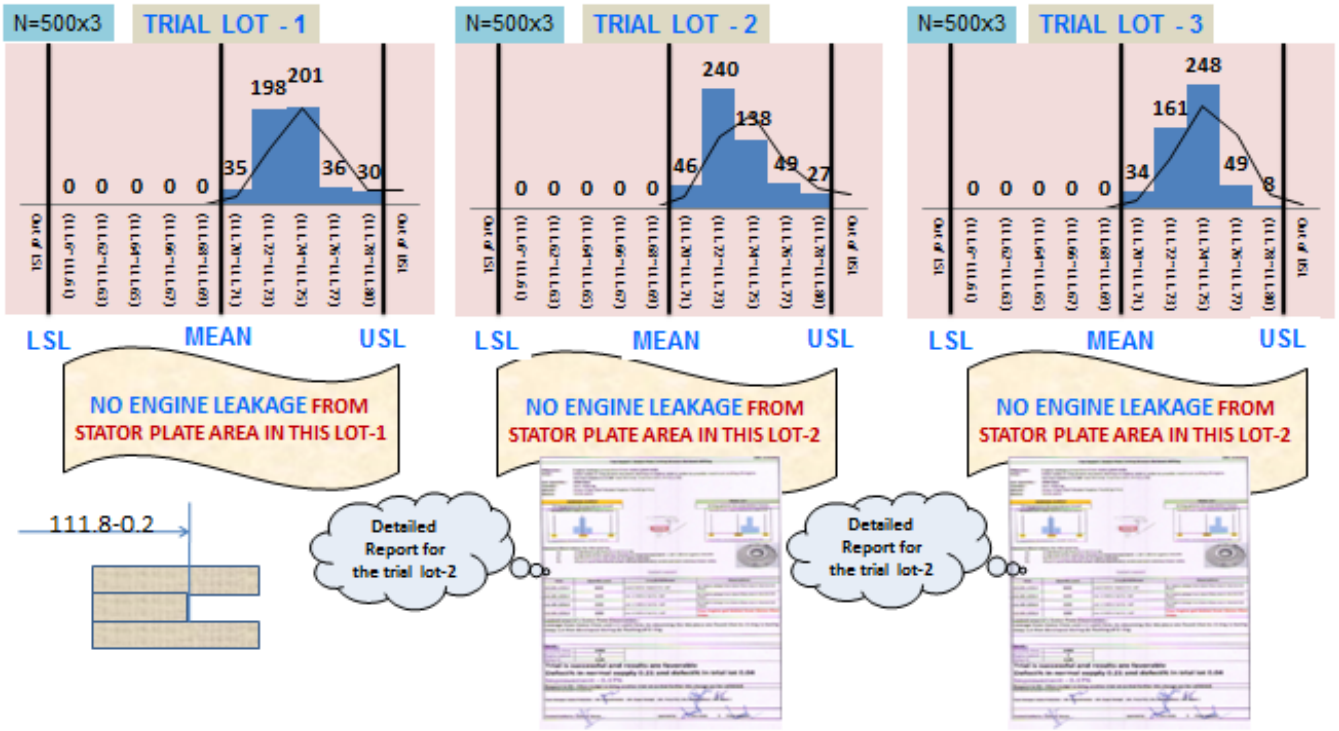
Subgroup Size-5
Duration -1 Month
Cp=2.73
Cpk=2.60





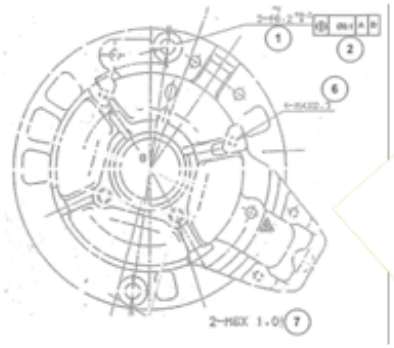
Subgroup Size-5
Duration -1 Month
Cp=2.76
Cpk=2.62

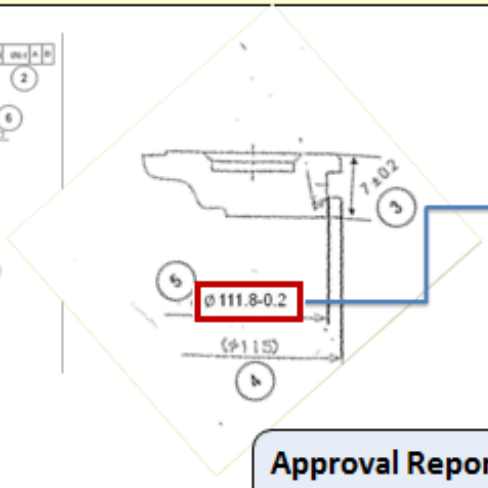
Further actions : **3 Lots of 10,000 Pieces** was demanded from **M/s. Nippon** having groove dia between Mean and USL



This trial confirms that keeping Stator Plate O ring groove dia(d) at upper side (between mean and USL) confirms maximum sealing in engine from stator plate area.

Drawing change request raised to maintain the O Ring Groove dia between mean and USL



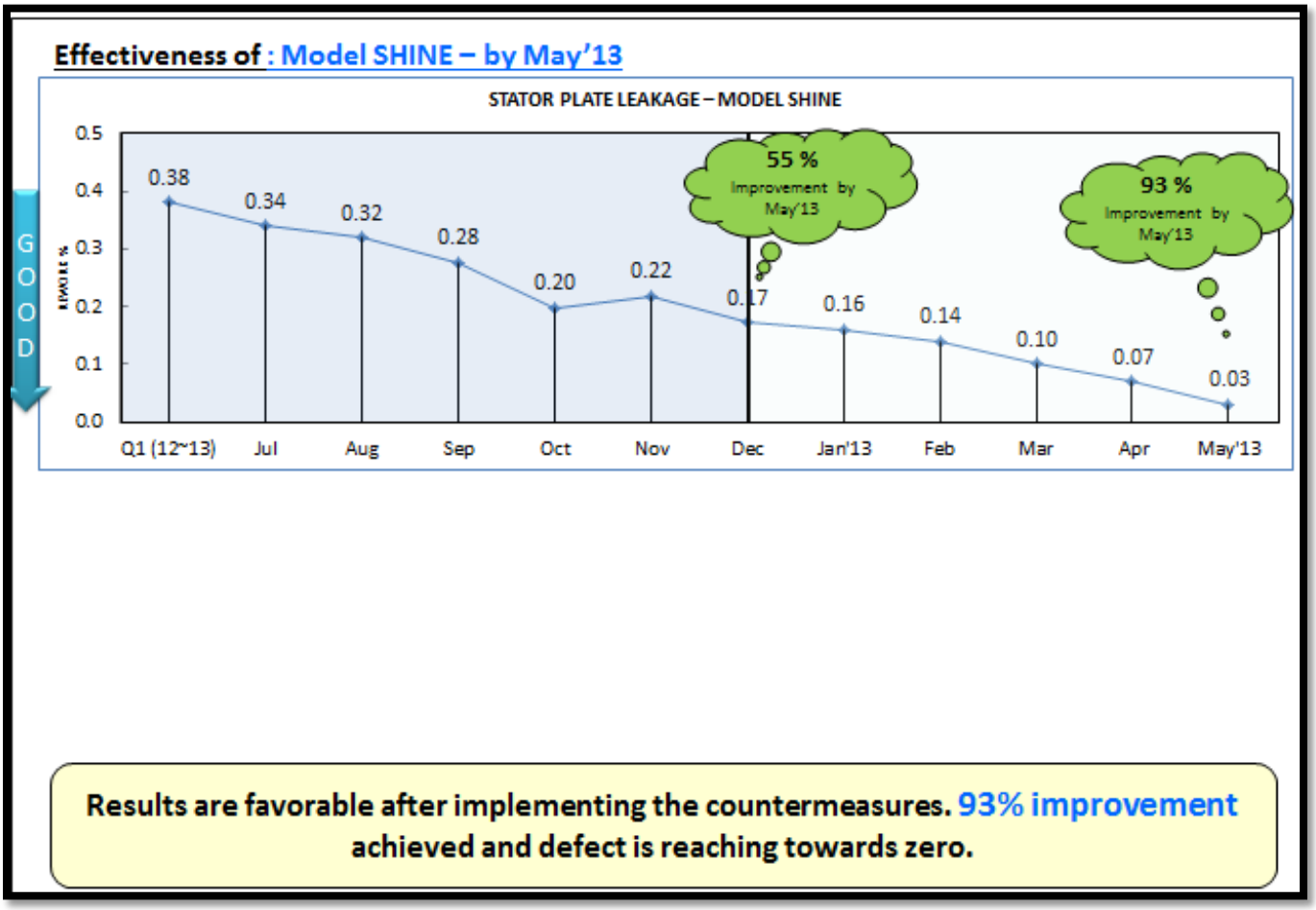


BEFORE	AFTER
Ø 111.8-0.2	Ø 111.8-0.1
Tolerance (-0.2)	Tolerance (-0.1)

Approval Reports of Trial Lots

DCR raised to change Stator Plate O ring groove dia from 111.8-0.2 to 111.8-0.1
The Tolerance Bend has to maintained by -0.1mm at both the supplier end

CONFIRM EFFECTIVENESS: RESULT CONFIRMATION



STANDARDIZING & ESTABLISHING CONTROL:

Countermeasure conformation and adherence standards :-

Countermeasure conformation Standard updated

Countermeasure conformation check sheet revised

HONDA

Stator Plate Leakage prevention action monitoring Sheet

Engine Assy.

Document No.	
Revision No.	0
Effective Date	14/11/2011
Page Number	1 of 1
Month	NOV 2011

Sr. No.	Detail of Check Point	Model	Controlling At	Why	Verification Method.	Controlling Frequency	Remarks
1	Oil Seal Guide Should not be cracked	BEEE XXX	Process	To avoid oil seal cut	Visual verification	1 Per Shift	
2	Oil Seal Guide must be used 100%	BEEE XXX	Process	To avoid layer Fitment	Visual verification	1 Per Shift	
3	Alignment Pin Shuld not bend and damage	All Models	Process	To avoid layer Fitment	Visual verification	1 Per Shift	
4	Alignment Pin must be used 100%	All Models	Process	To avoid layer Fitment	Visual verification	1 Per Shift	
5	Spl Pin(XXX) Stator Plate should be placed on Flywheel in marshal conveyor	XXX	Process	To avoid extra material stickness on Plate from marshal conveyor	Visual verification	1 Per Shift	
6	BEEE Stator Plate Should be placed UP side dowrn (Uri touches to the Marshal conveyor)	BEEE	Process	To avoid extra material stickness on Plate from marshal conveyor	Visual verification	1 Per Shift	
7	Tighten the screw(nos.) by 1-2-1 method of tightening	All Models	Process	To avoid layer Fitment and torque loss of stator plate	Visual verification	1 Per Shift	
8	Extra Material should not be in Stator Plate at O ring Groove and Oil Seal	All Models	Input	To avoid extra material stickness on Plate from input	Visual verification	1 Per Shift	
9	Deep Parting Lines, Flashes and Deep cut should not be on O ring	All Models	Input	To avoid leakage	Visual verification	1 Per Shift	
10	Oil Seal Cut should not be cut	All Models	Input	To avoid leakage	Visual verification	1 Per Shift	
11	SOP sequence must be followed	All Models	Process	To avoid leakage	Visual verification	1 Per Shift	

Prepared By Sachin Kr. Sharma Approved By Amit Handa

HONDA

Stator Plate Leakage prevention action monitoring Sheet

Engine Assy.

Document No.	
Revision No.	0
Effective Date	14/11/2011
Page Number	1 of 1
Month	Jan' 2013

Line :-

Sr. No.	Detail of Check Point	Model	Controlling At	Why	Verification Method.	Date															
						A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1	Oil Seal Guide Should not be cracked	BEEE XXX	Process	To avoid oil seal cut	Visual verification																
2	Oil Seal Guide must be used 100%	BEEE XXX	Process	To avoid layer Fitment	Visual verification																
3	Alignment Pin Shuld not bend and damage	All Models	Process	To avoid layer Fitment	Visual verification																
4	Alignment Pin must be used 100%	All Models	Process	To avoid layer Fitment	Visual verification																
5	Spl Pin(XXX) Stator Plate should be placed on Flywheel in marshal conveyor	XXX	Process	To avoid extra material stickness on Plate from marshal conveyor	Visual verification																
6	BEEE Stator Plate Should be placed UP side dowrn (Uri touches to the Marshal conveyor)	BEEE	Process	To avoid extra material stickness on Plate from marshal conveyor	Visual verification																
7	Tighten the screw(nos.) by 1-2-1 method of tightening	All Models	Process	To avoid layer Fitment and torque loss of stator plate	Visual verification																
8	Extra Material should not be in Stator Plate at O ring Groove and Oil Seal	All Models	Input	To avoid extra material stickness on Plate from input	Visual verification																
9	Deep Parting Lines, Flashes and Deep cut should not be on O ring	All Models	Input	To avoid leakage	Visual verification																
10	Oil Seal Cut should not be cut	All Models	Input	To avoid leakage	Visual verification																
11	SOP sequence must be followed	All Models	Process	To avoid leakage	Visual verification																
					Total Nos.(✓)																
					Total NG's (✗)																

✓ - WORKING ✗ - NOT WORKING

Countermeasure conformation and adherence standards :-

One Point Lesson

ONE POINT LESSON

OPERATION : Stator coil OD turning | PRODUCTS : STATOR COIL

	FAILURE	ROOT CAUSE	CONTROL METHOD
1	Chips Problem In ACG P17	Stator coil not cleaning 100% by brush after OD turning & No cross check available	100% Clean by brush after OD turning

EFFECT ON PRODUCT QUALITY & CUSTOMER USAGE :

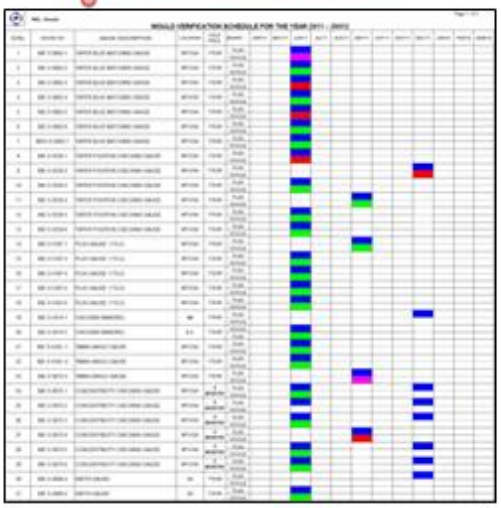
1. Obtained problem

CUSTOMER COMPLAINT HISTORY

S. No	NATURE OF COMPLAINT	APPLICATION	DATE OF COMPLAINT	CORRECTIVE ACTION
1	Found chips in stator coil	P 17 ACG	05.11.11	100% Clean by brush - Keep >> Operator. Cross check by Line supervisor
2				
3				

Prepared by : Approved by :

Tool Maintenance Schedule



MOULD VERIFICATION SCHEDULE FOR THE YEAR 2011 – 2012