REDUCTION OF GOVERNOR HOUSING JOINT LEAKAGE IN APUMPS THROUGH SHAININ APPROACH

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Abstract : A-type diesel fuel injection pumps are used for large engines, diesel locomotives, marine engines and construction machinery and have lower efficiency, higher emissions and higher rejections while manufacturing. Based on the higher rejection cost pump is selected for the study. This product has higher rejections rate at prepacking process.

The methodology used was Shainin®. In the present project good and bad parts are collected to identify the root cause, that's done by swapping parts from the good to the bad system and vice versa. When the experiment shows that a certain part can switch a good system into a bad, and simultaneously a bad into a good system, then that part is causing the problem. Now we know the culprit part, we finally have to identify the feature, the characteristic of the part that is causing the problem. This is done by paired comparison.

To begin with repeatability of the assembly process and calibration process is studied. It is observed that there is no significant effect of the above process. Then component search was conducted.

***IndexTerms* – A-TYPE FUEL INJECTION PUMP, GOVERNOR HOUSING ,**

1. Introduction

An Injection Pump is the device that pumps diesel into the cylinders of a diesel engine. Traditionally, the injection pump is driven indirectly from the crankshaft by gears, chains or a toothed belt that also drives the camshaft. It rotates at half crankshaft speed in a conventional four-stroke diesel engine. Its timing is such that the fuel is injected only very slightly before top dead center of that cylinder's compression stroke. It is also common for the pump belt on gasoline engines to be driven directly from the camshaft. In some systems injection pressures can be as high as 200 MPa.

Earlier diesel pumps used an in-line layout with a series of cam-operated injection cylinders in a line, rather like a miniature inline engine. The pistons have a constant stroke volume, and injection volume is controlled by rotating the cylinders against a cut-off port that aligns with a helical slot in the cylinder. When all the cylinders are rotated at once, they simultaneously vary their injection volume to produce more or less power from the engine. Inline pumps still find favour on large multi-cylinder engines such as those on trucks, construction plant, static engines and agricultural vehicles.

For use on cars and light trucks, the rotary pump or distributor pump was developed. It uses a single injection cylinder driven from an axial cam plate, which injects into the individual fuel lines via a rotary distribution valve. Later incarnations such as the Bosch VE pump vary the injection timing with crankshaft speed to allow greater power at high crank speeds, and smoother, more economical running at slower

revolution of crankshaft. Some VE variants have a pressure-based system that allows the injection volume to increase over normal to allow a turbocharger or supercharger equipped engine to develop more power under boost conditions.

Fig 1.1Diesel fuel injector pump

1.2 Working Principle

Diesel engine is a compression ignition engine. It draws only air and compresses the working mixture to a much greater level than a spark ignition engine. It is more efficient as compared to other compression engine. The diesel engine can be of two types –two strokes and four strokes. It draws in air only during the suction stroke. During the compression stroke the air is heated to a high temperature that the diesel fuel injected into engine at the end of the compression stroke ignites itself without any external ignition assistance.

Unlike the petrol engine, the diesel engine is a self-igniter. The air suctioned into the cylinders is heated up to a temperature of approx. 700-900°C through compression, which results in self ignition when fuel is injected. Therefore, a diesel engine requires higher compression and a correspondingly more stable construction than the petrol engine. In order to guarantee that the necessary temperature is reached even in unfavorable conditions such as cold-starting or frost, additional heat must be introduced to the combustion chamber.

2. METHODOLOGY

In this chapter Shainin® Methodology and its approach is discussed in detail. Shainin methodology uses FACTUAL approach for problem solving. It uses tools like paired comparison, isoplots, regression analysis, DOE etc.

Methodology utilized for obtaining objectives mentioned above is FACTUAL obtained from Shainin quality improvement technique. Seven steps of Shainin methodology can be subdivided to two parts. One first four steps subsequently called focus, approach, converge & test comes under diagnostic part. In first part Red X candidate or root cause is identified and confirmed.

Remaining three steps understand, apply and leverage comes under remedial part. In second part remedial action is confirmed to avoid the repetition of root cause. Seven steps of methodology are shown below :

i) **Focus:** Used for converting business problem into the technical project this will lead to focusing on resources which is nothing but generating problem definition tree which gives clear idea about the problem. Problem definition trees of all three subprojects are included in problem definition

ii)**Approach:** This involves identifying the Green Y or output, develops the investigative strategy and establishing the effective measurement system. This involves generating project definition tree which helps to understand exact effect of problem on product or process.

iii)**Converge:** In this converging from Output to Red X or root cause is achieved. Converge is most important stage as root cause is found in this step. but validating the cause of problem. This makesuse of tools like B vs. W (Better vs. Worst) This involves generation of solution tree and strategy diagram. These two diagrams will guide to reach Red X candidate.

iv)**Test:** Test is to insure the Red X or root cause by making Green Y or output on and off. This is nothing but validating the cause of problem. This makes use of tools like B vs. W (Better vs. Worst) analysis to confirm the contrast achieved after application of remedial action

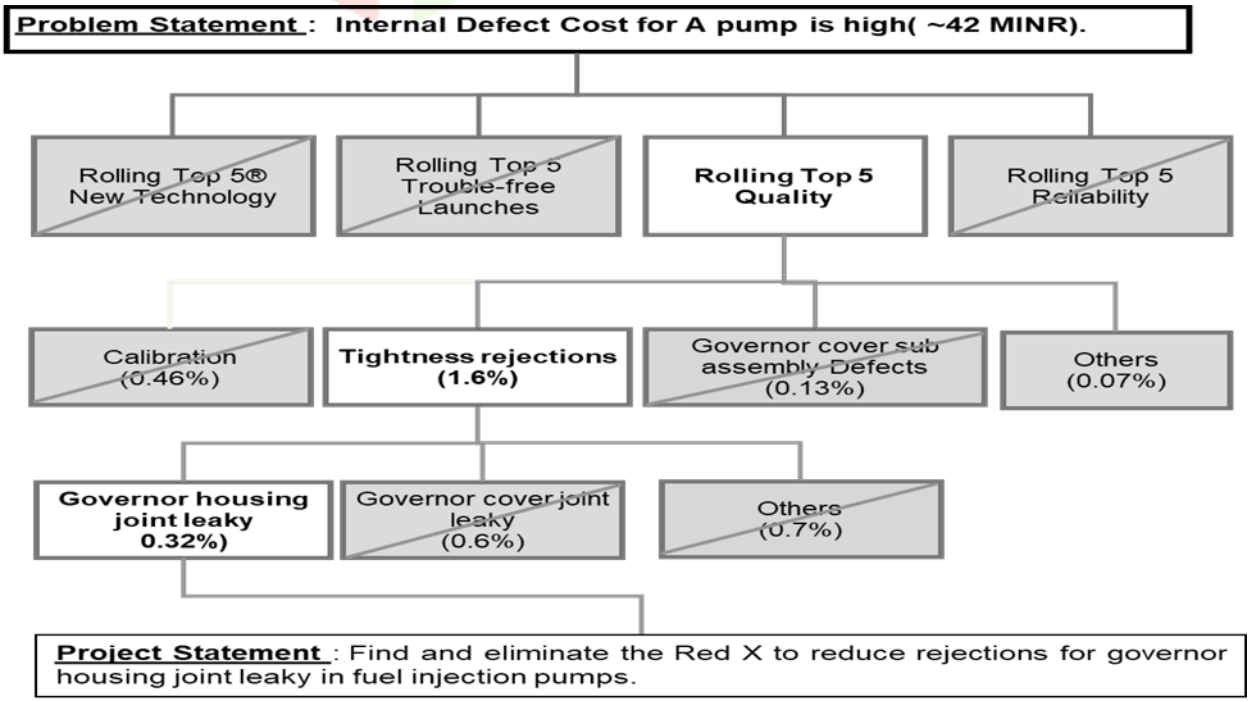
v)**Understand:** Develop the relation between output and root cause and optimize the interactions. This correlation between Red X and Green Y will help to understand project. This step makes use of tools like concept diagram where Red X is indicated on one axis and Green Y on another.

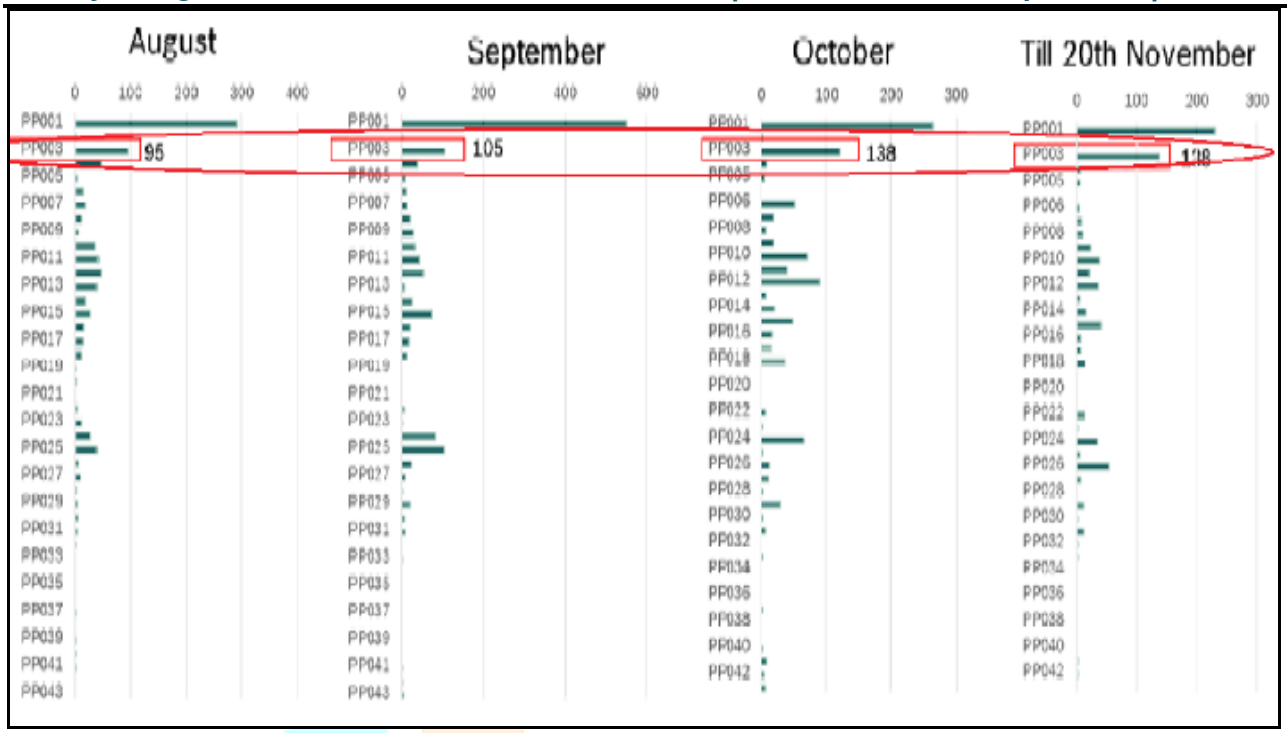
vi)**Apply:** This is nothing but control cause and observe the output and evaluating control operation. This involves generation of internal documents which insures what kind of changes are required to implement remedial actions and who will take the responsibility.

vii)**Leverage:** Leverage step involves applying strategy to similar challenges. This also suggests g enerating internal document which indicates similar problems where learning from current project can be applied.

3. SHAININ APPROACH

3.1 FOCUS

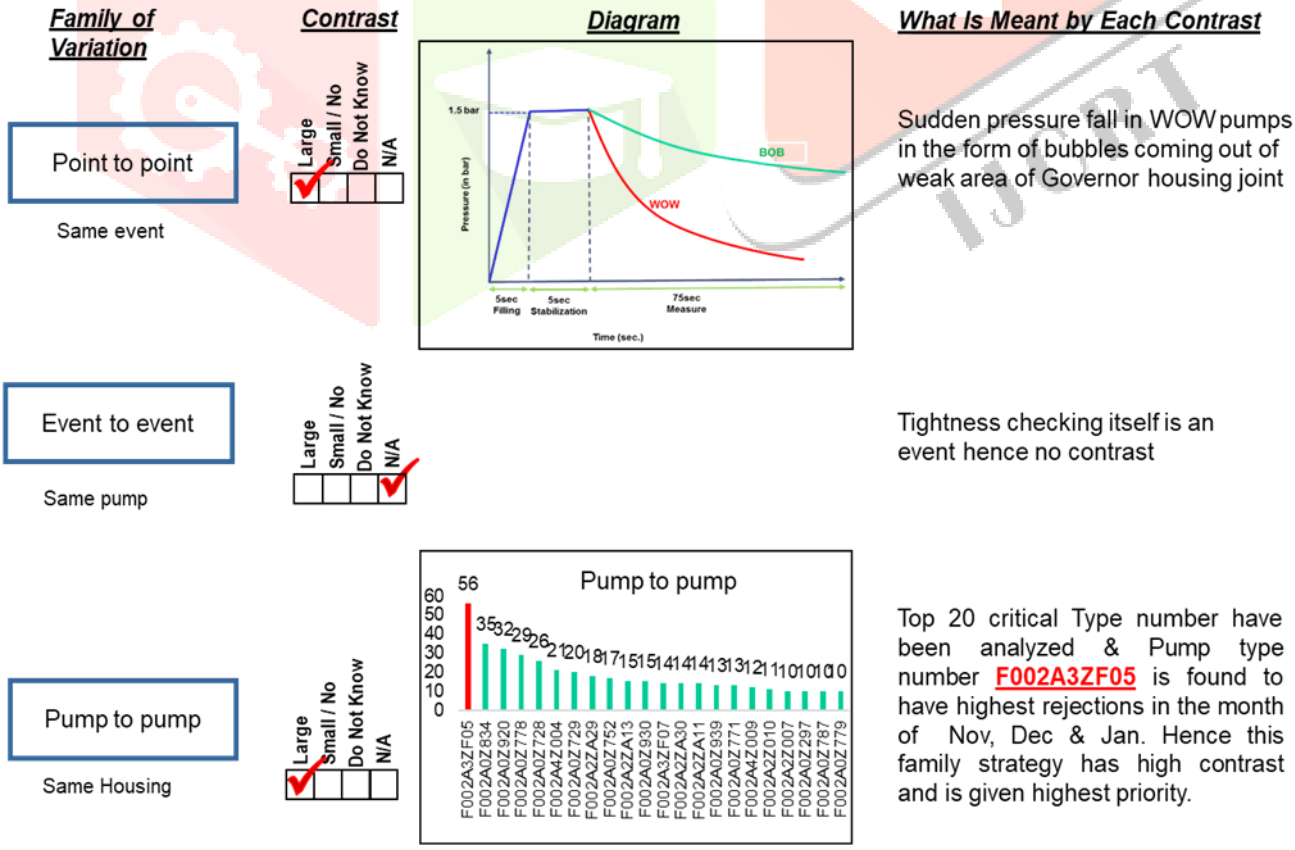




Problem Manifestation: There is 1.6% rejection at tightness checking.

Problem

Discovery Point: Focus split, Repair cost is high. (GHJL repair calls for rephrasing & re calibration ,hence repair cost more)

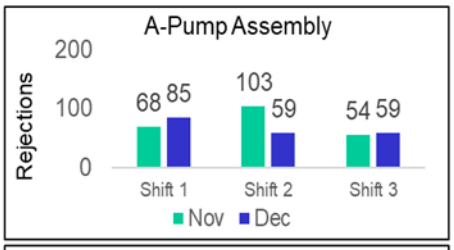
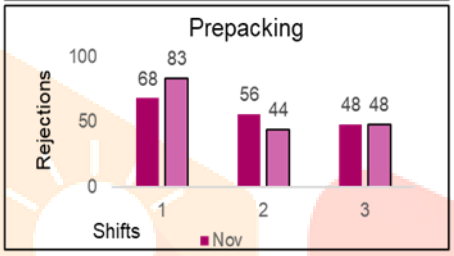
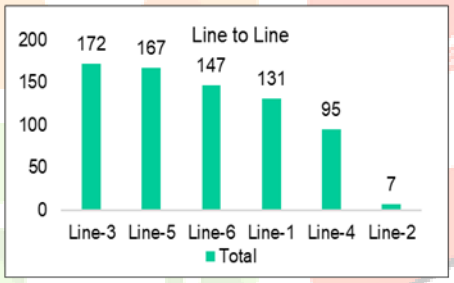


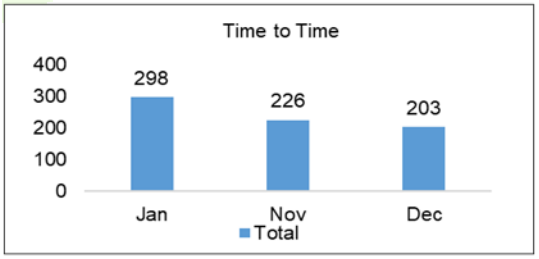
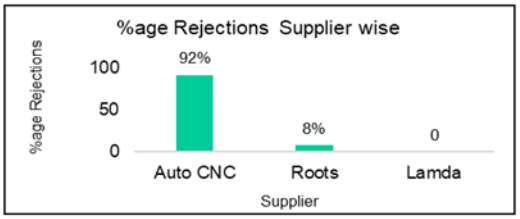
Find and eliminate the Red X to reduce rejections for governor housing joint leakage in fuel injection pumps. Event describes whether the problem is destructive or malfunctioning an event happening at a

determined time and place. Malfunctioning comes under event in which problem is occurring and can be repaired from some alterations and occurring non randomly in different points and at different time. Most of all leakage occurring at inspection cover side.it is observed that 90% of rejections are occurring in the inspection cover side.

3.2 Approach

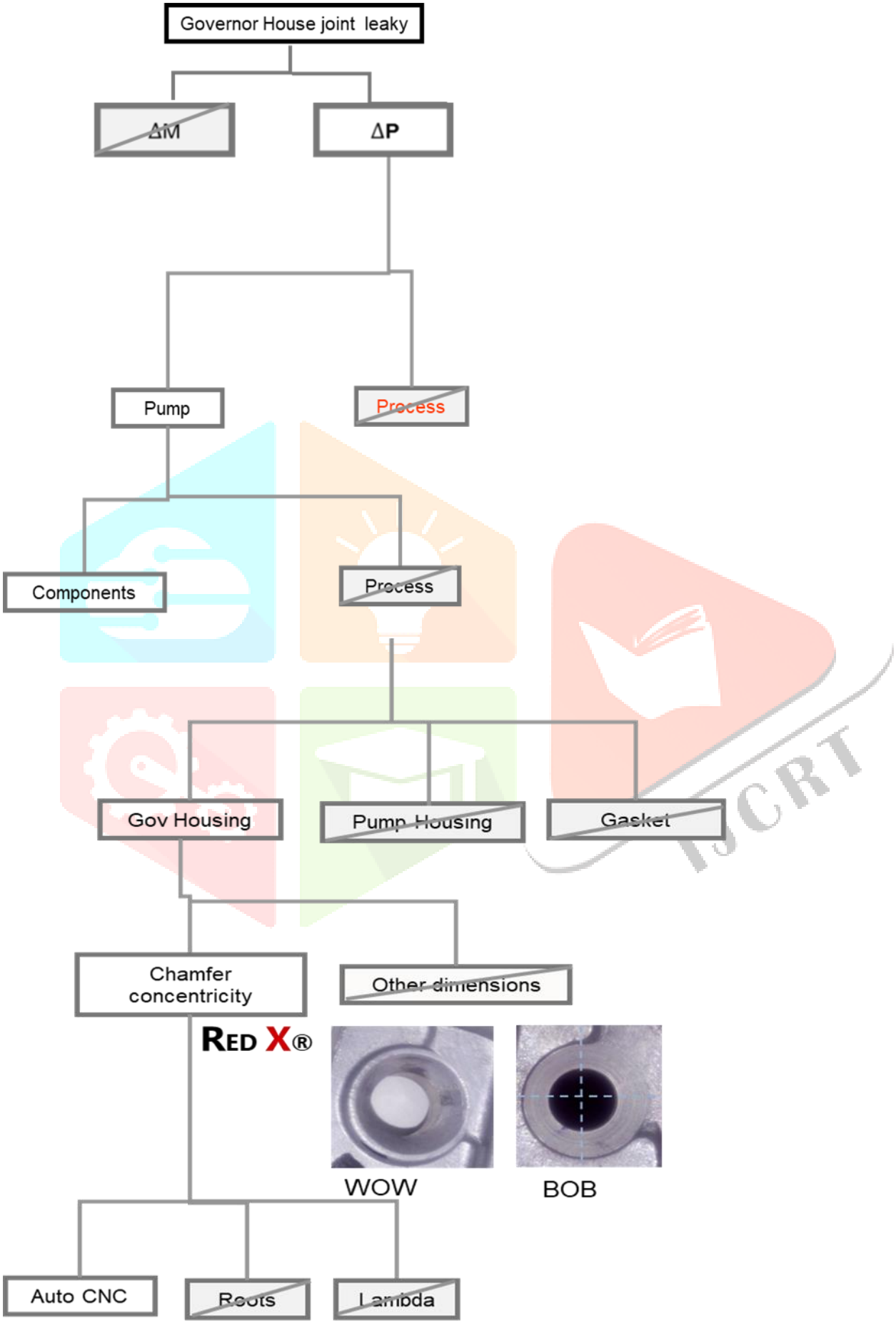
Green Y® =

Family of Variation	Contrast	Diagram	What Is Meant by Each Contrast
Shift to Shift Same Assembly line	Large / Small / No / Do Not Know / N/A		▪ There is no significant contrast observed and hence small contrast
Shift to Shift Same Tighteness-abnceh Bench	Large / Small / No / Do Not Know / N/A		▪ The delta value is high when compared & analyzed the rejection rate in all the shifts. Hence high contrast is taken in to consideration.
Assembly Line to assembly line Same Time	Large / Small / No / Do Not Know / N/A		▪ The same results are repeating in different assembly lines, (Line 2 is a Odd line & Line 4 is not planned for all 3 shifts.) Hence there is no contrast in line.

Family of Variation	Contrast	Diagram	What Is Meant by Each Contrast
Time to Time Same Supplier	Large / Small / No / Do Not Know / N/A		▪ As delta value is smaller, comparing data in 3 different months at assembly lines, Hence there is small contrast seen in line.
Supplier to supplier	Large / Small / No / Do Not Know / N/A		10days rejected data was analyzed , & 92% of the rejections found to be from one supplier.

Summary: Pump to Pump and Supplier to Supplier strategy is adopted

3.3 CONVERGE



Component search is conducted between two pumps ,one is BOB (Non-Leaky) & WOW (Leaky). Every time new gasket was assembled.

- Stage 0 : BOB and WOW selected and checked and the there was no variation.
- Stage 1 : dis-assembling & assembling Governor housing and the tightness check was carried out & found BOB to be BOB & WOW to be WOW.
- Stage 2 : After Swapping Governor housing ,full reversal detected, where in leakage pump became OK and Ok pump was leaky. Swapping back governor housing, full reversal was detected.

3.4 TEST

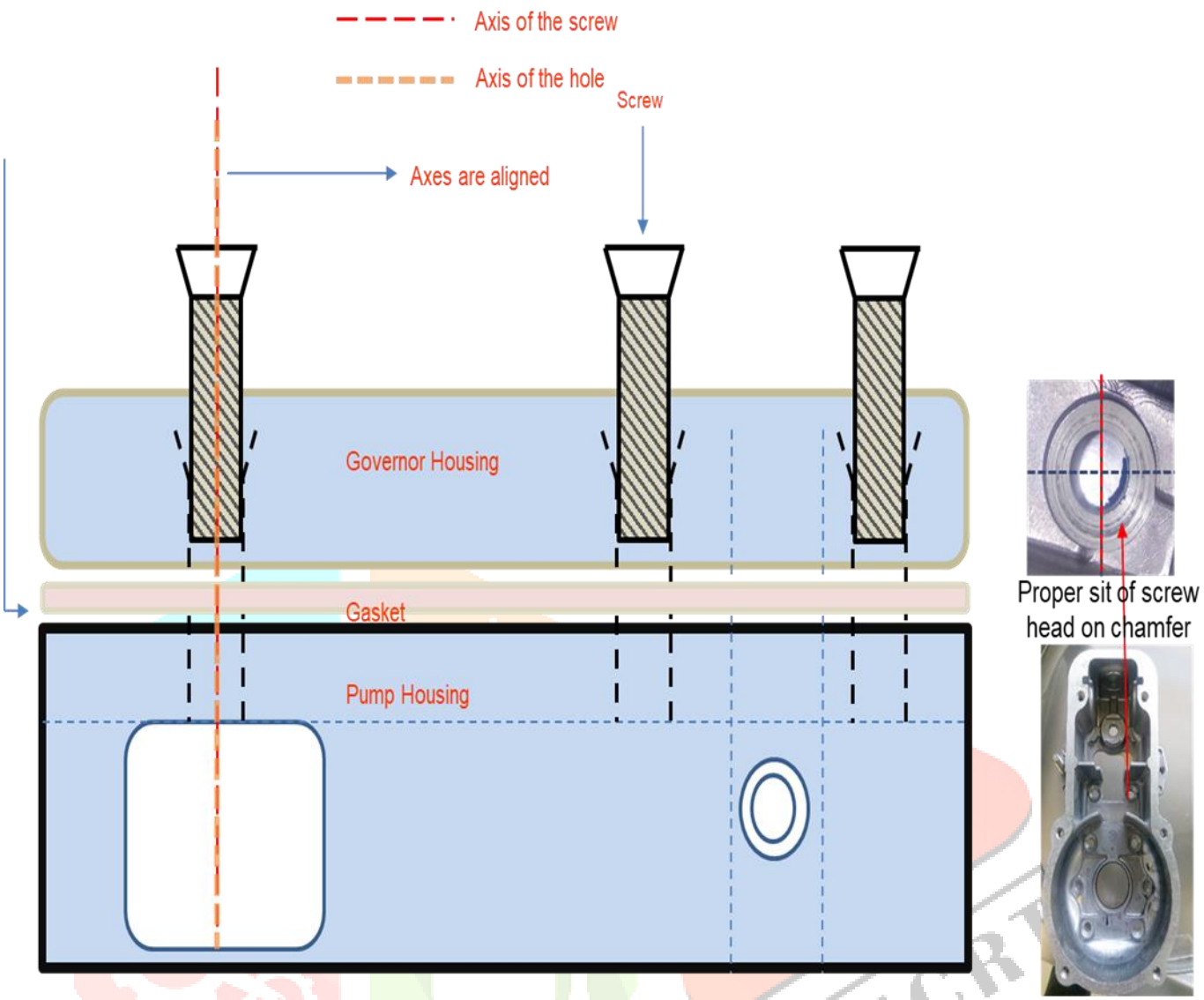
Paper Gasket

Paper Gasket has the inherent property of Swelling after dipping into the oil.

After analysis we found the gasket thickness is also changing after testing in the checking station, there were two variables (Chamfer concentricity and gasket thickness and hence the test had failed.

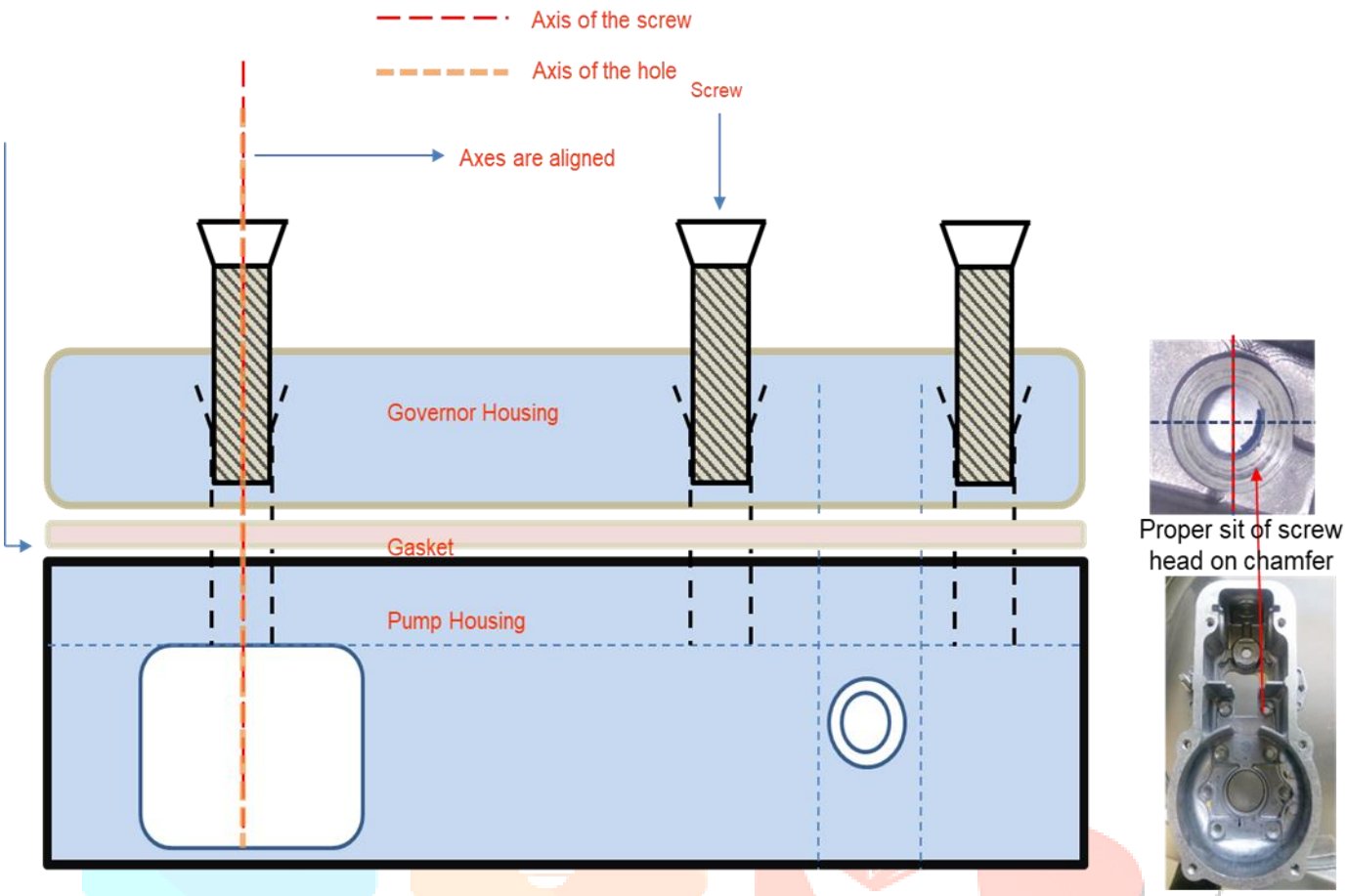
To overcome this we had tried metal gasket which will not vary its dimensions after dipping in the oil.

3.5 UNDERSTAND



The governor housing supplier cnc and roots are not done machined screw holes in this problem will be identified to sent to the R&D department in that dept are tested in that process they are tested shown in above the diagram . The CNC and ROOTS parts are casting the screw holes are not properly coming in center axis so that's why pump assembled time governor housing not sitting properly on pump housing ,the M6and M8 screws are tightened at their pressure is M6is 8+/-1nm and M8 is 18+/-2nm pressure is occurred ,in this amount of pressure is apply to the governor housing to the tightening of screw the governor housing holes are not correctly obtained in this process screw are tightening axis are changing to the Centre axis of the hole ,so in this problem is identified.in this process screw are not sitting properly gasket are not sitting on pump housing some minute space will occurred

3.6 Apply



In this above the diagram governor housing screw holes are machined after machined screw are sitting properly the screw axis are coincide with the centre axis of the governor housing, after testing to inform to suppliers for next coming parts are all are machined to supply the parts , after one week all parts are coming machined .

The machined parts are send to assembly line that machined governor housing parts after assembled send to the next process for phasing and calibration after completed send to final inspection in this tightness checking are tested to applying the air pressure to apply to the fuel pump

4. Conclusions

4.1 Conclusions

Shainin problem solving methodology is used for this particular project work, it is seven steps convergent problem solving method. Those seven steps are Focus, Apply, Converge, Test, Understand, Apply and Leverage amongst these first four comes under diagnostic part and last three steps comes under remedial part. In focus problem definition is confirmed with problem definition tree to understand problem better. Effect of root cause or input is generated in approach phase by generating project definition tree. Next step is converge where best of best and worst of worst parts are compared to identify the root cause. Test phase involves confirmation of root cause. In understand step cause-effect relationship is studied. Apply and leverage involves documentation and identifying the potential areas where the current solution can be applied. As through the shainin tool, we could successfully find and eliminate the RED-X. The red x

found is Chamfer concentricity with respect to hole diameter is more in WOW pumps. Leading to the tightness rejections. Relative actions were implemented and monitored. As the result were good in all the actions taken hence, ECR (engineering changes) are raised

RESULT: The percentage of governor housing joint leaky was being 0.32% (from January-march) and has been rejections are came down by 0.09% by April.

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