# PNP HEAD MATRIX II ASYNCHRONOUS PICK BODY STROKE; CAUSES, EFFECTS AND SOLUTIONS

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***ABSTRACT***

In recent years, customers' expectations for the productivity and adaptability of their production lines have significantly increased. This is the reason why *Pick-and-Place devices* are becoming more prevalent in various electronics sectors.

Among all ATS products, *PnP Head Matrix II* has the lowest First Pass Yield (FPY) results which significantly affects the Key Performance Indicator (KPI) for Production and Engineering departments. For the previous six (6) consecutive quarters, it has failed to meet the target of 99.50% with an average of 97.61%. *Asynchronous Pick Body Stroke* problem has the highest defect rate according to the ATS Test Pass Down.

This paper has experimentally investigated the causes and effects to the Asynchronous Pick Body Stroke problem, and to provide solutions to improve the First Pass Yield (FPY) up to 1.90% in the 4th quarter of 2023.

## 1. 0 INTRODUCTION

### 1.1. THE MANUFACTURER

**Cohu,** a Global Technology and Market Leader in Semiconductor Test which offers the broadest portfolio of equipment and services for back-end semiconductor manufacturing. **Cohu Malaysia** manufactures the *Delta Matrix*.

**Automation Technology and Solutions (ATS)** is one of the business units of *P.IMES Corporation* that manufactures semiconductor equipment in compliance with customer's design specifications.

JEDEC Load Port. JEDEC Top Plate, Offline (Binning) Handler, Eclipse and *Matrix II* are the products of ATS.

As a contract manufacturer of Cohu, ATS manufactures *PnP Head Matrix II*, a component of Delta Matrix. ATS assemble and test the machine before its delivery to Cohu Malaysia.

Cohu Malayisa will integrate the PnP Head Matrix II into the Delta Matrix, perform final testing and ship to the end user.

### 1.2 THE PRODUCT

#### *1.2.1 Delta Matrix: High Parallel Tri-Temp Pick and Place Handler*

*Cohu's MATRiX thermal pick-and-place handler* has a highly flexible test site configuration that's well suited for a wide range of test applications. It provides full temperature control in extreme environmental conditions from -55 °C to +175 °C.


Figure 1. Delta Matrix: High Parallel Tri-Temp Pick and Place Handler

#### *1.2.1.1 Main Mechanical Components*

The Delta Matrix consists of the following five main areas:


Figure 2. Delta Matrix Areas and Components

The Delta Matrix consists of three (3) integrated *Pick-and-Place Head* devices.

1. 1x Input Pick-and-Place (PnP) Head
2. 1x Output Pick-and-Place (PnP) Head
3. 1x Transfer Pick-and-Place (PnP) Head

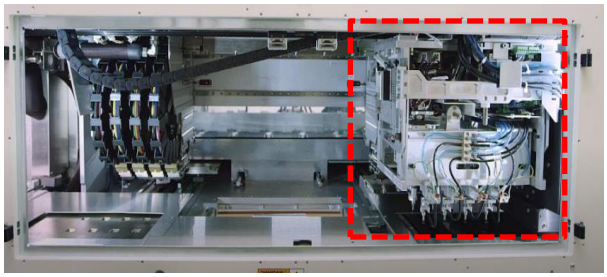


Figure 3. PnP Head integrated inside the Delta Matrix.

### *1.2.2 Pick-and-Place (PnP) Head Matrix II*

Pick-and-Place (PnP) module precisely picks devices from a tray or boat then transfer the it in another tray or boat.

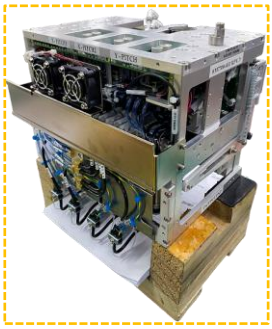


Figure 3. Pick-and-Place (PnP) Head Matrix II

### *1.2.2.1 Pick-and-Place Head Pneumatic Function Flow*

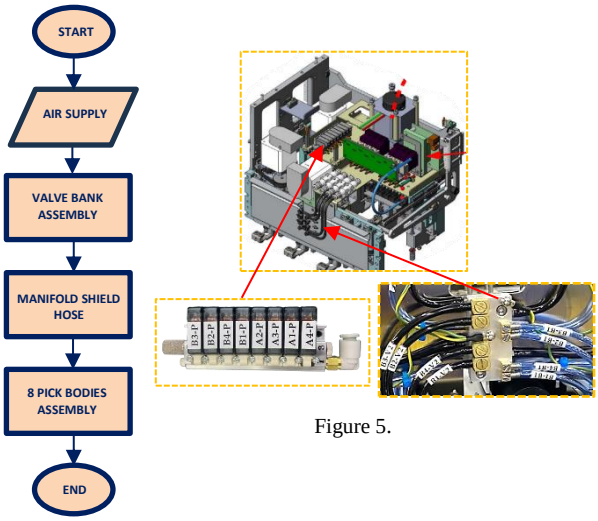



Figure 5.

*Valve Bank* and *Manifold Shield Hoses* are the sub-assemblies integrated into PnP Head Matrix II shown in Figure 5.

**Valve Bank Assembly (Pneumatic Brake Supply)** – If air is applied, eight (8) Valve Base(s) will control blow-off pressure going to Manifold Shield Hoses and generates individual supply for eight (8) Pick Bodies.

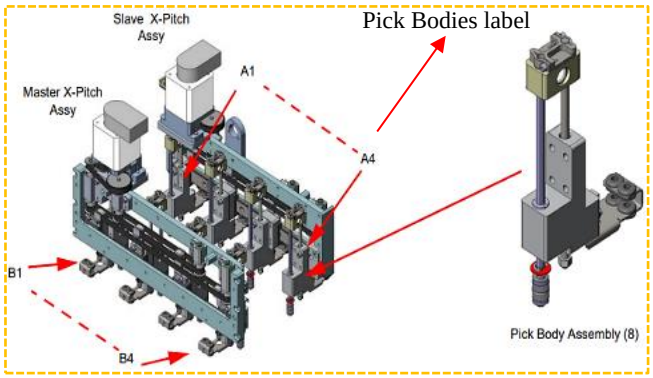



Figure 6.

*Master X-Pitch* and *Slave X-Pitch Assemblies* are the sub-assemblies integrated into PnP Head Matrix II. Eight (8) Pick Bodies are integrated in 2 X-Pitch rows (four (4) Pick Bodies per row) shown in Figure 6.

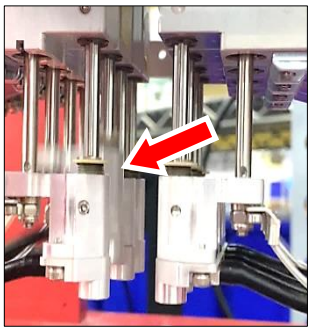
**Pick Body Assembly (Pick Tip Control)** – If air is applied, Spring will compress and the Piston Brake will release the brake that holds the Brake Shaft. The Float Lock Assy will move downward to pick or place the device.

### *1.2.2.2 Pick-and-Place Head Test Requirements*

PnP Head must pass the *Brake Counter Test* and other test requirement before it can be shipped to Cohu. Any defects or failure encountered from the machine must be recorded on *ATS Test Pass Down*.

**Brake Counter Tes Requirement –** The eight (8) Pick Bodies Assembly on Master X-Pitch and Slave X-Pitch must be able to lower its *pick tips synchronously* when the brake released.

GOOD Pick Body Stroke



Asynchronous Pick Body Stroke

**Test Pass Down –** A monitoring sheet that keeps track of any defects of failures encountered in all ATS products.

### 1.3 THE PROBLEM

The trendline of the graph is moving upward by showing a +1.43% from 1st Quarter of 2022 to 2nd Quarter of 2023 but still it didn't meet its target due to reoccurring problem or failure recorded on ATS Test Pass Down.

Out of all ATS products, *PnP Head Matrix II* has the lowest First Pass Yield (FPY) which significantly affects the Key Performance Indicator (KPI) of Production and Engineering department. For the previous (six) 6 consecutive quarters, it has failed to meet the target of 99.50% with an average of 97.61%, and a variance of -1.89%.

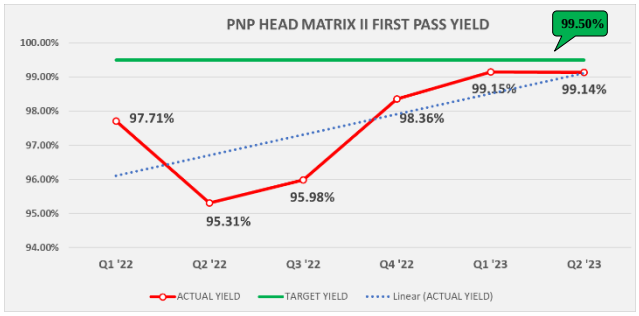



Figure 7. First Pass Yield of PnP Head Matrix II from Q1 of 2022 to Q2 of 20223

### 1.4 PROBLEM SCOPE

Asynchronous Pick Body Stroke problem have the largest number of errors on PnP Head Test Pass Down. It makes up for about 70% of errors.

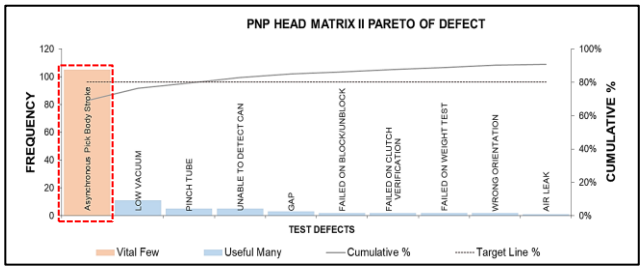



Figure 8. PnP Head Matrix II Pareto of Defects

The author of this paper is motivated to improve the First Pass Yield (FPY) of PnP Head Matrix II by eliminating the Asynchronous Pick Body Stroke problem through implementation of actions with relation to the method, material and man's contribution to the problem.

## 2.0 EXPERIMENTAL SECTION

### 2.1. PROCESS MAPPING

To clearly understand the Asynchronous Pick Body Stroke problem, a process mapping of the entire assembly of PnP Head Matrix II was conducted.

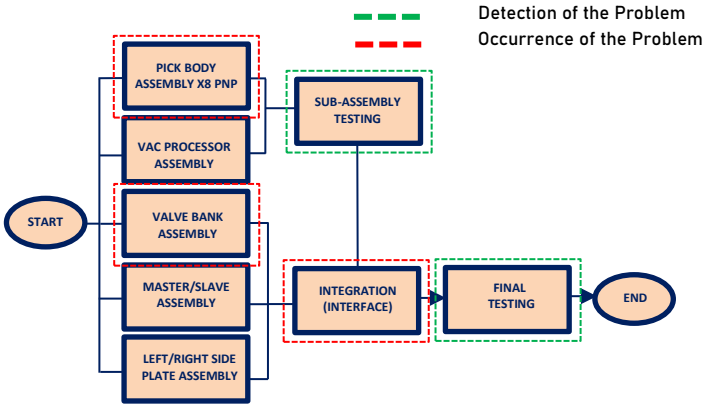



Figure 9. Assembly Process Flow of PnP Head Matrix II

#### *2.1.1 Detection of the Problem Verification*

In order to assess if the Asynchronous Pick Body Stroke problem might be detected, two tests were compared.

| TESTING | AIR SUPPLY | BRAKE TEST OPERATION | BRAKE COUNTER TEST REQUIREMENT | ASSEMBLY | Able to detect Asynchronous Pick Body Stroke? |
|---|---|---|---|---|---|
| Sub-assembly offline tesing  | 80 PSI | Brake release when air applied. | N/A | Single (1) Pick Body Assy. | X |
| Final testing  | 80 PSI | Brake release when air applied. | Sycnhronous | 8 integrated Pick Body Assy. | ✓ |

Figure 10. Comparison of two (2) testing

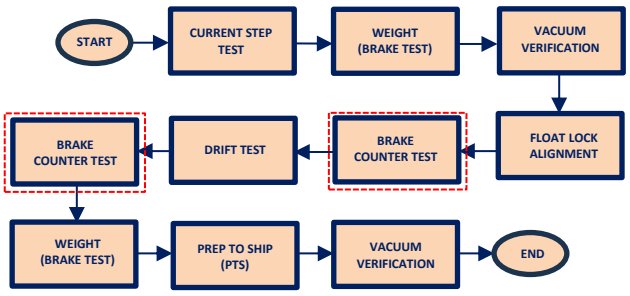



Figure 11. Final Testing Process Flow

**Analysis:** Asynchronous Pick Body Stroke problem cannot be detected on the Assembly Offline Testing but could be detected on the *Final Testing during Brake Counter Test "before and after" drift test.*

### *2.2.1 Occurrence of the Problem Verification*

Processes for each sub-assembly of PnP Head Matrix II was reviewed in order to confirm the possible occurrence of Asynchronous Pick Body Stroke problem.

| SUB-ASSEMBLY PROCESS | NON-RELATED | RELATED |
|---|---|---|
| **I. Pick Body Assembly x8** | | ✓ |
| **II. Master/Slave Assembly** | ✓ | |
| **III. Left/Right Assembly** | ✓ | |
| **IV. Valve Bank Assembly** | | ✓ |
| **V. Vacuum Processor Assembly** | ✓ | |
| **VI. Integration of above and below sub-assembly processes:** | | |
| i. Interface Plate Assembly | | ✓ |
| ii. Float Lock Assy and Pick Body Assy installation. | | ✓ |
| iii. Mounting Plate Assembly | | ✓ |
| iv. Manifold Shield Hoses | | ✓ |

Figure 12. Identifying related and non-related to the problem

**Analysis:** Asynchronous Pick Body Stroke problem were found to occur on *Pick Body Assembly*, *Valve Bank Assembly* and *Integration process.*

## 2.2 IDENTIFYING CAUSAL FACTORS

Asynchronous Pick Body Stroke problem was investigated using Ishikawa Diagram to identify possible causes. Factors causing an overall effect for Man, Machine, Method, Material and Environment were considered.

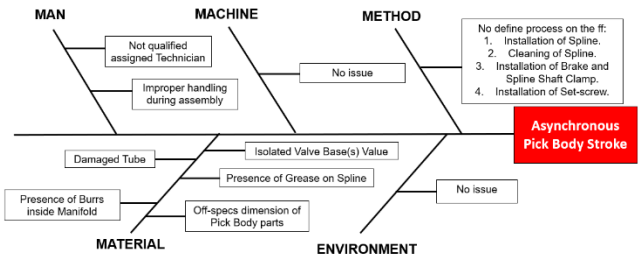



Figure 13. Ishikawa Diagram for Asynchronous Pick Body Stroke problem

### *2.2.1 Material*

| MATERIAL DEFECT CATEGORY | | POSSIBLE CAUSES | VERIFICATION | BRAKE COUNTER TEST RESULT | JUDGEMENT |
|---|---|---|---|---|---|
| **OFF-SPEC DIMENSION OF PICK BODY ASSEMBLY PARTS** | I. Piston Brake and O-ring inside. | Off-spec Piston Brake and O-Ring installed. | Reinstalled Piston Brake. | **Passed** | **NOT A POSSIBLE CAUSE** |
| | II Pick Body Base with Bushing. | Off-spec Pick Body Base and Bushing installed. | Reinstalled Pick Body Base. | | |
| | III. Spline and Brake Shaft | Off-spec Spline and Brake Shaft installed. | Reinstalled Spline and Brake Shaft. | | |
| **FAILD VALVE BASE(S)** | IV. Valve Base | Failed Valve Base(s) installed. | Reinstalled Failed Valve into a passed Pick Body Assy. | **Failed** | **POSSIBLE CAUSE** |
| **PRESENCE OF BURRS INSIDE MANIFOLD** | V. Manifold | Installed Manifold with Burrs inside. | Air blowing of Manifold before assembly. | **N/A** | **NOT A POSSIBLE CAUSE** |
| **DAMAGED TUBE** | VI. Tube | Pinch tube installed. | Can detect damaged tube during routing. | | |
| **PRESENCE OF GREASE OIL ON SPLINE.** | VII. Spline | Pre-pack Grease oil present on Spline. | With applied anti-corrosion oil by manufacturer. | | |

Figure 14. Identifying causal factors in Material

### *2.2.1.1 Possible Cause Verification*

| SIMULATION DETAILS | | PICK BODIES | Valve Base(s) Value (PSI) | RESULT |
|---|---|---|---|---|
| Integrated a Valve Bank Assembly with a failed Valve Base (A3) installed into a PnP Head. |  | A1 | 5.3 |  *Asynchronous Pick Body Stroke (A3)* |
| | | A2 | 5.1 | |
| | | **A3** | **2.5** | |
| | | A4 | 5.4 | |
| | | B1 | 5.4 | |
| | | B2 | 5.5 | |
| | | B3 | 5.2 | |
| | | B4 | 5.3 | |

Figure 15. Verifying the Failed Valve Base(s) identified as a True Cause

**Analysis:** In material verification, *Failed Valve Base(s)* was found to be a true cause of Asynchronous Pick Body Stroke.

| PROBLEM | FAILED VALVE BASE(S) |
|---|---|
| WHY 1 | Installed a failed Valve Base(s) during Valve Bank Assembly. |
| WHY 2 | Cannot identify passed/failed value of Valve Base(s) before Valve Bank Assembly. |
| WHY 3 | No sub-testing was conducted before Valve Bank Assembly. |

Figure 16. Use of Why-Why Analysis to determine the Root-Cause

### *2.2.2 Method*

A force to fail simulation was conducted after verifying that Failed Pick Body Assembly tended to pass after the reinstalling process. Other likely causes had initially identified logically.

| METHOD DEFECT CATEGORY | | SIMULATION DETAILS | 1st BRAKE COUNTER TEST RESULT | VERIFICATION | 2nd BRAKE COUNTER TEST RESULT AFTER VERIFICATION | JUDGEMENT |
|---|---|---|---|---|---|---|
| NO DEFINED PROCESS | **I. SPLINE** i. Spline Nut being forcibly installed onto Pick Body Base. | Forcibly installed Spline Nut (Preload) onto Pick Body Base. | Failed | Replaced Preload Nut to Clearance Nut then install to Pick Body Base. | Passed | POSSIBLE CAUSE |
| | ii. Incorrect cleaning, lubrication, and exercising of Spline. | SET 1 - No application of PS2 but with cleaning of Spline Shaft, and exercising of Spline. | Passed | Achieved free falling (fast) when more effort applied on cleaning of Spline Shaft. | N/A | NOT A POSSIBLE CAUSE |
| | | SET 2 - No application of PS2, no proper cleaning and, no exercising of Spline. | Failed | Swap Pick Body's location using of same PNP Matrix Head. | Failed | POSSIBLE CAUSE |
| | | SET 3 - No application of PS2, no cleaning of Spline Shaft, but with exercising of Spline Nut. | | Swap Pick Body's location using of same PNP Matrix Head. | | |
| | | SET 4 - No application of PS2, with cleaning of Spline Shaft, but no exercising of Spline Nut. | Passed | Achieved free falling (fast) when more effort applied on cleaning of Spline Shaft. | N/A | NOT A POSSIBLE CAUSE |
| | **II. BRAKE SHAFT** Misaligned Brake Shaft. | Manually misaligned Brake Shaft's alignment by twisting Clamp using finger tip. | Failed | Manually aligned Brake Shaft's alignment by twisting Clamp using finger tip. | Passed | POSSIBLE CAUSE |
| | **III. SPLINE AND BRAKE SHAFT CLAMP** Loose screw installed on Clamp Brake. | Loose screw installed on Clamp Brake after Brake Shaft alignment. | | Twisting of Spline and Brake Shaft. | N/A | |
| | **IV. SET SCREW** Overtightened set screw installed. | Fully tightened set screw installed on upper and lower of Pick Body Base screw hole. | | Loosen lower then upper set screw. | Passed | |
| | Loose set screw installed. | Loose set screw installed on upper and lower of Pick Body Base screw hole. | | Twisting of Spline and Brake Shaft. | N/A | |
| | **V. PISTON BRAKE** Misaligned intallation of Piston Brake. | Piston Brake is misaligned with reference to Pick Body Base. | Passed | Piston Brake re-adjusted its position inside of the Body Base when the Shaft is inserted. | Passed | NOT A POSSIBLE CAUSE |
| | **VI. BRAKE SHAFT** With and without Alignment jig used. | Used of with and without alignment on one PnP Head. | | Brake Shaft was realigned when Brake and Spline Shaft Clamp is installed. | | |

Figure 17. Identifying Causal Factors in Method

### *2.2.2.1 True Causes Verification*

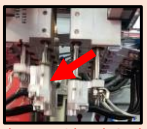
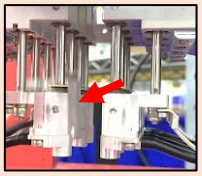
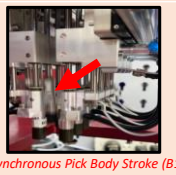
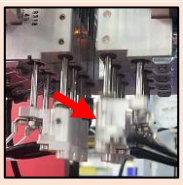
| SIMULATION DETAILS | | AFFECTED OF SIMULATION | RESULT |
|---|---|---|---|
| Spline Nut being forcibly installed onto Pick Body Base. |  | A1, A2, A3, A4, B2, B3, B4 - **X** B1 - ✓ |  *Asynchronous Pick Body Stroke (B1)* |
| Loose set screw installed. Overtightened set screw installed. |  | A1, A2, A3, A4, B1, B3, B4 - X B2 - ✓ |  *Asynchronous Pick Body Stroke (B2) Will fail After Drift Test* |
| Loose screw installed on Spline and Brake Shaft Clamp. |  | A1, A2, A3, A4, B1, B3, B4 - X B2 - ✓ |  *Asynchronous Pick Body Stroke (B1) Will fail After Drift Test* |
| No or insufficient cleaning of Spline. |  | A2, A3, A4, B2, B3, B4 - X A1 - ✓ |  *Asynchronous Pick Body Stroke (A1)* |

Figure 18. Verifying above factors which identified as a True Causes

**Analysis:** In Method verification, the following are found to be the true causes of Asynchronous Pick Body Stroke problem:

1. *Spline Nut being forcibly installed onto Pick Body Base.*
2. *No or insufficient cleaning of Spline Shaft.*
3. *Overtightened and loose set screw installed on Pick Body Base screw hole.*
4. *Loose screw installed on Spline and Brake Shaft Clamp.*

| PROBLEM | Spline Nut being forcibly installed onto Pick Body Base. | No or insufficient cleaning of Spline Shaft. | Overtightened set screw installed. | Loose set screw installed. | Loose screw installed on Spline and Brake Shaft Clamp. |
|---|---|---|---|---|---|
| WHY 1 | Installed a Spline Nut onto a mismatch Pick Body Base. | Installed an uncleaned Spline Shaft. | Fully tightened of set screw installed. | Loose set screw installed. | Loose set screw installed. |
| WHY 2 | Incorrect installation of Spline Nut was performed. | No or insufficient cleaning of Spline Shaft was performed. | Incorrect tightening of set screw was performed. | | Incorrect tightening of screw was performed. |
| WHY 3 | No correct process was defined. | | | | |

Figure 19. Use of Why-why Analysis to determine the Root-Causes

### *2.2.3 Man*

| MAN | PROBABLE CAUSE | VERIFICATION | JUDGEMENT |
|---|---|---|---|
| **I. NOT QUALIFIED TECHNICIAN** | Assigned assembler is not qualified in the said stations. | Assigned assembler is qualified in Pick Body and Integration Assembly Process. | NOT POSSIBLE CAUSE |
| **II. NO PROPER HANDLING** | No proper handling during assembly process. | Manual assembly process. | POSSIBLE CAUSE |

Figure 20. Identifying Causal Factors in Man

### *2.2.3.1 True Cause Verification*

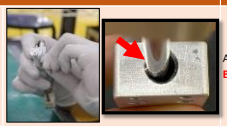
| SIMULATION DETAILS | AFFECTED OF SIMULATION | RESULT |
|---|---|---|
| No proper handling during assembly which caused Brake Shaft to misalign.  | A1, A2, A3, A4, B1 B2, B3 - X<br>B4 - ✓ |  <br>*Asynchronous Pick Body Stroke (B4)* |

Figure 21. Verifying above factor which identified as a True Cause

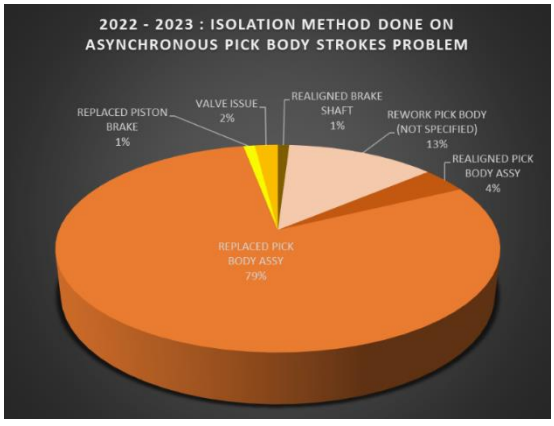
**Analysis:** In man verification, *No Proper Handling* was found to be the true causes of Asynchronous Pick Body Stroke.

| PROBLEM | NO PROPER HANDLING DURING ASSEMBLY PROCESS |
|---|---|
| WHY 1 | Incorrect handling during assembly process. |
| WHY 2 | Experience difficulties with assembly process. |
| WHY 3 | No tool was provided to support with assembly process. |

Figure 22. Use of Why-why Analysis to determine the Root-Cause

### *2.2.4 Machine and Environment*

Based on below data, no isolation involving environment and machine performed since 2022 to present, thus any potential causes occurring in the machine and environment as a source of the issue have been eliminated.




## 2.3 SOLUTIONS TO THE PROBLEM

### *2.3.1 Material*

**Before:** No sub-assembly testing was conducted after Valve Bank Assembly.

**After:** Sub-assembly testing of Valve Bank Assembly was added before Integration process.

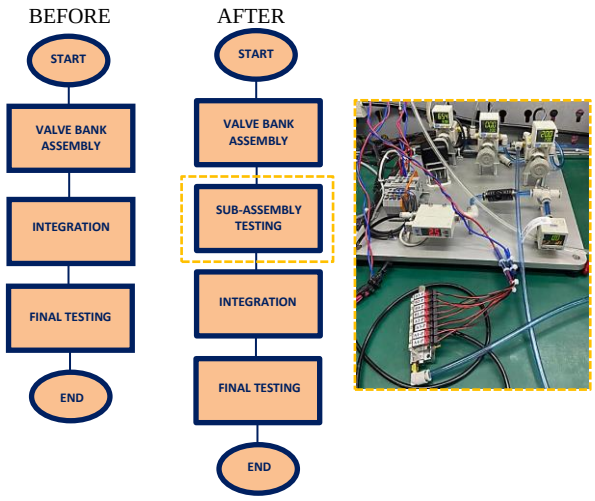



Figure 23. Valve Bank Assembly Testing was added on the existing process flow.

Different combinations of Valve Base values were installed and tested as a set (x8 Valve Bases per set), and based on the results, a good Valve Bases' values would range from *4.8 to 6.0 PSI*. This helped to generate Manufacturing Test Instructions (MTI) and determined the passing criteria for Valve Bank Assembly.

| Combination of different value (PSI) of Valve Base(s) Installed | | Result |
|---|---|---|
| **SET 1** | 4.9, 5.1, 5.1, 5.3, 5.5, 5.7, 5.9, 5.9 | Passed |
| **SET 2** | 4.8, 4.8, 5.0, 5.0, 5.2, 5.4, 5.6, 5.8 | Passed |
| **SET 3** | 5.5 (x8) | Passed |

Figure 24. Results of different combinations of Valve Base's value installed

### *2.3.2 Method*

A Manufacturing Process Instructions (MPI) of Pick Body Assembly were generated in order to document the implemented actions.

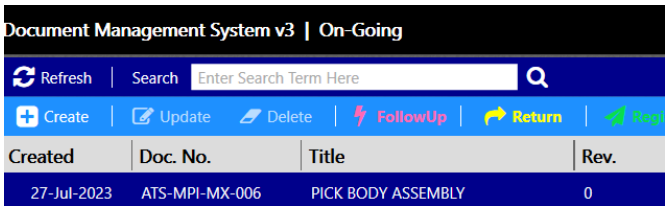



Figure 25. Actions are already documented

### *Action 1.*

**Before:** No defined process for proper cleaning of Spline.

**After:** Use of Alcohol to wipe off any corrosion oil applied on Spline.

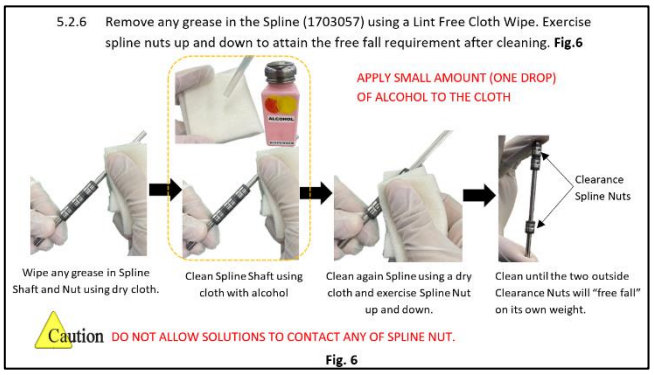



Figure 26. Defined process for proper cleaning of Spline.

| SIMULATION DETAILS | AMOUNT OF SOLUTIONS APPLIED | PROCESS TIME (secs) | RESULTS |
|---|---|---|---|
| Cleaning and exercising of Spline. | None | 125 | Failed |
| | | 255 | Passed |
| Cleaning of Spline using IPA. |  | 107 | Passed |
| Cleaning and exercising of Spline with application of lubricant. |  | 205 | Failed |
| |  | 96 | Passed |

Figure 27. Selecting the best alternative solution

Pick Body Assembly is more likely to pass the Brake Counter Test if Spline has experienced an adequate cleaning of Spline Shaft and enough exercising of Spline Nut regardless of what chemicals have been applied to it. To achieved the "free falling" of Spline more quickly, it is advisable to use an *Ethyl Alcohol* on cleaning the Spline rather than Lubricant. According to *CPLabSafety*, Ethyl Alcohol has an A-Excellent compatibility with Stainless Steel.

Even if the Spline will tend pass when more lubricant applied to it, it is still necessary to follow the standard relubrication procedure. And, according to *THK* for every approximately 100 km of travel distance (3 – 6 months) is the recommended greasing of the system.

### *Action 2.*

**Before:** No defined process for proper tightening of set screw installed onto Pick Body Base.

**After:** Spline Shaft tightening procedure was defined.

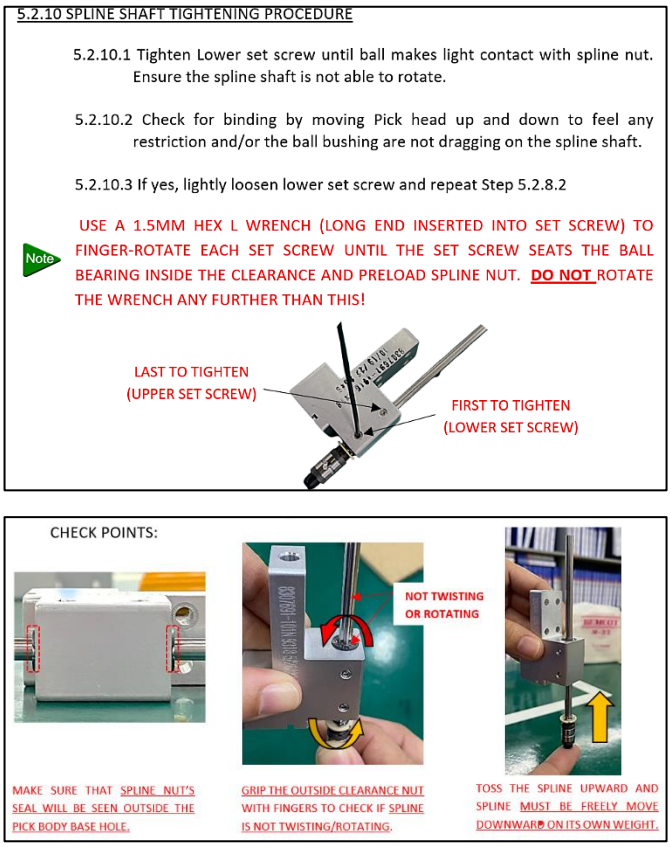



Figure 28. Defined process for proper tightening of set screw

| SIMULATION DETAILS | TORQUE VALUE (Nm) | SUB-ASSEMBLY TEST RESULTS |
|---|---|---|
| Applied different torque values. | 0.01 | Failed *(with bindings)* |
| | 0.05 | |
| | 0.10 | |
| | 0.15 | |
| | 0.20 | |

Figure 29. Selecting the best alternative solution

To get the proper tightening of set screw, several torque values were simulated. Since we had already reached the smallest value of 0.01Nm that our meter could read, we were unable to get the precise value. That is how I arrived at the solutions listed above, which I verified after trying to simulate different torque values.

*Action 3.*

**Before:** No defined precaution on installation of Spline Nut onto Pick Body Base.

**After:** Identified a precaution on installation of Spline onto Pick Body Base.

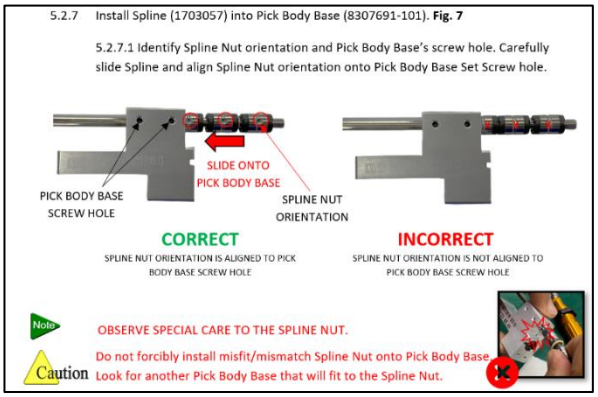



Figure 30. Defined precaution on installation of Spline Nut.

If no Pick Body Base will fit onto Spline Nut, it will declare as a material defect and Product Engineer will coordinate to the buyer of the parts.

*Action 4.*

**Before:** No defined proper for proper tightening of Brake and Spline Clamp.

**After:** Proper tightening of Brake and Spline Shaft Clamp must be no gap will be seen between the clamp.

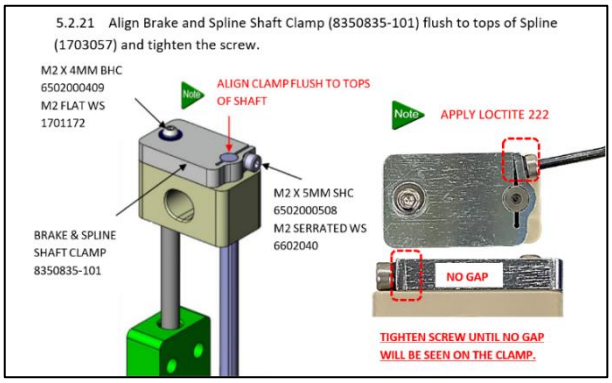



Figure 31. Defined process for proper tightening of Brake and Spline Clamp.

Since clamp has different sizes of gap, we were unable to get the precise torque value.

*2.3.3 Man*

**Before:** No proper handling during assembly process.

**After:** Provided a Pick Body Assembly Jig.

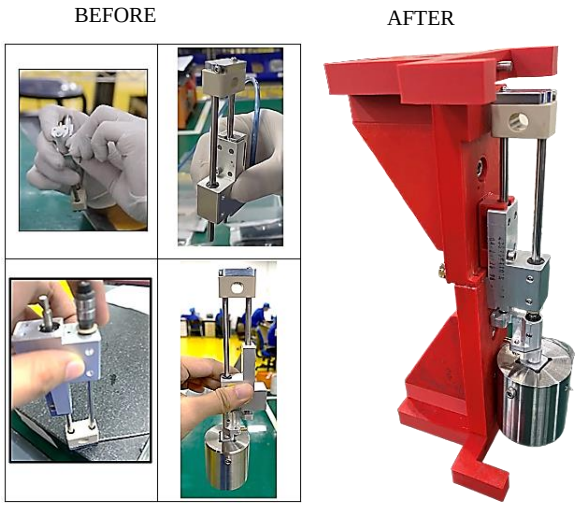



Figure 32. Actual scenario of with and without Jig used

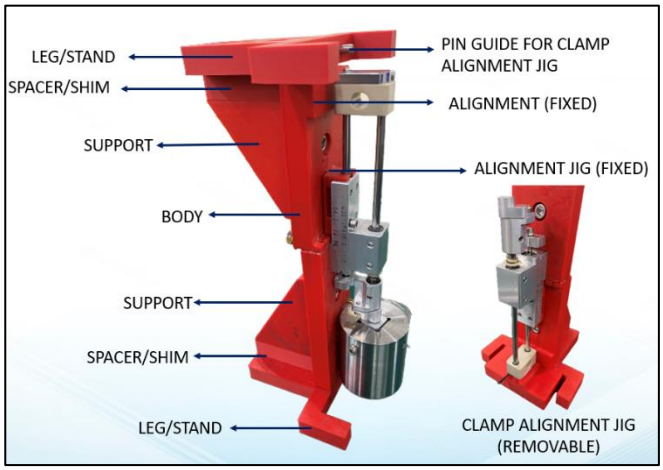



Figure 33. Pick Body Assembly Jig's Parts and Description

Based on actual run of the prototype, a lot of good feedbacks were received from the primary user of the jig. Aside from ergonomically designed, quality, and cycle time were also improved.

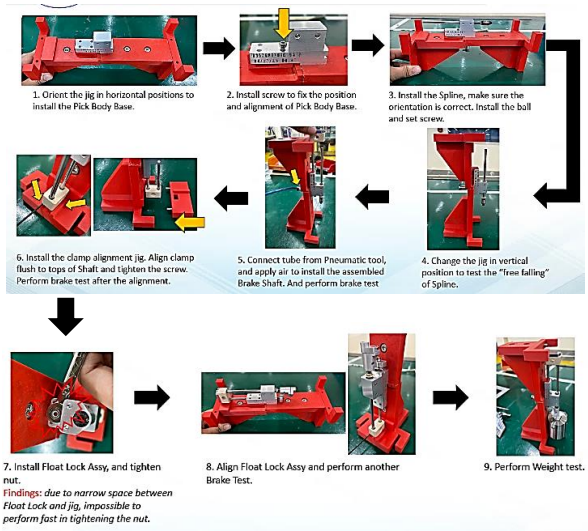



Figure 34. Pick Body Assembly flow using a jig.

| DISADVANTAGE (No jig used) | ADVANTAGE (With jig used) |
|---|---|
| More handling.<br>• Prone to contamination.<br>• Prone to misalignment. | Less handling.<br>• Not prone to contamination.<br>• Not prone to misalignment. |
| Can skip process. | No skip process. |
| No fixed alignment | With fixed alignment. |
| Single alignment. | Double alignment.<br>New alignment features added. |
| Difficulties in performing brake and weight test. | Easy to perform brake and weight test. |
| Use of granite to align Clamp to Shaft. | Built in flat surface (Clamp alignment jig) to align Clamp to Shaft. |
| Cannot install Float Lock Assy. | Can install Float Lock Assy. |

Figure 35. Advantage and disadvantage of with and without jig used in assembly process.

## 3.0 RESULTS AND DISCUSSION

### *3.1 Yield Improvement*

The objective of this project is to improve the PnP Head Matrix II by eliminating Asynchronous Pick Body problem. The KPI was monitored after the implementation of the actions.

Based on data, as of June 2023, PnP Matrix II met the target of 99.50% with actual yield of 100% and no Asynchronous Pick Body Stroke problems have been detected.

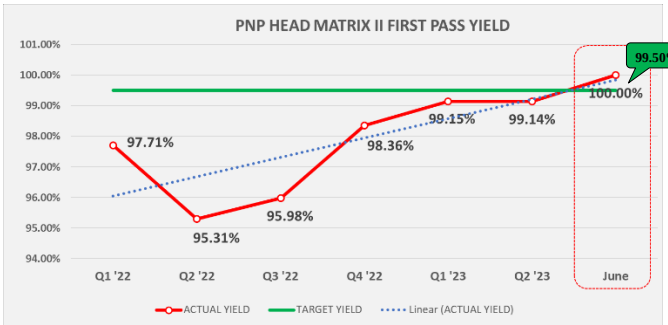



Figure 36. PnP Head Matrix II First Pass Yield as of June 2023

### *3.2 Rework and Idle Time Elimination*

This project also completely eliminated the 59 mins rework time of Asynchronous Pick Body Stroke problem on PnP Head Matrix II.

It takes 26 minutes to rework the affected Pick Body Assembly, and 33 minutes to integrate it into the PnP Head. As a result, waiting for Pick Body replacement will also cause the unit and test cart being idle for 59 mins.

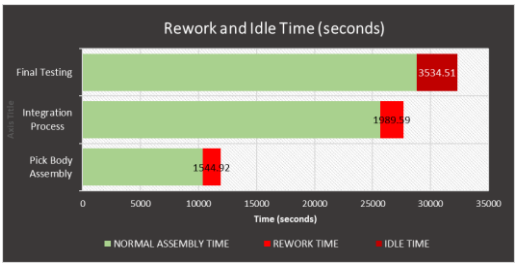



Figure 37. Normal Assembly, Rework and Idle Time.

| Rework Activities | Rework Time (secs) |
|---|---|
| **I. Dis-integrate Pick Body Assembly from PNP Head Matrix II** | |
| **i.** Uninstall Float Lock Tip Adapter | 1395 |
| **II.** Uninstall Fitting Elbow | 101.7 |
| **iii.** Uninstall Shaft | 61.36 |
| **iv.** Uninstall Pick Body Assembly from BRNG Adapter | 69.3 |
| **II. Pick Body Assembly Rework** | |
| **i.** Loosen Clamp Brake | 20.91 |
| **ii.** Uninstall Spline shaft | 104.23 |
| **iii.** Cleaning of Spline Shaft | 246.17 |
| **iv.** Exercising of Spline Shaft | |
| **v.** Re-install Spline Shaft and tightening of set screw (if encountered difficulties in insertion onto Pick Body Base look for new Pick Body Base that matched its size) | 93.84 |
| **vi.** Offline Test (Free-fall test), if binding, go back to step ii. | 485 |
| **vii.** Uninstall Brake Shaft | 10.9 |
| **viii.** Realignment and reverse positioning of Piston Brake | 15.14 |
| ix. Reinstall Brake haft | 23.86 |
| **x.** Realignment of Brake Shaft using alignment tool | 140 |
| **xi.** Tighten Clamp Brake | 20.91 |
| **xii.** Install Fititng Elbow | 34.6 |
| **xiii.** Offline Test (Pneumatic Brake Test), if delay, go back to step xiv, i, viii-xiii | 314.76 |
| **xiv.** Uninstall Fititng Elbow | 34.6 |
| **III. Integrate Reworked Pick Body Assembly PNP Head Matrix II** | |
| **i.** Float Lock Tip Adapter | 129.87 |
| **ii.** Reinstall Pick Body Assembly from BRNG Adapter | 69.3 |
| **iii.** Reinstall Shaft | 61.36 |
| **iv.** Reinstall Fitting Elbow | 101.7 |
| **IV. Retest PNP Head Matrix II** | |
| **i.** Machine's Idle Time | 3534.51 |
| TOTAL rework time in seconds | 3534.51 |
| in minutes | 58.91 |
| in hours | 0.982 |

Figure 37. List of rework activities and time (seconds, minutes and hours)

## 4.0 CONCLUSION

In this study, different factors with relation to the method, material and man's contribution to the Asynchronous Pick Body Strokes problem have been identified and resolved.

First Pass Yield has improved, making it possible to achieve the target of 99.50% in the upcoming quarter.

## 5.0 RECOMMENDATIONS

It is recommended to ensure the proper execution and standardization of actions. A close monitoring of implemented actions is necessary in order to improve consistency of results.

To effectively address the Asynchronous Pick Body Strokes problem, every potential contributing aspect must be considered.

## 6.0 ACKNOWLEDGMENT

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## 7.0 REFERENCES

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