REDUCTION OF CRUMPLED STRIPS OCCURRENCE FOR SOHED AT MECO-01

Vicente R. Caraggayan Jr.
Rizal M. Rodriguez
Jeoffrey Ian C. Palomo

Assembly Process Engineering Department
Allegro MicroSystems Philippines, Inc. 4756 Sampaguita St., Marimar Village 1, Sun Valley, Parañaque City
vcaraggayan@allegromicro.com, rrodriguez@allegromicro.com, ipalomo@allegromicro.com

ABSTRACT

Crumpled strips ranked 2nd on Top Assembly Defects from April to Sept 2022, 66% of the Material Review Board (MRB) cases were contributed by Tin Plate process. Allegro Microsystems Phils., Inc (AMPI) has four (4) MECO plating machines with a combined 69 crumpled cases on that same span. About 43.48% (30/69) of crumpled strips cases were incurred at MECO EDF+EPL Plating Machine - 001 (MECO-01). Out of the 30 occurrences at MECO-01, 50% of which were accounted for Plastic Small Outline Transistor (SOHED) mini gull-wing surface mount package.

The cycle time for SOHED (commit CT = 11days) is affected by the activities to be performed on the lots that encountered crumpled strips at plating. An additional 2-3 days of added inspection and testing for the affected lots must be completed (passed) before it can be processed at the next station.

Root cause analysis showed that crumpled strips on SOHED at MECO-01 were due to 1) Strip warping; 2) Un-optimized y-aligner set-up; 3) Misaligned belt set-up; 4) Location of solenoid valve is prone to vibration; 5) No reference because Blow-off gauge was defective; and 6) Broken retractor sensor mounting. Through Gemba Walk, two probable contributors were also identified: 1) Excessive strip wiggling at 2-3 Deflash and 2) Strip handling-induced warping or deformation.

A series of corrective actions were done to address these issues which emphasized the implementation of major improvement projects like installation of rod-type jamming sensor, thru-beam sensor, additional sprocket roller assembly, etc. These countermeasures had significantly reduced crumpled strips defects per million (DPM) and MRB case at MECO-01 by 97% and 100%, respectively, since October 2022. Zero recurrence of crumpled strips due to identified factors was also recorded, which equates to 100% improvement. Cycle time for SOHED was also met due to the zero recurrence of crumpled strips after project implementation.

1. 0 INTRODUCTION

1.1 Background of the Study

Fiscal Year (FY23) highlighted the increase in Crumpled Strips MRB. Based on Apr-Dec 2022 data, it topped all Assembly defects with 6 MRBs, four of which were from Tin Plate (TP) station (see Figure 1-2).

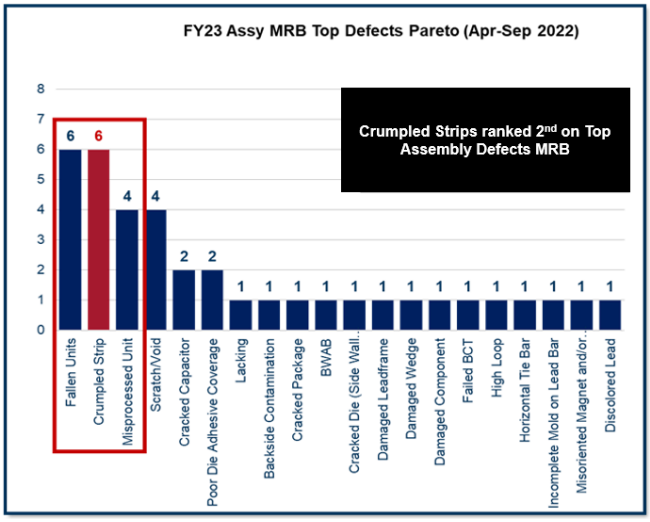


Figure 1. FY23 Assy MRB Top Defects Pareto.

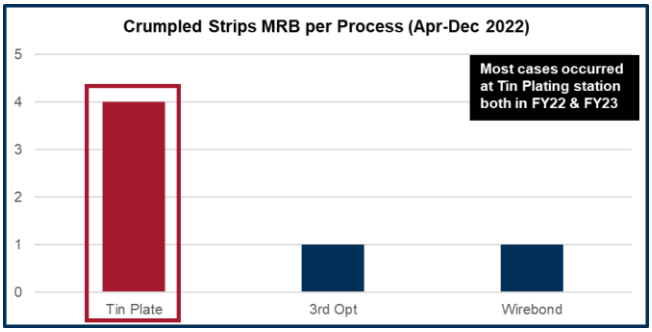


Figure 2. Crumpled Strips MRB per Process.

In terms of number of cases per machine, 30 of 69 cases (43.48%) were from MECO-01 (Figure 3). Of these 30 cases, 15 cases (50%) were incurred on SOHED package (see Figure 4). The crumpled strips DPM on average for

SOHED at MECO-01from Apr-Sep 2022 is at 52 (see Figure 6).

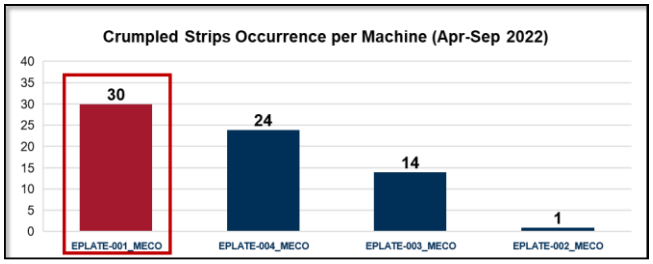


Figure 4. Crumpled Strips Occurrence per Machine.

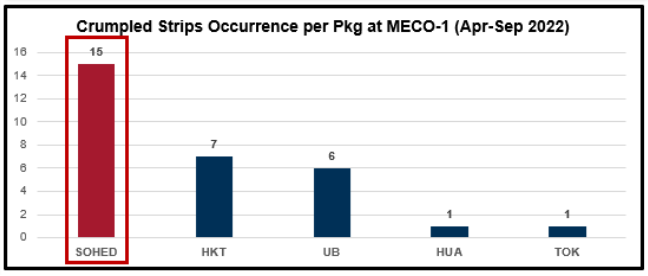


Figure 5. Crumpled Strips occurrence per Package at MECO-1.

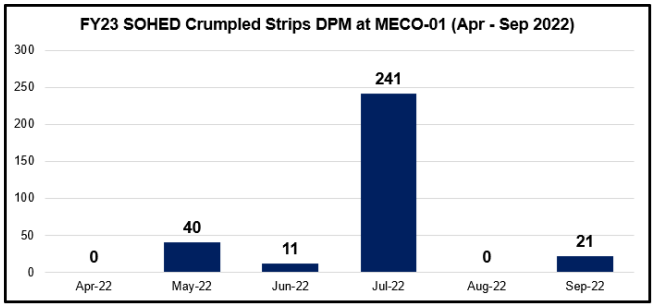


Figure 6. SOHED Crumpled Strips DPM at MECO-01.

1.1.1 Crumpled Strips Contributing Factors

All 15 crumpled strips cases on SOHED were gathered to check for commonalities in root causes.

Using Why-Why Analysis, data revealed that majority of crumpled strips were due to 1) gross strip warping; 2) un-optimized y-aligner set-up; 3) misaligned belt set-up; 4) absence of detailed checking and cleaning procedure for PVC roller; 5) location of solenoid valve is prone to vibration; 6) no reference because Blow-off gauge was defective; and 7) broken retractor sensor mounting. After series of Gemba Walks, the team were also able to identify two additional contributors: 1) excessive strip wiggling at 2-3 Deflash and 2) strip handling-induced warping or deformation. See Table 1.

Table 1: Tin Plate Crumpled Strips Why-Why Analysis

Defect	No of Occurrences	Why 1	Why 2	Why 3	Why 4	Why 5	Why 6
Crumpled Strips	7	Strip was stuck at entrance of process cell	Bottom rail was deformed	Bottom rail hit the inner PVC roller	Strip warpage	-	-
	2	Strips were hit by buffer during initialization	Strips were misaligned during stacking	Stuck y-aligner	Unlubricated y-aligner	-	-
	1	Strips was stuck at the entrance of neutralizer	Bottom rail hit the inner PVC roller	Misaligned belt relative to PVC roller	Altered belt alignment set-up	-	-
	1	Strips stuck at the entrance of plating cell	Strips were hitting the predip exit inner PVC roller	PVC roller was tuck	Solidified chemical deposit on the guide block	Absence of detailed checking and cleaning procedure	-
	1	Strips hit the fixed aligner at unload	Strips misaligned during stacking	Strip not properly clamped by mechanical gripper	Delayed strip pick-up at belt due to slow movement of gripper	Loose connection of gripper solenoid valve	Location is prone to vibration
	1	Strips was stucked at the entrance of 6-1 plating cell	Bottom rail was deformed	Bottom rail hit the outer PVC roller	Misaligned belt relative to PVC roller	Misaligned copper contact assembly	Worn-out copper contact
	1	Buffer hit trips during initialization of unload	Uneven stacking	Strips have deformed prior unload	Strips was bent at blow-off cell	High blow-off pressure	No reference due to defective gauge
	1	Strip hit the fixed aligner at unload	Strip was not properly picked and placed during unloading	Retractor cylinder sequence malfunction	Retractor sensor was on incorrect position	Broken retractor sensor mounting	-

1.2 Objective

This study aims to reduce the Crumpled Strip occurrences on SOHED at MECO-01 from 15 to 4 cases or 73% reduction by end of Q3'FY23.

1) Reduce occurrences by 50% or 4 occurrences due to inherent strip warpage.
2) Zero-out occurrence due to unoptimized y-aligners
3) Zero-out occurrence due to defective blow-off gauge
4) Zero-out occurrence due to misaligned belt setup
5) Zero-out occurrence due to broken retractor sensor mounting.
6) Zero-out occurrence due to worn-out copper contact
7) Zero-out occurrence due to location of solenoid valve at unload is prone to vibration.

1.3 Scope and Limitation

This project will only cover SOHED package at MECO-01 (pilot package & machine).

2.0 REVIEW OF RELATED WORK – NOT APPLICABLE

3.0 METHODOLOGY

To identify the contributing factors of Crumpled Strips, the team consolidated all the cases to check for commonalities in terms of root cause. GEMBA walk was also performed to observe the actual work process, engage with employees, and explore opportunities for continuous improvement. To fully understand each root cause the team used Why-Why Analysis and Brainstorming techniques. After that countermeasure/s for each item were defined. The top contributors derived from root cause analysis and countermeasures done are discussed in succeeding paragraphs.

3.1 Machine Defect Mapping

In Figure 6, mapping was done to identify the specific cells where crumpled strips were encountered. Eight (8) of 15

cases were incurred inside the cells of UHPR, Plating and Neutralizer while the rest were at Load and Unload sections.

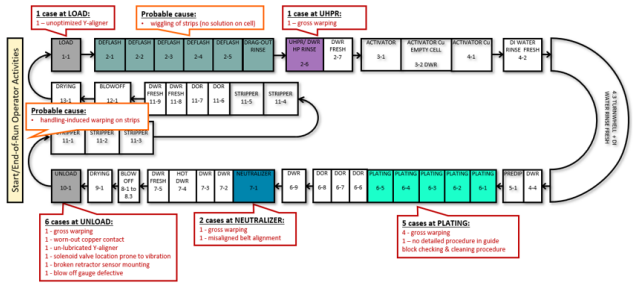


Figure 6: Crumpled Strips Mapping at MECO-01

3.2 Factors for Validation

3.2.1 Strip Warpage on SOHED Strip

Allegro Microsystems Phils., Inc. (AMPI) had shifted to high-density (HD) leadframes to generate more units per strip to increase productivity and attain higher output. However, one of the major drawbacks faced was strip warpage which is inherent even prior to the Tin Plate process. As discussed by Wyant, et al.1, "lead frame packages continue to become thinner, the capability to handle wider leadframes becomes more difficult. Becoming both wider and thinner, the strip's ability to handle die mass will decrease, causing the strip to bow during handling operation." Among all products, SOHED (see Figure 7) with dimensions of 75 mm X 250 mm and 480 units per strip, has the worst strip warpage that manifested in two types:

a) Concave warping: Facing the outside PVC roller
b) Convex warping: Facing the inner PVC roller

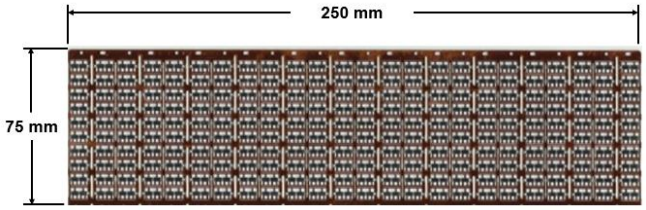


Figure 7. Photo of SOHED Leadframe.

The maximum concave and convex warping measured on SOHED strips were 9.0 mm and 7.0 mm, respectively. These strip warpages are already beyond the optimum distance of 6 mm that the existing roller-to-belt set-up at MECO-01 could accommodate, see Figure 8. Based on data, 46.67% (7/15 occurrences) of SOHED crumpled strips were due to strip warpage.

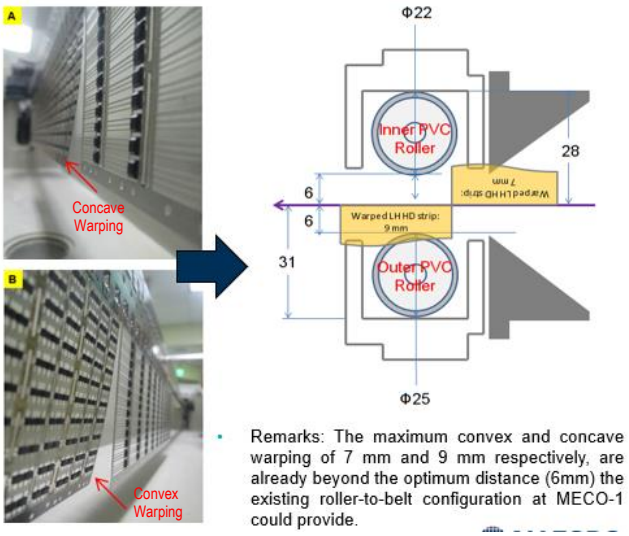


Figure 8. Correlation of Warped SOHED HD Strip and Solution Slot Assembly.

3.2.2 Crumpled Strips at Product Placement Assembly due to Strip Warpage

One of 15 cases was at the Product Placement of Load section. The Product Placement is an assembly where "Product too Low", "Product Angled" and "Product Missing" sensors are installed. These sensors are used to detect improper loading orientation - whether it is missing, loaded low or angled.

The defect mechanism revealed that the bottom rail of the first affected strip was deformed as it hit the nicked area of strip aligner. The deformation had aggravated into crumpled strips; thus, it caused jamming of succeeding strips. Non-detection of affected strips was due to the absence of sensor at entrance of Product Placement assembly.

As corrective action to the root cause, the polypropylene strip aligner was changed into stainless steel material. Meanwhile, for the escape cause, two thru-beam sensors were installed at entrance of Product Placement, see Figure 9. By operation, the thru-beam sensors will flag an error once warped strip crosses the optical axis between transmitter and receiver, thereby stopping the process.

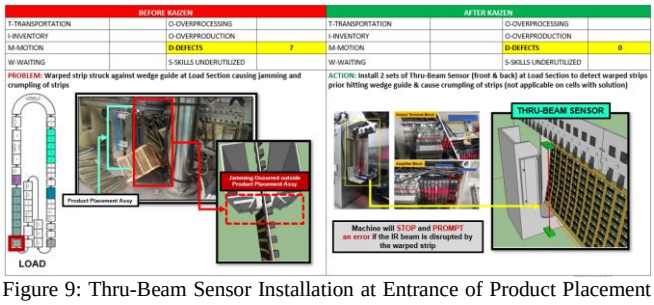


Figure 9: Thru-Beam Sensor Installation at Entrance of Product Placement Assembly.

The distance between two the thru-beam sensors was set to 7 mm to ensure that warpage greater than that will be arrested. Refer to Table 2.

Table 2: Thru-Beam Sensor Functionality Test Matrix

Package	Warpage (mm)	Result	Remarks
SOHED	3	NO Product Angled Error	NO Affected STRIP
	5	NO Product Angled Error	NO Affected STRIP
	7	NO Product Angled Error	NO Affected STRIP
	9	WITH Product Angled Error	NO Damaged Leads on Affected STRIP
	11	WITH Product Angled Error	NO Damaged Leads on Affected STRIP

Functionality testing and dummy qualification results showed that "Group 01 (Load Unit/Product Placement/Product Angled" error was prompted by the system upon detection of leadframe across the optical axis between transmitter and receiver, see Figure 10. To rectify this, the operators should straighten the strip before reloading.

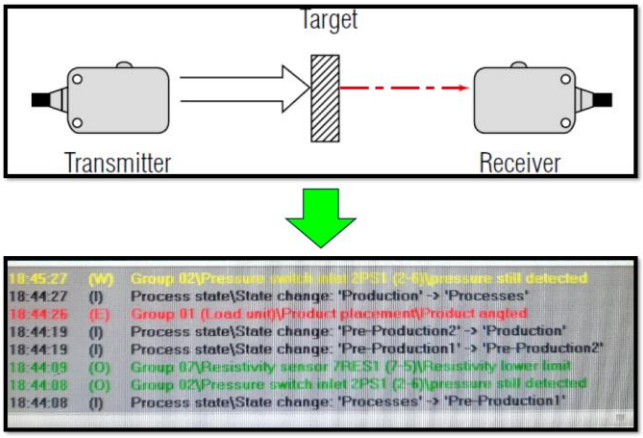


Figure 10: Thru-Beam Sensor Functionality and Error Validation.

Five and 25 qualification runs were processed after installation. All lots had zero crumpled strips at Product Placement and other sections of MECO-01, see Table 3. Hence, the thru-beam sensor is effective in detecting products with gross warping and preventing crumpled strips at Product Placement assembly.

Table 3: Five and 25 Qualification Runs Processed After Installation of Thru Beam Sensor at Entrance of Product Placement Assembly

❑ First 5 SOHED HD lots processed after installation showed zero crumpled strips.

Equipment	Lot	Item	First Track In Time Stamp	Qty In	Qty Out	Reject Qty	Processed Qty	Yield
EPLATE-001_MECO	2251457DDAC	7687HLH-000 (AEA)	12/25/2022 12:52:26 PM	53022	53019	Tape Test Sample: 3	53022	99.99 %
EPLATE-001_MECO	2249859DDAH	1178ZLH-000 (BBA)	12/25/2022 1:25:08 PM	32266	32266	0	32266	100.00 %
EPLATE-001_MECO	2251457DDAG	7687HLH-000 (AEA)	12/25/2022 1:25:08 PM	35356	35356	0	35356	100.00 %
EPLATE-001_MECO	2251458DDAL	3291ZLH-000 (ABA)	12/25/2022 1:25:08 PM	35176	35176	0	35176	100.00 %
EPLATE-001_MECO	2251458DDAH	3291ZLH-000 (ABA)	12/25/2022 1:25:08 PM	35038	35038	0	35038	100.00 %

❑ First 25 SOHED HD lots processed after installation showed zero crumpled strips.

Equipment	Lot	Item	Date Processed	Qty In	Qty Out	Reject Qty	
EPLATE-001_MECO	2252639DDAM	1228HLH-150 (BVA)	12/25/2022 2:14:04 PM	47272	47272	0	100.00 %
EPLATE-001_MECO	2251457DDAE	7687HLH-000 (AEA)	12/25/2022 2:14:04 PM	53014	53014	0	100.00 %
EPLATE-001_MECO	2251457DDAD	7687HLH-000 (AEA)	12/25/2022 2:14:04 PM	52874	52874	0	100.00 %
EPLATE-001_MECO	2251459DDAJ	1228HLH-150 (BVA)	12/25/2022 2:14:04 PM	47414	47414	0	100.00 %
EPLATE-001_MECO	2251458DDAN	3291ZLH-000 (ABA)	12/25/2022 2:37:25 PM	35222	35222	0	100.00 %
EPLATE-001_MECO	2251458DDAB	3291ZLH-000 (ABA)	12/25/2022 2:37:25 PM	35235	35235	0	100.00 %
EPLATE-001_MECO	2251454DDAN	1250ZLH-000 (BAA)	12/25/2022 2:37:25 PM	21540	21540	0	100.00 %
EPLATE-001_MECO	2251459DDAM	1228HLH-150 (BVA)	12/25/2022 2:47:48 PM	23591	23591	0	100.00 %
EPLATE-001_MECO	2252639DDAA	1244ZLH-000 (BSA)	12/25/2022 2:47:48 PM	44160	44160	0	100.00 %
EPLATE-001_MECO	2252748DDAA	7510ZLH-000 (AAA)	12/25/2022 2:57:57 PM	50413	50413	0	100.00 %
EPLATE-001_MECO	2252639DDAC	1228HLH-150 (BVA)	12/25/2022 2:57:57 PM	47309	47309	0	100.00 %
EPLATE-001_MECO	2252639DDAK	1228HLH-150 (BVA)	12/25/2022 3:11:42 PM	47301	47301	0	100.00 %
EPLATE-001_MECO	2251390DDAE	1245012LH-000 (AAA)	12/25/2022 3:11:42 PM	52275	52275	0	100.00 %
EPLATE-001_MECO	2252639DDAH	1228HLH-150 (BVA)	12/25/2022 3:36:28 PM	47259	47259	0	100.00 %
EPLATE-001_MECO	2252639DDAG	1228HLH-150 (BVA)	12/25/2022 3:36:28 PM	47279	47279	0	100.00 %
EPLATE-001_MECO	2252744DDAC	3100011HLH-000 (ACA)	12/25/2022 3:36:28 PM	51807	51807	0	100.00 %
EPLATE-001_MECO	2252744DDAB	3100011HLH-000 (ACA)	12/25/2022 3:36:28 PM	51523	51523	0	100.00 %
EPLATE-001_MECO	2252744DDAD	3100011HLH-000 (ACA)	12/25/2022 4:12:08 PM	51192	51192	0	100.00 %
EPLATE-001_MECO	2252639DDAL	1228HLH-150 (BVA)	12/25/2022 4:12:08 PM	47211	47211	0	100.00 %
EPLATE-001_MECO	2251460DDAA	7788HLH-000 (AAA)	12/25/2022 4:12:08 PM	52976	52976	0	100.00 %
EPLATE-001_MECO	2252744DDAF	3100011HLH-000 (ACA)	12/25/2022 4:12:08 PM	52697	52697	0	100.00 %
EPLATE-001_MECO	2252638DDAB	1244ZLH-000 (BSA)	12/25/2022 5:50:29 PM	44207	44207	0	100.00 %
EPLATE-001_MECO	2252708DDAA	703101HKT-000 (ACA)	12/26/2022 12:29:23 AM	10618	10606	12 units (Solderability Test: 6; Tape Test Sample: 3; Retained Samples: 3)	99.89 %
EPLATE-001_MECO	2252609DDAB	703101HKT-000 (ACA)	12/26/2022 12:34:23 AM	10740	10740	0	100.00 %
EPLATE-001_MECO	2251476DDAF	913641HKT-001 (AAA)	12/26/2022 12:34:23 AM	12461	12461	0	100.00 %

3.2.3 Crumpled Strips Inside Process Cells due to Strip Warpage

At Tin plate (TP), the belt conveys the strips from load to unload. The strips will pass through narrow cells wherein occurrence of crumpled strips and product drop are highly feasible. To detect these issues, MECO machines are equipped with "Product Drop Function" using leadframe detect (LFD) sensors. By design, the Product Drop Function is used to detect if a product is dropped between LFD sensors. With the belt direction running from right to left, the reference sensor is located on the right side. This means that each LFD sensor is the reference for the next LFD sensor. For example, with the design of 4-1 Activator cell in MECO-01, 3LFD1 is the reference sensor for 4LFD1 sensor (see Figure 11). The distance between 3LFD1 and 4LFD1 sensors is 2.42 meters which is equivalent to 9 SOHED strips. Since there was no LFD sensor installed in the entrance of 4-1 Activator cell, nine strips will be crumpled first at entrance 4-1 Activator before 4LFD1 sensor will prompt an error, upon sensing the absence of strips seen by 3LFD1 sensor. Since multiple strips are affected, this scenario usually results in maverick lot.

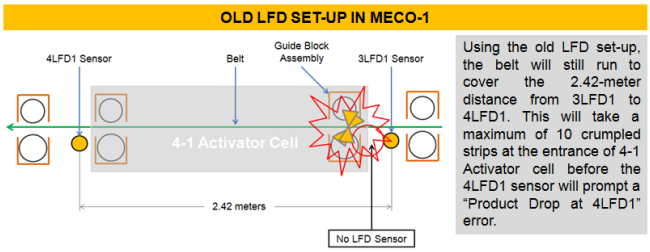


Figure 11: Crumpled Strips Escape Cause Mechanism

To address this design weakness, the team had improved it into a rod-type jamming sensor. This new design is composed of sensor rod, rod holder, proximity sensor and sensor trigger (Figure 12). The sensors are placed on the side of the cell to prevent early wear-out.

Figure 12: Sample of Rod-type Jamming Sensor Design.

The electrical connections of LFD sensors were tapped in the Production Stop system. Once the strip hits either side of the bottom rod, the sensor will detect the metal plate as it oscillate in front of the sensor head. Upon detection, "General\Production Start/Stop/ ONS1 (Frontside)\Production Stop" error will flag in the monitor (see Figure 13). To identify the location of crumpled strips, the switch button of corresponding cell where the crumpled strip is detected will light on. This improvement project is error-proof since the operator could not reset the button unless the crumpled strips are removed, thus preventing multiple crumpled strips.

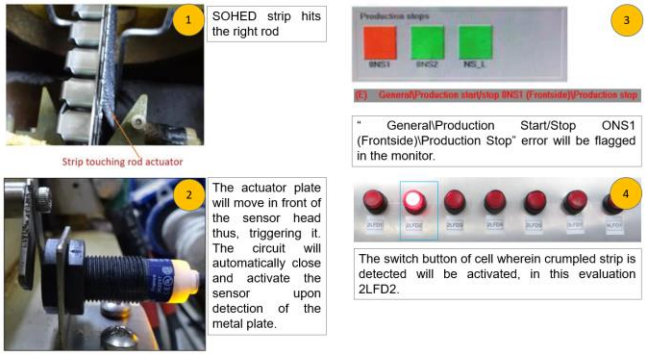


Figure 13: Sensor Trigger Mechanism of Rod-type Jamming Sensor.

A total of 14 rod-type jamming sensors were installed across MECO-01, see Table 4. The locations were based on past cases. Based on engineering judgement, the team also considered those critical areas that are highly feasible to induce the defect.

Table 4: Location of Rod-type Jamming Sensors

Process	Cell	Location	Jamming Sensor Type
Deflash	2.1	Entrance	Straight ROD (Exit Design)
Predip	5.1	Entrance	Straight ROD (Entrance Design Longer)
		Exit	*Not Applicable (due to shielding presence)*
Plating	6.1	Entrance	Straight ROD (Entrance Design Longer)
		Exit	Straight ROD (Exit Design)
	6.2	Entrance	Straight ROD (Entrance Design Longer)
		Exit	Straight ROD (Exit Design)
	6.3	Entrance	Straight ROD (Entrance Design Longer)
		Exit	Straight ROD (Exit Design)
	6.4	Entrance	Straight ROD (Entrance Design Longer)
		Exit	Straight ROD (Exit Design)
	6.5	Entrance	Straight ROD (Entrance Design Longer)
		Exit	Straight ROD (Exit Design)
Neutralizer	7.1	Entrance	Straight ROD (Entrance Design Longer)
HOT DWR	7.4	Entrance	Straight ROD (Entrance Design Longer)

The maximum warpage that MECO machine can cater is 7 mm and it was validated during the trial run that the rod-type jamming sensor can detect strips with warping greater than that. See simulation results in Table 5.

Table 5: Rod-type Jamming Sensor Warpage Simulation

Package	Warpage (mm)	Result	Remarks
SOHED	3	NO Jamming Rod Error	NO Affected STRIP
	5	NO Jamming Rod Error	NO Affected STRIP
	7	NO Jamming Rod Error	NO Affected STRIP
	9	WITH Jamming Rod Error	NO Damaged Leads on Affected STRIP
	11	WITH Jamming Rod Error	NO Damaged Leads on Affected STRIP

To further validate the effectiveness, five and 25 lots were qualified after installation. Results showed zero crumpled strips on all lots validated, see Table 6. Thus, the rod-type jamming sensor is effective in detecting strips with gross warping and preventing crumpled strips inside the cells.

Table 6: Five and 25 Qualification Runs Processed After Installation of Rod-type Jamming Sensors

Five (5) -Lot Qualification — *Result: No Trigger and occurrence of Crumpled Strips*

Equipment	Lot	Package	First Track In Time Stamp	Last Track Out Time Stamp	Processed Qty	Yield
EPLATE-001_MECO	2249650DDAE	HUA	12/3/2022 3:04:45 PM	12/3/2022 3:48:09 PM	17670	100.00 %
EPLATE-001_MECO	2249650DDAB	HUA	12/3/2022 3:04:45 PM	12/3/2022 4:11:30 PM	17678	100.00 %
EPLATE-001_MECO	2249650DDAF	HUA	12/3/2022 3:04:45 PM	12/3/2022 4:11:30 PM	17677	100.00 %
EPLATE-001_MECO	2249650DDAC	HUA	12/3/2022 3:42:29 PM	12/3/2022 4:11:30 PM	17680	100.00 %
EPLATE-001_MECO	2249650DDAJ	HUA	12/3/2022 3:44:36 PM	12/3/2022 4:51:00 PM	17680	100.00 %

Twenty-five (25) -Lot Qualification — *Result: No Trigger and occurrence of Crumpled Strips*

Equipment	Lot	Package	First Track In Time Stamp	Last Track Out Time Stamp	Processed Qty	Yield
EPLATE-001_MECO	2249675DDAL	HUA	12/3/2022 4:50:03 PM	12/3/2022 6:16:34 PM	21287	100.00 %
EPLATE-001_MECO	2249719DDAB	SOHED	12/3/2022 8:20:24 PM	12/3/2022 8:38:41 PM	50695	100.00 %
EPLATE-001_MECO	2249719DDAA	SOHED	12/3/2022 8:20:24 PM	12/3/2022 8:54:56 PM	50309	100.00 %
EPLATE-001_MECO	2249719DDAF	SOHED	12/4/2022 12:30:41 AM	12/4/2022 1:09:13 AM	50694	99.99 %
EPLATE-001_MECO	2249641DDAE	SOHED	12/4/2022 12:49:26 AM	12/4/2022 1:14:57 AM	42844	100.00 %
EPLATE-001_MECO	2249641DDAE	SOHED	12/4/2022 12:49:26 AM	12/4/2022 1:29:28 AM	42773	100.00 %
EPLATE-001_MECO	2249641DDAK	SOHED	12/4/2022 12:49:26 AM	12/4/2022 1:29:28 AM	42941	100.00 %
EPLATE-001_MECO	2248496DDAE	SOHED	12/4/2022 12:49:26 AM	12/4/2022 1:54:43 AM	47429	100.00 %
EPLATE-001_MECO	2249641DDAH	SOHED	12/4/2022 1:32:42 AM	12/4/2022 1:54:43 AM	42667	100.00 %
EPLATE-001_MECO	2249641DDAB	SOHED	12/4/2022 1:32:42 AM	12/4/2022 2:17:12 AM	42719	100.00 %
EPLATE-001_MECO	2249576DDAE	SOHED	12/4/2022 1:32:42 AM	12/4/2022 2:17:12 AM	45758	100.00 %
EPLATE-001_MECO	2249641DDAD	SOHED	12/4/2022 1:32:42 AM	12/4/2022 2:38:02 AM	43120	100.00 %
EPLATE-001_MECO	2249641DDAC	SOHED	12/4/2022 2:21:16 AM	12/4/2022 2:38:02 AM	43688	100.00 %
EPLATE-001_MECO	2248496DDAK	SOHED	12/4/2022 2:21:16 AM	12/4/2022 3:09:17 AM	47439	100.00 %
EPLATE-001_MECO	2248496DDAF	SOHED	12/4/2022 2:21:16 AM	12/4/2022 3:09:17 AM	47389	100.00 %
EPLATE-001_MECO	2248496DDAL	SOHED	12/4/2022 2:21:16 AM	12/4/2022 3:20:48 AM	47408	100.00 %
EPLATE-001_MECO	2249557DDAF	SOHED	12/4/2022 3:12:27 AM	12/4/2022 3:20:48 AM	23442	100.00 %
EPLATE-001_MECO	2248496DDAM	SOHED	12/4/2022 3:12:27 AM	12/4/2022 3:37:23 AM	23653	100.00 %
EPLATE-001_MECO	2248497DDAN	SOHED	12/4/2022 3:12:27 AM	12/4/2022 3:37:23 AM	22436	100.00 %
EPLATE-001_MECO	2248498DDAB	SOHED	12/4/2022 3:12:27 AM	12/4/2022 3:56:43 AM	34012	100.00 %
EPLATE-001_MECO	2249641DDAL	SOHED	12/4/2022 3:40:40 AM	12/4/2022 3:56:43 AM	42973	100.00 %
EPLATE-001_MECO	2249576DDAA	SOHED	12/4/2022 3:40:40 AM	12/4/2022 4:12:49 AM	45905	100.00 %
EPLATE-001_MECO	2249719DDAE	SOHED	12/4/2022 3:40:40 AM	12/4/2022 4:12:49 AM	50566	100.00 %
EPLATE-001_MECO	2248496DDAC	SOHED	12/4/2022 3:40:40 AM	12/4/2022 4:41:44 AM	46628	100.00 %
EPLATE-001_MECO	2249641DDAJ	SOHED	12/4/2022 4:32:22 AM	12/4/2022 4:41:44 AM	42981	100.00 %

3.3 Other Probable Root Causes Identified During Gemba Walk

3.3.1 Strip Wiggling

During GEMBA walk, excessive belt and strip wiggling were observed at 2-3 Deflash cell. Excessive belt wiggling is one of the potent factors of crumpled strips. This usually happens when warped strips strike against the guide block due to diminished and or restricted passage area. In this case, excessive wiggling was due to 1) the absence of solution in Deflash section and 2) limited number of sprocket rollers installed. As defined through design of experiment (DOE), SOHED does not require Electrolytic Deflashing and Ultra High-Pressure Rinse (UHPR) processes to minimize delamination. So, this factor is not controllable. On the other hand, the sprocket rollers at 2-3 Deflash were far from each other that it has gap of 1240 mm. As shown in Figure 14, this was addressed by installing additional sprocket roller in the middle of 2-3 Deflash cell to stabilize belt vibration.

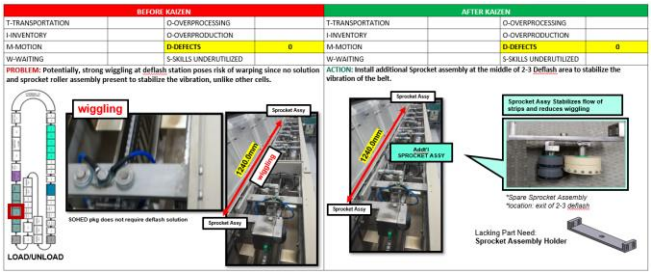


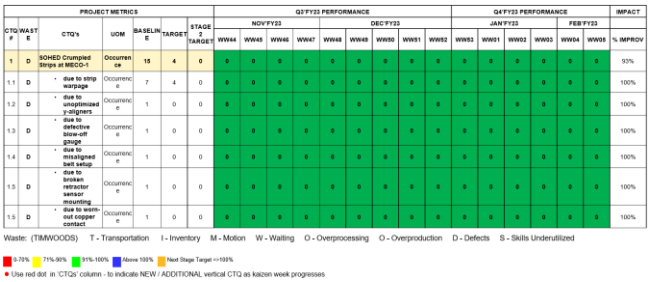
Figure 14: Strip Wiggling Issue at 2-3 Deflash Before and After Kaizen.

To validate this result, five and 25 runs were processed. All lots had zero crumpled strips which proved that additional sprocket roller is effective in controlling wiggling-induced crumpled strips.

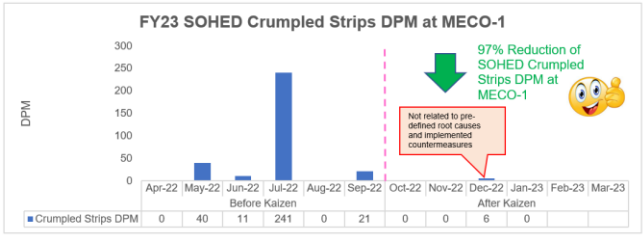
4.0 RESULTS AND DISCUSSIONS

The aim of this project was to reduce the SOHED crumpled strips in MECO-01 by 73%, from 15 to 4 cases. Validation in large production scale was conducted to determine long-term capability and applicability of implemented actions at MECO-01. Q3'FY23 data in Table 7 showed that the countermeasures done had resulted in 100% improvement due to zero recurrence of crumpled strips relative to identified factors.

Table 7: Post Kaizen Attainment

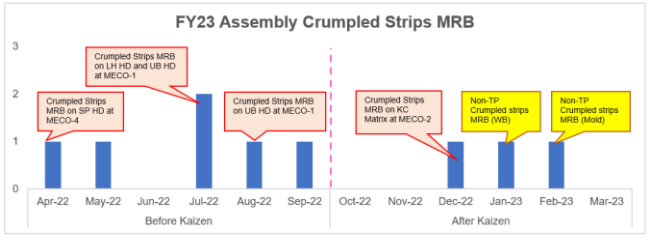


Based on 4-month post-Kaizen data (Oct 2022 to Jan 2023), the SOHED crumpled strips had decreased from 52 DPM to 2 DPM after implementation of corrective actions, which translates to 97% DPM reduction. One occurrence was encountered in Dec 2022, but the root cause was not related to implemented countermeasures. However, this will still be tackled in future studies. On the other hand, from a total of 3 MRB cases in MECO-01, it was lowered down to zero after implementation of countermeasures (see Figures 15-16).



	Crumpled Strips Average DPM	May-22
Before Kaizen	52	97%
After Kaizen	2	

Figure 15: SOHED Crumpled Strips DPM at MECO-01 Before and After Kaizen.



	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23
Tin Plate (TP)	1	0	0	2	1	0	0	0	1	0	0	
Non TP	0	1	0	0	0	1	0	0	0	1	1	
Total	1	1	0	2	1	1	0	0	1	1	1	0

Figure 16: FY23 Assembly Crumpled Strips MRB Count Before and After Kaizen.

5.0 CONCLUSION

Crumpled strips on SOHED at MECO-01 were due to 1) strip warping; 2) un-optimized y-aligner set-up; 3) misaligned belt set-up; 4) absence of detailed checking and cleaning procedure for PVC roller; 5) location of solenoid valve is prone to vibration; 6) no reference because Blow-

off gauge was defective; and 7) broken retractor sensor mounting. In addition, through Gemba Walk the team were also able to identify two additional contributors: 1) excessive strip wiggling at 2-3 Deflash and 2) strip handling-induced warping or deformation.

A series of corrective actions were done which highlighted the implementation of major projects like installation of rod-type jamming sensor, thru-beam sensor, additional sprocket roller assembly, optimization of Blow-off pressure setting, etc. Quick wins included documentation and checking of retractor sensor mounting, y-aligner lubrication and instruction on handling induced warpage prior plate. It had been concluded that these countermeasures had significantly reduced the occurrence of crumpled strips at MECO-01. Data showed zero recurrence of crumpled strip due to the above factors which equates to 100% improvement. Also, SOHED crumpled strips DPM had decreased from 52 to 2, which translates to 97% reduction. Moreover, it had zeroed out the crumpled strips related MRB for SOHED since October 2022. In parallel, the cycle time (CT=11days) for SOHED was also met due to the zero recurrence of crumpled strips after kaizen project implementation.

6.0 RECOMMENDATION

It is recommended to apply the Lean methodologies used in this project to resolve other underlying contributors. Meanwhile, to apply the Yokoten approach principle, the implemented actions pertinent to SOHED crumpled strips reduction will be fanned to other AMPI MECO machines (MECO - 02/03/04).

7.0 ACKNOWLEDGMENT

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9.0 ABOUT THE AUTHORS

Vicente R. Caraggayan Jr. is a Bachelor of Science in. Chemical Engineering graduate from the Mapua Institute of Technology (MIT) better known now as Mapua University. He is a licensed Chemical Engineer and is assigned at APE Plating process as Lead Engineer.

Jeoffrey Ian C. Palomo is a graduate of Bachelor of Science in Industrial Technology from Don Mariano Memorial State University. He is currently the Senior Supervisor for the APE Plating Preventive Maintenance (PM) Group for the past four (4) years.

Rizal M. Rodriguez is a graduate of Bachelor of Science. Industrial Engineering from the University of Batangas. He has been working for AMPI the past 22 years and is the Senior Supervisor of the Sustaining Group of APE Plating Maintenance.

10.0 APPENDIX – NOT APPLICABLE