

Chapter 6

Implementation and Evaluation

6. Implementation and Evaluation

The FMEA project has been implemented from October 2002 to January 2003. The detail of implementation and evaluation are discussed as the following :

6.1 Implementation of the FMEA

Prior to FMEA implementation, team members were called meeting to explain the new document and working procedure. The objective was to ensure that all of team members understand and clear the proposed FMEA. The target of project for 18 color shades in alkyd products as mention in Chapter 3 (Table 3.3) are also disseminated. The result will be discussed every month.

6.2 Evaluation of the FMEA

6.2.1 With the Failure Mode and Effect Analysis

After FMEA projected finished, Project team analyzed and revised the recommendation action that mentioned as Chapter 4 (Table 4.3 : The RPN summary that ranks from highest score to lowest score at 90% confidence). The Severity, Occurrence, and Detection of each issue, which show its RPN higher than 100, is reevaluated by using the team judgement. The RPN before and after implementation is also compared and shown as the Table 6.1 : Comparison of RPN before and after implementation the FMEA.

The percentage of reduction of RPN comparison between before and after implementation ranges from 73% to 95%. The Occurrence (the possibility that potential causes of failure happen) and detection have been dramatically reduced because :

- New work instructions and some modification in tinting section are generated to control the potential failure mode. They have also increased the ability of detection both of potential causes of failure and subsequent failure modes.
- People are the key factor for project implementation. So all of concerning people in tinting section is trained for new work instruction and brush up the paint knowledge in terms of tinting technology. This leads to dramatically reduction of occurrence.

PROCESS FMEA (Potential Failure Mode and Effect Analysis in process)

Process Name : **Raw material preparation** Supplied by : **Grinding section**
 Product Name : **Alkyd** Received by : **Tinting section**
 Responsible person : **Process Engineer** Documented by : **Piyawat R.**
 Approved by : **Lab Manager** Approved date : **6/7/2002**
 Team : **Piyawat R., Watcharin S., Surin P., Sawitree L., Sukanya P., Wiroth S., Chokchai N.**

PFMEA Number : **02/001**
 FMEA Date (Orig.) : **5/4/2002**
 FMEA Date (Rev.) : _____
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Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	O	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Result				
											Action	S	O	D	RPN
White base preparation	White base that color strength deviate from standard	Color deviation	7	No color strength control for white base	9	No control	9	567	1. Set up work instruction for color strength control	QC (10/9/02)	As the recommend (WI Doc3)	7	2	2	28
									2. Specific color strength of white base in 20-25%	Process Eng. (10/9/02)	As the recommend	7	2	2	28
Tinting formulation	Starting formulation is not good	CIE of color is high	7	No verification before implement in production	9	No control	9	567	Revise new formulation Sheet with verification	Color Eng. (13/9/02)	As the recommend (Doc 13)	7	2	2	28
Tinter preparation	Color strength of Tinters are too board (±10%)	Color deviation	7	Specification of color strength control are too board	10	Control by formulation	8	560	Revise specification for controlling from +/-10% to ±5%	Process Eng. (13/9/02)	As the Recommend	7	2	2	28
Tinter Storage -Buffer tank -Tinter tank	Skinning of tinter	Color deviation and fineness of paint	7	Circulation pipe is too high	9	No control	8	504	1. Modify pipe Pipe extension 2. Set new min. stock	Maintenance Process Eng. (13/9/02)	Set new min. level of tinter (WI Doc6)	7	4	2	56
Score				S= Severity		O= Occurrence		D= Detection	RPN= SxOxD						

PROCESS FMEA (Potential Failure Mode and Effect Analysis in process)

Process Name : **Raw material preparation** Supplied by : **Grinding section** PFMEA Number : **02/001**
 Product Name : **Alkyd** Received by : **Tinting section** FMEA Date (Orig.) : **5/4/2002**
 Responsible person : **Process Engineer** Documented by : **Piyawat R.** FMEA Date (Rev.) : _____
 Approved by : **Lab Manager** Approved date : **6/7/2002** Page 1 of 23
 Team : **Piyawat R., Watcharin S., Surin P., Sawitree L., Sukanya P., Wiroth S., Chokchai N.**

Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	O	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Result				
											Action	S	O	D	RPN
Keep it into drying cabinet	Dust on paint film	Color deviation	7	Ventilation fan without filter	6	No control	9	504	Install the new ventilation fan with filter	Maintenance (13/09/02)	As the recommend	7	2	2	28
Tinter Storage -Buffer tank -Tinter tank	Settling of tinter	Color deviation	7	Stirring system is not good enough to stir tinter	7	No control	10	490	Set up Max and Min of tinter	Process Eng. (13/9/02)	As the recommend (WI Doc6)	7	4	2	56
Making draw down panel as following specification	Bubble on paint film	Color deviation	7	Film is too thick	7	WI does not suit with paint system	9	441	Revise WI	Color Eng. (13/9/02)	As the recommend (WI Doc4)	7	3	2	42
Keep it into drying cabinet	Dust on paint film	Color deviation	7	Cleanness of drying cabinet	7	No Control	9	441	Set up schedule for cleaning	Color Eng. (10/09/02)	As the recommend	7	2	2	28
White base preparation	Long drying time of white base	Color deviation	7	Quality of binder (long drying time of binder)	7	No control	8	392	Set up work instruction to investigate before using	QC (10/9/02)	As the recommend (WI Doc1)	7	2	2	28
Score			S= Severity		O= Occurrence		D= Detection		RPN= SxOxD						

PROCESS FMEA (Potential Failure Mode and Effect Analysis in process)

Process Name : **Raw material preparation** Supplied by : **Grinding section** PFMEA Number : **02/001**
 Product Name : **Alkyd** Received by : **Tinting section** FMEA Date (Orig.) : **5/4/2002**
 Responsible person : **Process Engineer** Documented by : **Piyawat R.** FMEA Date (Rev.) : _____
 Approved by : **Lab Manager** Approved date : **6/7/2002** Page 2 of 23
 Team : **Piyawat R., Watcharin S., Surin P., Sawitree L., Sukanya P., Wiroth S., Chokchai N.**

Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	O	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Result				
											Action	S	O	D	RPN
Tinter weighing	Error of tinter weigh	Color deviation	7	Accuracy of dispenser in Full machine	7	No control	8	392	Create short form for calibration during loading Tinter into tank	Process (13/9/02)	As the recommend (WI Doc11)	7	2	2	28
White base preparation	Long drying time of white base	Color deviation	7	No checking the RH in the lab	6	No control	8	336	Install the RH controller In the laboratory	Maintenance (13/9/02)	As the recommend	7	2	2	28
Keep it into drying cabinet	Long drying time of panel	Color deviation	7	Ventilation system in drying cabinet is not good	6	No inspection and control	8	336	1. Check flow rate 2. Set PM for ventilation	Maintenance (13/9/02)	As the recommend (PM Plan)	7	2	2	28
Keep it into drying cabinet	Long drying time of panel	Color deviation	7	Ventilation system in drying cabinet is not good	6	No inspection and control	8	336	1. Check flow rate 2. Set PM for ventilation	Maintenance (13/09/02)	As the recommend (PM Plan)	7	2	2	28
Curing film in oven	Film is not fully cure	Color deviation	7	In accuracy temperature in oven	4	No control	9	252	1. Set up work instruction for calibration 2. Set up calibration schedule	Process Eng. (13/9/02)	As the recommend (WI Doc10)	7	4	2	56
										Process Eng. (13/9/02)	As the recommend	7	2	2	28
Score				S= Severity		O= Occurrence		D= Detection		RPN= SxOxD					
PROCESS FMEA (Potential Failure Mode and Effect Analysis in process)															

Process Name : **Raw material preparation** Supplied by : **Grinding section** PFMEA Number : **02/001**
 Product Name : **Alkyd** Received by : **Tinting section** FMEA Date (Orig.) : **5/4/2002**
 Responsible person : **Process Engineer** Documented by : **Piyawat R.** FMEA Date (Rev.) : _____
 Approved by : **Lab Manager** Approved date : **6/7/2002** Page 3 of 23
 Team : **Piyawat R., Watcharin S., Surin P., Sawitree L., Sukanya P., Wiroth S., Chokchai N.**

Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	O	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Result				
											Action	S	O	D	RPN
Tinter Storage -Buffer tank -Tinter tank	Skinning of tinter	Color deviation and quality of paint in terms of fineness	7	Tank is dirty from dry skin of tinter	4	No control	9	252	Set up cleaning procedure	Production (13/9/02)	As the recommend (WI Doc12)	7	3	2	42
									Set up cleaning schedule	Production (13/9/02)					
White base preparation	Long drying time of white base	Color deviation	7	Inaccuracy of cube applicator	6	No calibration	8	224	1. Set up work instruction for calibration	Process Eng. (10/9/02)	As the recommend (WI Doc8)	7	4	2	56
									2. Set up calibration schedule	Process Eng. (10/9/02)	As the recommend	7	2	2	28
Curing film in oven	Film is not fully cure	Color deviation	7	Amount paper panel in oven is too much	4	Internal inform	7	196	Internal training	Color Eng. (13/9/02)	As the recommend	7	3	2	42
White base preparation	Long drying time of white base	Color deviation	7	Inaccuracy of drying time recorder	3	No calibration	9	189	1. Set up work instruction for calibration	Process Eng. (10/9/02)	As the recommend (WI Doc9)	7	4	2	56
									2. Set up calibration schedule	Process Eng. (10/9/02)	As the recommend	7	2	2	28
			Score	S= Severity		O= Occurrence		D= Detection	RPN= SxOxD						

PROCESS FMEA (Potential Failure Mode and Effect Analysis in process)

Process Name : **Raw material preparation** Supplied by : **Grinding section** PFMEA Number : **02/001**
 Product Name : **Alkyd** Received by : **Tinting section** FMEA Date (Orig.) : **5/4/2002**
 Responsible person : **Process Engineer** Documented by : **Piyawat R.** FMEA Date (Rev.) : _____
 Approved by : **Lab Manager** Approved date : **6/7/2002** Page 5 of 23
 Team : **Piyawat R., Watcharin S., Surin P., Sawitree L., Sukanya P., Wiroteh S., Chokchai N.**

Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	O	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Result				
											Action	S	O	D	RPN
Tinter storage -Buffer tank -Tinter tank	Settling of tinter	Color deviation	7	Tinter level is lower than level of impeller	3	No control	9	189	Set up the min. level of tinter in buffer tank	Process Eng (13/9/02)	As the recommend (WI Doc6)	7	4	2	56
Tinter storage Buffer tank Tinter tank	Skinning of tinter	Color deviation and quality of Paint in terms of fineness	7	Level of tinter is nearly the same level of impeller	3	Set up minimum stock of tinter at PLC	9	189	Set up the min level of tinter in buffer tank	Process Eng (13/9/02)	As the recommend (WI Doc6)	7	4	2	56
White base preparation	White base that color strength deviate from standard	Color deviation	7	Dust from dust suction	3	Visual inspection	8	168	Set PM plan in dust suction pipe	Maintenance (10/9/02)	As the recommend (PM Plan)	7	2	2	28
White base preparation	Long drying time of white base	Color deviation	7	No re inspection after adjusting drying time	6	Specify in work instruction	4	168	Set training Course	QC (10/9/02)	As the recommend	7	2	2	28
Mixing	Inhomogeneous paint in mixing stage	Color deviation	7	Stirring time does not suitable	3	Specify into the formulation	7	147	Revise WI	Color Eng. (13/9/02)	As the recommend (WI Doc4)	7	3	2	42
Score			S= Severity		O= Occurrence		D= Detection		RPN= SxOxD						
PROCESS FMEA (Potential Failure Mode and Effect Analysis in process)															

Process Name : **Mixing Process**
 Product Name : **Alkyd**
 Responsible person : **Process Engineer**
 Approved by : **Lab Manager**
 Team : **Piyawat R., Watcharin S., Surin P., Sawitree L., Sukanya P., Wiroth S., Chokchai N.**

Supplied by : **Grinding section**
 Received by : **Tinting section**
 Documented by : **Piyawat R.**
 Approved date : **6/7/2002**

PFMEA Number : **02/001**
 FMEA Date (Orig.) : **5/4/2002**
 FMEA Date (Rev.) : _____
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Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	O	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Result				
											Action	S	O	D	RPN
Tinter storage -Buffer tank -Tinter tank	Settling of tinter	Color deviation	7	Circulation time of tinter is not suitable	5	Set up and control at PLC	4	140	Revise to Stirring every 20 min	Maintenance (13/9/02)	As the recommend	7	2	2	28
Tinter storage -Pail	Low hiding power of paint film	Color deviation	7	Inaccuracy of applicator	2	No calibration	9	126	1. Set up work instruction for calibration 2. Set up calibration schedule	Process Eng. (10/9/02) Process Eng. (10/9/02)	As the recommend (WI Doc8) As the recommend	7 7	4 2	2 2	56 28
Making draw down panel as the following specification	Wrinkle color Panel	Color deviation	7	Inaccuracy of applicator	2	No calibration	9	126	1. Set up work instruction for calibration 2. Set up calibration schedule	Process Eng. (10/9/02) Process Eng. (10/9/02)	As the recommend (WI Doc8) As the recommend	7 7	4 2	2 2	56 28
Score				S= Severity		O= Occurrence		D= Detection		RPN= SxOxD					

PROCESS FMEA (Potential Failure Mode and Effect Analysis in process)

Process Name : **Color panel preparation** Supplied by : **Grinding section**
 Product Name : **Alkyd** Received by : **Tinting section**
 Responsible person : **Process Engineer** Documented by : **Piyawat R.**
 Approved by : **Lab Manager** Approved date : **6/7/2002**
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Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	O	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Result				
											Action	S	O	D	RPN
Curing film in oven	Wrinkle film	Color deviation	7	Temperature in oven is higher than standard	2	No control	9	126	1. Set up work instruction for calibration	Process Eng. (10/9/02)	As the recommend (WI Doc9)	7	4	2	56
									2. Set up calibration schedule	Process Eng. (10/9/02)	As the recommend	7	2	2	28
White base and neutral base storage	Skinning of white and neutral base	Quality of Paint in terms of fineness	7	Closing system for storage tank is low efficiency	2	No control	9	126	1. Set up preventive maintenance	Production (13/9/02)	As the recommend (PM Plan)	7	3	2	42
									2. Training	Production (13/9/02)	As the recommend	7	3	2	42
Tinter Storage -Pail	Settling of tinter	Color deviation	7	Operator does not stir before using	2	No control	9	126	1. Set up the WorkInstruction	Production (13/9/02)	As the recommend (WI Doc7)	7	2	2	28
									2. Training Tinting operators	Process Eng. (20/9/02)					
Tinting m/c container preparation	Uncleanness of tinting m/c	Color deviation	7	Brush for cleaning is not suitable	6	-Visual inspection	3	126	Modify the equipment to match with cleaning	Production (13/9/02)	As the recommend	7	2	2	28
Score				S= Severity		O= Occurrence		D= Detection		RPN= SxOxD					

PROCESS FMEA (Potential Failure Mode and Effect Analysis in process)

Process Name : **Color panel preparation** Supplied by : **Grinding section** PFMEA Number : **02/001**
 Product Name : **Alkyd** Received by : **Tinting section** FMEA Date (Orig.) : **5/4/2002**
 Responsible person : **Process Engineer** Documented by : **Piyawat R.** FMEA Date (Rev.) : _____
 Approved by : **Lab Manager** Approved date : **6/7/2002** Page 8 of 23
 Team : **Piyawat R., Watcharin S., Surin P., Sawitree L., Sukanya P., Wiroth S., Chokchai N.**

Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	O	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Result				
											Action	S	O	D	RPN
White base preparation	Color strength of white base is deviate from batch to batch		7	Weight of each TiO ₂ packaging	2	No inspection but it was guarantee by supplier	9	126	Random checking	Raw Material (10/9/02)	Set up WI and random checking (WI Doc2)	7	2	2	28
Curing film in oven	Film yellowing	Color deviation	7	Temperature in oven is higher than standard	2	No control	9	126	1. Set up work instruction for calibration 2. Set up calibration schedule	Process Eng. (13/9/02) Process Eng. (13/9/02)	As the recommend (WI Doc9)	7	4	2	56
White base and neutral base storage	Skinning of white and neutral base	Quality of Paint in terms of fineness	7	Leakage of seal of the lid	2	No control	8	112	Set up preventive maintenance	Production (13/9/02)	As the recommend	7	3	2	42
Making panel as the following specification	Low hiding power of paint film	Color deviation	7	Low skill operator	3	Training	5	105	Set up training	Color Eng. (13/10/02)	As the recommend	7	2	2	28
			Score	S= Severity		O= Occurrence		D= Detection	RPN= SxOxD						

Table 6.1 : Comparison of RPN before and after implementation the FMEA.

Remark : The detail of Work Instruction and Preventive Maintenance Plan as recommendation are indicated in Appendix III to IV respectively.

6.2.1.1 The way to revise the score of the severity, occurrence, and Detection of each process

The FMEA team has revised the score of severity, occurrence, and detection of each process in tinted alkyd products that The RPN > 100. They are shown in table 6.1 : Comparison of the RPN before and after implement the FMEA. It was found that there are 33 high-risk area that are revised. Only one of them will be explained the way to revise the severity, occurrence, and detection.

In the raw material preparation process, I have mentioned as the 4.1.4.1 that one of main critical failure mode is uncontrolled color strength of white base. After revise the score, it was found that the severity is ranked at the same level prior to FMEA implementation: = 7 (major effect) because the process does not change. It also can not rate at score 8, because it does not impact to paint quality that lead be waste. In addition, it also cannot be ranked at level 9 or 10, because it does not concern with the government regulation and safety related. In terms of occurrence and detection, they are ranked at score 2, because the work instruction for color strength control of alkyd white base for tinted products procedure (Work Instruction Document No. 3) is generated and trained to user. The users understand and follow the instruction with high skill. Moreover, it is implemented in quality control process to prevent the color deviation of alkyd tinted products before release to tinting section. The detail of work instruction is listed in the Appendix III.

As the result, the RPN score is $7*2*2 = 28$, which is the new work instruction can prevent the failure effectively.

6.2.2 Improvement of color adjustment and process time in tinting section

There are improvements of tinted alkyds products line in terms of color adjustment and process time when the FMEA project is implemented.

Prior to project starting, only 13% of total batches in 18 color shades could achieve right first time for color control, while 87% need color adjustment more than 1 time. The average process time per batch is 233 min. After the

FMEA implementation, we can achieve the right first time target for 73% of total trial batches. We also save the mixing time from 30 min to 20 min per batch, because 20 min is enough for homogenous in mixing process. This result leads to process time reduction in tinted alkyd product line. At the present, the average process time for tinted alkyd product lines after implement the FMEA project is 147 min. The ABC Company can save the process time = 63.0 % when compare with prior to project starting. The detail shows as the table 6.2 :



Table 6.2 : Amount correction time and average process time in tinted alkyd products before implement FMEA

Product Code	Product Name	Total Batches	Amount Correction time			Average Process time (min)
			1 time	2 times	3 times	
245125	GE: Island Green	7	0	7	0	230
245315	GE : Pacific Blue	11	1	9	1	230
245702	GE : Pastel Green	6	0	5	1	249
245940	GE : Royal Blue	5	0	3	2	276
245M05	GE : Grey	10	4	5	1	196
248T03	JG : Custard Cream	6	0	5	1	249
3524810B	JG : Early Rain	8	0	7	1	245
3524880T	JG : Oak	9	4	4	1	214
248R45	JG : Gaily Blue	7	3	4	0	181
3524870A	JG : Smoke Grey	8	4	4	0	173
3524860H	JG : Dusky Green	10	2	8	0	207
3524850T	JG : Pacific Blue	14	0	10	4	263
3524850K	JG : Dazzle Blue	5	0	2	3	299
3524810I	JG : Peppermint	9	0	9	0	230
3524810F	JG : Mellow Yellow	7	0	6	1	247
3524810L	JG : Ivory Bisque	11	0	8	3	262
3524853C	JG : Baby Blue	3	0	3	0	345
248R10	JG : Blue Sapphire	3	0	0	3	235
Total		139	18	99	22	233

Average process time = 233 minutes

Average correction time per batch = 2.03 times

Table 6.3 : Amount correction time and average process time in tinted alkyd products after implement FMEA

Product Code	Product Name	Total Batches	Amount Correction time			Average Process time (min)
			1 time	2 times	3 times	
245125	GE: Island Green	1	0	0	1	345
245315	GE : Pacific Blue	3	3	0	0	115
245702	GE : Pastel Green	1	0	1	0	230
245940	GE : Royal Blue	4	4	0	0	115
245M05	GE : Grey	6	5	1	0	134
248T03	JG : Custard Cream	6	5	1	0	134
3524810B	JG : Early Rain	4	3	1	0	144
3524880T	JG : Oak	4	1	3	0	201
248R45	JG : Gaily Blue	5	5	0	0	115
3524870A	JG : Smoke Grey	4	4	0	0	115
3524860H	JG : Dusky Green	4	3	1	0	144
3524850T	JG : Pacific Blue	6	4	2	0	153
3524850K	JG : Dazzle Blue	2	1	1	0	173
3524810I	JG : Peppermint	2	2	0	0	115
3524810F	JG : Mellow Yellow	1	1	0	0	115
3524810L	JG : Ivory Bisque	2	2	0	0	115
3524853C	JG : Baby Blue	3	1	2	0	192
248R10	JG : Blue Sapphire	3	1	2	0	192
Total		60	44	15	1	147

Average process time = 147 minutes

Average correction time per batch = 1.28 times

Figure 6.1 : The comparison in terms of correction times between before with after the FMEA implementation

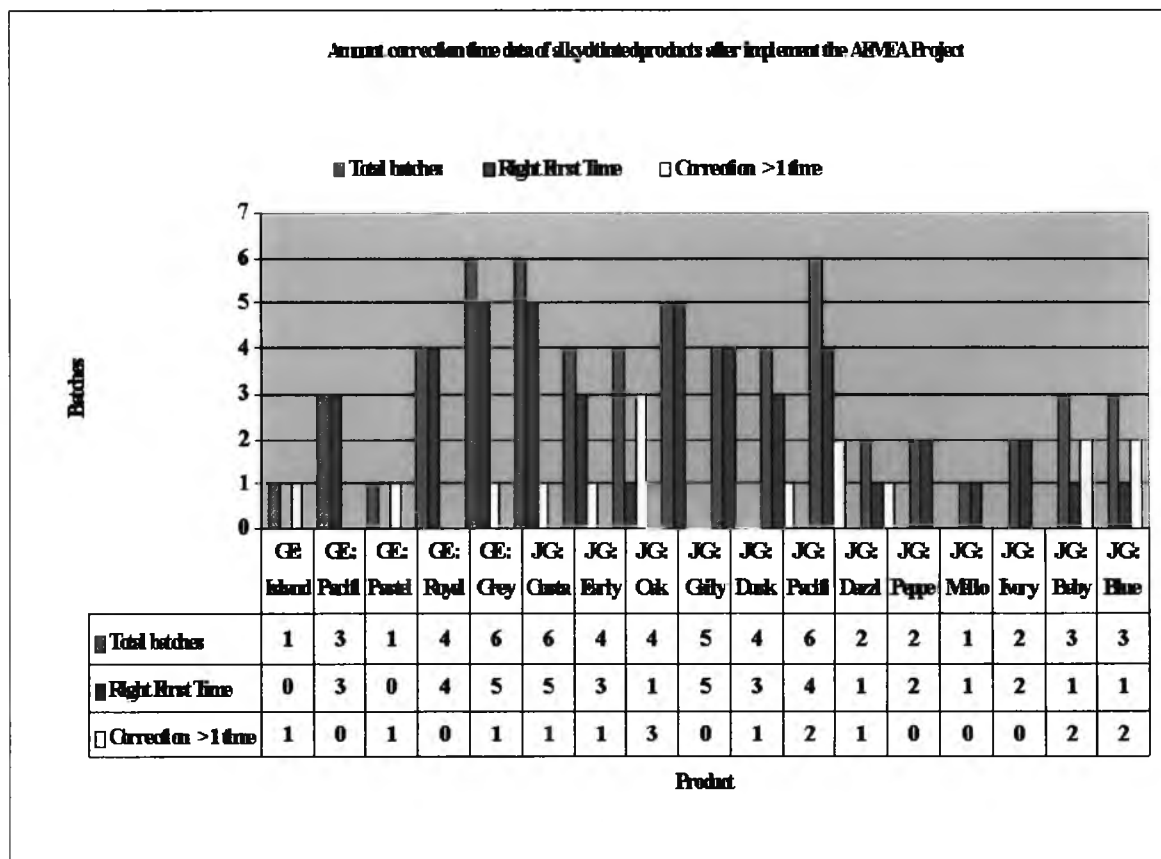
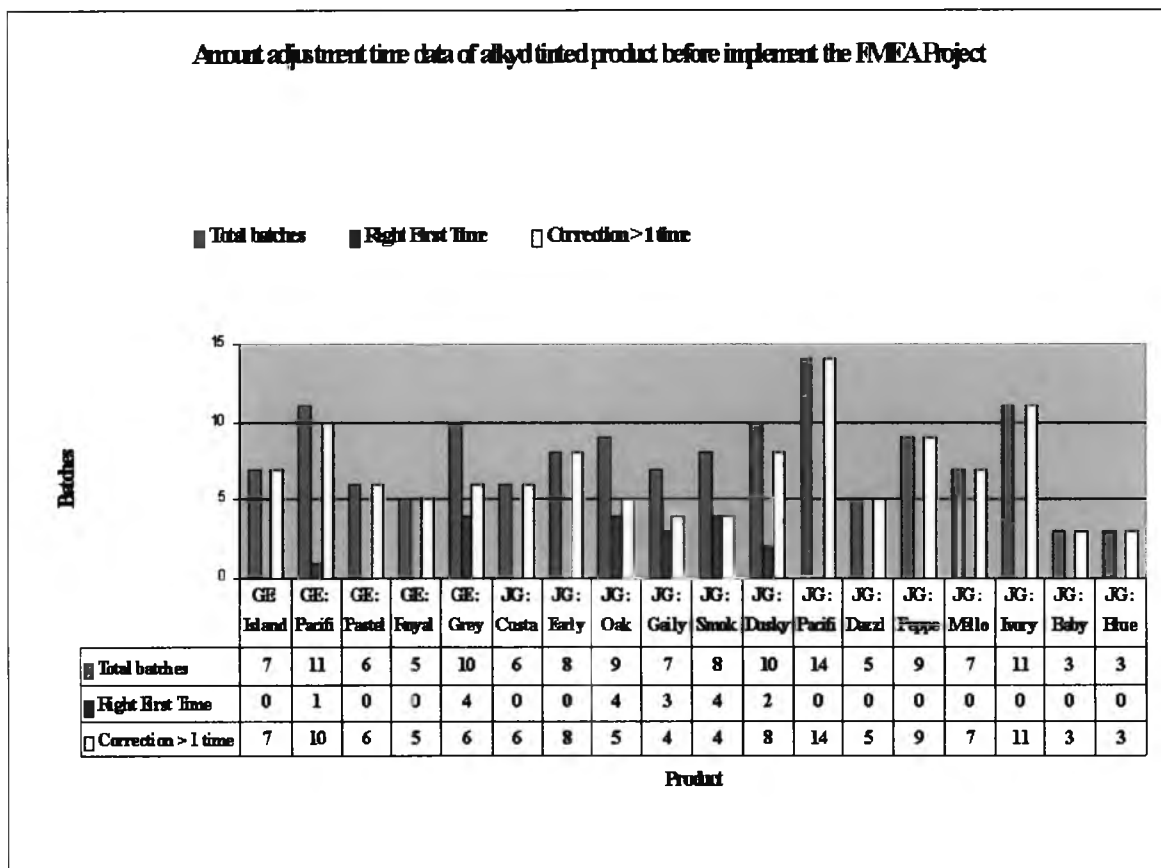


Figure 6.2 : The comparison in terms of Right First Time between before with after the FMEA implementation

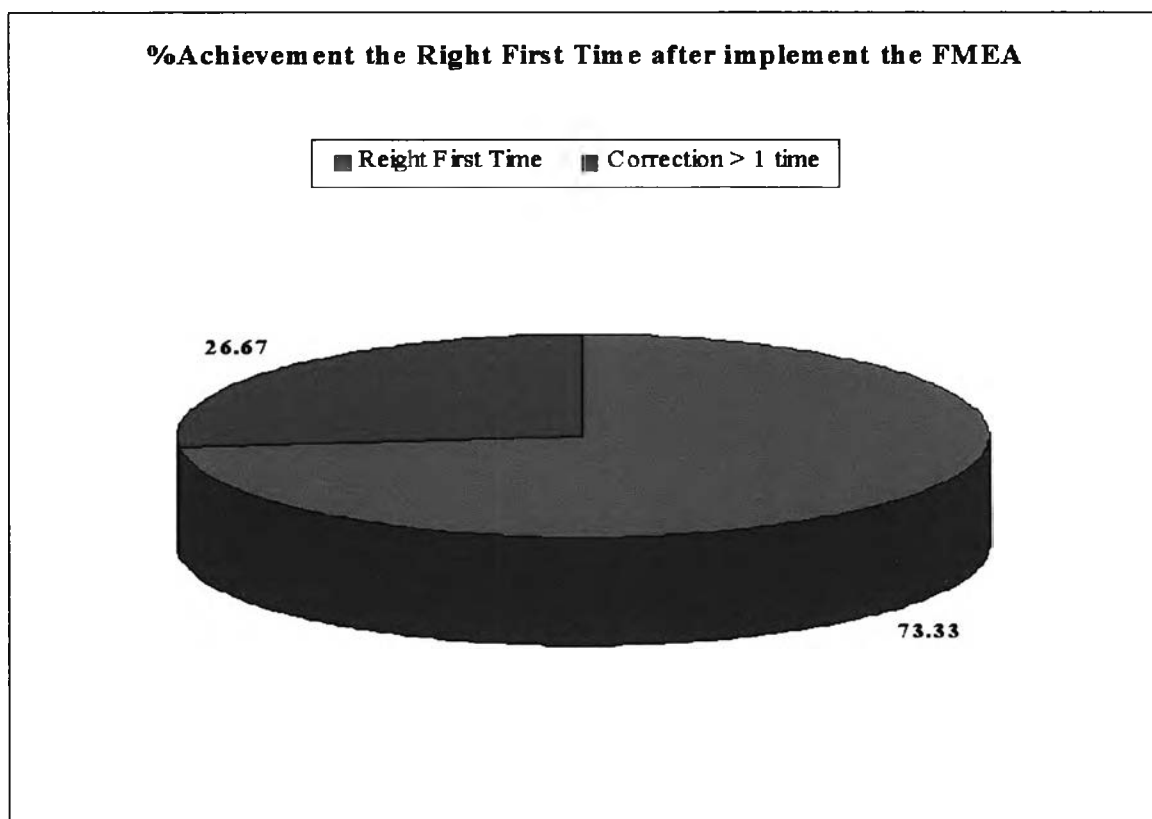
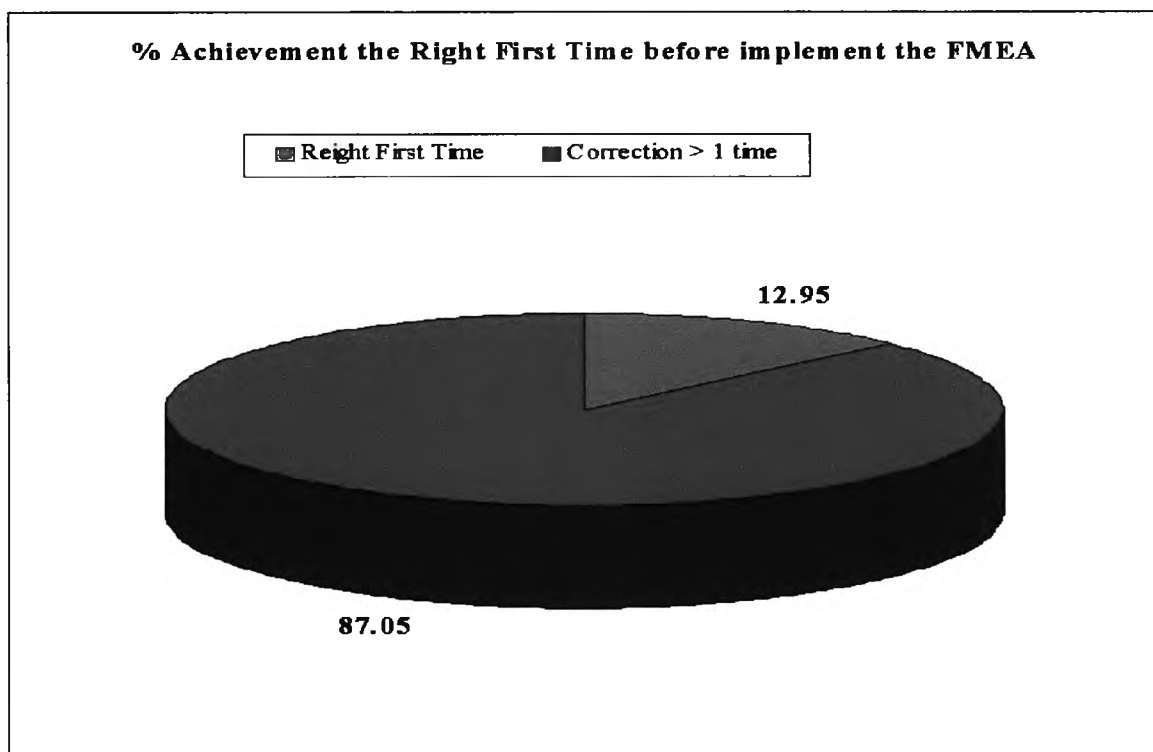
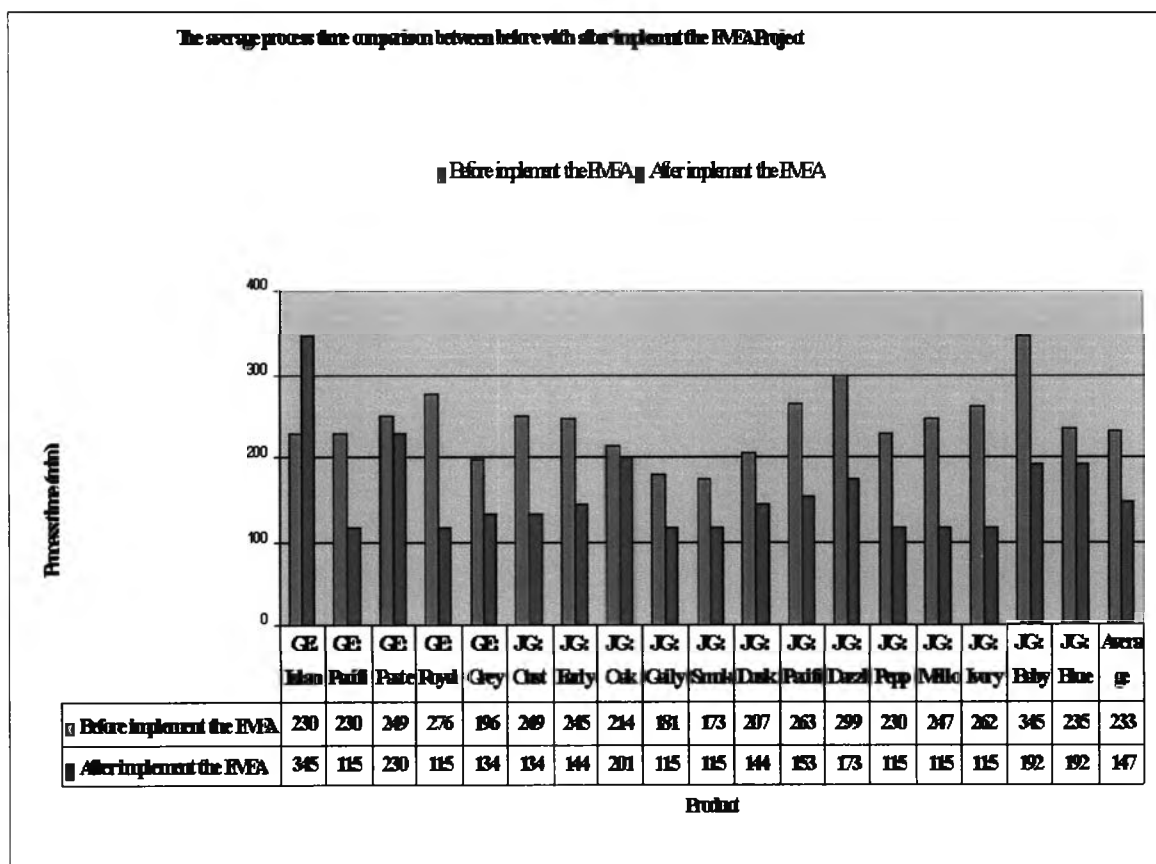


Figure 6.3 : The comparison in terms of process times between before with after the FMEA implementation



6.3 The process standard for color control in tinted products

Based on evaluation, I summarized the standard process for color control in tinted product as following :

6.3.1 Raw Material Preparation

- Alkyd White Base

This raw material needs to be controlled the color strength in the range of 20-25%. The procedure for color strength control of Alkyd White Base show as following Document 3 in Appendix III. Moreover, the drying time of product is also controlled at 3-6 Hours as the specification of products before release to tinting section.

- Alkyd Neutral Base

Only drying time needs to be controlled strictly (3-6 Hours as the product specification) before pass through tinting section.

- Tinter

The color strength for all of tinters will be controlled at level $\pm 5\%$. The storage condition will be divided into 3 categories as following :

1. Tinter tank 1000 liters

The volume of storage is recommended as the following Document No. 6 in Appendix III. Moreover, the stirring time of each tank is revised from 30 minute to 20 minutes per time every hour to make them homogenous.

2. Tinter in canister 100 or 200 liters

The volume of storage is recommended at 80% of canister volume. The circulation time will be run every 1 hour.

3. Tinter in pail size 20 liters

Before using these tinters, they need to be stirred to make them homogenous. The work instruction of Tinter Pail Handling is created as Document No. 7 in Appendix III.

- Tinting Formula

Tinting formula must be precision and repeatability. Before release into the production, they should be verified. The new formulation sheet for color development is developed as the following Document No. 13 in Appendix III.

- Raw Material Weighing

1. The error of weighing is acceptable at level $\pm 1\%$.
2. Tinters that use in Full machine (Automatic dispenser) need to be calibration after load the new batch into tinter tank or canister. The

calibration sheet for Full machine is generated as the Document No.11 in Appendix III.

6.3.2 Mixing Process

- The minimum and maximum volume of paint for each container is generated in terms of Work Instruction Document No. 5 in Appendix III.
- The speed of stirrer, stirring time for mixing is generated in work instruction document No. 4 Tinting Process Procedure in Appendix III

6.3.3 Color Panel Preparation

The specification for color panel preparation for tinted alkyd product show as following :

Color shade	Film thickness from applicator	Drying time in drying cabinet (minute)	Curing time in oven at 50 °C	Cooling time for panel exposure at ambient
Pale	200	20	30	3
Medium-Dark	300	20	30	3

The detail of work instruction is generated in Document No. 4 Tinting Process Procedure in Appendix III

6.3.4 Color Measurement

The work instruction for color measurement is also included in the work instruction document No. 4 Tinting Process Procedure in Appendix III.

Moreover, all of equipment that use in tinting process and tend impact to color adjustment will be calibrated in annually. The procedure of calibration in each equipment show as following :

Equipment	Work Instruction Document No.	Appendix No.
Cube Applicator	8	III
Drying Time Recorder	9	III
Oven	10	III