Chapter 4

The Proposed FMEA Technique

4. The Proposed FMEA Technique

In order to reduce the amount color adjustment (correction time) and improve productivity in terms of cycle time in tinting section, it is imperative to identify and eliminate the potential problems in the systematic way. The failure mode and effect analysis (FMEA) is an engineering technique used to define, identify and eliminate potential failures that impact to tint for tinted alkyd products. Moreover, the cause and effect diagram is also applied in the FMEA process as a supplement to identify root causes.

4.1 Problem Analysis by means of the FMEA and The Cause and Effect Diagram

As stated in Chapter 3 (Table 3.2 : Problem identification in tinted alkyd paint in terms of quality and color adjustment), the potential failure mode causes will be analyzed and executed. So The Failure Mode and Effect Analysis (FMEA) and The Cause and Effect Diagram have been introduced in the ABC Company.

4.1.1 The FMEA Types Selection

There are four types of FMEA : system, design, process, and service. The tinting process in tinted alkyd products in ABC Company use only the process FMEA because it relates with analysis in manufacturing process. It focuses on failure modes caused by process deficiencies.

4.1.2 The FMEA Team Selection

The FMEA concept is a team function, not individually. The team must be crossfunctional and the team members must be willing to contribute the project. The team must be set up as properly for specific project. It can not serve as the company FMEA team. Therefore, the team for tackle the problem in tinted alkyd products has been establishes based on education qualification or extensive experience in paint manufacturing. The FMEA team in this project consists of 7 persons with multi functional backgrounds, and 2 color specialists from headquarter to suggest and comment all of problem identification. Team includes the members as following :

1. **Process Engineer**

He graduated from a university in Textile Chemical Engineering with the second class honor since 1993. He has joined with ABC Company more than five years. He has been trained about paint processing and quality control techniques from headquarter in Norway, Malaysia, and Singapore. He also joined projects with specialists from headquarter to develop the production process and optimize the process for manufacturing line. He takes responsible for paint process design, troubleshooting in production line both of water base and solvent base.

2. Color Engineer

She graduated from a university in Chemical Engineering since 1993. She has joined with ABC Company more than six years. She has been trained about color technology and processing by Asia Pacific Regional Laboratory in Malaysia. She also works with color specialist to develop the color processing in ABC Company. She takes responsible for tinting processing, color development in production line both of water base and solvent base.

3. Quality Control Chemist

She graduated from a university in Chemistry Science since 1998. She has joined with ABC Company more than two years. She has been trained about paint technology and quality control technique in paint manufacturing by Asia Pacific Regional Laboratory in Malaysia. She takes responsible for quality control both of raw material and finished goods.

4. Solvent Base Supervisor

He graduated from a university in Textile Chemical Engineering since 1993. He has joined with ABC Company more than six years. He has been trained about paint production and processing from specialist from headquarter. He also visited and trained some course in terms of production management in Singapore and Malaysia. He takes responsible for production line management in solvent base.

5. Specialist Engineer

He graduated from a university in Technology Electronic since1983. He has joined with the ABC Company more than 10 years. He has been trained about engineering system and plant design in many countries in the ABC groups. He also the member of the design engineer team for new factory in the ABC Company. He is the expert in plant design, automation and control system, electronic system.

6. Solvent Base Foreman

He received the diploma from Technical School in Electronic and Power Control in 1992. He has joined with the ABC Company more than 3 years. He takes responsible for assist the production supervisor in solvent base to manage and supervise in grinding and tinting section in solvent base.

7. Raw Material Foreman

He received the diploma from Technical School in Industrial Technical in 1992. Before he joined with the ABC Company, he worked as the production planning and supervisor in truck manufacturing. He has joined with the ABC Company more than 3 years. Before he worked as production planning and control system in chemical industry. He supervises in section of raw material preparation, and raw material handling.

Moreover, one color specialist from the headquarter that comment for this is

1. Head of Color Development Chemist

He received the degree in Chemistry from the Norwegian Institute of Technology since 1983. He worked at ABC Company as the Color Development Chemist at Pigment Laboratory for 12 years, and promoted to Senior Color Development Chemist. Until now, he works as the Head of Color Development Chemist. His responsible includes research and development the tinter formulation, color formulation etc. He is the one of expertise in the ABC Company in the field of color both of water base and solvent base.

4.1.3 The Process of Conducting the FMEA

After FMEA team is established the flowchart of four processes in tinting section of alkyd products is briefed and explained to all of team members. This is to make sure that everyone understands the process as the same direction. The team started to collect the data of failures and categorized them appropriately. Problem identification will be done firstly. It shown as the Table 3.2 : Problem identification in tinted alkyd paint in terms of quality and color adjustment in Chapter 3. All of them is sent to color specialist at headquarter of the ABC Company to approve and comment.

The failure in each process is brainstormed by means of using the caused and effect diagram technique. They are shown in the Appendix I. The information from this analysis will be used to fill in the columns of the FMEA form in relationship to the effects of the failure, existing controls. The score of severity, occurrence, and detection will be rated base on team judgement.

The ranking of each criterion in severity, occurrence, and detection of process FMEA is modified from Table 2.8 : the example of evaluation criteria for the Process FMEA that uses for QS 9000. They are summarized as the following :

Effect	Criteria	Score
Hazardous Effect	Hazardous Effect. Safety-related—sudden failure in	10
	process production. Non compliance with government	
	regulation.	
Serious Effect	Potential hazardous effect. Able to stop product without	9
	mishap; safety-related ; time dependent failure.	
	Disruption to subsequent process operations.	
	Compliance with government regulation is in jeopardy.	
Extreme Effect	Extreme effect on quality of products, tinting process;	8
	equipment damaged. Product can not achieve their	
	specification but safe. They are treated as waste.	
Major Effect	Extreme effect on quality of products, color adjustment,	7
	rework/repair on product necessary. Product/process	
	performance severely affected but functionable and safe.	
Significant Effect	Product/process performance degraded, but operable	6
	and safe.	
Moderate Effect	Moderate effect on product/process performance in	5
	terms of quality and color adjustment. Product needs	
	perform color adjustment> 1 time with minor quality	
	adjustment.	
Minor Effect	Minor effect on product/process performance. Product	4
	needs perform color adjustment> 1 time without quality	
	adjustment.	
Slight Effect	Slight effect on product or process performance. Product	3
	needs perform color adjustment only 1 time with minor	
	quality adjustment.	
Very slightly	Very slightly effect on product/process performance.	2
effect	Product needs perform color adjustment only 1 time	
	without quality adjustment.	
No Effect	No effect on product or subsequent processes.	1

Severity (s) Evaluation Criteria

Detection (D) Evaluation Criteria

Effect	Criteria	Score
Almost	No known controls available to detect the failure.	10
impossible		
Remote	Remote likelihood current work instruction and controls	9
	will detect the failure.	
Very slight	The current work instruction and control are not	8
	applicable to detect the failure.	
Slight	The current work instruction and control are applicable,	7
	but not effective to detect the failure.	
	(Slight likelihood current controls will detect the failure)	
Low	The current work instruction and control are applicable	6
	and effectiveness, but lack of training to user.	
	(Low likelihood current controls will detect the failure)	
Medium	The current work instruction and control are applicable	5
	and effectiveness. They are trained to users, but they are	
	not fully clear and understanding.	
	(Medium likelihood current controls will detect the	
	failure)	
Moderately high	The current work instruction and control are applicable	4
	and effectiveness. They are trained to users, but they	
	might be don't follow instruction strictly.	
	(Moderately high likelihood current controls will detect	
	the failure)	
High	The current work instruction and control are applicable	3
	and effectiveness. They are trained to users, but they	
	perform with low skill.	
	(Good likelihood current controls will detect the	
	failure.)	
Very high	The current work instruction and control are applicable	2
	and effectiveness. They are generated in form of	
	controlled document and are trained to users. The users	
	understand and perform as the instruction with high	
	skill.	
	(Very high likelihood current controls will detect the	
	failure.)	
Almost Certain	The current work instruction and control are applicable	1
	and effectiveness. They are generated in form of	
	controlled document and are trained to users. The users	
	understand and perform as the instruction strictly.	
	(Current controls almost always will detect the failure.	
	Reliable detection controls are known and used in	
	similar processes)	

Effect	Criteria	Score
Almost certain	Failure almost certain. It is inevitable. History of	10
	failures exists from previous or similar design	
Very high	Very high number of failure likely (80-90%)	9
High	High number of failure likely (70-79%)	8
Moderately high	Frequent high number of failure likely (60-69%)	7
Medium	Moderate number of failure likely (50-59%)	6
Low	Occasional number of failure likely (30-49%)	5
Slight	Few failures likely (20-29%)	4
Very slight	Very few failures likely (10-19%)	3
Remote	Rare number of failures likely (1-9%)	2
Almost never	Failure unlikely. History shows no failures.	1

Occurrence (O) Evaluation Criteria

Table 4.1:Evaluation Criteria Table for the Process FMEA

The rank of 1 to 10 is mostly used because it provides ease of interpretation, accuracy, and precision in the quantification of the ranking (Stamatis, 1995 : 35).

All of criteria that we use for ranking the score of severity, occurrence and detection in this research were generated by FMEA members, and final revised and approved by corporate pigment and color specialist team at headquarter in June 2002.

After FMEA team quantify the severity, occurrence, and detection in process FMEA. The priority of the failure is then articulated via the RPN (Risk Priority Number). It is the outcome of the Severity (S), Occurrence (O), and Detection (D) ranking. The relationship shown as below :

$$RPN = (S) * (O) * (D)$$

The RPN is the value by itself that use only for ranking and concerning in the process of tinting section in alkyd products. The RPN will be between '1' and '1000'. All RPNs have no other value or meaning (Stamatis, 1995 : 35) The

result of quantification the severity, occurrence, detection, and RPN are summarized in Appendix II.

The FMEA team agree to pursue failures or problems based on a 90 percent confidence and a 1 to 10 guideline scale. It means that 90 percent of all failure must be addressed for a very critical process. Since the maximum score possible for the RPN is 1000 (10*10*10 from severity, occurrence, and detection). Ninety percent of 1000 is 900. Now subtract 1000-900 = 100. Therefore, the threshold of examining the failures would be anything equal to or greater than a 1000 RPN. It means that the RPN of failure that is higher score than 100 must be addressed.

Concept of addressing the failure is the failure with high RPN will be stated first. In case of there are more than two failures with the same RPN, the first address is failure that has high severity, and then detection respectively. Severity is approached first, because it impact directly to failure, while detection is used over the occurrence, because it is customer dependent, which is more important than the frequencies of the failure (Stamatis, 1995 : 40)

4.1.4 The way to quantify the Severity, Occurrence, and Detection of each process

The FMEA team has ranked the score of severity, occurrence, and detection of each process in tinted alkyd products based on table 4.1 : Evaluation Criteria Table for the Process FMEA. There are many failure modes in four process for tinted alkyd products, only three of them will be explained the way to rank the score of severity, occurrence, and detection in the process being discussed.

4.1.4.1 Raw Material Preparation Process

In the raw material preparation process, one of main critical failure mode is uncontrolled color strength of white base. It was found that color strength of white base impact directly to color deviation. The higher color strength of white base, more impact to color deviation of tinted shade. Therefore, the severity is ranked at score 7 (major effect). It can not rate at score 8, because it does not impact to paint quality that leads to be waste. In addition, it also can not be ranked as level 9 or 10, because it does not concern with the government regulation and safety related. In terms of occurrence and detection, they are rated at level 9 because there is no formal procedure to control or detect the failure from reoccurring, only Process Engineer or Color Engineer who understand the problem can investigate. As the result, the RPN score is 7*9*9 = 567, which is the highest RPN because it leads to color adjustment for many times.

4.1.4.2 Mixing Process

In mixing process, level of the impeller of tinting machine impacts to color deviation. It can create the homogenous paint. This leads to incorrect color shade during color measurement. Consequently, it needs to perform color adjustment for many times to achieve the target. That is the reason why the score of severity is equal 7. It does not affect to paint quality, government regulation, and safety-related. So score at level 8,9,10 is not appropriate. At the present, the ABC Company has the work instruction to set up the maximum and minimum level of paint in each container (pot, tank). It is the preventive action for this problem. Consequently, the score of occurrence is only 2 (Remote). The score of detection is equal to 4 (Moderately high) because the current work instruction and control are applicable and effectiveness to detect the failure, but sometime users doesn't follow the instruction strictly. As the result, the RPN = 7*2*4 = 96. It means that the existing procedure can prevent the failure effectively.

When compare the RPN of example in raw material preparation (Uncontrolled color strength of white base) with mixing process (level of impeller), it was found that the RPN of first failure cause is much higher than the second failure cause. This is because first mode does not have controlling system for preventing the

problem. Consequently, score of occurrence and detection are high. That is the reason why the first failure mode is higher than the second.

4.1.4.3 Color Panel Preparation Process

In color panel preparation process, The potential mode is wrinkle film on paper panel. This is the one of problem that impacts to color deviation till to rework. So the score of severity is 7 (major effect). It can not rate at score 8, because it does not impact to paint quality that leads to be waste. In addition, it also can not be ranked as level 9 or 10, because it does not concern with the government regulation and safety related.. The cause of problem is paint film is thicker than standard. It maybe caused by inaccuracy of paint film applicator. Normally, this problem rarely occurs (less than 9%). So the score of the occurrence is equal to 2. At the present, the existing process control is not implemented yet. Therefore, the detection is ranked to high score. It is level 9. As the result, the RPN is 7*2*9 = 126.

4.1.5 Results of Conducting the Process FMEA

The results of conducting the FMEA are expressed in Appendix II. Moreover, The cause and effect diagram is used for identification the root causes of each failure are also shown in Appendix I. The outcome of identification are recorded into the process FMEA form for evaluating the severity, occurrence, detection to calculate the RPN score. The critical failure mode that the RPN is higher than 100 (90% confidence) must be addressed to take the action. All of them shown as the following :

Table 4.2 :Summary the process FMEA that RPN is higher than 100(90% confidence)

ltem	Potential Failure Mcde	Potential cause(s) of Failure	RPN
1	W hite base/ Neutral base preparation	Quality of TiO 2	112
2	W hite base/ Neutral base preparation	Weight of each TiO2 packing	126
3	W hite base/ Neutral base preparation	Dust fom suction dust in dissolver	168
4	W hite base/ Neutral base preparation	No color strength control for white base	567
5	W hite base/ Neutral base preparation	Quality of binder in terms of drying time	392
6	W hite base/ Neutral base preparation	Inaccuracy of cube applicator	224
7	W hite base/ Neutral base preparation	Inaccuracy of drying time recorder	189
8	W hite base/ Neutral base preparation	Ventilation system in drying cabinet is low efficency	336
9	W hite base/ Neutral base preparation	No re inspection after drying time adjustment	168
10	Tinter preparation	Color strength of tinter are board (+/-10%)	560
11	W hite base/ Neutral base preparation	Closing system for storage tank is low efficiency	126
12	W hite base/ Neutral base preparation	Leakage of lid seal in storage tank	112
13	Tinter storage in tinter tank	T:nter level 15 lower than stirring blade	189
14	Tinter storage in tinter tank	C:rculation time in tinter tank is not suitable	140
15	Tinter storage in tinter tank	Stirring system is not good enough to stir the tinter	490
16	Tinter storage in pale	Operator does not stir the tinter in pale before use	126
17	Tinter storage in pale	Level of tinter is the same of level of stirring blade	189
18	Tinter storage in pale	Circulation pipe in tinter tank is too high	504
19	Tinter storage in pale	Tinter tank is dirty from dry skinning of tinter	252
20	Tinting formulation	Tinting formualtion is not precision	567
21	Tinter W eighing	A ccuracy of dispenser in Full machine	392
22	Uncleanness of tinting tank	Brush that use for cleaning is not suitable	126
23	Inhomogeneous paint in mixing stage	Stirring time is not suitable	147
24	High bubble in paint film	Film is too thick	441
25	Low hiding power on paint film.	Inaccuracy of applicator	126
26	Low hiding power on paint film	Low skill tinting operators	105
27	W rinkle film color panel during draw down	Inaccuracy of applicator	126
28	Dust on paint film in drying cabinet	Cleanness of drying cabinet	441
29	Dust on paint film in drying cabinet	Ventilation system does not have the filter	504
30	Long drying time of color panel	Ventilation system in drying cabinet is low efficency	336
31	Film is not fully cure during keep in oven	Inaccuracy of temperature in oven	252
32	Film is not fully cure during keep in oven	A mount color panel in oven is too much	196
33	W rinkle film in during curing in oven	Temperature in oven is higher set point	126





PROCESS FMI	EA (Potential Failure	Mode and Eff	fect A	nalysis in process)											
Process Name Product Name Responsible per Approved by	: Raw material : Alkyd rson : Process Engine : Lab Manager	preparation eer		Supplied by Received by Documented Approved da	: :' by: te :	Grinding section Finting section Piyawat R. 6/7/2002		* NI		PFMEA Number FMEA Date (Ori FMEA Date (Rev Page 1 of 9	: 02/00) (g.) : 5/4/20 (v.) :	002			_
Team	: Piyawat R., W	atcharin S., S	Surin	P., Sawitree L., Suk	anya	P., Wiroth S., Cho	okcha	i N.							
Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	0	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action	Action F	O O	D	R P N
White base	Color strength of	Color	7	Quality of TiO ₂	4	Only check	4	112	Revise	Process Eng.					
preparation	white base is	deviation		(%TiO ₂ , Purity		COA from			formulation	(13/9/02)					
	deviation from			whiteness)		supplier			by using only						A. C.
	batch to batch					(This raw			TiO ₂ TR 92						
······						material was									
						specified as our									
	-					specification)									
			7	Weight of each	2	No inspection	9	126	Random	Raw					
				TiO ₂ packaging		but it was			checking	Material					
						guarantee by				(10/9/02)					
						Supplier									
	White base that	Color	7	Dust from	3	Visual	8	168	Set PM plan	Maintenance					
	color strength	deviation	· · ·	dust suction		inspection		100	in dust suction	(10/9/02)					•••••
	deviate from		+						nine	(10/2/02)					
	standard		+		-				F-F-					·	
			7	No color strength	0	No control	0	567	Set up work						
			+	control for white	9		9	507	instruction for	(10/9/02)					
			+	base					color strength	(10/ 9/02)					4 (0)-) =
	-		+	0430			-		control						
	· · · · · · · · · · · · · · · · · · ·		+						Specific color	Process Eng					
			-						strength of	(10/9/02)	numero estatemente con				
							-		white base						
					-				in 20-25%						-
·					-		-		111 20-23 /0						1
					-		-				1110				
	<u> </u>	Score		S= Severity	+	O= Occurrence		D= D	etection	RPN= SxOxD			1	L	

PROCESS FM	EA (Potential Failure	Mode and Ef	fect A	nalysis in process)											
Process Name Product Name Responsible pe Approved by Team	: Raw material : Alkyd rson : Process Engine : Lab Manager : Pivawat R., W	preparation eer /atcharin S., S	Surin	Supplied by Received by Documented Approved da P., Sawitree L., Suk	PFMEA Number : 02/001 FMEA Date (Orig.) : 5/4/2002 FMEA Date (Rev.) : Page 2 of 9 :										
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Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	0	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action	Action R	O	D	R P N
White base	Long drying	Color	7	Quality of binder	7	No control	8	392	Set up work	QC					
preparation	time of white	deviation		(long drying time					instruction to	(10/9/02)					
	base			of binder)					investigate						
									before using						
			7	Inaccuracy of	6	No calibration	8	224	Set up work	Process Eng.					
				cube applicator					instruction for	(10/9/02)				l .	
									calibration						
					-				Set up	Process Eng.					
					-				cal. schedule	(10/9/02)					
			7	Inaccuracy of	3	No calibration	9	189	1. Set up work	Process Eng.	a dana 3000000				
				drying time					instruction for	(13/9/02)					
				recorder					calibration						
									2. Set up	Process Eng.					
									ccalibration	(13/9/02)					
									schedule						
			-	Ventilation	4	No increation	0	276	1 Charle floor	Maintener			-		
				ventilation	0	INO inspection	0	330	T. Check now	(12/0/02)					
				system in drying					I Tale	(13/9/02)					
									2. Set PM for						
				2000					ventilation		****	-			
													-		1
		······································		•											+
							1	1							
		Score		S= Severity	1	O= Occurrence	[D=D	Detection	RPN = SxOxD					

PROCESS FM	EA (Potential Failure	Mode and Eff	ect A	nalysis in process)											
Process Name Product Name Responsible pe	: Raw material j : Alkyd rson : Process Engine	preparation eer		Supplied by Received by Documented	: : by :	Grinding section Finting section Piyawat R.				PFMEA Number FMEA Date (Ori FMEA Date (Rev	: 02/001 ig.) : 5/4/20 v.) :	l)02			_
Approved by	: Lab Manager	atcharin S S	urin	Approved da	ite :	6/7/2002 P Wiroth S Ch	akcha	i N		Page 3 of 9					
Team	. Fiyawat K., W	atenarin 5., 5	urm	1 ., Sawin ee L., Sur	ka ii ya	1., whom 5., en	JACHA								
Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	0	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion	Action	Action R S	O	D	R P N
White base	Long drying	Color	7	No checking	6	No control	8	336	Install the	Maintenance		+	┝──┦		<u> </u>
preparation	time of white	deviation	+ '	the RH in the lab				550	RH controller	(13/9/02)					
proputation	base							a a a a a a a a a a a a a a a a a a a	in the laboratory						
			7	No re inspection	6	Specify in work	4	168	Set training	OC				namm - ma	
				after adjusting		instruction			Course	(10/9/02)					
				drying time			-								
Tinter	Color strength of	Color	7	Specification	10	Control by	8	560	Revise	Process Eng.					
preparation	Tinters are too	deviation		of color strength		formulation			specification	(13/9/02)					
	board (±10%)			control are too					for controlling						
				board					from +/-10%						
									to ±5%						
White base	Skinning of white	Quality of	7	Closing system	2	No control	9	126	1. Set up	Production					
and neutral	and neutral base	Paint in		for storage tank					preventive	(13/9/02)					
base storage		terms of		is low efficiency					maintenance						
		fineness													
				n na sunna sun	_				2. Training	Production					
										(13/9/02)					
					-										
			-					-							
			1											1	
		Score		S= Severity		O= Occurrence		D=D	etection	RPN = SxOxD					

PROCESS FIMI	· Paw material	propagation		Supplied by		Crinding soction				DEMEA Number	. 07/001	1			
Product Name	: Alkyd	preparation		Received by	· : '	Finting section				FMEA Date (Ori	ig.) : 5/4/20	1 002			
Responsible per	son : Process Engine	er		Documented	by :	Piyawat R.				FMEA Date (Re	v.) :				
Approved by	: Lab Manager			Approved da	te :	6/7/2002				Page 4 of 9					_
Team	: Piyawat R., W	atcharin S., S	urin	P., Sawitree L., Suk	anya	P., Wiroth S., Che	okcha	i N.		-					
Process Function	Potential Failure Mode	Potential	S	Potential cause(s)/	0	Current process	D	RPN	Recommended	Responsibility		Action I	Result		
and Requirement		Effect(s) of Failure		Mechanism(s) of Failure		controls			Action(s)	& Target Completion Date	Action	S	0	D	R P N
White base	Skinning of white	Quality of	7	Leakage of seal	2	No control	8	112	1. Set up	Production		_			
and neutral	and neutral base	Paint in		of the lid					preventive	(13/9/02)					
base storage		terms of							maintenance						
		fineness													
									2. Training	Production					
							-			(13/9/02)					
Tinter	Settling of tinter	Color	7	Tinter level is	3	No control	9	189	Set up the min.	Process Eng					
storage		deviation		lower than level	1				level of tinter	(13/9/02)					1
-Buffer tank				of impeller					in buffer tank					•····	
-Tinter tank				•											
	and when we address to the second states of the second states of the second states of the second states of the		7	Circulation time	5	Set up and	4	140	Revise to	Maintenance			1		
				of tinter is not		control at PLC			Stirring every	(13/9/02)					
				suitable					20 min						
			7	Stirring system	7	No control	10	490	Set up Max and	Process Eng.					
				is not good					Min of tinter	(13/9/02)					-
				enough to stir											
				tinter											
Tinter	Settling of tinter	Color	7	Operator does not	2	No control	9	126	Set up the work	Production					
storage	×	deviation		stir before using			-		instruction	(10/9/02)					
-Pail															
													-		-
	a														
		Score		S= Severity		O= Occurrence	+	D= D	l etection	RPN= SxOxD					⊥

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PROCESS FM	EA (Potential Failure	Mode and Eff	fect A	analysis in process)					· · · · · · · · · · · · · · · · · · ·						
Process Name Product Name Responsible per Approved by	: Raw material : Alkyd rson : Process Engine : Lab Manager	preparation eer		Supplied by Received by Documented Approved da		PFMEA Number : 02/001 FMEA Date (Orig.) : 5/4/2002 FMEA Date (Rev.) :									
Team	: Piyawat R., W	'atcharin S., S	Surin	P., Sawitree L., Suk	anya	P., Wiroth S., Cho	kcha	i N.		-					
Process Function	Potential Failure Mode	Potential	5	Potential cause(s)/		Current process		PPN	Recommended	Perponsibility		Action E	ecult		
and Requirement		Effect(s) of Failure		Mechanism(s) of Failure		controls	D		Action(s)	& Target Completion Date	Action	S	0	D	R P N
Tinter	Skinning of tinter	Color	7	Level of tinter	3	Set up minimum	9	189	Set up the min	Process Eng		_			
storage		deviation		is nearly the same		stock of tinter			level of tinter	(13/9/02)					
Buffer tank		and		level of impeller	ļ	at PLC			in buffer tank						
Tinter tank		quality of													
		Paint in	7	Circulation pipe	9	No control	8	504	1. Modify pipe	Maintenance					
		terms of		is too high					pipe extension						
		fineness							2. Set new min.	Process Eng.					
									stock	(13/9/02)					
	10 April 10		7	Tank is dirty	1	No control	0	252	Set un cleoning	Production					
			/	from dru skin of	4		9	252	Set up cleaning	(12/0/02)					
1				tinter	• •••••				procedure	(13/9/02)					-
			1		•				Set up cleaning	Production					-
									schedule	(13/9/02)					
Tintan	E	C-1-r		A		NT- 4 1		202		D					
1 IIItel		doviation	/	Accuracy of	/		ð	392	Create short	Process					
weigning	weign	deviation		Eull machine					IOIT IOI	(13/9/02)					
	··· •·································			Full machine					calibration						
									during loading						
		•••• •••••••••••••••••••••••••••••••••							I inter into tank						
Tinting	Starting	CIE of	7	No verification	9	No control	9	567	Revise new	Color Eng.					
formulation	formulation is	color is		formulation					formulation	(13/9/02)					
<u></u>	not good	high		before implement					sheet with						• • • • • • • • • • • • • • • • • • •
				in production					verification						
	· · · · · · · · · · · · · · · · · · ·														
		Score		S= Severity		O = Occurrence		D = D	etection	RPN= SxOxD			I		

PROCESS FMI	EA (Potential Failure	Mode and Ef	fect A	nalysis in process)											
Process Name Product Name Responsible per Approved by	: Raw material : Alkyd rson : Process Engine : Lab Manager	preparation		Supplied by Received by Documented Approved da		PFMEA Number : 02/001 FMEA Date (Orig.) : 5/4/2002 FMEA Date (Rev.) :									
Team	: Piyawat K., w	atcharin S., S	Surin	P., Sawifree L., Su	kanya	P., wiroth S., Ch	okcha	u N.							
Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	0	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action	Action R S	O	D	R P N
Tinting m/c	Uncleanness of	Color	7	Brush for	6	Visual	3	126	Modify the	Production					
container	tinting m/c	deviation		cleaning is not		inspection			equipment to	(13/9/02)					
preparation				suitable					match with						
									cleaning						
								••••••••••••••••••••••••••••••••••••••	- mail						
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	1 Mar		_												

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							_								
								 			9 - 1 martin - 2000 100 - 2000 100				
							-								
	I	Score	-	S= Severity		O = Occurrence		D = D	etection	$\frac{ }{ RPN = SxOxD }$					

PROCESS FM	EA (Potential Failure	Mode and Eff	fect A	nalysis in process)											
Process Name Product Name Responsible per	: Mixing Proces : Alkyd	SS Ger		Supplied by Received by Documented	: : bv :	Grinding section Tinting section Pivawat R				PFMEA Number FMEA Date (Or FMEA Date (Re	: 02/001 ig.) : 5/4/20	0 02			
Approved by	Lah Manager	eer		Approved da	Uy. te•	6/7/2002				Page 6 of 9	v.)				_
Team	· Pivawat R W	Jatcharin S	Surin	P Sawitree L. Suk	anva	P Wiroth S Ch	hkcha	iN							
			,	1 (,) a () () () ()											
Process Function	Potential Failure Mode	Potential	S	Potential cause(s)/	0	Current process	D	RPN	Recommended	Responsibility	-	Action F	lesult		· · · ·
and Requirement		Effect(s) of Failure		Mechanism(s) of Failure		controls			Action(s)	& Target Completion Date	Action	S	0	D	R P N
Mixing	Inhomogeneous	Color	7	Stirring time does	3	Specify into	7	147	Create short	Color Eng.					
	paint in mixing	deviation		not suitable		the formulation			form	(13/9/02)					
	stage														
	statut			and a second second second											
					-		-								
					-										
														() ()	
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		-													
														•	
											W				.
		_													
			-												
					-		-	-		to the second					·
• • • • •		Score		S= Severity		O= Occurrence		D= D	letection	RPN= SxOxD				L	<u> </u>

PROCESS FM.	EA (Potential Failure	Mode and En	tect A	(nalysis in process)								-			
Process Name	: Color panel pr	reparation		Supplied by	:	Grinding section				PFMEA Number	: 02/001	l			
Product Name	Function Potential Failure Mode Function Potential Failure Mode			Received by	:	Tinting section				FMEA Date (Or	ig.) : 5/4/20)02			
Responsible pe	rson : Process Engine	eer		Documented	by :	Piyawat R.				FMEA Date (Re	v.) :				_
Approved by	: Lab Manager			Approved da	te :	6/7/2002				Page 7 of 9					
leam	: Piyawat R., W	atcharin S., S	Surin	P., Sawitree L., Suk	anya	P., Wiroth S., Ch	okcha	u N.							
Process Function	Potential Failure Mode	Potential	s	Potential cause(s)/	0	Current process	D	RPN	Recommended	Responsibility		Action F	lesult		
and Requirement		Effect(s) of Failure		Mechanism(s) of Failure		controls			Action(s)	& Target Completion Date	Action	S	0	D	R P N
Making	Bubble on paint	Color	7	Film is too thick	7	WI does not	9	441	Revise WI	Color Eng.	and a second				
draw down	film	deviation				suit with	1	1		(13/9/02)					
panel as						paint system								1	
following							1							1	
specification							1								
	Low hiding power	Color	7	Inaccuracy of	2	No calibration	9	126	1. Set up work	Process Eng.				1	
	of paint film	deviation		applicator		······································			iinstruction for	(13/9/02)					
######################################			1		Continues				calibration						
								1	2. Set up	Process Eng.					
					1				calibration	(13/9/02)					
			1				*******		schedule	·····					1
			7	Low skill operator	3	Training	5	105	Set up training	Color Eng.					
		9								(13/10/02)					
			1				1								
	Wrinkle color	Color	7	Inaccuracy of	2	No calibration	9	126	1. Set up work	Process Eng.					
	panel	deviation	1	applicator			1		iinstruction for	(13/9/02)					
							1		calibration						1
			1				1		2. Set up	Process Eng.					
		······	1			1			calibration	(13/9/02)					-
			1						schedule						
	······································	·······	1				1								1
					-										-
		· · · · · · · · · · · · · · · · · · ·			1										-
													an e Sentania		
							+								-
						······································	-								-
	.k	Score	<u> </u>	S= Severity		O = O c c u r r e n c e	1	D = D	letection	RPN = SvOvD			L	L	1

PROCESS FMI	A (Potential Failure	Mode and Eff	ect A	nalysis in process)		-									
Process Name Product Name Responsible per Approved by	: Color panel pro : Alkyd son : Process Engine : Lab Manager	eparation eer		Supplied by Received by Documented Approved da	: : ' by : .te :	Grinding section Tinting section Piyawat R. 6/7/2002				PFMEA Number FMEA Date (Or: FMEA Date (Re Page 8 of 9	: 02/001 ig.) : 5/4/20 v.) :	002			
Team	: Piyawat R., W	atcharin S., S	urin	P., Sawitree L., Suk	anya	P., Wiroth S., Cho	okcha	i N.							
Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	0	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action	Action F	O	D	R P N
Keep it into	Dust on paint film	Color	7	Cleanness of	7	No Control	9	441	Set up schedule	Color Eng.					
drying		deviation		drying cabinet					for cleaning	(10/09/02)					
cabinet						-10-11-11-11-11-11-11-11-11-11-11-11-11-									
			7	Ventilation fan	6	No control	9	504	Install the new	Maintenance					[
				without filter			-		ventilation fan	(13/09/02)					
						······································			with filter						
	T 1 · · · ·	C.1	-	NT		Ne increation	0	226	1 Charle flow	Maintananaa					
	Long drying time	Color	/	ventilation	0	No inspection	8	.3.30	1.Uneck now	Maintenance					
	of panel	deviation		system in drying			-		2 Set DM for	(13/09/02)		-			
						_	-		2.Set FW IOI						
				good			-		ventilation						
Curing film	Film is not fully	Color	7	Іп ассигасу	4	No control	9	252	1. Set up work	Process Eng.					
in oven	cure	deviation		temperature in			1		iinstruction for	(13/9/02)	summing summing				
	oure			oven					calibration						
				a a ann an		······································			2. Set up	Process Eng.					
			1	and an					calibration	(13/9/02)				••••••	
			1				1		schedule						
		angeleiten zu sin einen geheinen.													
		· · · · · · · · · · · · · · · · · · ·	7	Amount paper	4	Internal inform	7	196	Internal training	Color Eng.					
			1	panel in oven						(13/9/02)					
			1	is too much											
			1												
			1				1								
			1		-										
	• • • • • • • • • • • • • • • • • • •				1	-									
			1												
		Score		S= Severity		O= Occurrence		D=D	etection	RPN = SxOxD				_	

PROCESS FME	EA (Potential Failure	Mode and Eff	fect A	nalysis in process)											
Process Name	: Color panel pre	eparation		Supplied by	: (Grinding section	-			PFMEA Number	: 02/00	1			_ · _ ·
Product Name	Alkyd			Received by	: '	Finting section				FMEA Date (Or	ig.) : 5/4/2	002			
Responsible per	son : Process Engine	er		Documented	l by :	Piyawat R.				FMEA Date (Re	v.) :				_
Approved by	: Lab Manager			Approved da	ite :	6/7/2002				Page 9 of 9					_
Team	: Piyawat R., W	atcharin S., S	Surin	P., Sawitree L., Suk	canya	P., Wiroth S., Ch	okcha	i N.							
Process Function	Potential Failure Mode	Potential	S	Potential cause(s)/	0	Current process	D	RPN	Recommended	Responsibility		Action R	esult		
and Requirement		Effect(s) of Failure		Mechanism(s) of Failure		controls			Action(s)	& Target Completion Date	Action	S	0	D	R P N
Curing film	Wrinkle film	Color	7	Temperature in	2	No control	9	126	1. Set up work	Process Eng.					
in oven		deviation		oven is higher					iinstruction for	(13/9/02)					
				than standard					calibration						
									2. Set up	Process Eng.					
									calibration	(13/9/02)					
									schedule						
Curing film	Film vellowing	Color	7	Temperature in	2	No control	9	126	1. Set up work	Process Eng.					
in oven		deviation		oven is higher	-				iinstruction for	(13/9/02)					
in oron				than standard					calibration	(17 Sand Miccoll (1997)			
									2. Set up	Process Eng.					
									calibration	(13/9/02)					
									schedule						
	- Marine - Minimum - Mi													antin -	
			-												
			-												
										*** 174					
			-				-								
			1												
					-										
		Score	-	S= Severity	-	O= Occurrence		D= D	etection	RPN= SxOxD			_		

Table 4.3:Summary the process FMEA that RPN is higher than 100 (90% confidence) in detail

Based on analysis, it was found that there are 33 high-risk area must be addressed. The next step is that all of RPN are ranked from the highest to lowest to set up the priority of action. It has shown as the table 4.3.

It was found that the raw material preparation process in terms of color strength (No control) and starting tinting formula (high CIE) show highest score. So they should be taken the action first because it impact directly to color adjustment. Otherwise, the tinting process in tinting section is also needed to adjust and create to the standard to reduce the RPN.

PROCESS FN	MEA (Potential Failu	re Mode and E	ffect	Analysis in process)											
Process Name Product Name Responsible p Approved by Team	e : Raw materia e : Alkyd person : Process Engi : Lab Manage : Piyawat R.,	ll preparation neer er Watcharin S.,	Suri	Supplied by Received b Documente Approved c in P., Sawitree L., Su	/ y ed by late 1kany	: Grinding section : Tinting section : Piyawat R. : 6/7/2002 a P., Wiroth S., C	hokcl	hai N.		PFMEA Numb FMEA Date (C FMEA Date (F Page 1 of 23	er : 02/0 Drig.) : 5/4 / Lev.) :	01 2002			
							_	_							
Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	0	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action	Action F	O O	D	R P N
White base	White base that	Color	7	No color strength	9	No control	9	567	1. Set up work	QC					
preparation	color strength	deviation		control for white					instruction for	(10/9/02)					
	deviate from			base					color strength						
	standard								control						
									2. Specific color	Process Eng.					
									strength of	(10/9/02)					
									white base						
					-				in 20-25%		maa ayyy a 11 a 11 a 11 a 11 a 11 a 11 a				
Tinting	Storting	CIE of	7	No verification	0	No control	0	567	Device new	Color Eng					
formulation	formulation is	cile of	<i>'</i>	formulation				507	formulation	(13/9/02)					
	not good	bigh	a	hefore implement					Sheet with	(15/5/02)					
	not good	Ingn		in production					verification						
									vermeation					<u></u>	
Tinter	Color strength of	Color	7	Specification	10	Control by	8	560	Revise	Process Eng					
nreparation	Tinters are too	deviation	<u> </u>	of color strength	10	formulation			specification	(13/9/02)					-
preparation	$\frac{1111(c13)a1c}{board}$	Geviation		control are too		Tommunution			for controlling						-
	00alu (±1076)		-	board				-	from $\pm/-10\%$						
			+						$t_0 + 5\%$						
								-	10 25 70		91000000000000000000000000000000000000				
Tinter	Skinning of tinter	Color	7	Circulation pipe	9	No control	8	504	1. Modify pipe	Maintenance			•		
Storage	Jan	deviation	<u> </u>	is too high			1		Pipe extension						1
-Buffer tank		and	-						2. Set new min.	Process Eng.	····				
-Tinter tank		fineness of			-				stock	(13/9/02)			• • • • • • • • • • • • • • • • • • • •		
		paint													
									-						-
															Į
		Score		S= Severity		O= Occurrence		D = D	etection	RPN = SxOxD					

PROCESS FN	IEA (Potential Failur	e Mode and E	ffect	Analysis in process)										-	-
Process Name Product Name Responsible p Approved by Team	: Raw materia : Alkyd erson : Process Engin : Lab Manage : Piyawat R., V	l preparation neer r Watcharin S.,	Suri	Supplied by Received b Documente Approved c n P., Sawitree L., Su	/ od by late Ikany	: Grinding section : Tinting section : Piyawat R. : 6/7/2002 /a P., Wiroth S., C	hokcl	nai N.		PFMEA Number FMEA Date (Or FMEA Date (Re Page 1 of 23	: 02/00 ig.) : 5/4/20 v.) :	1 D 02			_
Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	0	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Ac	tion Res	sult		
Keep it into	Dust on paint film	Color	7	Ventilation fan	6	No control	9	504	Install the new	Maintenance					
drying cabinet		deviation		without filter			-		fan with filter	(13/09/02)					
Tinter	Settling of tinter	Color	7	Stirring system	7	No control	10	490	Set up Max and	Process Eng.		-			
Storage		deviation		is not good					Min of tinter	(13/9/02)					
-Buffer tank				enough to stir											
-Tinter tank				tinter										A661.1	
Making	Bubble on paint	Color	7	Film is too thick	7	WI does not	9	441	Revise WI	Color Eng.					
draw down	film	deviation	<u> </u>			suit with				(13/9/02)					
panel as following specification						paint system									
Keen it into	Dust on paint film	Color	7	Cleanness of	7	No Control	9	441	Set un schedule	Color Eng.					· CriteX
drving		deviation	+	drving cabinet	-				for cleaning	(10/09/02)					
cabinet															
White base	Long drying	Color	7	Quality of binder	7	No control	8	392	Set up work	QC					
preparation	time of white	deviation		(long drying time					instruction to	(10/9/02)					
	base			of binder)					investigate						
									before using						
· · · · · · · · · · · · · · · · · · ·		Score		S= Severity		O= Occurrence		D= D	Detection	RPN= SxOxD					

PROCESS FI	MEA (Potential Failu	re Mode and H	Effect	Analysis in process)											
Process Nam Product Nam Responsible J Approved by Team	e : Raw materia e : Alkyd person : Process Engi : Lab Manage : Piyawat R.,	al preparation neer er Watcharin S.	, Sur	Supplied b Received b Document Approved in P., Sawitree L., S	y oy ed by date ukany	: Grinding section : Tinting section : Piyawat R. : 6/7/2002 ya P., Wiroth S., C	hokc	hai N.		PFMEA Numb FMEA Date (C FMEA Date (R Page 2 of 23	er : 02/0 Drig.) : 5/4/ Rev.) :	01 2002			
Process Function and	Potential Failure Mode	Potential Effect(s) of	S	Potential cause(s)/ Mechanism(s) of	0	Current process controls	D	RPN	Recommended Action(s)	Responsibility &	Action	Action F	lesult		
Requirement		Failure		Failure						Target Completion Date					P N
Tinter	Error of tinter	Color	7	Accuracy of	7	No control	8	392	Create short	Process					
weighing	weigh	deviation		dispenser in					form for	(13/9/02)					
				Full machine					calibration						
									during loading Tinter into tank						
White base	Long drying	Color	7	No checking	6	No control	8	336	Install the	Maintenance		-			
preparation	time of white	deviation		the RH in the lab					RH controller	(13/9/02)	Arranges of the second descent second s				
	base								In the laboratory						
Keep it into	Long drying time	Color	7	Ventilation	6	No inspection	8	336	1. Check flow	Maintenance					
drying	of panel	deviation		system in drying	····· • • • • • • • • • • • • • • • • •	and control			rate	(13/9/02)					
cabinet			•	cabinet is not			1		2. Set PM for						
				good					ventilation						
Keep it into	Long drving time	Color	7	Ventilation	6	No inspection	8	336	1.Check flow	Maintenance					
drying	of panel	deviation		system in drying		and control			rate	(13/09/02)		- tone deller terrerend			-
cabinet	-			cabinet is not					2.Set PM for						
				good					ventilation						
Curing film	Film is not fully	Color	7	In accuracy	4	No control	9	252	1 Set up work	Process Eng					
in oven	cure	deviation		temperature in	†		+		instruction for	(13/9/02)				1	
				oven					calibration						
									2 Set up	Drocess Enc		·· ···			-
									2. Set up	(13/0/02)					
					_				schedule	(15/9/02)			·		-
						0-0-0	-						******		
		Score	1	S= Severity	1	$\cup = \bigcirc $	1	D=D	relection	KPN = SXUXD					

PROCESS F	MEA (Potential Failu	re Mode and F	Effect	Analysis in process)											
Process Nam Product Nam Responsible Approved by Team	e : Raw materia e : Alkyd person : Process Engi : Lab Manage : Piyawat R.,	ll preparation neer er Watcharin S.,	, Suri	Supplied b Received b Document Approved in P., Sawitree L., S	y oy ed by date ukany	: Grinding section : Tinting section : Piyawat R. : 6/7/2002 ya P., Wiroth S., C	hokc	hai N.		PFMEA Num FMEA Date (FMEA Date (Page 3 of 23	ber : 02/00 (Orig.) : 5/4/2 (Rev.) :)1 :002			
Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of	S	Potential cause(s)/ Mechanism(s) of	0	Current process controls	D	RPN	Recommended Action(s)	Responsibility &	Action A	ction F	O	D	R
		Tanure		Tanuic						Completion Date					r N
Tinter	Skinning of tinter	Color	7	Tank is dirty	4	No control	9	252	Set up cleaning	Production	As the				
Storage		deviation	ļ	from dry skin of					procedure	(13/9/02)	recommend				
-Buffer tank		and		tinter				_		-					
-Tinter tank		quality of							Set up cleaning	Production					
		paint in							schedule	(13/9/02)					
		terms of		•					· · · · · · · · · · · · · · · · · · ·						
		fineness													
1111															
white base	Long drying	Color	/	Inaccuracy of	6	No calibration	8	224	1. Set up work	Process Eng.	As the				
preparation	time of white	deviation		cube applicator					instruction for	(10/9/02)	recommend				
	Dase								calibration						
									2 Satur	Drocoss Eng	Acthe				-
								-	2. Set up	(10/0/02)	As the				
									schedule	(10/9/02)	Tecommenu				
		-							schedule	· · · · · · · · · · · · · · · · · · ·					-
Curing film	Film is not fully	Color	7	A mount naner	4	Internal inform	7	106	Internal training	Color Eng	As the				
in oven	cure	deviation	<u> </u>	nanel in oven				170	Internal training	(13/9/02)	recommend	**			
				is too much				-		(15/5/02)			Bishislismi		
White base	Long drying	Color	7	Inaccuracy of	3	No calibration	9	189	1. Set up work	Process Eng.	As the				
preparation	time of white	deviation		drying time					instruction for	(10/9/02)	recommend				
	base			recorder					calibration						
									2 Set up	Process Eng	As the				
									calibration	(10/9/02)	recommend	-			-
					-				schedule	(10/9/02)	recommend				- (
									sonouic						
		Score		S= Severity	1	O= Occurrence	†	D= D	etection	RPN= SxOxD)	1	1	L	1

PROCESS FM	IEA (Potential Failur	re Mode and E	ffect	Analysis in process)											
Process Name Product Name Responsible pe Approved by Team	: Raw materia : Alkyd erson : Process Engin : Lab Manage : Piyawat R., V	l preparation neer r Watcharin S.,	Suri	Supplied by Received by Documente Approved d n P., Sawitree L., Su	d by ate kany	: Grinding section : Tinting section : Piyawat R. : 6/7/2002 'a P., Wiroth S., Cl	nokcl	nai N.		PFMEA Num FMEA Date (FMEA Date (Page 5 of 23	ber : 02/00 Orig.) : 5/4/2 Rev.) :	01 2002			
							<u> </u>	DDV			r				
Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	0	Current process controls	D	RPN	Action(s)	Responsibility & Target Completion Date	Action	S	O	D	R P N
Tinter	Settling of tinter	Color	7	Tinter level is	3	No control	9	189	Set up the min.	Process Eng	As the				
storage		deviation		lower than level					level of tinter	(13/9/02)	recommend				
-Buffer tank				of impeller					in buffer tank						
-Tinter tank															
Tinter	Skinning of tinter	Color	7	Level of tinter	3	Set up minimum	9	189	Set up the min	Process Eng	As the			i	
storage		deviation		is nearly the same		stock of tinter			level of tinter	(13/9/02)	recommend				
Buffer tank		and		level of impeller		at PLC			in buffer tank						
Tinter tank		quality of													
		Paint in													
		terms of													
		fineness													
White base	White base that	Color	7	Dust from	3	Visual	8	168	Set PM plan	Maintenance	As the				
preparation	color strength	deviation		dust suction		inspection			in dust suction	(10/9/02)	recommend				
	deviate from								pipe						
	standard							-							
	· · · · · · · · · · · · · · · · · · ·		1												
White base	Long drying	Color	7	No re inspection	6	Specify in work	4	168	Set training	QC	As the				
preparation	time of white	deviation		after adjusting		instruction			Course	(10/9/02)	recommend				
	base			drying time	-										
		0.1		· · · · · · · · · · · · · · · · · ·				1.47			A = 4h =				
Mixing	Inhomogeneous	Color		Stirring time does	3	Specify into	/	14/	Create short	Color Eng.					
	paint in mixing	deviation		not suitable		the formulation			form	(13/9/02)	recommend				ļ
	stage														
										-					
		Score		S= Severity		O= Occurrence		D= D	letection	RPN= SxOxD	1	1			<u> </u>

PROCESS FN	MEA (Potential Failu	re Mode and H	Effect	Analysis in process)											
Process Name Product Name Responsible p Approved by Team	e : Mixing Proc e : Alkyd person : Process Engi : Lab Manage : Piyawat R.,	ess neer er Watcharin S.	, Sur	Supplied b Received b Document Approved in P., Sawitree L., S	y oy ed by date ukan y	: Grinding section : Tinting section : Piyawat R. : 6/7/2002 ya P., Wiroth S., C	l Chokcl	hai N.		PFMEA Numl FMEA Date (FMEA Date (Page 6 of 23	ber : 02/00 Orig.) : 5/4/2 Rev.) :	1 2002			
Process Function and Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential cause(s)/ Mechanism(s) of Failure	0	Current process controls	D	RPN	Recommended Action(s)	Responsibility & Target Completion	Action	ction F	Cesult O	D	R P N
			<u> </u>							Date		ļ	ļ'	<u> </u>	
Tinter	Settling of tinter	Color	7	Circulation time	5	Set up and	4	140	Revise to	Maintenance	As the				
-Buffer tank -Tinter tank		deviation		of finter is not suitable		control at PLC			20 min	(13/9/02)	recommend				
Tinter	Low hiding power	Color	7	Inaccuracy of	2	No calibration	9	126	1. Set up work	Process Eng.	As the				
storage	of paint film	deviation		applicator			·····		instruction for	(10/9/02)	recommend				
-Pail									calibration						
														[
									2. Set up	Process Eng.	As the				
								•	calibration schedule	(10/9/02)	recommend				
		<u></u>										•			
Making	Wrinkle color	Color	17	Inaccuracy of	2	No calibration	9	126	1. Set up work	Process Eng.	As the				
draw down	Panel	deviation		applicator					instruction for	(10/9/02)	recommend				
panel									calibration				-		
fallowing									2.0.		A = 41 -				
lonowing				······································					2. Set up	Process Eng.	As the	-			
specification									calibration	(10/9/02)	recommend				
									schedule						
Curing film	Wrinkle film	Color	7	Temperature in	2	No control	9	126	1. Set up work	Process Eng.	As the				
in oven		deviation	1	oven is higher					instruction for	(10/9/02)	recommend				
				than standard					calibration						
					_										
									2. Set up	Process Eng.	As the				
	· · · · · · · · · · · · · · · · · · ·						_		calibration	(10/9/02)	recommend				
							-		schedule						
		Score		S= Severity		O= Occurrence		D= D	Detection	RPN= SxOxD)				

PROCESS FN	MEA (Potential Failu	re Mode and E	ffect	Analysis in process)											
Process Name Product Name Responsible p Approved by	e : Color panel j e : Alkyd person : Process Engi : Lab Manage	preparation neer r		Supplied by Received b Documente Approved o	/ y ed by late	: Grinding section : Tinting section : Piyawat R. : 6/7/2002	Ì			PFMEA Num FMEA Date (FMEA Date (Page 7 of 23	ber : 02/00 Orig.) : 5/4/2 Rev.) :	1 002			
Team	: Piyawat R., Y	Watcharin S.,	, Suri	n P., Sawitree L., Su	ıkany	a P., Wiroth S., C	hokel	nai N.		-					
Process	Potential Failure Mode	Potential	S	Potential cause(s)/	0	Current process	D	RPN	Recommended	Responsibility	A	ction R	esult		
Function and Requirement		Effect(s) of Failure		Mechanism(s) of Failure		controls			Action(s)	& Target Completion Date	Action	S	0	D	R P N
White base	Skinning of white	Quality of	7	Closing system	2	No control	9	126	1. Set up	Production	As the				
and neutral	and neutral base	Paint in		for storage tank					preventive	(13/9/02)	recommend		_		
base storage		terms of		is low efficiency					maintenance						
		fineness										_	_		
									2. Training	(13/9/02)	As the recommend				
Tinter	Settling of tinter	Color	7	Operator does not	2	No control	9	126	Set up the work	Production	As the				
Storage		deviation		stir before using					Instruction	(9/10/02)	recommend				
-Pail									Training tinting	Process Eng.					
							-		operators						
Tinting m/c	Uncleanness of	Color	7	Brush for	6	-Visual	3	126	Modify the	Production	As the				
container	tinting m/c	deviation		cleaning is not		inspection			equipment to	(13/9/02)	recommend				
preparation				suitable					match with						
	-								cleaning						
				NY - 1 - C 1				120	D	D	0-1	s			_
White base	Color strength of			weight of each	2	INO Inspection	<u> </u>	120	Kandom	Matarial	Set up				
preparation	white base is			TIO ₂ packaging		Dui ii was			checking		wiand				
	deviate from					guarantee by				(10/9/02)	checking				
Gegraamsenverter	batch to batch					supplier					checking		-		
					-		-								
		-													
		Score		S= Severity		O= Occurrence		D= D	Detection	RPN= SxOxD)				J

PROCESS FN	IEA (Potential Failur	e Mode and E	ffect	Analysis in process)											
Process Name	: Color panel p	reparation		Supplied by		: Grinding section				PFMEA Num	ber : 02/00)1			
Product Name	Alkyd	-		Received by	/	: Tinting section				FMEA Date (Orig.) : 5/4/2	2002			
Responsible p	erson : Process Engin	neer		Documente	d by	: Piyawat R.				FMEA Date (Rev.) :				
Approved by	: Lab Manage	r		Approved d	ate	: 6/7/2002				Page 8 of 23					
Team	: Piyawat R., V	Watcharin S.,	Suri	in P., Sawitree L., Su	kany	a P., Wiroth S., C	hokch	1ai N.							
Process	Potential Failure Mode	Potential	S	Potential cause(s)/	0	Current process	D	RPN	Recommended	Responsibility	A	ction R	esult		
Function and		Effect(s) of		Mechanism(s) of		controls			Action(s)	&	Action	S	0	D	R
Requirement		Failure		Failure						l arget Completion Date					P N
Curing film	Film yellowing	Color	7	Temperature in	2	No control	9	126	1. Set up work	Process Eng.	As the				
in oven		deviation		oven is higher					instruction for	(13/9/02)	recommend				
				than standard				······	calibration						
									2. Sct up	Process Eng.	As the				
									calibration	(13/9/02)	recommend				
									schedule						
White base	Skinning of white	Quality of	7	Leakage of seal	2	No control	8	112	Set up	Production	As the			_	
and neutral	and neutral base	Paint in		of the lid					preventive	(13/9/02)	recommend				
base storage		terms of							maintenance						
		fineness													
Making	Low hiding power	Color	7	Low skill operator	3	Training	5	105	Set up training	Color Eng.	As the				
draw down	of paint film	deviation								(13/10/02)	recommend				
panel										-				_	
as the															
following															
specification															
		Score		S= Severity		O= Occurrence		D = D	Detection	RPN= SxOxD)				

Table 4.4:The RPN summary that rank from highest score to lowest score at 90% confidence

The FMEA team have meeting to generate the recommendation and action plan to reduce for each failure in process FMEA. It can conclude as following :

Table 4.5:The summary Action for FMEA Project

Production

:

Торіс	Due Date	Remark
1. Create preventive maintenance plan (PM P	lan)	
 Closing system for storage tank (Base and Holding Tank) 	13/9/02	To prevent the base skinning
• Leakage of seal of storage tank lid (Base and Holding Tank)	13/9/02	To prevent the base skinning
• Untight close of storage tank lid (Tinter Tank)	13/9/02	To prevent the tinter skinning
2. Set up work instruction		
Cleaning procedure for tinter tank/ cleaning schedule	23/9/02	To reduce risk of dry skinning of tinter tank
Cleaning procedure for buffer tank/ cleaning schedule	23/9/02	To reduce risk of dry skinning of tinter tank
• Operator does not stirring the tinter in pail before using (Tinter pail handleing)	10/9/02	To prevent the settling of tinter
4. Training		
Pot scale instruction	23/9/02	
Full machine instruction	23/9/02	
Cleaning procedure for tinter tank/ cleaning schedule	23/9/02	
• Cleaning procedure for buffer tank/ cleaning schedule	23/9/02	

Maintenance :

Торіс	Due Date	Remark
1. Create preventive maintenance pla	n (PM Plan)	
• Set up PM plan for dust suction pipe for dissolver	10/9/02	To prevent the contaminate of dust suction pipe with the batch
• Study the feasibility to modify the stirring system in tinter tank	10/9/02	Coordinate with Process Eng. Improve homogenous of tinter, and prevent settling
• Set up PM plan for ventilation system in drying cabinet	13/9/02	To ensure the ventilation system in drying cabinet
2. Miscellaneous		
• Revise stirring time in tinter tank from every 30 min to 20 min	13/9/02	To prevent the tinter setting
• Set the schedule of printing the record of PLC in terms of re circulation of buffer tank	13/9/02	To ensure that re circulation is working
• Install new ventilation fan with filter	13/9/02	To reduce dust on paint film.
• Install the Relative Humidity Controller	13/9/02	To control the drying time of white base and neutral base

Raw material :

Торіс	Due Date	Remark	
1. Create check sheet (Short form)			
• Create short form for raw material weight checking plan	10/9/02	To ensure the weight of TiO_2	

QC :

Торіс	Due Date	Remark		
1. Set up Work Instruction				
• Quality of binder in terms of drying time	10/9/02	To ensure quality of binder in terms of drying time		
• Work Instruction for color strength control in white base	13/9/02	To control the color strength of white base before releasing into tinting section		
2. Training				
• Draw down paint on drying time panel and re inspect after drying time adjustment	23/9/02	To ensure the drying time of white base and neutral base before release to tinting section		
Color strength control for white base	23/9/02	Coordinate with Process Engineer		
Color strength control for tinter	23/9/02	Coordinate with Color Engineer		

Color Engineer :

Торіс	Due Date	Remark		
1. Set up Work Instruction				
• Scaling instruction of paint in each container	13/9/02	To prevent unsuitable volume with tank		
• Create short form of speed, stirring time of paint	13/9/02	To ensure that paint is homogenous		
Revise work instruction of color panel preparation	13/9/02	Reduce error in color panel preparation		
• Revise the formulation sheet for new color (CIE, Verify)	13/9/02	Reduce correction time		
2. Miscellaneous				
• Set up the schedule for drying cabinet cleaning	13/9/02	To prevent the dust on paint film panel		
3. Training				
Basic for tinting	23/9/02			
• Speed and stirring time for each batch size	23/9/02			
Color panel preparation	23/9/02			

Process Engineer :

Торіс	Due Date	Remark		
1. Revise formulation				
• Specify the TiO ₂ TR-92 for Alkyd White Base	13/9/02	To control quality of paint		
• Specify the color strength for Alkyd White base at 20-25% to control the color quality	03/9/02	To control quality of paint		
 Revise the specification of tinters for controlling the color strength from ±10% to ±5% 	13/9/02	To control quality of tinter		
• Confirm the formulation for trial	23/9/02	To ensure the formulation before releasing in the production		
2. Set up Work Instruction				
• Calibration for Full machine after loading the new tinter into tank	13/9/02	To ensure the accuracy of tinter weigh during weighing		
• Calibration of applicator/ Set up the calibration schedule	10/9/02	To ensure the precision of applicator		
• Calibration of drying time recorder/ Set up the calibration schedule	13/9/02	To ensure the precision of drying time recorder		

	Торіс	Due Date	Remark		
2.	2. Set up Work Instruction				
•	Set up the minimum and maximum level of tinter in tinter tank and buffer tank	13/9/02	To reduce the skinning problem and create homogenous of SI tinter		
•	Calibration thermometer for production line/ Set up the calibration schedule	13/9/02	To ensure the precision of thermometer		
•	Calibration the temperature in oven/ Set up the calibration schedule	13/9/02	To ensure the precision of temperature in oven		
3. Training					
•	Basic of paint processing	23/9/02			

After action plan is done, the FMEA team implements the FMEA in tinting section in October 2002. We collect the data of amount correction times and process time in tinting section compare with before implement the FMEA.