CHAPTER 5

IMPLEMENTATION

This chapter describes an implementation for the chosen RPN number. We start at the highest RPN number to the lowest RPN number and implementations are followed by the recommendation in the decision tree diagrams that aim to reduce the defective product for a plastic injection process.

5.1 Mould design

According to the Why-Why analysis, the implementation team realises the mould design is affect on the setting time between the front and the rear injected resin. Therefore, we decide to redesign the mould of the selected product. The time setting between the front and the rear injected resin is equal if we can inject nitrogen gas at the mould. In the beginning, we contact to the owner of the mould. We cannot redesign the mould ourselves because the mould of the selected product is a customer's property. We are pirate if we do not receive permission from the owner. We describe the effect of mould design to the customer and ask for permission to do so. In addition, we explain the benefit for them such as time production, and the modernized mould design. If the customer is interested and thinks about the allowance, after that, we look forward to hear from them an take an action. Six weeks ago, we contact them again and ask the detail. The result is they do not need to improve their mould design. In their opinion, the present design is the best and they do not to waste money and time on this topic. They think we can operate on this design although they do not do such a thing. Moreover, there is not any advantage for them to edit. Therefore, we cannot improve the mould design in any way. Finally, we decide to improve the shut off valve instead because it is a company's property. However, the RPN number on this stays the same.

After the redesign mould is failed, the implementation team designs the experiences for the rest of recommendation in the decision tree diagrams. We starts at the shut off valve system by using mechanic-shut off valve instead of hydraulic-shut off valve. This experience test for the setting time between the front and rear injected resin. If it becomes better, the defective products will reduce. We test it in the first two weeks in September 2003. In addition, the rest parameters are fixed, such as use the same machine, same heaters, and gas option including the raw material receiving relies on the old procedure.

Next, we concentrated on the heaters' temperature experiment. We test it in last two weeks in September 2003. This experience is an observation and attention from the related personnel to the heater's temperature. We mention it on the original machine, which is the main machinery to produce the selected product. We operate it on the before condition of changing the shut off valve parameter. In this experience, we just looked after the

temperature and record it on the control graph every day. If it shows the error signal, we can improve it on time.

Then, we try to see the delayed time of gas injection on the full option machine. Therefore, we change to use the other machine that has a gas option and fix the other constant. For example, we use the hydraulic-shut off valve system, same heaters, same gas injection machine, and same raw material obtaining rule. However, the planning department plans to use the full option machine's schedule to operate the other product all the year. Therefore, we can run this experiment in 1-10 October 2003 because the time limitation.

Lastly, there are two experiences for the raw material receiving. First experiment, the raw material receiving should refer to the Military Standard 105E Level II 0.4% of acceptable quality level. Second experiment, we request the suppliers specify the qualification of raw material. However, the both experience is tested on the last period of the research study that is on the last two weeks in October 2003.

5.2 Shut off valve system

After we cannot redesign the mould, we are concentrated on the shut off valve system. The selected product can only use the shut off valve that can inject nitrogen gas at the needle. This is the side effect of mould design. We assign the engineer department is to take responsibility on this issue. They study in depth about the detail of the shut off valve system and try to tune in the speed of closing. The nitrogen gas cannot leak to meet the melted resin in the shut off valve and the different of setting time between the front and the rear injected resin are reduced if the speed of closing is quick enough. Two weeks ago, they cannot adjust the closing speed. They give the result, which there is a cushion for bump against of piston in a hydraulic system. If we still use the shut off valve hydraulic system, we cannot tune the closing speed as many as the present speed. They advise the improvement team to change to use the mechanic shut off valve system in the next meeting. They recognize the mechanic system is better than the hydraulic system. Both of opening and closing speed of mechanic system is very sensitive than the hydraulic system. Therefore, we believe them and decided to change the shut off valve system from hydraulic to mechanic system. We have two weeks for trial this experience because the supplier gives the sample part to us for two weeks. We will order this equipment if the result of experience is good. However, the other parameters are fixed to constant such as using the original machine to operates as before condition. For example, speed of screw rotation is 95 RV%; speed of resin injection is 80 IV%; temperature of heater number one to number six is 210, 240 250, 250, 250, 250, respectively; raw material mixing ratio is followed the UL standard; raw material obtaining with same action; same gas injection machine. The result of defect in the production line after we change to use the mechanic system is shown in the following figure.

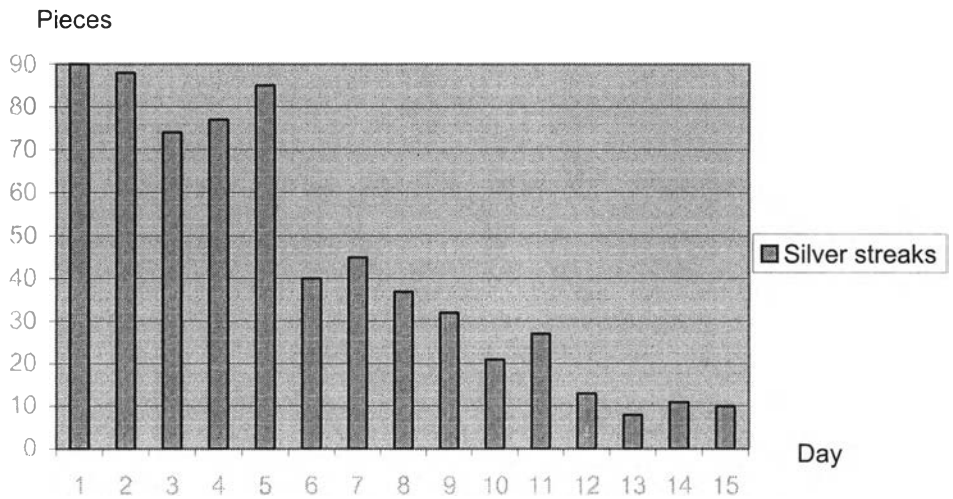


Figure 5.1: Silver streaks in September 2003 by using new shut off valve system

The figure above illustrates the silver streaks defect in the first two weeks in September 2003. We set the operation in September as 1200 pieces per day and acceptable of silver streaks is 5% of the production. That means an amount of acceptable mean is 60 pieces per day. During the first week, the defect is over 5% and the highest is 7.5% on the 1st day. In contrast, it reduces to 3.33% on the 6th day using the mechanic system and the lowest is 0.67% on 13th day. The trend of defect will reduce steadily while we using the new shut off valve system and the RPN number is reduced as well.

5.3 Continual maintenance

The continual maintenance can become from the attentive users. If the related personnel pay attention and observe the machine and its component, it can reduce its part or machine out of order, especially the heater. If the temperature of the heater cannot reach the set point, it will affect silver streaks because the melted resin becomes sticky and difficult to inject. In contrast, being overheated has an effect on brown streaks as well because the melted resin is burnt in the cylinder part of machine and we will drain it off. Therefore, the improvement team assigns the chief of production responsible to brief all production personnel for look after the heaters. Time limitation of this topic is two weeks because there are a lot of works in every staff's hand. He briefs the workers and listens to the yesterday's result from them in every morning in September 2003. In addition, we use the research's machine for observing with the original condition such as speed of screw rotation is 95 RV%; speed of resin injection is 80 IV%; raw material mixing ratio is followed the UL standard; raw material mixing ratio is followed the UL standard; raw material obtaining with same action; same gas injection machine; and using hydraulic-shut off valve system. For the heater's temperature, we set it as same as before setting but we pay more attention on it that is temperature of heater number one to number six is 210, 240 250, 250, 250, 250, respectively.

We set the acceptable temperature of heater number one at the cylinder part of machine is not over and below five centigrade from the setting point, which is 210 centigrade. The following figure shows the actual temperature of heater number one.

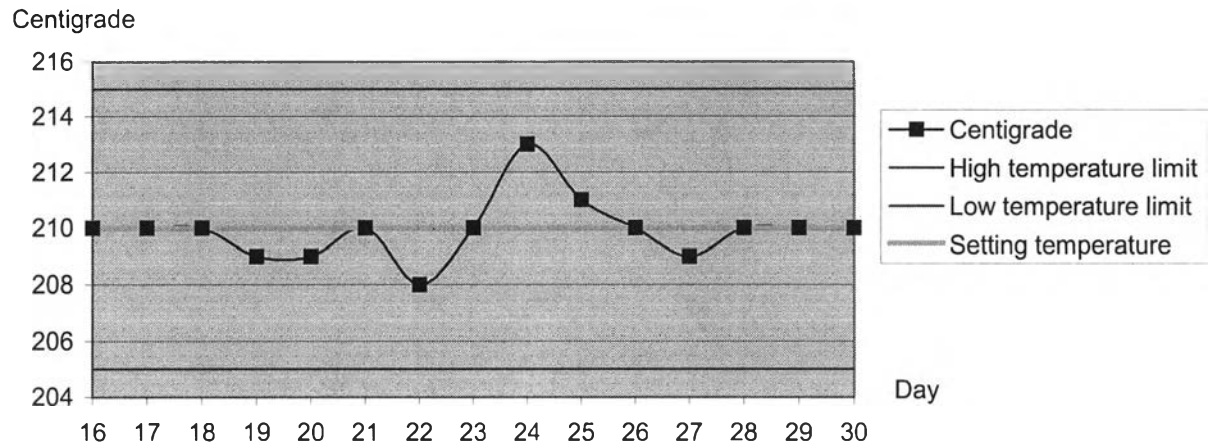


Figure 5.2: Actual temperature of heater no. 1 in September 2003

From the figure above, the actual temperature of heater number one is not over the limitation. If the temperature is over the limitation, we can modify it immediately because the workers are more attended with it. Similar to the heater number one, the heater number two is set at 240 centigrade and the limitations are not over and below five centigrade from the setting point.

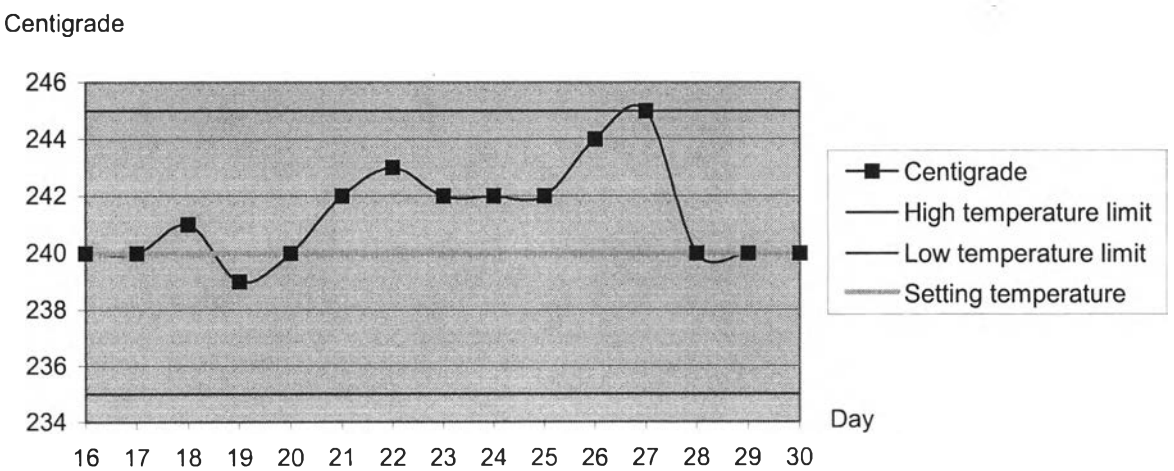


Figure 5.3: Actual temperature of heater no. 2 in September 2003

From the figure 5.3, we can see the actual temperature of heater number two is equal the limitation on 27th and will be reduced to the setting temperature on the next day. It is because of the workers modify the heater after they see the signal. The benefit of this action is preventing the heater from damage thus decreasing defects. However, we should modify it on 26th before it equals the limitation on 27th because the closely signal is shown in the control graph. There is a huge damage if we edit the error too late.

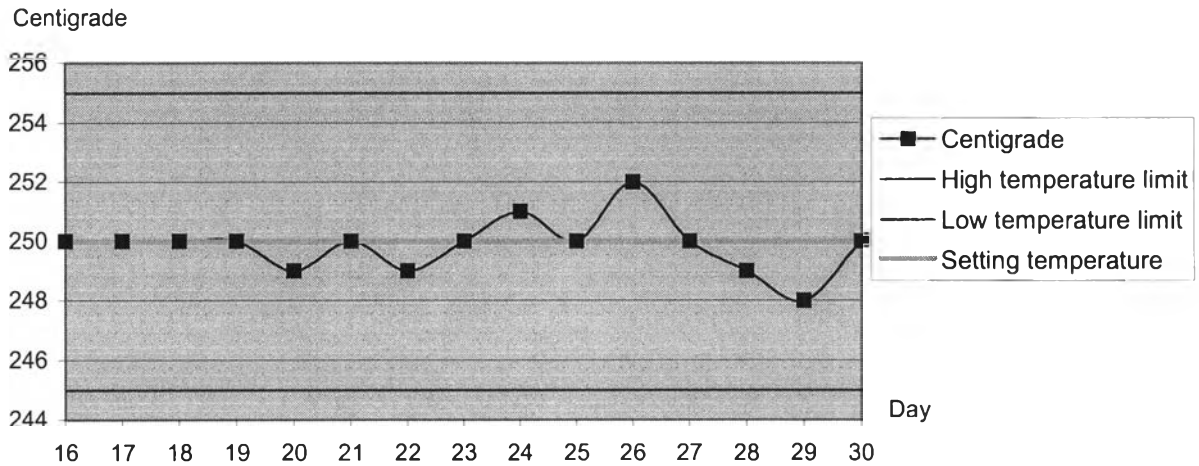


Figure 5.4: Actual temperature of heater no. 3 in September 2003

The set temperature of heater number three is 250 centigrade and the result by applied the attentive user below the limitation. These results are shown in the figure 5.4. Similar to the heater number three, we set the temperature of heater number four at 250 centigrade. The following figure shows the results of it.

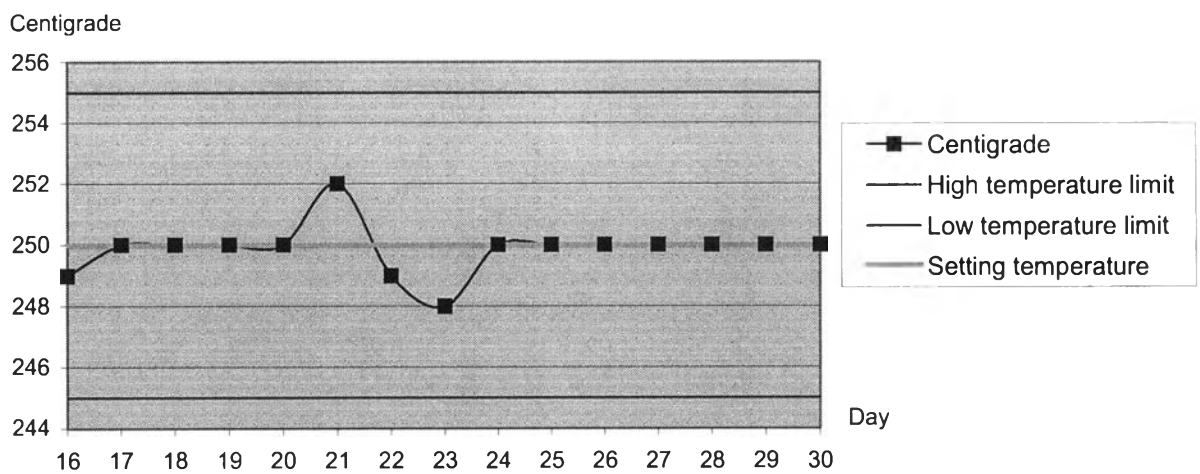


Figure 5.5: Actual temperature of heater no. 4 in September 2003

From the figure above, the result of actual temperature of heater number four is not over the limit. On the same hand, the actual temperature of heater number five near the shut off valve and the heater number six at the shut off valve are not over the limit. The following figures show the result of both heaters.

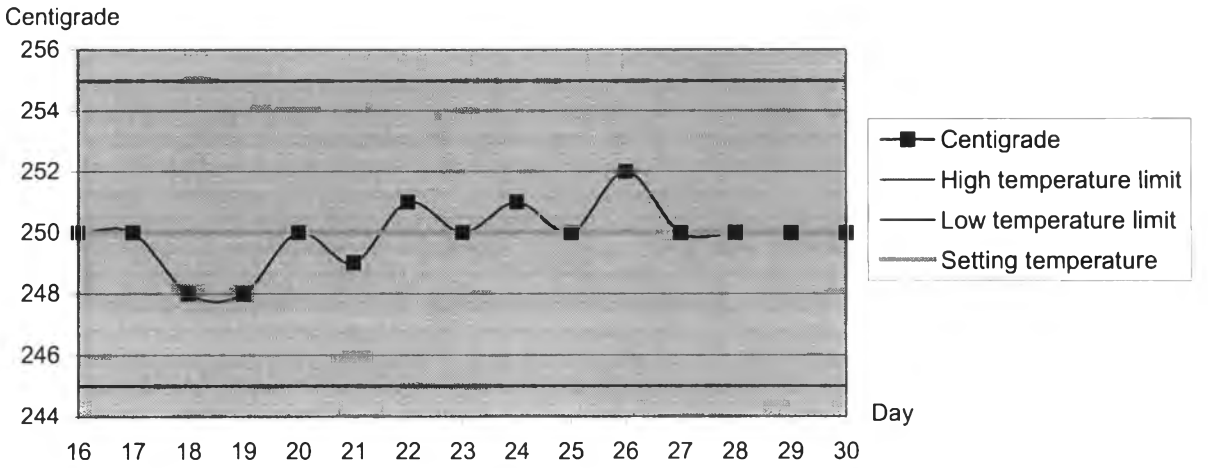


Figure 5.6: Actual temperature of heater no. 5 in September 2003

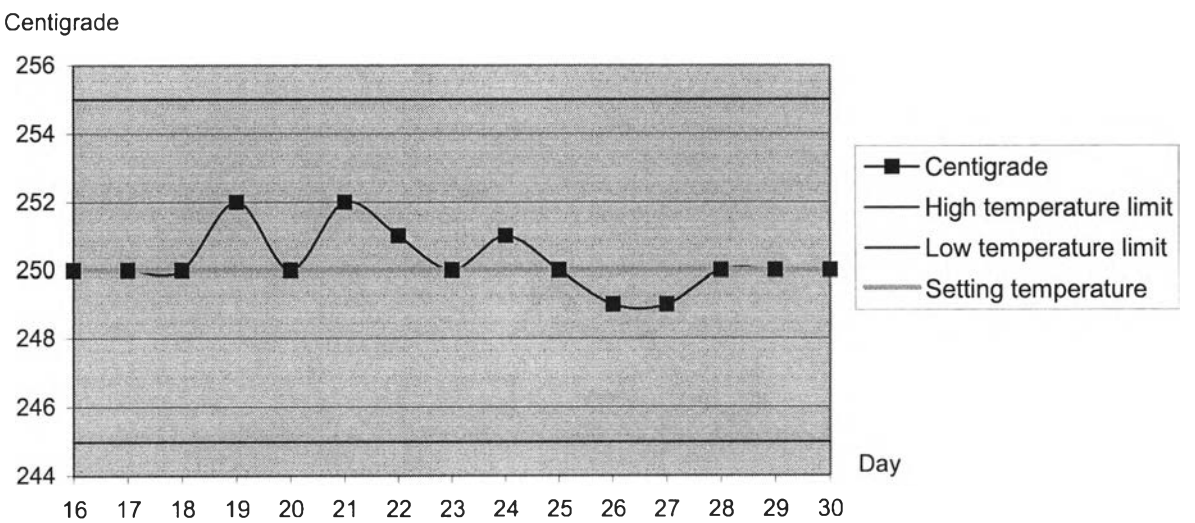


Figure 5.7: Actual temperature of heater no. 6 in September 2003

The figure 5.8 demonstrates the silver streaks in the last two weeks in September 2003. We set the machine to operate 1200 pieces per day so acceptable of silver streaks is 5% of the production. During fifteen days of the production period, we see the silver streaks are still acceptable. Therefore, the ready-to-use heaters are affect on the number of silver streaks and the RPN number.

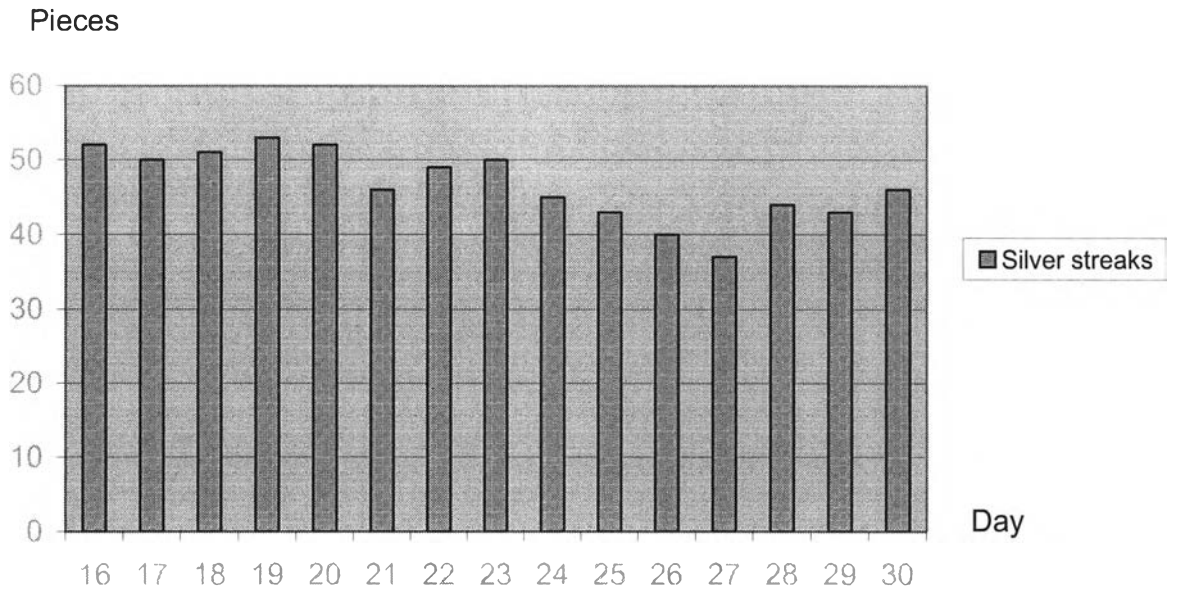


Figure 5.8: Silver streaks in September 2003 with the heaters ready in use

From the figure above, the highest percentage of defect is 4.42% on the 19th day and the lowest percentage of defect is 3.08% on the 27th day. More over, we can see the relation between the heater's temperature and silver streaks that are the silver streaks will increase if the temperature is lower. On the other hand, the silver streaks will reduce if the heater's temperature is higher. The silver streaks reduction is affect on the brown streaks defect because the high heater's temperature will increase the number of brown streaks defect.

5.4 The delayed time of gas injection

The unstable delayed time of gas injection is affect on the setting time between the front and rear injected resin. These come from setting the gas option by themselves which it is not compatible with the Japanese's technology machine. The implementation team decides to use a full option machine. The specification of this machine is similar to the research's machine and it has the gas injection option. We can set the delayed time to stable which is one second after the melted resin is injected into the mould. In addition, we set the other parameters as same as the original condition. For example, speed of screw rotation is 95 RV%; speed of resin injection is 80 IV%; temperature of heater number one to number six is 210, 240 250, 250, 250, 250, respectively; raw material mixing ratio is followed the UL standard; raw material mixing ratio is followed the UL standard; raw material obtaining with same action; same gas injection machine; and using hydraulic-shut off valve system. After we set the stable delayed time, we operate the machine and record the result as follow. However, we can operate the research's product on this machine only two weeks because it is not the main machine to produce the front cabinet 14-inches television.

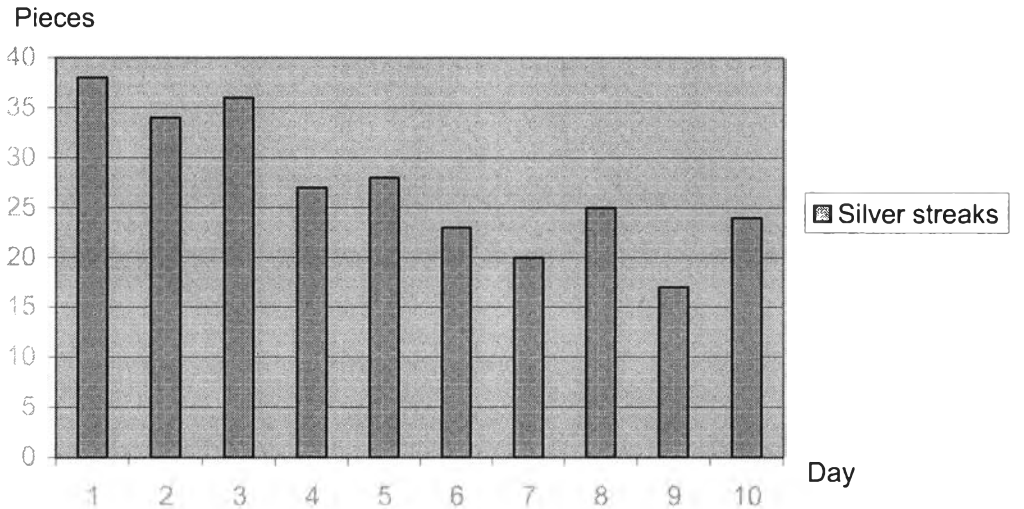


Figure 5.9: Silver streaks in October 2003 by using a full option machine

The figure demonstrates the silver streaks in the first two weeks in October 2003. As same as the September productivity, we set the operation is 1200 pieces per day and acceptable of silver streaks is 5% of the production. During ten days of production on this machine, we see the silver streaks are not over the acceptable limitation. The highest percentage of defect is 3.17% on the 1st day and the lowest percentage of defect is 1.42% on the 9th day. Therefore, the planning department should plan a proper schedule for switching the selected product to operate on the full option machine.

5.5 Raw material receiving

The improvement team decides to increase sampling quality test and request the supplier to specify raw material qualification precisely. We assign the chief of quality control to be responsible on both decisions. In a primary stage, he briefs the raw material quality control personnel, who should strictly check raw material on switching sampling plan every time. This solution cannot make qualification more clear but it can reduce the low quality raw material and pass to the next process. He designs new check sheet to support stricter testing. The figure 5.10 is shown the new check sheet. We never rejected raw material in raw historical. After we do it seriously, we realise the quality is not similar in every bag and we can reject it which does not meet the requirement.

RAW MATERIAL INSPECTION CHECK SHEET

Appearance, Flammable, Dimension (0.4% acceptable quality level)

A : Lot Number at Raw Material bag	PART NAME : PART NO :
B : Certificate or color plate in every lot	SUPPLIER : REC. DATE :
C : Dirty or torn bag	QUANTITY/LOT : LOT NO. :
D: Flammable by lighter	SAMPLING QUANTITY :
E: Dimension	O.K. : NOT O.K. : INVOICE NO. :

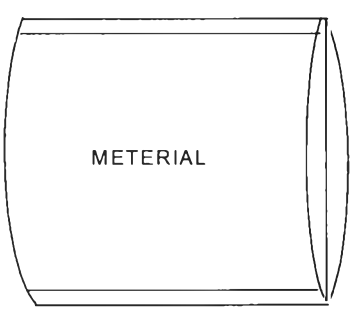
If it's o.k.,check ✔ at the result block

If it's not o.k.,check ✕ at the result block and note a mistake at note block

No.	Appearance	Flammable	Dimension	No.	Appearance	Flammable	Dimension	No.	Appearance	Flammable	Dimension	No.	Appearance	Flammable	Dimension	No.	Appearance	Flammable	Dimension	No.	Appearance	Flammable	Dimension	No.	Appearance	Flammable	Dimension
1				31				61				91				121				151				181			
2				32				62				92				122				152				182			
3				33				63				93				123				153				183			
4				34				64				94				124				154				184			
5				35				65				95				125				155				185			
6				36				66				96				126				156				186			
7				37				67				97				127				157				187			
8				38				68				98				128				158				188			
9				39				69				99				129				159				189			
10				40				70				100				130				160				190			
11				41				71				101				131				161				191			
12				42				72				102				132				162				192			
13				43				73				103				133				163				193			
14				44				74				104				134				164				194			
15				45				75				105				135				165				195			
16				46				76				106				136				166				196			
17				47				77				107				137				167				197			
18				48				78				108				138				168				198			
19				49				79				109				139				169				199			
20				50				80				110				140				170				200			
21				51				81				111				141				171				201			
22				52				82				112				142				172				202			
23				53				83				113				143				173				203			
24				54				84				114				144				174				204			
25				55				85				115				145				175				205			
26				56				86				116				146				176				206			
27				57				87				117				147				177				207			
28				58				88				118				148				178				208			
29				59				89				119				149				179				209			
30				60				90				120				150				180				210			

Note :

Dimension



Sampling	Result	Date	Inspected By	Chief	Manager
☐ Normal ☐ Reduce ☐ Tighten	☐ Accepted ——Bag ☐ Rejected ——Bag				

Figure 5.10: Raw material check sheet

On the receiving day, the quality control chief briefs the workers in the morning. He needs the workers to understand the procedure of quality testing. He explains how to check the appearance, flammable, and dimension and also explain how to use the new check sheet. He emphasizes them to be strict on the switching sampling plan that is refer to the Military Standard 105E Level II 0.4% of acceptable quality level. The sample size per one lot is ten percents of total quantity and the acceptable quality level is 0.4 percent of sample size, approximately. For example, we received 5000 kilograms or 200 bags on day 11th October and sample size of normal standard is 32 bags. We will reject that lot if we meet one bag is not satisfied in the normal standard sampling. The result of this lot is pass and we ordered again on day 21st October. On day 21st, we received 1000 kilograms or 40 bags. The worker picks up 8 bags with normal standard but one bag of sample size is not satisfied. Therefore, we rejected of that lot. We try to maintain the quality level of raw material; only accepted raw material can pass to the next process. The following table shows the switching sampling plan.

Quantity (Bag)	Normal (AC-RE)	Reduce (AC-RE)	Tighten (AC-RE)
2-8	2 (0-1)	2 (0-1)	2 (0-1)
9-15	3 (0-1)	2 (0-1)	3 (0-1)
16-25	5 (0-1)	2 (0-1)	5 (0-1)
26-50	8 (0-1)	3 (0-1)	8 (0-1)
51-90	13 (0-1)	5 (0-1)	13 (0-1)
91-150	20 (0-1)	8 (0-1)	20 (0-1)
151-280	32 (0-1)	13 (0-1)	32 (0-1)
281-500	50 (0-1)	20 (0-1)	50 (0-1)
501-1200	80 (1-2)	32 (0-1)	80 (1-2)
1201-3200	125 (1-2)	50 (0-1)	125 (1-2)
3201-10000	200 (2-3)	80 (1-2)	200 (1-2)
1001-35000	315 (3-4)	125 (1-2)	315 (2-3)
35001-150000	500 (5-6)	200 (2-3)	500 (3-4)
150001-500000	800 (7-8)	315 (3-4)	800 (5-6)
500000-And over	1250 (10-11)	500 (5-6)	1250 (8-9)

Table 5.1: Switching sampling plan of raw material receiving

In addition, an advantage of this recommendation is the real action by the workers because the chief is looking by himself. However, this action cannot reduce the silver streaks number because the qualifications are not clear enough to set the heating condition. Therefore, we need to request the suppliers to identify raw material qualifications. It is in progress for this recommendation. We still wait for the reply after explaining the reasons why we need the precise qualifications of raw material. The table 5.2 will show the new RPN number after the action taken.

Process	Potential failure mode	Potential effect of failure	S	Potential cause	O	Current control	D	RPN	Recommended action	Action result				
										Action taken	S	O	D	RPN
1. Raw material receiving	Raw material qualification is vague such as melting temperature or melting point and humidity.	The company cannot set a suitable heating condition between it and that raw material lot.	4	The company did not have a strict inspection of raw material's qualification one reason is they believe a certificate too much.	4	Check colour and dimension by visual, test inflammably by the lighter that they do not know an exact melting point. They pick 1 bag per lot for quality checking (dimension and inflammable). They do not pay attention to receive quantity in addition, they are not cautious about a mistake in supplier's certificate	7	112	Request supplier to specify qualification Increase sampling of quality test	In progress Increase sampling of quality test	- 4	- 3	- 6	- 72
2. Raw material heating	Hopper machine cannot get rid of humidity.	Raw material still has humidity and pass to the next process.	5	Time duration and temperature do not match to raw material	3	Hopper machine has an alarm alert for an error	3	45	None					
	Improper mixing ratio	Wrong colour and high stress	4	A lot of raw material grade B in the mixing ratio	4	The production personnel measure the mixing raw material follow by UL standard	4	64	None					
3.Injection	Incomplete mixing	Compound not together	4	Low speed of screw rotation	4	The production personnel read and check rotation speed program in injection machine	3	48	None					

Table 5.2: FMEA of silver streaks defect and new RPN number

	Sticky melted resin	Stop machine for changing heater	6	Temperature cannot reach the set point	6	The production personnel read and check temperature program in injection machine	5	180	Observation and awareness from the related personnel	Observation and awareness from the related personnel	4	4	5	80
	Time setting at the front injected resin is not equal to the rear injected resin	The front injected resin will meet the nitrogen gas before the rear injected plastic. Therefore, the front is cool down faster than the rear	7	Low speed of inject resin	4	The production personnel read and check inject speed program in injection machine	3	84	None					
				Nitrogen injection at the needle of shut off valve	6	The production personnel connect the path of gas injection depends on the mould design, which is the customer's property	7	294	Redesign mould	Contact to the customer but it is failed	7	6	7	294
				Shut off valve open quickly but close slowly	6	Use hydraulic system to control open and close speed of shut off valve	7	294	Adjust the shut off valve to close quickly	Change to use mechanic system	7	3	4	84
				Delay time of gas injection is unstable	6	The production personnel read and check the delayed time program in gas injection machine	7	294	Change to use the other machine	Use the full option machine	7	3	4	84

Table 5.2: FMEA of silver streaks defect and new RPN number (continued)

	Stop machine	Cannot reach the target and/or drain resin in machine	4	Oil leakage at shut off valve (O-ring damaged)	5	3 months checking	4	80	None					
4.Inspection	Defects pass to the next process	Waste money and time, customer dissatisfy, document errors	6	No action taken, insufficient, ignorance, workload	3	Chief and/or manager	5	90	None					

Table 5.2: FMEA of silver streaks defect and new RPN number (continued)