

การลดและควบคุมเวลาสูญเสียในการผลิตโดยวิธีการบำรุงรักษาเชิงป้องกัน



นายวิภาส จิรภาส

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ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

REDUCTION AND CONTROL OF LOSS TIME IN A PROCESS  
BY PREVENTIVE MAINTENANCE



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วิทยานิพนธ์นี้ เป็นการศึกษาเพื่อหาแนวทางในการลดและควบคุมเวลาที่เครื่องจักรหลักหยุดในกระบวนการผลิตขนมอบเคี้ยวประเภทเนื้อปลาอย่าง อันเนื่องมาจากการขาดการซ่อมบำรุงรักษาเครื่องจักรอย่างเหมาะสม โดยการประยุกต์ใช้การบำรุงรักษาเครื่องจักรเชิงป้องกัน เพื่อให้เครื่องจักรหลักในการผลิต สามารถเดินได้อย่างต่อเนื่อง เกิดของเสียน้อยลง ประสิทธิภาพของเครื่องจักรเพิ่มมากขึ้น รวมทั้งเป็นการเพิ่มความปลอดภัยในการทำงานเครื่องจักรการศึกษาเริ่มจากการวิเคราะห์ระบบการซ่อมบำรุงรักษาเครื่องจักรในปัจจุบัน โดยเก็บข้อมูลเวลาที่เครื่องจักรหยุด และค่าความสูญเสียโอกาสในการผลิต อันเนื่องมาจากเครื่องจักรหยุดกระทันหัน ปัญหาที่พบจากการวิเคราะห์ ประกอบด้วยปัญหาด้านการจัดการภายในแผนกวิศวกรรมไม่ดีพอ ปัญหาจากการใช้วิธีการบำรุงรักษาเครื่องจักรหลังเกิดเหตุขัดข้อง และปัญหาการสูญเสียโอกาสในการผลิต เพื่อทำการวิเคราะห์หาสาเหตุของปัญหาดังกล่าวในการวิเคราะห์หาสาเหตุ เครื่องมือที่ใช้คือ การนำหลักการของการบำรุงรักษาเครื่องจักรเชิงป้องกัน มาเปรียบเทียบกับ การบำรุงรักษาเครื่องจักรในปัจจุบัน โดยแยกประเภทของสาเหตุที่ทำให้เครื่องจักรขัดข้อง เพื่อนำมาหาวิธีป้องกันไม่ให้เครื่องจักรหยุดเนื่องจากสาเหตุนั้น ๆ อีก รวมทั้งได้ทำการปรับปรุงด้านการจัดการภายในแผนกวิศวกรรม เพื่อให้มีความพร้อมก่อนการนำระบบบำรุงรักษาเครื่องจักรเชิงป้องกันมาประยุกต์ใช้

จากผลการศึกษาวิจัย ได้ทำการปรับเปลี่ยนระบบการบำรุงรักษาเครื่องจักรจากการบำรุงรักษาเครื่องจักรภายหลังเกิดเหตุขัดข้อง มาเป็นการบำรุงรักษาเครื่องจักรเชิงป้องกัน โดยเริ่มจากการปรับเปลี่ยนโครงสร้างภายในแผนกวิศวกรรม การจัดระบบการทำงานใหม่ให้มีประสิทธิภาพมากขึ้น และได้จัดทำคู่มือมาตรฐานการทำงานของแผนกวิศวกรรมให้สอดคล้องกับข้อกำหนดของ มาตรฐาน ISO 9002 หลังจากการประยุกต์ใช้ระบบการบำรุงรักษาเครื่องจักรเชิงป้องกันเป็นที่เรียบร้อยแล้ว ผลการดำเนินการที่เก็บ ได้ถูกนำวิเคราะห์ และพบว่า มีจำนวนครั้งที่เครื่องจักรขัดข้อง ลดลงจาก 12 ครั้งต่อเดือน เหลือ 5 ครั้งต่อเดือน มีค่าความสูญเสียโอกาสในการผลิตลดลง 73% และไม่มี สถิติอุบัติเหตุถึงขั้นหยุดงานเกิดขึ้น เป็นระยะเวลามากกว่า 600 วัน จนถึงปัจจุบัน

ภาควิชา .....ลายมือชื่อนิสิต .....

สาขาวิชา.....ลายมือชื่ออาจารย์ที่ปรึกษา.....

ปีการศึกษา.....ลายมือชื่ออาจารย์ที่ปรึกษาร่วม.....

##4071621521 : MAJOR ENGINEERING MANAGEMENT

KEY WORD PREVENTIVE MAINTENANCE / BREAKDOWN MAINTENANCE /  
ENGINEERING MANAGEMENT / LOSS TIME IN A PROCESS

WIPAS JIRAPAS : REDUCTION AND CONTROL OF LOSS TIME IN A  
PROCESS BY PREVENTIVE MAINTENANCE.

THESIS ADVISOR : Dr.JITTRA RUKIJKANPANICH

The objective of this thesis is to study in order to acquire the effective resolution to reduce and control the machine breakdown of critical machine in the fish snack production line as a result of lacking of the appropriate and effective machine maintenance system. The study has been conveyed by adopting the preventive maintenance system to increase the effectiveness of the operation of the machine in the production line and to reduce and prevent the machine breakdown and to provide the safety awareness in the workplace. The study begins with the analysis on the existing maintenance system. The data in connection with the Down Time and Cost of Loss Time caused by the sudden machine breakdown have been collected throughout the study. The Find-out indicates that there are various problems in management structure within the Engineering department and the existing machine maintenance system causing the Cost of Loss Time in the production line. The analysis equipment and method being used is to compare the existing machine maintenance system with the preventive maintenance program based upon types of cause of machine damage and the appropriate maintenance system to prevent the re-occurrence of such damage. Furthermore, the management structure within the Engineering department has been improved prior to the implementation of the preventive maintenance program.

From the study, the preventive maintenance system has been implemented and adopted in place of the existing maintenance program that provides repair and maintenance only after damage and machine breakdown has been occurred. First step of the process is to restructure the management line within the Engineering department to increase its management effectiveness. Also, the procedure manuals and work instructions have been implemented to comply with the ISO 9002 standards. After the implementation of the preventive maintenance program, it is found that the machine breakdown rate has been significantly decreased from 12 times per month to 5 times per month and the Cost of Loss Time has reduced for 73% and no serious accident has occurred within the 600 day period up to present.

Department .....Student's signature .....

Field of study.....Advisor's signature.....

Academic year.....Co-advisor's signature.....

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สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย

# CHAPTER 1

## Introductions

### 1.1 Background of business

Efficient use of machine and equipment is a vital factor for current situation, particularly in a fall down economy like ours. Machines and equipment are very expensive. Some machines are imported involving valuable foreign exchange. Further the cost of machines and equipment forms a considerable portion of the total cost of production. Thus it is force us to look after them as carefully as possible. Machine maintenance is of great importance as it provides a means to maintain the machine and equipment in a high state of operating efficiency and enhance its productivity.

A.B.C. Food Co., Ltd. established since 1982 at Lat Krabang industrial Estate, Bangkok to produce baked fish snack under different flavors. Subsequently, crispy green peas was produced. In 1995, the second and third factories, promoted by the Board Of Investment (BOI), was built up at Kabinburi Industrial Zone, Prachinburi to produce also baked fish snack and new snack products. The numbers of direct employees are about 360 persons and indirect employees are about 100 persons.

The production process can be divided into 5 main steps

1. Mixing; mixed fish meat and other raw material to press into forming machine by meat pump. (This step typically made in batches)
2. Forming and Preheating; press into flat piece with preheating
3. Drying & saucing; making the fish roll dried to cover the surface by sauce
4. Baking and cutting; make the fish roll to swell up cutting in the large piece
5. Small cutting; cutting in small piece.

## 1.2 Statement of problems

This process, the maintenance function is an essential aspect of a line production. Breakdown of a single machine stops the entire production process resulting to waste of time and other resources especially food product like ours. At present time, A.B.C. Food Co., Ltd. use breakdown maintenance system. In the case of breakdown maintenance the machines and equipment are generally attended only when they breakdown. The maintenance staff will carry out the necessary repairs, when the machines have actually broken down and are not able to function, in order to put them back into commission. The cost due to lost time in process is more than 150,000 bahts per month as shown in Table 1.1

Process	Nov. 98		Dec. 98		Jan. 99	
	downtime (min.)	cost (Bahts)	downtime (min.)	cost (Bahts)	downtime (min.)	cost (Bahts)
1. Mixing	0	0	40	12,558	0	0
2. Forming	140	21,977	435	68,284	445	69,854
3. Drying	418	131,231	280	87,906	390	122,441
4. Baking	0	0	0	0	0	0
5. Cutting	0	0	0	0	0	0
Total	558	153,208	755	168,748	835	192,295

Table 1.1 : Cost of lost time in baked fish snack process



There are many productivity disadvantages in breakdown maintenance system. Some of them are :

1. More production downtime, with the corresponding disadvantages by higher breakdowns, i.e., lower employee morale, lower quality product, higher production cost through fewer efficiency.
2. More product rejects due to waste of materials in process
3. More overtime pay due to higher emergency breakdown repairs compared to planned or scheduled maintenance
4. Fewer employee safety resulting from the worse operating condition of machine
5. Results in unbalanced utilization of maintenance & operation staff, spare parts planning and machine loading
6. Higher manufacturing costs due to increased downtime of production machine

As against breakdown maintenance where main machine gets the attention only when they breakdown, preventive maintenance is a planned and systematic procedure which takes a continuous care of the machine, mending and repairing as and when required to minimize breakdowns and unscheduled stoppage, resulting in various advantages and savings. From many disadvantages with breakdown maintenance system during the past years of A.B.C Food, preventive maintenance can offer a greatly needed solution for productivity improvement problems.

### 1.3 The objective of the study

To reduce and control downtime of critical machine by preventive maintenance

### 1.4 Scope of study

In this research the problem of lost time in 4 baked fish snack process lines will be studied. (Supporting machines are not included.)

## 1.5 Procedures

Procedures	Implementation Item
1. Prepare the proposal	<ul style="list-style-type: none"> <li>* Create the objective</li> <li>* Scope of the study</li> <li>* Expected benefit</li> </ul>
2. Theoretical consideration	<ul style="list-style-type: none"> <li>* Consider the related theory</li> </ul>
3. Selection the problem area	<ul style="list-style-type: none"> <li>* Identify the problem</li> <li>* Select the theme</li> </ul>
4. Understand the current situation, and set targets	<p>Grasping of existing conditions</p> <ul style="list-style-type: none"> <li>* Collect the facts, information and data</li> <li>* Decide faults to improve</li> <li>* Explore current system</li> </ul>
5. Cause analysis , Identify the cause and effect relationship	<p>Develop countermeasures</p> <ul style="list-style-type: none"> <li>* List the causes</li> <li>* Analyze the causes</li> <li>* Determine the countermeasures points</li> </ul>
6. Implementation of countermeasures	<ul style="list-style-type: none"> <li>* Study how to achieve the countermeasure</li> <li>* Implement countermeasures</li> </ul>
7. Standardization	<ul style="list-style-type: none"> <li>* Establish the standard</li> <li>* Determine the control method</li> </ul>
8. Evaluation	<ul style="list-style-type: none"> <li>* Compare the result with the goal value</li> <li>* Review the problem</li> </ul>
9. Summarize	<ul style="list-style-type: none"> <li>* Prepare report and presentation</li> </ul>

## 1.6 Expected benefit

1. Reduce cost of lost time and downtime in baked fish snack
2. Implementation of preventive maintenance in maintenance section

## 1.7 Literature survey

### **N.V. KRISHINA (1987), "Preventive Maintenance (Management Guide)"**

Preventive maintenance is based on the old adage "Prevention is better than cure" or "a stitch in time saves nine". Preventive maintenance is a systematic maintenance procedure wherein the condition of the plant is constantly watched through a systematic inspection and preventive action taken to reduce the incidence of breakdowns. The necessity for either major or minor repairs is determined, to prevent unscheduled interruptions to the plant and equipment or any deterioration.

The fundamental activities of preventive maintenance are:

- a) Periodical inspection of plant and equipment to discover conditions of deterioration
- b) Upkeep of equipment to remove or repair such conditions while they are still in a minor stage. Thus the essence of the preventive maintenance is a well-planned inspection system.

### **Elmo J. Miller (1983), "Modern Maintenance Management"**

Because of the increased complexity and high initial cost of machinery, it has become essential to have a formal or planned maintenance program. However, there isn't sufficient justification to have a planned program for every piece of machinery in a plant, nor is it possible to eliminate all breakdowns. But we can minimize interruptions in the work schedule. This is done by concentrating on those units that are considered as "critical units." A unit qualifies as a critical unit if:

1. Failure of the unit would endanger health or safety of operating personnel.
2. Failure would affect quality of the product.
3. Failure would stop production.
4. Capital investment for a unit is high.

When the critical-unit concept is applied to preventive maintenance, the basic principle of value engineering can be brought to bear—that is, we can place primary emphasis on those units in a process that require critical maintenance and which, through good maintenance, will provide the greatest return in reduced downtime and high production. For those units which do not qualify as critical, random or routine maintenance may be all that is required for satisfactory operation. The basis idea is to concentrate the preventive maintenance program on select units and inspect these units thoroughly and conscientiously.

**Lawrence Mann, Jr. (1983), "Maintenance Management" state that**

Preventive maintenance programs yield numerous benefits, although few plants realize all of the following advantages:

1. Minimum maintenance cost: Maintenance can be planned, standards can be used, and materials can be prior to the start of the work order.
2. Maintenance performed when convenient: Decision can be made about when in the production cycle it is most advantageous for equipment to be removed from service. In addition, the work can be done when it is the most convenient to maintenance in terms of availability of materials, equipment, and personnel.
3. Ability to contract maintenance: When a number of PM jobs can be packaged, it becomes feasible for maintenance management to have the alternative of contracting the work.
4. Less downtime: If the job can be engineered before removal of the equipment from service, the time that equipment is out of service can be minimized.
5. Minimum spare parts inventory: If it is possible to maximize PM, the work order can be anticipated and spares can be obtained from the supplier. This minimizes the number of

spares that must be purchased and stored in anticipation of emergency maintenance.

6. Less disruption through emergency maintenance: When the work order is anticipated, the sequence of operations can be documented better so that future work orders of a similar nature can be written with more knowledge than if the job had been an emergency that was not documented.

7. Less standby equipment needed: When it is possible to anticipate maintenance, equipment can be taken out of service at a time convenient to operations, and standby equipment need not be used.

8. Less overtime needed: Preventive maintenance makes it possible to plan and schedule maintenance jobs with a greater degree of accuracy, and knowing how long the job should require reduces overtime.

9. Increased safety: Rules of safety can be applied better to anticipated work than to emergency work.

**Kanit Sereetrakul (1990), "Maintenance system improvement to increase productivity of a tuna-canning factory"**

This thesis is aimed to study what appropriate adjustment for maintenance system should be done to improve the productivity. That is to plan the maintenance program by means of preventing the machine breakdown. A tuna-canning factory has been chosen as a prototype factory to be studied. It is expected that this study can be used as basis or guidelines for productivity improvement for a tuna-canning factory in general. In summary, the adjusted maintenance system can lower the fault rate of approximately 3.54% of lid sealing machine and can reduce the maintenance expense of approximately Baht 0.26 per carton.

**Fukunaga Ichiro (1987), "Maintenance Techniques in the Factory"**

The book talks about causes of damages and how to arrange the machine or spare parts inspection, machine modification and repair that are mostly found in the production line, i.e., bearing, motor, hydraulic system and lubrication system. Besides, it proposes the fundamental concepts of machine maintenance especially the preventive maintenance together with case studies with regard to maintenance system of factory in Japan.

**Shoei Ebi (1987), "Cost reduction within the factory"**

The concepts with regard to the Preventive Maintenance (PM), the Corrective Maintenance (CM) and the Maintenance Prevention (MP) are proposed to increase productivity and decrease machine breakdown.

Besides, this book presents the concepts for cost saving in connection with machinery equipment based upon certain economic and management factors. The cost saving concepts will be put together with PM, CM and MP in order to develop the normal maintenance to the Productive Maintenance System in the future. This book also gives suggestions on techniques to upgrade the reliability and the effectiveness of machine repair and maintenance and techniques on how to evaluate such repair and maintenance program.

**Poonporn Sangbangpla (1995), "Total Productive Maintenance"**

She proposes the importance of maintenance data collecting and the use of such data. She also indicates the certain objectives of data collecting, the characteristics of good data, types of data collecting on daily basis, an inspection checklist, an accidental report, a maintenance schedule and its advantages, a plan for machine maintenance (Plan), a plan for machine modification and inspection (Do), a record and analysis (Check), and the feedback toward the data collecting (Feedback) which will be beneficial for future use (Action).

## CHAPTER 2

### Theoretical Consideration

#### 2.1 Introduction to Preventive Maintenance

Efficient use of plant and equipment is a vital factor for industrial growth, particularly in a developing economy like ours. Plant and equipment besides being very expensive, are in many cases imported involving valuable foreign exchange. Further the cost of plant and equipment forms a considerable portion of the total cost of production. Thus it is forced to look after them as carefully as possible. Plant maintenance is importance as it provides a means to maintain the plant and equipment in a high operating efficiency and enhance its productivity.

Generally in Thailand industries the utilization of plant and equipment needs to be considerably improved. While there may be many reasons for under utilization, downtime due to unscheduled breakdowns and stoppages is one of the primary causes. It is necessary to increase the working life of the existing plant and increase the utilization. Efficient utilization of plant becomes extremely important in order that the capital resources are available for expansion schemes rather than replacement of equipment, which in turn will help industrial development.

Poor maintenance causes economic losses such as:

- 1) Increased downtime
- 2) Poor efficiency
- 3) Deterioration of equipment
- 4) Poor quality of product
- 5) High labor cost
- 6) Loss of material in process
- 7) Higher production costs
- 8) Increased hazards etc.

Systematic maintenance procedure offers possibilities for savings in money, materials and manpower. These savings come through :

- 1) Reduction in downtime
- 2) Reduced losses of material in process
- 3) Increased life of the equipment
- 4) Reduction in overtime
- 5) Optimum spares inventory
- 6) Timely replacement of spares and machines
- 7) Maintenance of product quality
- 8) Proper running of the equipment
- 9) Optimum operational cost of the machines.

Through proper maintenance the downtime of equipment comes down considerably. Machines are attended to before they breakdown. Spare parts are replaced before they fail. Lubrication is done regularly and according to a timetable. All these and many other activities keep the equipment in good running condition.

Whenever the equipment breaks down, the materials in process, which are all inside the various types of machine, undergoing some process get spoiled. The losses due to this wastage can be substantial if the materials are expensive. The installed equipment should be kept in good working order as long as possible. Proper maintenance, timely replacement of parts, modifications to suit the conditions of operation etc help to enhance the life of the machine.

Good maintenance leads to higher output through lower downtime of plant and machine, better quality of products through improved efficiency and lower unit costs through reduced breakdown expenses. Machine and equipment deteriorate with use. If the deterioration is not checked they will not function and will become unserviceable. Maintenance primarily aims at keeping the machine and equipment in efficient operating conditions, minimizing the downtime, as to ensure their maximum availability for production. The objectives of a systematic maintenance scheme are, to safeguard the investment, to



keep the machine in good working condition, to prolong the life of the machine and to assure optimum availability.

### **Types of Maintenance**

Maintenance practices can be broadly classified into following two types:

- a) Breakdown maintenance
- b) Preventive maintenance

### **Breakdown Maintenance**

In the case of breakdown maintenance the machine is generally attended only when it breakdown. The maintenance crew will carry out the necessary repairs, when the machine has actually broken down and is not able to function, in order to put it back in to commission. Such breakdowns may occur to any machine at any time. There are many disadvantages in this system. Some of them are:

- 1) There is always an urgency to put the machine back in the working condition and hence the machine may not get adequate maintenance.
- 2) Since the type and time of breakdown is uncertain, production plans get completely disrupted.
- 3) Planning of maintenance work is not possible.
- 4) Distribution of workload is difficult.
- 5) Results in imbalance utilization of maintenance staff
- 6) May result in overstaffing the maintenance department.
- 7) Increase overtime.
- 8) Increase downtime of machine due to non-availability of manpower.
- 9) Excessive inventory of spares.
- 10)Waste of materials in process in continuous industries.
- 11)Poor working conditions for maintenance staff.

However, breakdown maintenance system may be suitable in certain condition such as (a) where plant capacity exceeds market demand (b) Standbys are available and quick switching over is possible (c) process is obsolete and more modern machine is under consideration (d) may be economical for non-critical machine where this type of maintenance is cheaper than any other system.

Normally, breakdown maintenance is not recommend in a general practice since it has may disadvantages and more systematic types of maintenance are now gradually replacing this system of maintenance.

### Preventive Maintenance

As the name itself indicates preventive maintenance is based on the old adage "Prevention is better than cure" or " a stitch in time saves nine". Preventive maintenance is a systematic maintenance procedure wherein the condition of the plant is constantly watched through a systematic inspection and preventive action taken to reduce the incidence of breakdowns. The necessity for either major or minor repairs is determined, to prevent unscheduled interruptions to the plant and equipment or any deterioration.

The fundamental activities of preventive maintenance are:

(a) Periodical inspection of plant and equipment to discover conditions of deterioration (b) upkeep of equipment to remove or repair such conditions while they are still in a minor stage. Thus the essence of the preventive maintenance is a well-planned inspection system. Proper inspection at the right time is the crux of the preventive maintenance system. The results of inspection are used to analyze the problems of upkeep, replacement and modification well in advance and thereby help proper planning and assessment of the work contents of the jobs. It is of course necessary to determine with great care what is to be inspected and when. Meticulous recording of the facts revealed during such inspections is another important point. Analysis of such records indicates the type of maintenance work needed, replacements required, planning of maintenance work and inventory of spares. Preventive maintenance renders more effective use of manpower and

material and helps to attain greater efficiency in plant operation. Planning of maintenance work and optimum inventory of spares and components became possible with the introduction of this system. It will be possible to synchronize the maintenance program so that there is least interruption to continuous operation and production.

As against breakdown maintenance where plant and equipment gets the attention only when they breakdown, preventive maintenance is a planned and systematic procedure which takes a continuous care of the equipment, mending and repairing as and when required to minimize breakdowns and unscheduled stoppages, resulting in various advantage and saving.

However, certain limitations of preventive maintenance are, that during the initial stages of its introduction, it may appear to be expensive, although in the long run it is highly beneficial. The procedure and the frequency of inspection would have to be carefully worked out and improved over a period of time. The data for preventive maintenance will have to be built up gradually and the system has to be refined depending on the data collected.

The various elements of a preventive maintenance system in an industry are as follows:

- (1) An inventory of all the plant and equipment that need to be maintained.
- (2) Categorization of equipment to assess the relative importance and thereby determine the equipment requiring preventive maintenance.
- (3) A well designed inspection system.
- (4) A good lubrication system.
- (5) Maintenance of adequate records and analysis of these records.
- (6) Planning of maintenance work.
- (7) Control of maintenance stores and spares.
- (8) Organization for preventive maintenance work.

## 2.2 Categorization of equipment

Before launch preventive maintenance program, the management will have to make a careful analyze as to which type of equipment needs preventive maintenance. It may not be economical to have desirable to have preventive maintenance on all equipment, for initial introduction of the system in only the important equipment within the framework of preventive maintenance. As discussed in the previous chapter, in certain situations breakdown maintenance may be economical. There are various other systems of maintenance like Scheduled Maintenance, which may be desirable for certain types of equipment.

Because of all these factors, it would be necessary to determine the relative importance of equipment in an industry. While every equipment in an industry is important, from the overall efficiency point of view. The criticality varies from machine to machine. The overall damage caused by the mal-functioning or the non-functioning of one equipment may be entirely different from that of another. For example, in an office the magnitude of problems created would be different depending on whether a typewriter or computer goes out of order. Similarly the difference will be quite vast between an ordinary lathe and a special purpose machine or between a small pump and a major electric motor etc.

Thus it is necessary to categorize the equipment depending on its overall importance as compared to the others in the same industry. Often this comparison can be done by maintenance and process engineers who are experienced in the industry can do this comparison. Many times their differences are obvious and apparent and no detail analysis is necessary. However, if the number of machinery involved is too large, or when it is desired to have a very systematic categorization, to bring about the differences then a point system of evaluation based on certain factors may adopted for a details categorization of equipment. The method, which is briefly described below, can be used to determine if necessary the total points for each piece of equipment in the factory, which in turn will be the deciding factor for arriving at their relative importance.

Some of the factors that need to be taken into consideration are (i) whether the equipment is a continuous or intermittent running equipment. An unscheduled or a sudden breakdown of a continuous running machine with a high degree of utilization, will obviously cause considerable production loss. (ii) In the event of failure of a particular machine, whether a substitute or a standby is available. If there is a standby the same can be lastly switched on without any delay and meanwhile the machine can be repaired and put in condition. (iii) How important is the machine from the point of view of the quality of the product that is coming out of the machine. In other words what could be the loss as a result of poor quality or rejections. (iv) What is the position with regard to availability of spares, easy or difficult to obtain (v) What are the likely hazards that the equipment can cause the workers and other employees. Equipment, which has certain inherent hazards, needs meticulous care.

Questions such as above and similar are to be answered for each piece of equipment and an evaluation can be done by the production and maintenance personnel in order to arrive at the overall criticality. Machines of similar degree of importance can be grouped together which in turn will help to determine the type of maintenance required. Based on this type of analysis priority for preventive maintenance can be decided.

### 2.3 Inspection

*REF. [1], page 8-11.* Inspection is the crux of preventive maintenance program. Inspection of the equipment is carried out in a systematic way periodically in order to determine the condition of the equipment. Certain parts may wear out and deteriorate, certain bolts and nuts may become, loose due to vibrations, certain surfaces may get corroded, defects may occur as a result of over heating, alignment may go out of order and a host of defects may develop, in any equipment. These defects if not corrected may result in malfunctioning or breakdown of the machine or cause hazards. Corrective action can be taken if they are noticed well in time, and breakdowns can be avoided. In other words, through a process of inspection it will be possible to check the condition and take preventive

measures, which may include repair, reconditioning or replacement of defective parts. Hence inspection is a very important aspect of preventive maintenance.

### **Methods of Inspection**

There are different methods by which the equipment can be inspected. They can broadly be classified into (i) External and (ii) Internal.

The external methods of inspection can be visual, which can be easily noticed such as corrosion, cracks, color and other external defects. Certain other conditions like abnormal sound, vibration, wear etc. can be easily observed. Temperature of bearings and similar parts can be felt and gauged. Thus the external inspection can be carried out when the plant is in operation.

The internal method of inspection is more detailed and would have to be carried out when the plant is under shut down. Wear and tear of moving parts, internal cracks and many other defects which are not likely to be easily noticed fall into this category. A Detailed inspection may become necessary as a result of certain defects noticed during the external checking. It may even be necessary to use certain inspection equipment and testing devices to determine the extent of the defect.

### **Use of Check –lists**

In order to ensure correct and proper inspection checklists are of great importance. Checklist is a guide indicating the items to be inspected in each equipment. The list may also include what it to be checked, how it is to be checked and the standards of acceptable conditions. Preparation of checklists requires considerable skill, experience and judgement. Carefully prepared exhaustive checklists would be of immense help to an inspector and ensures that no items or defect is overlooked and the inspection is carried out properly. Besides, checklists provide permanent documents, which can be used by anyone for the purposes of inspection. The inspector would go with the relevant check-list to the equipment,

inspect each and every item listed, and record the condition observed, for necessary corrective action to be taken by the Maintenance Engineer.

Inspection as already explained is an important step in the whole PM procedure. The condition of the equipment became apparent during inspection and the action to be taken depends entirely on the report of the Inspector. If the person inspecting the machine reports wrongly, after a faulty inspection, it can cause a lot of damage.

An inspector should be a skilled and an experienced person with full knowledge of the machines he is inspecting. He should be able to detect unhealthy sign in any equipment and interpret the conditions. The level of the Inspector would depend on the type process, nature of equipment etc. An Inspector could be a skilled mechanic or an Engineer depending on the level of sophistication. For example, an Aircraft may be inspected by a Senior Engineer in the Aviation industry whereas a skilled mechanic might do the same job in a medium sized metal working unit. An inspector will have to often use his discretion for taking corrective action himself when the situation demands the same. Such actions may include undertaking of repairs or advising a shut down when he thinks the defect notices will lead to a major problem if immediate action is not taken.

## 2.4 Lubrication

*REF. [1], page 12-18.* Lubrication is an important activity in any system of maintenance. The functions of a lubricant are many. They are to reduce friction and wear and tear between the moving parts, to economize power consumption, to keep the bearings within allowable temperature limits, to protect them from dust and corrosion etc. Correct lubrication of all moving parts is necessary to ensure proper running of the equipment, to maintain plant efficiency and to prolong the life of the equipment and its components. A well conceived application by the right method, at proper frequency. Storage, handling identification and standardization of lubricants are also to be covered in the program.

## Selection of the Lubricant

Many different types of lubricants have been developed to suit the varying operation conditions. The selection of the lubricant depends on the conditions under which it is used such as temperature, speed, exposure to dust, water etc. The type of lubricant to be used is normally recommended by the equipment manufacturer or the lubricant supplier.

Lubricants are sold in any number of trade names. However, they can be broadly classified into following types:

- (1) Spindle oils
- (2) Electric motor oils.
- (3) Gear oils
- (4) General Bearing oils
- (5) Turbine oils
- (6) Air Compressor oils
- (7) Refrigeration compressor oils
- (8) Steam Cylinder oils
- (9) Automotive oils
- (10) Cutting oils
- (11) Hydraulic oils and
- (12) Greases

## Planning of Lubrication

It would be desirable to have detailed charts for each equipment indicating the points to be lubricated, type of lubricant to be used for each point, the method of lubrication and the frequency of application.



Like any other job, lubrication work is also to be planned properly. When the lubrication charts for all the equipment are ready, a schedule can be prepared for each giving the machines and the points to be lubricated, frequency and the sequence to be followed. This can be either a daily or a weekly schedule so that a worker knows what he should do during the day or the week. This will ensure attention to all the machine and fix responsibility. Color and symbol codes can be used in the scheduling forms to facilitate the oiler in easy identification. The supervisor who will also take action wherever necessary as reported by the oiler will check the scheduling form.

Often lubrication work is entrusted to a relatively lower level of worker. Machine or process operators are also entrusted with the responsibility of lubrication. While it is goods to involve the operators in the maintenance of equipment, the responsibility must be clearly demarcated. An oiler or greaser must be a fairly skilled person properly trained in the types, uses and methods of lubrication.

## 2.5 Measurement of Maintenance Work

Like all other Industrial activities, maintenance work also needs to be controlled. In order to control, it is necessary to compare actual conditions with certain predetermined targets. The necessity for control is comparatively more in maintenance activity due to the operations being more manual and variations in work contents of the same job, on different occasions.

The important benefits provided by maintenance work measurements are:

- i) Increase performance with reduced labor
- ii) Reduction of delays
- iii) Reduction of downtime
- iv) Improved manning
- v) Improved scheduling

The measurement is the application of techniques to establish the time for a qualified worker to carry out a specified work at a defined level of performance. The allowed time thus obtained is known as standard time for the job.

When the standard time is determined it would be possible to arrive at the standard output that can be expected. This will help in judging the performance and improving on it. Number of persons required for any maintenance job and the maintenance department can be estimated. Scheduling of maintenance jobs becomes possible. Delays if any could be identified and reduced. Motivation of employees through suitably designed incentive schemes can be done. By attempting to complete the job as quickly as possible the downtime of the machine can be reduced.

Measurement of maintenance work is quite difficult because of the nature the jobs and the variations that occur. The type of work measurement technique to be used depends upon the type of maintenance jobs to be measured. It is usually a combination of the different techniques that gives best results.

## 2.6 Maintenance Records

*REF. [1], page 24-25* . Building up of data and an analysis of the same is one of the basis aspects of preventive maintenance. Some data is normally maintained in the form of logbooks by every maintenance department. But this is mostly incomplete and haphazard and would not serve any useful purpose if any analysis were to be carried out. Various decisions involved in respect of inspection to be carried, repairs and replacements to be undertaken, manpower to be provided, spares to be stocked and schedules to be drawn up, are all dependent on an analysis of accurate data. Installation of a preventive maintenance system and refinement of the system for effective results calls for a proper data bank. While paper work is essential, it should be reduced to the minimum.

Some of the essential documents to be maintained are:

(i) *Instruction Manuals and Drawings* : Machinery manufacturers supply the manuals along with the equipment. These manuals contain some very useful information regarding the operation and maintenance of the equipment. They are very valuable guides for installation, commissioning and running of the equipment. The maintenance engineer would need to refer

to these manuals often and therefore they should be in the physical custody of the maintenance department. For easy reference, it is preferable to keep them properly indexed.

In addition, relevant drawings of the equipment and the parts would also need to be made and filed in cabinets.

*(ii) Equipment Data* : All relevant information about each and every equipment should be available in the maintenance department. Equipment data sheet will contain information like (1) description of the equipment (2) supplier's name (3) date of installation (4) cost of equipment (5) physical dimensions (6) operating characteristics (7) spare parts required (8) type of lubrication etc.

*(iii) Equipment History Card* : This is a record of all the repairs, overhauls, modifications and replacements done on an equipment. All the events that have occurred during the life span of equipment are chronologically and systematically recorded, giving complete history. The history cards enables the maintenance man to study the behavior of the equipment and analyze the life of parts, determine and refine inspection plans, and decide modifications.

The data thus collected through history cards will have to be further analyzed in detail in order to determine the causes of failures and decide on the corrective action to be taken and the maintenance program to be adopted for maintaining and improving the performance. This analysis will be category wise such as electrical and mechanical, accessory wise like failures of compressor pump, motor etc. The possible causes of failure may be further classified as (1) defective design (2) defective material (3) poor maintenance (4) improper operation (5) environment and working conditions etc. When the causes of delay are classified in the above matter, it becomes possible to take corrective action to remove the cause and improve the efficiency.

## 2.7 Maintenance Planning

*REF. [1], page26-28.* Planning of maintenance work involves deciding as to what jobs are to be done, how they are to be carried out, when they should be taken up and the various resources required to do the work. Correction measures are also to be taken up as and when there is likely to be deviations from the plan during the actual execution of the work. The objective of planning is to carry out all the jobs in the most effective way using the correct amount of resources.

Maintenance planning will consist of :

- (1) forecasting the future work
- (2) determining the best method of carrying out the work
- (3) arranging for the spares and other maintenance materials required
- (4) working out a schedule in consultation with the production departments
- (5) deciding the number and type of people required to do the job
- (6) allocation of work to individuals
- (7) follow-up and control regarding progress of work.

Planning of maintenance work is far more difficult than planning of regular production jobs, due to the nature of work and the uncertainties involved. But with a system of preventive maintenance, considerable part of maintenance work can be brought within the preview of planning.

Inspection and lubrication are routine activities, which can be easily planned.

Periodic overhauls can be planned in advance. Repairs and replacements to be done on the basis of inspection reports can also be planned to some extent. But the breakdowns cannot be forecast and these are difficult to plan. However, a certain amount of spare man-hours will have to be kept unscheduled to cater to the to the emergency breakdowns. The number of breakdowns will also be less with the preventive maintenance system in operation.

The type of work that need to be done may arise from inspection reports, requires from operating departments, scheduled replacements and overhauls and any special work assigned by management. It would be preferable to document the method of work for each type of routine maintenance job. The method of attending to breakdown jobs however would have to be decided by the maintenance engineer as and when they occur. A good system of spare control will ensure availability of materials as and when required. The type of people required to do the job will have to be determined by the maintenance engineer depending on the skills required, while the number of people required can be estimated through the use of any of the work measurement techniques explained earlier.

### Scheduling

Scheduling is the preparation of a timetable, showing the allocation of the various jobs to specific time periods. In order to prepare such a schedule the estimate of time required for various jobs is necessary. The jobs to be done are all collected and the total man-hours required are estimated. Once the man-hours required are computed craftsman, it is compared with the available man-hours. The jobs are then scheduled according to priority and the availability of man-hours. Scheduling of maintenance work requires detailing of maintenance and production schedules. Hence, it is necessary to involve production personnel in decision-making regarding jobs to be carried out, priority of each job and the time when it is to be undertaken. It may be advisable to prepare a tentative schedule for a period of 2-4 weeks and finalize it in consultation with production. Schedules can be prepared in two stages, long term and short term. Long term schedule can be for a period of 8-10 weeks whereas a short-term schedule will be a final and a detailed break-up of work for the next one week.

The authorization for executing the work will be through a work order which will give the details of work to be done, estimated time, scheduled period, materials required, labor requirement and the method of work. Materials required for the work will be drawn against authorized material requisitions. Time spent on each job/work order will be booked in the time cards by the foreman or the individual employees.

Gantt Charts are useful for scheduling the various jobs and indicating the actual progress against the schedules. Necessary action to reinforce the strength or overtime working will have to be taken by the superiors in case of behind schedule situations.

Major maintenance jobs like periodic overhauls and replacements can be very effectively scheduled using network techniques.



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## CHAPTER 3

### The Study of Sample Factory's Production Line and Maintenance System

#### 3.1 Company Profile

##### 3.1.1 Company Background

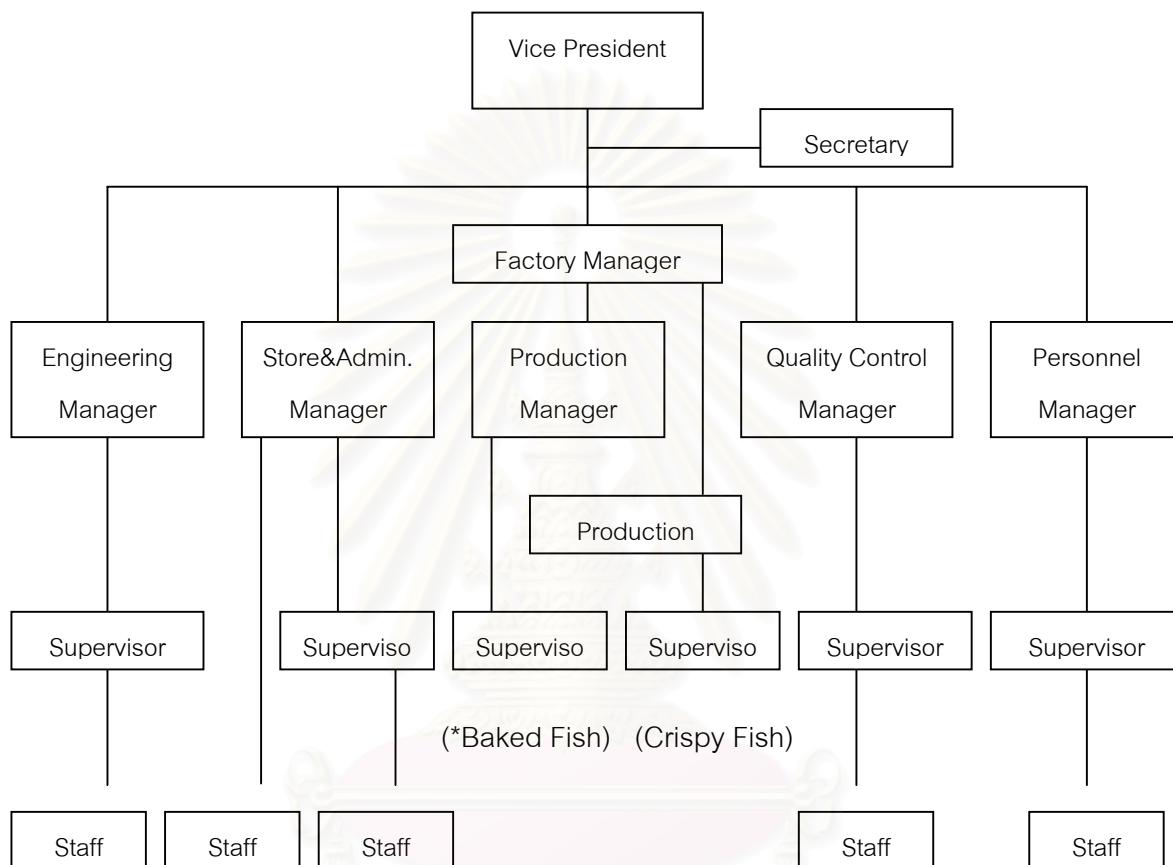
As we have presently experienced, there are many factories for food snack production in Thailand and a lot of new food snack products have been continuously launched to the market. A fish snack production factory, therefore, has been chosen as a sample factory to study. This fish snack factory is founded in 1995 under the Promotion of the Board of Investment (BOI). In spite of its newly opening, it is found that the machines has been frequently damaged and broken down due to the lack of proper machine maintenance system and mismanagement within the Engineering Department.

The general information of the factory is as follows:

- Total number of employees: 457 employees divided into
  - 350 Permanent employees
  - 100 Temporary employees and
  - 7 Management level employees
  
- Types of Product
  1. The Baked Fish Snack
  2. The Crispy Fish Snack

### 3.1.2 Organization Chart

The following is the Company's organization chart and job delegation.



\* The Baked Fish Snack section that we study.

Figure 3.1 Organization Chart



From the organization chart (Figure 3.1), there are five management positions in five sections as follows:

1. Production Manager  
Be responsible for all production for baked fish snack. For the crispy fish snack production, it is under the responsibility of the Production Chief supervised by the Factory Manager.
2. Store & Administration Manager  
Be responsible for R/M filing and delivering F/G including all administrative jobs within the factory.
3. Engineering Manager  
Be responsible for all machine maintenance, machine and spare parts build-up and installation, production development and all factory utility maintenance.
4. Quality Control Manager  
Be responsible for all inspection and product quality control as indicated in product specification including all production control according to Food Production Standards.
5. Personnel Manager  
Be responsible for all personnel recruitment, salary and compensation and regulatory control as set by the company.

In this Chapter, only the working system for baked fish snack production under the responsibility of Engineering Manager and Production Manager will be studied.

## 3.1.3 Business Process

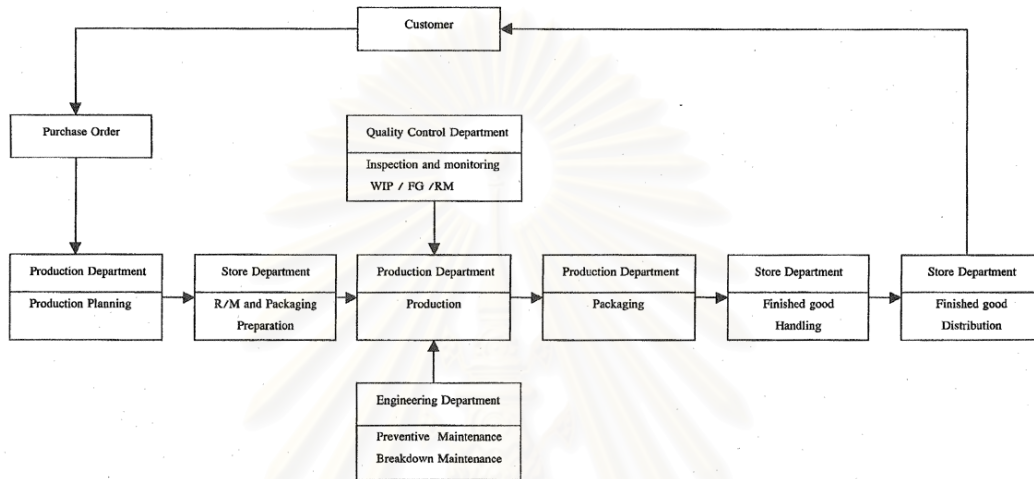


Figure 3.2 Business Process

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From Figure 3.2, the business process can be explained as follows:

After receiving purchase orders from the distributors, the Production department will do the production plan and then forward the production plan to the Store department to prepare raw material and packaging prior to the production. The Production department must set up the production plan to meet the customer's needs and fix amount of products as set in the production plan under the support by the Quality Control department in connection with product inspection and monitoring work in production process, the quality of raw materials and finished products. The Engineering department has main duty in machine maintenance by using the preventive and breakdown maintenance. Then, the products will be packed and kept in the stock and delivered to the customers in a later time.



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## 3.2 Production Line of Fish Snack Product

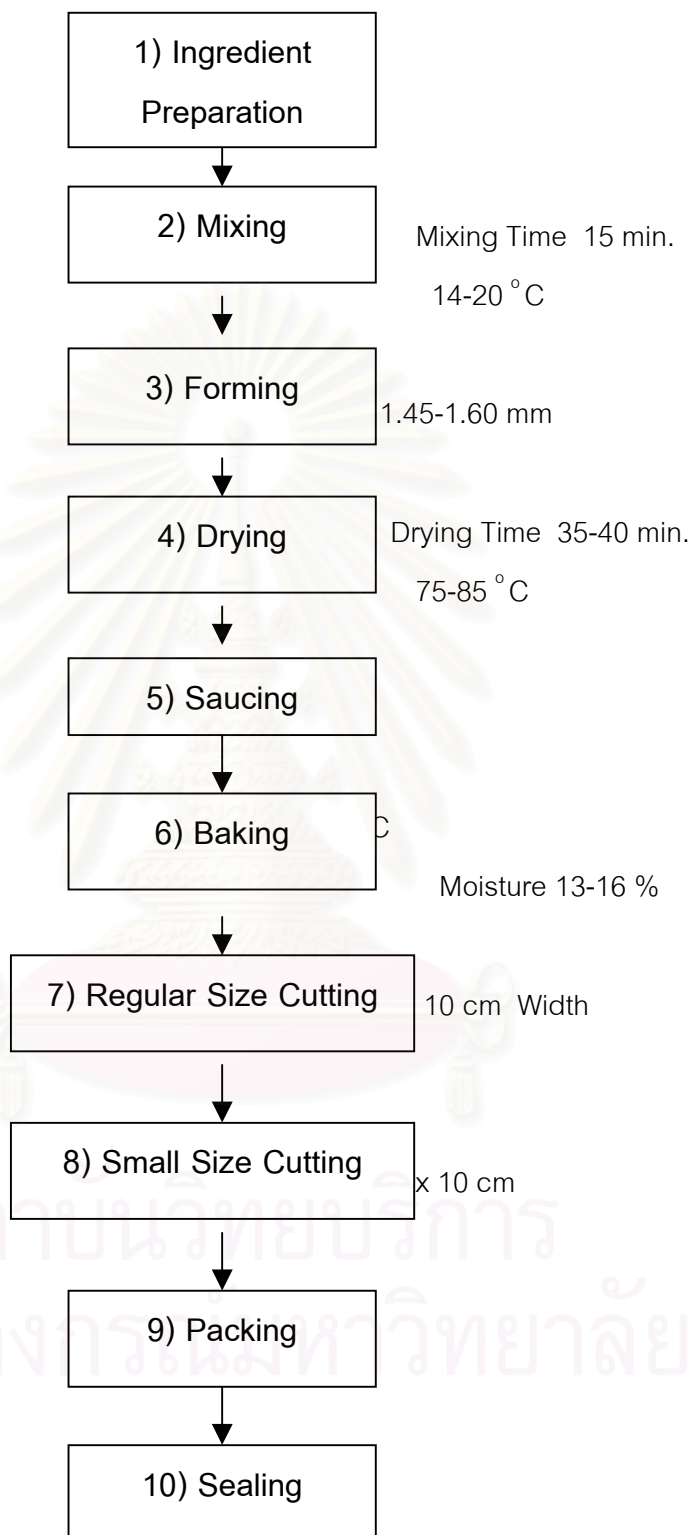


Figure 3.3 Baked Fish Snack Process

### Production Line of Fish Snack Product

From figure 3.3 the baked fish snack process can be explained as follow:

#### 1. Ingredient Preparation

The production line begins with the preparation of ingredients such as wheat, chili, sugar, soy sauce, salt and etc. (Figure 3.4), which have been brought from the stock room and randomly, checked through the quality control process. Then, all ingredients will be mixed in accordance with the recipe. After having been weighed, ingredients will be packed in plastic bag. (The weight unit of ingredients is named as 1 Batch.) Put those ingredients in the basket by 1 batch per basket. Then, they will be kept in the mixing room waiting for later mixing process.

As for Surimi, frozen fish filet, it will be taken out from the frozen room (temperature  $-5$  to  $-10$  ° C) to be thawed at room temperature for not more than 24 hours. The nature of thawed Surimi is the combination of 30%soft and 70% frozen and ready to be mixed.



Figure 3.4 Ingredient Preparation

## 2. Mixing

This step is to mix all prepared ingredients with Surimi in a mixer, by filling 1 batch of mixer per bowl per 15 minutes. Mixing will start with low speed at temperature of approximately  $8^{\circ}\text{C}$  and speed up at temperature of  $14 - 20^{\circ}\text{C}$  until fish dough is smooth and then lower the unloader in order to unload fish dough from the bowl to the Feed Pump (Figure 3.5)



Figure 3.5 Mixer

## 3. Forming

Fish dough will be conveyed (by pressure supplied from 1 Feed Pump) through rubber stator to the 2 units of Forming Machine. At this process, thick and well-mixed fish dough (at the temperature  $17 - 23^{\circ}\text{C}$ ) will be kept at the Forming Unit that forms the fish dough into evenly smooth and thick sheet with the shape of 50 cm. width and 1.45-1.60 mm. thick). The smooth and non-wavy edged fish sheet will be conveyed from the Forming Unit through the Thickness Adjustment Plate to the Drum that continually rotate through Infrared Burner that forms the fish sheet to the smoother sheet. Then, the fish sheet will be pre-heated by another Infrared Burner. (Figure 3.6)



Figure 3.6 Forming Machine

#### 4. Drying

After preheating, the fish sheet will be heated in the Dryer for 35-40 minutes at the temperature of  $75^{\circ}$  -  $85^{\circ}$  C in order to keep the moisture content as per the specification. Then, the fish sheet will be conveyed along the conveyor to be dried evenly by the heat from the Blower ignited by the Burner. (Figure 3.7)



Figure 3.7 Dryer

## 5. Saucing

This step is to dip the fish sheet with the sauce mixed form soy sauce and red pepper. Fish sheet will be conveyed through the Seasoning tank and formed by sponge rollers to soak the fish sheet evenly. After that, the fish sheet dipped with sauce will be spread out for at least 30 minutes to let the sauce soak into the fish sheet. (Figure 3.8)



Figure 3.8 Saucing Machine

## 6. Baking

This step is to bake the sauced fish sheet with appropriate gas pressure at 200-300 mmAq and mesh conveyor rotation to keep the moisture at 13-16 °C. In order not to burn the fish sheet, adjust the heat of the burner at the appropriate heat level at 150-200 °C. (Figure 3.9)





Figure 3.9 Baking Machine

#### 7. Regular Size Cutting

The baked fish sheet will then be cut horizontally into pieces with 10 cm. width. After cutting, the size of each fish piece will be 10X50 cm. Then, load the fish pieces into a basket. (Figure 3.10)



Figure 3.10 Regular Size Cutting Machine

## 8. Small Size Cutting

Before cutting, take out any burnt or too small or too big pieces and then stack fish pieces into pile. The fish pieces will be cut into smaller pieces with the size of 2 mm. X 10 cm. (Figure 3.11)



Figure 3.11 Small Size Cutting Machine

## 9. Packing

Before packing, the product will be weighed by digital weighting machine according to specification of each packing size. Then, pack the product and stack the product in the basket. (Figure 3.12)

## 10. Sealing

The product will be sealed. Check whether the product is sealed appropriately by squeezing the package to see if there is any air leakage. Then, pack the product in bag by the quantity of 1dozen, seal it and pack the product into box and deliver them to the stock. (Figure 3.13)



Figure 3.12 Packing



Figure 3.13 Sealing

### 3.3 Specifications of Machine Used in the Production Line

The critical machine used in the production line as follow:

#### Mixer

Amount: 4 sets

Capacity: mixing capacity is 270 kg./hour or mixing speed is 1.5 times/hour (not more than 180 kg. of raw ingredients each time to prevent the overflow of ingredients after mixing.)

Components:

1. *The Bowl Unit* having 210 liters capacity and 2 level adjustment for rotation speed—high at 10 r.p.m. and low at 5 r.p.m.—depending on the condition of fish filet. Its function is enforced by a Motor Pulley passed along the Belt.
2. *The Blade Unit* composed of 6 blades arranged in radius order. Those blades are rotated across the Bowl rotation in order to fully smash fish filet. Blade rotation can be adjusted at 2 speeds—high speed at 1,500 r.p.m. and low speed at 750 r.p.m. depending upon the condition of fish dough we need. Blades are enforced by a Motor Pulley through a Belt.
3. *The Unloader* which is a plate-like equipment having the same radius of the Bowl. It is used to load fish dough from the Bowl to the Feed Pump. It will be worked only if its body touches with the Limit Switch and it is enforced by the Motor attached with the Unloader Shaft.

#### Feed Pump

Amount: 4 units

Capacity: Pumping capacity is approximately 200 kg./hr. / pumping can be adjustable.

Function: Its function is to pump the mixed Surimi from the Mixer into the Forming Machine by the Rotor, screw thread equipment rotating through the Rubber Stator. Fish dough passing through these two parts will be pushed to the Forming Unit and be replaced by the new dough. The upper part of the Feed Pump is a tray for keeping the

mixed Surimi from the Mixer. One Feed Pump will work simultaneously with one Mixer and 2 Forming Units.

### Forming Machine & Pre-heater

Amount: 8 units

Components:

#### 1. *The Forming Unit*

It is composed of 2 Rollers, which are to press the fish dough to pass through the Drum and the Thickness Adjustment Plate which, is adjustable in order to determine the thickness of the fish dough. The Forming Unit is pushed by the adjustable Motor.

#### 2. *The Drum*

It is the place where the fish dough is pressed and formed into a fish sheet. The width of the Drum is 55 cm. It can produce the widest sheet of 50 cm. at maximum. Both sides of the Drum are composed of the Infrared Burners which help provide the heat for the fish sheet in order to make it smooth and have the proper thickness. The Drum will be pushed by the adjustable Motor under the function of the Sprocket and Chain.

#### 3. *The Cooling System*

It is the cooling system to keep constant temperature inside the Drum after continually heated by the Infrared Burners. The water heated by such Infrared Burners will be cool down and be circulated through the Cooling Tower and the Pump which are set up outside the production line. (the flowing rate of the water is 5 liters per minute approximately.)

#### 4. *The Pre-heater or The Pre-dryer*

Components: Adjustable Mesh Conveyor and upper and lower Infrared Burners.

Its function is to dry the fish sheet before baking. The reason to pre-heat the fish sheet is to check the thickness and the moisture content of the fish sheet before drying. It helps make sure that the thickness of the fish sheet is in accordance with the standard.

**Dryer**

Amount: 4 units

Function: It is used to bake the fish sheet in order to control its moisture content.

Components:

1. *The Mesh Conveyor*

It will transport the fish sheet from the Pre-heater to the Dryer and helps circulate the fish sheet within the Dryer machine. (There are 12 stacks of the Mesh Conveyor within the Dryer). Its speed can be adjusted by using the Belt System Reducer. Drying time for the fish sheet is determined by the rotation speed of the Mesh Conveyor.

2. *The Burner & Blower*

It is the source of energy and heat worked by using the Burner ignited by LPG gas. The Burner's function is controlled by the temperature control system. The hot air will be blown by the Blower and circulated within the Dryer.

**Saucing Machine**

Amount: 4 sets

After being dried, the fish sheet will be continually passed along the Saucing machine to be dipped with the sauce from the Seasoning Tank. Then the sauced fish sheet will be passed through the Sponge Saucing Rollers, which help squeeze the excess sauce from the fish sheet.

**Baking Machine**

Amount: 6 units

Component:

1. Mesh Conveyor which is adjustable and at the upper and lower part of it, there are Burners which can be adjusted to increase the heat by moving it down or reduce the heat by moving it up.

### Regular Size Cutting Machine

Amount: 6 sets

Capacity:

- Be able to cut the product at the maximum width of 600 mm. which can be adjusted by using the size adjustment screw/ cutting speed = 35 times per minute
- The thickness of the product can be determined by the adjustment of the upper Blade and the lower Blade.

### Small Size Cutting Machine

Amount: 7 sets

Capacity: Be able to set the cutting pitch (the width of fish piece) from 0.25-0.45 mm./ cutting speed = 160 times per minute maximum/ be able to stack the product at 10-55 mm. thick.

Components:

1. The Blade (straight not curved)
2. The Cutting pitch setting unit based on the concept of Ratchet & Feeding Pawl
3. The Conveyor Belt which feeds the fish piece to be cut by the Blade.

### Sealing Machine (Supporting Machine)

Amount: 16 sets

After being cut, the product will be laid down and passed along the Conveyor to be packed and sealed by the heater sheet with the Teflon conveyor.

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### 3.4 Facts and Details of Machine Breakdown and Accident Rate Occurred in the Factory

#### 3.4.1 Machine Breakdown Summary

As per the nature of the factory is to produce two types of fish snack-the baked fish snack and the crispy fish snack, it is found that the frequency of machine breakdown is quite high as shown in the Table 3.1.

Machine Breakdown Frequency (Times)														
No	Department	1998		1999										
		N	DE	JA	FE	M	AP	M	JU	JU	AU	SE	O	TOT
		OV	C	N	B	AR	R	AY	N	L	G	P	CT	AL
1	Baked Fish Snack	15	10	16	13	11	7	11	13	11	10	9	13	<u>139</u>
2	Crispy Fish Snack	3	5	8	2	2	2	6	9	5	3	4	4	<u>53</u>
TOTAL		18	15	24	15	13	9	17	22	16	13	13	17	192

Table 3.1 Machine Breakdown Frequency of Each Department

From the above Table, it is found that the frequency of machine breakdown of the baked fish snack department is 139 times per year, or equal to 12 times per month in average, higher than that of the crispy fish snack department. Therefore, the baked fish snack production line will be chosen for studying the machine maintenance system in order to later apply the Preventive Maintenance to the system.



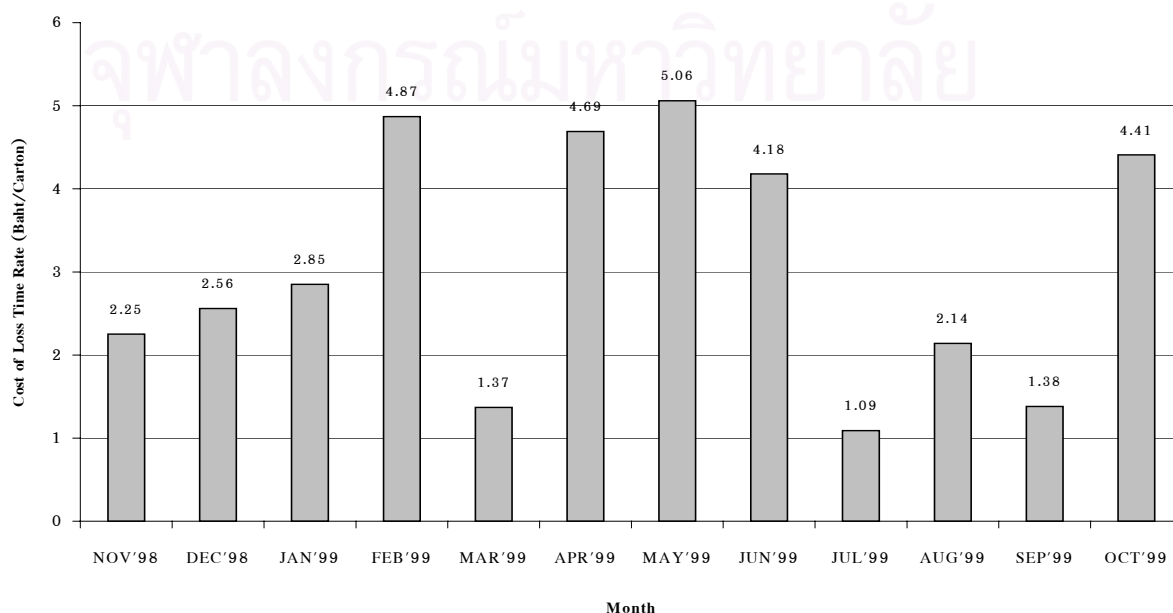
### 3.4.2 Cost of Loss Time Rate

In case of the machine breakdown, the production line has to be temporarily ceased and awaited for the repair by the Engineering Department. Such loss within that period is called *Cost of Loss Time*, which can be valued. If the machine runs properly and continually, Cost of Lost Time will be equal to "0". See the comparison of the production volume and Cost of Loss Time in Table 3.2 and can be seen the trend that increased from November 1998 to June 1999 in Figure 3.14.

Cost of Loss Time Rate (C)													
ITEM	1998		1999										
	NO V	DE C	JA N	FE B	MA R	APR	MA Y	JU N	JUL	AU G	SE P	OC T	TOTA L
A.PRODUCTION VOLUME (CARTON)	68, 025	65, 854	67, 524	65, 739	57, 67 0	30,7 70	51, 529	62, 362	58, 200	57, 300	59, 116	54, 059	698,1 48
B. COST OF LOST TIME (BAHT)	153 ,20 8	168 ,74 8	192 ,29 4	320 ,22 9	79, 27 2	144, 417	260 ,57 9	260 ,57 9	63, 575	122 ,44 1	81, 627	238 ,60 2	2,085 ,570
C=B/A BAHT/CARTON	2.2 5	2.5 6	2.8 5	4.8 7	1.3 7	4.69	5.0 6	4.1 8	1.0 9	2.1 4	1.3 8	4.4 1	2.99

Table 3.2 Cost of Lost Time Rate

Figure 3.14 Graph representing Cost of Loss Time Rate



### 3.4.3 Accident Rate

Accidents occurred during the working hours are mostly resulted by the following causes:

1. Staff's carelessness and dangerous action  
While working, staffs have no sense of safety awareness ie. Teasing each other or not paying attention to what they are doing.
2. Incorrect Machine Usage  
Staff lack of knowledge on how to use the machine properly and what function of the machine is.
3. Having no preventive maintenance for the machine

The following table 3.3 indicates the accident occurred in the production line of baked fish snack from November 1998 to October 1999.

Date	Machine Name	Type of Accident	Cause	Type of Cause	Ceasing Period (days)
1/12/98	Small Size Cutting	-The right middle fingertip torn out -Scratched wound on the back of the hand	- Dangerous part of the machine be reached by hand - Lacking of training on how to use the machine properly	- Nature of the machine being unsafe - Improper work procedures	2
20/3/99	Baking Machine	- Fire seriously burnt at the gas hose	- Lacking of regular machine inspection - Using hose clip instead of ring joint for gas valve	- Lacking of machine preventive maintenance - Improper and low quality equipment	-
2/5/99	Small Size Cutting	- The left middle fingertip torn out	- Dangerous part of the machine be reached by hand - Not being the responsible staff to perform task	- Nature of the machine being unsafe - Not being the responsible staff to perform task	-
3/9/99	Sealing Machine	- Staff being on electric shock	- Lacking of regular machine inspection - Plug having no ground wire	- Lacking of machine preventive maintenance - Incorrect machine installation	-

From table 3.3, it is found that all four accidents has been caused by lacking of preventive maintenance program for the machine and equipment and one of those accidents has been very serious and caused the staff to be stopped working for two days. These accidents have reflected that the preventive maintenance program is in urgent need to be adopted.



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## CHAPTER 4

### Maintenance System

In this Chapter, the general conditions of machine maintenance system prior to the introduction of the Preventive Maintenance System will be discussed. The meaning of machine maintenance system includes all activities implemented to prevent any damages that will occur and be harmful to machine functions, all activities implemented to help increase the effectiveness of machines and to repair any damaged machine to regain its proper condition.

In addition, it will present the summary of work process within the Engineering Department in light of machine maintenance system compared to the Preventive Maintenance System discussed in Chapter 2 i.e. machine spare parts replacement, machine inspection, machine lubrication, machine cleaning system and etc. Moreover, process of repair request, repair and maintenance planning and repair record including the Engineering Department's organization chart and work environment will be discussed to see what else are needed to fulfill the implementation of the Preventive Maintenance System in the sample factory.

#### 4.1 Organization Chart of Engineering Department

In the year 1998, prior to initiating Preventive Maintenance Program, the Engineering department has been formed as the following organization chart:

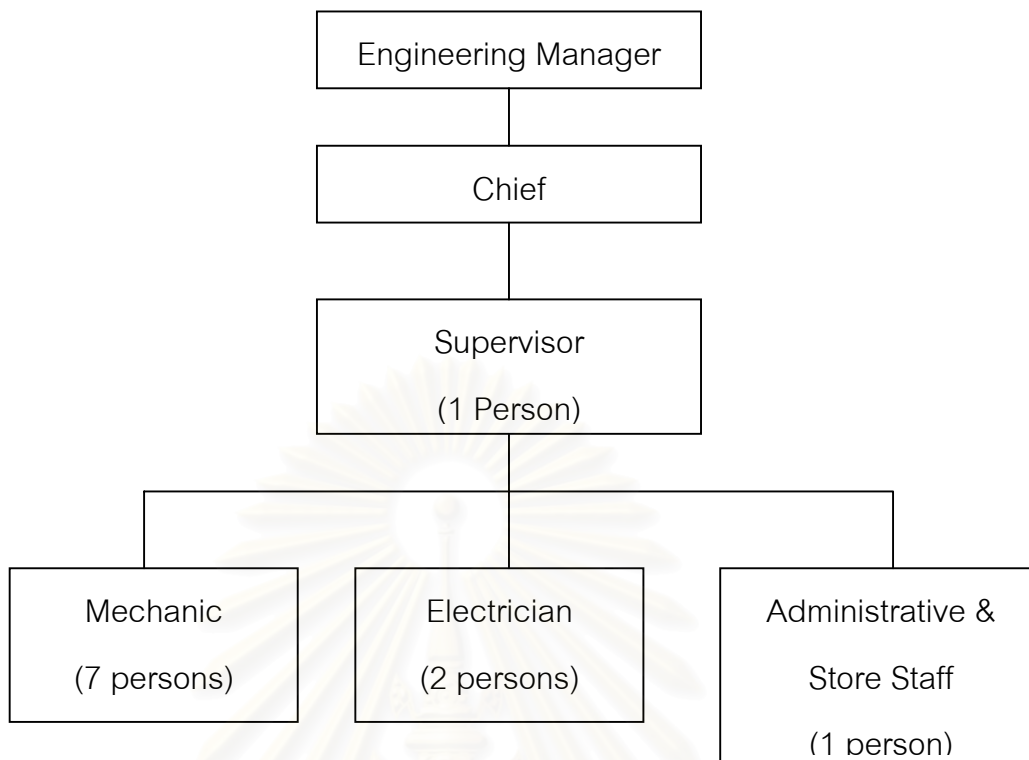


Figure 4.1 Organization Chart of Engineering Department

From the above organization chart, it is obviously seen that the most important staff who is responsible for all maintenance jobs in the Engineering section is a Supervisor since he must take care of and supervise those mechanics to work effectively as assigned by the Engineering Section Manager and to follow the company's rules. Therefore, the Supervisor must possess the following qualifications:

- Have good expertise and experience in machine repair and maintenance and be able to repair/ fix the machine himself.
- Be able to supervise and guide subordinates to work effectively.
- Possess good leadership skills, be able to think and be a good decision-maker.
- Know how to set up a work plan.
- Be able to analyze every aspect of machine related problems and find preventive solutions.
- Have been acknowledged by all staff and mechanic in the section.

However, at present, such supervisor has still lacked and missed some of the above qualifications. The reason is that the company fails to employ a qualified Engineer as a Supervisor. Mostly, such an Engineer is a new graduate, having no experience, lacking of job knowledge and having no attention to apply or adopt any preventive maintenance plan. The most important reason of all is that he has not been acknowledged by his subordinates, colleagues and other staff. Those weaknesses cause very negative attitude and image toward the Engineering department. Other than all the reasons mentioned above, lacking the support from management is another significant factor causing problems in management within the department.

#### 4.2 Productivity Improvement : 5S

5S (Productivity Improvement) is counted as a basic foundation to improve workplace environment within the Engineering department. It is the first significant step that facilitates workplace environment and improves job effectiveness. Without good workplace environment, it is difficult to improve or train any staff to perform their job effectively and productively.

The following pictures describe the "before" workplace condition;

As shown in the Figure 4.2 – 4.10, it is found that 5S program has not been seriously adopted. The workplace such as Shop, Engineering Office, Engineering Store, front and back of work area, staff's desks, shelves and file cabinets including all machines, tools and equipment are not in good order, mess up and dirty. Staff have no sense of belonging in their workplace. Supervisor has no sense of responsibility and leadership skills. A mechanic lacks of good knowledge on 5S. These cause danger workplace environment, equipment/tool misplacement, spare parts shortage and in damaged condition, problem in finding document due to lacking good filing system, dusty and lubricated work area. It is often found that there are times that unexpected machine breakdown happens which requires urgent repair both within office hours or overtime. Such situation gradually destroys staff's morale.



Figure 4.2 : Engineering shop (1)



Figure 4.3 : Engineering shop (2)



Figure 4.4 : Engineering shop (3)



Figure 4.5 : Engineering shop (4)



Figure 4.6 : In front of shop



Figure 4.7 : Within engineering store



Figure 4.8 : Engineering office (1)



Figure 4.9 : Engineering office (2)



Figure 4.10 : Safety equipment

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### 4.3 General Information of Machine and Equipment

**Present:** It is assumed that mechanic and staff have to know what are the frequently used equipment, machine spare parts and their capacity and where to find them. The outstanding problems are that the Engineering department has no appropriate filing system and database for machine/ spare parts such as a list of machine, machine code/serial number, machine capacity and etc. These cause the following results:

4.3.1 In case of production capacity planning, there is no precise information for calculating line balancing. At present, the only source of data is based on information from the Production department that is not reliable. Therefore, it often creates errors in production capacity estimation.

4.3.2 In case of increasing in production capacity, some important information and some key factors have not been brought to consideration such as dimension of the machine, power to produce electricity, some necessary machine spare parts, advantages and disadvantages of each machine. These factors are ground knowledge to be used in evaluating purchasing needs and to see whether the new machine is compatible to the old one or not. Presently, It is found that an old model machine has been purchased from monopoly vendors in stead of buying higher quality machine from reliable and appropriate manufacturers.

4.3.3 There is no standard for what machine is counted as main function and what machine is supporting. Such information is very crucial for classifying types of machine in machine database. Currently, it is found that there is no machine classification. This creates problems in planning the preventive maintenance and staff doesn't know priority of which to be done first. Especially, it seems that a mechanic tends to fix the machine that is not complicated and easy to fix first because to repair the main machine takes a lot of time and requires more expertise, competence and techniques. Therefore, the main function machine will be fixed later on, which obviously causes unexpected machine malfunction in production line.

4.3.4 At present, it is found that there is no reliable system for setting up machine code or serial number that is easy to remember in stead of using machine description or machine name. Sometimes, misunderstanding has occurred between the Production department and the Engineering department. For example, the mechanic fixes the wrong machine since it is in the same model but appears to be another machine. Furthermore, at the work area where the machines are located, there is no serial number of each machine. Some machines have more than one names to be called such as a mixer or a blender. To solve the above mentioned problems is to create a machine name list including each machine's serial number.

4.3.5 There is no appropriate filing system for repair history and database for each machine classified by location. Presently, all data was mixed up.

#### 4.4 Work Order Procedures

A Work Order is counted as the most important document to trace the repair history of a machine. The form includes:

- What is wrong with the machine? Something noticeable.
- Which machine? On what date?
- Who makes a repair request and to whom?

Also, it may include previous repair status that is composed of the following:

- What are causes of damage?
- Troubleshooting?
- Who makes a repair request and to whom?
- When and how long to do a repair after receiving a request?
- What spare parts have been used?
- How long has the machine been shut down during repair?

- How long does it take to get a mechanic ready for such repair?
- Test Run period.

Therefore, in conclusion, a Work Order is very resourceful document to help analyze causes and find out the preventive solution to ensure that there will not be such a damage occurred again in the future.

#### Current and Available Work Order Procedures

**Present:** there is only one standard form called a Work Order to be used for making all kinds of repair request ie. request for repairing the machine component, broken down machine and routine repair for a machine as shown in the following:

#### **Work Order**

Division \_\_\_\_\_ Request Date \_\_\_\_\_ Time \_\_\_\_\_

Received by \_\_\_\_\_ Date \_\_\_\_\_ Time \_\_\_\_\_

Repairer \_\_\_\_\_ Starting Date \_\_\_\_\_ Time \_\_\_\_\_

Inspector \_\_\_\_\_ Date \_\_\_\_\_ Time \_\_\_\_\_

No.	Location	Description of Damage	Remarks

Requested by \_\_\_\_\_ Controller \_\_\_\_\_

Figure 4.11 Current Work Order

It is obviously seen that a requester will often request for a repair by phone or in person and leave a message to maintenance staff to fix the machine without filling out a Work Order or any written evidence. Such action caused by requester and especially by maintenance staff themselves who do not follow the repair procedures create problems in keeping track on previous repair of such a machine. Furthermore, a Work Order itself has some deficiencies as follows:

- Not providing a copy of Work Order for requester to keep track on repair status.
- Having ambiguous wording such as in the block of requester, machine location, remarks block (not clear enough about what it is for and who will make such remarks), responsible staff (not clear who he is), space (why to leave too much space), and inspector block (not clear who it should be and if no inspection, what will happen).
- Not providing classification or prioritization of repair request (not knowing which one is required urgent treatment).
- No specific authorized signatory within the Production department to issue a Repair Circular. Everyone can issue it at anytime.
- No specific delegate within the Engineering department to collect such requests. A person who receives the request has to follow up the case from beginning to end.
- No order setting for a Work Order. Unable to control which request has been done and unable to prepare a monthly repair summary report.
- Not providing records on repair details and descriptions of what spare parts have been replaced and what has been done so far. Not knowing that the repair be approved yet and no record on time spent and total downtime.
- No appropriate filing system for those Work Orders. Unable to find out back date data/information.

#### 4.5 Machine Inspection

Currently, the Engineering Department has inspected all machines while the Production department will inspect the machine only in case of the machine breakdown.

As we know that each machine consists of many parts and each part has possessed special function and qualification, the current and available Machine Maintenance Schedule classifies type of machine and equipment into 11 machine types with details of what has to be inspected. Furthermore, in the Remarks block, it shows how frequent the machine has to be checked. See the following schedule:



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### Machine Inspection Schedule

#### Type of Machine

Machine No.	Machine Name	Inspection Checklist	Remarks
1	Freezer	Check temperature and leak test	Daily
2	Mixer	Oil and grease lubrication	Weekly
3	Forming M/C	Oil and grease lubrication	Weekly
4	Dryer	Grease lubrication	BI-weekly
5	Saucing Machine	Oil and grease lubrication at Bearing machine	Monthly
6	Baking Machine	- Check the gas burner	Daily
		- Oil and grease lubrication	Weekly
7	Regular Size Cutter	Oil and grease lubrication	Monthly
	Small Size Cutter	- Oil lubrication at glass tube  - Grind a blade	Weekly  Daily
8	Packing Machine	Clean the inner part of the weighing machine.	Monthly
9	Sealing Machine	Clean the inner part and lubricate it with  grease	Monthly
10	Lift	Make sure if it is ready to use and in good  condition	Daily
11	Motor Gear	Check the oil drain conveyer belt	Monthly

Figure 4.12 Current Machine Inspection Schedule

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DAILY MAINTENANCE REPORT

REPORTED BY \_\_\_\_\_ DATE \_\_\_\_\_

No.	Machine Name	Maintenance Checklist	Ready to Use	Need Repair	Time	Remarks
1	Freezer	- Check temperature and meter - Check Controlling System				
2	Mixer	- Check Rotation Speed - Check Blade sharpness - Check Motor and V-Belt				
3	Feed Pump	- Check Rubber Stator - Check Motor and adjust rotation speed				
4	Drum Former and Pre-Heat Machine	- Check Former Roller Bush - Check Thickness Adjustment Plate - Check Cooling Tower - Check Gas Burner and Valve - Check Wire Mesh Conveyor				
5	Dryer	- Check Controlling System - Check Gas Burner - Check Sprocket - Check all Bearings - Check Wire Mesh Conveyor				
6	Baking Machine	- Check Gas burner and Valve - Check Motor and adjust speed - Check Wire Mesh Conveyor				
7	Cutting Machine	- Lubrication - Check Feeding Belt - Check Motor and adjust speed				
8	Cutting Machine (small size)	- Replace the blades - Check Gap between Blade and Conveyor - Check Gear and Gear Wheel - Check Motor and adjust speed				
9	Main Control Power DB Cabinet	- Clean the cabinet - Check all meter and gauge				

Checked by: \_\_\_\_\_

Approved by: \_\_\_\_\_

Figure 4.13 Daily Maintenance Checklist

From the current Machine Inspection Schedule, we found the following remarks:

1. Although this schedule has covered almost every item of required inspection for each machine such as machine cleaning, lubrication, machine spare parts replacement, safety system checking, and etc., it does not enter into the adequate maintenance details of each item. For example, the Dryer Machine, the maintenance is related to only oil lubrication in general, not providing which single part such as bearings and chain has to be lubricated and how frequent, which spare parts have to be replaced and where to be clean.

2. After setting up a Machine Inspection Schedule, a Daily Maintenance Report has been introduced as shown in Form 4.13.

It is found that maintenance items in both Figure 4.12 and Figure 4.13 are quite different. For example, the number of machine to be inspected of both forms is not the same (there are 11 types of machine in a Machine Inspection Schedule but 9 machines in a Daily Maintenance Report). Maintenance Frequency in a Daily Maintenance Report was set up as daily, which does not reflect the frequency in Machine Inspection Schedule. Therefore, to apply it to the real situation is useless since it is hard to know how, when and by whom to fix the machine if the defected and damaged parts are found.

3. In practice, it is difficult to apply such daily inspection. The priority of maintenance and repair often depend upon the decision of a Supervisor and the condition of the damaged machine. Therefore, the inspection is assumed only the way to check whether the machine works properly, without providing any numerical data back up and good filing system.



The weaknesses of the current machine inspection system can be summarized as follows:

- There is no inspection data collected to be used as back up information for planning a repair schedule. It is obviously seen that in the next inspection, the old problems still remain.
- The defected/damaged condition as set in a Daily Maintenance Checklist does not reflect the condition in a Repair Circular, which will be used as repair history for new repair and maintenance. Currently, it depends on the Supervisor to send a mechanic to fix the machine without specific timing, any evidence of a repair request. There is no clear information on what spare parts have been already replaced or what has been fixed and what is pending.
- Staff in the Engineering department lack of experience and expertise in performing their jobs. In many cases, there are misunderstanding and misinterpretation on the maintenance data/description that is too short and not clear enough. It is suggested that there should be training for all staff on how to input the data so that they will have the same understanding at the same direction.
- Source of machine inspection description/data mostly come from the estimation on what should be inspected of a responsible maintenance staff without reference from any procedure manual or any repair history. Some required inspection was missing. Although everything has been already fixed according to the checklist, there is still an unidentified cause for machine breakdown.
- There is no cooperation in applying maintenance checklist from staff in the Production department who is the first person to know what is going wrong with the machine. Staff has no sense of belonging and responsibility. A Production Operator performs only what he has to do. Although there is something wrong with the machine, he continues to run the machine until his duty is finished. Such irresponsibility brings danger to all functions of the machine. Therefore, it is

suggested that to have all production operators participate in machine inspection is required.

#### 4.6 Machine Spare Parts Replacement

**Present:** The Engineering department is responsible for all purchasing and stock control of machine spare parts but it is often found that when the machine is broken down and required spare parts replacement, such spare parts has been run out of from the stock. There are times that we have to fix other spare parts temporarily so that the machine will not be shut down since as the factory being in upcountry, it takes quite a long time to process spare parts purchasing and delivery.

**Problems:** The following are the problems in spare parts stock control:

1. There is no list of required and important spare parts as instructed.
2. There are no details regarding on specifications of each spare parts, model and supplier/manufacturer's contact person, purchasing period, compatible model of spare parts and etc.
3. There is no replacement record of each machine.
4. There is no spare parts replacement schedule providing the list of spare parts that have specific condition of operation, age and quality.
5. The minimum stock of required and important spare parts has not been indicated and systemized. Thus, it is unable to know how many of each spare parts has been left in the stock.

#### 4.7 Machine Lubrication

**Present:** The Engineering department has attempted to urge the Production department to proceed machine lubrication by themselves with full support from the Engineering department by providing the oil lubrication procedure manual, necessary oiling device, oil, lubricating substances and greases.

**Problems:** The following are the problems found regarding machine lubrication procedures:

1. Production Operators have no sense of responsibility. They are unable to realize the importance of machine lubrication. They do not perform their jobs as instructed.
2. Some parts of the machine need to be taken off before applying appropriate lubricants. Thus, a Production operator unable to do such a complicated job by himself.
3. There is no lubrication record or checklist to make sure if the correct lubricant and the right method have been applied at proper frequency.
4. There is still machine breakdown caused by lacking of lubrication at the proper time.
5. There is no appropriate selection of the correct lubricant, its application by the right method for specific type of machine component.
6. Parts of machine such as circulation oil pipe, seal of gear unit, gasket, greasing Points have not been inspected. Most of them are in damaged condition.
7. Both mechanic and Production Operator have not been provided appropriate training on machine lubrication.

#### 4.8 Machine Cleaning System

**Present:** Production Operators are the responsible persons to clean the machine after use.

**Problems:** It is mostly found that they tend to clean up the outer part of the machine and the noticeable work area. Parts that are difficult to clean and need to be taken off before cleaning ie. An Infrared Burners are often neglected. In many cases, there are machine breakdown caused by dirty machine parts.

#### 4.9 Maintenance Planning

**Present:** Neither machine maintenance standards nor machine maintenance plan has been arranged in advance except the case of new machine installment that is bound with specific timing. Most of the time, there will be an urgent repair when the machine was broken down.

Here is the summary of current and available machine maintenance plan:

- In practice, all machines in the production line have to be operated continuously, thus, there is no timetable for machine shutdown in order to have such a machine repaired.
- There is no scheduling plan in advance for machine maintenance such as monthly plan and annual plan.
- Spare parts and other maintenance materials have not been provided.
- There is no good cooperation between the Engineering department and the Production department for planning advance machine shutdown.
- There is no allocation of tasks among mechanic and maintenance staff in advance.
- It is unable to know what has been done and what step has been undertaken and what is still pending.

- There is no involvement between the Engineering department and the Production department in preparing a tentative schedule for machine maintenance and finalizing it in consultation with each other.
- There is no plan for machine spare parts replacement.
- There is no clear authorization for executing the machine maintenance planning.

#### 4.10 Machine Maintenance Records

##### Instruction Manuals and Drawings

For all machines within the production line of Baked Fish Snack, machinery manufacturers have supplied the instruction manuals and drawings along with the machine and equipment. In the real practice, it is found that staff hardly refers to such manuals and drawings. They tend to use their own experience and fix the machine on trial and error basis. It becomes more haphazard since the corrective action has not been taken to the right place. Moreover, it might add more serious failures to that part of machine.

Instruction manuals contain some very useful information regarding the operation and maintenance of the equipment. Although they are very valuable guides for installation and running of the equipment, there are times that a mechanic has not refer to such manuals. For example, in case of the blades of the mixer machine has been broken, a mechanic will remove the broken blades and replace them with the new ones. In the step of remove and replace the blades, a mechanic is not sure of what to do as shown in Figure 4.14.



Figure 4.14 Mixer's Blade Replacement by a Mechanic

As instructed in the manual, the blade holder is designed to fix the blades into their places. To lock the blade, move the blade holder to the left direction in contrary to the moving direction of the blades. In practice, to replace the blades, a mechanic will remove the old blades by mounting the wrench on the blade-fixing collar against clockwise that is not the correct way to do. It might damage the screw thread of the collar. See the Figure 4.15 regarding the correct way to replace the blades.

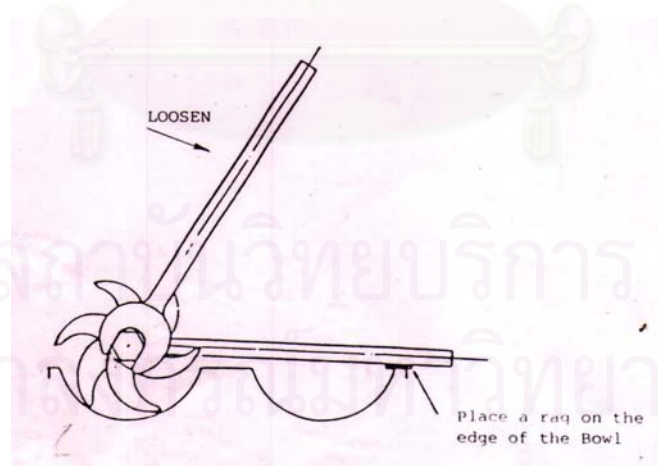


Figure 4.15 Mixer's Blade Replacement as Instructed in the Manual

#### 4.11 Safety System

From the statistics of in house accident in November 1998 through October 1999 as demonstrated in Table 3.3 in Chapter 3, it indicates that the workplace is in dangerous environment. Many serious accidents happen very often and the main cause comes from out of order machine. Especially, the alarm system of the machine has been damaged. Some damaged machines have been fixed and replace with temporary spare parts. When an accident occurs, staff become frightened and loses their morale.

The following are the summary of the causes of accident:

1. There is no regular machine inspection since most of production operators are female staff and the only thing they know is how to turn on and turn off the machine. When the machine is broken down, they just request for a repair. For the Engineering staff themselves, they do not provide the Production Operators with safety guides for operating the machine. Furthermore, they never check if the alarm system has worked properly.
2. When an accident occurs, there is no cause analysis to find the preventive plan for such loss. The accident happens repeatedly to the same place. The preventive plan must be undertaken immediately after the accident occurs.
3. Safety training has not been provided for all staff especially for new staff. All training and orientation are mostly related to work procedures and employee's benefit and remuneration package.

## CHAPTER 5

### Problem and Cause Analysis for Machine Breakdown

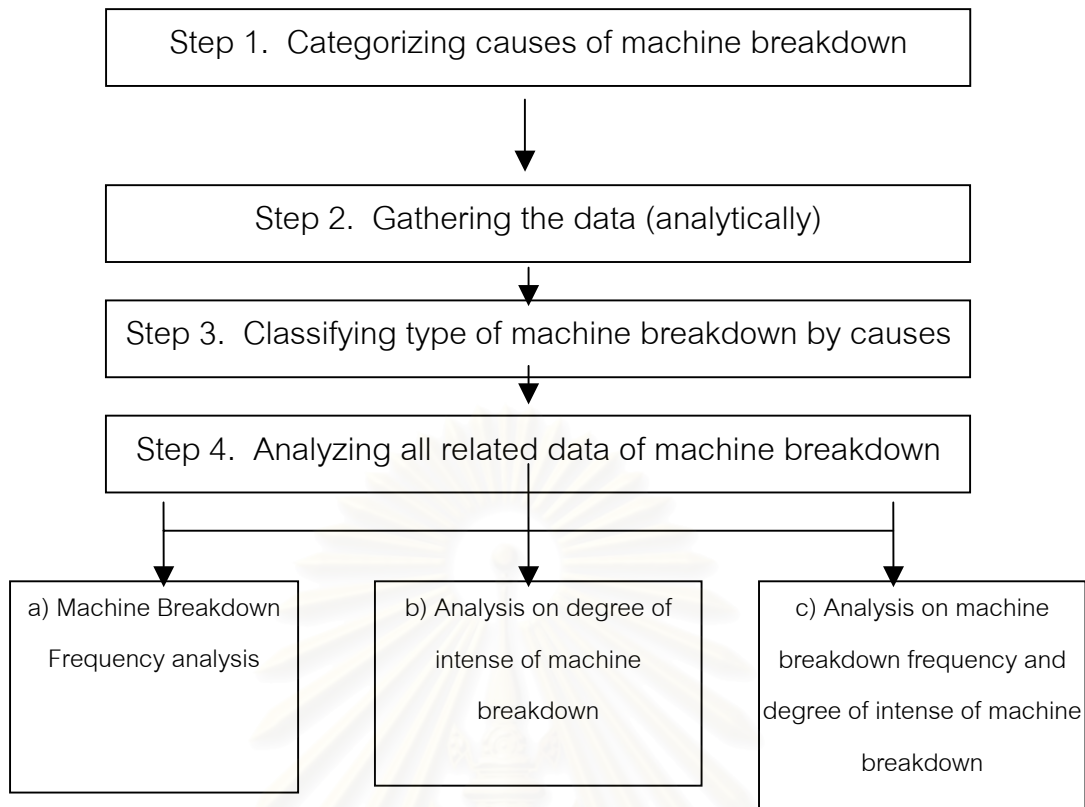
To proceed cause and problem analysis of machine breakdown, type of analysis equipment must be specified in order to provide a guideline for gathering the data to find out what causes there will be and then categorize those causes. This will assist in finding the right, effective and practical resolution for preventing the machine breakdown. In this Chapter, we will discuss analysis procedures to study the existing preventive maintenance program for the sample factory, the calculation of Cost of Loss Time together with the frequency and degree of intense when machine breakdown has occurred to avoid the reoccurrence of damage caused by the same old factors.

#### Analysis Procedures of the Machine Breakdown

The researcher has proceeded the analysis through two and a half-year working experience at the Engineering department within the factory producing corrugated boxes combining with the knowledge gained through the factory manager who has designed, implemented and applied the effective preventive maintenance program to the production system. The program has been successfully adopted and the breakdown can be solved effectively. The following flowchart is the analysis procedures.

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#### Step 1: Categorizing cause of machine breakdown

The researcher has classified type of cause of machine breakdown into 6 types based upon the principles of preventive maintenance system, which can help prevent the occurrence of machine breakdown. The comparison method has been used to compare the actual operation of the Production department and the Engineering department as shown in above flowchart to find out the causes of machine breakdown. Then, classify those causes into types to be used for further analysis.

#### Step 2: Gathering the data (analytically)

To get the full benefits from the data, the researcher has designed the data collecting method (see Topic 5.2) in order to have the clear understanding and objectives of what to analyze. In this step, the researcher has collected the machine breakdown data of the sample factory for one year starting from November 1998 to October 1999.

**Step 3:** Classifying types of machine breakdown by causes

Data collected as indicated in Step 2 (see Appendix A) can be classified by various types of cause. Machine breakdown might be caused by many factors but the most outstanding cause will be recorded in order to avoid too complex analysis.

**Step 4:** Analyzing all related data of machine breakdown

This step consists of 3 types of analysis as follows:

a) Frequency analysis to find out which machine has faced with machine breakdown and how frequent per month.

b) Analysis on degree of intense of machine breakdown

Some machines have often faced with machine breakdown but when calculating the Cost of Loss Time of Downtime, it is found that the machine breakdown is not serious. Therefore, when the machine breakdown has occurred, it is necessary to compare which machine creates the least Cost of Loss Time. Then, it will be more easier to find the right way to prevent the reoccurrence of such breakdown.

c) Analysis on machine breakdown frequency and degree of intense of machine breakdown to find out which is the main cause of frequent machine breakdown and which is the cause of longest Downtime and highest Cost of Loss Time.

The detail of machine breakdown analysis has been shown in Topic 5.3.

## 5.1 Type of Causes of Machine Breakdown

Since the components of each machine in the baked fish snack production line are significantly varied depending upon their main functions, it is necessary to classify those components into categories in order to acquire causes of the machine breakdown and resolutions for such breakdown. The categories are as follows:

- 5.1.1 Lacking of Machine Cleaning System
- 5.1.2 Lacking of Regular Machine Inspection
- 5.1.3 Lacking of Machine Lubrication
- 5.1.4 Lacking of Machine Spare Parts Replacement
- 5.1.5 Lacking of Machine Modification
- 5.1.6 Deficiency on Machine Design
- 5.1.7 Others

### 5.1.1 Machine Cleaning System

The operators often claim that the machines are clean regularly and it is their misunderstanding that to clean only the outer parts of the machine is sufficient. In fact, the appropriate cleaning system for the machine in the production line is to clean both outer parts and especially the parts that perform main functions of the operation. Machine cleaning is beneficial to control the quality of the product. Therefore, it is necessary to control the machine to be in good condition and always maintain its optimum standards. There are often times that the operators misunderstand that it is adequate to clean the outer part of the machine. Such concept is incorrectly perceived.

### Example

At the end of each working day, the operators in charge of Forming & Preheat machine do the daily cleaning at the outer part of the machine as shown in Figure 5.1. As for the Preheat Unit, problem that is mostly found is the temperature of the infrared burner is differently adjusted.



Figure 5.1 Operator clean at the outer part of the forming unit

From the inspection by the Engineering Department, it is found that the operators do the blow cleaning only at the outer part of the infrared burners. The ceramics plate where to ignite the flame is completely damaged and dirty as shown in Figure 5.2. In addition, some infrared burners cannot be ignited. Consequently, the temperature is consistent and the operators have to adjust the valve of the infrared burner to control the heat. The fish sheet at this stage is heated by the inconsistent temperature and it will effect the quality of the product in the next process.



Figure 5.2 The damaged and dirty infrared burners

As for the Forming Unit, whose main function is to form the fish sheet into the evenly flat sheet, there are some fish chips and small flour dough remain over the Forming Unit. Consequently, the fish sheet that moves through the unit is torn apart. Prior to implementing the preventive maintenance program, there are often times that operators have to be stand-by to take out fish chips remaining between the thickness adjustment plate and the drum. Such problem has occurred in most of the production line. From the inspection by the Engineering Department, it is found that the main and important parts of the Forming Unit are not cleaned properly. It is necessary to take off parts of the Forming Unit and clean thoroughly to prevent future damage.

As we can see that machine cleaning plays the very important role in quality control within the production line. If the machine is dirty, it may lead to machine breakdown as the following example.

It is found that the burner in the Dryer machine does not work. After checking, every part of the machine work properly except the Ignition Electrode of the burner whose main function is to spark the flame is covered with soot as shown in Figure 5.3. The cleaning takes 60 minutes to make the burner become in good condition and work properly again. Such damage indicates that there is no regular cleaning for the Ignition Electrode.

Also at the main dryer's duct, it has a lot of pieces of burned fish as shown in Figure 5.4.



Figure 5.3 The Ignition Electrode of the burner covered with soot



Figure 5.4 The lacking of cleaning of dryer main duct.

### 5.1.2 Machine Inspection

One of the main causes of machine breakdown is lacking of regular machine inspection. As stated in Chapter 4 in connection with the general conditions of the machine maintenance system for the fish snack production factory, only the inspection by the Engineering Department is still not adequate. If the inspection system is still not implemented by the users, machine breakdown problems still remain.

#### Examples

1. The often-found problem is the Wire Mesh Conveyor is broken. To fix it takes a very long time and exploits a lot of manpower. The cause of such problem is lacking of regular machine inspection. The sprockets whose function is to drive the Wire Mesh Conveyor are misaligning. If there is proper machine inspection at appropriate time frame, we can fix the sprockets to have correct alignment. The best solution is to plan the systematic machine inspection by indicating how many items to be inspected and how often. The details will be discussed further in Chapter 6.

2. The Forming Unit is counted as the main function of the production line. It composes of many complicated parts. Prior to implementing the preventive maintenance program, the problem found is mostly related to the drum main drive and the Forming Unit in every unit of the production line. It takes a lot of time to fix the problem since it is necessary to reset the machine. The cause is that there is no machine inspection on specific parts of the machine such as sprockets, sprocket key, and sprocket alignment as shown in Figure 5.5. To do the machine inspection is not the difficult task but the most importance of all is when the problem occurred, fix it right away and don't let it happen again.



Figure 5.5 The Lacking of Regular Machine Inspection of the drum main drive

### 5.1.3 Machine Lubrication

As known among technicians and engineers that lubrication is necessary for the operation of the machine, there are still times that machine is damaged as the consequence of lacking appropriate machine lubrication on the main or specific parts of the machine. Parts that need lubrication are parts that are movable both in circular or straight line directions.

The fish snack production factory itself has implemented the machine lubrication program by encouraging the production department to do machine lubrication by themselves. The program is not successfully implemented since the operators do not realize its importance. In addition, they have little know-how of machine specifications and its maintenance. In summary, the problem regarding machine lubrication is not serious since parts that need lubrication are not complicated, noticeably seen and its moving speed is quite low.



### Example

The Dryer Machine composes of many Wire Mesh Conveyors moving through inside the Dryer carrying the fish sheet in order to be heated until having got the appropriate moisture. To adjust the moisture within the Dryer in relation to the time frame and speed of the Wire Mesh Conveyor can be done by using the Reduce Speed Control as shown in Figure 5.6. To increase or decrease the speed, a disc of pulley pushed by Speed Adjustment Handle will move in and out to control required speed.

The operators seem to oversight the lubrication over this part since it is hard to see comparing to other bearings. Therefore, it is more important to provide training (learning by doing) in connection with machine lubrication, where to lubricate and its effects than preparing the ideal manual.



Figure 5.6 The damaged reduce speed control because of lacking of lubrication

#### 5.1.4 Machine Spare Parts Replacement

Wear and tear of the machine is unavoidable and it may finally lead to machine breakdown. In order to fix the machine to be in good condition, the spare parts replacement is required. But the replacement is not successfully adopted since there are a lot of limitations. Firstly, it takes much more time for replacement than temporary machine adjustment. Second, to replace the damaged spare parts has to take off many components and it requires a lot of techniques and experience of the technicians. The responsible staff tends to fix the damaged parts by using the easiest way that takes shortest time.

##### Examples

1. Parts of machine that are movable always require spare parts replacement. The Mixer composing of blades and bowl v-belt which consists of a lot of rollers supported by bearings. The cause of breakdown is those bearings are worn and used up. No bearing can be used forever and if there is no appropriate bearing replacement, the machine will be seriously damaged and it will take a lot of time to fix it.

2. Another important thing is to plan the appropriate machine spare parts replacement schedule together with the preparation of spare parts by making sure that those spare parts are enough in stock and always ready when required. For example, the Thickness Adjustment Plate in the Forming Unit machine whose function is to form the thickness of the fish sheet as shown in Figure 5.7 is worn and torn. The new plate is required but there is no such plate in stock.



Figure 5.7 The Thickness Adjustment Plate was worn

#### 5.1.5 Lack of Machine Adjustment

In the normal maintenance process, even having effective machine cleaning, lubrication, and spare parts replacement system, it is inevitably facing the problem of machine misplacement. Therefore, the machine adjustment process is counted as one of the most important process to make the machine ready to use and exploit the highest benefits of each machine under their limited capacity.

Machine adjustment will be proceeded when the machine parts are damaged or machine fatigue has occurred, for example, alignment adjustment of Chain and V-Belt in case they are stretching out and Sprocket adjustment, and etc. Furthermore, the adjustment standards should be considered since each of maintenance staff has his own capability and is likely to use their own expertise to perform the job. Therefore, after the adjustment, it is required to provide another particular adjustment in the later time. Besides, it is required regular machine adjustment, always going along with the machine inspection and maintenance, to avoid the problem of machine breakdown. When the damage is founded, the Engineering department will be responsible for planning the repair based upon the seriousness of the damage that might cause the machine breakdown.

### Examples

As previously mentioned, regular machine adjustment must be provided. The worn out of the Wire Mesh Conveyor is a good example of lacking regular inspection. Since the Wire Mesh Conveyor is driven by four Sprockets at four different corners, we have to make sure that those Sprockets are well aligned and balanced as shown in picture 5.8. It is often found that such Wire Mesh Conveyor is slipped out and scratches the wall of the Baking Machine causing the Wire Mesh Conveyor Pin worn out. Therefore, regular inspection and Sprocket alignment adjustment can help prevent the damage of the Wire Mesh Conveyor.

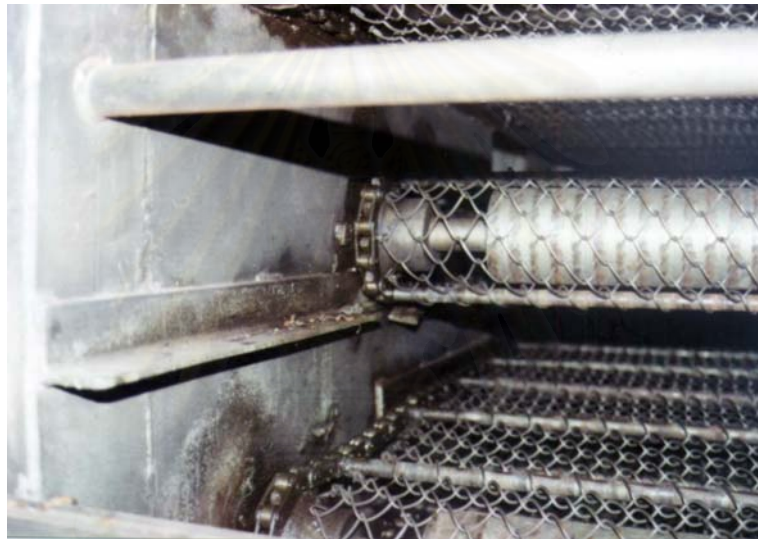


Figure 5.8 The misalign wire mesh conveyor

#### 5.1.6 Deficiency of Machine Design

Normally, every single machine has its own deficiency since there are some oversights when designing the machine in light of its maintenance. This deficiency is likely to cause the machine breakdown even though we provide effective machine cleaning, lubrication, replacement and machine adjustment.

### Examples

Blower is the function to equally disperse the heat throughout the Baking Machine. It is operated by rotation of the Blower Blade under the Hood and Air Duct. Both Shafts of the Blower Blade are supported by the Bearings. It is found that the Blower is designed inappropriately since it is difficult to lubricate those Bearings as shown in Figure 5.9. For a period of time, without adequate lubrication, the Bearings are gradually damaged. As a result, the Blower is finally unable to rotate causing the V-Belt driven the Blower outside the Hood torn as shown in the Figure 5.10. Upon the repair request by the Production department, the maintenance staff or the technician tends to only replace the V-Belt. After that, the V-Belt is again worn out. Thorough inspection is proceeded and it is found out that, after taking the Hood off, the Bearings are seriously damaged. It is not relatively because of lacking of Bearing lubrication or Bearing replacement. The fact is that the machine is wrongly and inappropriately designed. It is not practical to take the Hood off every time when lubrication or spare parts replacement is required. The designer overlooks the practical way to maintenance. The problem can be fixed by connecting grease point at the outside of the Hood.

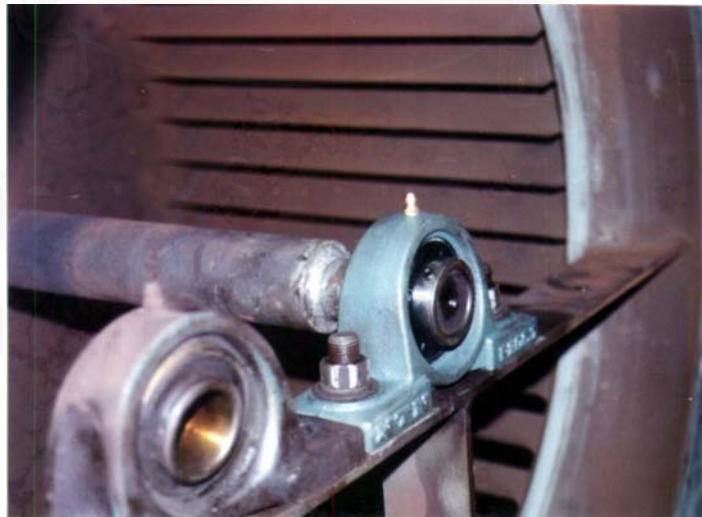


Figure 5.9 The bearing inside blower that can not lubricate



Figure 5.10 The V-Belt of blower that torn

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### 5.1.7 Other Causes

Other causes of machine breakdown are as follows:

1. Wrong operation by the Operator such as adjusting too high temperature or operate the machine at too fast speed and etc.
2. Inappropriate machine adjustment by the technician such as applying too much lubrication for the Baking Machine, wrongly connecting the electric wire and etc.



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## 5.2 Database of Machine Maintenance

To analyze the results of machine maintenance requires data collecting as the following scope:

1. Database is the summary of details from Machine Maintenance Record and Monthly Production Report from November 1998 to October 1999.
2. Only the maintenance results for the main or core machines will be analyzed. The main or core machines are a Mixer & Feed Pump, a Forming Machine & Pre-heater, a Dryer & Saucing Machine, a Regular Size Cutting Machine and a Small Size Cutting Machine. The supporting machines are a Sealing Machine, a Cooling Tower, Fork Lift and small equipment will not be counted and analyzed.
3. A Feed Pump is counted as a part of a Mixer and a Saucing Machine is counted as a part of a Dryer. The maintenance data of those machine will be collected in the same category since the nature of the operation are related to each other.

### 5.2.1 Repair and Maintenance Record

The method for analysis of the machine repair and maintenance is collecting the record of machine breakdown of the fish snack production factory from November 1998 to October 1999 classified by machine type and the following data:

1. Date of Machine Breakdown
2. Machine Code of the damaged machine
3. Description of Errors
4. Corrective Action
5. Cause of Machine Breakdown
6. Downtime or Loss Time: Duration of machine breakdown
7. Cost of Loss Time in Baht
8. Type of cause



### 5.2.2 Downtime Calculation

*Downtime* means the duration of time from when the Production Section requests the repair from the Engineering Department until the repair is completely fixed and the machine can work properly including related document preparation, repair period and test run period which will not be brought to analysis since when the machine is broken down, the Engineering Department will proceed the repair right away assuming that it is urgent task to be done first.

### 5.2.3 Cost of Loss Time Calculation

1. Loss Time in Process will be calculated only if the machine cannot be run or operated and it requires the immediate repair.

Type of the fish snack production line is not continuous operation but station by station type. In case the main machine is broken down, there is spare machine provided for such machine in specific production process such as a Baking Machine, a Regular Size Cutting Machine and a Small Size Cutting Machine. Therefore, when those machines are broken down, there will not be record for Cost of Loss Time. The Cost of Loss Time will be calculated only for a Mixer & Feed Pump, a Forming Machine & Pre-heater, and a Dryer & Saucing Machine since these machines cannot be operated when breaking down.

#### 2. Cost of Loss Time Calculation

In addition to calculation of Downtime and machine breakdown frequency, to analyze the effectiveness of machine maintenance program must include the Cost of Loss Time in Baht. This indication will show how serious the machine breakdown is. The method of calculation is as the following:

Within 60 minutes, production capacity of a Mixer is 2.3 Batch  
 1 Batch of fish dough consisting of fish yield = 39 kg.  
 1 kg. of fish yield costs 210 Baht  
 $\therefore$  within 60 minutes, can produce fish yield of  
 = 2.3 Batch x 39 kg/Batch x 210 Baht/kg. = 18,837 Baht  
 Cost of Loss Time (Mixer) = 18,837 Baht / 60 minutes  
 = 313.95 Baht / minute

3. As for the production line from a Mixer, Feed Pump, Forming Machine & Pre-heater, Dryer to a Saucing Machine being all connected, in case one of them is broken down, others cannot continue the operation. Therefore, Cost of Loss Time of these machines will be equal to Cost of Loss Time of a Mixer.

The Appendix A are the summary of machine repair and maintenance of the fish snack production factory from November 1998 to October 1999.

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### 5.3 Problem and Cause Analysis for Present Machine Maintenance System

From the table appeared in Appendix A, it can be concluded the machine repair and maintenance of the fish snack production factory as follows:

#### 5.3.1 Machine Breakdown Frequency

The analyses of Machine Breakdown Frequency from November 1998 to October 1999 are the followings:

- Machine Breakdown Frequency of Baked Fish Snack is in average of 11.6 times per month as shown in Table 5.1
- Small Size Cutting Machine appears to have the most frequent machine breakdown in average of 3.2 times per month as shown in Table 5.1

The details of machine breakdown in the production line of the baked fish snack from November 1998 to October 1999 are shown in Table 5.1 and Figure 5.11.

#### 5.3.2 Degree of Intense of Machine Breakdown

The analyses of the degree of intense of machine breakdown from November 1998 to October 1999 are as follows:

1. Downtime or Loss Time in Process that depends upon how serious the machine breakdown is.

- Downtime or time for repairing the broken down machine, Time in average of 958 minutes per month as shown in Table 5.2
- Forming Machine & Pre-heater and Dryer are the machine that require the longest time in average of 308 minutes per month and 286 minutes per month respectively to fix when breakdown.

## 2. Cost of Loss Time

Cost of loss time by converting downtime into the form of money (Baht) can indicate how important each machine is. See the following find-out:

- Cost of loss time in Baked Fish Snack Process is in average of 173,797 Baht per month as shown in Table 5.2.

- Dryer is the machine that has the highest cost of loss time in average of 84,453 Baht per month as shown in Table 5.2.

Downtime of a Baking Machine, Regular Size Cutting Machine and Small Size Cutting Machine will not be converted into cost of loss time since when the machine is broken down, the spare machine will be replaced.

The details of machine downtime and cost of loss time in the production line of the baked fish snack from November 1998 to October 1999 are shown in Table 5.2, Figure 5.12 and Figure 5.13.

### 5.3.3 Causes of Machine Breakdown

From November 1998 to October 1999, causes of machine breakdown can be categorized into 7 types as shown in Table 5.3, Figure 5.14 and Figure 5.15.

#### 1. Machine Breakdown Frequency of each category of causes

It can be summarized as follows:

- Lacking of proper machine inspection is the most significant cause of machine breakdown. From November 1998 to October 1999, 67 out 139 times of machine breakdown or 50% of the total machine breakdown are mainly caused by lacking of machine inspection as shown in Table 5.3.

## 2. Cost of Loss Time in categories of causes

Cost of loss time of each category of causes of machine breakdown as appeared in Table 5.3 and Figure 5.15 are summarized as follows:

- From November 1998 to October 1999, the most significant cause that creates the highest cost of loss time is lacking of machine spare parts replacement. The cost of loss time created by lacking of machine spare parts replacement is 626,300 Baht or 30% of total cost of loss time by other causes.

Number of Machine Breakdown	MONTH												Grand Total	AVG
	Nov-98	Dec-98	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99		
MIXER		1		4	2	1	2	2	1			1	14	1.2
FORMING MACHINE	3	2	6	2	2		2	3	2	5			27	2.3
DRYER	3	1	3	3	1	2	3	2	3	1	1	5	28	2.3
BAKING MACHINE	6		3		1	1		2			4	4	21	1.8
REGULAR SIZE CUTTING MACHINE		1		1	2	1	1	1	1		2	1	11	0.9
SMALL SIZE CUTTING MACHINE	3	5	4	3	3	2	3	3	4	4	2	2	38	3.2
Grand Total	15	10	16	13	11	7	11	13	11	10	9	13	139	11.6

Table 5.1 Number of Machine Breakdown (November 1998 - October 1999)



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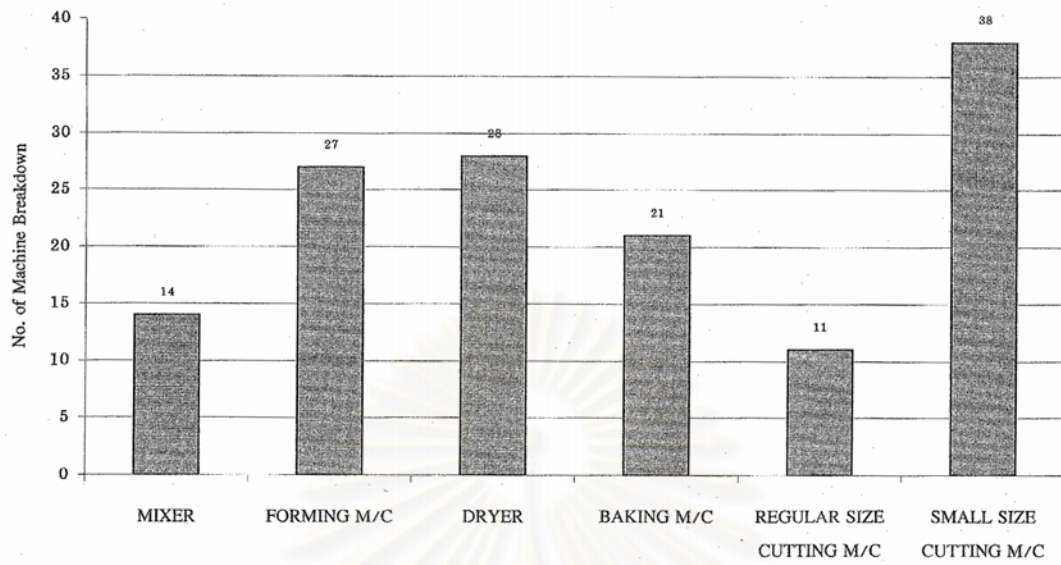


Figure 5.11 Summary of Machine Breakdown (November 1998 - October 1999)

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Data	MACHINE	MONTH												Grand Total	AVG.
		Nov-98	Dec-98	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99		
Downtime (Min.)	MIXER		40		465	120	60	435	285	30			130	1,565	130
	FORMING M/C	140	435	445	380	145		360	700	345	750			3,700	308
	DRYER	418	280	390	425	60	400	215	195	105	15	260	670	3,433	286
	BAKING M/C	195		75		70	20		25			85	100	570	48
	REGULAR SIZE CUTTING M/C		60		90	90	40	120	30	65		185	80	760	63
	SMALL SIZE CUTTING M/C	80	115	120	215	225	60	110	190	150	120	45	55	1,465	122
Cost of Loss Time (Baht)	MIXER		12,558		145,987	37,674	18,637	136,568	89,476	9,419			40,814	491,332	40,944
	FORMING M/C	21,977	68,284	69,854	59,651	22,761		56,511	109,683	54,158	117,731			680,808	48,401
	DRYER	131,231	87,906	122,441	114,692	18,837	125,580	87,489	61,220		4,709	81,627	197,789	1,013,431	84,453
	BAKING M/C														0
	REGULAR SIZE CUTTING M/C														0
	SMALL SIZE CUTTING M/C														0
Total Downtime (Min.)		813	930	1,030	1,575	710	580	1,240	1,425	695	685	575	1,035	11,493	958
Total Cost of Loss Time (Baht)		153,208	168,748	192,294	320,229	79,272	144,417	280,579	260,579	63,575	122,441	81,627	238,602	2,085,570	173,787

Table 5.2 Summary of Downtime and Cost of Loss Time Before Implement Preventive Maintenance

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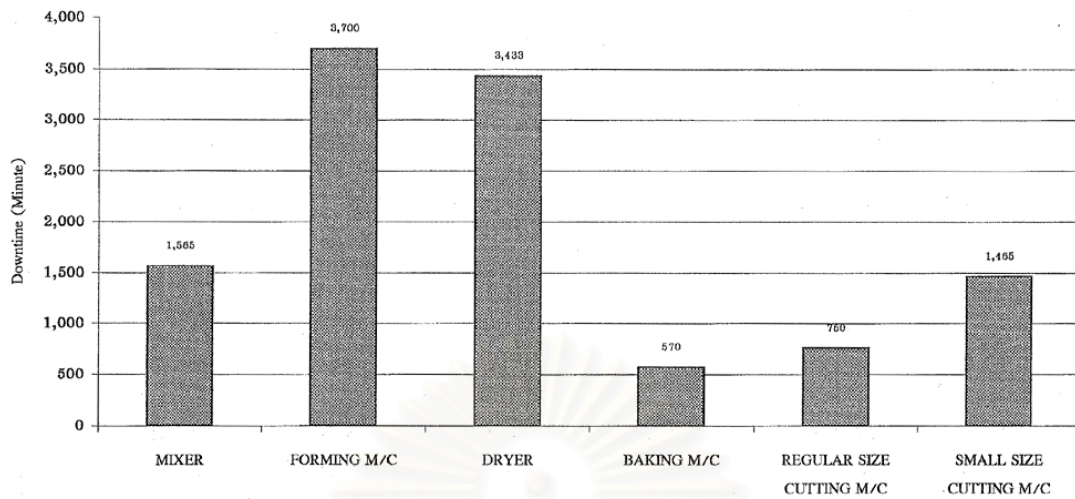


Figure 5.12 Summary of Downtime (November 1998 - October 1999)

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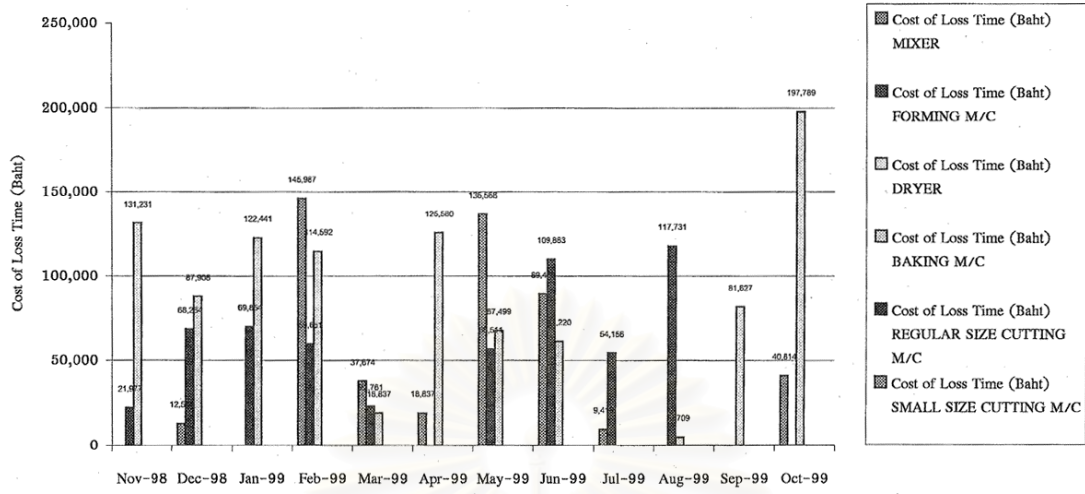


Figure 5.13 Summary of Cost of Loss Time (November 1998 – October 1999)

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Data	CAUSE	MACHINE					Grand Total	AVG.
		MIXER	FORMING M/C	DRYER	BAKING M/C	REGULAR SIZE CUTTING M/C		
Cost of Loss Time (Baht)	Cleaning	78,488		18,837			97,325	8,110
	Inspection	47,093	282,555	91,046			420,693	35,058
	Lubrication		42,883	14,128			56,511	4,709
	Replacement	323,369	174,242	128,720			626,330	52,194
	Adjustment		6,279	464,018			470,297	39,191
	Faulty Design	23,546	37,674	73,778			134,998	11,250
	Others	18,837	37,674	222,905			279,416	23,285
Sum of Machine Breakdown	Cleaning	3		1	4		8	1
	Inspection	3	16	4	11	3	30	6
	Lubrication		1	1			2	0
	Replacement	6	7	3		4	1	2
	Adjustment		1	11	4	2	5	2
	Faulty Design	1	1	5	2		9	1
	Others	1	1	3		2	2	1
Total Cost of Loss Time (Baht)		491,332	580,808	1,013,431			2,085,570	173,797
Total Sum of Machine Breakdown		14	27	28	21	11	38	12

Table 5.3 Summary of Machine Breakdown and Cost of Loss Time in Cause Categories (November 1998 - October 1999)

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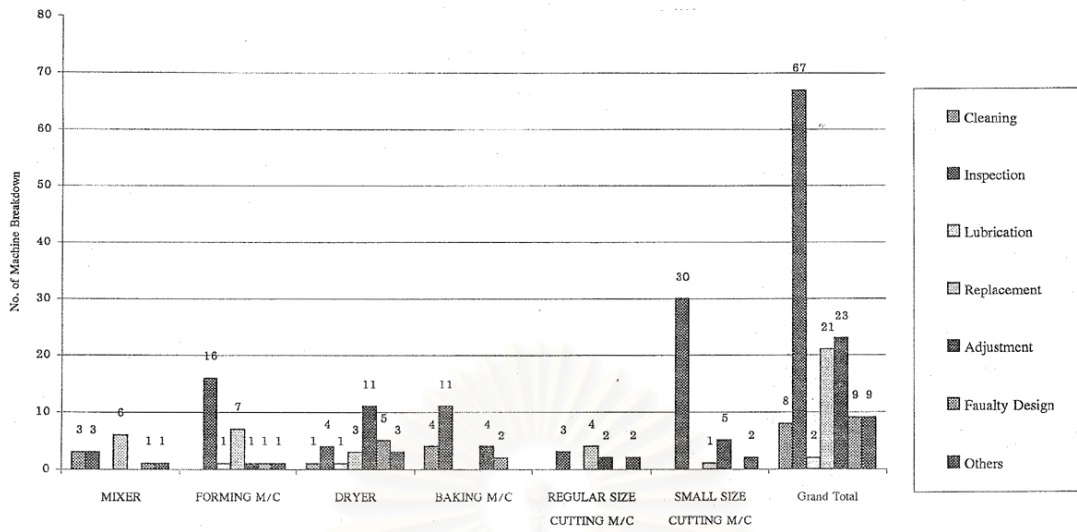


Figure 5.14 Number of Machine Breakdown in Cause Categories (November 1998 - October 1999)

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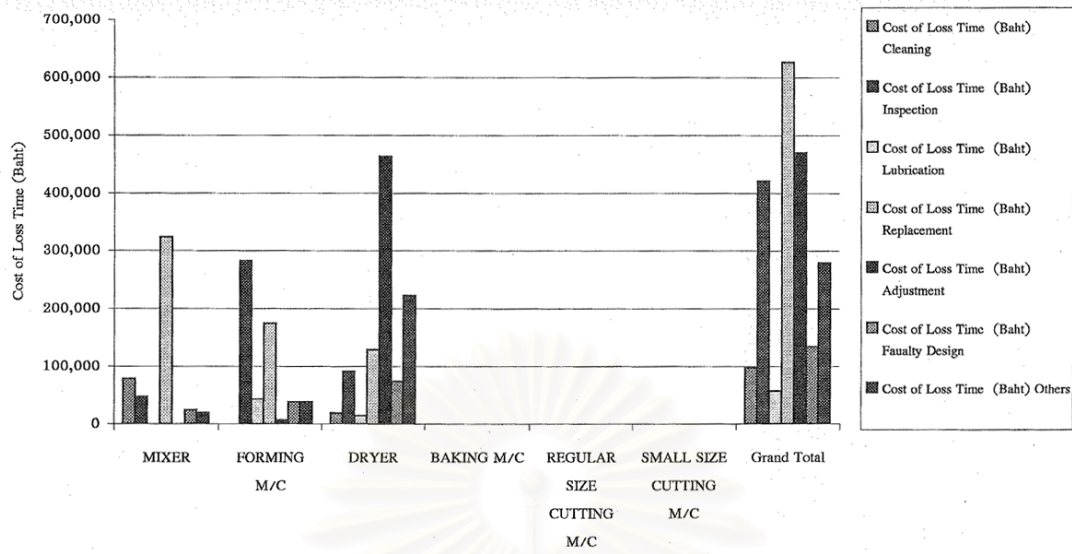


Figure 5.15 Cost of Loss time in Cause Categories (November 1998 - October 1999)

## CHAPTER 6

### Implementation of Preventive Maintenance Program

From general information of machine maintenance system in Chapter 4 and problem & cause analysis for machine breakdown in chapter 5, it is found that the present machine maintenance program has to be adjusted and preventive maintenance program has to be implemented. Prior to the implementation of preventive maintenance program, the first activity needed is to re-organize the maintenance management within the Engineering Department in order to get it ready in light of its manpower, training, work environment improvement, spare parts stock control and work order system modification.

In this chapter, the maintenance management reorganization and the implementation of the preventive maintenance program will be discussed as the followings:

#### SECTION 1: Maintenance Management

- 6.1 Engineering Department Re-organization
- 6.2 Work Environment Improvement
- 6.3 Manpower Training
- 6.4 Work Order System Modification

#### SECTION 2: Preventive Maintenance Program

- 6.5 Machine Classification
- 6.6 Maintenance Planning
- 6.7 Maintenance Work Standards
- 6.8 Machine Spare Parts Replacement
- 6.9 Machine Inspection
- 6.10 Machine Repair Request Form and Document Control System
- 6.11 Shift Mechanic Checklist and Machine Breakdown Report

6.12 Machine Maintenance Record

6.13 Machine Modification

SECTION 3: Preventive Maintenance System Control

6.14 ISO 9002 Certification

6.15 Auditing of Engineering Department's Work Procedures

6.16 Corrective Maintenance



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## SECTION 1: MAINTENANCE MANAGEMENT

### 6.1 Engineering Department Re-organization

It is counted as the most important step of all. Although the present management system is workable, it is required some improvement. For example, in the managerial level, there is only one supervisor taking care of all management activities. Despite such supervisor is directly reported to the production manager, it is hard for the Production Manager to closely monitor his subordinate's managerial performance. Therefore, the structure of the Engineering department is adjusted as follows:

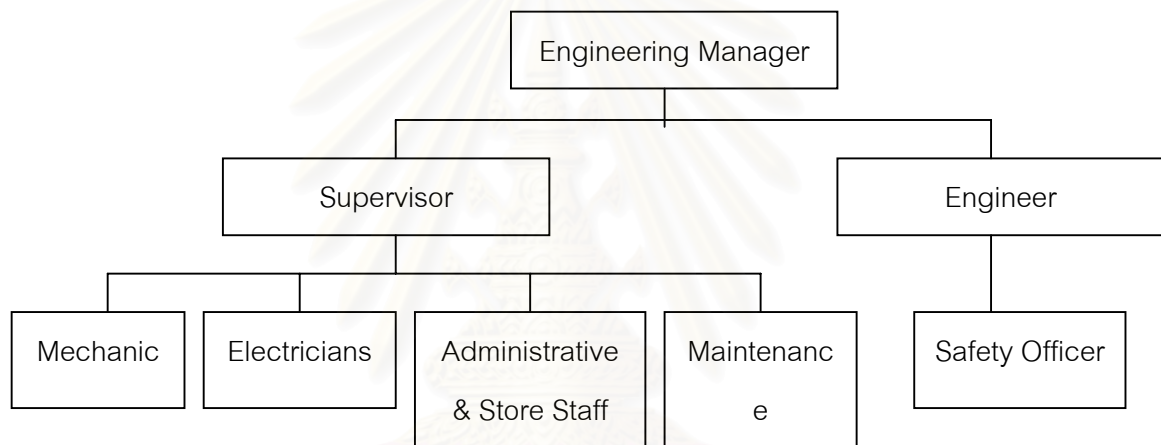


Figure 6.1 Engineering Department After Re-organization

1. Managerial Level consisting of 3 positions namely Engineering Manager, Chief, and Supervisor.
  - Appointing one additional Engineering Manager taking care of all administrative functions within the Engineering department including all planning jobs on personnel management, maintenance system, machine installation, machine repair and machine modification, plant & utility administration, budget, and safety administration.

- Appointing one additional Engineering Supervisor taking care of all duties of the existing Engineering Supervisor has to perform as instructed by the Engineering Manager including supervising the subordinates to perform jobs and to follow the company's rules and regulations, guide and help develop staff's performance. The existing Supervisor will take care of all safety jobs complying with the Labor law requiring one Safety Officer to be appointed in each factory.

2. Operational Level consisting of Engineering Staff (Mechanical Technician, Electrical Technician and Maintenance Planning Staff), Administrative & Store Staff and Safety Staff

- Appointing one additional Maintenance Planning Staff to be responsible for the preventive maintenance program and coordinating with the Production department in connection with machine maintenance program, including follow up the repair by the supplier.
- Appointing one Safety Staff to perform safety work as assigned by the Safety Officer.

After the re-organization of both levels, the management within the department and with the Production department becomes more effective. In order to increase the quality and performance of the staff, job descriptions of each position level have to be indicated as shown in Figure 6.2 –6.8.

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POSITION: Engineering Manager	SECTION: Engineering
DEPARTMENT: Engineering Management	OFFICE: A.B.C. Food Co.,LTD.
JOB DESCRIPTION	% OF TIME SPENT
1. Take care of all installation, repair and maintenance related to machine, electric equipment and all mechanical tools.	10
2. implement plans for machinery maintenance and all production related equipment and tools to enhance the effectiveness of production line.	10
3. Implement a machinery repair checklist together with all related machine repair manuals to enhance the effectiveness of machine maintenance programs.	10
4. Guide or give recommendations to all related departments regarding to spare parts vendors and qualified machine service center.	10
5. Take care of and be responsible for spare parts stock keeping by providing appropriate number of required and frequently used spare parts.	10
6. Be responsible for budget control in connection with all operational expenses such as electricity, water supply, gasoline, etc.	10
7. Supervise/ advise all subordinates to follow the company's rules and regulations, help them develop/enhance their knowledge and capacity to best perform their jobs.	10
8. Encourage and support all corporate activities such as 7S, Safety Awareness and etc.	10
9. Perform other jobs as assigned by immediate supervisor.	10
10. Prepare budget for machinery maintenance and manpower planning.	5
11. Be able to get along well with subordinates and colleagues in other departments.	5
Total	100
<b>AUTHORITY LINE</b>	
Immediate Supervisor: General Manager	
Subordinates: Engineers, Engineering Supervisor, Maintenance Staff	
<b>QUALIFICATIONS</b>	
Educational Background: Bachelor Degree	
Working Experience: 5 years and up	

Figure 6.2 Job description of Engineering Manager

POSITION: Engineer	SECTION: Engineering
DEPARTMENT: Engineering Management	OFFICE: A.B.C. Food Co.,LTD.
JOB DESCRIPTION	% OF TIME SPENT
<p>1. Be responsible for any jobs related to safety engineering and also perform as a company's safety staff.</p> <ul style="list-style-type: none"> <li>- Develop a training and orientation program for new employees to help them realize safety awareness;</li> <li>- Make sure that the workplace is always in good and safe condition;</li> <li>- Inspect cause of accident occurred in the workplace in order to find out what is caused and how to handle such possible accident;</li> <li>- Be appointed as Secretary of Healthy and Safety in Workplace Environment Committee, encourage all members to regularly participate in a monthly meeting;</li> <li>- Provide staffs with all related safety equipment and make sure that they follow safety instructions and use such equipment to prevent any accident that might occur from performing jobs within the workplace;</li> <li>- Monitor and make sure that all staff follow safety instructions, regulations and standards of the company;</li> <li>- Encourage all supporting activities regarding safety awareness;</li> <li>- Act and be responsible for safety in the workplace as assigned by supervisor.</li> </ul>	70
2. Be responsible for academic assignment in order that the company be certified ISO 9000.	20
3. Be responsible for other related jobs as assigned.	10
Total	100
<b>AUTHORITY LINE</b> Immediate Supervisor: Engineering Section Manager Subordinates:	
<b>QUALIFICATIONS</b> Educational Background: Bachelor Degree Working Experience: 3 years	

Figure 6.3 Job description of Engineer

POSITION: Engineering Supervisor	SECTION: Engineering
DEPARTMENT: Engineering Management	OFFICE: A.B.C. Food Co.,LTD.

JOB DESCRIPTION	% OF TIME SPENT
1. Be responsible for all machine installation, repair and maintenance; <ul style="list-style-type: none"> <li>- All electrical and mechanical jobs as assigned,</li> <li>- All electrical system, public utility system, audio-visual system and any related facilities in the factory,</li> <li>- All machine installation in the factory (both mechanical and electrical),</li> <li>- Spare parts stock control, making sure that the workplace is well organized and safe,</li> <li>- Other related jobs as assigned.</li> </ul>	70
2. Take care of and supervise subordinates to work productively and effectively; <ul style="list-style-type: none"> <li>- Making sure that the subordinates follow the company's rules and regulations and provide proper punishment for those staff who violate the company's rules and regulations,</li> <li>- Mentoring, supervising and giving proper advice to subordinates,</li> <li>- Working with Supervisor on subordinates' performance appraisal.</li> </ul>	30
<b>Total</b>	<b>100</b>

<b>AUTHORITY LINE</b> Immediate Supervisor: Engineering Section Manager Subordinates: Maintenance staff
<b>QUALIFICATIONS</b> Educational Background: Technical level and up Working Experience: 5 years

Figure 6.4 Job description of Engineering Supervisor

POSITION: Safety Staff	SECTION: Engineering
DEPARTMENT: Engineering Management	OFFICE: A.B.C. Food Co.,LTD.

JOB DESCRIPTION	% OF TIME SPENT
1. Perform all safety related jobs as assigned by immediate supervisor.	20
2. Make sure at all time that all equipment/tools be in good condition and ready to use.	10
3. Be responsible for master plan and installation of safety related equipment/machine as assigned.	10
4. Be able to think and initiate ways to provide and increase safety in the workplace.	10
5. Record and report the progress on safety related performance to immediate supervisor.	10
6. Be responsible for stock keeping, procure and purchase all necessary material/tools and spare parts.	10
7. Make sure that all tools and equipment are ready to use and the workplace is clean and in order.	10
8. Follow the Company's rules and regulations and safety standards.	10
9. Perform other related jobs as assigned by immediate supervisor.	10
Total	100

<b>AUTHORITY LINE</b> Immediate Supervisor: Engineering Section Manager, Engineer Subordinates:
<b>QUALIFICATIONS</b> Educational Background: Technical level and up Working Experience: Vocational Training

Figure 6.5 Job description of Safety Staff

POSITION: Maintenance Planning Staff	SECTION: Engineering
DEPARTMENT: Engineering Management	OFFICE: A.B.C. Food Co.,LTD.
JOB DESCRIPTION	% OF TIME SPENT
1. Prepare an Annual Machinery Shut Down Plan and Monthly Machine Repair and Spare Parts Replacement Schedule.	20
2. Prepare a Machine Lubrication Plan.	10
3. Analyze all results from machine inspection in order to prepare a machine repair plan effectively.	10
4. Make a machine inspection plan and machine repair program to be sure at all time that all equipment/tools be in good condition and ready to use.	10
5. Be responsible for preparing and regularly updating machine database such as machine specifications and repair records to prevent loss that may be occurred.	10
6. Be able to coordinate with staff in other departments regarding machine maintenance and repair program in order to fulfill the effectiveness of the program.	10
7. Regularly monitor and follow-up repair activities.	10
8. Follow the Company's rules and regulations and safety standards.	10
9. Perform other related jobs as assigned by immediate supervisor.	10
Total	100
<b>AUTHORITY LINE</b> Immediate Supervisor: Engineering Section Manager, Engineering Supervisor Subordinates: -	
<b>QUALIFICATIONS</b> Educational Background: High School Graduation Working Experience: 3 years	

Figure 6.6 Job description of Maintenance Planning Staff

POSITION: Technician, Maintenance Staff	SECTION: Engineering
DEPARTMENT: Engineering Management	OFFICE: A.B.C. Food Co.,LTD.
JOB DESCRIPTION	% OF TIME SPENT
1. Repair and adjust both electrical and mechanical types of machine.	10
2. Take care of all installation of new equipment and machine as assigned.	10
3. Record all repair details and make comments in connection to repair work, if any.	10
4. Request for the materials, equipment and spare parts which are needed to perform the repair and maintenance jobs.	10
5. Give suggestions to improve the productivity of each machine.	10
6. Be able to identify which spare parts are needed.	10
7. Be able to perform jobs such as welding and planing the spare parts when needed.	10
8. Take care of and always keep all equipment and workplace clean and ready to use.	10
9. follow the company's rules and regulations including safety awareness' instruction.	10
10. Be able to perform any other jobs as assigned by the supervisor.	10
Total	100
<b>AUTHORITY LINE</b> Immediate Supervisor: Engineering Section Manager, Engineering Supervisor Subordinates:	
<b>QUALIFICATIONS</b> Educational Background: High Vocational Certificate Working Experience:	

Figure 6.7 Job description of Maintenance Staff



POSITION: General Staff	SECTION: Engineering
DEPARTMENT: Engineering Management	OFFICE: A.B.C. Food Co.,LTD.
JOB DESCRIPTION	% OF TIME SPENT
1. Be responsible for all document administration and general work within Engineering Section.	20
2. Coordinate effectively with Purchasing Section and Lat Krabang Engineering Section regarding all purchasing of equipment, tools and spare parts.	10
3. Take care of and be responsible for equipment and spare parts stock keeping by providing appropriate number of required and frequently used spare parts and equipment.	10
4. Be responsible for equipment and spare parts distribution control.	10
5. Prepare monthly status report on spare parts and equipment stock to Accounting Section.	10
6. Be initiative to give suggestions on productivity improvement to immediate supervisor.	10
7. Make sure that all tools and equipment are ready to use and the workplace is clean and in order.	10
8. Follow the Company's rules and regulations and safety standards.	10
9. Perform other related jobs as assigned by immediate supervisor.	10
Total	100
<b>AUTHORITY LINE</b> Immediate Supervisor: Engineering Section Manager, Engineering Supervisor, Engineer Subordinates: -	
<b>QUALIFICATIONS</b> Educational Background: High School Graduation Working Experience: -	

Figure 6.8 Job description of General Staff

## 6.2 Work Environment Improvement of Engineering Department (5S)

*REF. [7], page63.* Both the Engineering Department and Maintenance Section have been considered negatively on the ineffectiveness to improve their work environment namely 5S. They have been truly seen as the dirtiest and unorganized workplaces as well as the fact that the equipment being under their own responsibility are mostly damaged and lost. As we know that the most important factor to success in implementing 5S program is a good leader. Leader does not mean only the person who makes an order to do or not to do or the person who sets up the policies, but also the person who behaves himself as a good model of the society. Furthermore, he has to always improve and develop himself to be a successful leader. From the researcher's point of view, not only the Engineering Department but also every department within the company has to continuously and seriously adopt the implementation of 5S which has to be done regularly not temporarily. The comparison of work environment "before" implementation and "after" implementation is shown in the Appendix B.

Implementing 5S by every single staff of the company provides the lasting and better work environment. Staffs have the feeling that they are a part of the workplace where they belong to as for the fact that everyone normally would like to work in a clean and well-organized workplace. If every single staff have such consciousness and the responsibility, to implement the preventive maintenance is also an easy step to go forward.

### 6.3 Training

REF. [8], page285. In the past, the evidence indicates that both in-house and outside training courses are rarely provided for staffs in the Engineering department. Most of training courses arranged are not related to or beneficial for machine maintenance work. The staffs themselves lack of basic understanding and knowledge on nature of preventive maintenance and have occupied very little work experience. In addition, the department fails to implement mentoring program for the new inexperienced staff. Such weaknesses are obstructed to the successful implementation of each element of preventive maintenance program. Staffs will only perform their jobs as instructed neither knowing of the benefits nor being active members to get involved and make comments on the effectiveness of the program. Therefore, it is required to arrange related training courses prior to the preventive maintenance implementation.

The following is the existing schedule for training, which has been arranged before setting the preventive maintenance program:



Figure 6.9 Preventive maintenance program for engineering staff

Course Title	Objectives	Attendees	Instructor
Preventive Maintenance and its Benefits	<ul style="list-style-type: none"> <li>- To give the ground knowledge on benefits and importance of the preventive maintenance.</li> <li>- To give some examples of prototype companies that have successfully implemented the preventive maintenance program.</li> </ul>	All staffs	Engineering Manager
Machine Breakdown Analysis VS the Best Preventive Maintenance	<ul style="list-style-type: none"> <li>- To analyze machine breakdown and find the most effective preventive maintenance program.</li> </ul>	All staffs	Engineering Manager
Techniques for Spare Parts and Machine Maintenance:			
- Lubrication	<ul style="list-style-type: none"> <li>- To provide ground knowledge on machine lubrication, lubricator selection and methods of lubrication.</li> </ul>	All staffs	Engineering Manager
- Bearing & Mechanical Parts	<ul style="list-style-type: none"> <li>- To provide ground knowledge on machine code reading, the operation of each machine parts and the correct machine maintenance program.</li> </ul>	All staffs	Engineering Manager
- Reduce Speed Control	<ul style="list-style-type: none"> <li>- To provide the most effective repair, lubrication and adjustment techniques.</li> </ul>	All staffs	Engineering Manager
- Inverter	<ul style="list-style-type: none"> <li>- To provide ground knowledge on machine selection, machine set up and repair techniques.</li> </ul>	All staffs	Supplier
- Pneumatic & Control System	<ul style="list-style-type: none"> <li>- To provide ground knowledge on machine maintenance and set up techniques.</li> </ul>	All staffs	Supplier
Machine Maintenance Planning			
TPM	<ul style="list-style-type: none"> <li>- To provide the methods for effective machine maintenance planning.</li> </ul>	Planning Staff	Outside Course
Occupational Safety Officer	<ul style="list-style-type: none"> <li>- To provide the benefits of TPM Implementation.</li> <li>- To realize the importance of safety in the workplace, have knowledge on safety law and safety regulations within the factory.</li> </ul>	Supervisor  Engineer, Safety Staff	Outside Course  Outside Course

Table 6.1 Training courses prior to the preventive maintenance implementation

## 6.4 Work Order System

*REF. [2] page 57.* Work order system has been amended from the previously known repair request procedures that are considered as an ineffective process as discussed earlier in chapter 4, topic 4.4. This work order system has been designed based upon the maintenance work order procedure as shown in figure 6.10 and the example of work order is shown in figure 6.11.



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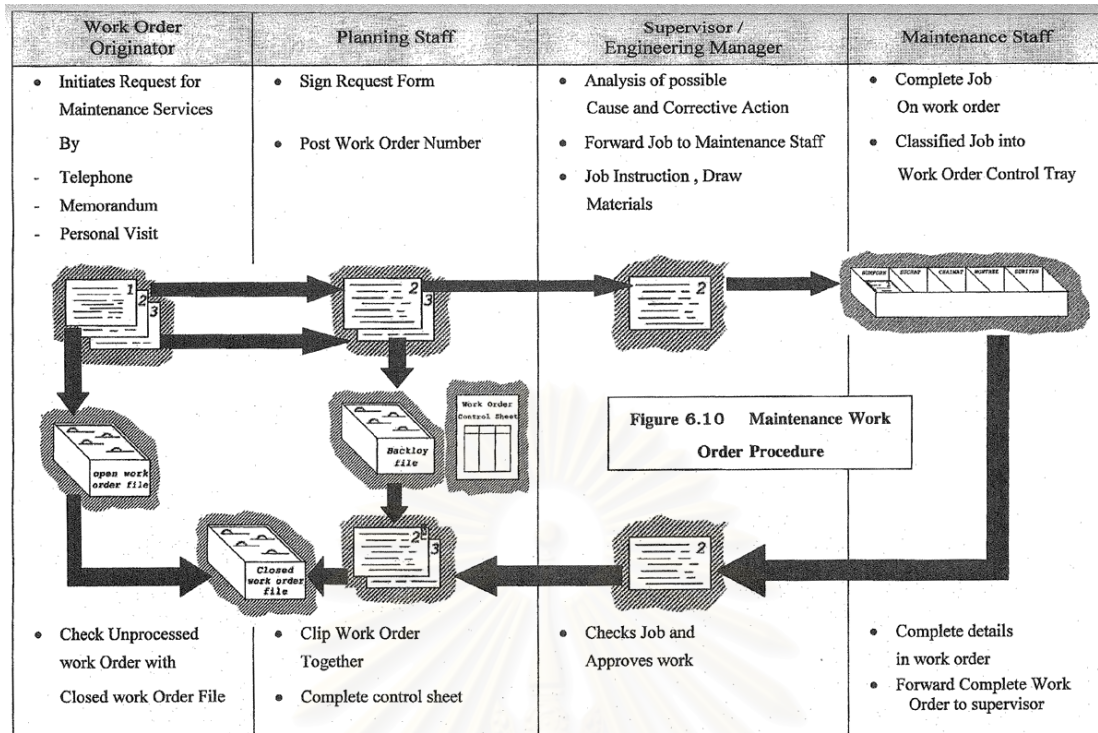


Figure 6.10 Maintenance Work Order Procedure

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ABC FOOD Co. Ltd.

### Work Order Form

DATE \_\_\_\_/\_\_\_\_/\_\_\_\_/ TIME \_\_\_\_ NO. \_\_\_\_

TO: Engineering Section Manager / Engineer / Engineering Supervisor

FROM: \_\_\_\_\_ LOCATION \_\_\_\_\_ MACHINE NAME \_\_\_\_\_ MACHINE CODE \_\_\_\_\_

CAUSE/ TYPE OF ERROR \_\_\_\_\_

---

During the repair, the machine is  unable to run or work  able to run or work

Please proceed the repair  immediately  when available  SHUT DOWN DAY  on Sunday

Starting Date \_\_\_\_/\_\_\_\_/\_\_\_\_ Time \_\_\_\_ Due Date \_\_\_\_/\_\_\_\_/\_\_\_\_ Time \_\_\_\_

Requester \_\_\_\_\_ Approved by \_\_\_\_\_  
Please write/print Supervisor

FR/EN 001

---

Received by \_\_\_\_\_ Date \_\_\_\_/\_\_\_\_/\_\_\_\_ time \_\_\_\_

Job delegated to 1. \_\_\_\_\_ Date \_\_\_\_/\_\_\_\_/\_\_\_\_ time \_\_\_\_

2. \_\_\_\_\_ Date \_\_\_\_/\_\_\_\_/\_\_\_\_ time \_\_\_\_

3. \_\_\_\_\_ Date \_\_\_\_/\_\_\_\_/\_\_\_\_ time \_\_\_\_

List of Repaired Items \_\_\_\_\_

---

Required Spare Parts 1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

Repairer \_\_\_\_\_ Date \_\_\_\_/\_\_\_\_/\_\_\_\_ Starting time \_\_\_\_ Ending time \_\_\_\_

Performance  Good  Need Improvement

BREAK DOWN (MINUTE)

Job Inspected by \_\_\_\_\_ Date \_\_\_\_/\_\_\_\_/\_\_\_\_ time \_\_\_\_

Performance  Good  Need Improvement

Inspector's comments \_\_\_\_\_

Document No. : FR/EN 005

Figure 6.11 Work Order Form (FR/EN 001, FR/EN 005)

## SECTION 2: PREVENTIVE MAINTENANCE PROGRAM

It is quite difficult to settle the Preventive Maintenance Program based upon the relevant theories. The concern is that how to make the program realistic in order that the improvement or adjustment will be provided appropriately. Therefore, the Preventive Maintenance Program must be set up to comply with the Company's culture, staff literacy and basic knowledge including the appropriate and practical timing for implementation. The initial guidelines for settlement of the Preventive Maintenance Program are as follows:

1. Appointment of the ad-hoc working team for the Preventive Maintenance Program composing of the Engineering Manager, the Supervisor, the Maintenance Planning Staff and the Engineering Staff.
2. Categorization of all related information with regard to machine repair and maintenance record by cause of breakdown in order that the ad-hoc team can analyze what is really caused by such machine breakdown.
3. Arrangement for staff training on methods and procedures of the Preventive Maintenance.
4. Settlement of the Breakdown Maintenance and the Preventive Maintenance by the ad-hoc team. After completing item 2 and item 3 above, the ad-hoc team will set up the flow chart as in figure 6.12. The said plan will definitely relate to prevention rather than repair and the preventive maintenance techniques are based upon the work experience of the Engineering Staff and the repair and maintenance guidelines in the manual.
5. With regard to the plan setting for various kinds of maintenance, i.e., Inspection Plan, Shutdown Plan, Spare Parts Replacement Plan, theoretically, the MTBF analysis (Mean



Time between Failure) can be used in order to acquire the amount of time spent in the maintenance process. This analysis, however, takes quite a lot of time to collect the reliable data. As a consequence, the launch of the Preventive Maintenance Program will be delayed. Therefore, the working team first starts with the setting of prototype of all related plans, i.e., providing a quarterly Machine Shutdown Plan. In the first year, the inspection on the said plan has been done and the MTBF has been recorded in order to be used for adjusting the said plan in accordance with the current condition of such machine requiring appropriate repair.

6. Repair items as appeared in the Inspection Report and Spare Parts Replacement Plan have been acquired by the analysis of the Machine Maintenance Record. The working team will select and set up only the items that can be used to prevent the machine breakdown. As a consequence of having too many repair items, to schedule the inspection period or the spare parts replacement will take substantial amount of time and it is unlikely to meet the schedule. It will be more productive to first launch the program to what can be done and changes or appropriate adjustment will then be required which will keep the Preventive Maintenance Program exist longer.

*REF. [3], page 135.* After the renovation of Engineering Management until the Engineering department is ready to implement the preventive maintenance program, the second step is to consider whether any elements of preventive maintenance program require modification or improvement or any elements of the program need to be deleted. The most importance of all is to make sure that we provide good and appropriate system in connection with work procedures, work environment and management policies to give full support both time and expenses to the program in the early stage of implementation. The program that combines too many details and being too complicated does not work well in this prototype company and there is chance to be unsuccessful since the company has very little experience and just begins to implement the preventive maintenance program. Therefore,

the program must be easy to understand and practical to do. The simple method is to review previous maintenance record as reference. For example, if machine breakdown is caused by lacking of cleaning at some specific parts, we need to prevent the breakdown by scheduling regular machine cleaning. Therefore, the preventive maintenance program can significantly secure the occurrence of machine breakdown.

The definitions of preventive maintenance system are:

1. System means any prevention toward causes of machine breakdown.
2. Prevention means any action to maintenance. Give specific time for maintenance staff or technician to shut down the machine when maintenance is required.
3. Actions and annual/monthly maintenance planning have to come along with each other.
4. After all of the three steps have been completed, the maintenance should then be recorded so that we can use such records as reference in the future.

The planning of preventive maintenance system consists of three main parts as shown in figure 6.12:

1. Breakdown maintenance or unplanned maintenance work

When having machine breakdown, repair is immediately required as used to do but the difference is to analyze or find what causes the machine breakdown and see what element of preventive maintenance need to be improved or remedied.

2. Preventive maintenance work or planned maintenance work

Both monthly and annual preventive maintenance plan will be implemented to cover all prevention toward all aspects of machine breakdown as discussed later in this chapter.

3. Machine maintenance record and filing system as mentioned in figure 6.10 maintenance work order procedure.

After the preventive program has completely implemented, the responsibility of the Engineering staff turns to what we call "repair before the breakdown comes" instead of "breakdown before, repair later". To maintain the effectiveness of the preventive program will be discussed in Chapter 8.



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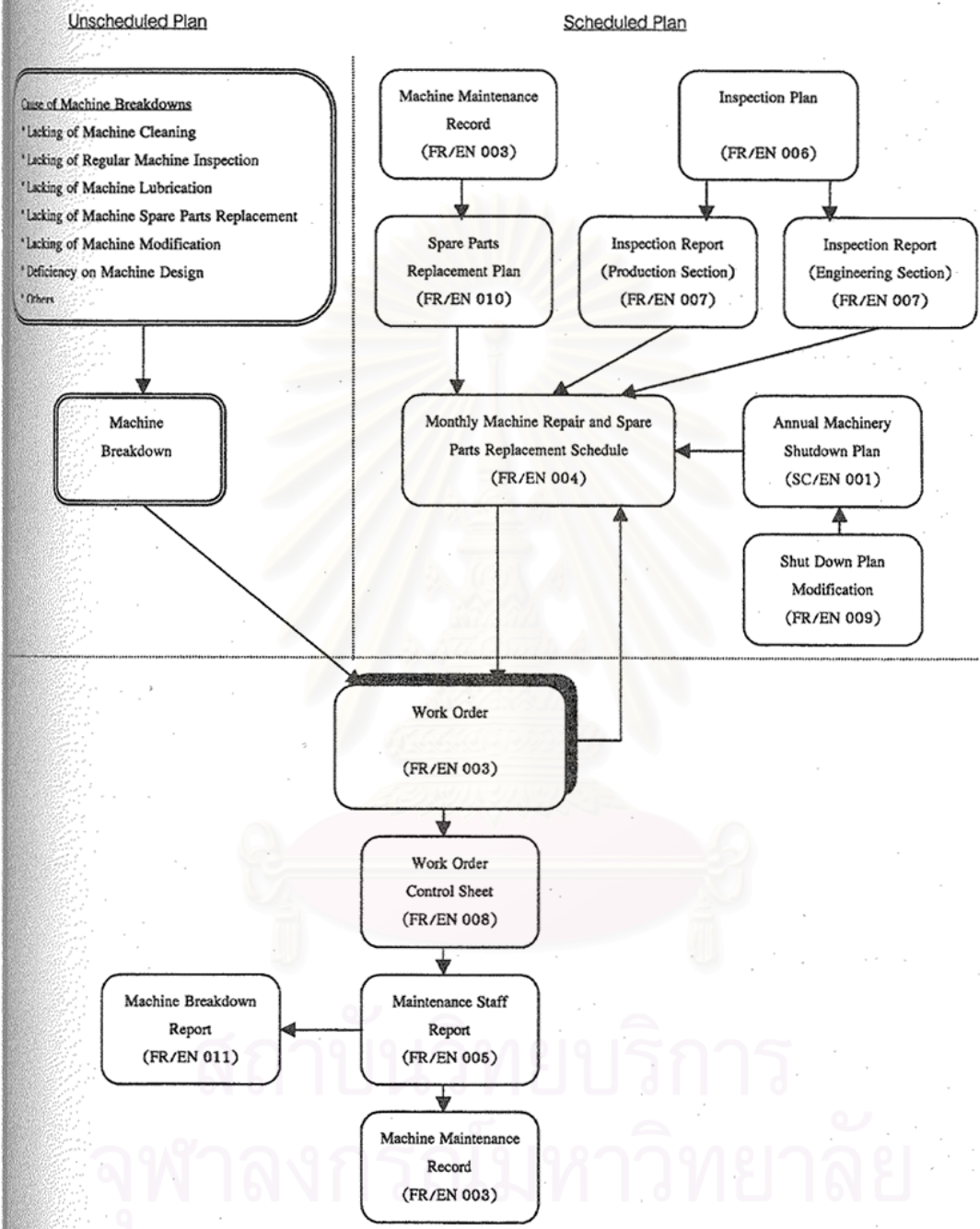


Figure 6.12 Preventive Maintenance Program

## 6.5 Machine Classification

Before the implementation of the preventive maintenance program, it is found that there is no coding or machine name system, therefore, the main machine list has been created as shown in figure 6.13 consisting of a code made by giving the initial alphabet of a machine name followed by the number representing the order of such machine. Only main function machines will be put into the main machine list and will be implemented under the preventive maintenance program. The main machine list will contain only main and important specifications of machine while the machine maintenance record contains all detailed specifications and machine parts as shown in figure 6.14. *REF. [5], page60-61*

The advantages of both main machine list and machine maintenance record are:

1. Providing the standardized name of machine to be used among the Production and Engineering department.
2. Being a reference for documents in connection with preventive maintenance program.
3. Being used in calculating production capacity of each machine.
4. Giving details of important spare parts and machine parts.

Machine Code	Machine Name	Location	Model	Capacity	Power Consumption	Dimension (m x m x m)	Manufacturer
M 1	Mixer (Blender)	Mixing Room	AP 100 AW	130 Liter/Batch , 1.5 Batch/hr	15.75 kw	2.25 x 1.55 x 1.2 m	BIBUN
M 2	Mixer (Blender)	Mixing Room	AP 100 AW	130 Liter/Batch , 1.5 Batch/hr	15.75 kw	2.25 x 1.55 x 1.3 m	BIBUN
M 3	Mixer (Blender)	Mixing Room	AP 150 AW	210 Liter/Batch , 2.0 Batch/hr	22.75 kw	2.60 x 2.15 x 1.8 m	BIBUN
M 4	Mixer (Blender)	Mixing Room	AP 100 AW	130 Liter/Batch , 1.5 Batch/hr	15.75 kw	2.25 x 1.55 x 1.5 m	BIBUN
FP 1	Feed Pump	Mixing Room	NP16	15 Liter/min	2.2 kw	1.00x13.28x0.938 m.	BIBUN
FP 2	Feed Pump	Mixing Room	NP16	15 Liter/min	2.2 kw	1.00x13.28x0.938 m.	BIBUN
FP 3	Feed Pump	Mixing Room	NP16	15 Liter/min	2.2 kw	1.00x13.28x0.938 m.	BIBUN
FP 4	Feed Pump	Mixing Room	NP16	15 Liter/min	2.2 kw	1.00x13.28x0.938 m.	BIBUN

Figure 6.13 Main Machine List

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Machine Code	Machine Name	Location	Model	Capacity	Power Consumption	Dimension (m x m x m)	Manufacturer
F 1/1	Forming Machine & Preheater	Forming Room	-	55 cm Width	1.2 kw	0.82x3.275x1.124 m.	NATTAKON
F 1/2	Forming Machine & Preheater	Forming Room	-	55 cm Width	1.2 kw	0.82x3.275x1.124 m.	NATTAKON
F 2/1	Forming Machine & Preheater	Forming Room	-	55 cm Width	1.2 kw	0.82x3.275x1.124 m.	NATTAKON
F 2/2	Forming Machine & Preheater	Forming Room	-	55 cm Width	1.2 kw	0.82x3.275x1.124 m.	NATTAKON
F 3/1	Forming Machine & Preheater	Forming Room	-	55 cm Width	1.2 kw	0.82x3.275x1.124 m.	NATTAKON
F 3/2	Forming Machine & Preheater	Forming Room	-	55 cm Width	1.2 kw	0.82x3.275x1.124 m.	NATTAKON
F 4/1	Forming Machine & Preheater	Forming Room	-	55 cm Width	1.2 kw	0.82x3.275x1.124 m.	NATTAKON
F 4/2	Forming Machine & Preheater	Forming Room	-	55 cm Width	1.2 kw	0.82x3.275x1.124 m.	NATTAKON

Figure 6.13 Main Machine List

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Machine Code	Machine Name	Location	Model	Capacity	Power Consumption	Dimension (m x m x m)	Manufacturer
D 1	Dryer	Forming Room	-	40 min/round	9.0 kw	2.335x10.250x4.053 m.	NATTAKON
D 2	Dryer	Forming Room	-	40 min/round	9.0 kw	2.335x10.250x4.053 m.	NATTAKON
D 3	Dryer	Forming Room	-	40 min/round	9.0 kw	2.335x10.250x4.053 m.	NATTAKON
D 4	Dryer	Forming Room	-	40 min/round	9.0 kw	2.335x10.250x4.053 m.	NATTAKON
SA 1	Saucing Machine	Forming Room	-	-	0.4 kw	1.2x2.04x1.7 m.	NATTAKON
SA 2	Saucing Machine	Forming Room	-	-	0.4 kw	1.2x2.04x1.7 m.	NATTAKON
SA 3	Saucing Machine	Forming Room	-	-	0.4 kw	1.2x2.04x1.7 m.	NATTAKON
SA 4	Saucing Machine	Forming Room	-	-	0.4 kw	1.2x2.04x1.7 m.	NATTAKON
B 1	Baking Machine	Baking Room	-	100 kg/hr	0.4 kw	0.71x3.68x1.25 m.	NATTAKON
B 2	Baking Machine	Baking Room	-	100 kg/hr	0.4 kw	0.71x3.68x1.25 m.	NATTAKON
B 3	Baking Machine	Baking Room	-	100 kg/hr	0.4 kw	0.71x3.68x1.25 m.	NATTAKON
B 4	Baking Machine	Baking Room	-	100 kg/hr	0.4 kw	0.71x3.68x1.25 m.	NATTAKON
B 5	Baking Machine	Baking Room	-	100 kg/hr	0.4 kw	0.71x3.68x1.25 m.	NATTAKON
B 6	Baking Machine	Baking Room	-	100 kg/hr	0.4 kw	0.71x3.68x1.25 m.	NATTAKON
RC 1	Regular Size Cutting Machine	Baking Room	-	45 times/min, 33 g/time	0.75 kw	0.94x0.98x1.40 m.	BIBUN

Figure 6.13 Main Machine List

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Machine Code	Machine Name	Location	Model	Capacity	Power Consumption	Dimension (m x m x m)	Manufacturer
RC 2	Regular Size Cutting Machine	Baking Room	-	45 times/min, 33 g/time	0.75 kw	0.94x0.98x1.40 m.	BIBUN
RC 3	Regular Size Cutting Machine	Baking Room	-	45 times/min, 33 g/time	0.75 kw	0.94x0.98x1.40 m.	BIBUN
RC 4	Regular Size Cutting Machine	Baking Room	-	45 times/min, 33 g/time	0.75 kw	0.94x0.98x1.40 m.	BIBUN
RC 5	Regular Size Cutting Machine	Baking Room	-	45 times/min, 33 g/time	0.75 kw	0.94x0.98x1.40 m.	BIBUN
RC 6	Regular Size Cutting Machine	Baking Room	-	45 times/min, 33 g/time	0.75 kw	0.94x0.98x1.40 m.	BIBUN
SC 1	Small Size Cutting Machine	Small Size Cutting Room	-	160 times/min, 5.8 g/time	0.75 kw	1.2x1.7x1.720 m.	BIBUN
SC 2	Small Size Cutting Machine	Small Size Cutting Room	-	160 times/min, 5.8 g/time	0.75 kw	1.2x1.7x1.720 m.	BIBUN

Figure 6.13 Main Machine List

A.B.C. CO.,LTD.

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Machine Code	Machine Name	Location	Model	Capacity	Power Consumption	Dimension (m x m x m )	Manufacturer
SC 3	Small Size Cutting Machine	Small Size Cutting Room	-	160 times/min, 5.8 g/time	0.75 kw	1.2x1.7x1.720 m.	BIBUN
SC 4	Small Size Cutting Machine	Small Size Cutting Room	-	160 times/min, 5.8 g/time	0.75 kw	1.2x1.7x1.720 m.	BIBUN
SC 5	Small Size Cutting Machine	Small Size Cutting Room	-	160 times/min, 5.8 g/time	0.75 kw	1.2x1.7x1.720 m.	BIBUN
SC 6	Small Size Cutting Machine	Small Size Cutting Room	-	160 times/min, 5.8 g/time	0.75 kw	1.2x1.7x1.720 m.	BIBUN
SC 7	Small Size Cutting Machine	Small Size Cutting Room	-	160 times/min, 5.8 g/time	0.75 kw	1.2x1.7x1.720 m.	BIBUN

Figure 6.13 Main Machine List

A.B.C. CO.,LTD.

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## MACHINE MAINTENANCE RECORD

Equipment Name <b>MIXER (BLENDER)</b>	Equipment Number <b>M3</b>
Serial Number	Model <b>AP-150</b> Year <b>1996</b>
Manufacturer <b>BIBUN CORPORATION</b>	Address <b>9-30,1-CHOME,MYOTIN-CHO FUKUYAMA</b>
Vendor <b>BIBUN CORPORATION</b>	Address <b>HIROCHIMA-KEN, JAPAN 81-849-22-2020</b>
Date Purchased <b>1996</b>	Purchase Price <b>8,300,000 YEN</b>
Date of Installation <b>1996</b>	Date of Employment <b>1996</b>
Machine Size <b>2.6 X 2.15 X 1.8 m</b>	Weight <b>2,200 kg</b>
Speed <b>1,500 rpm High, 750 rpm Low</b>	Capacity <b>210 Liters</b>
Drawing Number	Instruction Book Number <b>QB-4004-Q1A</b>

### MAIN MOTOR DATA

H.P.	TYPE	SIZE	SPEED	VOLTS	AMP.	PHASE	FREQ.	SER. NO.	MFG.	OTHERS
30/15 kW	TIKK	3d/13	1450/ 725	380	6.2/ 2.6	3	50 Hz.	59/47	Toshiba	4/8 POLES

### PARTS OF MAIN MOTOR

FRONT BEARING	REAR BEARING	CHAIN	BELT	BRUSH COMMU SIZE	BRUSH SLIP RING	OTHERS
6213-2Z	G213-2Z	-	V-Belt	-	V-Ring - V.90	V-Belt 6 pcs.

### AUXILIARLY EQUIPMENT & PARTS OF THEM

Bowl Motor	Unloader Motor	Component Blade
0.75 kW 4P 380V 50Hz	0.75 kW 4P 380V 50Hz	S-Cut (6 pcs.)
2.0 A 1,430 rpm SUMITOMO	2.0 A 1,430 rpm SUMITOMO	Blade V-Belt Bando
Front Bearing No. 6314 2 pcs	Rotation Speed 100 rpm	No. 5V-750 (6 pcs.)
Rear Bearing No. 6309 1 pc.		
Rotation Speed 10/5 rpm		

ADDITIONAL DESCRIPTION:

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Figure 6.14 Machine Maintenance Record-PART A (FR/EN 003)

## 6.6 Maintenance Planning

*REF. [6], page156.* The noticeable difference between preventive maintenance and breakdown maintenance is the advance planning for machine repair, when to repair, which machine and what to do instead of having repair upon request.

There are two levels of planning, which are:

### 6.6.1 Annual Machine Shutdown Plan

The first thing to do is to determine which machine needs to be shutdown and how frequent to shutdown for each machine. Steps for machine shutdown planning are as follows:

Planning items	Requirements
1. What machine needs to be shutdown?	Main machines in the production line as mentioned in item 6.5 (see figure 6.13)
2. How frequent machine needs to be shutdown?	Each machine needs machine shutdown for repair and maintenance at quarterly basis that set from the experience of supervisor and production schedule.
3. How long does the machine shutdown take each time?	Normally takes 1 day for shutdown except a Mixer, Forming machine & Pre-heater and Dryer takes 3 days for shutdown.
4. Who is Machine shutdown planner?	Planning staffs and Engineering Manager with authorization from the Production department.

Annual machine shutdown for the year 2000 is shown in figure 6.15. When there is any adjustment or changes of machine shutdown schedule, a Shutdown Plan Modification form requested by either the Production department or the Engineering department as shown in figure 6.16 is required.

MONTH	DATE																																					
	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN		
JANUARY						H		H																														
FEBRUARY			L3	L3	L3																																	
MARCH																																						
APRIL																																						
MAY		H	L2	L2	L2	H																																
JUNE																																						
JULY																																						
AUGUST																																						
SEPTEMBER																																						
OCTOBER																																						
NOVEMBER																																						
DECEMBER																																						

SC/EN 001      Reviewed by \_\_\_\_\_      Approved by \_\_\_\_\_      Approved by \_\_\_\_\_  
 (Engineering Manager)      (Production Manager)      (Factory Manager)

Figure 6.15 Shut down Plan (SC/EN 001)

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**A.B.C. CO., LTD.**

**Request Form for Machine Shutdown Re-scheduling**

**TO: Production Manager / Engineering Section Manager / Maintenance Planning Staff**

**FROM:** \_\_\_\_\_

\*\*\*\*\*We would like to cancel the machine shutdown as scheduled on \_\_\_\_\_  
by the reason that \_\_\_\_\_

\_\_\_\_\_

\*\*\*\*\*We would like to re-arrange the date for the machine shutdown from \_\_\_\_\_  
to \_\_\_\_\_ and to switch the machine from \_\_\_\_\_  
to \_\_\_\_\_ by the reason that \_\_\_\_\_

\_\_\_\_\_

Requester \_\_\_\_\_

( \_\_\_\_\_ )

STAFF

...../...../.....

Approved by \_\_\_\_\_

( \_\_\_\_\_ )

Position \_\_\_\_\_

...../...../.....

Document Code : FR/EN 009

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Figure 6.16 Shut down Plan Modification (FR/EN 009)

### 6.6.2 Monthly Machine Repair and Spare Parts Replacement Schedule

This schedule is counted as the core of preventive maintenance system because it helps control and plan the following items:

1. The timing for machine shutdown as scheduled.
2. Spare parts replacement when due.
3. Machine repair when damage is found as recorded in the Inspection Report
4. Pending work form a Work Order Control Sheet

All details and information will be recorded in this schedule and will then be arranged as work order delegated to the Engineering staff for further repair.

Monthly Machine Repair and Spare Parts Replacement Schedule (as shown in figure 6.17) has stated the following characteristics:

1. Being a summary of monthly work plan as indicated in the 4 items above which could help fix the timing for repair and give balance between workload and existing resource,
2. Stating a list of goals determining what to do for each month and advance work plan,
3. Being able to indicate work prioritization and time frame of each particular work,
4. Being able to set up a machine repair plan in case a machine is still able to run, not seriously in breakdown condition, and
5. Being flexible enough and able to reschedule a plan in an appropriate manner and having no effect on other jobs in case the shutdown date has been postponed.

A.B.C. CO., LTD.

**MONTHLY MACHINE REPAIR AND SPARE PARTS REPLACEMENT SCHEDULE**

MONTH MARCH 2000 / = PLAN, X = ACTION PAGE 1

NO.	JOB NO.	SCHEDULED JOBS	DATE																															NOTE	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
1	001	SHUT DOWN M 5	X																																
2	002	SHUT DOWN FP 5	X																																
3	003	SHUT DOWN FS1, FS2		X																															
4	004	SHUT DOWN DS, SA5			X																														
5	005	SHUT DOWN M 1				X																													
6	006	SHUT DOWN FP 1					X																												
7	007	SHUT DOWN FI1, FI2						X																											
8	008	SHUT DOWN DI, SA1							X																										
9	009	SHUT DOWN B1, RC1								X																									
10	010	SHUT DOWN B2, RC2									X																								
11	011	SHUT DOWN B3, RC3										X																							
12	012	SHUT DOWN B4, RC4											X																						
13	013	SHUT DOWN B5, RC5												X																					
14	014	SHUT DOWN B6, RC6													X																				
15	026	CLEAN COOLING TOWER																																	FEB. JOB
16	027	CHANGE AIR COMPRESSOR OIL																																	
17	028	CLEAN FILTER OF AIR CONDITIONERS (OFFICE 1)																																	

Prepared by \_\_\_\_\_ Maintenance Planning Staff  
 Approved by \_\_\_\_\_ Engineering Manager  
 FR/EN 004

Figure 6.17 Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004)

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## 6.7 Maintenance Work Standards

Maintenance work standards based upon the data from previous machine repair record are implemented in order to make sure that all required repair items are included in the shutdown plan.

The standards, which are based upon the data from previous machine repair record, have been analyzed and set up to prevent the repeat occurrence of machine breakdown that are the results of the following:

1. Lacking of regular machine adjustment  
Standards of machine adjustment are shown in figure 6.18
2. Lacking of regular machine lubrication  
Standards of machine lubrication are shown in figure 6.19 and
3. Lacking of regular cleaning  
Standards of machine cleaning are shown in figure 6.18

When the shutdown date is due, the Engineering staff will process the repair according to the work standards including relating jobs such as spare parts replacement and special work based upon machine inspection data. The standards can significantly help us in equipment preparation and staff delegation in advance.

## ABC CO., LTD.

## ADJUSTMENT &amp; CLEANING REPORT

NAME OF MACHINE	M/C CODE	REPORT BY	APPROVED BY
DRYER	D 1		
ADJUSTMENT PROCEDURE	/ = JOB DONE	X = NEXT PLAN	/,X COMMENT
<b>WIRE MESH CONVEYOR</b>			
Tightened set screws on sprocket (44 points)			
Rewelded broke pin on chain if necessary (11 points)			
Adjust sprocket alignment (44 points)			
Tightened chain if it jumped off sprocket			
Realigned shaft both side			
<b>MAIN DRIVE ASSEMBLY</b>			
Check condition of V-Belt for wear, Replaced it with a spare (if necessary)			
Realigned reducer and gear motor			
Replace o-ring / seal if detect oil leakage			
<b>BURNER AND CIRCULATING BLOWER</b>			
Check operating condition of Temperature control			
Check operating condition of Burner programmable control			
Measure and compare temperature both side			
Realigned burner position			
Tightened the two rods on the pilot burner			
<b>CLEANING PROCEDURE</b>			
Remove and clean Ignition rod			
Remove the fan and clean the pilot mixer air input hole			
Remove the filter and wash it with water			
Remove the air duct of circulating blower, clean the filter and remove scrap			

REMARK : .....

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Document No. :

Figure 6.18 Adjustment and Cleaning Report

ABC CO., LTD.

LUBRICATION REPORT

NAME OF MACHINE	M/C CODE	REPORT BY	APPROVED BY
DRYER	D 1		
PICTURE OF LUBRICATION POINTS		/,X	LUBRICATION POINTS
			1. Wire mesh conveyor (11 units)
			2. Drive shaft bearing (4 points)
			3. Chain of driving unit
			4. Gear of driving unit
			5. Gear unit
			6. Pulley of reducer
			NOTE :
LUBRICATION POINT	EQUIPMENT	LUBRICANT	METHOD OF LUBRICATION
1. Wire mesh conveyor (11 units)	Plain spring cup	Food grade oil	Once through oiling
2. Drive shaft bearing (4 points)	Pressure gun	Grease	Hand lubrication
3. Chain of driving unit	Apply manually	Open gear oil	Hand lubrication
4. Gear of driving unit	Apply manually	Open gear oil	Once through oiling
5. Gear unit	Plain spring cup	Gear oil No.90	Once through oiling
6. Pulley of reducer	Pressure gun	Grease	Hand lubrication

REMARK : .....

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Document No. :

Figure 6.19 Lubrication Report

## 6.8 Machine Spare Parts Replacement

Regular replacement can prevent the machine from the breakdown caused by the fact that the spare parts are too old. Therefore, a machine spare parts replacement schedule is required to determine which and when a specific spare parts has to be replaced as shown in figure 6.20. The methods are as follows:

1. Prepare a list of machine spare parts, indicating its lifetime, replacement record. In case such spare parts is important, a plan for replacement is definitely required.
2. Indicate each specific spare parts lifetime.
3. Find out from the machine maintenance record when the last replacement is.
4. Calculate the expiry date of such spare parts based upon the factors in item 2 and item 3.
5. Make a machine spare parts replacement schedule prior to the expiry date of such spare parts.

A Planning staff will be responsible for monitoring the machine spare parts replacement schedule and cooperation with the Administrative and Store staff to prepare the necessary spare parts in advance and planning the monthly machine repair and spare parts replacement schedule.



## 6.9 Machine Inspection

Mostly, machine breakdowns are caused by lacking of machine inspection. Before machine shutdown period, it is necessary to examine each of machines whether there are any damages and what machine requires a repair.

The main objective of machine inspection is to make sure whether the machine is in good condition and ready to use. Machine inspection process is based upon inspection plan as shown in figure 6.21 and must be made prior to the shutdown period. We will not set the inspection in periodically such as 3 month, 6 month or every one-year because from the experience of the researcher found that it may be failed with too complicated inspection schedule. Items stated in the Inspection Plan are gathered from analyzing the machine repair record to ensure that the machine breakdown will not happen again. Machine inspection is classified into 2 levels:

### 6.9.1 Machine inspection by the Production section

Inspection is normally related to the quality of products, damages, errors, which are heard or seen including errors caused by incorrect installation as indicated in the Operation Inspection Report (by the Production section) as shown in Figure 6.22.

### 6.9.2 Machine inspection by the Engineering section

Most of inspection is in connection with the condition of each machine part, functional errors and safety condition of such machine. Inspection Report (by the Engineering section) is shown in Figure 6.23. Machine inspection and machine adjustment have to be made altogether, which requires machine shutdown. The Planning staff will be responsible for machine inspection and setting up the priority of each damage to be repair and it is not necessary to do the inspection on the shutdown date. Any errors that need urgent repair can be done separately by including such errors into the Monthly Machine Repair and Spare Parts Replacement Schedule.

MONTH	DATE																																				
	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	
JANUARY						1 H	2 H	3 H	4	5	6	7 L.4	8 L.4	9	10	11	12	13	14	15	16	17	18	19 H	20	21	22	23	24	25	26	27	28	29	30	31	
FEBRUARY			1	2	3	4	5	6	7 L.4	8 L.4	9	10	11	12	13	14	15	16	17	18	19 H	20	21	22	23	24	25	26	27	28	29						
MARCH			1 L.1	2 L.1	3 L.1	4	5	6	7 B.1	8 B.2	9 B.3	10 B.4	11 B.5	12 B.6	13 SC	14 SC	15 SC	16 SC	17 SC	18 SC	19 L.2	20 L.2	21 L.2	22	23	24	25	26	27	28	29	30	31				
APRIL						1	2	3 L.4	4 L.4	5 L.4	6	7	8	9	10	11	12	13	14 H	15 H	16 H	17	18	19 L.3	20 L.3	21 L.3	22	23	24	25	26	27	28	29	30		
MAY		1 H	2	3	4	5 H	6	7	8 L.1	9 L.1	10 L.1	11	12	13	14	15	16	17 H	18	19	20	21	22	23	24	25	26	27	28	29	30	31					
JUNE					1	2	3	4	5 B.1	6 B.2	7 B.3	8 B.4	9 B.5	10 B.6	11 SC	12 SC	13 SC	14 SC	15 SC	16 SC	17 SC	18	19	20	21	22	23	24	25	26 L.4	27 L.4	28	29	30			
JULY						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 H	19 H	20	21	22	23	24 L.2	25 L.2	26 L.2	27	28	29	30		
AUGUST			1	2	3	4	5	6	7 L.1	8 L.1	9 L.1	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				
SEPTEMBER		1 B.1	2 B.2	3 B.3	4 B.4	5 B.5	6 B.6	7	8	9	10	11	12	13	14	15 SC	16 SC	17 SC	18 SC	19 SC	20 SC	21	22	23	24	25	26	27	28	29	30						
OCTOBER	1	2 L.4	3 L.4	4 L.4	5	6	7	8	9	10	11	12	13	14	15 L.3	16 L.3	17 L.3	18	19	20	21	22	23	24	25	26	27	28	29	30	31						
NOVEMBER				1	2	3	4	5 L.1	6 L.1	7 L.1	8	9	10	11	12	13	14	15	16	17	18	19	20 B.1	21 B.2	22 B.3	23 B.4	24 B.5	25 B.6	26	27	28	29	30				
DECEMBER						1	2	3	4	5 H	6 SC	7 SC	8 SC	9 SC	10	11	12 SC	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		

FR/EN 006

Reviewed by \_\_\_\_\_  
 \_\_\_\_\_  
 Engineering Manager

Approved by \_\_\_\_\_  
 \_\_\_\_\_  
 Production Manager

Approved by \_\_\_\_\_  
 \_\_\_\_\_  
 Factory Manager

Figure 6.21 Inspection Plan (FR/EN 006)

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## ABC CO., LTD.

## INSPECTION REPORT (PRODUCTION SECTION)

NAME OF MACHINE	M/C CODE	REPORT BY	APPROVED BY
FORMING MACHINE & PREHEATER	F 1/1		
INSPECTION PROCEDURE	/ = GOOD CONDITION	X = REQUIRE REPAIR	/,X
<b>FORMER ROLLER UNIT</b>			
Clearance between drum and thickness plate - check thickness of dough (1.45-1.60 mm)			
Thickness adjustment plate - check for wear and bend - check for operating action			
Metal plate - the former unit can place on drum easily			
Condition of scraper - can remove scrap from drum surface - cleanliness of scraper			
Former roller bush - not have dough outside the bush			
<b>DRUM</b>			
Check temperature on drum (35-50 °C)			
Check drum can rotate smoothly			
Check side cover no water leakage			
Check drum surface condition			
Check flow of supply water			
<b>PRODUCT SURFACE CONDITION - Check surface not a wavy shape</b>			
Check surface not a wavy shape			
<b>CONDITION OF BURNER (DRUM SIDE &amp; PREDRYER SIDE)</b>			
<b>CONDITION OF MESH CONVEYOR - Check for alignment</b>			
<b>ALL REDUCER &amp; GEAR MOTOR - Check for operating action, can adjust easily</b>			
<b>GENERAL CONDITION OF MACHINE, MACHINE CLEANLINESS</b>			
<b>CONDITION OF SWITCH &amp; PUSH BUTTON</b>			

REMARK : .....

Document No. : FR/EN 007

Figure 6.22 Inspection Report (Production Section) (FR/EN 007)



ABC CO., LTD.

INSPECTION REPORT (ENGINEERING SECTION)

NAME OF MACHINE	M/C CODE	REPORT BY	APPROVED BY
FORMING MACHINE & PREHEATER	F 1/1		
INSPECTION PROCEDURE	/ = GOOD CONDITION	X = REQUIRE REPAIR	/,X COMMENT
<b>MAIN DRIVE ASSEMBLY</b>			
Drive/Motor - temperature, vibration and/or unusual noise			
Reducer - temperature, vibration and/or unusual noise and leaks			
V-Belts - check for wear, tension and alignment			
Sprocket - check for wear and alignment with chain			
Chains - check for wear, tension			
V-Pulleys - check for alignment			
<b>GAS SECTION</b>			
Valve & Joint - check for gas leak			
Condition of Burner / Pressure gague / Main valve			
<b>ELECTRICAL SECTION</b>			
Condition of wiring, control box			
<b>SAFETY FEATURES</b>			
<b>GENERAL CONDITION OF MACHINE, MACHINE CLEANLINESS</b>			
<b>CHECK ENTIRE UNIT FOR PROPER LUBRICATION</b>			

REMARK : .....

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Document No. : FR/EN 002

Figure 6.23 Inspection Report (Engineering Section) (FR/EN 002)

## 6.10 Machine Work Order Form and Document Control System

As discussed earlier in item 6.4 in connection with the procedures of machine work order, the required document is a Machine work order form. In preventive maintenance program, after having a Monthly Machine Repair and Spare Parts Replacement Schedule, repair items have to be filled out into a Machine work order form in order to distribute to the Maintenance staffs to proceed the repair *REF. [4], page127*.

Therefore, it is assuming if there is either a machine breakdown or a repair according to an advance repair schedule, it is necessary to fill out the Machine work order form and the responsible staffs namely the Maintenance staffs will proceed the repair. Only the request appeared in such written form will be fulfilled. All work order forms will be controlled by the Monthly Document Control Sheet as shown in Figure 6.24 consisting of the number of the request form, responsible staffs, delegation date, completion date. The Engineering Manager and Supervisor can monitor/follow-up the progress of each delegation, what jobs are still pending, who the requester is. In case there are still pending repair jobs, planning staffs will gather such pending jobs into next Repair schedule.

## 6.11 Maintenance Staff Report and Machine Breakdown Report

The Maintenance Staff Report as shown in Figure 6.11 is one of significant parts of the Machine Work Order Form. Technicians will write down the details of repair, spare parts, and timeframe into the Machine Work Order Form. In case the shutdown is required, a Machine Lubrication Report and Machine Adjustment & Cleaning Report must be attached. In case there is machine breakdown, a Machine Breakdown Report as shown in Figure 6.25 is required for analyzing causes and effects and finding appropriate preventive solutions. Therefore, the Machine Breakdown Report is counted as one of the most important documents reflecting the effectiveness of the existing preventive maintenance program.

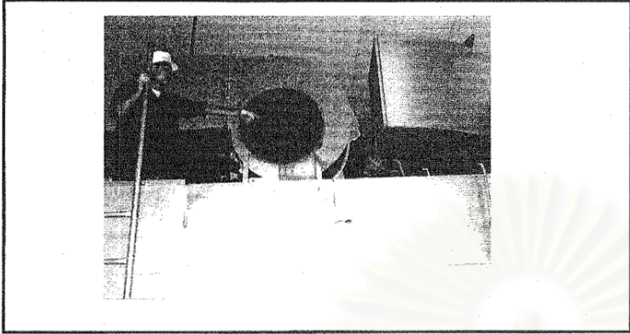
## A.B.C. CO., LTD.

### WORK ORDER CONTROL SHEET

No.	JOB NO.	From Department	Received Date	Receiver	Repairer	Start date	Finish date	Note
1	101	Baking room 2	2/3/00	Sakda	Montree	2/3/00	2/3/00	
2	102	Production 2	2/3/00	Chalerm	Somporn	2/3/00	2/3/00	
3	103	Mixing room 1	2/3/00	Prachuab	Suchat	3/3/00	3/3/00	
4	104	Mixing room 1	2/3/00	Prachuab	Noppadol	2/3/00	2/3/00	
5	105	Mixing room 1	6/3/00	Prachuab	Suchat	6/3/00	6/3/00	
6	106	Baking room 1	7/3/00	Sakda	Suriyan	7/3/00	7/3/00	
7	107	Mixing room 1	7/3/00	Sakda	Suriyan	7/3/00	7/3/00	
8	108	Baking room 2	7/3/00	Sakda	Somporn	7/3/00	7/3/00	
9	109	Small cutting room 2	8/3/00	Prachuab	Suchat	8/3/00	8/3/00	
10	110	Packing room 1	9/3/00	Viphas	Noppadol	9/3/00	9/3/00	
11	111	Production 2	10/3/00	Sakda	Suchat	10/3/00	10/3/00	
12	112	Sealing room 1	18/3/00	Sakda	Noppadol	18/3/00	18/3/00	
13	113	Production 2	15/3/00	Sakda	Montree	15/3/00	15/3/00	
14	114	Sealing room 1	15/3/00	Prachuab	Suchat	15/3/00	15/3/00	
15	115	Packing room 2	15/3/00	Prachuab	Suchat	15/3/00	15/3/00	
16	116	Packing room 1	15/3/00	Prachuab	Suchat	15/3/00	15/3/00	
17	117	Small cutting room 1	9/3/00	Prachuab	Kanong	9/3/00	9/3/00	
18	118	Baking room 1	13/3/00	Prachuab	Kanong	13/3/00	13/3/00	
19	119	Mixing room 1	16/3/00	Sakda	Suriyan	16/3/00	16/3/00	
20	120	Small cutting room 1	14/3/00	Sakda	Noppadol	14/3/00	14/3/00	
21	121	Baking room 2	17/3/00	Viphas	Somporn	17/3/00	17/3/00	
22	122	Small cutting room 1	14/3/00	Prachuab	Suchat	14/3/00	14/3/00	
23	123	Mixing room 1	17/3/00	Sakda	Montree	17/3/00	17/3/00	
24	124	Mixing room 1	16/3/00	Sakda	Montree	16/3/00	16/3/00	
25	125	Mixing room 1	24/3/00	Sakda	Somporn	24/3/00	24/3/00	
26	126	Packing room 1	18/3/00	Sakda	Somporn	18/3/00	18/3/00	
27	127	Mixing room 1	21/3/00	Viphas	Suchat	21/3/00	21/3/00	

FR/EN 008

Figure 6.24 Work Order Control Sheet (FR/EN 008)

A.B.C. CO., LTD.		
MACHINE BREAK DOWN REPORT		
TO : ENGINEERING MANAGER	DATE	29/6/99
		MACHINE NAME
		DRYER D 4
		
<b>DESCRIPTION OF BREAKDOWN :</b>		
MOTOR OF CIRCULATING FAN HAD		
UNUSUAL NOISE		
<b>CAUSE OF THE PROBLEM :</b>		
BEARING OF CIRCULATING FAN WAS BROKEN		
DUE TO LACK OF LUBRICATION		
<b>DESCRIPTION OF WORK DONE :</b>		
REPLACE BEARING NO. UPC 206 1 PC		
REPLACE BEARING NO. UPC 208 1 PC		
<b>CORRECTIVE ACTION :</b>		
1) SET REPLACEMENT SCHEDULE FOR THIS BEARING (CHANGE EVERY 1 YEAR)		
2) CHANGE THIS BEARING FOR OTHER DRYERS		
3) ADD OUTSIDE-BLOWER GREASING POINT		
STARTED TIME : 12.15      FINISHED TIME : 15.00      DOWNTIME : 165 MIN.		
REPORT BY : SUCHAT 29/6/00		APPROVED BY : WIPAS

FR/EN 011

Figure 6.25 Machine Breakdown Report (FR/EN 011)

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## 6.12 Machine Maintenance Record

This record is the summary of repair items:

1. Repair for machine breakdown
2. Repair for machine spare parts replacement

*REF. [1], page24.* All repair details will be filled out in the Machine Maintenance Record classified by machine types as shown in Figure 6.26. In addition, this record will be used to update the Machine Spare Parts Replacement Schedule and be a reference to improve the effectiveness of the preventive maintenance program.



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## A.B.C. CO., LTD.

### MACHINE MAINTENANCE RECORD

DATE	Machine Code	JOB NO.	Maintenance Staff	Description of action taken	Next Plan
Machine Name <span style="border: 1px solid black; padding: 2px;">MIXER</span> YEAR <span style="border: 1px solid black; padding: 2px;">2000</span>					
27/1/00	M 5	162	Suriyan,Kanong	Replace Bearing No. 6314 1 pc	27/1/02
				Replace Bearing No. 6309 1 pc	27/1/02
				Adjust double chain of main drive	
15/2/00	M 4	002	Suchat,Noppadon	Replace Bowl V-Belt A-54 2 pcs	15/8/00
				Replace Blade V-Belt 3V-630 2 pcs	15/2/01
				Replace Blade Rear Bearing No. 6311 1 pc	15/2/02
1/2/00	M 3	006	Hassaporn,Suriyan	Replace Blade V-Belt 5V-750 6 pcs	1/2/02
28/3/00	M 2	026	Kanong , Noppadon	Replace Bowl V-Belt A-54 2 pcs	28/9/00
				Replace Blade V-Belt 3V-630 2 pcs	28/3/01
6/3/43	M 1	005	Suriyan , Suchat	Replace Bowl V-Belt A-54 2 pcs	6/9/00
				Replace Blade V-Belt 3V-630 2 pcs	6/3/01
				Blade Front Bearing No. 6213 2 pcs	6/3/02
				Blade Rear Bearing No. 6311 2 pcs	6/3/02

FR/EN 003 (PART B)


Figure 6.26 Machine Maintenance Record-PART B (FR/EN 003)

### 6.13 Machine Modification

Another cause of machine breakdown is the modification of machine caused by defective design. After training all maintenance staff, we found that some maintenance staff and supervisor offer the idea to modify some deficiency parts of machine to prevent the possibility of machine breakdown. From the cause analysis of machine breakdown in Table 6.2 – 6.7, the Engineering department has begun to improve the following:



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<b>Machine Name:</b> Forming Machine & Preheater	1
<b>Frequently Occurred Problem:</b> The middle part of Thickness Adjustment Plate is bent. When forming the fish dough, it makes the middle part of the fish piece thicker than its both edges.	
<b>Cause (or Machine Defect/Deficiency):</b> The Thickness Adjustment Plate was designed to be too thin to bear the press and adjustment.	
<b>Resolution and Machine Modification:</b> Replace the Thickness Adjustment Plate from size 3 mm. to size 5 mm. and adjust the holder for the new thicker Plate.	
	
Table 6.2 Before and After Machine Modification # 1	

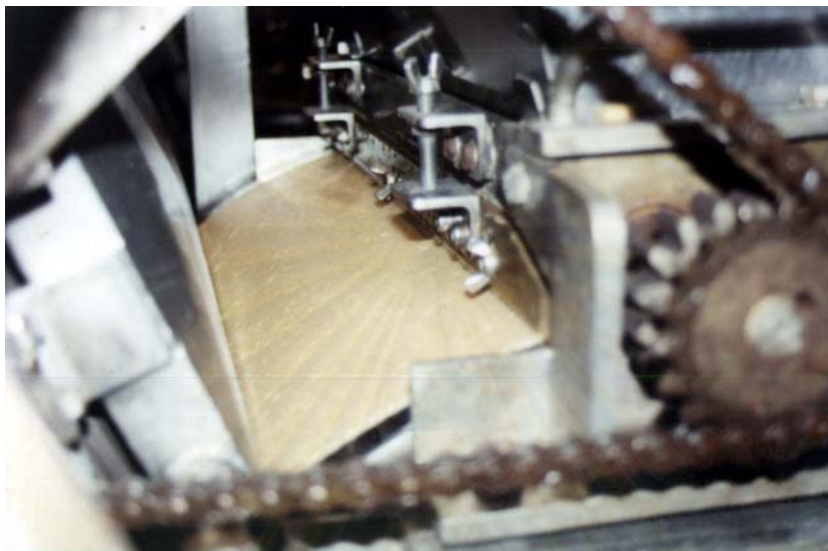
<b>Machine Name:</b> Forming Machine & Preheater	2
<b>Frequently Occurred Problem:</b> The fish piece after formed is not smooth.	



**Cause (or Machine Defect/Deficiency):** Pitch range of screw/nut and bolt for adjusting the Thickness Adjustment Plate is too far and screw size is too small to grasp.

**Resolution and Machine Modification:**

Re-design nut and bolt/screw with more tight pitch range and easy to be grasped.



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Table 6.3 Before and After Machine Modification # 2

**Machine Name:** Forming Machine & Preheater

3

**Frequently Occurred Problem:** Forming Roller Bushing made from bronze is easily damaged resulting that the Forming Roller moves away from its normal direction (eccentric moving). As

a result, the fish piece's thickness becomes wavy and fish leavings are slipped out of the Bush.

**Cause (or Machine Defect/Deficiency):** Forming Roller Bushing is made of low quality materials and the machine parts are too complicated to be replaced.

**Resolution and Machine Modification:**

Change the material for making the Bushing to Teflon, having longer life and easy to be replaced.

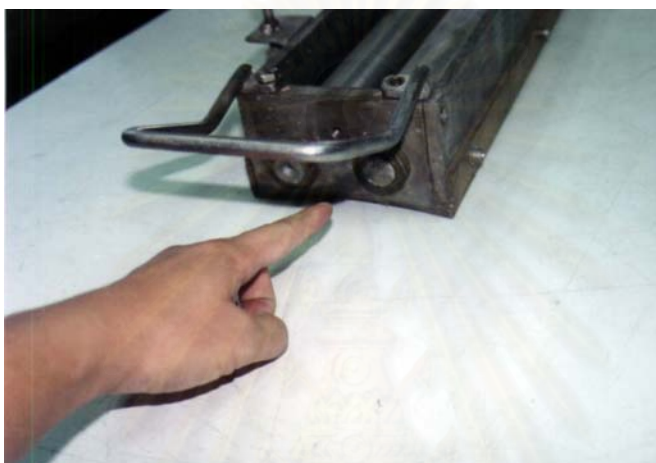


Table 6.4 Before and After Machine Modification # 3

**Machine Name:** Forming Machine & Preheater

4

**Frequently Occurred Problem:** The Sprocket joint with the Middle Shaft and driving unit of drum is too often misaligned so that chain or the Middle Shaft are worn out. This kind of

damage is quite hard to repair.

**Cause (or Machine Defect/Deficiency):** The Middle Shaft's diameter is too short or too narrow to bear the pressure from chain drive in both directions and there is no Key to lock the Sprocket.

**Resolution and Machine Modification:**

Re-size the diameter of the Middle Shaft to the longer one and fix the Key Slot to hold and lock the Sprocket.



Table 6.5 Before and After Machine Modification # 4

**Machine Name:** Dryer

5

**Frequently Occurred Problem:** The Bearing of the Circulating Blower is under high temperature condition and rotates with very high speed rotation often resulting that the

Bearing is broken and it takes at least 2 hours to fix and replace the Bearing.

**Cause (or Machine Defect/Deficiency):** Since the Applying Grease Point of the Bearing Housing is structured within the Hood, it is unable to apply the grease from outside excepting that the whole parts of the Circulating Blower are taken off.

**Resolution and Machine Modification:**

Install the Applying Grease Point of the Bearing Housing at the outer part of the Circulating Blower and set up a schedule for the Bearing replacement according its life.



Table 6.6 Before and After Machine Modification # 5

**Machine Name:** Baking Machine

6

**Frequently Occurred Problem:** The switch is malfunctioned too often.

**Cause (or Machine Defect/Deficiency):** Since the existing switch is directly connected with the electric wire, when the circuit is short, the switch is unable to cut off the electricity and

finally, the switch becomes out of order.

**Resolution and Machine Modification:**

Replace the existing switch with the magnetic on-off type. When the circuit is short, the magnetic will immediately cut off the electricity before the switch is damaged.



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Table 6.7 Before and After Machine Modification # 6

## SECTION 3: Preventive Maintenance System Control

Preventive maintenance system itself is not required a huge effort to implement but to keep it on track is a challenging job. How can we make every staff realize what they and the company significantly gain from preventive maintenance program and willing to give full participation in the program? The following are ways to maintain the effectiveness of the preventive maintenance program and to continuously improve the system:

### 6.14 ISO 9002 Certification

The most effective way to maintain the preventive maintenance system as compliance to the Element 4.9 in ISO 9002 regarding procedure control is to implement work procedure manuals. To apply for ISO 9002 Certification is one of the strategies to control the effectiveness of preventive maintenance program since the system will be periodically reviewed and audited. According to ISO 9002, work standards will be set up as the performance objectives. It is assuming that if those objectives have been fulfilled, jobs or products will be guaranteed for their optimum qualifications. ISO 9002 has set up the written references as the following to be used for confirming that every staff gives full participation on the program:

1. Quality Manual

It provides the policy statement stating the commitment to perform duties according to ISO 9002 regulations.

2. Procedure Manual

This manual is used as a reference for standard work procedures consisting of steps or procedures for performing jobs, required resources including related staff of such jobs.

3. Work Instruction

It is as the explanation of work procedures and staff's responsibility as indicated in the procedure manual.

4. Form, Specification and Schedule

Those documents are used as references to make sure that all jobs have followed the procedures indicated in the procedure manual.

ABC Co., Ltd. has adopted ISO 9002 to control the effectiveness of the preventive maintenance program and its continuous improvement by creating the following documents:

Procedure Manual

PM/EN 001 Preventive Maintenance  
PM/EN 002 Breakdown Maintenance

Work Instruction

WI/EN 001 Machine Repair Procedure (Machine Repair Request Form provided)  
WI/EN 002 Repair Process as Instructed in Preventive Maintenance Procedures  
WI/EN 003 Making Plan for Machine Repair and Spare Parts Replacement  
WI/EN 005 New Machine Inspection and Registration  
WI/EN 006 Spare Parts Purchasing Status Follow-up

Form and Schedule

As stated in reference part of Procedure Manual and Work Instruction

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## 6.15 Auditing of Engineering Department's Work Procedures

In addition to ISO 9002, five companies including ABC Co., Ltd. have adopted the auditing project to review the effectiveness of the Engineering department's performance as follows:

1. Evaluate the effectiveness of the preventive maintenance program by the Engineering department,
2. Preset the readiness of the department before applying for ISO 9002 Certification,
3. Be an example of having good work procedures and provide continuous work improvement,
4. Evaluate the participation in 5S project, good work environment and safety awareness issue.

### Auditing Standards

1. Have honorary professionals other than professionals in the company's business line as the committee.
2. Audit by review the real work condition and by one-day interview.
3. Fill out the score in standard form provided

### Summary of Auditing Results

The result of auditing the sample factory got the first place with score more than 80% (The last got 34%). After auditing, it is found that the preventive maintenance has really been adopted as a significant part of the Engineering department's work procedures. Work environment has been improved. Staff has widened their knowledge and understanding toward the program. In addition, they have realized the importance of having the preventive maintenance program and been willing to take an active part in the program. Most of all, overall performance of the Engineering department has successfully improved.



## 6.16 Corrective Maintenance

*REF. [2], page123.* Corrective Maintenance is the analysis of all equipment failures and breakdowns to determine what action is needed to prevent the reoccurrence. The analysis includes finding out cause of damage, what repairs should be made, and what further action is needed to ensure that the breakdown will not happen repeatedly by providing the following resolutions:

1. Redesigning the defective components
2. Replacing the damaged part with the repaired one or the entirely new part
3. Improving the preventive maintenance procedures for example, reschedule the frequency or restate the content of inspection as appropriate or needed.

The Engineering staff who directly performs the repair will conduct machine breakdown analysis by filling out all related details in the Machine Breakdown Report as in Figure 6.25 The details include the model picture of the machine providing the position of damaged machine part, cause analysis and preventive resolution. The report will be submitted to the Engineering manager for acknowledgement and monthly review in order to ensure the breakdown will not reoccur.

Only the corrective maintenance program itself cannot completely solve all breakdown problems. Therefore, the success of the program depends upon full participation of every single staff to maintain and continuously improve such program so that it keeps working effectively.

## CHAPTER 7

### Results of Implemented Preventive Maintenance

The Appendix D are the summary of machine repair and maintenance of the fish snack production factory from November 1999 to September 2000.

#### 7.1 Evaluation of the implemented preventive maintenance

From the table appeared in Appendix D, it can be concluded the machine repair and maintenance of the fish snack production factory as follows:

##### 7.1.1 Machine Breakdown Frequency

The analyses of Machine Breakdown Frequency from November 1999 to September 2000 are the followings:

- Machine Breakdown Frequency of Baked Fish Snack is in average of 4.5 times per month as shown in Table 7.1
- Small Size Cutting Machine appears to have the most frequent machine breakdown in average of 1.8 times per month as shown in Table 7.1

The details of machine breakdown in the production line of the baked fish snack from November 1999 to September 2000 are shown in Table 7.1 and Figure 7.1.

##### 7.1.2 Degree of Intense of Machine Breakdown

The analyses of the degree of intense of machine breakdown from November 1999 to September 2000 are as follows:

1. Downtime or Loss Time in Process that depends upon how serious the machine breakdown is.

- Downtime or time for repairing the broken down machine, Time in average of 384 minutes per month as shown in Table 7.2
- Forming Machine & Pre-heater and Dryer are the machine that require the longest time in average of 142 minutes per month and 141 minutes per month respectively to fix when breakdown.

2. Cost of Loss Time

Cost of loss time by converting downtime into the form of money (Baht) can indicate how important each machine is. See the following find-out:

- Cost of loss time in Baked Fish Snack Process is in average of 46,236 Baht per month as shown in Table 7.2.

- Dryer is the machine that has the highest cost of loss time in average of 22,833 Baht per month as shown in Table 7.2.

Downtime of a Baking Machine, Regular Size Cutting Machine and Small Size Cutting Machine will not be converted into cost of loss time since when the machine is broken down, the spare machine will be replaced.

The details of machine downtime and cost of loss time in the production line of the baked fish snack from November 1999 to September 2000 are shown in Table 7.2, Figure 7.2 and Figure 7.3.

### 7.1.3 Causes of Machine Breakdown

From November 1999 to September 2000, causes of machine breakdown can be categorized into 7 types as shown in Table 7.3, Figure 7.4 and Figure 7.5.

#### 1. Machine Breakdown Frequency of each category of causes

It can be summarized as follows:

- Lacking of proper machine inspection is the most significant cause of machine breakdown. From November 1999 to September 2000, 25 out 50 times of machine breakdown or 50% of the total machine breakdown are mainly caused by lacking of machine inspection as shown in Table 7.3.

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## 2. Cost of Loss Time in categories of causes

Cost of loss time of each category of causes of machine breakdown as appeared in Table 7.3 and Figure 7.5 are summarized as follows:

- From November 1999 to September 2000, the most significant cause that creates the highest cost of loss time is lacking of machine spare parts replacement. The cost of loss time created by lacking of machine spare parts replacement is 245,666 Baht or 48% of total cost of loss time by other causes.

### 7.1.4 The summary of maintenance result

As a result of applying the preventive maintenance for machine repair and maintenance system as discussed in Chapter 6, the comparison on the frequency of machine breakdown in the production line, downtime, cost of loss time and accident rate of before and after implementing the preventive maintenance is as following Table:

Check points (in average)	Before Preventive Maintenance Implementation (Nov. 98 – Oct. 99)	After Preventive Maintenance Implementation (Nov. 99 – Sept. 00)
1. Number of Machine Breakdown	11.6 time / month 958 min./month	4.5 times / month 384 min./month
2. Downtime	173,797 Baht / month	46,236 Baht / month
3. Cost of Loss Time	4 times	1 time
4. Safety Record		

Table 7.4 The comparison on maintenance result

After implemented preventive maintenance program, we can compare and see the trend of following items:

- The frequency of machine breakdown is reduced to 4.5 time per month in average and has a decreased trend as shown in Figure 7.6

- The cost of loss time is reduced to 46,236 time per month in average and has a decreased trend as shown in Figure 7.7

- The cost of loss time rate is reduced to 0.72 Baht per carton in average as shown in Figure 7.8

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## 7.2 Comparison of the maintenance work

As a result of applying the preventive maintenance for machine repair and maintenance system as discussed in Chapter 6, the comparison on the maintenance work before and after implementing the preventive maintenance is as following Table:

Table 7.5 The comparison of maintenance work

Before improvement	After improvement
1. Maintenance Organization	
<ul style="list-style-type: none"> <li>- Lack of person who responsible for setting up maintenance system</li> <li>- Supervisor lacked and missed some maintenance management skill</li> </ul>	<ul style="list-style-type: none"> <li>- Appoint engineering manager</li> <li>- Appoint maintenance planning staff and safety officer</li> <li>- Change supervisor who has suitable qualifications</li> </ul>
2. Workplace Environment (5 S)	
<ul style="list-style-type: none"> <li>- 5 S program has not been seriously adopted</li> </ul>	<ul style="list-style-type: none"> <li>- 5 S within department did regularly not temporarily</li> <li>- everyone normally would like to have an clean and well-organized workplace</li> </ul>
3. Information of machine and equipment	
<ul style="list-style-type: none"> <li>- No appropriate filing system and database for machine and equipment</li> </ul>	<ul style="list-style-type: none"> <li>- Create Machine Maintenance Record</li> <li>- Providing machine list, machine code</li> </ul>
4. Work Order Procedure	
<ul style="list-style-type: none"> <li>- Requester often not use work order</li> <li>- No have clearly work order procedure</li> </ul>	<ul style="list-style-type: none"> <li>- Every jobs must have work order</li> <li>- New work order procedure has been designed</li> </ul>
5. Training	
<ul style="list-style-type: none"> <li>- No have periodical training for maintenance staff</li> </ul>	<ul style="list-style-type: none"> <li>- Set schedule for both in-house and outside training provide all staff in technical knowledge and preventive maintenance program</li> </ul>
6. Maintenance System	
Breakdown maintenance	Preventive Maintenance
1) Machine inspection <ul style="list-style-type: none"> <li>- No have inspection plan</li> <li>- Only 9 checking items for all of machines</li> </ul>	<ul style="list-style-type: none"> <li>- Setup inspection schedule that can be actually done</li> <li>- Using inspection report to prepare maintenance work</li> </ul>

Before improvement	After improvement
2) Machine spare parts replacement - No have any plan and action	- Setup spare parts replacement schedule correspond to shut down plan
3) Lubrication, Cleaning, Adjustment - Have some checklists include in inspection report - No have any record in this item	- Setup work standards for this item - Process the work standard on shut down day
4) Maintenance planning - No have any maintenance planning	- Setup annual shut down plan and monthly machine repair - Based on inspection checklist, spare part replacement plan and work standard
5) Machine maintenance record - Using work order for maintenance record - Cannot use it in action	- Using Machine maintenance record for next maintenance planning
6) Safety system - No have person responsible for this items	- Appoint safety officer - Training all employee in any levels
7. Preventive maintenance system control	
- No have any system control	- Provide Procedure Manual and Work Instruction
8. Evaluating and Auditing	
- No have any actions in this item	- Periodically reviewed and audited according to ISO 9002 - Evaluate the preventive maintenance program by professionals in company's business line as the committee
9. Corrective Maintenance	
- No have any actions in this item	- Use analysis item in machine breakdown report to improve preventive maintenance procedure



### 7.3 The statistics of in house accident

The statistics of in house accident in November 1999 through September 2000 as demonstrated in Table 7.6

Table 7.6 Accidents Occurred in the Production Line of Baked Fish Snack from November 1999 to September 2000					
Date	Machine Name	Type of Accident	Cause	Type of Cause	Ceasing Period (days)
14/6/00	Finished Goods Rack	Three fingers of the right hand of the Operator are scratched as a result of falling down from 2 <sup>nd</sup> level rack.	<ul style="list-style-type: none"> <li>- Carelessnes</li> <li>- Nut tightening the Rack is damaged.</li> </ul>	<ul style="list-style-type: none"> <li>- Unsafe operation.</li> <li>- Machine and its parts are damaged.</li> </ul>	-



Figure 7.9 569 day without lost time accident till now

Number of Machine Breakdown	MONTH											Grand Total	AVG	
	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00			
MACHINE														
MIXER				1									1	0.1
FORMING MACHINE		1			2	1	2	4	3	1			14	1.3
DRYER	1	1			1		3		1	2			9	0.8
BAKING MACHINE								1		1			2	0.2
REGULAR SIZE CUTTING MACHINE	1						1	1		1			4	0.4
SMALL SIZE CUTTING MACHINE	1	4	1		1	4			6	2	1		20	1.8
Grand Total	3	6	1	1	4	6	6	5	11	6	1		50	4.5

Table 7.1 Number of Machine Breakdown (November 1999 - September 2000)



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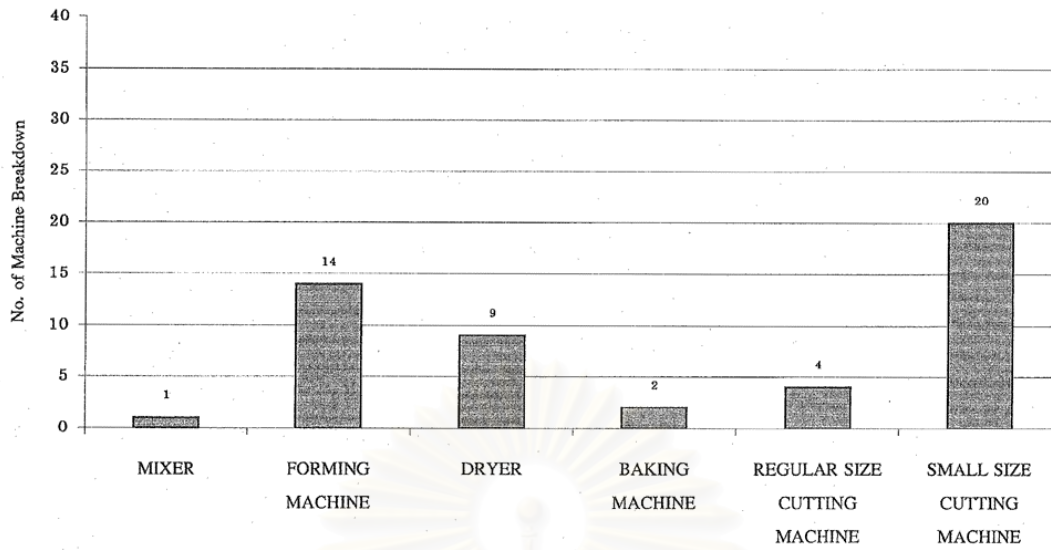


Figure 7.1 Summary of Machine Breakdown (November 1999 – September 2000)

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Data	MACHINE	MONTH											Grand Total	AVG.	
		Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00			
Downtime (Min.)	MIXER				40									40	4
	FORMING M/C		480			530	15	145	155	205	30			1,560	142
	DRYER	50	300			430		455		210	105			1,550	141
	BAKING M/C								20		60			80	7
	REGULAR SIZE CUTTING M/C	70					40	30		90				230	21
	SMALL SIZE CUTTING M/C	30	105	75		10	390			100	30	20		760	69
Cost of Loss Time(Baht)	MIXER				12,558									12,558	1,142
	FORMING M/C		75,348			83,197	2,355	22,761	24,331	32,180	4,709			244,881	22,262
	DRYER	15,698	47,093			67,499		71,424		32,965	16,482			251,160	22,833
	BAKING M/C														0
	REGULAR SIZE CUTTING M/C														0
	SMALL SIZE CUTTING M/C														0
Total Downtime (Min.)		150	885	75	40	970	445	630	175	605	225	20		4,220	384
Total Cost of Loss Time(Baht)		15,698	122,441			12,558	160,696	2,355	94,185	24,331	65,145	21,192		508,599	46,286

Table 7.2 Summary of Downtime and Cost of Loss Time after implement Preventive Maintenance

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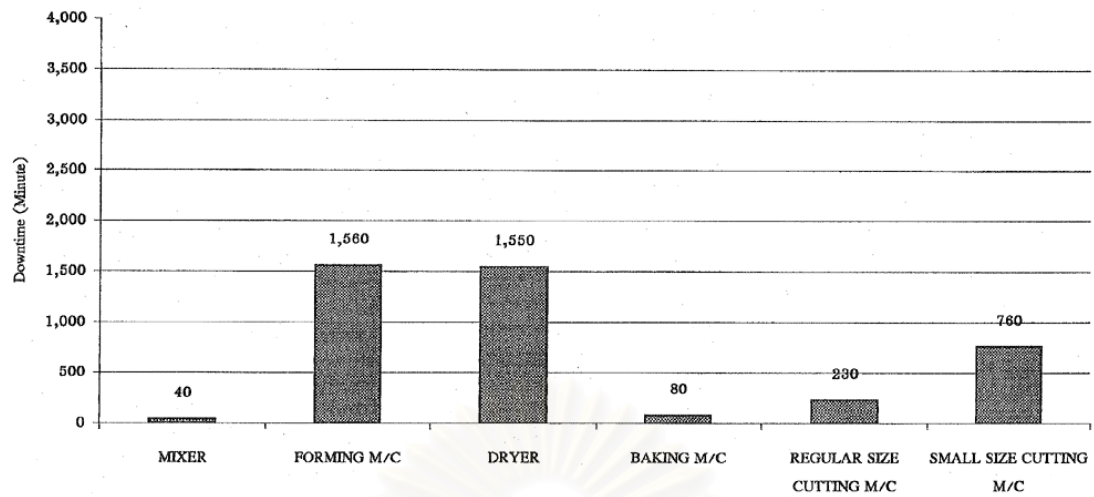


Figure 7.2 Summary of Downtime (November 1999 - September 2000)

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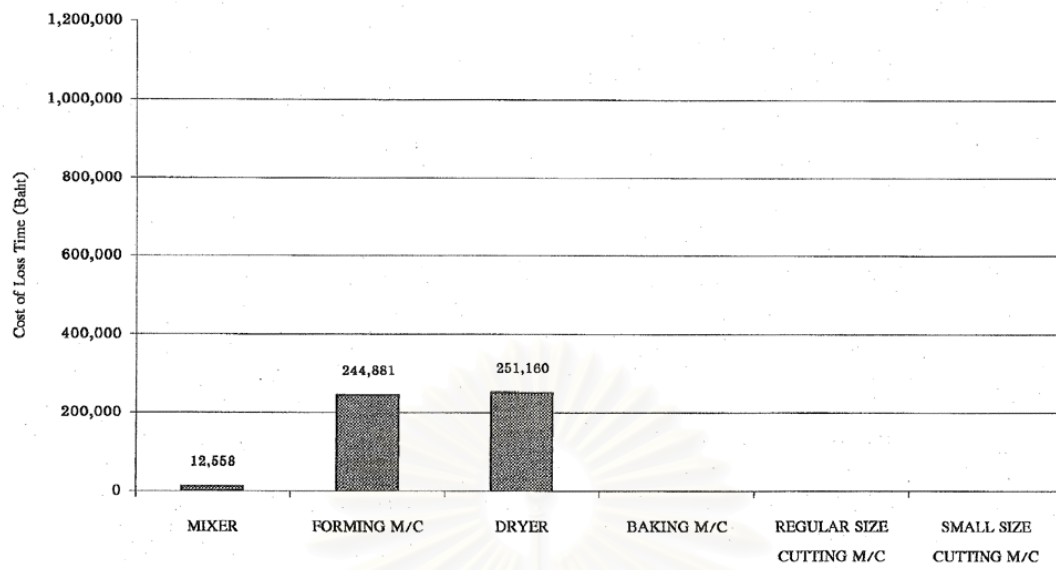


Figure 7.3 Summary of Cost of Loss Time (November 1999 - September 2000)

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Data	CAUSE	MACHINE					Grand Total	AVG.
		MIXER	FORMING M/C	DRYER	BAKING M/C	REGULAR SIZE CUTTING M/C		
Cost of Loss Time (Baht)	Cleaning			18,837			18,837	1,570
	Inspection	12,558	120,871				133,429	11,119
	Lubrication			7,064			7,064	589
	Replacement		106,743	138,923			245,666	20,472
	Adjustment			86,336			86,336	7,195
	Others		17,267				17,267	1,439
Sum of Machine Breakdown	Cleaning			1			1	0
	Inspection	1	8		2		14	2
	Lubrication			1			1	0
	Replacement		4	4		2	10	1
	Adjustment			3		2	6	1
	Others		2				2	0
Total Cost of Loss Time (Baht)		12,558	244,881	251,160			508,599	42,383
Total Sum of Machine Breakdown		1	14	9	2	4	20	4

Table 7.3 Summary of Downtime and Cost of Loss Time in Cause Categories (November 1999 - September 2000)

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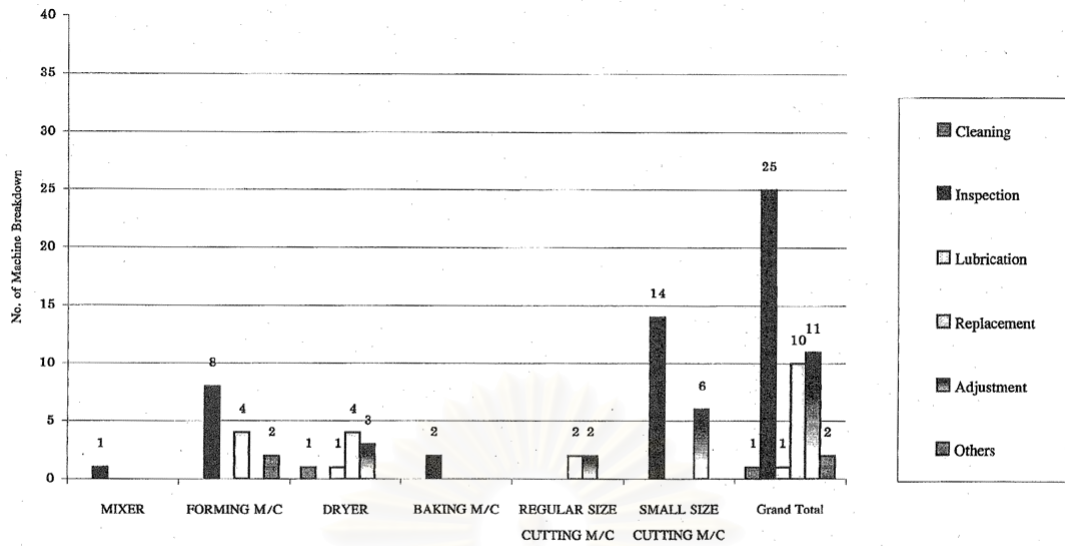


Figure 7.4 Number of Machine Breakdown in Cause Categories (November 1999 – September 2000)

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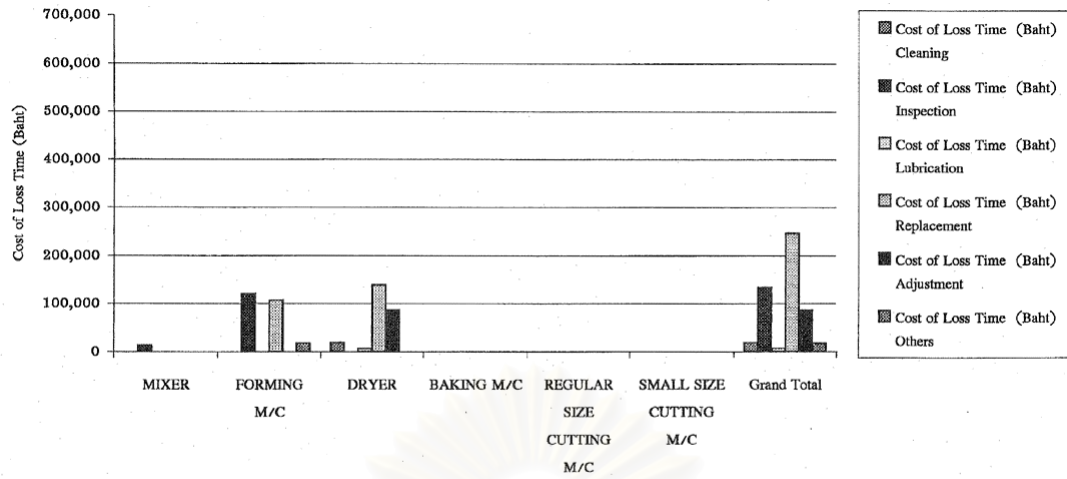


Figure 7.5 Cost of Loss Time in Cause Categories (November 1999 - September 2000)

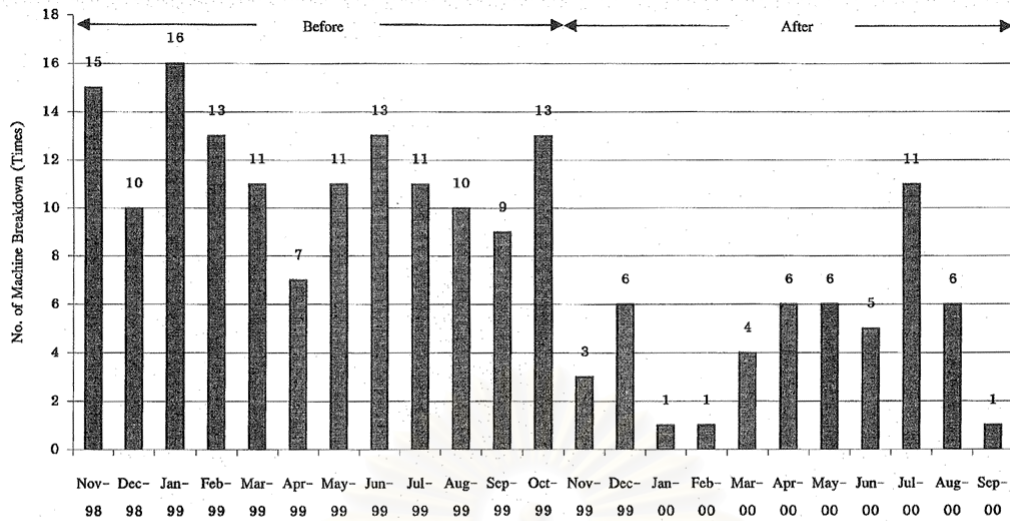


Figure 7.6 No. of Machine Breakdown Before and After implement Preventive Maintenance



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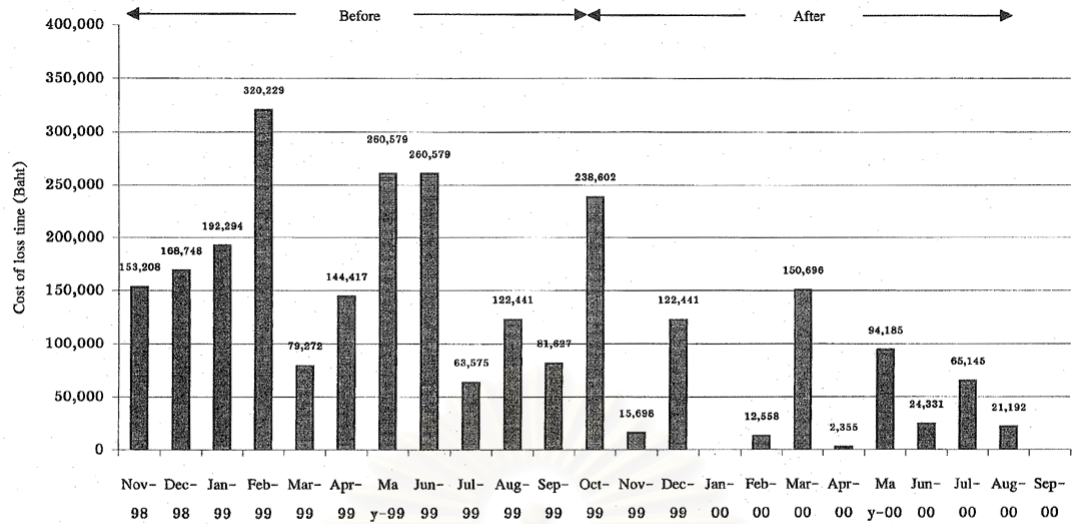


Figure 7.7 Cost of Loss Time Before and After implement Preventive Maintenance

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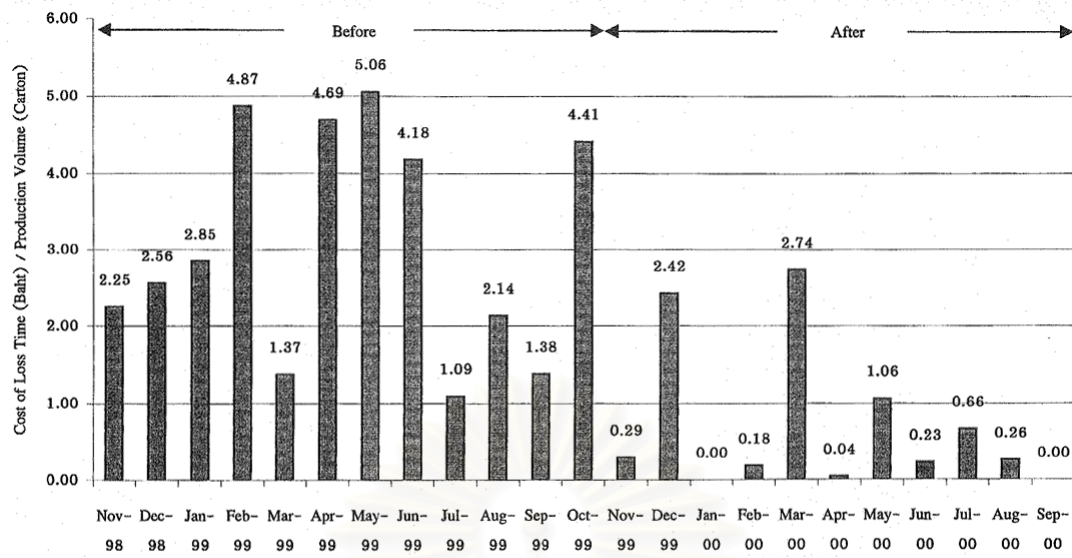


Figure 7.8 Cost of Loss Time Rate Before and After implement Preventive Maintenance

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After the Preventive Maintenance Program has been implemented and although the fault rate tends to decrease, the machine breakdown has still occurred. The assumptions of the said breakdown are the following:

(See figure 7.6)

- The Machine Inspection Plan or the Spare Parts Replacement Plan can help prevent only some specific machine breakdown. The existing inspection and spare parts replacement are based upon the machine repair and maintenance record of which does not cover all possible repair. Mostly, it only pays attention to what causes the machine breakdown without considering other parts of machine that will get damaged over the period and will finally likely to cause the breakdown. This problem can be fixed by having at least an annual review on the inspection and replacement items in order to ensure that the plan covers all maintenance to all parts of machine.
- As indicated in the Chapter 5 that every single machine has its own limitation especially the one produced in Thailand. Such limitation and deflection will cause the reoccurrence of the breakdown. It is recommended that the machine modification should be done regularly and the follow-up is needed to examine whether such modification is effective in order to eliminate the existing limitation and deflection.
- The annual machine maintenance plan for the year 2000 is set up mostly based upon the Machine Maintenance Record and experience of relevant staff. As a consequence, it is required that all machines will be shut down for maintenance at least every 3 month. Such timing may be too long that the machine will be damaged or its life becomes shorter than it should be. The Machine Breakdown Report can prevent the reoccurrence of breakdown and the data can be applied for effectively planning the machine shutdown, monthly maintenance and spare parts replacement.
- The wrong operation of the machine by a Maintenance Staff is one among causes of machine breakdown and the existing Preventive Maintenance Program does not cover

his type of breakdown since it hardly happens prior to the planning of the program.

Therefore, after implementing the program, the breakdown caused by the wrong operation is likely to happen especially by new staff with no technical experience. However, this problem has been fixed after having on the job training and applying ISO 9002 that helps control work quality and standards.

- Since there are still breakdowns caused by machine modification and machine cleaning, relevant standards must be revised and improved regularly. However, such revision and improvement will take much time and require a lot of expertise. Moreover, it is unavoidable that machine parts will be damaged despite that cleaning and lubrication are applied. Therefore, to effectively improve such standards, it recommends that training must be provided regularly to all Maintenance Staff.
- The last factor of machine breakdown is the high volume of production in some specific months. The more products have to be produced, the more machine has to be operated. In case that the volume of production cannot be reached, the machine shutdown has to be canceled. As a consequence, the machine breakdown will be likely to take place in the following month. This can be fixed by rescheduling the machine maintenance to any factory's holiday or on Sundays. The effectiveness of said plan, however, will be determined by the effective repair items, the appropriate manpower and spare parts planning.

The factor as stated above which is likely to cause the machine breakdown can be avoided by regular review and adjustment on elements of the Preventive Maintenance Program and what to be improved or eliminated. Besides, staff training can substantially prevent the machine breakdown to the extent that the cause analysis is done followed by the appropriate prevention as planned to avoid the reoccurrence of the breakdown in the future which can maintain the breakdown in a low rate.

## CHAPTER 8

### Conclusion and Recommendation

#### 8.1 Conclusion

From the study of the production process and maintenance system of the sample factory, we found that most of the existing machines are quite new but breakdowns seem to happen too often, which causes the cost of lost time in every process of the production line especially in critical machine parts. The accident rate seems to be very high as the result of the unsafe condition of machine. Besides, machine breakdown rate is likely to be significantly higher.

As a result of having the maintenance system, it is found that there are two main factors causing the damage of the machine namely:

1. Ineffective Engineering Management

Work procedures and workplace environment within the Engineering department in general does not get ready to effectively implement the maintenance system.

2. The only maintenance system used in the factory is the breakdown maintenance system. Engineering staffs have no or little knowledge and understanding toward the preventive maintenance system.

In order for the sample factory to gain the best outcome from the preventive maintenance, the researcher has collected all related data and machine repair record to analyze the causes of machine breakdown and cost of lost time. Consequently, causes of machine breakdown are divided into 7 categories as follows:

1. Lack of machine cleaning
2. Lack of regular machine inspection
3. Lack of machine lubrication

4. Lack of spare parts replacement
5. Lack of machine parts adjustment
6. Machine faulty design
7. Others ie. incorrect machine operation or incorrect machine repair

In addition to the above factors, the analysis of machine breakdown frequency and degree of machine breakdown can help focus on acquiring the appropriate maintenance program. The analysis of cause of machine breakdown as discussed in Chapter 5 by giving the examples of machine breakdown, which have not yet been repaired, also can assist not only in being the understandable work frame to follow but also in finding the right way to fix the damage and breakdown.

Regarding the resolution to decrease the downtime period or cost of loss time caused by machine damage or breakdown, prior to applying the preventive maintenance, firstly the Engineering management system must be modified. Based upon the finding discussed in Chapter 4, staff training and development must be brought for consideration. The Engineering department's organization must be restructured. Likewise, workplace environment and spare parts stock control must be improved. Subsequently, the preventive maintenance will be applied to prevent damage or breakdown in every part of machine. The system must be practical and understandable. Planning for machine repair is the most important characteristics of the system. All related jobs as scheduled and assigned when machine being shutdown, spare parts replacement, job assigned in connection with machine inspection and all machine repair record are counted as the best data sources providing the right way to improve the preventive maintenance.

As a result of applying the preventive maintenance for machine repair and maintenance system as discussed in Chapter 6, the comparison on the frequency of machine breakdown in the production line, cost of loss time and accident rate of before and after implementing the preventive maintenance is as follows:



Problem	Before Preventive Maintenance Implementation (Nov. 98 – Oct. 99)	After Preventive Maintenance Implementation (Nov. 99 – Sept. 00)	% Change
1. Number of Machine Breakdown in average	11.6 time / month	4.5 times / month	61.2%
2. Downtime			
3. Cost of Loss Time	958 min/month	384 min/month	60.0%
4. Safety Record	173,797 Baht / month 4 times	46,236 Baht / month 1 time	73.4% 75.0%

Table 8.1 The comparison on the frequency of machine breakdown in the production line, cost of loss time and accident rate of before and after implementing the preventive maintenance

The details of finding in Table 8.1 are summarized as follows:

1. The frequency of machine breakdown before implementing the preventive maintenance program is 11.6 time per month in average. After implementing the preventive maintenance, the frequency of machine breakdown is 4.5 time per month in average, decreasing for 7.1 time per month in average or equal to 61.2%.
2. Downtime before implementing the preventive maintenance is in the average of 958 minute per month. After implementing the preventive maintenance, the downtime is in the average of 384 minute per month, decreasing for 574 minute per month or equal to 60.0%
3. Cost of loss time before implementing the preventive maintenance is in the average of 173,797 Baht per month. After implementing the preventive maintenance, the cost of loss time is in the average of 46,236 Baht per month, decreasing for 127,561 Baht per month or equal to 73.4%.
4. Before implementing the preventive maintenance, four accidents have occurred. One of them is serious that operation be stopped. After implementing the preventive maintenance, only one accident has occurred caused by other factors not by unsafe condition of the machine.

After the preventive maintenance has been adopted, it is recommended that the system be controlled and followed continuously by providing standard manuals as instructed by ISO 9002 system in order to audit and make sure that all jobs performed meet the standards. Moreover, corrective maintenance as part of preventive maintenance program must be adopted to keep the preventive maintenance program in track.

In addition, the following are the benefits gained from preventive maintenance implementation:

1. The volume of defective product caused by machine breakdown has been decreased numerously.
2. Machine parts adjustment helps improve the quality of product.
3. Staff overtime expense in respect to the emergency breakdown has decreased significantly.
4. Staff's morale is better after having certain plan for repair in advance and staffs have more time to taking care of the machine.
5. Work process of the Engineering department becomes more systematic. Only spare parts as indicated in spare parts replacement schedule and some specific spare parts will be kept in stock.

## 8.2 Problems and Limitations

Problems and limitations found during the research can be summarized as the following:

### 8.2.1 Problems in Staff's Education and Training

Since the sample factory is located in upcountry, there are some limitations on providing the staffs with training and educational courses due to the transportation expense and time constraint. Such limitations obstruct the development of staff's knowledge, skills and understanding toward changes and adaptation in working system in order to be more appropriate and applicable in this today's high competitive world. On the other side, staffs themselves perceive what they are doing are good enough. Their attitudes toward work seem to be unchangeable or what we call "Regidification". They seem to oppose or not to admit new-coming technologies or new working process, which is more appropriate than the existing one. As experienced, such training's topic on preventive maintenance provided in annual training schedule has been far of the interest as reasons given above. Therefore, to educate them on the benefits of preventive maintenance program before implementing is substantially important. The training course must be planned in the first place for all Engineering staff and Production staff including all levels of supervisor and should be in-house training by in-house personnel in order to provide the ground knowledge and good understanding before implementing the system.

Another limitation in connection with staff training is most of staff especially in the operator level are rather uneducated moving themselves from the basic occupations such as gardener and farmer to work in the factory. Therefore, it is quite difficult and takes a long time to educate them so that they are able to understand what they are taught. Furthermore, the staffs in supervisor level seem not to develop their own knowledge or provide themselves with advance technology or changes that might affect the existence of the company. It is necessary to nourish the perception that every work has to be continuously improved and

adjusted. When attitudes has been brought up, then, the preventive maintenance program in the factory will no longer be difficult to implement.

### 8.2.2 Problems in Applying the Preventive Maintenance

➤ To implement the preventive maintenance program requires advance planing for machine shutdown that will affect the production plan provided that to shutdown the machine is to stop a machine for repair. There are often times staffs have doubtfully raised questions why to shutdown the machine. In addition, it accidentally happens to be the case after shutdown completed, the machine damage has occurred. This situation causes the misunderstanding among staffs that the shutdown brings a lot of problems. However, this kind of problem is coming just in the first place. After implementing several machine shutdowns, it is found that the result is worthwhile in light of quality of the products, the effective machine set-up process, equipment and machine parts being ready to use and the decreasing in machine damages.

➤ At the very first times, the Engineering staffs still lack of basic understanding toward the preventive maintenance implementation. Most of repair works have been performed according to their own knowledge or willingness or their expertise not by the specifications as indicated in the machine shutdown plan. As the shutdown period has been controlled to be as short as possible, it is necessary to focus only damaged machine parts often caused the machine breakdown. Then, making sure whether the breakdown is still re-occurred or not. Clear explanation on the above matter should be provided in order that the repair is correctly performed.

### 8.3 Suggestion

From the study, the preventive maintenance program has been successfully implemented and adopted, but there are some suggestions for increasing the effectiveness of the program as the following:

#### 8.3.1 Implementing the preventive maintenance program for supporting machine and equipment

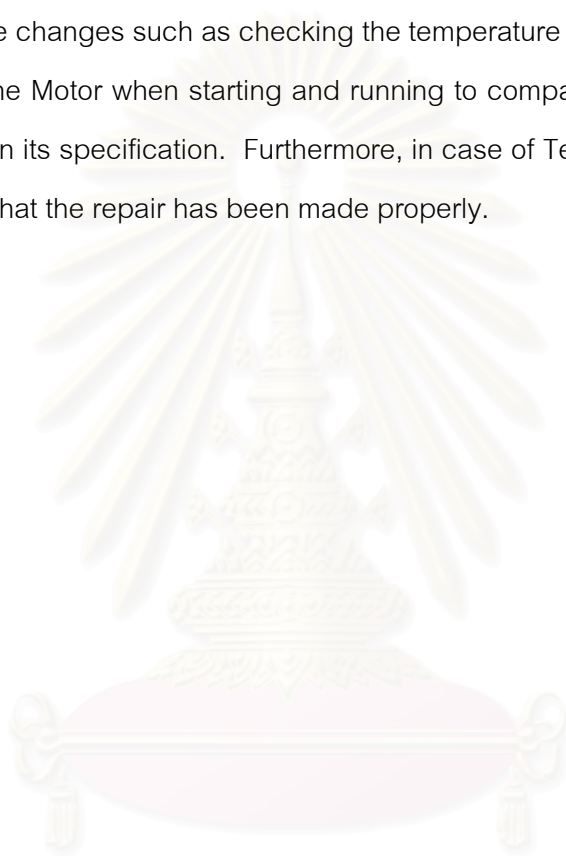
The implementation of the preventive maintenance as shown in this study is for critical machine but it is suggested that it can be applied to supporting machine and equipment. Even though, when machine breakdown, these supporting machines have no significant effects on the production line, they help facilitate the production to be completed faster and easier or they can help save energy. Those machines are a Cooling Tower, Forklift, Hand Lift, Air Compressor, Freezer, Air Condition, Sealing Machine, etc. They also required regular spare parts replacement, adjustment and inspection. Therefore, after successfully implementing the preventive maintenance for main machine, it is not difficult to do the same for the supporting machines.

#### 8.3.2 Downtime Calculation

Downtime is amount of time lost caused by machine breakdown calculating from point of time when machine stops until it works properly again. Downtime will be recorded into three periods namely repair request time, time spent before the repair and time spent during the repair. This Downtime data can be analyzed to indicate when the machine breakdown is. Furthermore, by comparing with the Downtime of similar repair or by setting up standard time for actual repair, we can indicate the effectiveness and skillfulness of the technician or maintenance staff and it can help fixing problem of too long period of Downtime and staff performance.

### 8.3.3 Improvement of inspection standards

Inspection as set in the existing preventive maintenance program has been made roughly by human senses, for example, we hear strange noise from the machine, we feel the machine is too hot to touch or we see some strange things appeared on the machine, and etc. These inspections by human senses are not standardized but they can be resolved by using the standard measurement equipment. It can help monitoring the changes such as checking the temperature within the Baking Machine, Amplifier of the Motor when starting and running to compare with the standard value as indicated in its specification. Furthermore, in case of Test Run, the standard value can indicate that the repair has been made properly.



สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย

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APPENDICES

สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย



Machine Name			Mixer and Feed Pump											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause							
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others	
1/12/98	M4	Short circuit is occurred at the Breaker of the Mixer.	Blow cleaning inside the Control Box and replace the new Breaker.	Lack of regular cleaning at a joint of the electric wire and the Breaker.	40	12,558	✓							
4/2/99	M4	The machine doesn't work.	Clean Front part of Magnetic Contact.	Plastic cover of the Control Box is torn out causing the fish chips getting into the Box.	190	59,651	✓							
16/2/99	M3	Limit Switch of the unloader is out of order.	Replace the new Limit Switch.	Lack of regular cleaning on the rotated point of the Limit Switch.	20	6,279	✓							
28/3/99	M3	High blade rotation speed is out of order.	Re-connect the right wire to the right 3 phases.	Misplace the wire when reshuffling the machines. No test run after re-connecting the wires.	60	18,837								✓
5/4/99	M2	The Blade is broken.	Replace the new Blade.	Lack of spare parts replacement when its life is expired.	60	18,837		✓						
7/5/99	M1	There is strange noise coming out of the machine.	Unlock and adjust the Bowl Bushing.	Lack of spare parts replacement when its life is expired.	360	113,022				✓				
23/6/99	M1	The Blade is broken.	Replace the new Blade.	Lack of regular inspection on the Blade locking.	60	18,837		✓						
30/7/99	M1	There is strange noise coming out of the machine.	Bowl V-Belt is worn out.	Lack of regular inspection on the V-Belt.	30	9,419		✓						
13/10/99	M4	Bearing of the V-Ring is broken.	Replace it with the new Bearing.	Lack of regular spare parts replacement.	130	40,814				✓				

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999.

Machine Name			Mixer and Feed Pump											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause							
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others	
1/2/99	FP3	Feed Pump is unable to run.	Replace the Reducer V-Belt of the Feed Pump.	Lack of regular spare parts replacement according to its life.	180	56,511				✓				
2/2/99	FP2	There is no pressure within the Feed Pump.	Replace the new Rubber Stator.	Lack of spare parts replacement when its life is expired.	75	23,546				✓				
12/3/99	FP1	Feed Pump is unable to run.	Replace the new Rubber Stator.	Lack of regular spare parts replacement according to its life.	60	18,837				✓				
10/5/99	FP4	Thread of the Hose Shank is broken.	Re-connect the Thread.	The Thread is too thin and easily broken when tightening.	75	23,546							✓	
9/6/99	FP3	Feed Pump is unable to run.	Replace the new Bearing of the Motor.	Lack of regular spare parts replacement according to its life.	225	70,639				✓				

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)

Machine Name			Forming & Pre-heater											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause							
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others	
9/11/98	F3/1	There is black liquid from of the side cover next to the Drum dropping on the fish dough.	Clean/wash and seal the side cover.	Lack of regular inspection whether there is any leakage on the side cover.	30	4,709		✓						
14/11/98	F3/1	The Drum Conveyor is slipped out of the Sprocket.	Replace the Conveyor and adjust the Conveyor to be appropriately straight.	Lack of regular replacement for the Conveyor.	90	14,128				✓				
16/11/98	F2/1	Thickness Adjustment Plate is blunt.	Re-sharpen the Blade.	Lack of regular inspection by the Production Department.	20	3,140		✓						
1/12/98	F2/2	The Drum is unable to rotate.	Re-align the Drum Conveyor.	Lack of regular inspection on the Sprocket.	165	25,901		✓						
15/12/98	F3/1	The Bearing of the Drum is broken.	Replace the new Bearing.	Lack of lubrication and spare parts replacement.	270	42,383								
14/1/99	F3/2	The Drum Conveyor is slipped out of the Sprocket.	Re-align the Drum Conveyor and adjust the Conveyor.	Lack of adjustment for the Drum Conveyor alignment.	40	39,244					✓			
14/1/99	F2/2	The Drum Conveyor is slipped out of the Sprocket.	Replace the new Conveyor next to the Drum.	The Sprocket is misaligned and lack of the spare parts replacement.	250	6,279		✓						
18/1/99	F3/1	The Drum Conveyor is slipped out of the Sprocket.	Re-arrange the Conveyor/ adjust the key	Lack of regular inspection.	70	10,988		✓						
18/1/99	F3/2	The Drum Conveyor is slipped out of the Sprocket.	Re-arrange the Conveyor/ adjust the key	Lack of regular inspection.	25	3,924		✓						
27/1/99	F2/2	Thickness Adjustment Plate is blunt.	Replace the new Blade.	Lack of regular spare parts replacement.	40	6,279				✓				

Machine Name			Forming & Pre-heater												
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause								
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others		
29/1/99	F4/1	Thickness Adjustment Plate is blunt.	Re-sharpen the Blade.	Lack of regular inspection by the Production department.	20	3,140		✓							
4/2/99	F2/2	Nut held the Former is loosened.	Re-joint the Nut with the Former.	Lack of regular inspection by the Engineering department.	50	7,849		✓							
5/2/99	F1/1	Former Roller Bush is loosened.	Replace the new Bush.	Lack of spare parts replacement.	330	51,802				✓					
17/3/99	F1/2	The Motor of the Drum is unable to run.	Replace the new Reducer V-Belt.	Lack of regular inspection on the V-Belt.	50	7,849		✓							
27/3/99	F1/1	Gear Motor is unable to work.	Replace the new Gear Motor.	Lack of inspection on the Gear Motor and lack of oil replacement as scheduled.	95	14,913		✓							
3/5/99	F4/2	Former Roller Bush is loosened.	Replace the new Bush.	Lack of inspection and spare parts replacement.	120	18,837				✓					
3/6/99	F2/2	Former Roller is bent.	Turn the Former Roller on a lathe.	Lack of inspection.	430	67,499		✓							
4/6/99	F4/2	Former is unable to make the fish piece smooth.	Replace the new Roller Bracket Plate.	Lack of regular Roller Bracket Plate replacement.	210	32,965				✓					
20/5/99	F3/1	The tip of Former Roller of the Former Unit is worn out.	Take the Former Roller off and reweld its tip.	The tip of Former Roller too tightly affixes with the Bearing.	240	37,674									✓

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)

Machine Name			Forming & Pre-heater											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause							
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others	
20/6/99	F2/1	Thickness Adjustment Plate is blunt.	Replace the new Blade.	Lack of spare parts replacement.	60	9,419				✓				
18/7/99	F2/1	The Drum is unable to rotate.	Adjust the alignment of the chain / tighten all Sprockets.	The Shaft is too small and designed inappropriately.	45	7,064		✓						
29/7/99	F2/2	After forming, the fish piece is wavy.	Turn the Former Roller on a lathe.	Lack of Forming Unit inspection.	300	47,093		✓						
13/8/99	F2/1	The Forming Machine is unable to be attached with frame.	Fix the Thread of damaged nut.	Lack of inspection by the Production department.	60	9,419		✓						
14/8/99	F3/1	The Burner is unable to be ignited.	Replace the new Gas Regulator.	Lack of inspection on whether the gas pressure of the burner is still OK.	30	4,709		✓						
21/8/99	F1/1	The Drum is unable to rotate.	Re-align the Drum's Sprocket and lock all Sprockets.	Lack of regular inspection.	160	25,116		✓						
24/8/99	F1/1	The Former Roller Bush of the Forming Unit is loosened causing the fish piece sullied with oil.	Turn the Bush on a lathe.	Lack of Bush replacement as scheduled.	260	40,814				✓				
25/8/99	F1/1	The Drum is unable to rotate.	Replace the Shaft of the Gear Motor.	The Shaft is too small and designed inappropriately.	240	37,674							✓	

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)

Machine Name			Dryer & Saucing Machine											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause							
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others	
10/11/98	D4	The Wire Mesh Conveyor of the Dryer is worn out.	Weld the Wire Mesh Conveyor Pin.	Lack of regular adjustment or locking the Sprockets causing the Wire Mesh Conveyor is slipped out and rubs against the Pin.	160	50,232						✓		
14/11/98	D2	The Wire Mesh Conveyor of the Dryer is worn out.	Weld the Wire Mesh Conveyor Pin.	Lack of regular adjustment or locking the Sprockets causing the Wire Mesh Conveyor is slipped out and rubs against the Pin.	48	15,070						✓		
16/11/98	D1	The Wire Mesh Conveyor of the Dryer is worn out.	Weld the Wire Mesh Conveyor Pin.	Lack of regular adjustment or locking the Sprockets causing the Wire Mesh Conveyor is slipped out and rubs against the Pin.	210	65,930						✓		
21/12/98	D3	The Wire Mesh Conveyor of the Dryer is worn out.	Weld the Wire Mesh Conveyor Pin.	Lack of regular adjustment or locking the Sprockets causing the Wire Mesh Conveyor is slipped out and rubs against the Pin.	280	87,906						✓		
4/1/99	D1	The temperature of the Dryer is dropped.	Replace the Burner Programmable Controller.	Lack of regular inspection on whether the function of the Burner Programmable Controller is working properly.	130	40,814						✓		

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)

Machine Name			Dryer & Saucing Machine											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause							
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others	
5/1/99	D2	The temperature of the Dryer is dropped.	Replace the Burner Programmable Controller.	Lack of regular inspection on whether the function of the Burner Programmable Controller is working properly.	150	47,093						✓		
6/1/99	D3	The temperature of the Dryer is dropped.	Replace the Burner Programmable Controller.	Lack of regular inspection on whether the function of the Burner Programmable Controller is working properly.	110	34,535						✓		
3/2/99	D2	The Wire Mesh Conveyor of the Dryer is worn out.	Weld the Wire Mesh Conveyor Pin.	Lack of regular adjustment or locking the Sprockets causing the Wire Mesh Conveyor is slipped out and rubs against the Pin.	155	48,662						✓		
15/2/99	SA4	The Saucing Roller is unable to move.	Replace the new Bearing of the Saucing Roller.	Lack of the Bearing inspection.	60			✓						
18/2/99	D1	The Wire Mesh Conveyor of the Dryer is worn out.	Weld the Wire Mesh Conveyor Pin.	Lack of regular adjustment or locking the Sprockets causing the Wire Mesh Conveyor is slipped out and rubs against the Pin.	210	65,930						✓		
22/3/99	D3	The Burner is unable to be ignited.	Take off and clean the Ignition Spark Rod.	Lack of the Ignition Spark Rod replacement and the Burner adjustment.	60	18,837	✓							

Machine Name			Dryer & Saucing Machine										
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause						
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others
5/4/99	D4	The Breaker of the Dryer is burnt.	Replace the new Breaker.	Short circuit occurred at the wire of the Freezer linked with the Breaker of the Dryer.	70	21,977						✓	
21/4/99	D1	Temperature Controller is unable to work.	Replace a new Temperature Controller.	Lack of replacement of the Relay in the Temperature Controller.	330	103,604				✓			
4/5/99	D2	The Burner is unable to be ignited.	Replace the new Ignition Spark Rod.	The Ignition Spark Rod is broken. Lack of spare parts replacement when due.	65	20,407				✓			
7/5/99	D4	The Wire Mesh Conveyor is unable to run.	Re-lock all Set Screws of the Sprockets of the Wire Mesh Conveyor.	Lack of adjustment when due.	10	3,140					✓		
10/5/99	D4	Fish piece is covered with oil.	Check and clean every single Wire Mesh Conveyor.	Too much lubrication on the Wire Mesh Conveyor.	140	43,953							✓
29/6/99	D4	The Blower runs noisily.	Replace the new Bearing of the Blower.	Lack of Bearing Replacement when its life is due.	165	51,802						✓	
29/6/99	D4	The Blower V-Belt is worn out.	Replace and adjust the new Blower V-Belt.	Lack of inspection and adjustment of the tightness of the V-Belt.	30	9,419		✓					
6/7/99	SA3	The Saucing Roller is broken.	Replace the new Saucing Roller.	Size of the Shaft is too small.	40							✓	
12/7/99	SA2	The Saucing Roller is broken.	Replace the new Saucing Roller.	Size of the Shaft is too small.	30							✓	

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)



Machine Name			Dryer & Saucing Machine														
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause										
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others				
19/7/99	SA1	The Saucing Roller is broken.	Replace the new Saucing Roller.	Size of the Shaft is too small.	35												
3/8/99	D3	The Wire Mesh Conveyor is slipped out of its track.	Lock and re-align the Sprockets.	Lack of Sprocket alignment adjustment and lack of regular inspection.	15	4,709							✓				
13/9/99	D1	Gas leakage at the joint of gas pipe with other machines.	Re-arrange the gas pipe and weld the joint of the gas pipe.	The joint of the gas pipe is not fastened tightly.	260	81,627		✓									
11/10/99	D1	The Wire Mesh Conveyor of the Dryer is unable to run.	Replace the new Reducer V-Belt.	Lack of spare parts replacement when due.	15	4,709					✓						
12/10/99	D1	The Reducer of the Dryer cannot be adjusted.	Replace the new Reducer.	Lack of lubrication on the Reducer causing its life expired too early.	45	14,128				✓							
13/10/99	SA3	The Saucing Roller is unable to move.	Replace the new Bearing of the Saucing Roller.	Lack of the Bearing inspection.	40			✓									
15/10/99	D2	Fish piece is covered with oil.	Clean the Wire Mesh Conveyor.	Too much lubrication on the Wire Mesh Conveyor.	60	18,837											✓
16/10/99	D2	Fish piece is covered with oil.	Clean and wash the Dryer with high-pressured water injection.	The damage is not completely fixed.	510	160,115											✓

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)

Machine Name			Baking Machine												
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause								
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others		
1/10/99	B5	Mesh Conveyor is worn out and scratches the Gas Burner.	Bend the Mesh Conveyor's edge and Adjust the alignment of the Conveyor.	Lack of inspection and request for repair when machine is damaged.	20			✓							
24/9/99	B1	The Gas Burner is unable to be ignited.	Take the Gas Burner's parts off and do the cleaning thoroughly.	Lack of the correct way for Gas Burner cleaning.	10		✓								
2/9/99	B2	Switch is out of order.	Reset the Switch.	Switch has been pressed too often.	10								✓		
3/11/98	B2	The Gas Burner is unable to be ignited.	Replace the new Gas Burner.	Lack of regular inspection.	55			✓							
2/11/98	B2	The Gas Burner is unable to be ignited.	Take the Gas Burner's parts off and do the cleaning thoroughly.	Lack of the correct way for Gas Burner cleaning.	35		✓								
24/11/98	B3	The Gas Burner is unable to be ignited.	Replace a valve of the Gas Burner.	Lack of inspection and spare parts replacement when damaged.	15			✓							
13/11/98	B3	Switch is unable to work.	Clean parts of Switch.	Lack of regular inspection and cleaning.	20		✓								
21/11/98	B5	The Wire Mesh Conveyor is worn out.	Weld the Wire Mesh Conveyor Pin and re-connect the Wire.	Lack of Conveyor alignment adjustment.	50							✓			
22/11/98	B5	Oil in the Gear Motor spilled out.	Tighten the Nut of the Side Cover of the Gear Motor.	Lack of regular inspection.	20			✓							
22/1/99	B5	The Switch is unable to work.	Replace the Overload.	Lack of regular inspection on the function of the electric system.	40			✓							

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)

Machine Name			Baking Machine												
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause								
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others		
7/1/99	B2	The Gas Burner is unable to be ignited.	Take the Gas Burner's parts off and do the cleaning thoroughly.	Lack of the correct way for Gas Burner cleaning.	10		✓								
14/1/99	B1	The Burner Mesh is worn out.	Replace the new Burner Mesh.	Lack of regular inspection.	25			✓							
12/3/99	B5	The Switch is out of order.	Replace the new Switch.	The Switch's design is not suitable for usage.	70								✓		
27/4/99	B4	The Wire Mesh Conveyor is loose.	Adjust the Sprocket in order not to be too loose or too tight.	Lack of regular inspection and adjustment.	20								✓		
23/6/99	B1	The upper Mesh Conveyor is unable to rotate.	Adjust both side of the wire to have the same length.	Lack of regular inspection and adjustment.	10								✓		
7/6/99	B2	The Mesh Conveyor is unable to rotate.	Take the Mesh Conveyor connected to the Gas Burner off and adjust the Gas Burner.	Lack of regular inspection.	15			✓							
6/9/99	B5	The machine is unable to run.	Re-connect the electric wire.	Lack of regular inspection on the Electric Wire.	45			✓							
22/9/99	B3	The Wire Mesh Conveyor is loose.	Adjust the Sprocket in order not to be too loose or too tight.	Lack of regular inspection and adjustment.	20								✓		
1/10/99	B5	Mesh Conveyor is worn out and scratches the Gas Burner.	Bend the Mesh Conveyor's edge and Adjust the alignment of the Conveyor.	Lack of inspection and request for repair when machine is damaged.	10			✓							
11/10/99	B1	The Switch is unable to work.	Reconnect the electric wire with s/w	Lack of regular inspection.	30			✓							
15/10/99	B2	The Gas Burner is unable to be ignited.	Replace the Gas Burner.	Lack of regular inspection.	40			✓							

Machine Name			Regular Size Cutting Machine												
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause								
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others		
10/9/99	RC1	The movement of the Conveyor Belt and the cutting pitch do not relate to each other.	Re-connect the electric wire.	The machines are relocated and after installation, there is no test run to make sure it runs properly.	135										✓
11/3/99	RC3	The Blade is blunt.	Replace the Blade.	Lack of Blade inspection and re-sharpening.	30			✓							
18/2/99	RC5	The Nut tightening the Crank Rod is broken.	Turn the Nut on a lathe and replace the Bearing of the Crank Rod.	Lack of Crank Rod' s Bearing replacement..	90					✓					
20/4/99	RC4	The Blade is blunt.	Adjust the Blade.	Lack of Blade inspection and pitch adjustment.	40							✓			
4/5/99	RC2	The Blade is blunt.	Replace the Blade.	Lack of Blade inspection and re-sharpening.	120										✓
19/12/98	RC5	The Blade is blunt.	Replace the Blade.	Lack of Blade inspection and re-sharpening.	60			✓							
27/3/99	RC5	The Nut tightening the Crank Rod is broken.	Turn the Nut tightening the Crank Rod on a lathe and fix the thread of the Crank Rod's Nut.	Lack of Crank Rod' s Bearing replacement..	60					✓					
7/6/99	RC4	There is strange noise from the machine and brake is damaged.	Replace brake	Lack of regular spare parts replacement according to its life.	30						✓				

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)

Machine Name			Regular Size Cutting Machine												
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause								
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others		
5/7/99	RC1	There is strange noise from the machine and brake is damaged.	Replace brake	Lack of regular spare parts replacement according to its life.	65						✓				
23/9/99	RC2	The Blade is blunt.	Adjust the Blade.	Lack of Blade inspection and pitch adjustment.	50							✓			
26/10/99	RC1	The Blade is blunt.	Replace the Nut of the Gear.	Lack of regular Nut inspection.	80			✓							

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)

สถาบันวิทยบริการ  
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Machine Name			Small Size Cutting Machine												
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause								
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others		
4/3/99	SC3	The rear Chute is slipped out.	Weld the Chute and re-lock the Nut.	Lack of regular inspection before being used.	45			✓							
9/3/99	SC1	There is noise from the Conveyor Belt.	Replace the Rear Drum Bearing.	The Belt is adjusted too tightly.	90										✓
29/3/99	SC4	Fish was cut unevenly.	Lower the Press Roller.	Lack of regular inspection.	90			✓							
26/4/99	SC2	The Blade slices off the V-Belt.	Adjust the Crank Adjustment Nut.	Lack of regular inspection on whether the Blade is ready to use.	30			✓							
26/4/99	SC2	Fish was cut unevenly.	Tighten the Pulley of the Feeding Pawl.	Lack of regular Feeding Pawl inspection.	30			✓							
27/5/99	SC2	The machine is unable to work properly.	Tighten the Safety S/W at the cover.	Lack of inspection of the safety related equipment.	20			✓							
13/5/99	SC6	The Small Size Cutter does not work well. Fish was cut into the wrong size.	Tighten the Pulley of the feed conveyor	Lack of regular inspection.	30			✓							
20/5/99	SC5	Fish was cut unevenly.	Replace the Feeding Pawl.	Lack of regular inspection.	60			✓							
2/6/99	SC1	The Small Size Cutter is unable to cut the fish.	Replace the new Conveyor Belt.	Lack of regular inspection.	115			✓							
11/6/99	SC3	Stopper Pawl Adjustment Screw cannot be locked.	Replace the Adjustment Screw.	Lack or regular inspection.	45			✓							

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)

Machine Name			Small Size Cutting Machine											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause							
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others	
18/6/99	SC2	The rear Chute is slipped out.	Weld the Mesh Conveyor and tighten the Nut.	Lack of regular inspection.	30			✓						
5/7/99	SC4	The Blade is blunt.	Replace the new Blade.	Lack of regular Blade sharpening.	30							✓		
26/7/99	SC4	Fish piece is unevenly cut or unqualified.	Replace the Feeding Pawl.	Lack of spare parts replacement when due.	85					✓				
19/7/99	SC3	Fish piece is unevenly cut or unqualified.	Adjust the Dividing Scale Bolt.	Lack of inspection before using.	10			✓						
15/7/99	SC1	The Chute is pressed against the Conveyor Belt.	Re-shape the Chute.	Lack of regular inspection.	25			✓						
26/11/98	SC1	Fish dough is stuck to the Press Roller at the Feeder.	Adjust and raise the Press Roller position.	Lack of inspection on the Crank Adjustment Screw.	30			✓						
23/11/98	SC1	Turning on Switch does not work.	Reset the magnetic Switch.	Lack of regular inspection on the electricity system.	10			✓						
21/12/98	SC6	Fish piece is unevenly cut or unqualified.	Replace the new Blade.	Lack of regular Blade sharpening.	10							✓		
17/12/98	SC2	Fish piece is unevenly cut or unqualified.	Replace the new Blade.	Lack of regular Blade sharpening.	30							✓		
9/12/98	SC1	The Adjustment Bolt of the Dividing Crank cannot be rotated.	Loosen the Bolt and repair its thread.	Lack of regular inspection.	45			✓						
7/12/98	SC2	The Blade is blunt.	The Blade Fixing Board is loosened.	Lack of regular Blade inspection.	10			✓						

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)

Machine Name			Small Size Cutting Machine												
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause								
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others		
18/12/98	SC3	The Blade is blunt.	Adjust the Crank Adjustment Nut to lower the Blade position.	Lack of regular Blade inspection.	20			✓							
26/11/98	SC4	The Blade is blunt and the middle part is nicked.	Replace the new Blade.	Lack of regular Blade inspection.	20			✓							
27/1/99	SC4	The Blade slices off the V-Belt.	Adjust the Crank Adjustment Nut.	Lack of regular inspection on whether the Blade is ready to use.	30			✓							
23/1/99	SC6	The Blade is blunt.	Replace the new Blade.	Lack of Blade sharpening.	10			✓							
7/1/99	SC1	The Adjustment Bolt of the Dividing Crank cannot be rotated.	Adjust the Nut.	Lack of regular inspection.	45			✓							
13/1/99	SC1	The remnant is stuck in the machine.	Loosen the Press Roller to remove the remnant.	Wrongly operate the machine.	35										✓
12/2/99	SC2	The Blade slices off the V-Belt.	Adjust the Crank Adjustment Nut.	Lack of regular inspection on whether the Blade is ready to use.	40			✓							
13/2/99	SC2	The cutting pitch is not consistent.	Replace the new Conveyor Belt.	Lack of regular inspection on the Conveyor Belt.	135			✓							
4/2/99	SC6	The cutting pitch is not consistent.	Replace and adjust the Blade.	Lack of regular inspection	40			✓							
2/8/99	SC5	The Chute is twisted.	Re-shape frame of the Chute.	Lack of regular inspection.	25			✓							

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)



Machine Name			Small Size Cutting Machine											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause							
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others	
13/8/99	SC1	The Blade is blunt.	Re-sharpen the Blade.	Lack of regular Blade sharpening.	40							✓		
23/8/99	SC3	The rear Chute is damaged.	Weld the Chute and tighten the Nut.	Lack of regular Chute inspection.	20			✓						
30/8/99	SC4	The Blade is blunt.	Replace the new Blade.	Lack of Blade sharpening.	35			✓						
2/9/99	SC4	Conveyor Belt is slipped out.	Adjust the alignment of the Conveyor Belt	Lack of regular inspection.	20			✓						
15/9/99	SC3	The Blade is blunt.	Replace the new Blade.	Lack of Blade sharpening.	25							✓		
2/10/99	SC3	Size of the Cutting Machine is not suitable.	Tightly lock the Feeding Pawl.	Lack of inspection on the locking of the Feeding Pawl.	15			✓						
11/10/99	SC1	Fish piece is stuck a the Chute.	Adjust the Chute to lie beside the Belt.	Lack of inspection before use.	40			✓						

APPENDIX A : The summary of machine repair and maintenance from November 1998 to October 1999 (Continued)

APPENDIX B : The comparison of engineering department's work environment "before" implementation and "after" implementation

Before Improvement



After Improvement



APPENDIX B : The comparison of engineering department's work environment "before" implementation and "after" implementation

Before Improvement



After Improvement



APPENDIX B : The comparison of engineering department's work environment "before" implementation and "after" implementation

Before Improvement



After Improvement





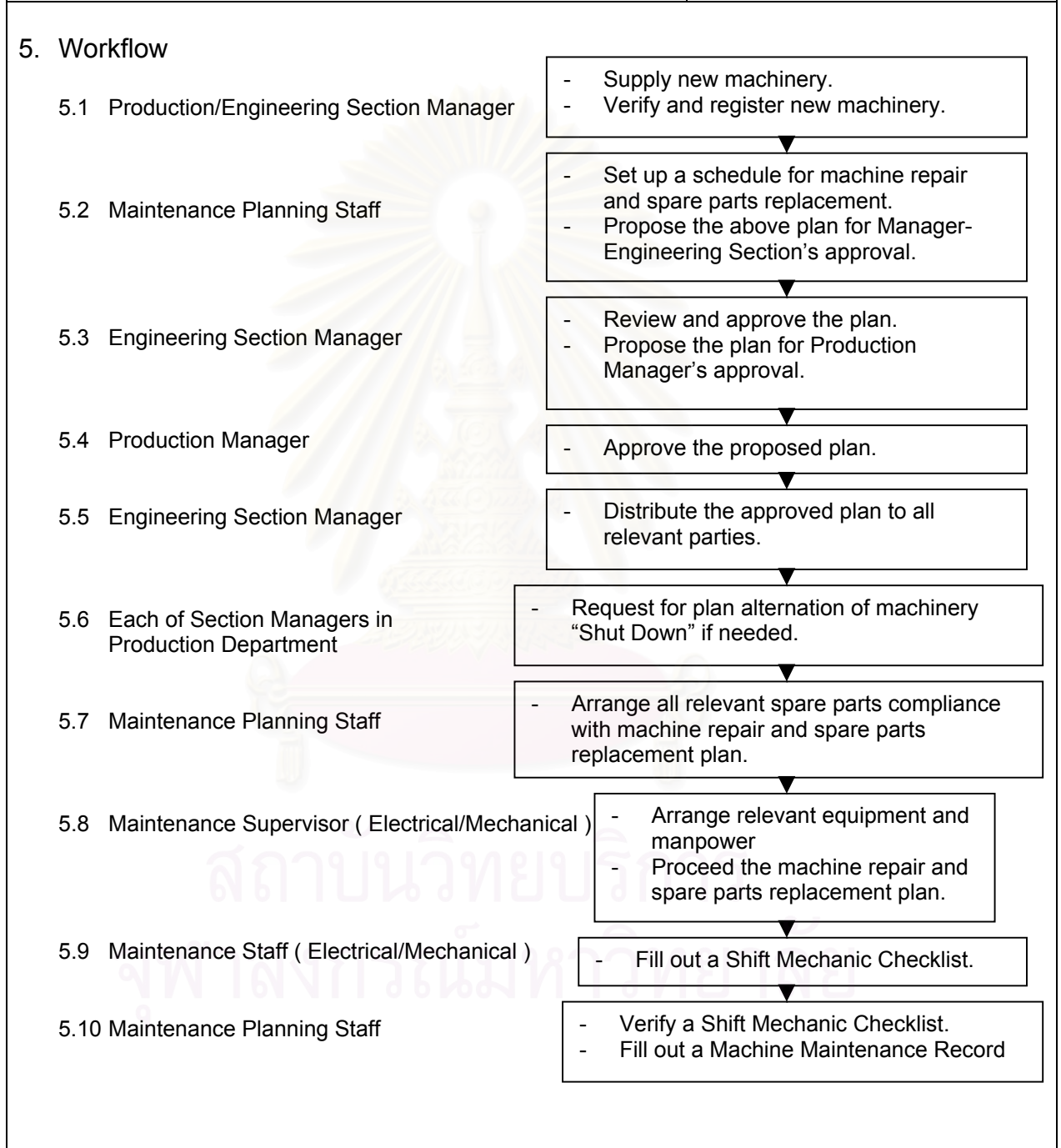
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APPENDIX C: The Procedure Manual & Work Instruction (Continued)

Procedure Manual		Document No. : PM/EN 001
Subject: Preventive Maintenance		Effective Date: 01/05/2000
ABC Food Co., Ltd.		Amendment No.: 2
		Page: 1/5
<p><b>1. Objectives</b></p> <p>This procedure manual has been prepared to provide the preventive maintenance plan and machinery inspection system to help enhance the effectiveness of the machine operated in the production process.</p> <p><b>2. Scope of Procedure Manual</b></p> <p>This procedure manual has been designed solely for preparation and processing the maintenance plan and replacement of the spare parts of main production machinery whereas the supporting production machinery will be maintained by the authorized department. In case that the department cannot fix the out of order or damaged machine, Engineering Section will take care of the problem.</p> <p><b>3. Definitions</b></p> <p>3.1 Main Production Machinery consist of: Mixer, Feed Pump, Forming &amp; Pre Heat, Dryer, Saucing Machine, Baking Machine, Regular Size Cutting, Small Size Cutting</p> <p>3.2 Supporting Production Machinery consist of: Hot Oil Boiler, Forklift, Handlift, Cooling Tower, Sealing Machine, Ice Maker, Frozen Room, and small machinery and tools such as a balance and any equipment for guarantee seal</p> <p><b>4. Responsible Staff</b></p> <p>4.1 Engineering Section Manager is responsible for setting up policy, planning the workflow and managing all relevant engineering job.</p> <p>4.2 Engineering Supervisor is responsible for inspecting and fixing the out of order machine by supervising a mechanic team and follow-up the progress.</p> <p>4.3 Maintenance Planning Staff is responsible for planning a machinery inspection checklist, repairing and ensuring that the machine are ready to use at all time.</p> <p>4.4 Maintenance Staff (Electrical/Mechanical) is responsible for fixing or replacing the spare parts, and inspecting the machinery within the timeframe.</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

APPENDIX C: The Procedure Manual & Work Instruction (Continued)

Procedure Manual Subject: Preventive Maintenance  ABC Food Co., Ltd.	Document No. : PM/EN 001
	Effective Date:01/05/2000
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	Page: 2/5



Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

## APPENDIX C: The Procedure Manual &amp; Work Instruction (Continued)

Procedure Manual		Document No. : PM/EN 001
Subject: Preventive Maintenance		Effective Date: 01/05/2000
ABC Food Co., Ltd.		Amendment No.: 2
		Page: 3/5
<p>6. Working Method</p> <p>6.1 Production Manager/Engineering Manager</p> <p>6.1.1) any Sections that requires new machinery replacement must supply new machinery and proceed machinery testing as instructed by New Machinery Registration Work Instruction (WI/EN 005).</p> <p>6.2 Maintenance Planning Staff</p> <p>6.2.1) gather all relevant data from Machine Maintenance Record (FR/EN 003), Machinery Inspection Report (prepared by Engineering Section) (FR/EN 002), Machinery Inspection Report (prepared by Production Section) (FR/EN 007) and Request Form for Machine Repair (FR/EN 001) to be used for developing a Monthly Spare Parts Replacement Plan (FR/EN 010), Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004), Annual Machinery Shut Down Plan (SC/EN 001) and Weekly Work Plan compliance with Machine Repair and Spare Parts Replacement Work Instruction (WI/EN 003);</p> <p>6.2.2) Deliver Monthly Spare Parts Replacement Plan (FR/EN 010), Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004) and Annual Machinery Shut Down Plan (SC/EN 001) to Engineering Section Manager for approval.</p> <p>6.3 Engineering Section Manager</p> <p>6.3.1) review Monthly Spare Parts Replacement Plan (FR/EN 010) and Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004)</p> <p>6.3.1.1 if agree, sign for approval</p> <p>6.3.1.2 if disagree, return such plans to be modified as instructed in item 6.2.1;</p> <p>6.3.2) review Annual Machinery Shut Down Plan (SC/EN 001) with Section Managers in Production Department, modify the plan as appropriated and propose such plan to Production Department Manager for approval.</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:



## APPENDIX C: The Procedure Manual &amp; Work Instruction (Continued)

Procedure Manual		Document No. : PM/EN 001
Subject: Preventive Maintenance		Effective Date: 01/05/2000
ABC Food Co., Ltd.		Amendment No.: 2
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<p>6.4 Production Department Manager</p> <p>6.4.1) review and approve Annual Machinery Shut Down Plan (SC/EN 001)</p> <p>6.4.1.1 If agree, sign for approval</p> <p>6.4.1.2 If disagree, return such plan to Engineering Section Manager and Maintenance Planning Staff to be modified as instructed in item 6.3.1;</p> <p>6.4.2) return the approved Annual Machinery Shut Down Plan (SC/EN 001) to the relevant parties.</p> <p>6.5 Engineering Section Manager</p> <p>6.5.1) distribute the approved Annual Machinery Shut Down Plan (SC/EN 001) to all relevant parties.</p> <p>6.6 Production Section Manager/ Engineering Section Manager</p> <p>6.6.1) In case there are some necessities to change the date for Machinery Shut Down as fixed in Annual Machinery Shut Down Plan, relevant staff must fill out the Request Form for Machinery Shut Down Plan Modification (FR/EN 009) and propose the Form to Production and Engineering Section Managers for approval and inform such modification to all relevant parties at least 1 (one) day prior to the modified Shut Down date.</p> <p>6.7 Maintenance Planning Staff</p> <p>6.7.1) arrange all relevant spare parts according to Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004).</p> <p>6.8 Maintenance Supervisor (Electrical/Mechanical)</p> <p>6.8.1) arrange all relevant equipment and manpower;</p> <p>6.8.2) proceed machine repair according to Machine Repair Work Instruction (WI/EN 002).</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

APPENDIX C: The Procedure Manual & Work Instruction (Continued)

Procedure Manual		Document No. : PM/EN 001
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<p>6.9 Maintenance Staff (Electrical/Mechanical)</p> <p>6.9.1) fill out a Shift Mechanic Checklist (FR/EN 005).</p> <p>6.10 Maintenance Planning Staff</p> <p>6.10.1) verify the data in Shift Mechanic Checklist (FR/EN 005) compliance with Monthly Machine Repair and Spare Parts Replacement Plan (FR/EN 004);</p> <p>6.10.1.1 if not completed, any pending jobs will be fixed in the following Monthly Machine Repair and Spare Parts Replacement Plan (FR/EN 004).</p> <p>6.10.1.2 fill out any job done in Machine Maintenance Record (FR/EN 003) ( in case that the machine has broken down)</p> <p>7. References</p> <p>7.1 Machine Repair Work Instruction (WI/EN 002)</p> <p>7.2 Machine Repair and Spare Parts Replacement Work Instruction (WI/EN 003)</p> <p>7.3 New Machinery Registration Work Instruction (WI/EN 005)</p> <p>7.4 Annual Machinery Shut Down Plan (SC/EN 001)</p> <p>8. List of Record</p> <p>8.1 Request Form for Machine Repair (FR/EN 001) having 1 year storage period</p> <p>8.2 Machinery Inspection Report (prepared by Engineering Section) (FR/EN 002) having 1 year storage period</p> <p>8.3 Machine Maintenance Record (FR/EN 003) having 2-year storage period</p> <p>8.4 Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004) having 1 year storage period</p> <p>8.5 Shift Mechanic Checklist (FR/EN 005) having 1 year storage period</p> <p>8.6 Machinery Inspection Report (prepared by Production Section) (FR/EN 007) having 1 year storage period</p> <p>8.7 Request Form for Machinery Shut Down Plan Modification (FR/EN 009) having 1 year storage period</p> <p>8.8 Monthly Spare Parts Replacement Plan (FR/EN 010) having 5-year storage period</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

APPENDIX C: The Procedure Manual & Work Instruction (Continued)

Procedure Manual Subject: Repair and Maintenance Process for Machine Breakdown ABC Food Co., Ltd.		Document No. : PM/EN 002 Effective Date: 01/05/2000 Amendment No.: 2 Page: 1/4
<p>1. Objectives</p> <p>This work instruction has been prepared as guidelines for effective repair and maintenance in case of machine breakdown.</p> <p>2. Scope of Work Instruction</p> <p>This work instruction has been designed to provide the process of help desk job, repair and maintenance process and analytical report beneficial for preventive maintenance.</p> <p>3. Definitions</p> <p>3.1 Machine breakdown means the machine that is unable to run or can run but not properly or its malfunction can be noticeably found so that inspection and repair are needed.</p> <p>4. Responsible Staff</p> <p>4.1 Engineering Section Manager is responsible for all policy planning and all work plans set for the whole Engineering Department.</p> <p>4.2 Engineering Supervisor is responsible for all machine inspection jobs including analyzing causes of breakdown, manpower preparation, spare parts required, machine repair and monitoring technician's performance in order to finish the work as instructed.</p> <p>4.3 Maintenance Planning Staff is responsible for regular machine inspection, analyzing and planning the repair and maintenance to make sure that the machine is ready to use at all time.</p> <p>4.4 Technician (Electrical and Mechanical) is responsible for all repair, maintenance and spare parts replacement when requested and machine test run to make sure that the machine runs properly together with regular machine inspection as scheduled.</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

APPENDIX C: The Procedure Manual & Work Instruction (Continued)

Procedure Manual Subject: Repair and Maintenance Process for Machine Breakdown  ABC Food Co., Ltd.	Document No. : PM/EN 002
	Effective Date: 01/05/2000
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5. Work Process Diagram

5.1 Engineering Section Manager/  
Engineering Supervisor

- Acknowledge the request when machine breakdown.
- Delegate jobs to responsible technicians (Electrical/Mechanical)

5.2 Technician  
(Electrical/ Mechanical)

- Repair and do machine test run.
- Prepare a repair summary report.
- Fill out the Shift Mechanic Checklist.
- Return the Assignment Sheet to the Maintenance Planning Staff.

5.3 Maintenance Planning Staff

- File and record all repair items as appeared in the Assignment Sheet.

6. Work Methods

6.1 Engineering Section Manager or Engineering Supervisor

- 6.1.1) Acknowledge a Request Form for Machine Repair (FR/EN 001) as requested by Production Supervisor/ Production Section Manager when machine breakdown.
- 6.1.2) Review and verify all details in a Request Form for Machine Repair (FR/EN 001). Acquire further details from the requester if needed.
- 6.1.3) Prioritize the importance of each item requested in light of influence toward the product's quality and service, plan and provide appropriate number of staff for each repair job.

Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

APPENDIX C: The Procedure Manual & Work Instruction (Continued)

Procedure Manual Subject: Repair and Maintenance Process for Machine Breakdown  ABC Food Co., Ltd.		Document No. : PM/EN 002 Effective Date: 01/05/2000 Amendment No.: 2 Page: 3/4
<p>6.1.4) Job Delegation</p> <p>6.1.4.1 In case a machine is unable to run but ready for repair, any required repair process must be adopted right away.</p> <p>6.1.4.2 Delegate job to maintenance planning staff to arrange repair schedule and spare parts replacement as in item 6.3.2 in case the machine is broken down but is still able to run.</p> <p>6.1.5) Guide and work together with the technician, in case the technician is unable to proceed the repair himself.</p> <p>6.1.6) Evaluate and select the best quality spare parts from the best supplier as instructed in Purchasing Standards Reference.</p> <p>6.2 Technician (Electrical / Mechanical)</p> <p>6.2.1) Proceed the repair, in case the Engineering Section Manager or Engineering Supervisor acknowledges a Request Form for Machine Repair (FR/EN 001).</p> <p>6.2.2) In case a technician receive the Repair Request Form, review all details of machine breakdown appeared in the Repair Request Form and request for additional details, if any, from the requester.</p> <p>6.2.3) Proceed the repair and maintenance or spare parts replacement as instructed in procedure manual, do the test run with the operator, Supervisor and the requester's section manager.</p> <p>6.2.3.1 In case the machine cannot be repaired immediately or temporarily fixed, follow item 6.3.2.</p> <p>6.2.3.2 In case the repair is already done, summarize all repaired items in the Request Form for Machine Repair (FR/EN 001) with the approval of the Engineering Section Manager/ Engineering Supervisor. Then, return the form to the Maintenance Planning Staff.</p> <p>6.2.4) Record all repaired items in a Shift Mechanic Checklist (FR/EN 005).</p> <p>6.2.5) In case the machine breakdown period exceeds 30 minutes, record all details in a Machine Breakdown Report (FR/EN 011).</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

## APPENDIX C: The Procedure Manual &amp; Work Instruction (Continued)

Procedure Manual Subject: Repair and Maintenance Process for Machine Breakdown  ABC Food Co., Ltd.	Document No. : PM/EN 002	
	Effective Date: 01/05/2000	
	Amendment No.: 2	
	Page: 4/4	
<p>6.3 Maintenance Planning Staff</p> <p>6.3.1) File all Request Form for Machine Repair sorted by machine type and record necessary data in a Control Sheet for Request Form (FR/EN 008) to follow up any pending jobs.</p> <p>6.3.2) Collect and arrange all pending jobs as appeared in item 6.1.4.2 and item 6.2.3.1 into Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004) to be proceeded along with preventive maintenance (PM/EN 001). After all items are fixed, return such Request Form for Machine Repair (FR/EN 001) to the technician (Electrical/ Mechanical) as instructed in item 6.2.3.2.</p> <p>6.3.3) Collect and file all Request Forms for Machine Repair (FR/EN 001) of each department that have been completed into the Machine Maintenance Record (FR/EN 003) to be used for planning preventive maintenance program more effectively.</p> <p>6.3.4) In case of following up spare parts purchasing, strictly comply with the procedure manual for</p> <p>7. References</p> <p>7.1 Machine Repair Procedures Work Instruction (WI/EN 001)</p> <p>7.2 Preventive Maintenance Procedure Manual (PM/EN 001)</p> <p>7.3 Purchasing Standards Reference</p> <p>7.4 Spare Parts Purchasing Status Follow-up Procedure Manual (WI/EN 006)</p> <p>8. List of Record</p> <p>8.1 A Request Form for Machine Repair having 1 year storage period</p> <p>8.2 A Machine Maintenance Record (FR/EN 003) having 2-year storage period</p> <p>8.3 A Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004) having 1 year storage period</p> <p>8.4 A Shift Mechanic Checklist having 1 year storage period</p> <p>8.5 A Machine Maintenance Breakdown Report (FR/EN 001) having 1 year storage period</p> <p>8.6 A Control Sheet for Request Form (FR/EN 008) having 1 year storage period</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

## APPENDIX C: The Procedure Manual &amp; Work Instruction (Continued)

Work Instruction		Document No. : WI/EN 001
Subject: Machine Repair Procedures (Request Form for Machine Repair provided)		Effective Date: 01/05/2000
ABC Food Co., Ltd.		Amendment No.: 1
		Page: 1/2
<p>1. Objectives</p> <p>To be used as practicing guidelines for maintaining the most effective function of the machine.</p> <p>2. Definition</p> <p>-</p> <p>3. Responsible Staff</p> <p>3.1 Maintenance Staff (Electrical/Mechanical) is responsible for machine repair and maintenance or spare parts replacement including machinery inspection within timeframe.</p> <p>4. Tools and Materials</p> <p>4.1 Mechanical tools 4.2 Required spare parts</p> <p>5. Standard / Related Documents and Guidebook</p> <p>5.1 Manual or Machinery Drawing</p> <p>6. Environment and Safety</p> <p>-</p> <p>7. Procedures</p> <p>7.1 acquire a Request Form for Machine Repair (FR/EN 001) from Maintenance Supervisor/ Engineering Section Manager; 7.2 prepare all necessary and related tools for repair; 7.3 inspect parts of machine which are damaged or out of order;</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

APPENDIX C: The Procedure Manual & Work Instruction (Continued)

Work Instruction Subject: Machine Repair Procedures (Request Form for Machine Repair provided)		Document No. : WI/EN 001
		Effective Date: 01/05/2000
		Amendment No.: 1
ABC Food Co., Ltd.		Page: 2/2
<p>7.4 repair or fix the damaged parts. If new spare parts are required, make sure that size and spare parts number of both new and damaged spare parts are exactly the same;</p> <p>7.5 fix and replace the new spare parts by using a Manual or Machine Drawing as guidelines (if job needs careful skills or not being a routine replacement);</p> <p>7.6 double check whether the repaired machine works properly. Make sure that all tools or equipment are taken out of the machine;</p> <p>7.7 re-test the machine with a supervisor in Production or related department to see whether the machine runs all right;</p> <p>7.8 record all outcome from repair or replacement in a Request Form for Repair (FR/EN 001), including a signature of responsible person with date (dd/mm/yy) and repair period;</p> <p>7.9 return a Request Form for Machine Repair (FR/EN 001) to requester (any supervisor / section manager) for signature to close the case;</p> <p>7.10 bring a Request Form for Machine Repair (FR/EN 001) back to Engineering Section for filing. In case the machine is broken down, a Maintenance Staff is responsible for recording all information related to prior repair/replacement in Machine Maintenance Record (FR/EN 003);</p> <p>7.11 fill out all requested jobs that have been done in a Shift Mechanic Checklist (FR/EN 005). In case the break down machine is fixed longer than up to 30 minutes, fill out all jobs done in Machine Break Down Report (FR/EN 011).</p> <p>8. Report Procedures</p> <p>8.1 record all outcome in the following:</p> <ul style="list-style-type: none"> <li>- Request Form for Machine Repair (FR/EN 001)</li> <li>- Machine Maintenance Record (FR/EN 003)</li> <li>- Shift Mechanic Checklist (FR/EN 005)</li> <li>- Machine Break Down Report (FR/EN 011)</li> </ul> <p>8.2 record and fill out related reports by a Maintenance Planning Staff and Maintenance Staff.</p> <p>8.3 verify all information in the report by an Engineering Supervisor/ Engineering Section Manager.</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:



## APPENDIX C: The Procedure Manual &amp; Work Instruction (Continued)

Work Instruction		Document No. : WI/EN 002
Subject: Repairing Process as instructed in Procedure Manual		Effective Date: 01/05/2000
ABC Food Co., Ltd.		Amendment No.: 1
		Page: 1/2
<p>1. Objectives</p> <p>To maintain the effectiveness of the machine.</p> <p>2. Definition</p> <p>-</p> <p>3. Responsibilities</p> <p>3.1 Maintenance Staff (Electrical/Mechanical) is responsible for machine repair and maintenance or spare parts replacement as requested, testing the fixed machine to make sure whether it works properly including machine inspection as scheduled.</p> <p>4. Tools and materials</p> <p>4.1 Mechanical equipment 4.2 Necessary spare parts</p> <p>5. Standard / Related Documents / Guidebook</p> <p>5.1 Manual or Machine Drawing</p> <p>6. Environment and Safety</p> <p>-</p> <p>7. Procedures</p> <p>7.1 acquire a Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004) from a section manager or supervisor at least 1 day prior to the Machine Shut Down Date;</p> <p>7.2 prepare all required spare parts and all related tools</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

## APPENDIX C: The Procedure Manual &amp; Work Instruction (Continued)

Work Instruction		Document No. : WI/EN 002
Subject: Repairing Process as instructed in Procedure Manual		Effective Date: 01/05/2000
ABC Food Co., Ltd.		Amendment No.: 1
		Page: 2/2
<p>7.3 fix and replace the new spare parts by using a Manual or Machine Drawing as guidelines (if job needs careful skills or not being a routine replacement);</p> <p>7.4 fix or replace new spare parts as assigned by a section manager or supervisor;</p> <p>7.5 double check whether the machine works properly (Machine Test Run);</p> <p>7.6 record all repaired jobs that have been done and pending items in a Shift Mechanic Checklist (FR/EN 005);</p> <p>7.7 return the Shift Mechanic Checklist (FR/EN 005) to requester (a supervisor or section manager) for verifying all repaired items as planned in a Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004).</p> <p>8. Report Procedures</p> <p>8.1 Record all outcome in the following:</p> <ul style="list-style-type: none"> <li>- Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004)</li> <li>- Shift Mechanic Checklist (FR/EN 005)</li> </ul> <p>8.2 Record and fill out related reports by a Maintenance Planning Staff and Maintenance Staff.</p> <p>8.3 Verify all information in the report by an Engineering Supervisor/ Engineering Section Manager.</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

## APPENDIX C: The Procedure Manual &amp; Work Instruction (Continued)

Work Instruction		Document No. : WI/EN 003
Subject: Making Plan for Machine Repair and Spare Parts Replacement		Effective Date: 01/05/2000
ABC Food Co., Ltd.		Amendment No.: 1
		Page: 1/3
<p>1. Objectives</p> <p>To draw an appropriate plan for Machine Repair and Spare Parts Replacement</p> <p>2. Definition</p> <p>-</p> <p>3. Responsible Person</p> <p>3.1 Maintenance Planning Staff is responsible for planning a machine inspection schedule, analyzing the outcomes, planning the machine repair procedures and monitoring and making sure that the machine is in good condition and ready for work.</p> <p>4. Tools and Materials</p> <p>-</p> <p>5. Standard / Related Documents / Guidebook</p> <p>5.1 Manual or Machine Drawing 5.2 Annual Machinery Shut Down Plan</p> <p>6. Environment and Safety</p> <p>-</p> <p>7. Procedures</p> <p>7.1 Making a Machinery Inspection Plan (FR/EN 006) 7.1.1) prepare a Machinery Inspection Report (prepared by Engineering Section) (FR/EN 002) with a machinery inspection checklist classified as annual, semi-annual, quarterly and monthly plan (per one specific machine);</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

APPENDIX C: The Procedure Manual & Work Instruction (Continued)

Work Instruction Subject: Making Plan for Machine Repair and Spare Parts Replacement  ABC Food Co., Ltd.		Document No. : WI/EN 003 Effective Date: 01/05/2000 Amendment No.: 1 Page: 2/3
<p>7.1.2) Set up a machine inspection period according to a Machinery Inspection Report (prepared by Engineering Section) (FR/EN 002) into a Machinery Inspection Plan (FR/EN 006) (per one specific machine);</p> <p>7.2 Making a Spare Parts Replacement Plan</p> <p>7.2.1) Calculate the average life of each parts of the machine based on data in Machine Maintenance Record (FR/EN 003)</p> <p>7.2.2) Classify all machine parts into into a Monthly Spare Parts Replacement Plan (FR/EN 010) and schedule each period for spare parts replacement based on the average life (as calculated in item 7.2.1).</p> <p>7.3 Making an Annual Machinery Shut Down Plan (SC/EN 001)</p> <p>7.3.1) Set up a Machinery Shut Down period for each machine as appropriate.</p> <p>7.3.2) Schedule a Machinery Shut Down date for each machine based on period set in item 7.3.1.</p> <p>7.3.3) Propose the Annual Machinery Shut Down Plan (SC/EN 001) to Engineering Section Manager.</p> <p>7.4 Making a Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004)</p> <p>7.4.1) Gather all information of what machine to be repair or replace spare parts (for each machine) from the following sources:</p> <p>7.4.1.1 Spare Parts Replacement Plan</p> <p>7.4.1.2 Machine Inspection Report by Engineering Section (FR/EN 002)</p> <p>7.4.1.3 Machine Inspection Report by Production Section (FR/EN 007)</p> <p>7.4.1.4 Request Form for Machine Repair (FR/EN 001)</p> <p>7.4.2) Schedule a date for each machine repair and spare parts replacement into a Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004).</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

## APPENDIX C: The Procedure Manual &amp; Work Instruction (Continued)

Work Instruction		Document No. : WI/EN 003
Subject: Making Plan for Machine Repair and Spare Parts Replacement		Effective Date: 01/05/2000
ABC Food Co., Ltd.		Amendment No.: 1
		Page: 3/3
<p>7.5 If any items has not been fixed or a Machinery Shut Down Schedule needs to be postponed as filled out in Request Form for Machinery Shut Down Plan Modification (FR/EN 009), such item will be included in the next Machine Shut Down by marking up “/” in red color in the box “next Machinery Shut Down date”.</p> <p>8. Report Procedures</p> <p>8.1 Record all outcome in the following:</p> <p>8.1.1) Request Form for Machine Repair (FR/EN 001)</p> <p>8.1.2) Machine Inspection Report by Engineering Section (FR/EN 002)</p> <p>8.1.3) Machine Maintenance Record (FR/EN 003)</p> <p>8.1.4) Monthly Machine Repair and Spare Parts Replacement Schedule (FR/EN 004)</p> <p>8.1.5) Machinery Inspection Plan (FR/EN 006)</p> <p>8.1.6) Machine Inspection Report by Production Section (FR/EN 007)</p> <p>8.1.7) Request Form for Machinery Shut Down Plan Modification (FR/EN 009)</p> <p>8.1.8) Monthly Spare Parts Replacement Plan (FR/EN 010)</p> <p>8.2 Verify all information in the report by Maintenance Planning Staff / Maintenance Staff</p> <p>8.3 Approve the report by Engineering Supervisor / Engineering Section Manager</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

## APPENDIX C: The Procedure Manual &amp; Work Instruction (Continued)

Work Instruction	Document No. : WI/EN 005	
Subject: New Machine Inspection and Registration	Effective Date: 01/05/2000	
ABC Food Co., Ltd.	Amendment No.: 0	
	Page: 1/2	
<p>1. Objectives</p> <p>To examine whether a new machine has meet all requirements/ specifications and to make sure that it works properly and effectively.</p> <p>2. Definition</p> <p>-</p> <p>3. Responsible Person</p> <p>3.1 Engineering Section Manager is responsible for setting up the policy and making an appropriate plan within the responsibility limit.</p> <p>3.2 Engineering Supervisor is responsible for machine inspection, machine malfunctioning analysis, staff preparation, spare parts inspection and machine repair including repair follow-up.</p> <p>4. Tools and Materials</p> <p>4.1 Mechanical equipment</p> <p>4.2 All required spare parts for new machine installation</p> <p>5. Standard / Related Documents / Guidebook</p> <p>-</p> <p>6. Environment and Safety</p> <p>-</p> <p>7. Procedures</p> <p>7.1 The Purchasing Section will inform Engineering Section Manager of the new machine delivery.</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

## APPENDIX C: The Procedure Manual &amp; Work Instruction (Continued)


Work Instruction		Document No. : WI/EN 005
Subject: New Machine Inspection and Registration		Effective Date: 01/05/2000
ABC Food Co., Ltd.		Amendment No.: 0
		Page: 2/2
<p>7.2 Engineering Section Manager and Production Section Manager proceed a new machine inspection and record all related data in a New Machine Inspection Checklist (FR/EN 012).</p> <p>7.3 Engineering Section Manager and Engineering Supervisor proceed new machine installation with close cooperation of Production Section Manager and a vendor's mechanic.</p> <p>7.4 Proceed machine Test Run to examine whether the machine works properly.</p> <p>7.5 Evaluate whether machine qualifications have met all standards. Record all data in New Machine Inspection Checklist (FR/EN 012).</p> <p>7.6 Input machine details / specifications and issue machine serial number in a Machine list (FR/EN 013).</p> <p>8. Report Procedures</p> <p>8.1 Record all data in a New Machine Inspection Checklist (FR/EN 012).</p> <p>8.2 Verify all data by Engineering Section Manager / Production Section Manager.</p> <p>8.3 Approve the report by Engineering Section Manager.</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

## APPENDIX C: The Procedure Manual &amp; Work Instruction (Continued)

Work Instruction		Document No. : WI/EN 006
Subject: Spare Parts Purchasing Status Follow-up		Effective Date: 01/05/2000
ABC Food Co., Ltd.		Amendment No.: 0
		Page: 1/2
<p>1. Objectives</p> <p>To follow-up the new spare parts purchasing status.</p> <p>2. Definition</p> <p>-</p> <p>3. Responsible Person</p> <p>8.1 Engineering Staff is responsible for monitoring and following up new spare parts purchasing status.</p> <p>4. Tools and Materials</p> <p>-</p> <p>5. Standard / Related Documents / Guidebook</p> <p>5.1 A copy of Purchasing Order</p> <p>6. Environment and Safety</p> <p>-</p> <p>7. Procedures</p> <p>7.1 A requester of new machine purchase has to provide a copy of purchasing order for an Engineering Staff.</p> <p>7.2 record the issue date of purchasing, the account number of purchasing order, spare parts specifications and amount to be purchased in a control book.</p> <p>7.3 after a spare parts delivery, record the receiving date in the control book to confirm that the purchased spare parts have been received.</p>		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:



## APPENDIX C: The Procedure Manual &amp; Work Instruction (Continued)

Work Instruction	Document No. : WI/EN 006	
Subject: Spare Parts Purchasing Status Follow-up	Effective Date: 01/05/2000	
ABC Food Co., Ltd.	Amendment No.: 0	
	Page: 2/2	
<p>7.4 monitor and check the purchasing list in the control book in a timely manner. In case any spare parts haven't been delivered for exceeding 1 month, Engineering Staff has to follow-up with the Purchasing Section.</p> <p>8. Report Procedures</p> <p>8.1 Record all outcomes in a Spare Parts Purchasing Control Book.</p> <p>8.2 Verify all data by Engineering Staff / Engineering Section Manager.</p> <p>8.3 Approve the report by Engineering Staff / Engineering Section Manager.</p> 		
Prepared by:	Verified by:	Approved by:
Date:	Date:	Date:
Position:	Position:	Position:

Machine Name			Forming											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause							
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others	
21/3/00	F1/2	Drum is unable to rotate.	Replace Bearing No. P 206.	Lack of spare parts replacement when due.	480	75,348				✓				
17/3/00	F2/2	Drum is unable to rotate.	Replace with new Gear Motor.	Gear Motor's life is expired.	50	7,849				✓				
18/4/00	F3/2	Forming Unit is slipped out and presses over the Drum.	Adjust the position of Forming Unit.	Inappropriate installment of the Forming Unit.	15	2,355								✓
10/5/00	F1/1	Wire Mesh Conveyor of the Pre-heater is unable to work.	Replace the broken Pulley of the Reducer.	Lack of regular inspection.	30	4,709		✓						
2/6/00	F3/2	Drum is unable to rotate.	Replace with the new Drum Reducer.	Drum Reducer's life is expired.	60	9,419				✓				
15/6/00	F1/2	Wire Mesh Conveyor of the Forming Unit is worn out.	Re-connect the Wire Mesh Conveyor.	Lack of regular inspection.	15	2,355		✓						
17/6/00	F3/2	Forming Unit is unable to work.	Replace the V-Belt of the Forming Unit Reducer.	Lack of regular inspection on the V-Belt.	40	6,279		✓						
12/7/00	F3/2	Shaft of the Forming Unit is worn out.	Replace the Roller.	Roller and Bush are too tightly connected.	95	14,913								✓
25/5/00	F1/1	Wire Mesh Conveyor of the Drum is worn out.	Replace the Wire Mesh Conveyor.	Lack of regular inspection.	115	18,052		✓						
12/7/00	F3/2	Drum is unable to rotate.	Replace the Bearing No. P 206.	Lack of regular spare parts replacement when due.	90	14,128				✓				
19/7/00	F4/1	Forming Unit is unable to work.	Tighten the Sprocket of the Forming Roller.	Lack of inspection on the locking of the Sprocket.	20	3,140		✓						

APPENDIX D : The summary of machine repair and maintenance from November 1999 to September 2000 (Continued)

Machine Name			Feed Pump, Forming, Baking, and Regular Size Cutting Machine											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause							
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others	
2/8/00	F4/2	Drum's Wire Mesh Conveyor is worn out.	Replace Chain Connector.	Lack of inspection.	30	4,709		✓						
7/12/00	F3/1	Shaft of the Forming Roller is worn out.	Replace the Shaft End.	Lack of Shaft inspection.	480	75,348		✓						
23/6/00	F2/1	Drum's Wire Mesh Conveyor is worn out.	Replace the Wire Mesh Conveyor.	Lack of regular inspection.	40	6,279		✓						
12/2/00	FP 3	Body of Hose Shank was broken	Straightened Hose Shank and rewelded	Lack of regular inspection	40	12,558								
26/6/00	B3	Burner is unable to ignite.	Replace the Burner.	Lack of regular inspection of the Burner.	20			✓						
23/8/00	B6	Electric leakage at the "in" electric wire.	Re-connect the electric wire.	Lack of regular inspection.	60			✓						
18/11/99	RC2	Fish piece is cut unevenly.	Replace the Nut tightening the Crank Rod.	Lack of regular spare parts replacement.	70					✓				
21/4/00	RC4	The Blade is blunt.	Adjust the Blade.	Lack of regular Blade adjustment.	40							✓		
2/5/00	RC2	The Blade is blunt.	Adjust the Blade.	Lack of regular Blade adjustment.	30							✓		
1/7/00	RC2	Bearing of the Crank Rod is broken.	Replace the Bearing.	Lack of regular spare parts replacement.	90					✓				

APPENDIX D : The summary of machine repair and maintenance from November 1999 to September 2000 (Continued)

Machine Name			Dryer											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause						Faulty Design	Others
							Cleaning	Inspection	Lubrication	Replacement	Adjustment			
30/11/99	D2	The Wire Mesh Conveyor is worn out.	Weld the Wire Mesh Conveyor Pin.	Lack of Adjustment and the locking of the Sprocket.	50	15,698					✓			
10/5/00	D1	Burner is unable to work.	Replace the Ignition Rod.	Lack of regular replacement for the Ignition Rod.	95	14,913				✓				
27/5/00	D2	The temperature is lower than normal.	Take off and clean the Ignition Rod.	Lack of regular cleaning.	120	18,837	✓							
6/5/00	D1	Wire Mesh Conveyor is worn out.	Weld the end of roller shaft	Lack of regular inspection and adjustment.	240	37,674					✓			
21/3/00	D4	Temperature Control System does not work.	Replace the Temperature Control set.	Lack of Relay replacement	430	67,499				✓				
19/7/00	D1	Temperature within the Dryer is dropped.	Replace the Burner Control Program set.	Lack of inspection whether the function of the Temperature Control works properly.	210	32,965					✓			
23/8/00	SA2	Saucing Roller is unable to rotate.	Replace Bearing of the Roller.	Lack of regular spare part replacement.	60	9,419				✓				
15/8/00	D3	Pulley of the Reducer Motor is unable to rotate.	Replace the Pulley.	Lack of thorough lubrication.	45	7,064			✓					
7/12/99	SA4	Saucing Roller is unable to rotate.	Replace Bearing of the Roller.	Lack of spare parts replacement when due.	300	47,093				✓				

APPENDIX D : The summary of machine repair and maintenance from November 1999 to September 2000

Machine Name			Small Size Cutting Machine											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause							
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others	
6/11/99	SC2	Fish piece is unevenly cut.	Replace the Blade.	Lack of regular inspection.	30			✓						
1/12/99	SC3	The Blade is blunt.	Sharpen the Blade.	Lack of regular Blade sharpening.	30							✓		
4/12/99	SC4	The Blade is blunt.	Sharpen the Blade.	Lack of regular Blade sharpening.	30							✓		
9/12/99	SC5	The Blade is blunt.	Sharpen the Blade.	Lack of regular Blade sharpening.	20							✓		
13/12/99	SC1	The Blade is blunt.	Sharpen the Blade.	Lack of regular Blade sharpening.	25							✓		
10/1/00	SC5	The Blade is blunt.	Replace the Blade.	Lack of regular inspection.	75			✓						
17/4/00	SC1	Fish piece is unevenly cut.	Adjust and tighten the Feeding Pawl.	Lack of regular inspection on the locking condition of the Feeding Pawl.	90			✓						
18/4/00	SC2	The Blade is blunt.	Sharpen the Blade.	Lack of regular Blade sharpening.	150							✓		
28/4/00	SC3	The Blade is blunt.	Sharpen the Blade.	Lack of regular Blade sharpening.	60							✓		

APPENDIX D : The summary of machine repair and maintenance from November 1999 to September 2000 (Continued)

สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย

Machine Name			Small Size Cutting Machine											
Date	Machine Code	Type of Damage	Repair and Maintenance	Cause of Damage	Downtime (Minute)	Cost (Baht)	Type of Cause							
							Cleaning	Inspection	Lubrication	Replacement	Adjustment	Faulty Design	Others	
27/5/00	SC4	The Blade is blunt.	Replace the Blade.	Lack of regular inspection.	10			✓						
28/4/00	SC2	Fish piece is unevenly cut.	Adjust the Press Roller.	Lack of regular inspection.	90			✓						
7/7/00	SC3	Fish piece is unevenly cut.	Adjust the Feeding Pawl.	Lack of inspection on the locking of the Feeding Pawl.	30			✓						
8/7/00	SC4	The Blade is blunt.	Replace the Blade.	Lack of inspection.	10			✓						
10/7/00	SC2	The Blade is blunt.	Replace the Blade.	Lack of inspection.	20			✓						
15/7/00	SC1	The Blade is blunt.	Repair and fix the Belt Joint.	Lack of regular inspection.	10			✓						
19/7/00	SC2	Fish piece is unevenly cut.	Adjust the Feeding Pawl.	Lack of regular inspection on the locking of the Feeding Pawl.	30			✓						
21/7/00	SC3	Fish piece is unevenly cut.	Adjust the Feeding Pawl.	Lack of regular inspection on the locking of the Feeding Pawl.	10			✓						
1/8/00	SC5	Fish piece is unevenly cut.	Adjust the Feeding Pawl.	Lack of regular inspection on the locking of the Feeding Pawl.	10			✓						
28/8/00	SC4	Fish piece is unevenly cut.	Adjust the Feeding Pawl.	Lack of regular inspection on the locking of the Feeding Pawl.	20			✓						
11/9/00	SC3	Fish piece is unevenly cut.	Replace the Blade.	Lack of regular inspection.	20			✓						

APPENDIX D : The summary of machine repair and maintenance from November 1999 to September 2000 (Continued)

## VITA

Wipas Jirapas was born on March 14, 1973 in Songkla Thailand. He graduated from Hatyai Wittayalai high school and obtained his Bachelor's degree in Mechanical Engineering from Prince of Songkla University in 1995. After he graduated, he worked as Maintenance Engineer at Thai Container Industry for three years. Then, he has joined with a food company as Engineering Manager since 1998.



สถาบันวิทยบริการ  
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