CHAPTER 3
THE STATEMENT OF PROBLEM AND THE ESTABLISHMENT OF MODIFIED FMEA

3.1 The company's problems

3.1.1 Price of feedstock and lube base oil

Since 1998, the fuel oil price in the global market has been increased continuously because the OPEC reduced the crude oil production capacity. This circumstance effects the company A both direct and indirect way. The direct way is the increasing of the feedstock's price because the price of feedstock called long residual is relied on the fuel oil price. For the indirect way, when the fuel oil price is increased, the lubricating oil demand especially for domestic market is decreased due to the change of car users' behavior on energy conservation. Because the price of lube base oil is relied on the lubricating oil's demand not the feedstock price like the fuel oil, when the demand of lubricating oil decreases, the price of lube base oil also decreases. The price of feedstock and lube base oil in 1999 is shown in figure 3.1.

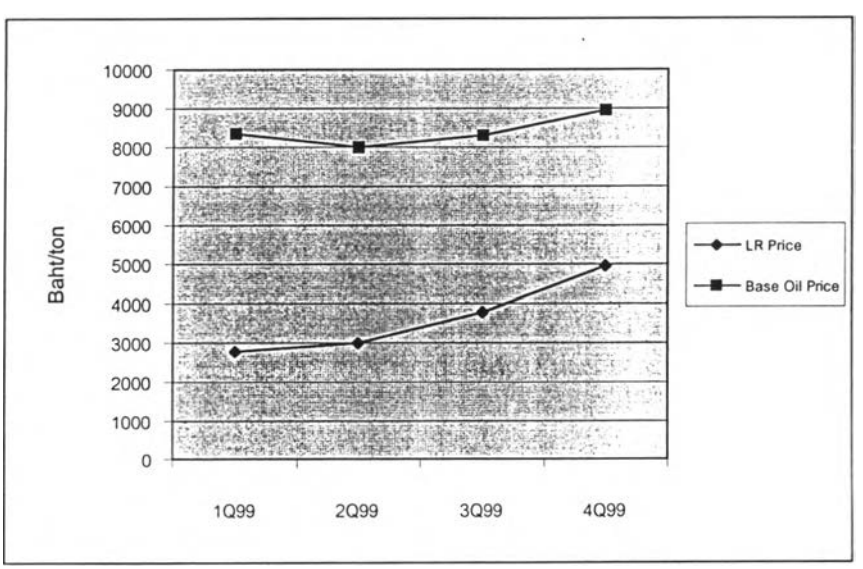

Figure 3.1: The price of feedstock and lube base oil *(Company A's "Business plan and financial projection 1999")*

3.1.2 ASEAN Free Trade Area (AFTA)'s regulation

The AFTA's regulation to reduce the tax of imported lube base oil between the countries in Asia pacific region from around 15% to 5% that will be applied in year 2002 is the main threat of the company. With this regulation, the domestic lube base oil producers have to reduce the lube base oil price to compete the imported oil that causes the company loss its margin around 400 million Baht per year. The estimated profit and loss in table 3.1 shows the estimated effect of this regulation.

Year	*2002*
Estimated Sale revenue before AFTA (US $ millions)	149.7
Estimated Sale revenue after AFTA (US $ millions)	138.45
Estimated reduced revenue (US $ millions)	11.25

Table 3.1: Effect of the AFTA regulation on the company *(Company A's "Business plan and financial projection 1999")*

3.1.3 The Threat of Substitute Product

The threat of substitute product for the lube base oil is the coming of synthetic oil. The synthetic oil is the product that can be used to replace lube base oil in lubricating oil and has the higher quality than lube base oil. However, the price of the synthetic oil is still higher than the lube base oil, but, with the new technology, the tread of the synthetic oil price is lower continuously. With this reason, it can predict that in the near future, the synthetic oil will be the significant competitor of lube base oil.

3.2 The problem's solution

According to the problems, in order to survive in this situation, the company has to reduce its operating cost to make the competitiveness in the

product price and gain enough margins to run the business. The operating cost of the company shows in table 3.2.

Item	Cost (Million Baht)	% of total cost
Steam cost	132	33.6
Electricity cost	107.5	27.4
Total variable cost	392.5	100

Table 3.2: The company's variable cost

Due to the table 3.2, the energy cost is around 61% of the total operating cost of the company. So, energy cost is the most interesting point to be considered on cost reduction activity.

3.3 Background of the modified FMEA

Although FMEA technique has never been used in the refinery's energy conservation purpose, but FMEA is the tool that can be used to analyze the failure modes in each process area that effect on the product and to prioritize the activities to solve or correct the selected failure modes by considering on three points of view 1) Severity of the effect, 2) Probability of occurrence, and 3) detection method of the failure mode. Moreover, this activity is the group activity that must create from people in different responsibility to do the productivity activities together, so, it can create the people awareness in product quality. With this feature of the FMEA, it can be modified to use in energy conservation activity by finding the failure modes in each process area that are the causes of loss of energy in the process area or the activities that can be improved to reduce the energy consumption. However, the existing FMEA is designed to identify the potential failure modes that have effects on the quality of product. In order to use in the energy conservation activity, it needs to be modified for the criteria to consider the level of severity, occurrence and detection.

3.4 Criteria for severity, occurrence and detection consideration

3.4.1 Severity of the effect: The severity of the effect on the energy consumption point of view is the cost of the energy loss per period of time and warning of the failure mode. In this case, the rank 10 is defined for the cost of energy loss more than 1.5 million Baht per month and without warning of the failure. The rank of severity is reduced by the reduction of the cost of energy loss. (see table 3.5)

3.4.2 *Occurrence of failure:* In order to identify the probability of occurrence in the energy conservation activity, the times of occurrence per period of time can be used. In this case, times of occurrence in one year will be used to identify the rank of occurrence. The rank 10, the highest probability of the occurrence, is defined for the failure that occurs all the time or come from the improper process or equipment design. The rank is reduced by the reduction of probability of the failure mode's occurrence. (see table 3.6)

3.4.3 *Detection the cause of failure:* In the detection of the cause of failure mode, the level of the existing detection system will be used to identify the rank. The rank 10 means there is no detection system or impossible to detect the cause of failure. The lower rank means the higher of ability to detect the cause of the failure mode before it occurs. (see table 3.7)

In order to prove that the modified criteria can be implemented for this activity, questionnaire technique will be used to ask concerning people for their opinion. The sampling group is composed of 15 people (3 process engineers, 2 shift superintendents and 10 process unit technicians). The questionnaire is composed of the following questions: (see Appendix H)

- *Suitability of the upper and lower limit of the criteria:* In this section, the suitability of upper and lower limit (level 10 and level 1) of the severity, occurrence and detection will be asked. The people who answer the question will consider the upper and lower limit of

the criteria and tell their opinion that it is too low, too high or suitable to use.

- *Suitability of level width of criteria's level:* The purpose of this question is to ask the people to consider on the suitability of the level width of each criterion that it is too narrow, too wide or suitable.
- *Other criteria that should be considered:* This question is asked to survey for the criteria that the concerning people think that they should be considered in failure mode analysis.

The result of the survey is shown in table 3.3 and 3.4.

Table 3.3: The survey result of suitability of upper and lower limit of the criteria

Criteria	L.L. too low	L.L. too high	U.L. too low	U.L. too high	Suitable
Severity of the effect	29%	29%		43%	**60%**
Occurrence of the failure mode		67%		33%	**60%**
Detection of the failure mode					**100%**

Table 3.4: The survey result of suitability of level width of criteria's level

Criteria	Too narrow	Suitable	To wide
Severity of the effect		67%	33%
Occurrence of the failure mode		100%	
Detection of the failure mode		73%	27%

From the survey result, it can be said that the modified criteria can be implemented in the refinery. However, some additional criteria such as technical approach or ease of implementation should be considered to use in the research.

Table 3.5: Evaluation criteria and ranking system for the Severity of Effects

Effect	*Criteria: Severity of Effect*	*Rank*
Hazardous – without warning	Failure will occur without warning and cost in losing energy more than more than 1,500,000 Baht/month.	**10**
Hazardous – with Warning	Failure will occur with warning and cost in losing energy more than 1,500,000 Baht/month.	**9**
Very High	Cost in losing energy is 1,000,000 – 1,500,000 Baht/month.	**8**
High	Cost in losing energy is 500,000 – 1,000,000 Baht/month.	**7**
Moderate	Cost in losing energy 100,000 – 500,000 Baht/month.	**6**
Low	Cost in losing energy 50,000 – 100,000 Baht/month.	**5**
Very Low	Cost in losing energy 10,000 – 50,000 Baht/month.	**4**
Minor	Cost in losing energy 5,000 – 10,000 Baht/month.	**3**
Very Minor	Cost in losing energy 1,000 – 5,000 Baht/month.	**2**
None	Cost in losing energy is less than 1,000 Baht/month.	**1**

Table 3.6: Evaluation criteria and ranking system for the Occurrence of Failure

Probability of Failure	***Failure Rates (days in 1 yesr)***	C_{pk}	***Rank***
Very High: Failure is almost inevitable - Improper design - Always malfunction	365 *(12 m)*	< 0.33	**10**
	300 *(10 m)*	≥ 0.33	**9**
High: Generally associated with processes similar to previous Processes that have often failed	240 *(8 m)*	≥ 0.51	**8**
	180 *(6 m)*	≥ 0.67	**7**
Moderate: Generally associated with processes similar to pervious processes which have experienced occasional failures, but not in major proportions	120 *(4 m)*	≥ 0.83	**6**
	90 *(3 m)*	≥ 1.00	**5**
	60 *(2 m)*	≥ 1.17	**4**
Low: Isolated failures associated with similar processes	30 *(1 m)*	≥ 1.33	**3**
Very Low: Only isolated failures associated with almost identical processes	15 *(2 w)*	≥ 1.50	**2**
Remote: Failure is unlikely. No failures ever associated with almost identical processes	< 15 *(< 2 w)*	≥ 1.67	**1**

Table 3.7: Suggested evaluation criteria and ranking system for the Detection of a Cause of failure

Detection	*Criteria: Likelihood of Detection by Process Control*	*Rank*
Almost Impossible	No known Controls available to detect Failure Mode or Cause	*10*
Very Remote	Very remote likelihood current Controls with detect Failure Mode or Cause	*9*
Remote	Remote likelihood current Controls with detect Failure Mode or Cause	*8*
Very Low	Very low likelihood current Controls with detect Failure Mode or Cause	*7*
Low	Low likelihood current Controls with detect Failure Mode or Cause	*6*
Moderate	Moderate likelihood current Controls with detect Failure Mode or Cause	*5*
Moderately High	Moderately high likelihood current Controls with detect Failure Mode or Cause	*4*
High	High likelihood current Controls with detect Failure Mode or Cause	*3*
Very High	Very high likelihood current Controls with detect Failure Mode or Cause	*2*
Almost Certain	Current Controls almost certain to Failure Mode or Cause. Reliable detection controls are known with similar processes.	*1*