SECTION 5

MAE MOH FACTORY REHABILITATION PLAN

Section 5 Mae Moh factory rehabilitation plan

Before this section, the problems and the counter-measure of Mae Moh factory are explained, and following to the results, here after, the rehabilitation plan of Mae Moh factory shall be explained. (cf Table-5)

The plan is based on the following policy.

(i) The most important subject to be realized urgently is to achieve the steady and safe operation.

(ii) To achieve the steady and safe operation, it is the dispensable requisite to carry out big repairing plan of whole plants as early as possible and recover the reliability of machines.

(iii) The supplement of engineers and the training of the engineers should be put in force immediately, which will provide the foundation for high level operation.

(iv) As the plan is intended the steady and safe rehabilitation of the factory, the rehabilitation of economical stand point shall be forced to be delayed a little.

The plan is the five-year (1979 ∿ 1983) program and devided into 2 steps.

The first step is the initial three years of five-year program and placed emphasis on accomplishing the restoration of equipment and consequently the restoration of reliability.

In parallel with the restoration of equipment, training for operators to be skilled with steady operation, for engineers to raise their knowledge of chemical engineering and for managers to manage the factory systematically, should be carried out.

The production rate is expected the highest record through the past ten years (ammonia production is 14700T/Y which is 50% up of present), yet the target is supposed to be easily achieved, when the maintenance of equipment will have been realized.

However the proceeds by this amount of production will not be able to clear the break-even point by the cost required to renew and to improve the equipment.

In the next two years, that is the second step, based on the reliability of equipment and the restoration of sprit, both of which will have been realized by the first step, it should be scheduled to realize the economical restoration by the production rate, of which proceeds will exceed the break-even point.

The target of ammonia production rate will be 20,000 T/Y which will be double of present rate and 70% of designed production. The production rate has never been realized, and therefore, the engineers may consider that the rate must be impossible. However, we supposed it will be realized rather smoothly when the operators and technicians will be skilled for steady operation and the managers will keep the spirit to solve the problems and to maintain the factory systimatically.

As for the successive plan on and after completion of the second step, the foundamental problem on gasification process should be settled, and the considerable amount of investment and term will be required to settle the problem.

Moreover the capacity problem of sulphuric acid plant will be come out when the increment of fertilizer or sulphuric acid production will be intended following to the modification of gasification plant.

Therefore the planning of future program should be carried out at the end of the first step, taking the future market demand for fertilizer or sulphuric acid same as the investment for gasification into consideration.

Table 5 Mae Moh Factory Rehabilitation Program

Subjectives	1st STEP: 1° Repair of Equipment, Restor the Reliability 2° Supplement and Training of Engineers 3° Training for Steady Operation and Maintenance			2nd STEP: 1° Increase the Production over the Break-even point based on the improvement of Technique and Equipment	
	the first year 1979	the second year 1980	the third year 1981	the first year 1982	the second year 1983
	2 3 4 5 6 7 8 9 10 11 12	2 3 4 5 6 7 8 9 10 11 12	2 3 4 5 6 7 8 9 10 11 12	3 5 7 9 11	3 5 7 9 11
Organization & Education					
Supplement of Eng'rs	10 Engineers				
Education by specialist					
Reorganization of machine maintenance section					
Training of operators and technicians					
Reorganization of factory			1st stage	2nd stage	
Prepare the security standard	Preparation	Establish the system			
(Scheme forward plan				Planning	Preparation
Operation & Maintenance					
Steady operation	Preparation of Standard procedure			Modification of Standard procedure	
PM system		Introduction of system		Establishment	
Production pattern	NH_3 production 70t/d x 10days (14700t/year)	Increse the NO. of operation days continuing the 70~75t/day production	Establish the planed production	80t/d x 15days trial	Establish the know-how for NH_3 2000t/y H_2SO_4 40000t/y Urea 1645t/y A.S. 35000t/y
Annual Repairing			Establish the standard for annual repairing		

5-1 Explanation of each item in the rehabilitaion plan

(1) Supplement of engineers

As described formerly in the chapter for organization of Mae Moh factory, the number of engineers in present Mae Moh factory has been far too insuficient.

It is urgently required to recruit and train the enginers, because of the managers have been held 2 or 3 additional posts of managing the plants and have no their successors by the insufficient number of engineers.

Moreover enough number of engineers have been required to control the operating condition of plants carefully and to train the operators and technicians.

(2) Education

It is very difficult to train the fresh engineers by existing engineers and so it is recommendable to invite the specialists from Japan or West Germany for the education of fresh engineers. The subjects to be trained are to achieve the know-how and knowledge which are required to accomplish the subjects described hereinafter.

(3) Improvement of Machine maintenance section

As described formely in section 4-4, it is really recommended to gather the maintenance groups, which are being distributed to each plant, into one section and to organize it systematically. This reorganization will be intended to gather and interchange the high grade technique held by skillful technicians and consequently to improve the performance of maintenance section.

Further this improvement also will be required for establishing the preventive maintenance system and annual repairing system both of which will be described in a later chapter. In Mae Moh factory a portional tendency toward this reorganization had been shown. Although the timing to accomplish the reorganization, the earlier the better, yet it is supposed to be the most smooth program to put in force the reorganization after the completion of big repairing plan which will be scheduled in the later 1979. Because it will be very difficult to complete the big repairing plan without better cooperation of each maintenance group, therefore after the big repairing the system is supposed to be moved itself naturally toward reorganization.

(4) Education of operators and Technicians

It is required the level up of operators and technicians to realize the steady operation, and the engineers should train them, since the education of them by foreign specialists is usually seemed to be very difficult and not effective, because the langauge problem between workers and foreigners is existing. In this meaning, the supplement of engineers should be hastened.

(5) Improvement of factory organization

Recommendation for this subject has been already described. As the first step of this improvement, it is necessary to be established the organization to find out where the responsibility lies and to make clear the directions and communications of existing leading managers.

In the second step, it is necessary to be established the simple organization by relieving the managers from additional posts.

(6) Preparation of security regulation

The security regulation and system met to actual situation of factory, should be prepared under the supervision of the specialists. And further to establish this security system the reortanization of factory will be also required. This preparation of security regulation and system is urgent problem to be solved for Mae Moh factory.

(7) Steady operation

Usually in continuous operation plants such as gasification or ammonia plant, it is not required to change the operating conditions so frequently, and especially for Mae Moh factory, considering the technical level of operators, it is recommendable to fix the operating conditions to stabilize the plant. In present Mae Moh factory, since the insufficient reliability of machines and instrument is the main cause disturbing the fixation of operating conditions, therefore when the big repairing plan in later 1979 will have be accomplished, this distrubing factor will be cleared. By the way, the preparation of operation standards to fix the operating conditions will be rather easy jobs when it will be put in force under the instruction of specialists, basing on the past operation records.

(8) PM System (Preventive Maintenance system)

There are several basic conditions before to introduce the PM system.

(i) Operators and technicians should check the equipment timely and carefully with sufficient understandings of equipment's characteristics.

(ii) Engineers should have sufficient knowledge of equipment and be able to control the specification, spare parts and budget of equipment.

(iii) The documents for equipment's specification and history should be prepared. (Survey team had prepared the equipment list in this report as the first step for preparation of equipment schedule)

(iv) Engineers should have enough knowledge of PM system.

(v) There should be budget satisfactorily.

As above explained, the introduction of PM system will be not only the improvement of maintenance section but also it will be including the improvement of the whole factory. Therefore the introduction of PM system has to be discussed and cooperated by all engineers and be started after the reorganization of the whole factory.

(9) Production Pattern

As for the production pattern and amount, the detailed explanation will be described in the later chapter discussing the economical balance of rehabilitation.

(10) Periodical repairing

To keep the sufficient maintenance condition, it is recommendable to practice the periodical repairing twice a year. In the first step of rehabilitation program, repairing term of one month is scheduled to inspect and repair the equipment. While, in 1979, the big repairing plan is scheduled and 2 to 2.5 months repairing term is scheduled.

Although every repairing term are scheduled as 1 month in both rehabilitation steps, yet it may be considerable to reduce the later repairing term of each year to half a month, when the periodical repairing system will have been established and the experience will have been accumulated.

(11) Investment budget for big repairing

Estimated budget for big repairing are as follows.

	1979	1980	Sum of 1979 1980 (Thousand Baht)
Machine	12,720.	5,599.	18,319.
Instrument	6,326.	4,397.	10,723.
Electric	750.		750.
Laboratory	450.		450.
Sum	20,246.	9,996.	30,242.

In this budget, the amount of Baht 16 million is to be imported for Thailand and the costs for equipment to be imported are estimated by F.O.B.

The total budget are finally estimated as Baht 40 million taking in consideration the import tax of Thailand and other factors.

Further, following budget for instruction fee by specialist is included in above total.

Machine	3,690.	Thousand Baht
Instrument	400.	
Electricity	300.	
Total	4,390.	

5-2 Study for economical balance

The result of economical study for the rehabilitation of Mae Moh factory has been tabled on the next page.

The summary of the study are as follows.

In present situation, Mae Moh factory had been suffered the loss of around 20 million baht every year.

In the first step of rehabilitation program, when the reliability of equipment will have been restored, the production amount will be increased about 50% comparing to present. And it is estimated that the proceeds will exceed the total of variable and fixed cost a little.

Further in second step of rehabilitation program by the promotion on operational technique following to the restoration of equipment reliability, the production amount is estimated to be increased double of present, and the proceeds will be exceeded the total of production costs and investment and created the benefit fairly. The repairing works, for improvement and replacement, will be practiced dividing twice in later 1979 and early 1980 by the restriction for delivery term of spare parts and large number of jobs to be done in short term.

Therefore the effects of improvement will appear 2 years after starting of the programme. Finally at the completion of second step, the benefit in the year fairly high enough exceed the cost and depreciation, yet the benefit will not be able to clear the accumulated loss and it will be delayed on 1984 to clear the accumulated loss. Those transition has been shown on Figure -1.

Table 5-2 Economic Balance

Present Condition

Production / Proceeds

	Day/Ope. Month	Ton/Day	Ope. Month/Year	Ton/Year	Unit Price Ton/Baht	Million Baht
NH_3	16	62	10	9920		
H_2SO_4	27	100	10	27000		
UREA	12	52	10	6240 →	3900	24.3
AMMONIUM SULPHATE	16	122	10	19520 →	2100	41.0
BOTTLED AMMONIA				1100 →	11000	12.1
TANK LORRY H_2SO_4				12070 →	1000	12.1
						89.5

Cost

	Unit Price Baht	Million Baht
Variable cost		
Lignite 61900 T/y	x 50	3.1
Electricity 57.6x10^6 KWH	x 0.52	30.0
Sulphur 9080 T/y	x 1700	15.4
Bag & Transportation		6.2
		54.7
Fixed cost		
Electricity (demand charge)		5.0
Chemicals & Oil		5.5
Personnel		25.0
Spare parts		5.0
General		14.5
		55.0
TOTAL COST		109.7

Balance

Proceed	89.5
Cost	109.7
	-20.2

Improvement 1st Step (1979~1981)

Production / Proceeds

	Day/Ope. Month	Ton/Day	Ope. Month/Year	Ton/Year	Unit Price Ton/Baht	Million Baht
NH_3	21	70	10	14700		
H_2SO_4	27	117	10	31590		
UREA	18	65	10	11700 →	3900	45.6
AMMONIUM SULPHATE	21	121.5	10	25520 →	2100	53.6
BOTTED AMMONIA				1100 →	11000	12.1
TANK LORRY H_2SO_4				12070 →	1000	12.1
						123.4

Cost

	Unit Price Baht	Million Baht
Variable cost		
Lignite 73400 T/y	x 50	3.7
Electricity 67.7x10^6 KWH	x 0.52	35.2
Sulphur 10600 T/y	x 1700	18.0
Bag & Transportation		8.9
		65.8
Fixed cost		55.0
TOTAL COST		120.8

Balance

Proceed	123.4
Cost	-)120.8
Investment	-) 10.0
	-7.4 (depreciation by 4 years)

Improvement 2nd Step (1982~1983)

Production / Proceeds

	Day/Ope. Month	Ton/Day	Ope. Month/Year	Ton/Year	Unit Price Ton/Baht	Million Baht
NH_3	25	80	10	20000		
H_2SO_4	28	139	10	38920		
UREA	23.5	70	10	16450 →	3900	64.2
AMMONIUM SULPHATE	25	140	10	35000 →	2100	73.5
BOTTLED AMMONIA				1100 →	11000	12.1
TANK LORRY H_2SO_4				12100 →	1000	12.1
						161.5

Cost

	Unit Price Baht	Million Baht
Variable cost		
Lignite 97600 T/y	x 50	4.9
Electricity 80.9x10^6 KWH	x 0.52	42.1
Sulphur 13100 T/y	x 1700	22.3
Bag & Transportation		= 12.3
		81.6
Fixed cost		55.0
TOTAL COST		136.6

Balance

Proceed	161.5
Cost	-)136.6
Investment	-) 10.0
	+14.5

Fig. 5-3

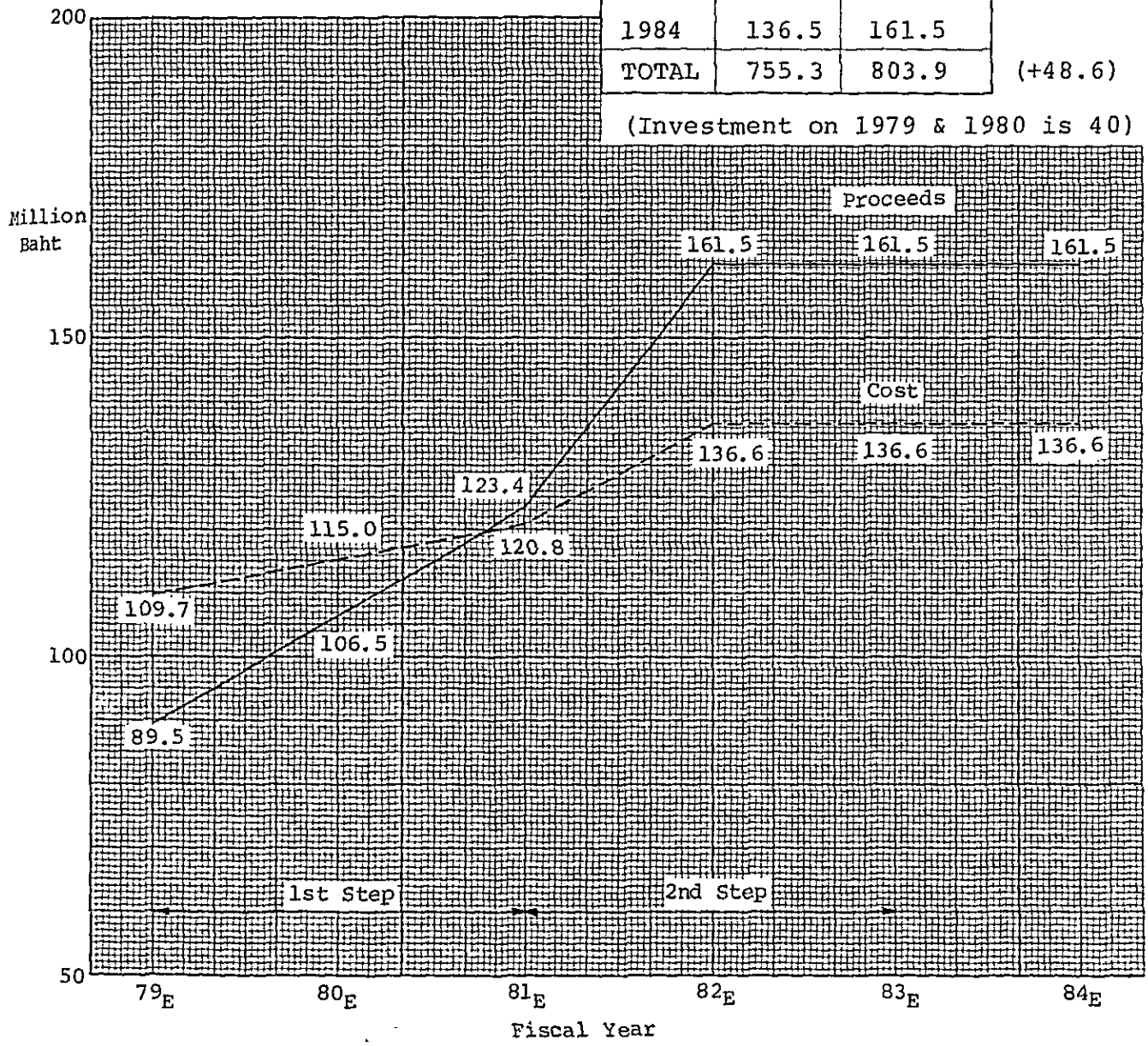
Transition of Proceeds and Cost

	Cost	Proceeds
1979	109.7	89.5
1980	115.0	106.5
1981	120.8	123.4
1982	136.6	161.5
1983	136.6	161.5
1984	136.5	161.5
TOTAL	755.3	803.9

Millon Baht

(+48.6)

(Investment on 1979 & 1980 is 40)



The base to estimate the economical balance is as follows.

(i) Production rate

i-a Present

The production rate and operation pattern is the average of past records.

i-b 1st Step

On the first step, the operation pattern of 10 days production operation by 70 TON/DAY and 3 days stopping the plant for repairing was estimated. As for the cause of factory shut down, the trouble of gasifier or tubular boiler in gasification plant had been supposed. The operation pattern estimated here was realized several times in 1976 and 1977, when fortunately there was scarecely the trouble in ammonia plant. That is, the target of production of first step is to realize continuously the smooth operation which had been experienced several times in the past. The production rate of urea had been set to the highest rate corresponding to ammonia production rate, because when the price of urea and ammonium sulphate are compared, it is clear that the advantage converting the ammonia to urea was higher than the advantage converting ammonia to ammonium sulphate. Further the timing of urea plant start up is considered as one day delay of ammonia plant start up. It is by the restriction of process that the urea plant should be started after the ammonia plant has been started and stabilized.
The marketing amount of liquid ammonia and sulphuric acid was estimated the same as present. The ammonia and sulphuric acid loss of 3% has been included for the production of urea and ammonium sulphate.

i-c 2nd Step

On the second step, the operation pattern, of 15 days and 80 T/DAY production operation and 3 days shut down for maintenance, had been estimated. The cause of shut down the factory was estimated the same as 1st step, that is, gasification plant trouble. Although in the past the condition of 80 T/DAY production or 15 days continuous production had been realized many times independently. Yet to realize the both conditions steadily, it is required the high grade careful and positive operation and maintenance works. Therefore the trial of 2nd step operation will be able to practice when the conditions of first step will have been established. Other conditions for 2nd step are almost the same as 1st step. However it should be taken care about sulphuric acid plant, that is, the estimated production rate of sulphuric acid on the second step shall be full load of the plant. Since sulphuric acid plant has scarecely the connection to other plants and is simple process comparing to others, the production rate was supposed to be realizable still it had some of the problems on equipment to be kept the perfect conditions. If the situation such as the requisite of marketing sulphuric acid or the production of ammonia would be increased unexpectedly or the trouble of urea plant would have been taken places, immediately the sulphuric acid plant would appear as the bottle neck of Mae Moh factory.

(ii) Sale price products

The prices of products are following to the data from CFC.

(iii) Production cost

All the cost, such as power rate or personnel expense, are depending on the data from CFC. Here it should be marked that the cost of Lignite, which is the main raw material of Mae Moh factory, is very cheap, comparing to other materials such as petroleum.

SECTION 6

REPORT FOR EQUIPMENT

Section 6 Report for Equipment

6-1 Summary

As it has passed 13 years after the completion of Mae Moh Factory, equipments thereof are overaged, and according, there exist such portions at each plant as have to be replaced, modified and/or repaired for their equipments.

However, it can be evaluated that the utmost endeavours have been made for the proper maintenance under insufficient materials and tools and by a small numbers of technicians. Also, it can be said that the technicians of the maintenance division are the first class grade. Especially, chiefs of each section have the excellent technical levels. However, regretful to say, due to the insufficient instructions and instruction capabilities of such first class technicians, necessary numbers of technicians as a whole are not fulfilled. Also, they are forced to be fully occupied in doing repairing works caused by overaged equipments.

Recently, it is said to increase the numbers of technicians sharply, and the replacements of towers and vessels, heat exchangers, etc. are performed with starting the large scale construction work.

However, as the present maintenance systems are separately packaged in small scale for each plant, big scale works cannot be performed and accordingly, partly repair works only can be done. This status is one of the factors to do maintenance under post-fact conditions.

For doing big work and preventive maintenance work, central control system is necessary through the establishment of maintenance center by reorganizing the present maintenance systems.

Furthermore, it has to be noted that this maintenance center would become only as a nominal systems if no nurturings of engineers and technicians would be performed.

Engineers with the capability of instructions have to be increased; this matter is necessary factors for the future development of chemical industries in Thailand.

6-2 Problems on each Plant

6-2-1 Boiler Plant

Two units of boilers are equipped and are operated alternately in approximately four months intervals.

At this stage, open inspection was made on No.2 boiler and it was found that the equipment itself are in comparatively stiff conditions in consideration of 15 years duration after completion, though problems are existing to some degree. As water quality contains no problems and accordingly, corrosion problems are also small, future maintenance shall be done through ehecking and repairing based on cleaning work mainly.

Since the boilers are operated alternately, repairing periods for boilers can be sufficiently provided. However, the maintenance of the equipments during stop period shall be done with enough cares.

As the problem point, manual cleaning is required in addition to mechanical cleaning by soot blowers for the economizer and air preheater, since the trouble outbreak is expected at ID-Fan due to increase the temperature of exhausting gas in case that economizer and Air Preheater are spoiled by dust, while the elements (nozzle) of the soot blowers shall be replaced.

Spare of air preheater is kept in the wooden box case at open air, where they might be suffered from the corrosion. This has to be used immediately.

At this stage, checking of No.2 Boiler was made and No.1 Boiler shall be also checked in the same procedure.

6-2-2 Feed Water Plant

(1) Pure water unit

Internal checking of Deaerator was performed for water ion exchanger and its water treatment performance was good and no corrosion problems were found..

For other equipments, as no problems were expected, internal checkings were not done.

(2) Low Pressure Steam (3.5 kg/cm^2 and 10 kg/cm^2 Line)

Deterioration of insulation are advanced considerably, (this conditions can be applicable to whole of Mae Moh Factory), and corrosions are advanced due to flow-in of rain water.

Replacement of piping and insulation are required.

(3) High Pressure Steam (30 kg/cm^2 Line)

Though the plant operation had been affected strongly by the fluctuation of steam pressure, stable plant operation has been achieved by modifying some lines and by instrumentation improvement.

From now on, it is required to detect steam leakage at an early stage and to treat it instantly. In case the steam leakage of an early stage is left as it is, it will cause the plant stop due to widening of the leakage hole by erosion.

For the case of grand leakage or flange leakage of valves, etc., re-use of them may become impossible due to the damages on them.

Leakage of high pressure steam shall be repaired within 24 hours after the leakage occurs, i.e., within small leakage stage.

(4) Boiler Feed Water Line

This time, repairing works were performed twice due to leakage troubles, the reason of which is, as the same to steam line, due to corrosion from external surface by the flow-in of rainwater through the deteriorated lagging materials.

This line is almost out of use and the replacement is required at the time of next occasion. Cautions to the leakages are the same as steam lines.

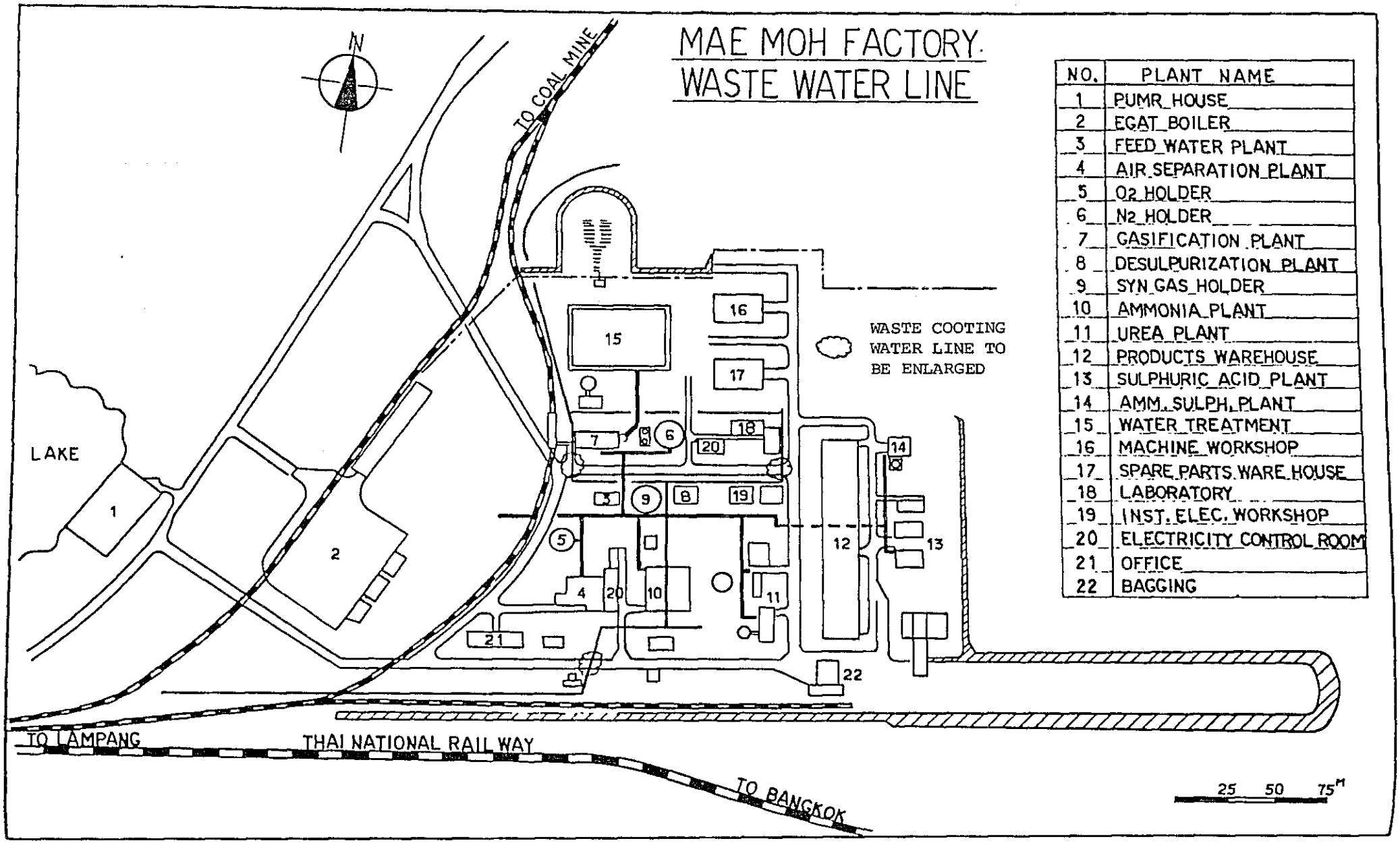
(5) Cooling Water Line

1) Five cases of leakages were repaired for the underground pipings, while these were not so serious. Since the capacity of pumps are decreased considerably, repair of pumps shall be planned.

2) For drain water line, due to the small size or drain trench (pipe), drain water is overflowed to the adjacent trench line and the corrosions are caused on trench line.
Modifications of waste water line, especially size up of pipes under road, shall be required.
Modifications of waste water line required are shown in the attached sheet.
Also, cleaning of waste water line is required at the annual regular checking.

(6) General matters of Feed Water Plant

Though small problems were found for each equipment, there were no big problems when compared with other plants, and its duty as a utility is fulfilled, under utmost maintenance by means of insufficient materials.



NO.	PLANT NAME
1	PUMP HOUSE
2	EGAT BOILER
3	FEED WATER PLANT
4	AIR SEPARATION PLANT
5	O2 HOLDER
6	N2 HOLDER
7	GASIFICATION PLANT
8	DESULPURIZATION PLANT
9	SYN GAS HOLDER
10	AMMONIA PLANT
11	UREA PLANT
12	PRODUCTS WAREHOUSE
13	SULPHURIC ACID PLANT
14	AMM. SULPH. PLANT
15	WATER TREATMENT
16	MACHINE WORKSHOP
17	SPARE PARTS WARE HOUSE
18	LABORATORY
19	INST. ELEC. WORKSHOP
20	ELECTRICITY CONTROL ROOM
21	OFFICE
22	BAGGING

6-2-3 Air Separation Plant

This plant cannot be stopped due to the system of the whole plant (N_2 is indispensable for N_2 seals a protection of catalist etc.) Even in case of scheduled stop of the plant, sufficient periods for checking and repairing can not be spared commonly, due to pretreatment periods (heating up the apparatus for five days) and post-treatment periods (cool down for six days).

For this tage, as the checking and repairing periods were 3 ∿ 4 days, only the cleaning of compressor cooler and partial cleaning of rashig ring repairing periods, only emergency treatment could be done.

Efficiency of operation of whole Mae Moh Factory has been low due to stop of the plant caused by troubles of switching devices of regenerators and air compressor.

As the problem of this Plant,

(1) Regular checking and repairs shall be done for four-way valves, switching valves and switching device of regenerators.
Annual checking and repairs are required for four-way valves and switching valves, since they are operated very often and are apt to be damaged.

(2) Corrosion of Spray Cooler and supplement of rashig ring.

For Raschig ring, ceramic rings ($50x50x5^t$) are used, where, the level of ring layers is lowered by one meter due to damages of the rings.
Supply of these rings (ceramic rings $50^{\phi}x50^{h}x5^{t}$ 3 m^3 21,000pcs) is required. Especially in the tower, the corrosion of bottom semi-spherical plate is serious. Though the repairs of lining of the bottom

semi-spherical plate were made on March, 1977, rechecking including bottom portion are required by taking out all of the rings at the next periodical checking time (October,1979).

(3) Overhaul of Air Compressor

Though the air compressor is important equipment, overhaul has not yet been performed due to no capable machine engineers and short repairing periods. However, cleaning of vanes at the first stage was made on March, 1977 and, at this time, the same portion was checked but not dusted.
Though the troubles occur mainly on the auxiliary equipments (cooler, etc.) at present, vibrations of 20 μ were observed to the longitudinal direction at the third stage casing.
As the standard alarm point of vibration is set at 12 ∿ 13 μ in Japan for the same type turbo compressor, according to which the troubles are expected in future, overhaul is required. However, at Mae Moh Factory, as the technicians for repairing compressor of reciprocation type are available but not available for turbo type, supervision by the specialists are required for the overhaul of this machine.

(4) Replacement of Perlite Heat Insulator in Cold Box

At present, freezing was observed at two locations of cold box casing.
Though it is not sure whether this freezing is caused by deterioration of insulation or internal leakage, anyway moisture in the air is frozen on the external surface of cold box by the internal cooled air.
If the case is due to the internal leakage, the

matter is serious. Therefore the checking should be done.

While, as the deterioration of insulation can be expected, the replacement of perlite and internal checking shall be done simultaneously.

(5) Construction of Air System for Instrumentation

For the request by the Process and Measurement side, case study was made for the cost estimation in respect of construction of instrument air unit. Design criteria is that the working air pressure shall be 8 kg/cm^2 (Min. 3 kg/cm^2) and the air volume shall be 500 NM^3/H.

	CASE I Motor Driven (60KW)	CASE II Diesel Engine Driven (80HP)	Remarks
	(1000Baht)	(1000Baht)	
Dryer (full auto-matic)	400	400	
Compressor	200	300	Including Driving Unit
Air Reservoir	450	——	Holding time is 10 minutes after Electric Power failure. Existing 3 m^3 tank is enough for Case II.
Accessories	300	100	Cost of electric room modification is big for motor driven case.
Total	1,350	800	

Running cost is presumed as Baht 30/H.

Case II is recommendable for Mae Moh Factory.

6-2-4 Gasification Plant

At gasification plant, gas is produced by burning the pulverized coal, where the clogging has occurred through the system caused by slag and fly ash formed and this much affected the efficiency of plant operation.

Since the perfect preventions of slag and fly ash forming are very difficult, the countermeasure for the mechanical side is that numbers of plant stop due to equipment troubles by clogging and corrosion are to be reduced by the repairing of the portions easily clogged with slag and fly ash and proportional prolongation of its life.

(1) Replacement of Tubular Boiler Tube

Total numbers of tubes of Tubular Boiler are 114 pcs., among which 20 pcs. can be cleaned off the slag by jet washing, while the remains can not be expected for any effective cleaning by jet washing.

This is caused by that, the replacement of the tube is performed by weld the tube in the boiler (long tube cannot be replaced due to heat exchanger structure), and that, the welding bead makes the inside diameter of tube be smaller due to inappropriate treatment of the bead at the time of welding, and that, consequently, the effective cleaning cannot be expected by jet washing to the slag sticked on those portion.

This problem cannot be solved only by repairing the welding bead, and, as the tube and tube sheet are overaged, the replacement of large scale is required.

For the replacement of the whole tube, heavy expansion at lower portion of tubular boiler and the castable line at downstream shall be removed.

Since the scale of this work is big one using heavy equipments, it is necessary to despatch the specialists to supervise the repairing.

Expansion Joint is also overaged and shall be replaced.

(2) Replacement of Soot Blower of Tubular Boiler

Soot Blower including universal joint is overaged and shall be replaced.

(3) Reinforcement of Heat Insulation

Superheat steam is used for Soot Blower, but the steam temperature at the entrance of soot blower is decreased due to existence of the exposed piping as resulted by deterioration of the lagging materials.

If the drains flow into tubular boiler, fly ash on the tube sheet will become soil.

Reinforcement of heat insulation and provision of steam traps are required.

(4) Replacement of Gasifier Neck (Quenching Zone)

Shell thickness of main short pipe (800^{ϕ}x1100^{h}x12^{t}) of gasifier neck becomes thin due to internal corrosion, and, especially, cracks are found at the welded zone, due to which the water leakage is caused and the slags stick very often.

This short pipe has to be replaced.

(5) Problems of Slag Clogging and Corrosions of Gas Cleaning Section.

Though many problems such as slag clogging, corrosions, etc. are found in this section, the best way for solving these problems is the accurate performance of the regular cleaning (semi-annual) and the regular replace-

ment (one every two years) providing the materials (especially, plate and pipe), since this equipment is under low temperature and low pressure where the common market material can be applied.

Though large diameter pipes (600 ø) are used for this section, replacements can be performed one by one by ordinally prefabricated pipes.

Paving is spoiled by soot heavily.

Gasification plant atmosphere shall be neatly modified.

(6) Modification of No Removal Tank to Filter.

Dusts produced at gasification plant cause influences to the downstream Adip Plant and Ammonia Plant.

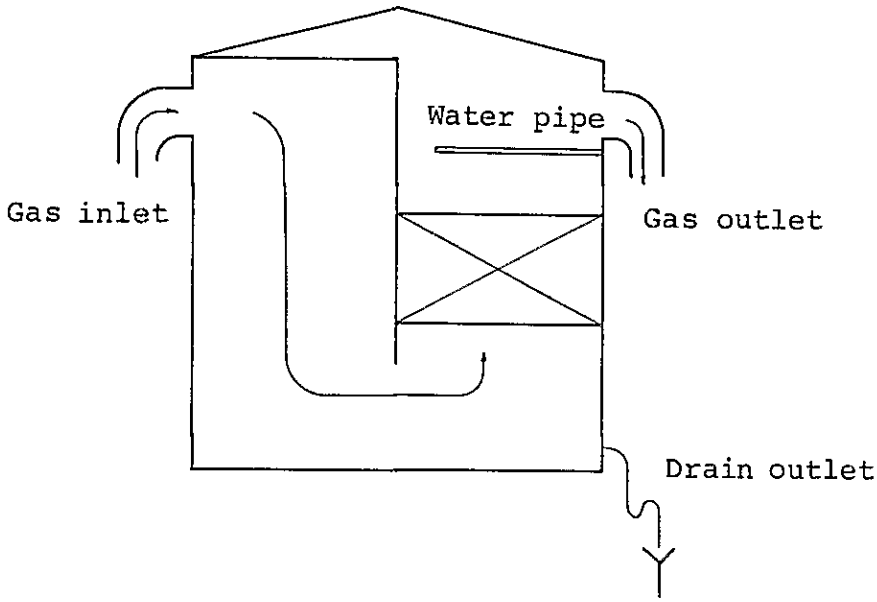
For the removal of dusts, it is recommended to modify the existing No Removal Tank to Filter.

At present, No Removal Tanks (6000 ø x 7000 h 2 units) have not been used.

Modification of these tanks to Filters, as shown in the attached sheet, shall be realized, since it can assure the removal of slags, economically.

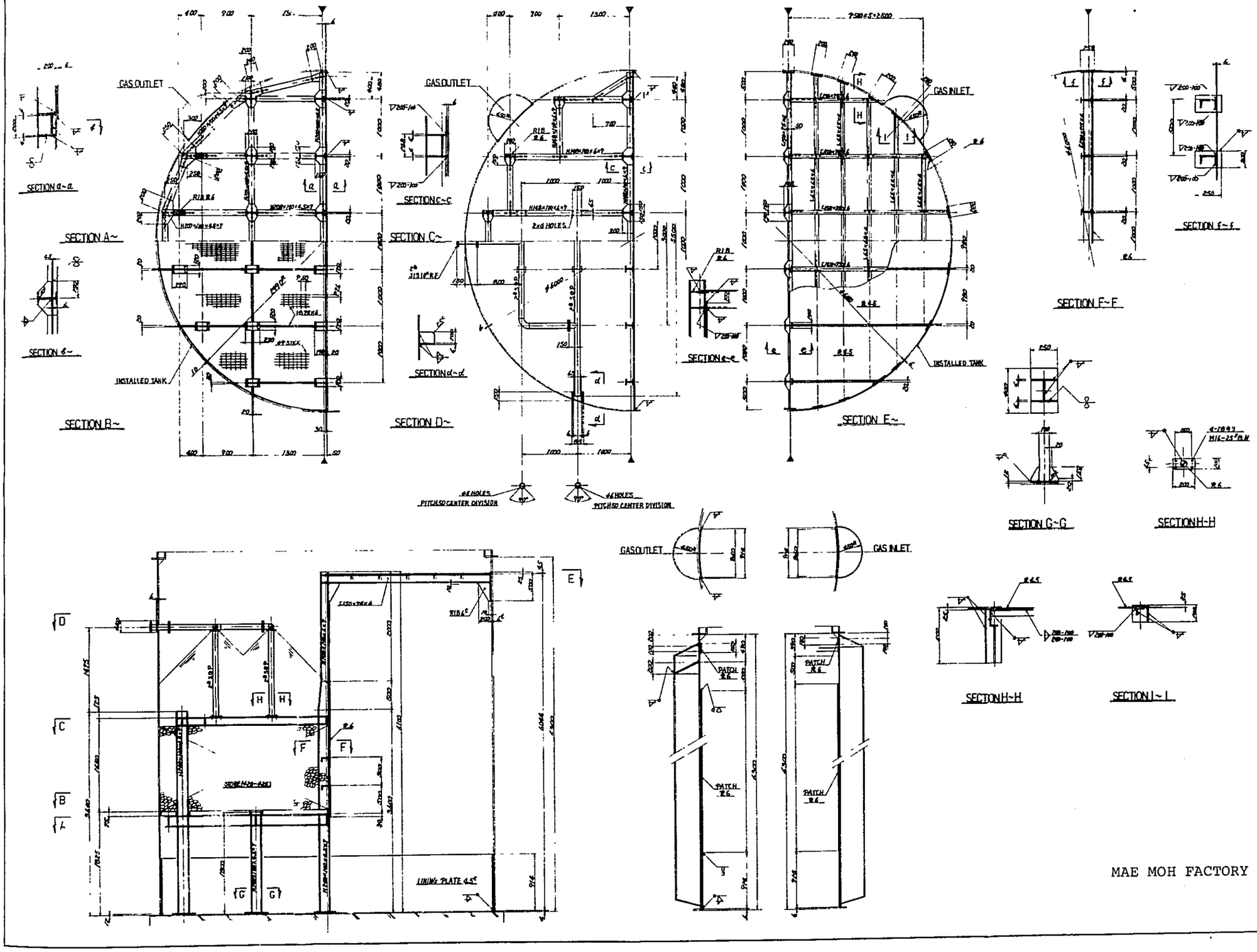
Main procedures for the modifications are to divide the tank by the wall at the center vertically, where one side shall be kept vacant to enable the dust and drain in the gas sinking by their gravity and the another side shall be provided with Filtering layer of stones (or ceramic balls) against coming-up gas flow. While, it is planned that the dusts filtered and clogged at the filter layer can be removed by water cleaning.

Schematic Drawing for the Remodeling of NO Removal Tank



The drain (mist of water) and fly ash were, at the first, separated by the gravity force in the left hand room of Tank. Then the fly ash is separated by the packed bed. Water pipe is installed to wash the packings.

The detail drawing is attached on next page.


GAS OUTLET
SECTION A~
SECTION B~
SECTION C~
SECTION D~
GAS INLET
SECTION E~
SECTION F~F
SECTION G~G
SECTION H~H
SECTION I~I
SECTION J~J
INSTALLED TANK
PITCH 50 CENTER DIVISION
LINING PLATE 4.5t
PATCH
MAE MOH FACTORY

6-2-5 ADIP PLANT

As this plant is operated under low temperature and low pressure, there are no serious problems for maintenance.

Establishment of regular cleaning system (semi-annual) shall be required to avoid the neck points due to slag cloggings in the gas.

However, this problems will be improved significantly by the modification of NO Removal Tank of the Gasification Plant to the Filter.

From now on, further improvement shall be made on the ADIP sol. filter for removing the dust of the gas in ADIP solution.

6-2-6 AMMONIA PLANT

At Ammonia Plant, following replacements are under performance for the large equipments:

(1) Replacement of Saturator ($20{,}185^{h}$) is performed on November, 1977.

(2) Replacement of Upper Tower ($1200^{\phi} \times 13^{t} \times 7000^{h}$) of Demoisture ($24{,}700^{h}$) is performed on July, 1978.

(3) Replacement of expansion of water preheater is performed on July, 1978.

(4) Replacement of Heater Exchanger I ($3182^{\ell} \times 700^{\phi} \times 10^{t}$) is performed on July, 1978.

(5) Repairing of Steam Mixer is performed on July, 1978.

(6) Repairing of Cooler Synthesis Gas Compressor is performed on March, 1977.

However, due to the insufficient consideration to the every details, above performances cannot be helpful for the improvement of the plant operation efficiency.

That is, many stops of plant occurred due to such troubles as leakage of locational pipings, leakage at flange portion, inferior function of valves, etc., whose repair and replacement are further required.

Present problems on the equipments are as follows:

I Check and Repair of Pipe Line

(1) Boiler Feed Water Line

As stated hereinbefore, partial replacements were performed due to the external corrosion casued by rainwater flowing-in through the deteriorated lagging materials, and further the remaining portions shall also be replaced immediately.

(2) Condense Line of CO_2 + H_2O

(A) Drain Piping around Saturator

As the life of carbon steel pipe used in this line is for one year only due to corrosion, the stainless pipes shall be used.

(B) Piping of gas exit and entrance of CO_2 Srubber and Hot water Line of Saturator and Demoisture

Following repairs are required on this line, to minimize the stop due to leakage from flange and pipe corrosion.

(i) Replacement of pipes

(ii) Replacement of Flange Gasket of different type

Asbestos seat packing used at preset is not suitable for the operation condition of this

Line (pressure 24 kg/cm^2 temperature 100°C). Therefore, spiral type gasket with inside and outside rings (inside ring shall be of stainless) shall be used.

(Sample of this spiral type gasket was brought with by the Second Survey Team)

(iii) Replacement of valves.

(C) CO-converter and Heat Exchanger I, II

Though the asbestos seat is used for flange gasket at Heat Exchangers, it is not suitable to the operation condition of this line.
Therefore, these asbestos seats shall be replaced to the spiral gasket with inside and outside rings (inside ring shall be of stainless).

(D) 1 ∿ 4^{TH} Stage Line of Synthesis Gas Compressor

As the corrosions are very heavy on this line also, checking shall be done once a year.
Especially, it is better to use stainless pipe for the drain pipe of separator.

(3) CO_2 Line

Checking shall be done regularly.
As the check point, accumulative portions of drains shall be thoroughly checked and the aging variations therefore shall be confirmed.
While, trench line shall be replaced immediately, as the corrosion advanced heavily due to water saturation by over-flow of drain ditch.

II It is necessary to keep the designed capability of rotating machines by regular overhaul and to reserve the spare parts.

(1) Synthesis Gas Compressor

(A) As the gas leakages from metalic pakings are found at higher stages (especially, 5 and 7 stages), repairs thereof and the rod checking shall be done.

(B) By checking the clearance at each points, adjustment shall be done within the standard allowance of Dia. x 1/1000 ∿ 1.5/1000.
To recognize the actual clearances will be helpful for the procurement of spare parts.

(2) Water Turbine

Corrosions by carbonic water shall be considered. Though Important portion is provided with stainless steel (casing is of stainless linings), corrosions are found on those portion with stainless plate by spot welding. Especially, spares are necessary for the first stage casing.

(3) NH_3 Compressor

As the damages of o-rings of eccentric valves are found for many cases, checking shall be made for finding out the differences of materials used on the previous o-rings and present o-rings.
Further, by checking the each clearance variation due to defacing, adjustment shall be made within the standard. Standard allowance are 1/1000∿1.5/1000.

III CO_2 Scrubber

Careful checking shall be made on the internal epoxy lining, since the peeling of this linging in small range will cause the serious corrosions.

IV Deterioration of Lagging Material

As the deterioration of lagging materials has advanced, checking of rainwater flow-in portion and the relative repairs are required. Due to such troubles, corrosion occured on Boiler Feed Water Line which had to be replaced due to resulted leakage.

Above are the points for the future checkings, while, if the conditions of equipments are confirmed and recorded through the regular checkings, not only the planned repair can be done but also the unexpected work will be reduced, and, accordingly, the efficiency of the plant operation will be raised. (This is the Process Management)

6-2-7 UREA PLANT

For UREA Plant,

(1) No problems of corrosion on low pressure portion.

(2) For Liq. ammonia line, since there shall be no internal corrosion, cares shall be taken on the external corrosion and vibration.

(3) Problems are concentrated on First Reactor and Second Reactor.

As the corrosion problems took large part for First Reactor, regular checking by annually shall be made and also, the spares for mixer and header shall be provided immediately considering heavy corrosions thereof.

For Second Reactor, replacement of linings at top portion and pipings at exit and inlet (including flanges), are required.

Piping replacements for,

Entrance piping: First Reactor ∿ 2nd Reactor
Exit piping : 2nd Reactor ∿ PCV

(4) For CO_2 compressor, as the replacement of damaged portions due to pipe bursting accident on May 13, 1978, and the overhaul of compressor were completed, there exist no problems.

Overhauls of each damper of CO_2 Drying Unit were performed under our supervision, as they were deemed as the cause of burst accident.

(5) As other points, spare parts shall be checked and arranged, since parts numbers and items are not so such compared with other plants.

6-2-8 Sulphuric Acid Plant

Corrosion at sulphuric Acid Plant has advanced throughout the plant, since the plant is operated under high temperature though low pressure, and the fluids thereof are S, SO_2, SO_3 and H_2SO_4.

Following serious problems are existing in this Plant:

(1) Converter

... Cracks by heat stress on it and external corrosions

(2) Sulphur Melting Pit

... Corrosions at steam heating pipe (coil)

(3) Waste Heater Boiler

... Corrosion at Header of Water Pipe by Sulphuric Acid Mist.

(4) Dryer

... Clogging at Raschig Ring due to soiling

(5) Absorber

... Same to (4) (Dryer)

(6) Stack

... Corrosion due to internal sulphuric Acid mist

(7) Building & Walkways

... Designed thickness is reduced due to corrosion

(1) Repair of converter cracks has been done by welding under the condition of insufficient cleaning of Sulphur sticked to crack portion and also under leak out the SO_2 gas from inside. Therefore, the sulphur inclusion has occurred and such portions are easily cracked due to high temperature during operation.

Gas leakage due to cracks of converter makes the corrosions of surrounding equipments advance and also makes the daily maintenance be difficult due to limitation of approaching to the plant by the poisonous gas leakage.

At the time of plant stop, perfect repairs shall be required with care of non-slag inclusion welding procedures.

(2) For Sulphur Melting Pit, corrosion of the inside heating pipes is the problem. Periodical replacements of the heating pipes and pumps are indispensable. This is a matter of common knowledge for the Sulphuric Acid Plant.

Present repair procedures are not appropriate. Under insufficient removal of sulphur, the works are performed, and, naturally, good works cannot be done under such unsuitable working conditions.

Also, the corrosions might be advanced due to water percolation from outside through the damaged wall of building and pit.

Repair of walls shall be performed after taking out the sulphur.

(3) Corrosions of the Water pipe header of Waste Heat Boiler advanced considerably and it shall be replaced immediately, since it has been temporarily repaired with over-lapped plate on January, 1978. The drum, installed on the waste heat boiler casing is supported by two columns (6 inch dia. pipe) and 72 water pipes (welded to header), and in case the water pipes are cut off for the replacement of water pipes, fall-down accident is assumed. Therefore, following 3 cases were studied for the replacement procedure.

CASE I After taking out the water pipes with drum from casing and laying them in the horizontal position, replacement of Header will be done.

CASE II For three Headers as equipped, replacement will be done one by one.

CASE III After temporary facilities are constructed against fall-down accident, water pipes headers will be replaced for their entirely.

For each case, specialists have to be despatched.

For Case II & III, safety measure cannot be taken sufficiently due to difficulty of protection against fall-down, and the satisfactory repair work cannot be assured due to narrow work spaces (side walking position working).

Case I can be recommendable as the repair work and safety measures under this method have the higher reliabilities.

Further discussions with specialists are necessary.

Study of Repair Cost for Waste Heat Boiler

	Work Periods Required	Repair Cost Unit: ¥1,000.-
CASE I	1.5 months (including stop, start and re-operation)	Despatching Fee of Specialits: $3^{Men} \times 52^{days} \times$ @US$300 = 9,360 Preparator Work: 1,800 Hiring Charge of 50 ton Crane: 1,500 Fire-Proof commodities 2 ton: 1,000 (to be furnished by CFC, including construction cost) Header, Tube, Plate: (To be furnished by CFC) Total 13,660
CASE II	2.0 months	Despatching Fee of Specialist: $3^{Men} \times 67^{days} \times$ @US$300 = 12,060 Preparatory Work: 1,800 Fire-Proof commodities: 800 Other materials (to be furnished by CFC) Total 14,840
CASE III	2.0 months	Despatching Fee of Specialist: $3^{Men} \times 67^{days} \times$ @US$300 = 12,060 Preparatory Work: 1,800 Hiring Charge of Crane: 1,500 Fire-Proof commodities (Furnished by CFC) 800 Materials for protection of fall-down (to be furnished by CFC) 500 Other materials (to be furnished by CFC) Total 16,600

(4) For the cleaning of Rashig Rings of Dryer and Absorber, the treatments of H_2SO_4 compound sticked to rings, accumulated in the bottom, and sticked to walls are the problems.

Furthermore, Raschig rings cannot be taken out easily, as the distributor of non-easily-removable construction (with weight of 8 tons in two separable pieces) is installed over the rings.

For safety works, considerably long working periods are required.

Though water cleaning inside of the tower can be deemed as possible, when considering the tower design, further confirmation to the manufacturer is recommended.

After water cleaning, the relative work is not so difficult.

While, it is better not to cut off the seal weld portion of cover, since the present situation of availability of heavy equipments in Thailand seems difficult to put it again correctly.

(5) Stack

There found big cracks near the top of the stack (Height = approx. 30 m). As the serious accidents are expected if the stack is broken and fall down, prompt repair is required. Interior surface of stack is presumed to be protected with acid-proof castables.

After the through inspection of inside construction of stack, together with the consideration of availabity of heavy equipments in Thailand, appropriate method of repairing shall be studied.

Further, at the time of repair work of stack inside, sufficient care shall be taken for gas removal inside of stack.

6-2-9 Ammonium Sulphate Plant

Though some corrosion problems are involved for each equipment as the relative fluids (H_2SO_4 and crabamate gas) are corrosive, the corroded conditions are not so serious ones. Due to the environmental conditions buildings, especially support column of conveyor are rather rusted and repainting thereof are required.

This time, investigation was made for finding out the causes of vibrations of centrifuge, by which casing crack often occurred, and the result indicates that the vibrations has occurred due to unbalance condition caused by eccentricity of interior welding repair of basket.

Re-alignment of the basket center and the spare basket shall be prepared. By checking the vibrations thoroughly during operation, and by cleaning the cakes if their stickings cause the increase of vibrations, it can be presumed that the cracks of casing will not occur. (For the center alignment method has been already explained.)

6-3 For Future Maintenance

6-3-1 Autual Capability of Maintenance

Technicians of maintenance divisions are the first-class grade in Thailand. Especially, each chief of each section is excellent, technically. However, regretfully, due to insufficient instructions or instructive capabilities of these excellent chiefs, technical level of the technicians is not enough as a whole.

It is said that the numbers of technicians are increased sharply now. However, essential points from now on is to educate the engineers with instruction capabilities.

6-3-2 Organization of Maintenance

Present situation is that there are maintenance teams of rotating equipment, etc., for each Plant.

According to the present organization, each mechanical maintenance section is belonged to each plant manager without any relation with the other mechanical maintenance sections.

Moreover, each maintenance team is composed of only 3 ∿ 5 small staffs, by which the scale or repair works are limited. In such works as to be done during plant stop, due to necessity to do works of many items, the working mesh becomes rather rough. Central control system is required through establishing the maintenance center for which the present maintenance sections shall be separated from each Plant.

Advantages of Central Control System are as follows:

(1) Large Scale Work can be performed.

(2) Whole situations can be grasped and timely counter-measures can be taken for each importance and each work volume.

(3) Through the combination with the higher level personnels and the experience to handle the various types of equipments of the whole plants, technical matters will be exchanged and the level-up corresponding therefore shall be expected.

(4) Level-up of daily repair work and systematic repair work can be realized.

(5) General level-up by training as a whole.

(6) (2), (4) and (5) advantages are indispensable and applicable for the execution of PM system.

Problems of Central Control System are as follows:

(1) Problems of communication and indication systems between Operation and Maintenance Divisions

(2) Division of works between Operation and Maintenance divisions

(3) Necessity of Maintenance Center

Present situation of Mae Moh Factory is the same to that of ours in some ten years ago, and the recommended one is our present organization. Item (1) and (2) of the above problems can be solved by the thorough daily checks and close communications.

For Item (3) of the problems, as the atmospheres are not preferable due to dust, etc. among the available spaces, the location of the maintenance center shall be decided after the careful study.

This maintenance center shall be divided into office and maintenance work room, with equal spaces for each, for the latter of which two sets of working table of 1 m x 2 m size, one overhead crane of 2 ton capacity, vise table, grinders, tool set with box, etc., shall be provided.

6-3-3 Promotion of Systematic Repair and Training of Engineers (part of PM system)

Unless the systematic repairs of spare and stand-by equipments are performed at normal time and overhauls of important equipments are performed at regular repair time, execution of the works required at the time of regular repair time cannot be fully completed without increase of staffs numbers, even if the maintenance center would be established.

Also, it is necessary to enable the engineers in capable to instruct by training them.

6-3-4 Tools and Equipments

Tools and equipments avialable at Mae Moh Factory at present are as follows:

(A) Welding Equipment

	Name of equipments	Q'ty
(1)	TIG WELDER	2
(2)	ARC WELDER	8
(3)	Automatic Cutting Tool	1
(4)	Manual Cutting Tool	1
(5)	Pipe Bender	1
(6)	Plate Bender	1
(7)	Pipe Cutter	1
(8)	Grinder	6
(9)	Hammering Bed	1
(10)	Electrode Dryer	3

(B) Lathing Machine

	Name of equipments	Q'ty
(1)	Lathe	2
(2)	Boring Machine	1
(3)	Eccentric Boring Machine	1
(4)	Expander (Manual Operation)	1

(C) Checking Tools and Equipments

(1)	x-RAY Apparatus	1
(2)	Handy Vibration Meter	1
(3)	Thickness Meter (Ultrasonic type)	4
(4)	Dial Gauge	6
(5)	Outside Micro Meter (0 ∿ 330)	1 set
(6)	Inside Micro Meter (0 ∿ 1000)	1 set
(7)	Level	6
(8)	Micro Gauge (6, 12, 24 inch)	14
(9)	Stretch	1
(10)	Hardness File	1 set
(11)	Other small tools	

(D) Others

	Name of equipments	Q'ty
(1)	20 Ton Crane Car	1
(2)	Jet Washing Machine	1
(3)	Baby Compressor	2
(4)	Hydraulic Pressure Test Pump (20 kg/cm^2)	1
(5)	Chain Block (1 ton)	7
(6)	Lever Block (3 ton)	5
(7)	Winch	2

Items of tools and equipments necessary for the maintenance work are provided, though the quantities are not sufficient.

However, at the time of the regular maintenance time, whole work schedules are dependent on that of crane and jet washing machine. This means that the shedule cannot be maintained as planned, though performed in good order, due to no allowance of the capacities of the crane and jet washing machine. As a result of checking, if unexpected works are found (such unexpected works commonly occur), there shall be no flexibility in the whole schedule to abosrb such works.

Four sets of thickness meters are available but the two sets are almost out of use and shall be replaced.

For baby compressor, as the available two sets are continuously used for conditioning the motor car and for H_2SO_4 Plant, baby compressors with travelling carts shall be provided for the repair of rotating equipments (especially for cleaning the small oil ditches).

[Items to be studied]

1. Truck Crane of 40 ton capacity closs 1 unit
2. Jet Washing Machine, with travelling cart 1 unit

Though both of the aboves are costly equipments, further studies shall be made for expediting the repair schedule. (At present, truck crane is sent from SINO-THAI, but limited to the sheduled works only. For the unexpected works, crane cannot be sent due to long distance between Bangkok and Mae Moh.)

Jet washing machine shall be replaced as it is overaged.

[Equipment to be procured]

1000 Baht

(1)	Thickness Meter	2 sets	80
(2)	Baby Compressor	1 set	240
(3)	TUBE Expander Machine	1 set	150
(4)	Pipe Cutter	1 set	10
(5)	Test Pump (600 kg/cm^2)	1 set	100

6-4 Plans for Replacement & Modification and Procurement of Parts

It is necessary for the rehabilitation of Mae Moh Factory that the considerable numbers of replacements, modifications and procurement of the corresponding parts have to be realized.

Detailed items are indicated on the attached lists and the summarized cost is as follows:

6-4-1 Cost for Replacement and Modification Plan

1000 Baht

PLANT	Cost		SUB TOTAL
	A CLASS	B CLASS	
BOILER	440		440
GASIFICATION	4,280	410	4,690
FEED WATER	240	260	500
AIR SEPARATION	1,750	300	2,050
AMMONIA	1,380	1,650	3,030
UREA	4,300	330	4,630
SULPHURIC ACID AMMONIUM SULPHATE	4,300	330	4,630
WORK SHOP	200	760	960
TOTAL	12,720	5,599	18,319

6-4-2 Main Items

(1) GASIFICATION PLANT

... Replacement of TUBULAR BOILER TUBE.
Modification of NO REMOVAL TANK

(2) AIR SEPARATION PLANT

... Overhaul of AIR TURBO COMPRESSOR

(3) AMMONIA PLANT ... Replacement of TURBINE CASING,

(4) UREA PLANT ... Repair of 2ND REACTOR LINING

(5) SULPHRIC ACID PLANT

... Replacement of WASTE HEAT BOILER HEADER
Replacement of STACK

(6) WORK SHOP

... Jet Cleaning Machine.

Above are the main items and the cost thereof is big.

6-4-3 Cost

Labor cost and stock material cost of Mae Moh Factory are enxluded.

Price of imported goods in of F.O.B. cost.

6-4-4 Explanation of Ranks

A Rank: Those items required to be modified or replaced during 1979, since further utility of them is almost impossible due to overaged condition and also they are important items for the process.

B Rank: Those items required to be modified or replaced during 1980, as they are important items for the process.

6-4-5 Works to be executed under Technical Supervision

(1) Works for Technical Supervision

(A) GASIFICATION PLANT ... Replacement of TUBULAR BOILER TUBE

(B) AIR SEPARATION PLANT ... Overhaul of AIR TURBO

(C) UREA PLANT ... Replacement of 2ND REACTOR LINING

(D) SULPHURIC AICD PLANT ... Replacement of WASTE HEAT BOILER HEADER

(2) Works desirable for Technical Supervision

(a) BOILER PLANT ... GOVERNER OVERHAUL

(b) GASIFICATION PLANT

... 1) Replacement of short pipes of Fasifier

... 2) Alignment of SCREW FEEDER

(c) AIR SEPARATION PLANT

... Installation work of Air Compressor, Reservoir and Dehumidificator for amplifying Instrument Air

(d) AMMONIA PLANT

... Alignment at WATER TURBINE OVERHAUL

(e) UREA PLANT

... Replacement of FIRST REACTOR HEADER and MIXTER

(f) SULPHURIC ACID PLANT

... Replacement of internal Heat Pipe Method of cleaning of Raschig Ring of Drying Tower

6-4-6 EQUIPMENT TO BE IMPORTED

PLANT	EQUIPMENT		COST (1000 Baht)
BOILER	SOOT BLOWER ELEMENT		80
	COAL CHARGER		120
	F.W. PUMP GORVERNER		200
GASIFICATION	LOOKING GLASS		15
	TUBULAR BOILER	TUBE & TUBE SHEET	700
		EXPANSION	200
		SOOT BLOWER	200
	BELT CONVEYER ROLLER		10
	ROTARY VALVE		150
	HAMMER MILL		200
	SCREW FEEDER		300
	N_2 BLOWER		300
	THEISEN	BEARING & CARBON RING	100
	BLOWER	GLAND SEAL RING	50
	BOOSTER	"	80
ADIP			
	SCRUBBER	DEMISTER	15
AIR SEPARATION			
	AIR COMPRESSOR (ENGINE)		200
	AIR RESERVOIR		300
	AIR DEHUMIDIFICATOR		300
SUB TOTAL			3,520

PLANT	EQUIPMENT		COST (1000 Baht)
AMMONIA	CO-CONVERTER	Al_2O_3 BALL & NET	60
		CATALYST	1,200
	DEMOISTURE	DEMISTER	20
	BUTTERFLY VALVE		300
	WATER TURBINE	CASING	1,000
	COPPER SOL. PUMP	TEE	10
	NH_3 " "	PIPE	5
	SY. GAS COMPRESSOR	LINER	60
		PISTON ROD	80
		NON RETURN VALVE	50
UREA	REACTOR	LINING	300
		PIPE & FLANGE	200
		OIL PUMP	100
		MIXER & HEATER	200
	N_2 COMPRESSOR	CYLINDER VALVE	100
	CO_2 "	PISTON ROD	80
SULPHURIC ACID			
		BURNER	300
AMMONIA SULPHATE		PUMP	100
WORK SHOP	THICKNESS METER		80
	AIR COMPRESSOR		120
	JET WASHING MACHINE		500
	EXPANDER "		150
	PIPE CUTTER		10
	TEST PUMP		100
SUB TOTAL			5,125
TOTAL			8,645

6-4-7 Planning of Replacement & Modification, and Procurement of Parts

A Rank: Within 1979 US1=200YEN

B Rank: Within 1980 1 BAHT = 10YEN (US 1$=20BAHT)

	PLANT Name / BOILER	Rank	Delivery of Equipment	Construction Periods		Procurement of Equipment			Technical Supervision		Description	Cost (1000 YEN)		Remarks
				Adjustment Periods	Construction Periods	Thailand	Japan	Germany	Thailand	Japan				
1	SUPER HEATER	A	6 months		2 days			o			Replacement of 2 elements of Soot Blower	Element 2 pcs	800	Special steel
2	ECONOMIZER	A	3 months		2 days	o					Replacement of 2 elements of Soot Blower	Element 2 pcs	400	Mild steel
3	STOKER	A	10 months					o			Spare chager	1 unit	1,200	
4	STEAM TURBINE	A	10 months	2 days	3 days			o		Δ	Adjusting governor and make it operational promptly	Governor Spares 2 units	2,000	Supervision by Specialist is desirable

	Plant Name	Rank	Delivery of Equipment	Construction Periods		Procurement of Equipment			Technical Supervision		Description	Cost (1000 YEN)	Remarks
	FEED WATER			Adjustment Periods	Construction Periods	Thailand	Japan	Germany	Thailand	Japan			
1	3 kg/cm^2 STEAM LINE	B	1 month	20 days (Prefabrication)	10 days	o					Replacement of Piping (Trench Line 250$^{\phi}$x100^{m})	st35 250$^{\phi}$A x 100^{m} 1,600 lagging Materials Lump Sum.	
2	10 kg/cm^2 STEAM LINE	B	1 month	20 days (Prefabrication)	10 days	o					Replacement of Piping	st 35 1,000 150^{A}x 100^{m} lagging Materials Lump Sum.	
3	30 kg/cm^2 STEAM LINE	A	2 months	10 days (Prefabrication)	10 days	o					(1) Replacement of Boiler Feed Water Line and lagging materials	STPG38 2,000 50^{A}x 400^{M}x S/40	
		A	1 month	5 days (Prefabrication)	10 days	o					(2) Construction of Cooling Water pipe of Tubular Boiler.	st35 25 x 120 150 Valve 2 sets	Modified Dwg., attached.
4	(812003) SCRUBBER)	A	3 months				o				Replacement of Demister (with Spec.)	Demister 150 one set	
5	HOT WATER HEAT EXCHANGER	A	1 month			o					Repair of lagging materials	100^{A} 20^{m} 100	

	Plant Name AIR SEPARATION	Rank	Delivery of Equipment	Construction Periods Adjustment Periods	Construction Periods	Procurement of Equipment Thailand	Japan	Germany	Technical Supervision Thailand	Japan	Description	Cost (1000 YEN)	Remarks
1	SPRAY COOLER	A	6 months		10 days	o					Supply of RASCHIG RING	Ceramic Rings 1,500 $50^{\phi}x50x5^{t}$ 3 m^3 (21,000)	
2	COLD BOX	B	6 months		30 days	o					Replacement of Heat Insulater (Perlite 300m^3)	Pearlite 3,000 300 m^3	
3	INSTRUMENT AIR	A	8 months	20 days (foundation work)	20 days		o o o			Δ	To Amplify INSTRUMENT AIR (1) AIR COMPRESSOR (5 kg/cm^2 600 m^3) (2) AIR Reservoir (20 m^3) (3) Dehumificator (automatic change)	ENGINE TYPE 2,000 1 set 1 set 3,000 1 set 3,000	Specialist Supervistion desirable for installation.
4	AIR TURBO COMPRESS COMPRESSOR	A		17 days	20 days					o	COMPRESSOR-OVERHAUL Despatching of Specialist	Despatching Cost $3^{Men}x30^{days}x300^{\$}$ Preparation 8,000 $21^{M-D}x300^{\$}$ Travel Expense & Tools 1,400	

	Plant Name	Rank	Delivery or Equip-ment	Construction Periods		Procurement or Equipment			Technical Supervision		Description	Cost (1000 YEN)	Remarks
	GASIFICATION PLANT			Adjust-ment Periods	Const-ruction Periods	Thailand	Japan	Germany	Thailand	Japan			
1	ELECTRO FILTER	A			30 days						(1) Repair of wall (2) Providing decks for repairing PRCA4 discharging Damper		Materials available at Mae Mo Factory
2	HOT GAS PRODUCER	B	3 months				o				LOOKING GASS 10 pieces	150	
3	GASIFIER	A		10 days	20 days				SINO THAI o	Δ	Change of Nozzle short pipe Fabrication of short pipe (Material stooked)	Bending roll (SINO THAI) 1,000	Specialist supervision desirable
4	FINAL COOLER	B	1 month	3 days	7 days	o					Repair shell with plate	Plate 10 sh. $1^M \times 2^M \times 6^t$ 150	
5	SEAL POT	B	1 month	3 days	7 days	o					Repair shell with plate	Plate 5 sh. $1^M \times 2^M \times 8^t$ 80	
6	NO REMOVAL TANK	A	1 month	30 days	30 days	o					Modification to Filter	I-Beam, Plate, etc. 6,000	
7	GAS LINE	B	1 month	30 days	20 days	o					Replacement of Gas Line (600^{ϕ})	Plate 40 sh. $1^M \times 2^M \times 6^t$ 500	

	Plant Name	Rank	Delivery of Equipment	Construction Periods		Procurement of Equipment			Technical Supervision		Description	Cost (1000 YEN)	Remarks
	GASIFICATION PLANT			Adjustment Periods	Construction Periods	Thailand	Japan	Germany	Thailand	Japan			
8	TUBLAR BOILER	A	8 months	10 days	30 days		o				(1) Whole replacement of Tube and Tube Plate	(1) TUBE PLATE 4,000 2 sh. TUBE STB35 76.1$^{\phi}$x2.9x7780 10 pcs. 76.1$^{\phi}$x5.6x7780 3,000 80 pcs.	
							o				(2) Replacement of cracked Expansion at Exit Line	(2) EXPANSION 2,000 900$^{\phi}$x625^{L}2^{K}Class (SUS304)	
										o	(3) Despatching Specialist above (2) work	(3) Specialist 2^{Men}x30^{days}x300$^{¢}$ Preparation 6,400 30^{M-D} Travel Expense & Tool 1,000	
								o			(4) Replacement of Soot Blower	(4) Spares 1 set 2,000	
9	RAW MATERIAL BELT CONVEYOR	B	6 month					o			Spares for carrier and return roller	5 pcs. each 100	
10	ELKO BELT	B	1 month		2 days	o					Construction of N_2 Seal piping	25^{A} pipe Valve 2 Nos. 100 (25^{A} stop valve)	

	PLANT Name GASIFICATION	Rank	Delivery of Equipment	Construction Periods		Procurement of Equipment			Technical Supervision		Description	Cost (YEN)	Remarks
				Adjustment Periods	Construction Periods	Thailand	Japan	Germany	Thailand	Japan			
11	HAMMER MILL	B A	2 months 10 months	1 day	7 days 25 days	o		o			(1) Overhaul of Reducer (2) Replacement of Hammer & Wall	High Speed Shaft 20 1 pc Spares Lump Sum 2,000	
12	ROTARY VALVE	A	10 months		2 days			o			Replacement of Rotary Valve	Rotary Valve 1 set 1,500	
13	SCREW FEEDER	A	10 months		7 days			o		Δ	Spare Units are to be provided, due to wearing and tearing	Feeder 2 units 3,000	Supervision by Specialist is desirable
14	N_2 BLOWER	B	1 year	1 day	7 days			o			Parts for blower (rotary & bearing), and for reducer are required.	Parts for Reducer Rotor & Bearing 3,000	
15	THEISEN WASHER	A	10 months		14 days			o			Spare Parts for Bearing Case and Gland sealing	for 2 units(4pcs) for 2 units(4sets) 1,000	
16	SYNTEHSIS GAS BLOWER	A A	8 months 10 months		2 days 7 days	o		o			(1) Replacement of inlet & outlet valves (2) Spare parts for Gland Seal Ring	2^K-500^{ϕ} sluice Valve 4 sets 4,800 for 2 units 500	
17	BOOSTER	A A	8 months 10 months		2 days 7 days	o		o			(1) Replacement of inlet valve (2) Spare Parts for Gland Seal Ring	2^K-500^{ϕ} sluice valve 4 sets 4,800 for 4 units 800	

	PLANT Name / WORK SHOP	Rate	Delivery of Equipment	Construction Periods: Adjustment Periods	Construction Periods: Construction Periods	Procurement of Equipment: Thailand	Procurement of Equipment: Japan	Procurement of Equipment: Germany	Technical Supervision: Thailand	Technical Supervision: Japan	Description	Cost (1000 YEN)	Remarks
1	Thickness Meter	A	2 months									2 sets necessary 800	
2	Baby Compressor	A	3 months									1 set necessary 1,200 Movable Type (7 kg/cm^2)	
3	Jet Washing Machine	B	8 months									1 set replacement 5,000	
4	Expander Machine	B	6 months									1 set 1,500	
5	Pipe Cutter	B	3 months									1 set 100	
6	Test Pump	B	6 months									1 set 1,000 (Hydraulic pressure pump of 600 kg/cm^2)	

	PLANT Name SULPHURIC ACID AMMONIUM SULPHATE	Rank	Delivery of Equipment	Construction Periods		Procurement of Equipment			Technical Supervision		Description	Cost (1000 YEN)	Remarks
				Adjustment Periods	Construction Periods	Thailand	Japan	Germany	Thailand	Japan			
1	DRUM	B	1 month		10 days	o					Construction of Ladders & Walkways for Drum Checking for direct access from economizer	Angle, round bar flat bar steel 300	
2	WASTE HEAT BOLIER	A		7 days	45 days					o	Replacement of Water Header (1) Despatching of Specialists Preparation & study Tools & Materials Travelling Expense	$3^{Men} \times 52^{days} \times$@US$300 $30^{M-D} \times$ @US$300 12,500 1,400	
									o SINO-THAI		(2) 50 Ton Crane	Lump Sum 1,500	
						o					(3) Fire-Proof Goods (Materials already arranged by CFC)	Lump Sum 1,000	
3	SULPHUR COMBUTION FURNACE	B	1 year					o			Spare of Burner	1 pc. 3,000	
4	STRUCTURE	A			20 days	o					Replacement of Grating & Supports	Lump Sump 1,000	
5	STACK	A	1 year	10 days	30 days	o					Replacement of Stack	1 unit 20,000	
6	CONVERTER	A	6 month		30 days	o				Δ	Replacement of internal Heat-exchange pipe Replacement of Lagging Materials	Lump Sum 3,000 Lump Sum 2,000	Technical Supervision is desirable
7	(511005) LYE PUMP	A	8 month		2 days			o			Procurement of spare unit	Pump 1 unit 1,000	
8	CENTRIFUGE	A	2 month		7 days	o					Replacement of basket	basket 2 Nos. 1,000	
9	ABSORPTION TOWER DRYING TOWER	A		10 days	35 days					Δ	(1) Detachment & Reset of Distributor (2) Cleaning of Tower inside (3) Cleaning of Raschig Ring		Confirmation from manufacturer & technical supervision are advisable.

	PLANT Name UREA	Rank	Delivery of Equip-ment	Construction Periods Adjust-ment Periods	 Const-ruction Periods	Procurement of Equipment Thailand	 Japan	 Germany	Technical Supervision Thailand	 Japan	Description	Cost (1000 YEN)	Remarks
1	(572101) 2ND REACTOR	B	6 months	7 days	30 days						Repalcement of Lining at Top Portion		
							o				(1) Lining Material (including bending work)	SUS316 L special 3,000	
										o	(2) Despatching of Specialist $3^{men} \times 30^{days} \times$ @US$400		
											Preparation & Adjustment $21^{M-D} \times$@US$400	10,000	
											Travelling Expense & Tool = 1,200		
		B	8 months					o			(3) Replacement of high pressure pipe at inlet & outlet	Piping materials Lump Sum 2,000	
		B	8 months					o			(4) High Pressure hydraulic pump for fastening cover	1 set 1,000	
2	(572104) FIRST REACTOR	B	8 months					o		Δ	Replacement of pipes for mixer & header	Header Lump Sum 2,000 Mixer	Supervision by Specialist at replacement time is desirable
3	(571006) H.P FLUSH WATER PUMP	B	2 months		3 days	o					Replacement of Plunger	Plunger 3 pcs 90	
4	(571002) NH_3 PLUNGER PUMP	A	3 months		7 days	o					Replacement of Pluger	Pluger 3 pcs. 300	
5	(571011) N_2 COMPRESSOR	A	8 months		7 days			o			Cylinder Valve, Piston, Piston Ring	Spare for 1 set 1,000	
6	(571001) CO_2 COMPRESSOR	B	8 months		7 days			o			Replacement of Piston Rod	90^{ϕ} piston rod 1 pc. 800	

	PLANT Name	Rank	Delivery of Equipment	Construction Periods		Procurement of Equipment			Technical Supervision		Description	Cost (1000 YEN)	Remarks
	AMMONIA			Adjustment Periods	Construction Periods	Thailand	Japan	Germany	Thailand	Japan			
1	(292004) CO-CONVERTER	B	6 months		25days		o				(1) For more effectuation as a filter, setting of Al_2O_3 Ball at gas outlet line and replacement of net	Al_2O_3 Ball 1/2" Ball 400$^{\ell}$ 400 Net 200	
		B	1 year		25 days		o				(2) For protection of catalizer at operation stop, providing of piping for N_2 seal, and replacement of catalizer	Catalizer Lump Sum 12,000	
		B	2 months	2 days (Pre-fabrication)	5 days	o						Pipe $8^{\phi}x3^{\phi}$ 200 Pressure Gauge 2 Nos. Valve 5^{ϕ}-4 Nos.	
2	(292006) DEMOISTURE	B	6 months		10 days		o				Replacement of Demister	1 set 200	
3	(312013) DEGASIFYING TOWER	A	2 months		25 days	o					(1) Repair of Lining (SUS material) at Gas Room	Stainless plate 350 $1^{M}x2^{M}x3^{t}$-$10^{sh.}$	
		A	3 months	10 days (Pre-fabrication)	10 days	o					(2) Replacement of outlet CO_2 Line (60m at trench line portion)	$350^{M}x\ 60^{m}$ 800	
4	(522001) FLASH VESSEL	A	2 months	10 days (Pre-fabrication)	10 days	o					(2) Replacement of (at trench line portion)	STPG38 Sch1 $^{\#}40$ 300 $50^{A}x\ 200^{H}$	
5	PIPING	B	10 months		10 days		o				Replacement of TCV (Butterfly valve) at CO-Converter	Butterfly valve 3,000 $350^{A}(40^{K})$ 2 sets	
6	(311001) WATER TURBINE	A	10 months		25 days						Overhaul		
								o		Δ	(1) Replacement of 1st Stair	1 set 10,000	Supervision by alignment is desirable.
						o					(2) Replacement of Shaft	1 pc. 300	
7	HOT WATER IRRIGATION COOLER	B	2 months	10 days (Pre-fabrication)	10 days	o					Spares of Cooler	STPG38 Sch$^{\#}40$ 500 4" x 5^{M}	

	PLANT Name AMMONIA	Rank	Delivery of Equipment	Construction Periods Adjustment Periods	Construction Periods	Procurement of Equipment Thailand	Japan	Germany	Technical Supervision Thailand	Japan	Description	Cost (100 YEN)	Remarks
8	(431001) COPPER SOLUTION PUMP	A	3 months		3 days		o				Replacement of Tee at outlet line	STPT42 Sch.#120 100 Tee $4^{B}x4^{B}x4^{B}$ 1 pc.	
9	(431002) HIGH PRESSURE AMMONIA WATER PUMP	A	3 months		5 days		o				Replacement of Pischarging Line	STPT42 Sch.#80 50 $25^{A}x25^{M}$	
10	(111002) SYNTHESIS GAS COMPRESSOR	A	10 months		20 days			o			(1) Replacement of 4 stage Cylinder Liner	Liner 1 pc. 600	
		A	10 months		20 days			o			(2) Replacement of piston rod of High pressure stage	Piston Rod 2 pcs 800	
		A	6 months		20 days		o				(3) non-return valve plate of 3 stage (Drawing is provided)	Spares for 4 sets 500	

6-5 Results of Open Inspection and Future Problems

(1)	BOILER PLANT	1/4 ∿ 4/4
(2)	FEED WATER PLANT	1/4 ∿ 4/4
	ADIP PLANT	
(3)	AIR SEPARATION PLANT	1/3 ∿ 3/3
(4)	GASIFICATION PLANT	1/10 ∿ 10/10
(5)	AMMONIA PLANT	1/12 ∿ 12/12
(6)	UREA PLANT	1/10 ∿ 10/10
(7)	SULPHURIC ACID PLANT	1/5 ∿ 5/5
(8)	AMMONIUM SULPHATE PLANT	1/2 ∿ 2/2

(1) BOILER PLANT 1/4

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm)			RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
		HEIGHT LENGTH	OUTSIDE DIAMETER	WALL THICKNESS	PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
DRUM	2	6,700^{L}	1,400	30	Though Pitting of 1.0^{mm} depth found, it is not serious one. Staining is little and in good condition.		Inside cleaning and checking is required regularly (one a year)		
FURNACE	2				(1) No staining, distortion, swelling and corrosion found, with good maintenance. (2) Though coater header exposed from laggings at some portions, no corrosion found and no problem. (3) In good condition, without damage for brick.				
DESUPER HEATER	2	4,100^{L}	191	16	(1) Crack found at welded portion of branch pipe. (2) Corrosion check Wall thickness loss is quite small and no problem.	Replacement of some branched piping. (65^{A} × 50$^{\ell}$)	Crack and corrosion check shall be done regularly (one a year)		

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
STEAM OUTLET HEADER	2	978	191	16	No corrosion and crack, and no problem				
DEARATOR	2				No checking (under operation)		Internal corrosion check and internal cleaning are required regularly once a year.		
SUPER HEATER					(1) External corrosion is of surface chapped and no problem. (2) No swelling and distortion (3) External stainings are big. (4) Vibration protectors are burnt-damaged at 2 portions but no problems at present. (5) Distortion of elements of Soot Blower found.		Corrosion, distortion and swelling shall be checked regularly once a year together with checking of vibration protector damage. Spares are required for elements.	Soot Blower Elements 2 pcs. (made in Germany) 800	Special steel
ECONOMIZER	2				(1) External staining is big and efficiency of Soot Blower becomes low. (2) Big distortion of baffle plate but smaller disorder of tubes and no problem at present. (3) Crack of element of soot blower.		Manual cleaning shall be done regularly once a year, together with checking.	Soot Blower Elements 2 pcs. (made in Thailand) 400	Mild steel

BOILER PLANT 3/4

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
AIR PREHEATER	2				(1) Havy cloggings of preheater fin with dust, which cause low efficiency and temperature raise of exhaust gas. (2) Detachings of fins (especially at lower portion), which cause low efficiency.		Cleaning by manual air blowing at regular checking times (one for every 6 months and at operation stop time) shall be one. Temperature of exhaust gas is higher by 40°C than designed one of 170°C, due to low efficiency of Preheater. Replacements with stocked spares are required.		
PIPING & VALVE					(1) Leakages at flanges of high temperature and pressure are found. (2) Leakages at gate valves of No.1 & No.2 Blower (150ø gate valve 3 sets)	(1) Repaired scrathes by welding and by grinding-finish. (2) Repaired under supervision how to finish fine-matching.	To find out leakage of steam at early stage and repair (Leaving it as it is will cause scratching due to erosion.)		
WATER PURIFICATION DEVICE					No checking		To equip float valve at sound filter for constant fluid level.	Idle equipments available at Mae Moh Factory.	

BOILER PLANT 4/4

Rotating Machine

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
BOILER FEED WATER PUMP	2	49.5	No checking		Overhaul shall be done at regular checking (once 2 years) for checking and maintaining proper functionings.		
STEAM TURBINE	2				Replace the govenor and make the machine operationable.	Governor 2 sets (made in Germany) 2,000	Specialist supervision desirable
ID FAN	2	105,000	No Internal distortions were found and no problem. Dust stickings are small.	Brushing of Impeller	(1) Take caution on temperature of exhaust gas at Inlet. (2) Regular greasing (one per 2 weeks) (3) Regular cleaning of Impeller (one year) (brushing from duct)		
1st AIR FAN	2	25,000	No checking		Regular greasing (monthly)		
2nd AIR FAN	2	6,100					
STOKER	6				As abnormal noise of bearing was detected, overhaul shall be done at operation stop and spare unit shall be provided. (one set of spare unit is required)	Charger 1 set (made in Germany) 1,200	

(2) FEED WATER, ADIP PLANT 1/4

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
3K STEAM LINE							Replacement of lagging materials and pipings. (specially, for trench line)	St35 250A pipe 100M & lagging material 1,600 (Thai made)	
10K STEAM LINE							- ditto -	St35 150A pipe 100M & lagging material 1,000 (Thai made)	
30K STEAM LINE					(1) Corrosion at Boiler Feed Water Line (2) Variation of Steam Pressure	Partial Replacement (100M among 500M) Modification of some portion of Line and supplement of instruction	(1) Due to deterioration of lagging materials at B.F.W. Line (especially, rain water flows in thru external plate), external corrosions are caused. Replacement of Lines shall be done regularly. (2) Supplement of temperature protection at steam line. (3) Expedition of cleaning working hours, by construction of Cooling water pipe for Tubular Boiler.	STPG38 (Sch.#40) 50Ax400M 800 Logging materials (Thai-made) 1,200 St35 25A x 120M 120 Valve 2 Nos. (Thai-made) 30	Modification Dwg. is attached.
WATER PURIFICATION DEVICE					No problem				
DEARATOR					Water treatment system is in good condition. Almost no corcorrisions and no problem.				

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	OUTSIDE DIAMETER	WALL THICKNESS	RESULT OF CHECKING PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(812007) REGENERATOR	1	15,650^{H}	1,500	6	(1) No problem for corrosion (2) Partial detachment of Tray valve	Setting of spares	Regular cleaning (semi-annual)		
(812005) ABSORBER	1	15,030^{H}	1,900	6	(1) No problem for corrosion				
& (812012) SEPARATOR	1	4,800	1,300	6	(2) Partial detachment of Tray valve	Setting of spares	Same as Regulator		
(812009) SCRUBBER	1	14,000	1,300	6	(1) Internal epoxy coating is peeled off and wall surface corrosion is advanced. (2) Heavy internal staining	Surface preparation by sand blasting and expoxy coating applied. Cleaning	(1) Regular cleaning (semi-annual) and damage check of epoxy coating. (2) Replacement is required for demister, as it is damaged heavily.	DEMISTER (Made in Japan) 150	
(812003) DEPHLEGMATER	1	SHELL 998^{H} TUBE 998^{L}	1,200 25	7 2	No corrosion, though being stained.	Cleaning.	Regular Cleaning (semi-annual)		
(812004) REBOILER	1	SHELL 3,470^{L} TUBE 3,000^{L}	1,100 25	5 2.6	No problem on corrosion and distortion and in good condition.		Checking of crack at Tube seal welding.		

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	OUTSIDE DIAMETER	WALL THICKNESS	RESULT OF CHECKING PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(812001) ADIP HEAT EXCHANGER	2	1,970" 1,870"	1,450 1,200	5 4	Good condition without distortion & corrosion	Cleaning	Regular cleaning (semi-annual		
(812006) COOLER	1	1,133"	1,050	4	- ditto -	"	- ditto -		
(812002) CIRCULATION COOLER	2				(1) Corrosion at Tube side (Cooling Water) (2) No problem at shell side.	Replaced with spare unit.	Regular cleaning (Semi-annual and check of leakage.		
HOT WATER HEAT EXCHANGER	1	SHELL 4,924 TUBE 4,100	521 25	7 2	(1) No internal corrosion at shell side. (2) No problem, though some spot corrosions are found at external surface of tube.	Replace tube on March, 1977.	(1) Though internal corrosion at inlet and outlet tube, external corrosions were found due to deterioration of lagging materials (No problem for strength of equipment) Replacement is required for lagging materials. (2) Leakage test and corrosion check of tube at regular check time (annually)	Lagging Materials 100A Line 20M (Thai-made) 100	

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
BOILER FEED WATER PUMP	3	13.5	Vibration of pillow block increased.	Replaced bearings for all 3 sets.	No proper maintenance. Capacity is decreased due to gap of 1.5mm against standard gap of 0.4mm Adjustment of gap is required.		
STEAM TURBINE FOR B.F.P.	1	13.5			No problem		
L.P. BOILER FEED WATER PUMP	2	7.0			Maintain the function as spare unit by overhaul at regular check time (every 2 years.)		
SOFT WATER PUMP	4	7.0			No problem		
COOLING WATER PUMP	3	1,600	Repair No.3 due to overload. Wearing is big for intermediate bearing, month ring and wearing 1st stage Impeller is cracked. Heavy rust on casing.	Replace with spares. Welding repair	For No.1 & No.2, same damage as No.3 is expected. Immediate repair is desirable. (Spares already delivered)		
(811001-3) ADIP SOLUTION PUMP	3	70			No problem		
(811005-6) PROCESS WATER PUMP	2	30			"		

(3) AIR SEPARATION PLANT 1/3

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
SPRAY COOLER	1				(1) Internal staining is small (2)	(1) Raschig Ring Cleaning (2) Lining of bottom semi-spherical plate was performed on March, 1977.	(1) Levels are lowered due to no supplements against damaged Raschig Rings (Ceramic) (2) Regular check for corrosion and cleaning are required (annually)	Raschig Ring (magnetic) (Thai-made) 50 x 50 x 5 (7000pcs/m^3) $3m^3$ 1,500	
WATER SEPARATOR	1				No problems on corrosion & staining		Corrosion check shall be done regularly (annually)		
COLD BOX REGULATORS					No check	Leakage test of 5Kg/cm^3 Line (No problem)	(1) Freezings were found at 2 locations of cold box external plate. This is presumed due to deterioration of cold proof materials or internal leakage. Therefore, after taking out cold-proof materials, checking shall be done for next stage. (2) After checking, cold-proof materials shall be substituted with new ones.	Cold-proof materials (earlite) $300m^3$ 3,000 (Thai-made)	

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
INSTRUMENT AIR							Quality of instrument Air is not good and also, the quantity is in short. Dehumidification device capacity is not enough and power-up shall be arranged.	(1) Air compressor ($5Kg/cm^2$, $600m^3/H$) 2,000 (2) Air Reservoir ($20M^3$) (made in Japan) 3,000 (3) Dehumidificator (made in Japan) 3,000	

Rotating Machine

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
AIR TURBO	1	24,400	Checked staining of suction vane & Impeller and stainging was not big.	(1) Brushing of Vane & Impeller. (2) Cleaning of motor cooler.	(1) By monthly regular measurement of vibration, tendency of vibration increase shall be checked. (2) Regular cleaning of impeller shall be done (every 2 years.) Overhaul shall be done by specialists immediately.	Despatch of specialists 3 Men x 3.7 days x @$300 preparatory work) 8,000	
EXPANSION TURBINE	1	5,130	As per leakage of shaft oil seal, internal check was made. Wearing and distortion are small and in good condition.	(1) Replace oil seal. (2) Repair of Expansion Valve (Stopper for Valve and Spindle was detached)	Regular vibration measurement shall be done monthly.		
N_2 COMPRESSOR	2	1,928	(1) Corrosions checked for 1,2,3 stage cooler and no problems found. (2) Pressure control of N_2 is difficult.	(1) Jet Cleaning. (Replace Tubes on March, 1977) (2) Provided PCV & FCV and good results obtained.	Maintain the capacity by regular overhaul. (every two years)		

(4) GASIFICATION PLANT 1/10

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
RAW LIGNITE BUNKER	1	16,300^{H}	7,500^{a} 3,000^{b}	500			No problem		
HOT GAS PRODUCER	1	9,350^{H}	3,010	5 5RICK 250	No problem for burner & Brick		Keep attention on flame disorder of Burner.	Looking Glasses 10pairs 150	
ELECTRO FILTER	1	22,095^{H}	3,560	5	Holes on walls due to corrosion No problem for dust collection pole plate	(1) Repair by attaching plate from inside. (2) Cleaning discharging damager. (3) Reinforcement of earth bond	(1) This time repairs are made for only upper portion from dust collection pole plates, and no checkings were made for dust collection pole plates portion. As same corrosions are expected there, checking and repair thereof are required. (2) Working floor shall be provided for enabling the repair of PRCA-4 (discharging damper)		
CYCLONE	2		1,412	6	Holes and wall thickness decrease due to internal erosion.	Replace for half circular portion with SUS316L materials of 5mm thickness	Take caution at connection portion of earth band provided for removing static electricity.		

GASIFICATION PLANT 2/10

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
FINISHED DUST BURNER	1	6,850^{H}	5,000	8	(1) Burst of cover and partial swelling of body due to explosion of 05 chain conveyor. (2) Other portions are in good condition without erosion.	(1) Repair by welding for 5 devided cover pieces. (2) Reinforced by ribsat 15 locations. (3) Repaired by attaching plate on cracked portions of lower channel portion.	Take caution to the connection of earth bond provided for preventing static electricity.		
NITROGEN TANK	2				No check		No problem		
GASIFIER	1	5,926^{L}	2,910 2,694 2,474	10 12 12	(1) Tearing-off of first-proof materials. (2) Detachment of fixing pin of fire-proof materials and its burnt-damage (especially at upper position) (3) No problem at inside wall, while cracks found at welded portion of pipe supporting portion.	Weld repair of portion of pipe supporting portion.	Check of weld crack (semi-annual). As being operated under high temperature, deteriorations of materials are expected. Continuous accurate checking and watching of operation		

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	OUTSIDE DIAMETER	WALL THICKNESS	RESULT OF CHECKING PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
GASIFIER					(4)Decrease of wall thickness of spray Nizzle short pipe at Gaifier. (Design thickness 12mm→Min. 8.0) (5)Decrease of wall thickness of pipe support at cleaning entrance. (Design thickness 6mm → Min. 2.8) (6)No staining and corrosion of Jacket. (7)Slaq conveyor & seal Tank	Replace all 7 pieces using 2 divided pieces of 6mm thickness.	conditions are required. Replacement of Nozzle short pipe 800$^{\phi}$ x 1100$^{\phi}$ x 1200^{H} x 12^{t} (3 divisions) (Materials of ready provided) Take caution for Jacket cooling water temperature at outlet by daily checking. Replace for every 2 years (maintenance semi-annually)	To be fabricated SHINO-THAI 1,000	Special supervision is desirable. spare fabricated.
SERVICE BIN	2	6,730^{H}	2,200	10			No problem		
COOLING WATER TANK	1								
WASHER	1	14,250^{H}	3,020	7 CASTABLE 75	(1) No damage of castable (2) Holes due to corrosion at spray Nozzle pipe support (2" pipe) (3) No flat surface of flange seat of the above due to corrosion.	Replace 20pcs of wall thickness decreased and holed, among 64 pipe supports. Repaired.	Air suction from gland seal of Bottom cleaning rod. Modification of Seal portion. Reinforcement of N_2 Seal.	VALVE & PIPE 30	

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm)			RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
		HEIGHT LENGTH	OUTSIDE DIAMETER	WALL THICKNESS	PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
STEAM DRUM	1				Water treatment is in good condition. No problems for corrosion and staining.		Regular checking annually.		
FINAL COOLER	1	10,350^{H}	2,216	8	Corrosion is advanced partially (1) Upper portion of dividing plate at Middle Stage Wall thickness decrease $8^{t} \rightarrow 3.8^{t}$ (2) Upper spray nozzle portion $8^{t} \rightarrow 4.6^{t}$ (Min.2.6^{t} at pitching portion)		No problem as under low pressure operation (Design 3000 mm WS), though big wall thickness decrease. However, by regular checking (annually) of corrosion, steel plate shall be provided for repairing with reinforcing plate from outside if thickness is decreased thinner than 2mm.	Plate $1^{M} \times 2^{M} \times 6^{t}$ SS41---- 10sheets 150	
SEAL POT	1 1 1	1,200^{H} 902^{H} 3,258^{H}	1,016 1,616 2,016	8 8 8		Partial Repair (Seal pipe)	Regular cleaning of slag and checking of corrosion (semi-annually) Provide steel plate for repairing.	Plate $1^{M} \times 2^{M} \times 8^{t}$ 5 sheet. 80	
NO REMOVAL TANK	2	6,725^{H}	6,000	8			Now not used. Slag from furnace causes problems to followed plants. Modification into Filter is required. (Modification drawing is attached)	I-Beam & Plate 6,000	

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
GAS LINE PIPING							Though low pressure operation, corrosion heavily advanced		
SEAL POT → BOOSTER BOOSTER → ADIP PLANT		40^{M} 150^{N}	609.6 508	6 6		Replaced on March, 1977 Cleaning of Line at this time.	due to slag and drain. Replacement is desirable at regular interval of early 2 years.	PLATE $1^{N} \times 2^{M} \times 6^{t}$ 40 sh. 500 Welding Rod	
COOLING WATER COOLER	3	PLATE TYPE					No problem		
RADIATION BOILER	1				Corrosion checking of Gas side. Checking of Corrosion, staining and crack at steam side. No problems for both sides.		Regular cleaning and corrosion. Check annually.		
TUBULAR BOILER	1	SHELL $9,800^{H}$ $1,550^{H}$ TUBE $7,780^{L}$	2,100 1,450 76.1	25 22 22 2.9 94 sheets 5.6 20 sheets	Gas side (1) Inside of tube is stained heavily and no effect by Jet cleaning. (2) No corrosion on Gas room wall.	Replace 20 pcs. of tubes due to leakage at test time.	Slags inside of tubes were cleaned for 20 pcs only by JET cleaning, and almost no effects were produced for others. Inside diameter becomes half of the original one due to inside slags.		

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
TUBULAR BOILER					STEAM SIDE (1) Corrosion (2) Staining } No problem		Due to construction, replacement of tubes is performed by used jointing of tubes. However, the welding work is inferior and slags are easily sticked, and the plant life becomes very short. (1) Replacement of whole tubes. (Perform by removing the outlet castable Line.) (2) Replacement of cracked expansion at outlet Line. (3) Reinforcement of temperature proof at Soot Blower Steam Line and Soot Blower element and universed joint.	(1)Tube plate 2sh. 4,000 ·76.1ø x 5.6t x 7780L 10pcs. ·76.1ø x 2.9t x 7780L 80pcs. (Made in Japan) 3,000 (2)Expansion 900ø x 625L 2K class SUS304 (Made in Japan) 2,000 (3)Despatching of Specialist 2 x 30days $300x60 M-D Tool,Travel Expense 1,000 ($1.-=¥200) 6,400 Soot Blower 1 pcs. (Made in Germany) 2,000	

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
RAW MATERIAL BELT CONVEYOR	1	1,000ø 52,000ℓ 20.5r.p.m.		Whole belts replaced on Nov. 1977.	Grease up of return roller and Carrier roller (monthly) Regular replacement of coil of geared Motor (annually)	Spares return Roller 5 Nos. Carrier Roller 5 Nos. (Made in Germany) 100	
ELKO BELT	1		Distortion and Crack of Belt Wearing of driving roller.	Replace with spares.	It seems the temperature is raised, due to spontaneous combustion, and the distortion and crack are caused. Construction of N_2 Seal piping enables Belt life be longer.	1" pipe 60m Valve 2 Nos. Stainless Net (Made in Thailand) 100	
HAMMER MILL	1	HAMMER 56PIECES	Small wearing of Hammer.	Replaced Hammer on Nov. 1977	(1) Regular overhaul of reducer (every 2 years) (last overhaul was on March, 1977) (2) In addition to present spares (Hammer parts, bearing, oil seal), high speed shaft of reducer shall be replaced. (3) Replacement of Hammer Wall (annually)	Shaft 1 pc. 20 (Made in Thailand) Lump Sum 2,000 (Made in Germany)	
RETURN VAPOUR FAN	1	41,400			Regular check of Vibration (monthly) (Spare for Impeller is provided)		
AIR FAN	1	11,520	Increase of Vibration due to unbalance.	Replaced Impeller shaft Bearing.	- ditto-		

Rotating Machine

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
ROTARY VALVE (ELECTRO FILTER)	2				Overhaul shall be performed at next time. (especially checking of sealing)		
ROTARY VALVE (CYCLONE)	2	5,000 Kg/H	(1) Inside check not performed. (2) Casing Crack (2 locations)	Reinforced by support for preventing crack advancing. Coating of Plastic Steel.	Temporary treatment was made at this time, and spare one set shall be procured.	Rotary Valve (Made in Germany) 1,500	
ROTARY VALVE (FINISHED DUST BUNKER)	1	1,200 Kg/H			Overhaul shall be performed at next time.		
05 CHAIN CONVEYOR	1		Damaged by explosion.	(1) Replaced casting. (2) Replaced roller bearing. (3) Reinforced earth band provided for prevention of static Electricity	Take caution to N_2 Seal		
RECYCLE VAPOUR FAN	1				Monthly check of Vibration		
VAPOUR FAN (CYCLONE)	1	16,200			- ditto -		
BELT CONVEYOR (FOR SERVICE BIN)	2				Take caution to N_2 Seal		

ITEM - NO EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
SCREW FEEDER	4		Wearings and found, though no bending and no distortion.	Adjusting gap	Spare units (2 sets) are required due to wearings.	Feeder 2 sets (Made in Germany) 3,000	
SLAT CONVEYOR	1				Checking of damages caused by dropping of big slags.		
O_2 BLOWER	2	5,330			Spare unit is provided and no problem.		
N_2 BLOWER	1 1	2,340 474			(1) This blouwer is operated continuously for N_2 seal of grinding section. For securing safety protection, the cannot be ignored, for which spares shall be provided. Spares for reducer (Lump Sum) Blower rotor and bearings	(Made in Germany) Spares for reducer (Lump Sum) 3,000 Blower rotor and bearings	
THEISEN WASHER	2			Replaced No.2 rotor on Mar., 1977. Replaced No.1 rotor on Mar., 1978.	(1) Vibration Measurement due to slag sticking. (1-2 times per month) (2) Sand blast cleaning of spare rotor and stator and checking of static balance. (3) Replacement of bearing case (weary) and carbon seal ring.	(Made in Germany) 600 Bearing (4 pcs.) Carbon Seal Ring (for 2 sets x2) 400	

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
SYNTHESIS GAS BLOWER	2	15,400	Increase of vibration due to unbalance caused by staining at No.1 Impeller.	Replaced spare impeller and bearing.	(1) Maintenance of spare unit is impossible due to mal-function of inlet and outlet valve of Blower (due to heavy corrosion) Spare valves are required. (2) Regular cleaning of slag at inlet & outlet pipe (semi-annually) (3) Blower Vibration check (1 - 2 times/day) and leakage check at gland seal ring.	2K CLASS GATE VALVES 500ø 4 sets (Made in Thailand) 4,800 CARBON SEAL RING for 2 sets x 2 (made in Germany) 500	
BOOSTER	4	13,700		No.1 Empeller cleaning. Replaced bend pipe of inlet piping due to corrosion.	(1) Maintenance of spare unit is impossible due to mal-function of inlet and outlet valve. Inlet valve - 4 sets Outlet valve - 4 sets (New ones stocked) (2) Regular slag cleaning of inlet and and outlet piping. (semi-annually) (3) Blower Vibration check (1 - 2 times/day) and leakage check at gland seal ring.	25 CLASS GATE VALVE 500ø 4 sets (Made in Thailand) 4,800 CARBON SEAL RING for 4 sets x 2 (Made in Germany) 800	
COOLING WATER PUMP	2 + 1	220			No problem		
SPRAY WATER PUMP	2	3			Maintain the function by overhaul, especially adjust mouth ring gap.		
FUEL OIL PUMP	2				No problem		

(5) AMMONIA PLANT 1/12 Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(292006) DEMOISTURE	1	24,700	1,200 1,500 2,000	13 16 21	Heavy corrosion at inside of tower upper portion Though corrosions at middle and lower stages are found, no problem on design strength.	Replaced partially for 7 meter at 1200ϕ dia. portion	(1) Regular corrosion check (annually) (2) Corrosion check of gas, hot water line (annually) (3) Provide drain valve at gas outlet line. (For draining at starting time) (4) Demister	DEMISTER (Made in Japan) 200	
(292001) SATURATOR	1	20,185	1,800 1,100	19 14	Modification of protector provided so collision plate at inside of Gas inlet portion. (due to expansion of linings, drains flow-in on this portion)	Replaced tower on Nov.,1977. Modified lining to collision plate type.	(1) Regular corrosion check (annually) (2) Regular check of corrosion grade at gas piping and water line. (3) Stainless materials should be used for draining line of LCV-01.		

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(292004) CO CONVERTER	1	8,491"	1,900	24	No plan at this time, in relation to life of catalizer.		(1) As no problem for corrosion, distortion and crack shall be checked at the time of taking catalizer out. Replace Net (3 mesh) of basket at gas outlet. For raising effect as filter almine ball shall be provided in the basket. (2) Piping shall be arranged for enabling N_2 seal, as protector of catalizer at operation stop time. (including pressure gauge)	Net 200 Almina Ball 3/4" size 200ℓ (made in Japan) 400 Pipe (8ø x 3ø) Pressure Gauge 2Nos Valve (5ø) 4 Nos. (Made in Thailand) 200 Catalizer one lot 12,000	
(312001) CO_2 SCRUBBER	1	26,673"	2,500	18	No special problem, as the corrosions advance slightly on partial damage of epoxy coating.	Epoxy recoating on Mar.1977. Partial repair at this time.	(1) Regular checking of adherence and peeling off of epoxy coating (annually) (2) Continue checking of corrosion grade at gas outlet and inlet pipings.		

Tower Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(312005) FLASH VESSEL	1	5,000^{L}	2,000	20	Adherence of partial Epoxy coating repair performed on Mar., 1977, is good enough. However, at other portions, small peeling-off is found.	Partial repair of epoxy coating.	Annual checking of epoxy coating peeling-off, as corrosion is expected on such portion.		
(312013) DEGASIFYING TOWER	1				Almost all epoxy linings of Gas room are damaged and leakage is found at some portions.		(1) Next time, partial stainless lining and epoxy lining shall be performed. (2) Corrosion check of CO_2 gas conveyor line. Replacement of trench line due to water immersion by overflow of drainage ditch.	Stainless plate (SUS304) $1^{M}x2^{M}x3^{t}$ 10 sh. (made in Thailand) 350 St35 350A pipe 60m (made in Thailand) 800	
(432102) HIGH PRESSURE COPPER SOLUTION SCRUBBER	1	20,000^{H}	800	24	No Checking		Annual Regular wash cleaning of Raschig Rings, as no corrosion problems.		

Tower Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(432103) AMMONIA WATER SCRUBBER	1	15,705H	550	15	No checking		Annual wash cleaning of Raschig Ring		
(432104) PRESSURE BLAST VESSEL	2	1,905H	323.9	14.2	"		No problem for inside corrosion. Take care against external corrosion due to dewing on external surface by temperature variation. Special care against paint peeling-off.		
(432101) OIL SEPARATOR	1	3,960H	620	26	"				
(432001) REGENERATOR FOR COPPER SOLUTION	1	15,932H	1,000 650	6 8	No inside corrosion and in good condition	Rashig Rig Cleaning.	Check of ΔP due to Ring staining Regular Cleaning (annual)		
(432006) SURGE TANK	1	16,100H	1,400	TOP 6 10	No checking				
AMMONIA RECEIVER	1	5,000L	400	6		Painting of outlet pipe			
(522001) FLASH VESSEL	1	4,830H	1,200	13			Annual corrosion checking of liquid ammonium sulphate discharging pipe. Replace trench line due to corrosion.	St35 (Sch.#40) 50A x 200M (Made in Thailand) 300	

AMMONIA PLANT 5/12

Tower Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(522003) TAIL GAS SCRUBBER	1	8,590^{H}	450	7	No Checking				
(522107) HIGH PRESSURE OIL SEPARATOR	1	3,000^{H}	830	65	"				
(522106) HIGH PRESSURE NH_3 SEPARATOR	1	4,950^{H}	1,000	60	"				
(522101) NH_3 SYNTHESIS CONVERTER	1	13,000^{H}	950	75	Inside check of cartridge. No distortion and no crack were found, and in good condition.	(1) Replaced catalizer. (2) Replaced asbestos gasket to copper one for cartridge cover.			
PIPING							Replace TCV (Butterfly Valve) at CO-Converter due to leakage from Valve gland seal. (material: SUS)	Butterfly 2 sets (Made in Japan) 3,000	

Tower Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMLTER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(292002) HEAT EXCHANGER I	1	SHELL 3,182^{L} TUBE 2,000^{L}	700 26.9	10 2.3	Heavy corrosions on shell interior surface and external surface of inner shell and tube	Replace all with new materials	Annual cleaning and corrosion check.		
(292003) HEAT EXCHANGER II	1	SHELL 7,344^{L} TUBE 5,600^{L}	900 26.9	16 2.6	No problems on corrosion, while heavy stainings are found.	(Replaced tube on Nov. 1976) Cleaning	- ditto -		
(292005) WATER PREHEATER	1	SHELL 7,831^{L} TUBE 7,000	614 25	13 2	(1) Unoperationable condition due to crack at body expansion. (2) Leakage from seal weld of Tube.	Replace expansion with space. Repair by coking.	Replacement of expansion at this time is temperary repair. Therefore, further replacement is better after one year operation. (Spare heat exchanger is delivered on end of 1978)		
HOT WATER IRRIGATION COOLER							Spare cooler required	Cooler (Made in Thailand) 500	
(297008) COOLER FOR CIRCULATING WATER	1	SHELL 8,430^{L} TUBE 7,696^{L}	670 25	6 2	No Check		Cleaning by bubbling method side (cooling water) shall be done at next time.		
(432007) COPPER SOLUTION COOLER	5	SHELL 5,446^{L}	318	7.5	Leakage from tube:one unit	Replace with spare unit	Successive replacement is necessary in future, by stocking spare units.		

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
COPPER SOLUTION COOLER	1	SHELL 4,949^{L} TUBE 5,000	700 25	7 2	No Checking		Checking of staining at shell side by oils and fats of liquid ammonium sulphate.		
NH_3 CONDENSER	1	SHELL 5,949^{L} TUBE 6,000^{L}	700 25	8 2	No problem, though corrosion of inside of tube advances slightly.	Tube Jet Cleaning.	Annual regular cleaning of tube and peakage test of tube		
(522104) WASTE HEAT BOILER	1	SHELL 4,150^{H} TUBE 1,565^{M}	1,600 35	10 5	No problem, as some pittings at inside of shell side are of 0.8mm in depth. No distortion, no crack and no corrosion at tube side and in good condition.				
(522105) GAS COOLER	1	SHELL 11,884^{H} TUBE 2,200^{M}	800 20	5 3.6	No planning	Replaced whole of Heat exchanger on Mar., 1977.	Regular cleaning (every 2 years). Stocking of Spares and performing Hydraulic pressure Test.		

Rotating Machine

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
COOLING WATER PUMP	2						
(291001) HOT WATER PUMP	2	270	Leakage at gland Packing.	Replaced packing.	No lantern ring of gland seal prevents cooling water from flowing-in and causes heat-sticking of packing. Packing life will be prolonged by lantern ring setting and seal water.		
(291002) WARM WATER PUMP	2		(1) Leakage at Gland Packing. (2) Damage of No.1 Bearing.	Replaced Packing Overhauled No.1 pump and replaced shaft, bearing and oil seal.	(1) Due to no lantern ring, packings are apt to be heat-sticked. For prolongation of Packing life, fabricate lantern ring and set it for enable the cooling.		
(311001) WATER PUMP WATER TURBINE I " " II	1	1,600	Overhaul of Turbine I & II. Peeling-off of shaft Cr-plating and corrosion occurred. Wearing of Gear coupling.	Repaired each portion and adjusted gap. Replaced shaft with spare. Replaced coupling with spare.	Overhaul (every 2 years) Special check of corrosion at liquid contacting portion. Provide spare shaft (As replaced shafts on Nov., 1976 and July, 1978) Provide spare 1st stage casing.	Shaft 1 pc. (Made in Thailand) 300 1st stage casing (Spare) (Made in Germany) 10,000	

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
(431001) COPPER SOLUTION PUMP	2	33	No planning		(1) Take caution for vibration and corrosion of discharging line. (2) Replacement of discharge pipe is derable, as Tee pipe is out of standard.	Tee 1pc. 100 JIS STPT 42 (4^B x 4^B x 40) Sch.#120 (Made in Japan)	
(431002) HIGH PRESSURE AMMONIA WATER PUMP	2	3	External corrosion of Discharging Line (25^A x Sch.#80)	Partially replaced at this time (3m)	Replacement of remaining discharging Line (25m)	Pipe STPT42 50 25A x SCH.#80 x 25^M (Made in Japan)	
(431003) CONDENSATE PUMP	1	1			(1) Take caution of vibration and corrosion of Discharging Line. (2) Daily check of oil stainings due to insufficient seepage.		
(521001) GAS CIRCULATING COMPRESSOR	2	8,220			(1) Daily check of oil stainng and oil quantity. (2) Take caution of leakage at Metalic packing.		

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
AMMONIA COMPRESSOR	2		Level-down of flow volume (both for No.1 & No.2), due to O-Ring breaking of eccentric valve.	Replaced O-Ring	Repair planning and its execution at normal period. Repair No.2 Bearing as its temperature is high.		
(111002) SYNTHESIS GAS COMPRESSOR	2	5,730	For Main Portion (No.2) (1) Clearance of cross, crank metal is within allowable tolerances and in good condition.		(1) Overhaul of No.1 unit at next time.		
			(2) Cylinder Portion: Eccentricity is found on inside diameter of 3 stage cylinder.	Replaced piston Ring.	(2) Max. 2mm bigger at inside dia. of cylinder. Adjustment by spare piston is better (Size of spare is oversized by +1mm from the original)		
			(3) Scratches on 4 stage cylinder Liner.	Replaced piston ring, as scratches could not be repaired by file finishing.	(3) Provide spare of cylinder Liner.	4 stage Liner 1pc. (Made in Germany) 600	
			(4) Eccentric wearings of High pressure stage piston rod at sliding surface with metallic packing.	Adjusted at Metallic Packing.	(4) Spare of Rod is required, as still leakages are found due to eccentric wearing of piston rod, though adjusted at metallic packing.	110ø Red 2 pcs. (Made in Germany) 800	

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
(111002) SYNTHESIS GAS COMPRESSOR	2		(5) Heavy corrosion on Piston ring ditch of 3 stage	Replaced piston Ring	(5) (Spares of 3 stage piston are stocked at present) (6) Daily check of oil staining and oil quantity. Regular replacement of oil. (annually)		
			No planning for Separator Portion		(1) Annual checking of corrosions of Low Pressure stage (1 - 4) separator and Gas line. (2) Stainless material shall be used for the drain line of the said separator due to heavy corrosion. (3) Spares (value plate) of non-return valve are required, since it is the problem not to provide discharging non-return valve at 3 stage separator.	Plate for non-return valve (for 4 sets) (Made in Japan) 500	
			Cooler Portion Check of cleaning and corrosion for 4 - 7 stages of No.1 cooler at this time.	(Repaired cooler at 4 - 7 stages for No.1 and No.2 units on Mar., 1977)			

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
(111001) SYNTHESIS GAS COMPRESSOR (INTER COOLER)	2		(1) No problem for last time repair portion, i.e., Deep pitting (strength calculation)---------- Shallow pitting (strength calculation)---------- On other portion, newly pittings were found, and the surface treatment by painting was done, as no problems were found by strength calculation. (2) For other points, no distortions on gasket surface and tubes and in good condition.	--Repaired by welding --Paint of	(1) Checking of corrosion with annual regular cleaning. (2) Cleaning at appropriate chances (semi-annually, if possible) for lower pressure stage collers as their capacities are decreased (materials changed to stainless from Cu-p due to the corrosion). (3) At the time of procurement of spares for 4 - 7 stages, it is not necessary to procure whole set but to procure pipes, as the corrosions effected jacket portion of straight pipe. By re-use of flanges and bend pipes, fabrication with the procured pipes can be done at Mae Moh Factory. Procurement of pipes is required for one set only and, for another set, the removed materials can be used after repairing.		

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(572101) 2ND REACTOR	1	17,950"	1,000	50	(1) Though no corrosions at internal linings, many pin holes and hair cracks are found at welded portion, and these defects are mostly found at top portion. Types of cracks is of fatigue cracks, but not fully penetrated through. There are no other abnormal swellings.	(1) Repair welded on deep defects (14 defects) as detected by dye-penetrant checking. (2) Cracks occurred at 2 locations on top portion (spherical portion) by Hydraulic Pressure Test. (Cracked lengths are 70ℓ and 50ℓ). After grindly slightly, repaired by welding. (no leakage under hydraulic pressure test of 230Kg/cm^2)	(1) Replace top portion lining at next time (Oct., 1979). For this replacement, specialists shall be despatched with lining material supply.	Specialists 3Men x 30days x @$500 Preparation, Travel expence and Tools. 12,000 Lining Materials (Made in Japan) 2,000	
							(2) Replace outlet pipe (Jacket portion) and inlet pipe.	Pipe, Flange, Tee Lump Sum (Made in Germany) 2,000	
					(2) Continuous troubles on oil pump for fastening cover.	Repaired Valve and Piston.	Provide spare oil pump with bigger capacity, as existing ones are overaged.	High Pressure Oil Pump (Made in Germany) 1,000	

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(572606) WASHING COLUMN	1	6,820^{H}	412 720	6 10	No corrosion and in good condition. No crack and no distriction, and no problem.	Raschig Ring Cleaning.			
(572001) NH_3 FILTER	2	2,270^{H}	509	10	No corrosion, and no damage on Net and in good condition.	Net cleaning			
(572005) 1ST STAGE SEPARATOR	1				No corrosion and in good condition				
(572013) DISSOCIATION SEPARATOR	1				No Checking				
(572009) AMMONIA STORAGE TANK	1	3,110^{L}	1,200	14	(1) No internal corrosion (2) Penetrated crack due to stress was found. Though repaired, crack occurred at heat effected zone.	Repaired by welding after ground-flush by grinder.	At last time, also repaired, but the crack was not prevented. This time also, troubled for crack repairing. Therefore, replacement is required. (Tank to be delivered at the end of 1978)		

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	OUTSIDE DIAMETER	WALL THICKNESS	RESULT OF CHECKING PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(572020) SUPPLETION WATER TANK	1	1,500^{H}	1,000	14	No Checking				
(572001) CONDENSATE TANK	1	2,100^{H}	2,200	10	Wall thickness is decreased at lower portion, due to corrosion (Spot Corrosion)	Repair by welding	Regular checking (annual) of corrosion, though operated under no pressure (only Head pressure)		
(572031) SEAL TANK FOR CONDENSATE	1	2,300^{H}	500	2	No checking				
(812002) UREA STORAGE TANK	1	5,000^{L}	2,200		No internal corrosion and in good condition				
(812003) UREA FILTER	2	960	400	3	No corrosion and no damage on Net and in good condition	Net cleaning			
(572015) ABSORPTION COLUMN	1	2,996	400	3	No checking				
(572014) NH_3 CONDENSATE TANK	1	3,178^{H}	2,000		No checking				
(812007) 2ND SEPARATOR	1	2,700^{H}	700	6	No corrosion and in good condition				
(812005) SEPARATOR					No checking				
PRILLING TOWER	1				"				

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
CO_2 DRYING ABSORBER	2	3,000^L	1,800	8	No checking	Repaired change-over damper and Replaced gaskets(6pcs)			
(572104) FIRST REACTOR	1	SHELL 7,193^L TUBE 5,950^U x 12	1,500 25	13 3	Though no problem on corrosion as it is small (based on result of thickness measurement), cracks are found at welded portion of Header and Mixer.	Repaired by welding after ground-Flush by grinder.	(1) Though no problem for U-Tube, weldability of mixer and header contains problems. (Crack newly occurred at heat affected zone and troubled for its repairing). Therefore, it is necessary to provide immediately spares of Header & Mixer. (2) To perform annual regular repair of non-return valve at CO_2,NH_3 inlet.	Header, Mixer Lump Sum (Made in Germany) 2,000	Specialist Despatching is desirable
(812011) CONDENSATOR	1	SHELL 3,650^L TUBE 2,500^U x 81	550 25	4 2	No corrosion and in good condition	Tube cleaning			
(812009) CONDENSATOR 2ND STAGE EVAPORATOR	1	SHELL 4,750^L TUBE 3,650^U x 81	550 25	4 2	"	"			

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	OUTSIDE DIAMETER	WALL THICKNESS	RESULT OF CHECKING PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(812004) HEATER 1ST STAGE EVAPORATOR	1	SHELL 2,000 TUBE 2,000	450 25	5 2	No checking				
(812006) HEATER 2ND STAGE EVAPORATOR	1	SHELL 2,000 TUBE 2,000	273 25	4 2	No checking				
(572007) NH_3 CONDENSER	1	SHELL 5,235 TUBE 4,500	508 25	11 2	Corrosion is small and no problem	Tube jet cleaning	Annual cleaning and corrosion checking		
(572008) NH_3 CONDENSER	1	SHELL 3,000 TUBE 3,000	508 25	11 2	"	"	"		
PIPING (UTILITY)							(1) Repair of leakage at Steam line and Repair of Temperature-proof. (2) To find out steam leakage at early storage and its repair. (If leave the steam leakage as it is, scratches will occur at leakage portion due to erosion)		

Rotating Machine

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
AIR BLOWER	1	6,720			(1) Monthly check of vibration and recognizing of vibration tendency. (2) Grease up (every 2 weeks)		
CO_2 BLOWER	1	3,660	Increase of Vibration at No.1 Blower	Overhaul of No.1 unit. Repaired each portion and replaced bearing.	(1) Monthly check of vibration and recognizing of vibration tendency. (2) Grease up (every 2 weeks) (3) To maintain function by regular overhaul (every 2 years) Especially, to keep clearance with standard allowance, and conform the pressure higher than air blower. (for preventing air from mixing in the CO_2 Line)		
(571006) H.P. FLUSH WATER PUMP	1	0.5T/M			To maintain function by regular overhaul (every 2 years)	Spare plunger 3 pcs. (Made in Thailand) 90	
(571002) NH_3 PLUNGER PUMP	1	10		Replaced plunger Packing.	(1) Regular replacement of plunger packing. (2) Regular measurement of wall thickness of discharging Line. (semi-annually)	Spare plunger 3 pcs. (Made in Thailand) 300	

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
(571006) FEED WATER PUMP	2	2.73	No abnormal condition, no planning.				
(571010) CONDENSATE PUMP	1	3.6	- " -				
(571007) ABSORPTION CIRCULATING PUMP	1	16	- " -				
(571011) N_2 COMPRESSOR	1	25	High noise under operation		(1) To maintain function by annual regular overhaul. (2) Provide spare parts. Cylinder valve Piston & Piston Ring For 1 set (Made in Germany)	1,000	
(571009) SUPPLETION PUMP	2	1	No checking				
(B11002) UREA SOLUTION PUMP	2	35	"				
(B11003) UREA MELTING PUMP	2	54	"				
BELT CONVEYOR			"				

Rotating Machine

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
(571001) CO_2 COMPRESSOR	1	2,450	Restoration work was done for explosion accident on May 13, 1978, by procuring parts in Japan and by despatching six Japanese Engineers, together with overhaul of the equipment.				
			1. Overhaul of main portion Replaced parts.		(1) Regular cleaning of cylinder Jacket, annually. (2) Regular change of Oil (annually).		
			(1) 4, 5th stage CYLINDER LINER POSITION PISTON RING	Replaced due to internal wearing.			
			(2) CYLINDER VALVE	Replaced with space for whole numbers.			
			(3) METALLIC PACKING	Replaced with new one for whole numbers, as contacting surface is not in good condition due to eccentric wearing of piston rod.	(3) Checking of leakage at metallic packing. Spare piston rod: 2 pcs.	90ø piston Rod 2 pcs. (Made in Germany) 800	

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
(571001)							
CO_2 COMPRESSOR	1	2,450	Repair & adjustment				
			(4) 4,5th stage Cylinder	Repair by machining for heat damaged portion of flange seat surface.			
			(5) Though uneven contacts at some portion of main, cross crank bearing are found, no cracks are found and good condition	Adjustment of clearance by machining of contacting surface and by liner plate.	Take caution for beating noise of cross, crank portion, daily.		
			2. Separator and Cooler Portion				
			(1) 4th stage separator (2) 5th stage separator (3) 4th stage cooler (4) Heat damage of above relative piping.	Due to heat damage, replaced with new ones	Prompt remedial measure shall be taken for vibration prevention of Inter Cooler, Separator.		

ITEM - No EQUIPMENT	NUMBER	CAPACITY (Nm^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
(571001)							
CO_2 COMPRESSOR	1	2,450	3. Other Portion				
			(1) 1 - 3th stage Inter Cooler	Cleaning			
			(2) 3rd stage Cooler, separator	Good results by Hydraulic Pressure Test ($35Kg/cm^2$)			
			(3) Oil Pump	No problem by over-haul			
			(4) Oil Cooler	Leakage Test and tube cleaning.			
			(5) Oil change and Flushing.				

(7) SULPHURIC ACID PLANT 1/5 Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
SULPHUR MELTING PIT	3				No planning		Large scale repairings are necessary, as damages of pit and heat pipe are deemed as big.	1,000	
SULPHUR COMBUSTION FURNACE	1				Brick damage is small and no problem, while heavily stained due to burning under mixed condition of Sulphur with foreign substances (ferrous materials). (dark brown color stickings)	Repaired some portion of wall by reinforcing plate on Nov., 1977, due to corrosion by Sulphuric acid.	(1) Mixing-in of foreign substances can be solved by pit repairing. (2) Prevent rain water flow in, by repairing lagging materials. (3) Spare Burner.	made in Germany 3,000	
DRUM	1	3,000^{L}	1,200	17	(1) Though slight brown stickings are found, no deep pitting are found and no problem for 13 years operation. (2) Leakage from gland of auxiliary valve.	Replaced gland packing.	(1) Early stage detection of steam leakage and its repair. (2) Repair of lagging material. (3) Construction of ladder and walkways for Drum checking, for enabling direct access from economizer.	Material cost (made in Thailand) 300	

SULPHURIC ACID PLANT 2/5

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
WASTE HEAT BOILER	1	SHELL 10,150 TUBE ($280m^2$)	3,000 60.3 38 101.6	10 3.2 3.6 4.0	(1) Lower water header is exposed due to damage of fire-proof materials, especially at joint portion of header and water pipe.	(1) Repaired header by reinforcing plate on Jan., 1978.	(1) Water header and some portions of water pipe shall be replaced immediately. It is assurable to do this repair by laying down the boiler.	Specialists $3^{men} \times 52^{days}$ @$300 8,000 preparation & Travel expense 4,000	Further study is required for re-pairing procedure.
(ECONOMIZER)		($190m^2$)			(2) Corrosion of Lower Inner casing. 3 Heavy staining of tube	(2) Partial replacement of Lower casing.	In addition, inner casing and castable shall also be replaced. This is big scale work and specialists despatching is necessary. (2) No problem for economizer, as one set of spares is stocked.	Crane (Thai) 1,500 Fire-proof materials (Thai) 1,500 Materials (CFC)	
AIR PREHEATER	1	SHELL ^{H} 7725 TUBE 5570	2820 445	10 4	No checking				
STRUCTURE							Structure and gratings are heavily rusted and ragged. Painting and replacement are required.	Flat Bar Angle, etc (made in Thailand) 1,000	

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	SIZE (mm) OUTSIDE DIAMETER	SIZE (mm) WALL THICKNESS	RESULT OF CHECKING PROBLEM	RESULT OF CHECKING REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	FUTURE REQUIREMENTS & PROBLEMS COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
CONVERTER	1	10,500	6036 4800	8 10	(1) Corrosion on internal heat exchanger		(1) Replacement of heat exchanger tubes	Heat exchanger tubes (made in Thailand) 3,000	
					(2) Gas leakage due to well crack	Repaired by partial reinforcing plates	(2) Though cleaning is required for crack repairing, perfect cleaning cannot be performed due to severe atomosphere and removal of Sulphur (due to short working periods) Therefore, cracks will follow immediately after repair work. (Due to high temperature, materials are deteriorated to some extent.) Repairing work should be done, according to schedule of Waste Heat Boiler.		
							(3) Replacement of lagging materials.	Lagging materials (made in Thailand) 2,000	

ITEM = NO EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	OUTSIDE DIAMETER	WALL THICKNESS	RESULT OF CHECKING PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
DRYING TOWER ABSORPTION TOWER	1 1	8,150" 8,150	4,420 4,420	10 10	Staining of inner Raschig Ring		Confirm to manufacturer, as to inside washing procedure for Raschig Ring cleaning.		
STACK	1				Checking could not be performed.		Corrosion due to sulphuric acid at inside (especially at upper portion) (Gas leakage at top portion)	Stack (Made in Thailand) 20,000	
ACID TANK	2	7000	6,000		Under operation				

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
AIR FAN	2	25,920	No checking		Monthly regular checking of vibration		
ACID PUMP	8	45	"				

(B) AMMONIUM SULPHATE PLANT 1/2

Tower, Tank Structure

ITEM - No EQUIPMENT	NUMBER	SIZE (mm) HEIGHT LENGTH	OUTSIDE DIAMETER	WALL THICKNESS	RESULT OF CHECKING PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	REMARKS
(512001) SATURATOR		7,350^{H}	4000	10	(1) No damage on bricks Detachment of some sealing materials at joint portion	Repair of seal materials			
					(2) Corrosion of cover due to some interior Pb linings of cover	Repair of Pb Lining.			
(512003) LEY TANK	1	7,154	2800	4	No checking				
(511001) DRYER	1				Corrosion of inner vane	Replaced rusted vane			

ITEM - No EQUIPMENT	NUMBER	CAPACITY (NM^3/H) (Kg/H)	RESULT OF CHECKING		FUTURE REQUIREMENTS & PROBLEMS		REMARKS
			PROBLEM	REMEDIAL MEASURE	FUTURE REQUIREMENTS & PROBLEMS	COST FOR REMEDIAL MEASURE (1,000 YEN)	
(511005) LYE PUMP	2		No checking (under operation)		One set is damaged and out of use snow. One set as spare is necessary.	Pump 1 set (made in Germany) 1,000	
(511003) CENTRIFUGE	2		Crack of casing due to increase of vibration at No.1 unit	Performed overhaul for checking vibration causes.	(1) Vibration is caused by misalignment of basket centerline. (Misalignment of centerline by defective repair welding for cracks) Adjustment of center alignment and spare basket is required. (2) Take cause of vibration increase daily, and to perform cleaning of basket if vibration being increased.	Basket 2 Nos. (Made in Thailand) 1,000	
BELT CONVEYOR					Supporting structure of conveyor is heavily rusted. Painting is required.		

SECTION 7

REPORT FOR INSTRUMENT

Section 7 Report for Instrument

7-1 Summary

Process instrumentation of Mae Moh Factory is designed, mainly with pneumatic system.

Thermometer, analysis meter, and recorder are not only in overaged conditions, but also the maintenances thereof are insufficient. Such insufficient conditions of the said instruments complete the operators to be distrustful of the whole instruments.

While, control valve, detector, etc. are under operational conditions, though not enough.

Though total numbers of staffs at Instrument Maintenance Workshop are 18 personnels, being considered as sufficient in number, most of them, except 2 or 3 staffs, have to deemed as having low technical level for instrument, whereas technical training is indispensable from now on.

Among those points recommended by us at the time of the First Survey team, stabilization of steam system and modification of N_2 line into automatic system, both of which were of important and urgent, have been completed using materials and equipments provided by CFC and us, and under our surpervision.

Furthermore, safety instrumentation of CO_2 dehumidification system, as being direct factor of the burst accident of CO_2 COM$\underline{\text{or}}$, was newly constructed under our supervision.

For this stage, investigations were made on each portion under open-checking and simultaneously, supervision and instruction were also made for overhaul of instrumentation equipments.

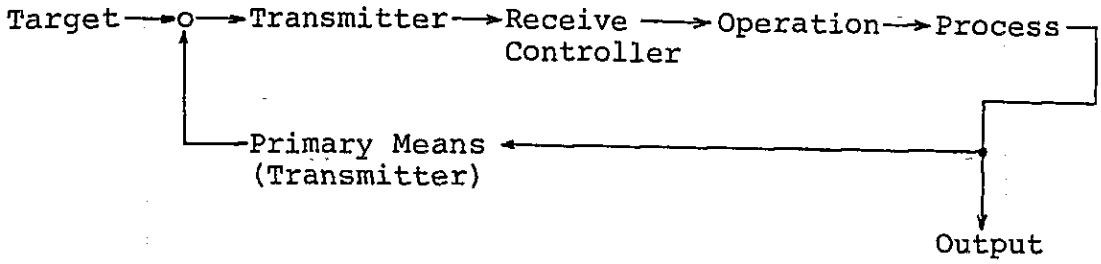
Among all instruments, though 90% of them can be deemed as operational, at least, 30% of them are not stable for their reliabilities.

Especially, thermometer and analysis meter have to be replaced immediately.

Modification and replacement plan is shown hereinafter based on the investigation results, and the estimated cost required thereof for the furture 3 years is Baht 11 million.

7-2 Condition of Instrumentation Equipment

In general, system of automatic control is of close-loop as shown below.



There are electronic type and pneumatic type for such control system.

Electronic type is widely adopted recently, taking advantage of its high speed for signal transmittance and of relation to computor system. While, pnuematic type has been adopted for long time, in consideration of its working stability, reliability and easy-maintenance characteristic.

At Mae Moh Factory, all instrument of each plant, except boiler plant, are designed mainly with pneumatic instrumentation under 0.2 $\sim$ 1.0 kg/cm^2G uniform signal for both in-put and out-put. The system is of center control type, the advantages of which are that the transmitters are located at measuring places and controller recorders are centerized in the control room.

Pneumatic instrumentation, mainly adopted for Mae Moh Factory, is most suitable for the Factory, when considering its easy maintenance characteristic, climate and environment at Mae Moh.

(Transmitter)

As the transmitters, differential pressure type flowmeter with orifice, float-type level gauge and Bourdon type pressure gauge are mainly used.

For setting up the transmitters, its location shall be selected where there would be no influence from the factors other than process valuables to be measured, and consideration shall be given against vibration, shock, corrodible gas/fluid, temperature and humidity, which affect the functioning of transmitters, as well as consideration for checking and maintenance. At Mae Moh Factory, those points as stated in the above are checked for transmitters and it was found that, generally, all transmitters are in satisfactory conditions, except two locations which were modified. Though half the number of the pressure gauges have small vibrations and those of flow meters are affected by pulsation, they shall be treated after level-up of whole measurement system being established as not so urgent matters.

(Pressure Gauge)

Common industrial gauge is for measuring the pressures of fluid and gas, and there are high pressure gauge, vacuum gauge and differential pressure gauge for measuring high pressure, low pressure and pressure difference, respectively.

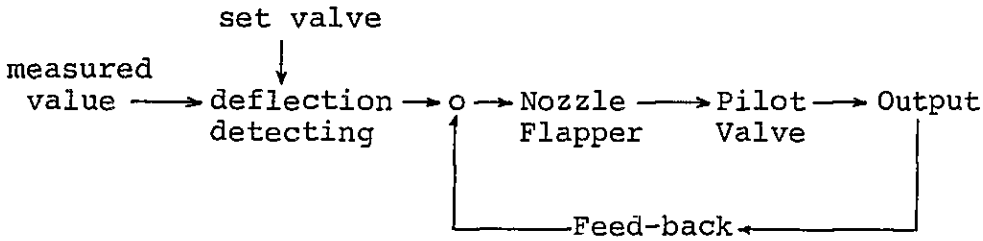
In case of Mae Moh Factory, it is equipped with Bourdon gauge and diaphram manometer for high pressure and low pressure, respectively, selection of which involves no problem. However, since corrosions are found on the gauge or meter itself and dial plates are over-aged, it is desirable to replace them in due course.

There are no problem on range to the maximum operation pressure and selection of materials.

Pressure gauges have to be maintained according to their measurement environment, kinds and scales of measurement pressure, accuracy of measurement; that is, calibration of pressure gauges shall be performed systematically, by establishing the calibration standard of two classes of frequencies for each six months and for each year in proportion to each magnitude and each type.

(Pneumatic Controller)

Pneumatic controller is operated under pneumatic pressure of 0.2 ∿ 1.0 kg/cm^2G of the uniform signal for both in-put and out-put, and its mechanism is as follows:



Overhauling was performed for 35 units of controllers, being 50% of whole controllers at Mae Moh Factory, and there were found five cases of clogging at nozzle, which are excessive numbers. This means that the instrument air is not suitable and its countermeasure shall be taken immediately.

Through the checking of proportional + integral + differencial control action at the time of overhaul, two mal-functioning case of differential control action were found and were repaired under our supervision, controller and regulator are plug-in type and sealed with "O" rings.

These "O" rings are more than overaged and have caused the troubles of unstable out-put due to leakage of signal air. These portions were repaired using spare parts provided by us. Sufficient numbers of "O" rings shall be kept as spares for future maintenance.

(Thermo Recorder)

Thermor recorder is classified in moving coil type and electronics auto balance type.

Moving coil type recorder is not applicable one for the industrial use, as its pointer will be actuated by very weak energy from measuring object.

Auto balance type recorder has been improved rapidly for those years, which can fulfill the weak point of the moving coil type, and mostly, auto balance type recorder has taken place in Japan.

In Mae Moh Factory, mostly, the moving coil types are equipped and they involve weak points of proportional variation of temperature indication to the surrounding temperature because of the fixed compensation of basic contact.

Indications of the thermo recorder to the designed input were checked for all fourteen (14) sets, and their results were quite unsatisfactory; for example, insufficient sensitivity, large scale hysteresis, inferior point record, etc., were found. All recorders, except two sets of Ammonia Plant, have to be replaced. Numbers of thermo recorders necessary to be replaced are twelve (12) sets.

(Thermo Detector)

Types of thermo detectors are thermo couple type and resistance tupe. In Mae Moh Factory, mostly, thermo couple type is adopted, where numbers of CA thermo couple are used. Considerable numbers of CA thermo couple were replaced as they were overaged. Replacement is required during coming one or two years for the compensating lead wires between terminals of termometers and thermo recorders, as it is time of their insulation being insufficient due to overaged conditions.

Thermo couple cannot be used without inserted condition into protective tube. In case this protective tube would be damaged, serious accident can be expected. At this stage, pick up checkings were made for gas line, where plant damages are especially presumed, and for high temperature and pressure line, during open inspection periods. The results showed the slight corrosion like pitchings, etc., but no problems were expected against pressure and maximum operating temperature.

However, prompt replacements are required for TR-01-4 and TIC-2-51-09 of AMMONIUM SULPHATE PLANT. Further, TIC-3-29-04 of AMMONIA PLANT and TR-23-3 of GASIFICATION PLANT shall also be immediately replaced. In total, 31 points were checked, and no special problems were found except those as stated in the above.

At this stage, measurement of correspondence speed, etc., were not performed with thermo couples and protective tubes.

(Signal Instrument Air Line)

Copper pipes or partly vinyl pipes are used for the air pressure piping for the signal transmittance between transmitter and receiver, and, in case of long piping distance, errors are apt to occur for the very variable process measurement due to large time delay by piping resistance, as a weak point of air pressure transmittance system.

For the case of Mae Moh Factory, there existed one transmitting distance of 300m at Steam Line, where the control was difficult due to extremely inferior correspondence characteristic. At this stage, this part were modified into and replaced with all electronics type and the relative effects were accomplished by means of electric instruments advantage. No special problems were found on other points.

(Indicator, Indication Alarm Device)

Most of the receivers are located in the control rooms under contral control system and the indicators located in field are a few numbers.

At Mae Moh Factory, the enviromental conditions of some of the control rooms are not so suitable, and, at least, ventilation and illumination shall be made in better conditions.

Layout of indicater, recorder, alarm, etc., is made on the panel in order of each process and the announciater is located on the graphic panel for easy reading without errors. However, maintenance for enfunctioning the instruments is quite poor.

At least, prompt repairing and replacement are required for alarm system.

(Control Valve)

Maintenance of pneumatic control valves are not enough and valve body is overaged. Moreover, size of a few valves are not suitable and satisfactory controls at the portions cannot be expected. Other points, such as rated pressure, valve characteristic, material quality, are generally good. Hydraulic pressure valves are generally good, while electric valves involve a few problems like poor condition of insulation. Conditions and remedial measures for those problems are stated, in details, at "Open Inspection report" hereinafter.

(Analyzer)

Industrial analyzer is used for the process control, through the measurement of the concentration of the sample materials. It will take much time to perform manual chemical analysis, where there exist such inferior points that only intermittent data are available and also that these data involve variable results dependent on each analysis technicians. Industrial analyzer is for compensating this inferiority, and, since the measured value under this method is accurate with continuous results of no personal errors, this equipment is import for Mae Moh Factory from security purpose as well as process control purpose.

At Mae Moh Factory, CO, CO_2 and O_2 meter are provided at the important portions as Gas analyzer. However, only five sets of analyzer are operated without any trouble among 19 sets, and most of them have to be totally replaced or partially replaced at their sampling portion. As mentioned in the above, system and technical capability for analyzers are not sufficient, and have to be improved immediately.

Especially, CO, CO_2 & O_2 meters of Gasification Plant, O_2 meter of Urea Plant and CO & CO_2 meter of EGAT Boiler have to be repaired immediately. As a special attention, list of analyzers is provided in the next page to enable the provision of the specification for the modification or replacement of analyzers.

LIST OF ANALAYSER

	RANGE	OPERATION VALUE	TEMP	PRESSURE	COMPOSITION	REMARK
GASO					CO_2 O_2 CO H_2 N_2 CH_4 Moisture vol%	
O_2RA-9-23-1 (HOT GAS PRODUCER OUT)	0∿21% O_2	4.5%	600	-150 mmWG	9 10.5 0 1.0 79.5 27.9	SAMPLING SYSTEM CHANGE
O_2RA-9-23-2 (ELECTRO FILTER)	0∿21% O_2	10%	130	-160 "	7 11.8 0 2.7 78.0 0.5 24.9	"
O_2RA-9-23-3 (FINISHED DUST BUNKER)	0∿21% O_2	0.5%	55	0	0 0 0 0 100 0 -	ALL CHANGE
O_2RA-9-23-1 (SYN-GAS BLOWER OUT)	(0∿1% 0∿5% O_2	0	51	1600 "	11.2 0 57.5 26.5 4.4 0.4	"
CO_2RA-9-23-2 (WASHER OUTLET)	0∿20% CO_2	11	60	50 "	11.2 0 57.5 26.5 4.4 0.4	"
AMMONIA					CO_2 CO H_2 N_2 Ar CH_4 NH_3	
ARA-3-29-01 (DEMOISTURE OUT)	0∿10% CO	3%	33°C	20 kg/cm^2	37.0 2.7 52.3 7.8 0.2 0 0	OK
AR-3-29-02 (SATURATOR OUT)	3∿9 pH	6.5∿8 pH	90°C	0 "		ALL CHANGE
ARA-3-31-01 (CO_2 SCRUBBER OUT)	0∿3% CO_2	0.1%	25°C	21.5 "	3.6 91.9 3.4 1.1	"
ARA-3-43-01 (H.P. COPPER SOLUTION SCRUBBER)	0∿100 ppm CO_2	20 ppm	30°C	105 "	3.6 91.9 3.4 1.1	"
ARA-3-43-02 (NH_3 WATER SCRUBBER OUT)	0∿50 ppm CO+CO_2		27°C	111 "	74.3 25.3 0.3	"
ARA-8-21-01 (N_2)	0∿100 ppm O_2	10 ppm	21°C	830 mmWG	N_2 100%	OK
DR-3-52-01 (NH_3 CONV)	0.3∿0.7 kp/Nm^3	0.55	25	340 "		OK
DR-3-43-01 (NH_3 WASHER)	0.3∿0.5 "	0.58	30	21.5kg/cm^{2}G		OK
H_2SO_4						
DR-861-2 (H_2SO_4 CONCENTRATION)	94∿98.5%	97%	45°C			ALL CHANGE
DR-861-3 (")	96.5∿99.5%	99.2%	70°C		SO_2 SO_3 O_2 N_2	"
SO_2 (AnR-861-1) CONVERTER IN)	5∿12% SO_2		330°C		10.7 0.5 9.5 79.3	"
UREA					CO_2 O_2 N_2 H_2	
ARA-3-57-01 (CO_2-C IN LET)	0∿1% O_2	0.8	40°C	610 mmWG	97.5 0.5 1.9 0.1	RECORDER 0∿2.5 mVDC (0∿1% SCALE) CHANGE
BOILER						
BOILER						
CO_2 (INSIDE FARNECE)	0∿20% CO_2		250	0		ALL CHANGE
CO+H_2 (")	0∿20% CO+H_2		250	0		"

(Emergency System)

At Mae Moh Factory, sequence control system is provided on the large rotator of NH_3, UREA and Air Separation Plant and Gasification Plant as the safety measure at the time of process trouble. However, those systems have almost become unreliable due to their mal-functioning by overaged condition of Sequence control equipments and tools like electromagnetic relay, timer, switch, etc.

During our stay at the factory, plant was stopped unnecessarily for three times due to mal-functioning. These troubles occurred because of mal-function of relays and switches, all of which have to be replaced immediately. Prevention of artifitial mal-functioning and improvement of safety for operation have to be achieved as target of sequence control. For such achievement, mal-functioning shall be prevented by rechecking of power supply capacity. fluctuation rate, insulation of distribution conductors, etc., and safety precautions shall be provided for the case of troubles like mal-functioning, etc.

Furthermore, if any trouble would occur, solution of the reason and its remedial measure have to be provided entirely for preventing the future occurrence of the trouble of the same nature.

(Maintenance of Instrument)

Overaging of the instrument cannot be avoided due to its mechanism. Therefore, as unexpected troubles may occur, Daily maintenance is very important for keeping of its functioning.

(Maintenance)

At Mae Moh Factory, many instruments are left in out-of-order conditions due to inappropriate maintenance. Such condition is not only producing uneconomical status, but also causing distrustful feelings on instrumentation operation. This demoralizing influence is considerably big.

Maintenance system can be classified in post-fact method and preventive method. At Mae Moh Factory, post-fact maintenance system is adopted, while, in Japan, preventive maintenance system is adopted, through the regular checking, repairings and replacements of instruments, for preventing large scale plant like petrochemical plant, etc. from being troubled.

In case that remedial measures would be taken or repair work would be done after trouble having occured, efficiency of operation becomes in low grade due to taking much time for investigation of cause of trouble and for repairing work due to lack of spare parts in time. For Mae Moh Factory, instruments for emergency are desirable to be replaced at the next stage for the preventive maintenance.

Further, the maintenance work shall be done systematically through a year. In addition to daily work, monthly, semi-annual and annual works shall be summarized and classified in good order and be made as systematic ones, which can be deemed as good practice. Our recommendations on this aspect are stated in the table of next page.

Thus, at Mae Moh Factory, insufficient maintenance has made the operation efficiency of the instruments be around 60 to 70% except some plants, and the numbers of troubles would be pressumed to be increased proportionally to the progress of overaging conditions of the instruments. Therefore, the repairing and maintenance works as stated herein shall be realized.

Maintenance Item and Check Interval

Maintenance Item	Check Interval
[For All Plants]	
1. INSTRUMENT AIR LINE FILTER CLEANING	twice/year
2. CONTROLLER OVERHAUL and TEST	once/year
3. RECORDER OVERHAUL and TEST	"
4. THERMO RECORDER OVERHAUL and TEST	"
5. Pressure Conduit Pipe and Level Gauge Chamber BLOW	"
6. TRANSMITTER ZERO CHECK	"
7. CONTROL VALVE LIFT TEST	twice/year
8. PRESSURE GAUGE CHECK	once/year
9. GAS ANALYZER CALIBRATION	once/week
10. ALARM TEST	once/year
11. EMERGENCY SYSTEM SEQUENCE TEST (KOPPERS, AMMONIA, UREA, AIR SEPARATION)	twice/year
[GASIFICATION PLANT]	
1. O_2RA-1, O_2RA-2, O_2RA-3 SAMPLE LINE CLEANING	once/month
2. FR-16 ORIFICE CLEANING LEAD PIPE CLEANING	twice/year
3. FI-1, FI-2, FI-9 Venturi CLEANING	"
[H_2SO_4 PLANT]	
FR-861-1, FI-868-1 ORIFICE CLEANING	once/year

(Calibration Adjustment)

Aging variation, dust, corrosion and other environmental influence on the instruments will cause variations of their proper functions, which will result indicative errors and fluctuations. For maintaining the instruments in the reliable conditions, regular or timely calibration adjustments are required. At Mae Moh Factory, this performance is made partly only at the unavoidable time and is rather causing distrustful impressions for operators than producing reliable ones.

Furthermore, excluding irregular calibration adjustments, regular ones shall be done in accordance with the established work and treatment standards under the designed work methods as the regular ones are to be done systematically. The results of such calibration adjustment shall be maintained in good order for the easy application as well.

(Organization)

Though organization for measurement work is composed of day-time-work and three-shift-work, it is desiable to abolish three-shift system, being frankly stated. In Japan, although three-shift system is adopted sometimes at the large scale plants, etc., this is provided, under consideration of untimely arrivals of staffs by the post-fact calling, since the instrumentation facilities are advanced in high level and the quick counter-measures have to be made on measurement at the emergency case. For Mae Moh Factory, almost such case cannot be expected. Moreover, from the actual records of night time work, there have been almost seldom works at night time and is presumed that it is possible to be covered by day-time works. However, this abolishment shall be realized in consideration of the

appropriate counter-measure for the life status of the three-shift workers.

As the factual performance, all works were done only under day-time work by all staffs without three-shift system at this open-checking periods.

(Spare Parts)

When considering the locational conditions of Mae Moh Factory and the delivery periods for procurements, spare parts shall be stocked at the maximum. Under such circumstances as the spare parts are almost out of stock, the troubled equipments have to be left as they are due to impossibility of repairing. However, for those spares available in Bangkok, minimum stock quantities are enough.

In the next page, List of Equipments is provided.

Parts list shall be made for each listed equipment and necessary spare parts shall be planned.

(Testing Equipments and Tools)

Tools are sufficiently provided, while testing equipments, like tester, megar, MV generator, etc., are considerably overaged and shall be replaced. Megar, tester, etc., brought with us, were useful. Furthermore, other testing equipments like syncroscope, oscillator, etc., shall be provided. List of such testing equipments is shown in the next page.

Cost for procurement of Measurement testing equipments, tools and Spare Parts.

1. Testing Equipments

(Unit: 1000 Baht)

Equipments	Q'ty	Amount
mV Generator	1	42
Frequency Oscillator	1	30
Syncroscope	1	60
Digital Thermometer	1	72
Tester	2	8
PORTABLE PRESS. GAUGE	3	10
Pressure Testing Device for Control Valve	1	100
Total		320

2. Tools

(1000 Baht)

Tools	Q'ty	Amount
Tool Set (pneumatic)	5 sets	6
" " (electric)	1 set	2
Total		8

3. Spare Parts

(1000 Baht)

Spare Parts	Q'ty	Amount
Solenoid Valve	10	60
Recording Controller	1	54
PG	100	150
TG	50	100
Total		364

Grand Total of Procurement Cost for Measurement Equipment Baht 694,000.

(Instruction of Staffs)

Instructions to the local staffs have been performed for repairing method, checking procedure, overhaul procedure of each instrument and testing method, through the actual work during our staying periods. Superior staffs were 2 or 3 personnels.

Since the measurement technique is advancing higher and higher as the special aspect, the general and relative instructions thereof are necessary. It is deemed as being almost impossible to employ the excellent engineers in Thailand for the instruction staffs.

In addition to the training of the engineers, graduated from electronics course as the Instrument engineers (no instrument course in universities/college

in Thailand), it is necessary to raise the technical level through the training of staffs by the assistant manager of Mae Moh Factory and through the collaboration with the agency in Bangkok of measurement instrument manufacturer.

At the time of open-checking, staffs were willingly working, while the supervising or instructing engineers are in short regretfully.

7-3 Record of Open-checking

7-3-1 Control Valve

Internal checking were made for selected 25 sets at high temperature and pressure gas line and steam line, as being deemed important portion, among total 75 sets of Mae Moh Factory.

After internal checking being completed, pressure test and leakage test were performed.

In general, corrosions like pitching were found and gaps were found between inner valve and valve stem, all of which, however, are not so urgent matters but are to be replaced within a few years. Present problems are existing on LCV-5 of Gasification Plant and on LCV-861-1 of Sulphulic Acid Plant, which two sets have to be replaced since the proper control cannot be made due to operation close to shut-off point under normal operation time with large CV value.

7-3-2 Thermo Recorder

Overhaulings were performed on all 12 sets thermo recorders, except a new-type recorder at Ammonia Plant. Whole recorders are desirable to be replaced due to overaged condition and temperature compensation problem. These can present unclear records and also there are no spare recording tapes at all. In addition, their repairs are almost impossible due to short of gains. As the adjustment check cannot be done after overhaul, large indication errors are presented.

7-3-3 Controller

Checking were made on all 24 sets at Urea Plant and 11 sets at other plants, and there found five cases of clogging at nozzle due to dust from instrument air and two cases of mal-functioning of D-action. These were repaired under our supervision.

Here, it is obvious that the instrument air is not in suitable condition.

7-3-4 Valve Position Check

Valve positions were checked through the operation tests performed for all 103 sets of all plants. Overhaul was made for one unsatisfactory function case. Most of the valve positions were inappropriate and adjusted with positioner.

7-3-5 PG Check

Indication calibration check were made under our supervision for 188 sets of pressure gauges of Bourdon type and diaphram type. For appearances, though corrosions were found due to overaged conditions, it is not so urgent matters.

7-3-6 Thermometer protective tube check

Checkings were made for the thermometer protective tubes at the major portion of each plant, and the following four portions have to be replaced immediately, among 31 checked portions.

TR-23-3 of Gasification Plant

TR-01-4 and TIC-2-51-09 of Ammonium Sulphate Plant

TIC-3-29-04 of Ammonia Plant

Others are showing slight pitchings, etc.

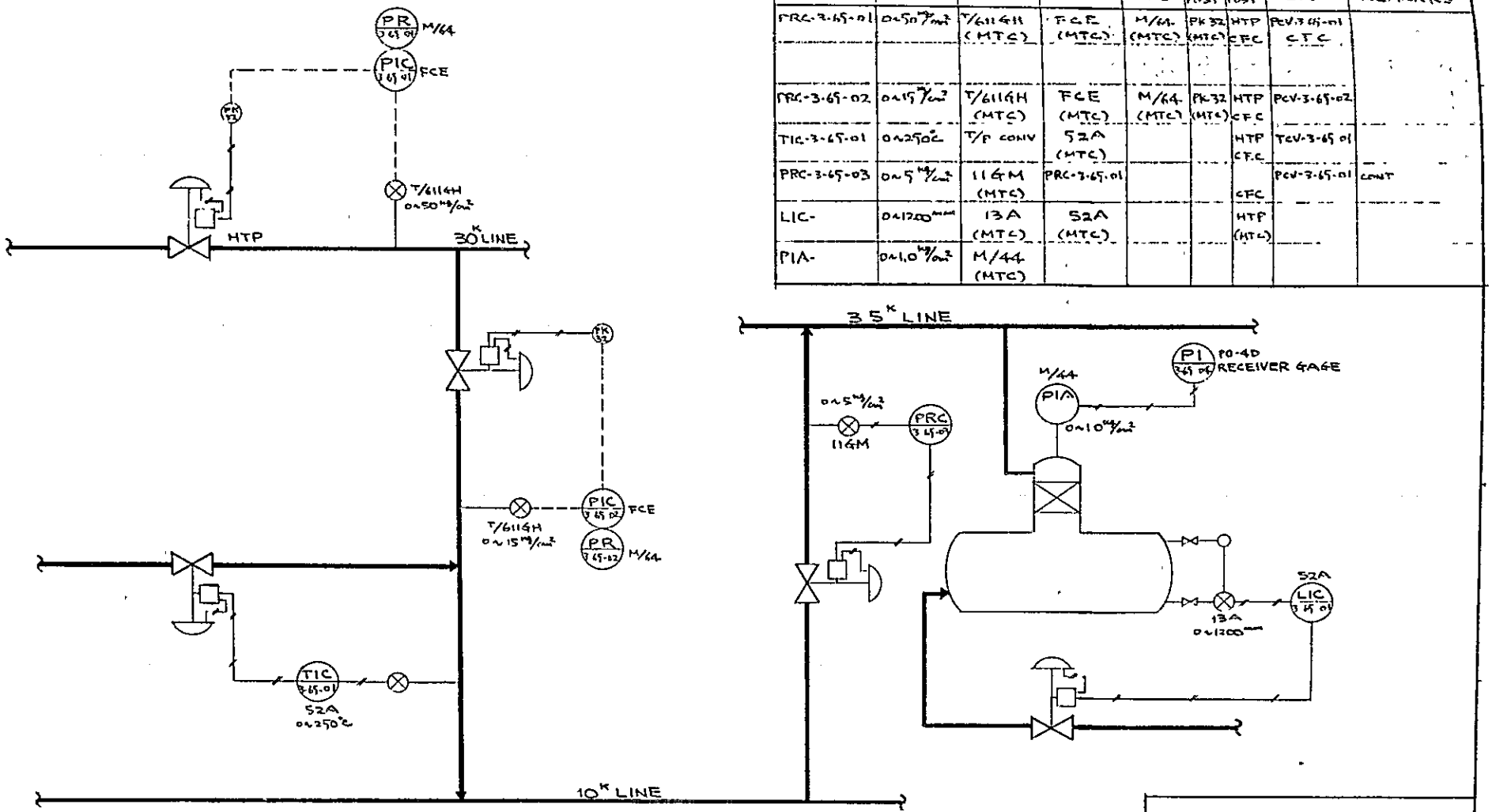
7-3-7 Replacement of Thermo Couple

Overaged and unsatisfactory ones at thermo couple of thermometer were replaced to new type. Replacements of total 48 portions were made; 15 points for Gasification Plant and 33 points for Ammonia Plant.

7-3-8 Modification Work of Steam Line

At the time of the First Survey team, it was found that the pressure variations at steam line affected the process. To improve this point replacement of control valves and adoption of electronic type instruments in lieu of pneumatic type ones during the Second survey team enabled the automatic operation of instruments in lieu of manual operation and the satisfactory control is realized from high pressure steam line to low pressure steam line. Details of the Modification Works are shown in those pages hereinafter.

Contents



TAG NO	RANGE	TRANSM	CONT	RFC	T/P POS1	HTP POS1	C.V	REMARKS
PRC-3-65-01	0~50 kg/cm²	T/6114H (MTC)	FCE (MTC)	M/64 (MTC)	PK32 (MTC)	HTP CFC	PCV-3-65-01 CFC	
PRC-3-65-02	0~15 kg/cm²	T/6114H (MTC)	FCE (MTC)	M/64 (MTC)	PK32 (MTC)	HTP CFC	PCV-3-65-02	
TIC-3-65-01	0~250°C	T/P CONV	52A (MTC)			HTP CFC	TCV-3-65-01	
PRC-3-65-03	0~5 kg/cm²	114M (MTC)	PRC-3-65-01			CFC	PCV-3-65-01	CONT
LIC-	0~1200 mm	13A (MTC)	52A (MTC)			HTP (MTC)		
PIA-	0~10 kg/cm²	M/44 (MTC)						

MAE MOH FACTORY

STEAM LINE

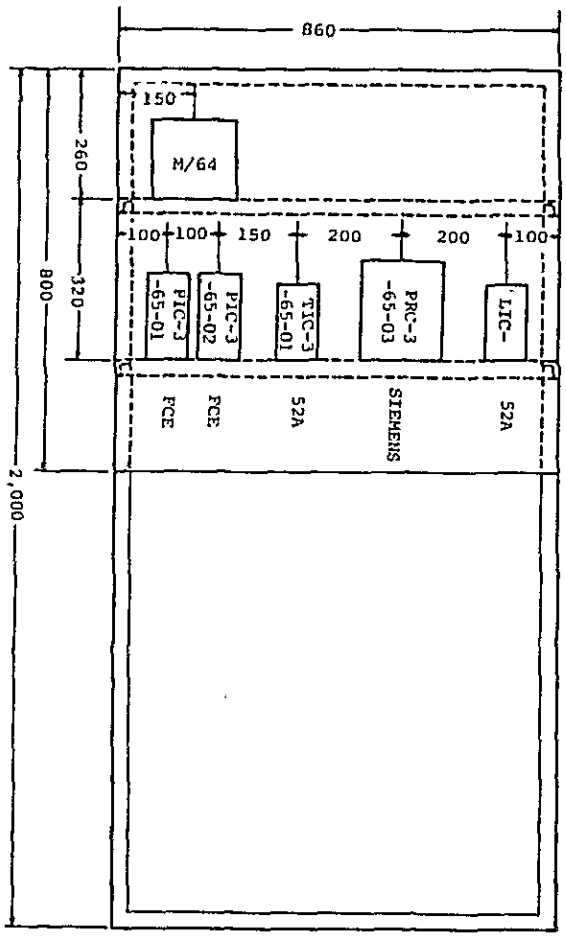
= 30K to 3.5K =

DWG NO.

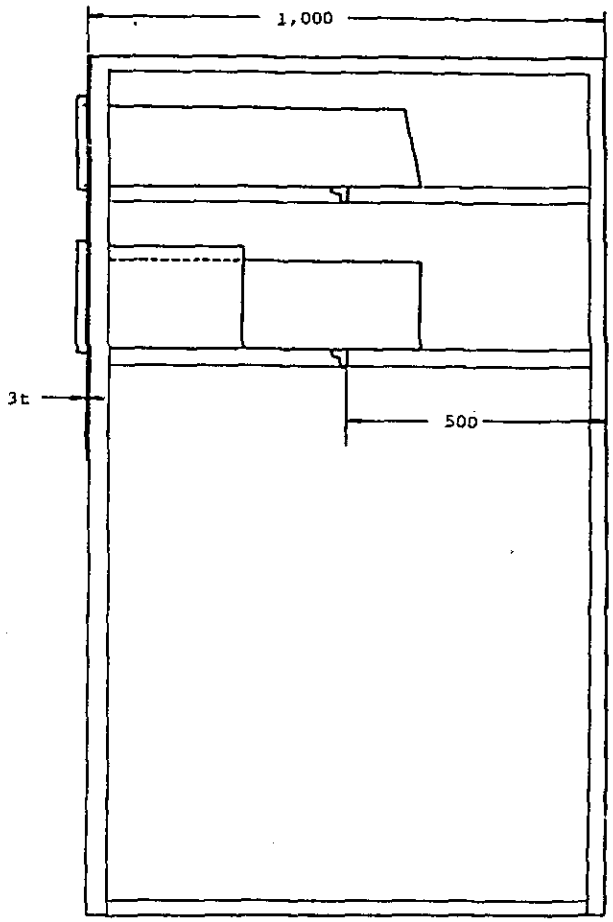
PANEL FABRICATION DRAWING

Plant FEED WATER

Panel Drawing
(Front View)

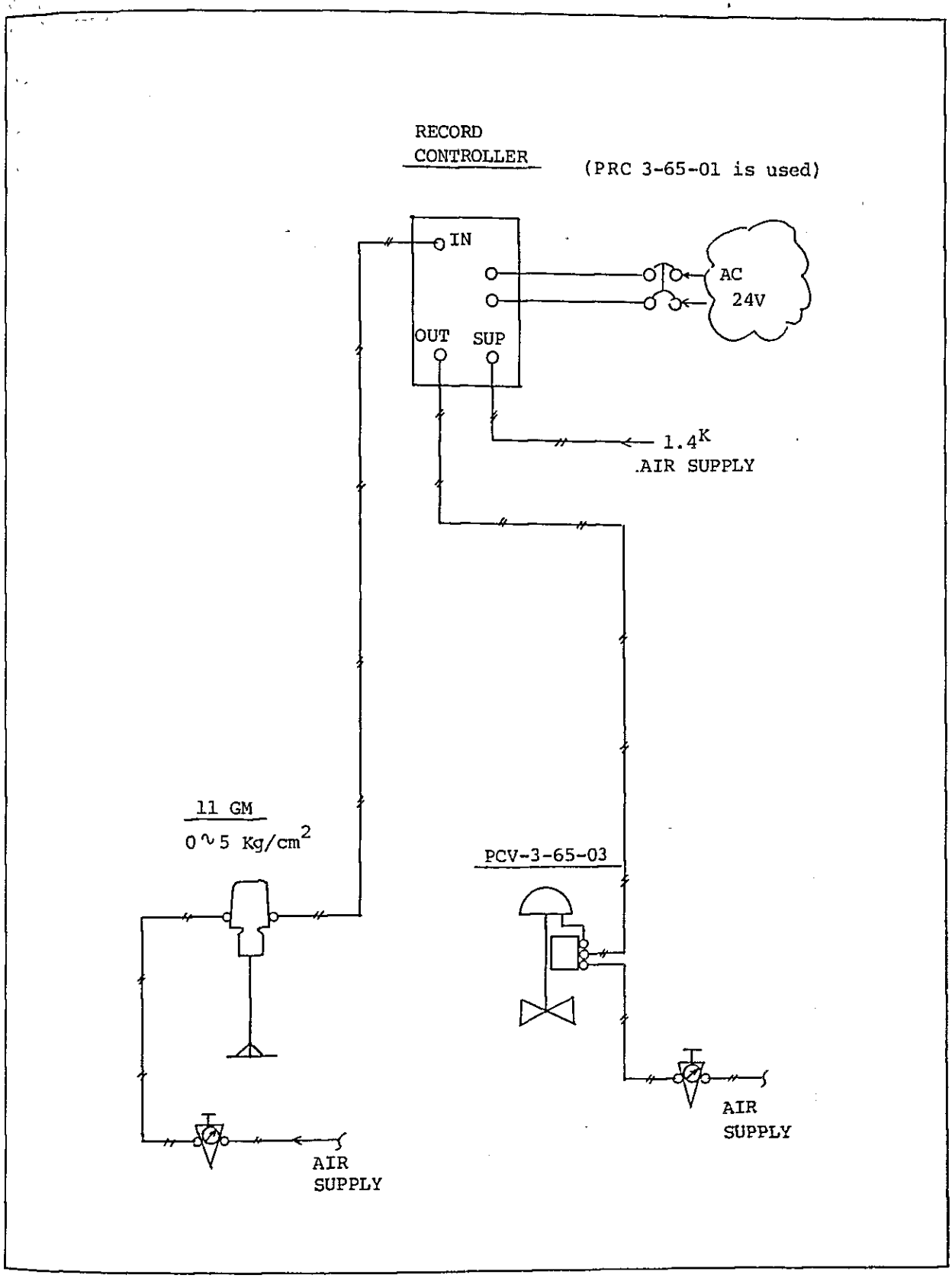


Panel Drawing
(Side View)

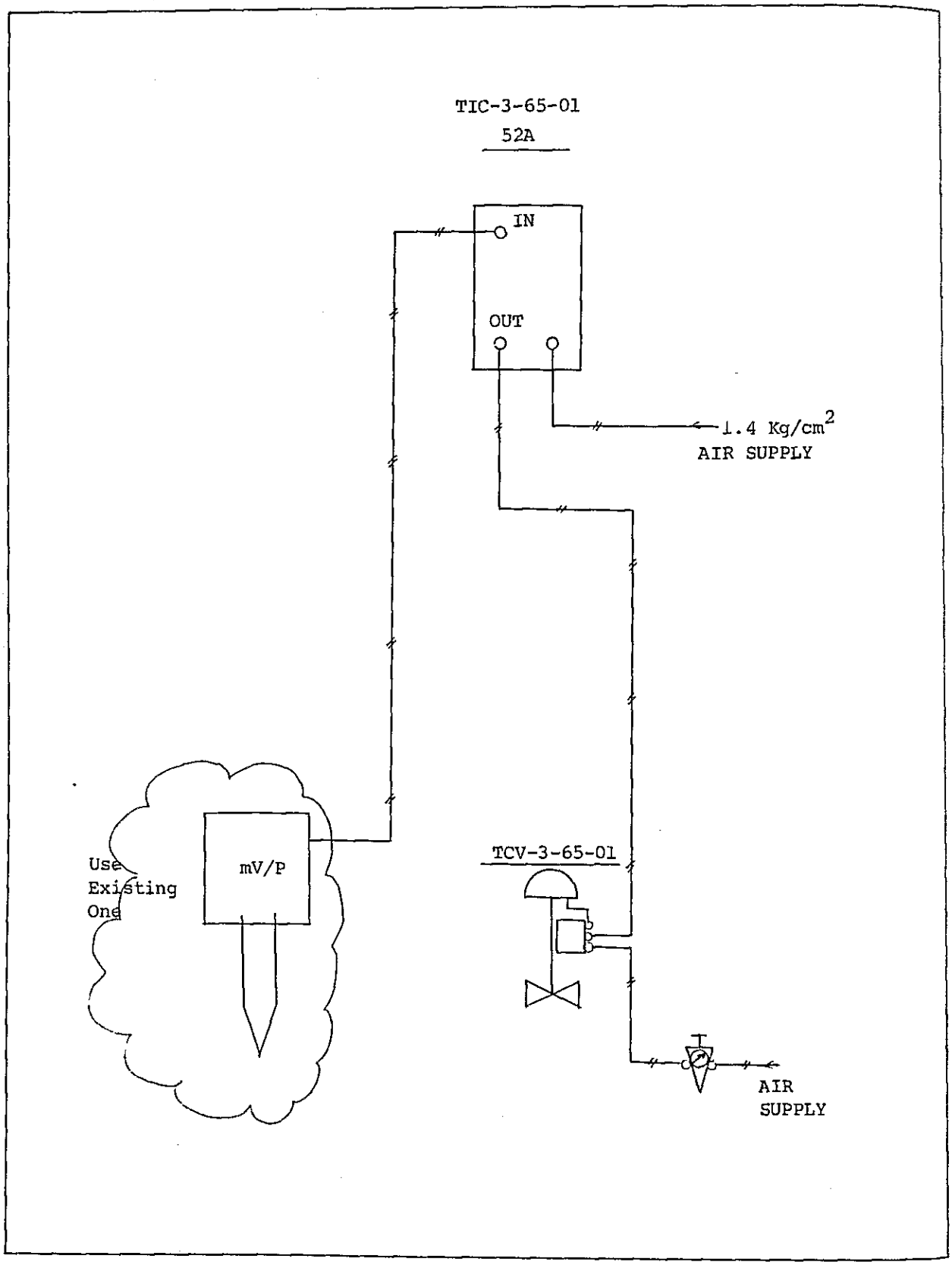


PANEL FABRICATION DRAWING

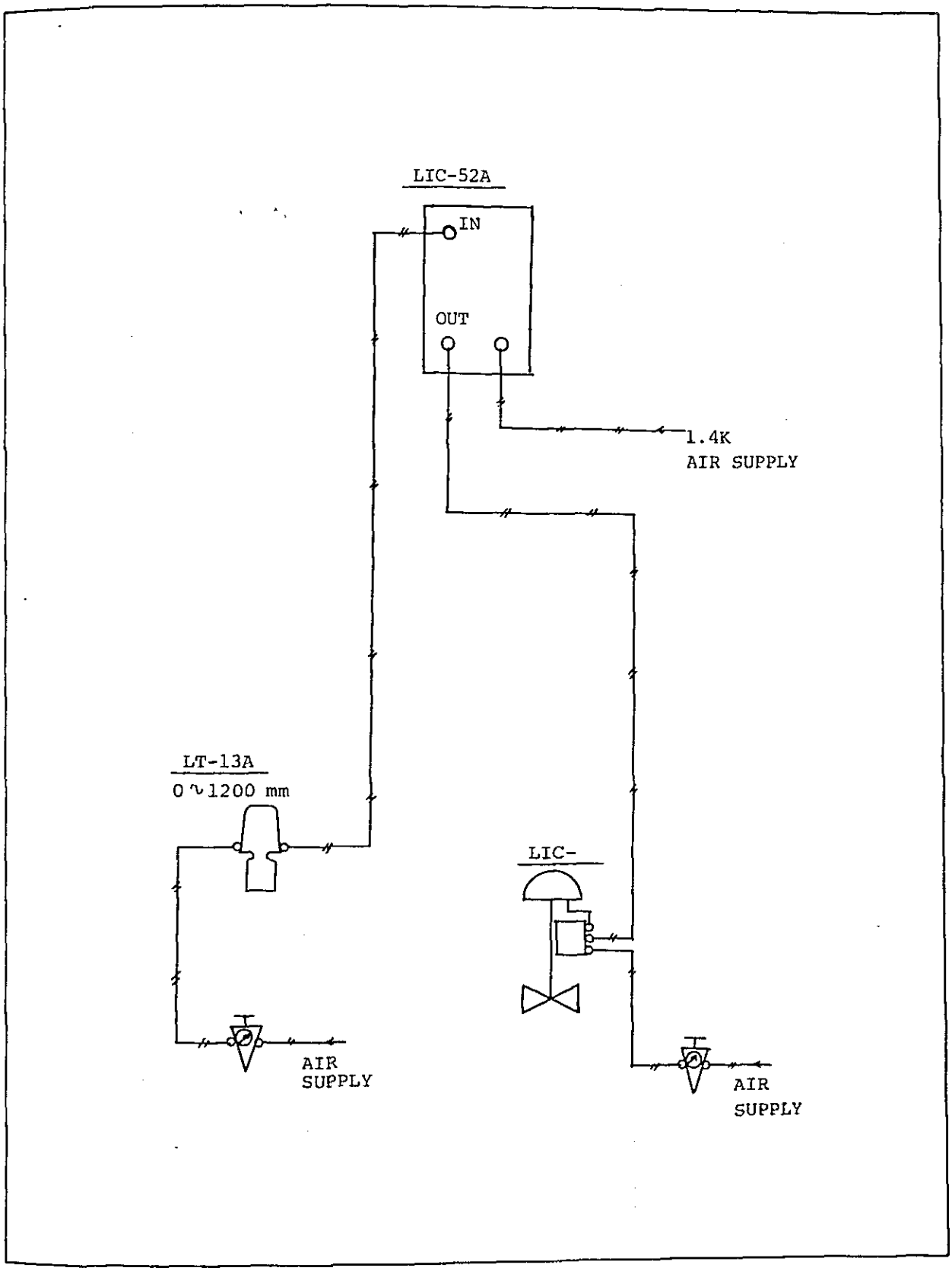
FEED WATER PLANT PRC-3-65-03 LOOP DRAWING



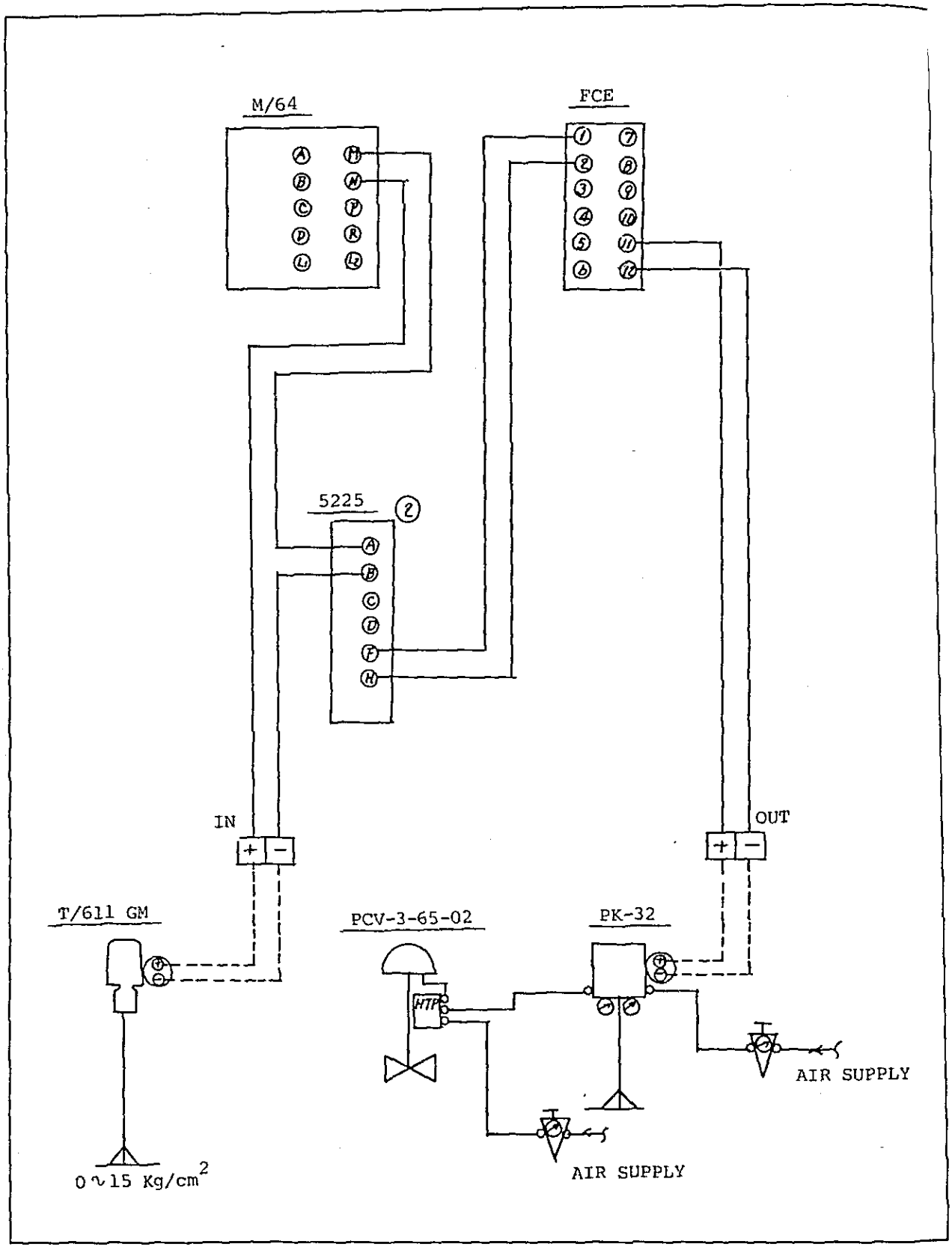
FEED WATER PLANT TIC-3-65-01 LOOP DRAWING



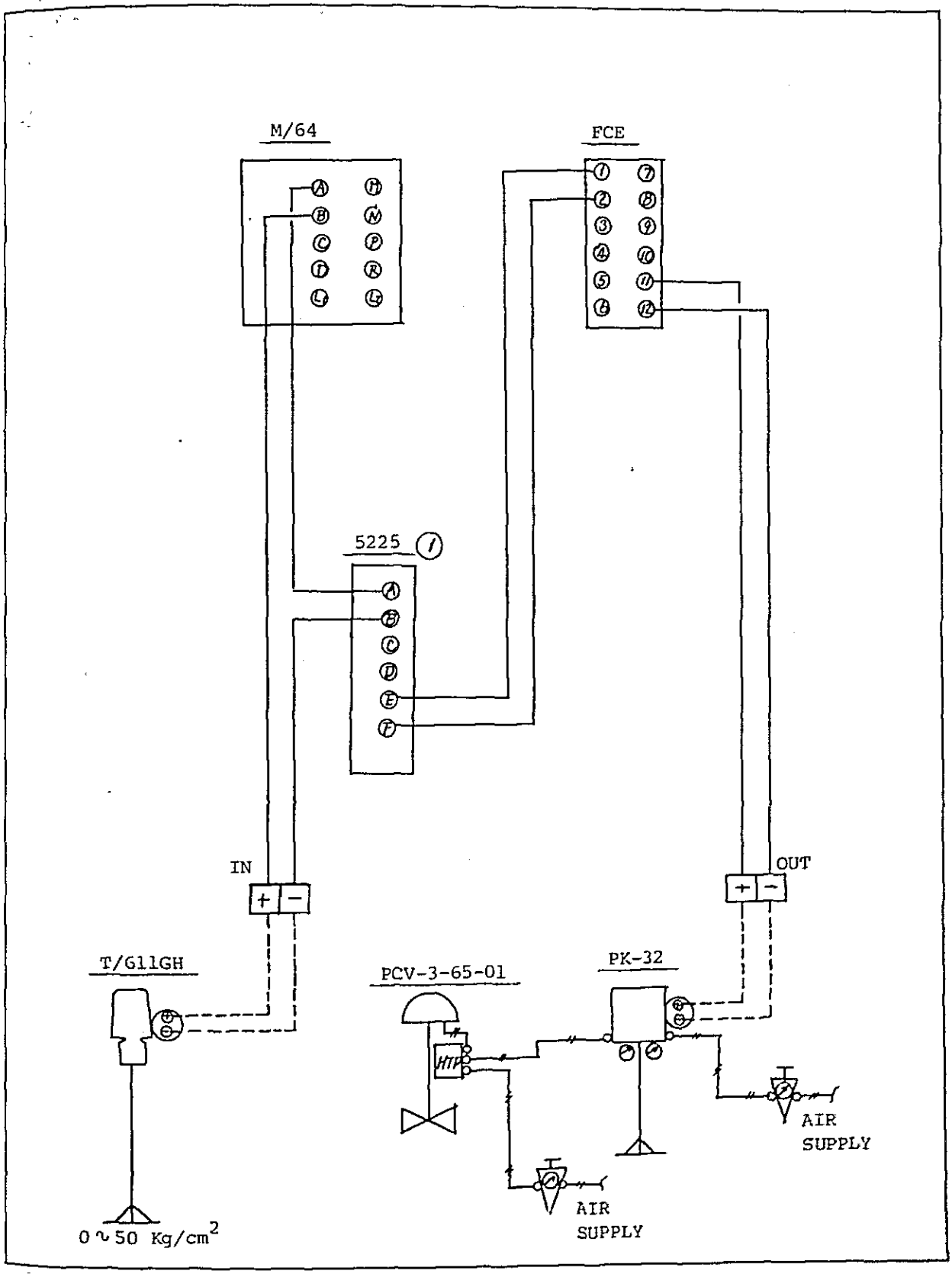
FEED WATER PLANT LIC-3-65-01 LOOP DRAWING



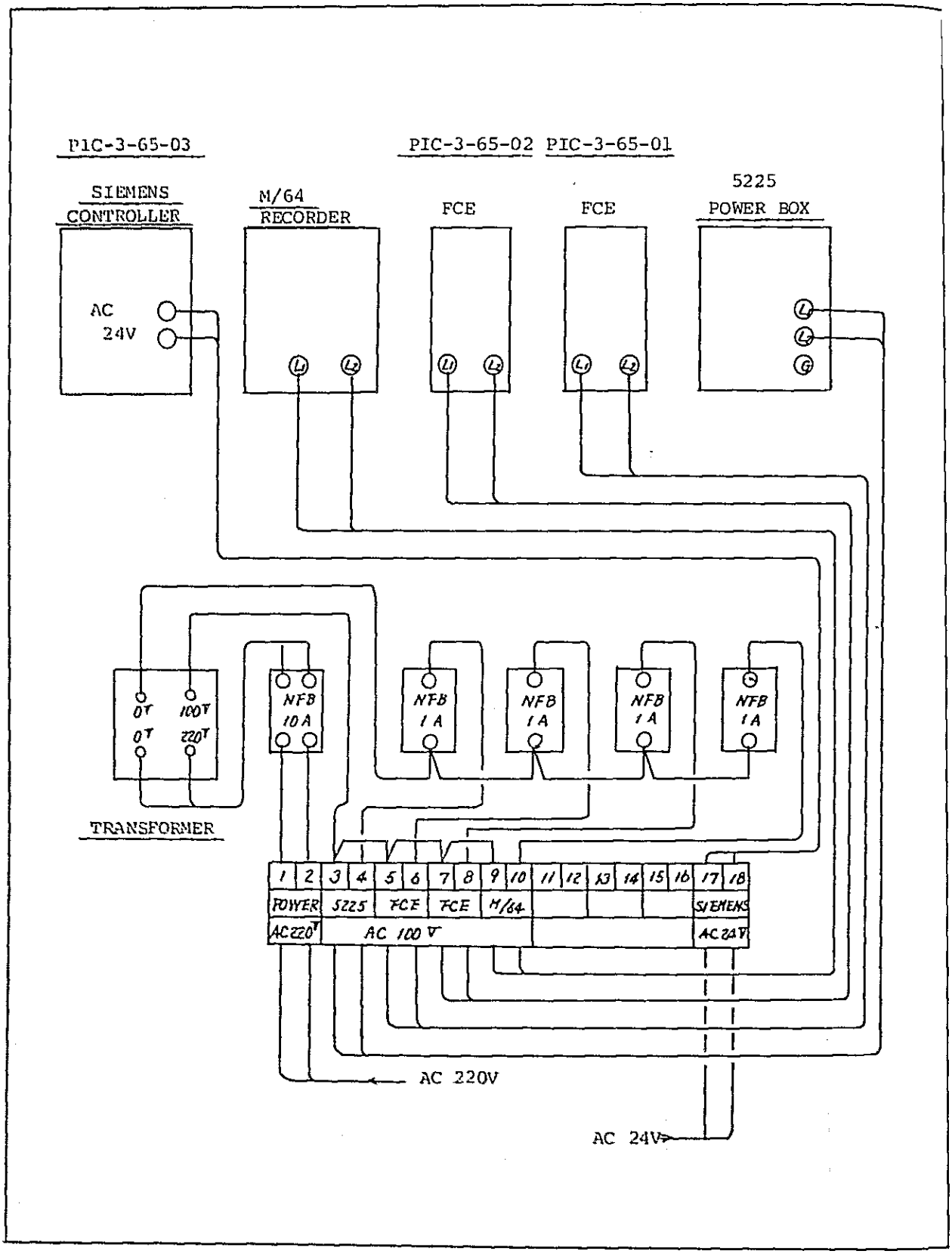
FEED WATER PLANT PRC-3-65-02 LOOP DRAWING



FEED WATER PLANT PRC-3-65-01 LOOP DRAWING



FEED WATER PLANT AC LINE DRAWING



FEED WATER PLANT (RECORDER)

TAG NO.	PR-3-65-01,-02	
LOCATION	30K STEAM 10K STEAM	
MANUFACTOR TYPE INPUT POINT SUPPLY SCALE (NO.1) (NO.2)	YEW M/64 10 ∿ 50 mADC 2 AC 100V 0 ∿ 50 kg/cm^2 0 ∿ 15 kg/cm^2	
REMARK	NO.1 INK color RED NO.2 INK color GREEN	

FEED WATER PLANT

	TAG NO.	PCV-3-65-01		
	LOCATION	30K STEAM		
CONTROL VALVE	MANUFACTOR	Y.H		
	MODEL	VDC		
	ACTUATOR	VA2R		
	SEAT TYPE	CAGE		
	CHARACTERISTIC	%V		
	VALVE ACTION	AIR TO OPEN		
	MAX CV	68		
	STANDARD OF CONNECTION	2 1/2 ANSI 600RJ		
	FACE TO FACE LENGTH	314 mm		
	POWER	AIR 2.8 k		
	MATERIAL OF THE BODY	SCS13		
	MATERIAL OF THE TRIM	SCS14ST		
	GASKET	V-543, V-595		
	GRAND PACKING	JM-397		
	GREASE	G-23		
	SPRING RANGE	0.8 ∿ 2.4 k		
	HAND WHEEL	YES		
	HEAT & COLD EQUIPMENT BONNET	YES		
POSITIONER	MANUFACTOR	YAMATAKE		
	TYPE	HTP		
	INPUT SIGNAL	0.2 ∿ 1.0 k		
	OUTPUT SIGNAL	0.8 ∿ 2.4 k		
	AIR SET	2.8 k		
FLUID	COMPOSITION	STEAM		
	NORMAL FLOW	2.8 T/H		
	MAXMUM FLOW	12.0 T/H		
	UPSTREAM PRESSURE	46 $kg/cm^2 \cdot G$		
	PRESSURE DROP	17 kg/cm^2		
	TEMPERATURE	500°C		

FEED WATER PLANT

	TAG NO.	PRC-3-65-01	PRC-3-65-02	PRC-3-65-03
	LOCATION	30K STEAM	10K STEAM	3.5K STEAM
CONTROLLER	MANUFACTOR	YEW	YEW	SIEMENS
	TYPE	FCE-65T	FCE-55T SP	C71450-A118-A2
	SCALE RANGE	0∿50 kg/cm^2	0∿15 kg/cm^2	0∿5 kg/cm^2
	NORMAL PRESSURE	29 kg/cm^2	10 kg/cm^2	3.5 kg/cm^2
	CONTROL ACTION	P + I DEC	P + I DEC	P + I DEC(REV)
	ALARM TYPE	NO.	NO.	NO.
	RECORDER	M/64 NO.1 PEN	M/64 NO.2 PEN	YES
TRANSMITTER	MANUFACTOR	YEW	YEW	YEW
	TYPE	T/611GM	T/611GM	M/11GM
	MEASURING RANGE	0∿50 kg/cm^2	0∿15 kg/cm^2	0∿5 kg/cm^2
	OUT PUT	10∿50 mADC	10∿50 mADC	0.2∿1.0 kg/cm^2
	SEALING METHOD			
	SEAL SIZE			
	CONNECTION	PT 1/2 B	PT 1/2 B	PT 1/2 B
DETECTOR	TYPE	T/611GH	T/611GM	T/11GM
	TEMPERATURE	50°C	50°C	50°C
	MOISTURE			
	TYPE OF DETECTING ELEMENT	SUS 316	SUS 316	SUS 316
	MATERIAL OF THE BODY	SUS 316	SUS 316	SUS 316
	MATERIAL OF THE IMPORTANT PART	SUS 316	SUS 316	SUS 316
	CONNECTION	PT 1/2 B	PT 1/2 B	PT 1/2 B
CONVERTER	MANUFACTOR	YEW	YEW	
	TYPE	PK-32	PK-32	
	IN PUT	10∿50 mADC	10∿50 mADC	
	OUT PUT	0.2∿1.0 k	0.2∿1.0 k	

FEED WATER PLANT

	TAG NO.	TIC-3-65-01	PIA-3-65-04	LIC-3-65-01
	LOCATION	10K STEAM	DEAERATOR	DEAERATOR
CONTROLLER	MANUFACTOR	YEW	NAGANO	YEW
	TYPE	52A	1/2 x 150 ø	52A
	SCALE RANGE	0∿250°C	0 - 100	0∿1200 mm
	NORMAL	180°C		1000 mm
	CONTROL ACTION	P + I INC		P + I INC
	ALARM TYPE	NO.		NO.
	RECORDER	NO.		NO.
TRANSMITTER	MANUFACTOR		YEW	YEW
	TYPE		M/44	13A
	MEASURING RANGE	0∿250°C	0∿1.0 kg/cm^2	-1140∿0 mmH_2O
	OUT PUT	0.2∿1.0 k	0.2∿1.0 kg/cm^2	0.2∿1.0 kg/cm^2
	SEALING METHOD			
	SEAL SIZE			
	CONNECTION	2B	PT 1/4 B	PT 1/2 B
DETECTOR	TYPE		M/44	13A
	TEMPERATURE		120°C	120°C
	MOISTURE			
	TYPE OF DETECTING ELEMENT		SUS 316	SUS 316
	MATERIAL OF THE BODY			SUS 316
	MATERIAL OF THE IMPORTANT PART		SUS 316	SUS 316
	CONNECTION		PT 1/4 B	PT 1/2 B