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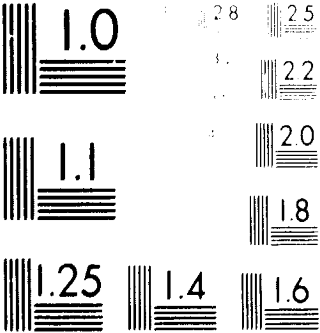
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UNICO INTERNATIONAL CORPORATION
TOKYO, JAPAN

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The Final Report
(Ghorasal Plant)

(2)

"Operation and Management of the Fertilizer Plants in Bangladesh"

(Project No. DP/BGD/78/002
Contract No. UNIDO 79/75)

March, 1981

Mr. H. Jindai

Team Leader Urea Fertilizer Plant Ghorasal

CONTENTS

1. Introduction

The Project "Operation and Management of the Fertilizer Plant in Bangladesh" was formulated by UNDP/UNIDO in order to improve the utilization of capacity of fertilizer plants in Bangladesh by providing the necessary technical assistance to the Urea Fertilizer Factory, Ghorasal (UFFG) and the T.S.P. Complex, Chittagong in the form of experts.

The field service of the experts under the project assigned to UFFG began in October, 1979 and their assignment was completed in December, 1980. The services for the T.S.P. Complex which began simultaneously is however expected to continue for a further year.

This final report is being submitted with the intention of reviewing the activities of the experts and in order to summarize the results of the assessment of the performance of the plants, and to provide for our recommendations for improving the performance. This report covers only UFFG.

Firstly, we would like to express our sincere appreciation for the effort of the people involved in the implementation of the project. We would also like to extend our gratitude for the assistance and cooperation rendered to the experts by the personnel of BCIC and UNDP/UNIDO during its execution.

Projects of this type cannot be successful without the full cooperation of Operation, Maintenance and Administration personnel of the factory concerned, and we again express our appreciation for the cooperation rendered to us by the factory staff.

Due to several problems which occured in the past year, the factory was unable to increase its production greatly, however, improvement incorporated during this period should minimize production loss and should contribute to improved plant performance. It is our great pleasure to be able to inform that the recent performance of the plant performance is very much improved and production continues at the rate above 90% of rated capacity. (Refer to attached production record)

One of the most important achievements of this project is the successful transfer of technology to those personnel who worked jointly in actual emergency repair and assessment of the performance of the equipment, and the implementation of the improvement plan.

The existing fertilizer plants in Bangladesh have a problem of retaining experienced indigenous engineers and technicians who should be the core of the training scheme of the factory. This fact is well known to the persons concerned.

The few experienced engineers and technicians available at UFFG are pre-occupied in maintaining the production level and are unable to devote time to "On the Job" training of new engineers and technicians which is essential for replacement of outward movement of more experienced personnel.

It is hoped that the newly introduced apprentice scheme, and continued intensive practical training of engineers and technicians will solve this problem in the future.

The work conducted during the field service of our experts and the result of assessment of plant performance, plus our observations of various aspects of the plant operation and our recommendation for improvement are included herein.

2. Summary

Operation and Management of Fertilizer Plant in Bangladesh (Urea Fertilizer Factory, Ghorasal)

Project No. DP/BGD/78/002

Contract No. UNIDO 79/75

2.1 Nature of the Report

It is our pleasure to submit this final report as stipulated in the contract drawn up between UNIDO/ Bangladesh Chemical Industries Corporation (BCIC) and UNICO INTERNATIONAL CO. (Contractor) for the above captioned project.

This report is prepared in order to identify the services provided by the experts assigned to the Urea Fertilizer Factory, Ghorasal (UFFG), the major findings of the experts, their suggestions for improvement of performance of the plants and the assessment of their achievement in the tasks assigned to them.

2.2 Objectives of the Project

The objectives of the project are defined in the project document "Operation and Management of Fertilizer Plants in Bangladesh" BGD/78/002 dated 30th November, 1978 prepared by UNIDO and the Government of Bangladesh. More specific tasks for the project are specified by the appendix G prepared by BCIC for the contract between UNIDO and the contractor.

These objectives include, but are not limited to, the following.

(1) To assist in the improvement of the utilization of capacity (daily production capacity) to 85% of the daily rated capacity.

(2) To assist in the reduction of plant shut down and to increase the "On-stream" days to above 300 days per year.

(3) To prepare an action programme and modification plan in order to improve capacity utilization to 100% and to increase the "On-stream" days beyond 300 days per year.

(4) To improve the technological ability of the BCIC staff through active "on the job" co-operation in order to achieve improvement and the assessment of the present performance of the plant and prepare the improvement plan.

The duration of service and Mobilization of Manpower.

The field service of the experts began in October, 1979 and the last of the experts left the project area in November, 1980. The total man months utilized for this service is 66 man months (Two man months more than the original plan. Total man months of UFFG and TSP complex are 144 man months).

2.3 The Achievement

(1) Annual production

The production of urea during the fiscal year of 1979 - 1980 reached a level of 256,600 tons, the highest production level in the history of the plant.
The previous year's performance of the plant was 236,100 tons.

The improvement of annual production is mostly contributed by higher production during the months before the service started, but there were already several serious problems which could cause significant production loss in later stage. The trouble shooting of such problems conducted by UFFG personnel and UNIDO experts could minimize production loss during the succeeding months contributed to achieve such production level.

This annual production 256,600 tons means 75.5% of design annual capacity, when the possible operable days in a year is presumed as 300 days.

However, if "330 days" is to be taken as the possible operable days as in the plants in developed countries, the 256,600 tons means 68.4% of design annual capacity.

Generally speaking, the turn around maintenance of a modern ammonia-urea plant requires 30-40 days scheduled shut down of the plant for the maintenance work in the plant where extra maintenance technicians avairable for the complete turn around maintenance.

The availability of high level technicians in Bangladesh is not sufficient to conduct turn around maintenance as fast as the case of development countries, the likely operable days in the year should be considered as 300 days.

(2) Daily production

The maximum daily production reached 86% of design capacity before overhauling, and after overhauling, it exceeds 90%. However, the production capacity of the plant will be limited by the capacity of 2 compressor and ammonia condenser in the ammonia plant during the high temperature season. The continuous operation of above 90% capacity will be difficult until cooling water system and air compressor are improved.
Note: Refer to attached production record.

(3) The on-stream days

The on-stream days of the plant was 279 days during the last fiscal year. (No turn around overhaul was conducted.)

There were several plant shut down caused by unexpected operational difficulties as power outage, unskill of operators, etc. If these unforeseen difficulties had not occurred, the plant could have been operated for more than 310 days.

(4) Participation to physical maintenance work

The experts physically aided and supervised repairing work of various machines. 20 Rotary Machines out of 27 major Rotary Machines in the plants were repaired through mutual co-operation. More than 100 instruments were repaired, High Pressure steam amounting to more than 5 t/h loss was recovered by adjusting and repairing the points at which loss was taking place. The performance of the Cooling Water Tower was improved by 10% after modification of the water distribution and air fans of the CW Tower in ammonia Plant. The performance of the air compressor was improved by 5% by arresting the loss of process air.

All items in appendix G are discussed in this report.

The reports of M/S. Bresler Associates Inc., and M/S. Chemie Linz AG were used as reference and many items recommended by M/S. Bresler Associates Inc., were executed.

2.4 Conclusions

(1) Several items of equipment exist which impair the possibility of increasing the daily production to 100% capacity. Further modification of the air compressor and Cooling Water System are requisite in order to acheive this target. The recommendations for De-bottlenecking are given in 2.5 and the detail in Chapter 5.

(2) There is an acute shortage of experienced high technical level engineers and technicians. Such people are required to give support to the manager for the daily operation and for the improvement of technical capabilities of the fresh graduation and newly recruited staff.

(3) The present technological level is only sufficient to maintain the operation and maintenance of the existing equipment and system. The development of the technological level to essential for the identification and assessment of the existing bottlenecks and procedure for de-bottlenecking is insufficient.

(4) Under existing conditions the turnaround is required once a year. 20 number of foreign experts and 25 overhaul working days plant shutdown is essential for normal overhaul work. The utilization of BCIC experts in all factories will be useful in minimizing the duration of shutdown days for turnaround.

2.5 Recommendations

Following items are recommendable to achieve the 100% capacity plant production load.

(1) Increase of the cooling water tower (2 cell) for ammonia and urea cooling water loop. The modifications of cooling water system are also included in this plan.

(2) An additional ammonia condenser for the refrigeration compressor.

(3) Improvement of air compressor.

(4) The installation of an additional high pressure decomposer reboiler of urea plant.

(5) Change the type of recirculating solution pump from reciprocating to centrifugal type to reduce the maintenance problems.

(6) Increase of the ammonia condenser in the recovery section of the urea plant.

(7) Increase of an pure water unit to cover the shortage of capacity of existing pure water units due to the low raw water quality.

Those above descrived recommendations are following to the items stipulated in the Annex G of ammendment and, also, basing on the plant analysis results.

Besides, the following modifications are, also, recommended.

(8) Recovery of ammonia in the fuel gas.

(9) Recovery of combusible gas in the vent gases.

(10) Recovery of urea and ammonia components in the waste water (Crystallizer vapour).

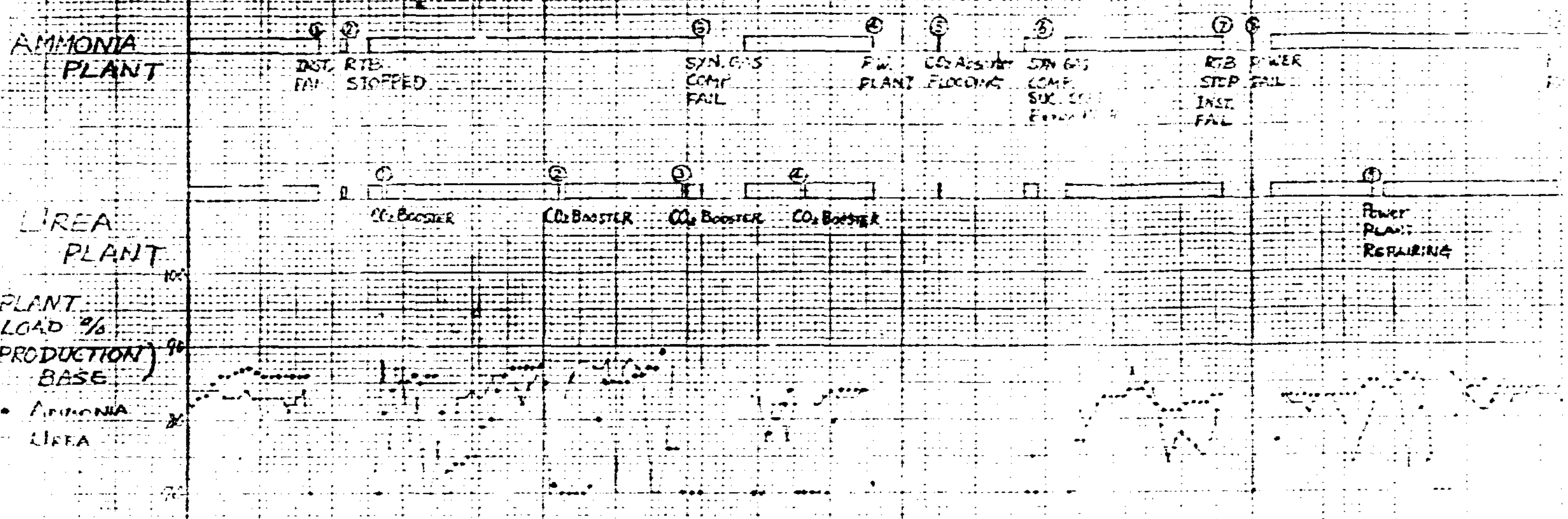
(11) Modification of instruments of ammonia and urea plants.

(12) Replacement of old aged instuments of ammonia and urea plants.

Recommendations for the preparation of spare parts and equipment for the maintenance work of equipment, rotary machines and instrument are also discribed.

Table 2.1 Ammonia and Urea Plant Operation (Activities of UNIDO Team)

	1979					1980	
	OCT	NOV	DEC	JAN	FEB	MAR	APR



MONTHLY PRODUCTION (UREA TON)	26,400	20,800	25,500	15,400	10,100	22,900	25,200

TEAM ACTIVITIES

ARRIVAL DACCA

	NOV	DEC	JAN	FEB	MAR	APR
AMMONIA OPERATION	GENERAL INVESTIGAT'N; PLANT SHUT DOWN REPAIRING	AIR Comp^r INVESTIGAT'N; CO2 Absorber & GV System INVESTIGAT'N	CW Adjustment; Steam Balance; Steam Traps check	Minor Overhaul	PLAN for TURNAROUND; CW Adjustment; CW Balance of Ammonia plant	Preparation; [illegible]
UREA OPERATION	Ditto	Dehumidifier Repairing plan; NH3 Loss INVESTIGAT'N	Waste Water Balance; Raw Water Balance; PW Plant Repair	Minor Overhaul	Plan for Turnaround; INVESTIGATION ON CW TOWER AMMONIA AND UREA	[illegible]
AMMONIA MAINTENANCE	Ditto; IRF BURNERS ADJUSTMENT	CO2 Booster repairing →; ① Bearing ② OIL TK CLEANG ③ Alignment ④ AIR Exhaust Fan; IRF Flue gas duct Repairing	PW Plant Repair	Minor Overhaul; CW Tower Modification; A/F FAN; CW DISTRIBUTION PLATE	PLAN for TURNAROUND	[illegible]
UREA MAINTENANCE	Ditto; UREA SOL'N CIRC. PUMP REPAIR →	NH3 preheater repairing →; CO2 Comp^r repairing	NH3 plunger pump; CO2 Booster Repairing	Minor Overhaul; Air Comp^r Repair	Plan for Turnaround; NH3 Preheater Modification	
INSTRUMENT	Ditto; Em. & Alarm Inst. CHECK; FEEDSTOCK NG FLOWMETER REPAIR	CW Flow Meter → Total 8 installation; Other repairing works	CO2 Analyzer; Drum Level Inst. Modification plan; Local Em. Sys. Investigation	Minor Overhaul	Plan for Turnaround; ALARM of Ammonia Plant Modification	[illegible]
PURE WATER					INVESTIGATION OF PURE WATER UNITS	

and Urea Plant Operation Record
...ies of UNIDO Team)

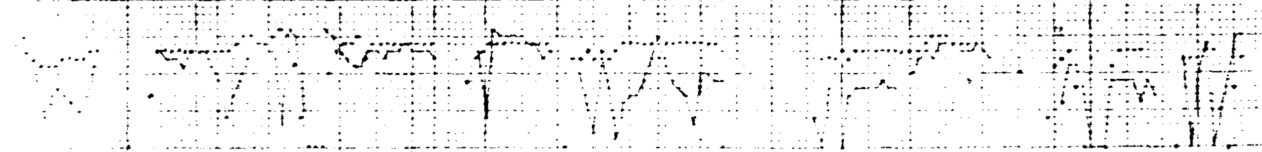
1980

MAR	APR	MAY	JUNE	JULY	AUG

TURNAROUND

POWER FAIL — POWER FAIL — SYN. GAS COMP GOV. FAIL — NG. SUPPLY FAIL — AUX. BOILER ACCIDENT — BFW LINE BREAK — SYN. GAS COMP. INTERCOOLER TUBE BREAK — BFW LINE BREAK

Power Plant Repairing



22,700 — 25,200 — 23,300 — 15,000 — 20,600 — 15,400

Plan for TURNAROUND — Preparation for Data gathering — (Home leave) — SOP of Ammonia plant
Adjustment — (Home leave) — NH3 Synthesis Loop & REFRIGERATION Loop Analysis →
Balance of Ammonia Plant — MATERIAL BALANCE for NH3 plant

Plan for Turnaround — Urea plant Overall analysis Trial 1 — (Assignment Over)
... on CW TOWER Ammonia and Urea

Plan for TURNAROUND — (Home leave) — Preparation for Data gathering — Aux. Boiler GV Safe... Repairing — FINAL CHECK of the Plan for TURNAROUND — PM check list — Spare parts list
RATE

Plan for TURNAROUND — NH3 Preheater Modification — Reporting for NH3 Synthesis Loop — Modification of CW cooler — (Assignment Over)

Plan for Turnaround — ... of Ammonia plant Modification — (Home leave) — Preparation for Data gathering — INSTRUMENT for Urea plant, Investigation — Modification plan of INSTRUMENT — FINAL CHECK of the PLAN for TURNAROUND

SECTION 2

Table 2.2 Record of Production of Ghorasal Plant
(100% Production Urea 1,137 T/D, NH3 660 T/D)

	1980			1979		
	NH3 Production T/D	Urea Production	Consumption T/D	NH3 Production T/D	Urea Production	Consumption T/D
11/11	211	43	99.0	301	236	191.7
12	519	818.8	504.4	-	-	-
13	550	957.3	589.7	258	369.0	308.2
14	564	990.1	609.9	308	834.2	513.9
15	566	985.7	607.2	448.	1,006.9	618.1
16	579	980.8	604.2	537	862.8	531.5
17	584	991.4	610.7	555	987.6	608.3
18	582	995.9	613.5	560	993.1	611.7
19	588	1,014.2	624.8	562	877.6	540.6
20	594	1,027.4	632.9	566	941.8	580.1
21	597	975.3	600.8	563	562.5	346.5
22	605	948.6	584.3	567	528.0	350.0
23	610	989.9	609.8	567.	875.6	539.4
24	610	1,013.2	624.1	530	829.7	511.1
25	611	1,000.8	616.5	480	706.0	461.3
26	608	990.1	609.9			
27	608	995.1	613.0	490	948.2	584.1
28	610	1,011.5	623.1	495	955.1	588.3
29	611	1,039.1	640.1	498	946.6	583.1
30	611	1,042.3	642.1	497	959.4	591.0
12/ 1	613	1,034.4	637.2	523	976.2	601.4
2	610	971.6	598.5	530	973.5	599.7
3	609	987.6	608.4	553	972.5	599.1
4	604	570	351.2	568	972.4	599.0
5	609	787.9	485.4	572	972.2	598.9
6	607	586.1	361.0	575	931.8	574.0
7	611	898.1	553.2	576	961.9	592.6
8	605	1,021.0	629.0	577	976.6	601.6
9	607	1,020.8	628.8	577	979.5	603.3
10	613	1,037.2	638.9	559	645.7	397.7

	1980			1979		
	NH3 Production T/D	Urea Production	Consump-tion T/D	NH3 Production T/D	Urea Production	Consump-tion T/D
12/11	613	1,047.9	645.5	467		
12	606	1,056.5	650.8	458	111.0	166.0
13	608	1,042.2	642.0	461	946.1	582.8
14	605	1,036.5	638.5	464	976.4	601.5
15	598	1,037.9	639.4	464	989.9	609.8
16	582	1,030.3	634.7	468	986.0	607.4
17-22	Urea prduction continued above 1,000 tons/day					

Note 1. Urea production figure is obtained by dividing ammonia consumption figure by 0.616(unit consumption of ammonia), when the production exceeds 300 tons in that day, but the leading of conveyor scale used in a day production is less than 300 tons in a day

Note 2. At present, the limitation of production is foaming problem in CO_2 scrubbing section. When foaming problem is solved, 95% production may be possible during winter. In summer, production will be limited by compressors and ammonia condensers.

Note 3 The improvement of production this years will be attributed to the improvement of cooling water tower performance, reduced pressure drop in CO_2 absorber, improved performance of Hyper-compressor inter-cooler, improved performance of air compressor and the solution of the problem of CO_2 booster compressor.

3. Team Organization/Duration

(1) H. JINDAI - TEAM LEADER

Process Engineer (Ammonia Plant)

14 Yrs experience in Ammonia Plants.
Participated in the investigation of the Ammonia Plant in addition worked as the Team Leader.
Prepared the analysis for Synthesis Loop and Refrigeration Loop.
Prepared the plan for De-bottlenecking of the Ammonia Plant.

(2) K. MINAGUCHI - Process Engineer (Ammonia Plant)

20 Yrs experience in Ammonia Plants.
Participated in the investigation of the Ammonia Plant.
Suggested modification of operating conditions of the Ammonia Plant.
Prepared the Heat and Material Balance for the Synthesis Gas Generation Process.
Prepared the Steam and Cooling Water (CW) Balance.
Prepared the Check List for the Emergency Trip of the Ammonia Plant.

(3) S. TAICHI - Process Engineer (Urea Plant)

10 Yrs. experience in Urea Plants. Participated in the investigation of the Urea Plant.
Suggested modification of operating conditions of the Urea Plant.
Prepared the analysis for the Ammonia and Urea Plant CW Tower.
Prepared the plan for the repair of the Dryer

for the Urea Bulk Storage.
Prepared the analysis for the Urea Plant.

(4) I. MIKAWA - Process Engineer (Urea Plant)

20 Yrs. experience in Urea Plants and some experience of Petroleum Chemical Industries.
Participated in the investigation of all plants including Urea Plant.
Prepared the Supply Water and Waste Water Balance for the whole of the factory.
Prepared the preliminary study for the Water Treatment Plant.

(5) M. NARUO - Process Engineer (Urea Plant)

5 Yrs. experience in Urea Plants.
Prepared the analysis and the De-bottlenecking Plan for the Urea Plant in co-operation with Mr. T. IWATA.

(6) T. IWATA - Process Engineer (Urea Plant)

20 Yrs. experience in Urea Plants.
Prepared the analysis and the De-bottlenecking plan for the Urea Plant in co-operation with Mr. M. NARUO.

(7) M. NAKAJIMA - Mechanical Engineer.

25 Yrs. experience in Plant machine maintenance of Ammonia and Urea Plants.
Employed in the daily maintenance and repair of the Ammonia Plant.
Supervised the modification of the Air Fans and the Distribution Plates of the Cooling Water

Tower of the Ammonia Plant.

Co-worked in reducing the steam loss from the Steam Traps.
Identified the cause of trouble and procedure for the repair of GV Solution Pump, Air Compressor and Carbon Dioxide Booster Compressor.

Prepared the daily maintenance check list for the Rotary Machine.

Prepared the treatment for the WHB.

(8) M. NOMURA - Mechanical Engineer.

23 Yrs. experience in machine maintenance of the Ammonia and Urea Plants.

Participated in the daily maintenance and repair of the Urea Plant.

Supervised the daily maintenance of the High Pressure Reciprocating Machine of the Carbamate Pump, Liquid Ammonia Pump and Carbon Dioxide Compressor.

Suggested the procedure for the repair of the Ammonia preheater.

(9) C. UEHARA - Instrument Engineer.

35 Yrs. experience in Planning, construction and maintenance of instruments.
Participated in the repair, investigation and planning for the modification of the Ammonia and Urea Plants.

Supervised the procedure for the repair of each unit of instrumentation (individual instruments) Prepared the plans for the replacement and modification of the Ammonia and Urea Plants.

Prepared the plan for the modification of the Emergency Trip. System of the Ammonia Plant.

(10) K. KAWAI - Water Treatment (Pure Water)

17 Yrs. experience in Pure Water Facilities. Employed in the investigation of the Pure Water Plant and identified the cause of trouble in the Pure Water Plant and suggested counter-measures.

(11) R. NIWA - Water Treatment (CW Treatment)

15 Yrs. experience in the field of corrosion inhibitors for Cooling Water.

Employed in the investigation of Cooling Water System of the Urea Plant and suggested to change the corrosion inhibitor from Chrome base to Phosphate base and supervised the execution.

Assignment Duration of UNIDO Ghorasal Team

	Name	Assignment	1979 OCT	1979 NOV	1979 DEC	1980 JAN	1980 FEB	1980 MAR	1980 APR	1980 MAY	1980 JUN	1980 JUL	1980 AUG	1980 SEP	1980 OCT	1980 NOV	1980 DEC	
1	H. JINDAI	PROCESS (AMMONIA)	23								27	29					19	393
2	K. MINAGUCHI	PROCESS (AMMONIA)	30						15	16			22					268
3	S. TAICHI	PROCESS (UREA)	23							29								220
4	I. MIKAWA	DITTO	30				8											102
5	M. NARUO	DITTO													24		9	47
6	T. IWATA	DITTO													24		9	47
7	M. NAKAJIMA	MECHANICAL	31						15	16			22					268
8	M. NOMURA	DITTO	30							29								213
9	C. UEHARA	INSTRUMENT	31						15	16					31			338
10	K. KAWAI							18	8									22
11	R. NIWA											29	22		7	14		64
													21 Turnaround 25					1982 man-days

4. Summary of the Team's Activities, Findings and Recommendations

4.1 Duration of Team Assignment

The one year duration of the assignment of the team may be divided into 3 periods. The first period was from November, 1979 to March, 1980.

During this period of 5 months the team concentrated on the stabilization of the plants.

By November, 1979, the plant had already been operated for more than one and a half years since the last turnaround and the conditions of the equipment including instruments were very bad. For example the bearing temperature of the major Rotary machines were high and the pressure drop of the carbon dioxide (CO_2) absorber was very high. Consequently one of the first tasks undertaken by the team was assisting UFFG in the settling of these problems in order of priority.

During February due to the flooding of CO_2 absorber, the decision was taken to replace the Rasching Rings. A plant overhaul of a minor scale was simultaneously undertaken which effectively helped in the stabilization of the plant.

By April, stabilized operation in the ammonia plant was apparent.

The second period extended from April, 1980 to August, 1980 during which the team made every effort to gather relevant data and prepare the plan for De-bottlenecking. Studying this plan, it is comparatively easy to identify the problem areas individually, for example, when one compares the actual operating conditions with the designed conditions. However it is essential to confirm that instruments are operating correctly and within the allowable limits. In order to prepare a practical modification plan, analysis of actual working conditions in the plant is to be the foundation of such planning.

The Ammonia and Urea Plants adopt the continuous flow system and each unit is therefore interacting on each other. To stabilize each unit and to keep the conditions constant is a pre-requisite as well as maintaining the accuracy of the instruments.

During the second period, the team was able to ather sufficient data for plant analysis.

Preparation of modification plan for the Cooling Water Tower, Cooling Water System and ammonia condenser of ammonia plant is one of the more important assignments undertaken by the team. The process of the preparation for the modification plan was executed as follows:

(1) General investigation of CW Tower and CW System was undertaken. It was found that the Air Fans of the CW Tower were not adjusted properly and that the Distribution plates of the CW Tower were not installed correctly. These have been rectified.

(2) Repair of the flow meters on the CW line by repairing and diverting the idling instrument. It was discovered that the CW flow rate was 135% of the CW Tower design. The adjustment of the CW flow rate to steam turbine condensers was recommended.

(3) Analysis of the heat load of CW in parallel with the analysis of the process side were carried out. From the result of this analysis it was determined that the CW flow meters for the ammonia comdenser were incorrect. It was consequently found when the CW line was opened during the overhaul, that there was a specification or manufacturing error in the orifice plate of the flow meter.

(4) The analysis of the CW Tower, whole plant heat balance and refrigeration system has been made and the modification plans based on actual data have been prepared. During the plant analysis, several flow meters were found to be faulty. The computer in the computer center of the Bangladesh University of Engineering and Technology was utilized for the CW Tower analysis and case study to decide the specification of CW Tower.

The third period began in September, 1980 until the departure of the team in December, 1980.

During this period the overhaul was executed. The manufacturer's experts were invited during the overhaul by UFFG and were assigned to the actual repair, or supervised such repair. The The team during this stage acted as adviser to UFFG.

After the overhaul when the plants were restarted, the foaming trouble of the GV System was again apparent. Extension of stay of the team initiated in order to fight this trouble.

At the end of the team's assignment, the operation and production of the plant had improved. (Ammonia

& Urea Plants operation record)

4.2 Utilization of Plant Capacity

It was determined that the plants can be operated at 86% for the ammonia and 88% for the Urea Plants during the summer.

The following modifications contributed to this achievement:

(a) Modifications to the cooling water tower and the operating procedure of the cooling water system.

(b) Inert gas purging procedure of the ammonia condensers.

(c) The operating procedure of the carbon dioxide removal unit.

During the period of 86% load operation in the summer, the ammonia plant load was found to be restricted by the inter-cooler of the Synthesis Gas Compressor. The discharge gas temperature of the Synthesis Gas Compressor was so high that it did not allow a higher plant load and discharge pressure of the compressor.

The problem of the inter-cooler was identified as being due to the superannuation (age) of the tube bundle. This has been replaced by a new bundle imported by UFFG at the beginning of the overhaul.

The Urea plant load was restricted mainly by the feedstock supply from the ammonia plant. However, the capacity of the high pressure decomposer was an additional restricting factor.

The "on-stream" days of the plant remained at 270 days. The number of "on-stream" days remained low due to operation trouble in the auxiliary Boiler and Carbon Dioxide absorber and also due to plant trouble, failure of Natural Gas supply and power failure. These troubles were beyond the control of the team. If these had not occured the plant could have been operated for more than 310 days.

The days required for repairing the Carbon Dioxide absorber were utilized as mentioned earlier for a short term overhaul of the plant.

As regards the auxiliary Boiler, before its re-start, the team prepared a brief S.O.P. (Standard Operation Procedure) for starting up of the boiler and explained this to the operators concerned.

4.3 Modification of the Plant

Regarding the modification and/or De-bottlenecking of the plant, 16 items are stipulated in Annex G of the ammendment of contract.

The team has tackled these items and prepared practicable recommendations. Besides the 16 items mentioned, a further number of modification plans are included in this report.

These 16 items and the UNIDO original recommendation include the major items described in the reports of M/S. Bresler Associates Inc., and M/S. Chemie Linz A.G. The item number and description of the 16 items in Annex G are as follows. Detailed description are given in this chapter and the specification in Appendix of this report.

Description of items of Annex G and the proposed modification plans are as follows:

(1)-C10 (Number in Annex G) Improvement of the efficiency of the Cooling Tower in the ammonia plant.

The Cooling Water Tower should be increased by two cells. The capacity will then be 3,000 t/h. The CW for the Carbon Dioxide (CO_2) Booster, CO_2 Compressor and the CW for CO_2 Generation and I.G. Generation plants are, at present, supplied from the ammonia and urea plant CW loops. These should be separated and the supply should be made via a new CW Tower to be constructed.

This plan is the result of studying the problems of the existing CW system and related modifications to the CW loop of both plants are recommended (5.1.1).

(2)-011 To improve the efficiency of the ammonia Refrigerator Condensers

These should be one more condenser installed, thereby, increasing the capacity by 50%.

As fouling is taking place on the ammonia side of the condensers. It is assumed that the fouling of CW side is also affected. CW for the new condenser shall be supplied from the CW spared by separating the CO_2 Booster. Other related modifications are set out in the same chapter (5.1.2).

(3)-012 Improvement of the efficiency of the Reformed Gas Waste Heat Boiler (RFWHB)

The Reformed Gas Waste Heat Boiler is not deteriorated.

The low generation of steam, as compared to the planned value, is due to low plant load and low temperature of the Secondary Reformer outlet gas.

(4)-013 Improvement of the efficiency of the Cooling Tower - Urea Plant

This item is included at item No. 010.

(5)-021 Improvement of the efficiency of the Recovered ammonia condenser

It is recommended that one additional condenser should be increased in parallel with the line of existing ammonia condensers.

The Cooling Water for this new condenser shall be supplied from CW spared by separating the Carbon Dioxide (CO_2) and Inert Gas Generation Plants.

(6)-022 Reduction of ammonia consumption per ton of Urea

The present loss of ammonia was measured and estimated as follows:

		Urea ton/day
(1)	Crystallizer vapour	15.0
(2)	Dust chamber	3.5
(3)	Wet cyclone	2.0
(4)	Ammonia PL-pump	6.0 - 8.0
(5)	R.C. pump	4.0
(6)	Melter	0.5
(7)	Misc pump	2.2
	Total	33.2-35.2

(1) Crystallizer vapour

The process for the recovery of ammonia and Urea loss from the vapour out of the crystallizer is patented by MITSUI TOATSU Chemicals, Inc.

The team believes that a change of process would be feasible and economical and recommended that this item be studied. This new process can be effective in recovering the loss from the crystallizer (CY) by 3,000 t/y. The present loss is 4,500 t/y. It can also reduce the problem of the waste water pollution.

(2) Dust chamber

The loss from the Dust chamber should be minimized by rectifying the spraying water nozzle. There is a patented process by MITSUI TOATSU Chemicals Inc. for anti-air pollution but is probably not suitable for the Ghorasal Plant for economical reasons.

(3) Wet cyclone

Same as (2).

(4) Ammonia PL-pump (4+1 pumps)

It is possible to reduce the loss by proper maintenance. The loss from a pump should be less than 0.3 t/d.

When all pumps are maintained properly the loss will be within allowable limits.

The modification of the gland packing cooling unit as planned by the plant operation manager of UFFG is expected to aid the maintenance of the gland packing. The utilization of a centrifugal pump is not recommended.

(5) R.C. pump

It is recommended that these 5 pumps be changed to one centrifugal type pump.

This recommendation is based on the fact that this will reduce the ammonia loss and will also facilitate maintenance. The present pumps are corroded, crank and bearing particularly are in serious condition. The material of these pumps is a special alloy and maintenance is costly.

Maintenance of the centrifugal pump should be undertaken with care as plant fluctuation increase the risk of damage to the pump. For continuous operation of long duration, special caution/maintenance of instruments is essential.

(6) Miscellaneous pumps

The leakage from the mechanical seals of the pumps is considerable.

The cooling water planned for the ammonia plunger pump is to be branched to the mechanical seal of the ammonia Booster pump.

The stuffing box of the High Pressure Absorber Solution pump (HA pump) had been changed by UFFG from a mechanical seal type to gland packing type. Gland packing can be utilized but conversion is not complete. The stuffing box has to be improved.

For correct estimation of ammonia consumption per ton of Urea, the standard Oval Flow Meter is recommended in this report.

(7)-030 Colloidal Silica/Ionic Silica Control in the Boiler Feed Water (BFW)

One water treatment expert was brought to join the team (utilizing the back-stop man-months) and proper investigation of the Water Treatment Plant was carried out.

As a result of the investigation the cause of the high silica concentration was defined as below:

(i) High ion concentration in the raw water. The concentration is 30% above the basis for design of the system.

(ii) The capacity of the ion exchange resin has dropped by 30% due to superannuation (old aged).

(iii) Insufficient regeneration of resin.

(iv) High temperature of the steam condensate.

During the year under review there was no serious problem of silica slip or that of colloidal silica. During the dry season the pure water units had to be operated at full capacity although the ammonia/urea plants were operating at only 86-90% capacity. This was due to the reason that the raw water hardness too high. The quality will tend to deteriorate further in future. It is, therefore strongly recommended that one more unit should be added to the existing pure water unit.

Specification of new pure water plant

It is recommended that the same type of plant be installed as the existing one. By using the same type of equipment, spare parts and man power become interchangeable.

In this way the quantity and difficulties in procurement of the spare parts will be minimized. Also the number of operators does not need to be increased. A different type of plant may create confusion among the operators and maintenance staff.

(8)-040/041 Study and Control Strategy of Steam Let Down System and Implementation of Recommendation for "B" Class Trip

Regarding the Steam Let Down System the steam pipes were modified by UFFG during the last overhaul and the capacity of the Let Down Station improved so that the capacity is sufficient for 100% Ammonia plant load. The facilities of the Ammonia plant for the B Class Trip are therefore adequate.

On the other hand the practice of B Class Trip is not recommended by the team because of the technical difficulties which operators have to face.

The dynamics and/or fluctuation pattern of the plant during the B Class Trip is completely different from the A Class Trip (Complete Shutdown) and may cause the serious damage to the plant by miss operation. During a B Class Trip,all the operators are required to know which parts have tripped and which parts are operating. This is essential because certain conditions which are difficult to control are to be maintained.

In an A class Trip everything is shutdown.

except the steam system, therefore, the requirements for this type of shutdown is comparatively simple. It is the practice at present that during an A Class Trip (Complete Shutdown) all the shift workers i.e. shift-in-Charge, Foreman, Operators leave control room to field and no-one is available observed in the control panel. This is not solely due to the fact of extra work in the field, but possibly due to inconscious fear, because of past mishap in the control room.

However it is essential that control room operators must be present to observe all the conditions. Under the present conditions the situation is such that B Class trip is considered unsuitable. Proper number of experienced operators are to be placed in position before "B" Class trips are resulted to.

The first step in training for an A Class emergency shutdown is to familiarize the operators with the emergency shutdown drill and procedures (referring to the check list provided). The aim should be to have thoroughly drilled personnel who capable of undertaking any emergency knowing the procedure and undue excitement in the Control Room.

(9)-
042/043 Study and Recommendation of Reducing the causes of Trips and the Implementation of Recommendation

The team has investigated the causes of trips incorporated in the system and found that 10 causes incorporated are not essential to the safety of the plant and can be removed from the system.

The list of causes recommended to be taken out of the system are elucidated in appendix.

Reversely, team prepared a list of trip causes to be put on line of emergency sequence which have been by-passed because of the malfunctioning in past.

In order to increase the reliability of the Trip System and plant security, several schemes were recommended and adopted by UFFG and it was intended to execute this scheme during the overhaul. For this purpose the Instrument Engineer's assignment was accordingly extended by two months. However, in spite of the best efforts on the part of UFFG the spare parts did not reach the site in time and the Instrument Engineer had to leave at the end of the overhaul without being able to execute the schemes.

The detailed information for instrumentation was submitted and is included in Appendix.

(10)-044 Preparation of check list for Preventive Maintenance (PM)

The check list for daily maintenance of the air compressor has been prepared.

The major three compressors excluding the Synthesis Gas Compressor (i.e. air Compressor, Refrigerator Compressor, Carbon Dioxide Booster Compressor) are all of the same type and arrangement and the check list prepared for the air compressor is equally applicable to the other two compressors.

The check list for Preventive Maintenance (PM) of the process line has also been prepared.

The check list for overhaul of the ammonia and Urea Plants has also been prepared.

The check lists above-mentioned are included in appendix.

These lists were used during the last overhaul.

(11)-045 Effluent Disposal

Prior to examination of this problem, the waste water balance was prepared. In order to check this balance the water consumption balance was also prepared in order to obtain a clear picture of the water balance of the whole factory. One of the modifications, the cooling water treatment of the Urea plant has been changed from Chrome Base corrosion inhibitor to Phosphate Base corrosion inhibitor.

One water treatment expert was attached to the team on two separate occasions, utilizing the back-stop man-months.

The initial assignment of this expert was to investigate the feasibility and the second assignment was to enforce the change over of the corrosion inhibitor.

The change over was smoothly carried out with the assistance of the expert.

The report and procedure for daily maintenance was submitted to UFFG and are enclosed with this report.

In the future when the effect of a polyphosphate corrosion inhibitor has been confirmed to be satisfactory, the corrosion inhibitor for the ammonia plant cooling water tower should also be changed.

Ammonia contamination of waste water;
when the improved process of the crystallizer and other counter measures are introduced (as out lined in item 022) this problem will be minimized.

Re-Arsenic contamination:

There is no leak from the process side which is apparent from the result of analysis. This was checked daily and when a small quantity was suspected repair work was promptly carried out.

Re-Oil Contamination:

This is due to leakage from the rotary machine. Proper daily maintenance is essential for elimination of leakage. All leak points are clearly visible.

(12)-046 Preparation of level and type of spares

Leakage of steam had been observed at the small valves for the high pressure steam lines. All the steam traps and by-pass valves were checked and repaired. As earlier stated, steam loss was reduced by 3-5 t/h. However the leakage has not been completely rectified because the valves and traps are in deteriorated conditions and are beyond repair.
All the traps and valves should be replaced and a list together with specifications has been prepared.

Other valves for the process lines were checked and the list prepared. Spares should be maintained at 10% of the total number installed.

Re-Carbon Dioxide Booster Compressor: The rotor, casing and inter-coolers are seriously damaged by corrosion. These should be replaced immediately.

(13)-047 To minimize the overhaul period

The job list and check list including instrumentation were prepared and submitted to UFFG in March 1980, 5 months prior to the start of the overhaul.

Consideration and decision on priorities of the same are in the hands of UFFG.

The suggestion of utilization of temporary power connection enabled the working schedule to be improved. By utilizing the temporary connection for utilities the period of overhaul was reduced by at least five days.

(14)-050 Preparation of Standard Operation Procedure (SOP) in the light of the present plant condition.

The senior operators who have about 10 years experience are well versed with the daily operating control points and function of the plant condition to an extent. This is mostly because the control range and the number of control points are not too numerous, but during the time of emergency shutdown all the shift workers leave the control room as mentioned above. This practice needs to be remedied.

The present practice could be dangerous because no-one is aware of the whereabouts of another or the actual condition of the plant nor even can it be known whether or not the safe shutdown action is complete.

From observations and conclusion the team prepared a check list for AA Class Trip and A Class Trip.

With these check lists as the basis for consideration and understanding it is hoped that the shift workers will be able to obtain the necessary insight for each action as given in the check list.

The brief start up procedure of the auxiliary Boiler was also prepared and submitted before start again the Boiler--this was also explained to the operators. It can be utilized as the model for Standard Operation Procedure (SOP).

The most important advantage to be gained by the preparation of this SOP is the operators themselves should now be able to prepare SOP using this SOP as models.

By preparing the start up procedure or shutdown procedure temselves the operators will be able to acquire a sound knowledge of each unit, function of each operation and critical points in the process. Obviously the senior engineers should guide the operators correctly in the respect.

Although the operators may well be conversant with the standard procedures. Nevertheless they are asked to write in detail about the pump start up procedure e.g. which valve should be opened first and the degree to which it should be opened, then they will understand better the relationship between the pumps and the process as well as learning the characters of the pumps.

In addition to Annex G the following De-bottlenecking schemes are recommended.

- Air Compressor

  It is recommended that the size of the compressor be increased. The capacity of the existing compressor is insufficient for 100% load operation. During the summer it is sufficient for only 95% load operation or even less.

  Low performance may be due to increase of Instrument air (IA) consumption, leakage of air through the labyrinth seal and deforming of rotar.

  If the IA extraction is stopped that is the IA source is transferred to the new IA compressor which has been already installed and the labyrinth and rotar of the old compressor are rectified then the capacity will be bordering the 100% load factor.

  In this scheme there are three problems.

  Firstly the discharge pressure from the new IA compressor is controlled by an unloader which allows too much fluctuations. IA pressure may vary between 6.0Kg to 7.0Kg. It is therefore unsuitable for this purpose as well as for the IA system as a whole (Please see Appendix VII.)

  The second problem is that the new IA compressor is a reciprocating type, therefore the problem of cylinder valves is unavoidable.

  When the IA source is to be changed from the process compressor to the new IA compressor (which becomes necessary when the low IA pressure alarm switches on) the plant condition is disturbed.

The third problem is such that deterioration of the labyrinth seal and rotor of the centrifugal compressor such as air compressor is unavoidable under long term continuous operation, therefore the air compressor should have some built-in allowance.

It is recommended that the size of the compressor be increased and air for the instruments be supplied from the existing compressor. The required air increase is 2,000 Nm^3/h at 33 Kg/cm^2. The increase of consumption of steam may be avoided by modifying the steam inlet line.

The pressure drop of the steam inlet line is estimated to be about 1.5 Kg/cm^2. The high drop of pressure is the obvious cause of the drop in the efficiency of the turbine.

The corresponding ΔP or dP of distribution are as follows:

Pipeline:	0.5^k
Orifice for flow meter:	0.5^k
Separator:	0.5^k

The orifice and separator can be removed from the steam line. It would be wrong to assume that when the traps on the main header are working properly the drains can find their way into the turbine.

- Boiler Feed Water Pump/GV Solution Pump

There are two steam driven pumps meant for normal operation whereas motor driven pumps are meant to be stand-bys, but in actuality the motor driven pumps are being operated leaving the steam driven ones idle. This is due to shortage of steam.

The cause of shortage of steam is due to the low load of the Primary Reformer, low temperature of the Secondary Reformer and loss of steam at various loss points.

After reduction of steam loss and adjustment of Cooling Water consumption one of the two pumps can be operated by steam turbine.

The capacity of the transformer of the ammonia plant is 5.6 MW and the normal consumption when the two pumps are operated by motors, the total load on this transformer adds upto 5.3 MW, therefore, under this marginal condition it becomes extremely difficult, if and when the operating CW pump (1,000 KW) needs to be switched over to the stand-by. If one of the two pumps is driven by steam turbine then the transformer will have sufficient allowance for easy change over.

It is recommended that the GV solution pump be driven by steam turbine because its steam consumption is less than the BFW pumps.

It is recommended that the BFW pump driven is changed to motor driven for safety reasons with these two modifications CW pump, GV solution pump and BFW pump can utilize the stand-by pump when required.

- Steam System

The steam balance of this plant is obviously very tight and the team recommends the following study and modification.

Firstly, the number of tubes in the Flue Gas Waste Heat Boiler should be increased. By this modification the steam generation may increase by 3-5 t/h. At the same time the temperature problem of the Feedstock preheater (FPH) could be resolved.

Whether or not the capacity of the down comer and riser pipes is sufficient for the increase of steam generation has to be ascertained. It is assumed that these pipes have sufficient built-in allowance and this should be determined by approaching the boiler maker for the necessary data and information.

The second recommendation is to halt the steam to the middle pressure steam line. During normal operation this steam is not required. The connection is only to the sealing steam to the turbine of the Synthesis gas compressor and is usually used only for start-up. If it is required for normal operation as back up, the supply can be shifted to the low pressure steam line.

By this modification 2 t/h steam can be saved.

- Recovery of Gas

There are three gas venting points normally,

(i) Ammonia condenser purging gas,

(ii) High pressure and low pressure purging gas and

(iii) Sour oil trap vent gas of synthesis gas compressor.

The vent gas from the ammonia condenser can be appreciably reduced by modifications of the ammonia condenser and venting point of inert gas and it can be recovered in urea plant.

The high pressure and low pressure purging gas is mainly used as fuel for the auxiliary boiler and a part of it is vented from the vent stock in order to seal the stack.

Ammonia is present in this vent gas (4.5 t/d) and can be recovered by washing with water in a small absorber. The aqueous ammonia can be sent to the stripper of the Urea Plant which would be constructed for the necessary of the crystallizer vapour recovery.

By this modification the NO_x in the boiler flue gas can be reduced considerably.

The other venting loss from the traps of the synthesis gas compressor is estimated at 500 m^3/h and can easily be recovered by connecting the pipe for the vent line to the fuel gas line.

- Training

The field work was undertaken in co-operation with the staff of UFFG who were section chiefs or young engineers with around three years experience. Some of the young engineers are holding the positions of section chiefs.

The technology transfer, on the job training was successfully executed, e.g. the adjustment procedure for the air fan of the ammonia CW tower was demonstrated by the team expert, then the UFFG, staff undertook the work under the expert's supervision.

The repair and adjustment of the bearing of the rotary machines, the gap and alignment were measured and the result checked. By actually participating in the work the UFFG staff has gained confidence in the maintenance and procedure for repair.

In the instrument section the transfer of technology from the team expert to the instrument section personnel was sufficient, as the number of people involved in this section was about 20 only.

For the instrument section particularly trained technicians are required from abroad. It was gathered that several technicians from this section who benefited from our expertise will be going abroad soon to take up other assignments and therefore a total loss to UFFG. These persons had taken keen interest to learn from the team's expert, especially regarding technical aspects and identification of causes of trouble and how to rectify these difficulties. Their departure from UFFG will make the problem even more acute.

In the process engineering side the chemical engineers who were able to work with us closely were also relatively few as most of these graduate engineer are working on the shifts also. Due to their essential preoccupation with the plant operation they were unable to devote sufficient time for working with the team experts.

The area all circumstances at Ghorasal is such that at present it is not possible for the personnel to gain insight and practical knowledge of the machines and equipment. As a consequence the engineer at Ghorasal lack the confidence and conviction of their own ability to identify troubles and the remedial measure chalked out by them.

In spite of the above observation the fact remaining that the team's work could proceed smoothly and many points could be satisfactorially dealt with also indicates the close cooperation achieved between the team and the UFFG staff member.

In this regard we should like to express our gratitude to UFFG personnel, at the same time pointing out that whenever possible within the power of team close co-operation and understanding were achieved and transfer of knowledge was effected.

4.4 The Technical Level of UFFG Personnel

It has been observed that the period of experience of the engineers, operators and technicians at UFFG is very little. The maximum amount of experience in any one case is 5 years with few exception. For this reason they do not possess the ability to contemplate in terms of the complete factory nor even on a more limited scale when dealing with inter-connected plants.

There is no attempt to discuss any technical matters quantitatively and such discussions there are deal only qualitatively therefore instructions and advice are given in broad outline without giving into detail.

For maintenance and operation of a stabilized plant it is essential that persons with sufficient knowledge and experience are available to do the detail work involved.

In order to achieve a sufficient level of knowledge and experience it is necessary that training in the plant extends for a period of a minimum of 3 years.

During these 3 years, a fundamental knowledge of the factory can be obtained after which such knowledge can be applied in actual on the job situations. This is supported by the fact that these engineers, technicians and operators possessing more than 3 years on the plant experience made detailed practical and intelligent queries.

In order to improve the technical level within the shortest possible time the team proposes the following training scheme or actual on the job practice.

(a) Operation Section

To prepare detailed SOP of the plant themselves using the SOP provided by the UNIDO team for the start up of the firing of the auxiliary boiler.

As stated earlier in order to prepare a detailed SOP precise knowledge of the function of each unit is a pre-requisite as well as a having a thorough knowledge of the position, the inter-connection and the capacity of the equipment.

The senior personnel at UFFG were able to describe the SOP satisfactory and these others who were present and participated in the discussion have attained the knowledge necessary and will now be capable of following the SOP when they operate the plant because their participation in the preparation of the SOP.

(b) Maintenance Section

Daily checking of machines is recommended by referring to the check list prepared and attached with this report. In this manner the daily fluctuations in the condition of the machines and also the character of the machines can be readily understood. Referring to the detailed data in the check list and also by consulting the drawing a thorough knowledge and experience of the machine should be attained aiding discussion and identification the causes of trouble.

Discussion without reference to the data available results in the inability to identify all the relevant factors.

(c) Instrument Section

The knowledge and experience essential for maintenance of instruments is complicated and therefore takes a longer time to acquire because an instrument has numerous parts such as the loop, say detector, controller and valve and in addition mathematical ability to understand gain and feed back are necessary.

In order to aquire maintenance people within the shortest possible time it is recommended that only graduates from the University of Engineering of Bangladesh or other foreign universities be recruited. These new recruits should be allowed to repair the instruments from the former ammonia control room and kept in the warehouse after the explosion, in this way obtaining the necessary experience. Identification of causes of instrument failure and situation leading upto such failure is normally difficult. For this reason preventive maintenance is also difficult. Experience and thorough knowledge of the instrument in question is only aid to solving such problems, therefore, it is essential to provide the opportunity for practical training to the technicians with the capacity to learn within the shortest possible time.

4.5 The Condition of the Equipment in Each Section

(a) Reforming Section

Condition of the equipment of the primary and secondary reformer as a whole are maintained in good condition.

The operating condition of the reformer tubes is good. It is essential however to determine the life of the tubes and the schedule for replacement should be pre-planned as this operation is lengthy and requires the plant to be shutdown for a long period.

The spare burner for the secondary reformer should be available at site.

The linings and castable of the line from the primary reformer to the waste heat boiler inlet are to be repaired or replaced throughout. The lining can no longer be repaired by temporary (stop-gap) methods.

The thermocouples as well as the thermowell should be replaced and the position of the thermocouples rectified. It is assumed that the temperature indication of the process gas outlet of the primary reformer and secondary reformer and also the temperature of the flue gas outlet of the primary reformer are both low.

The CH_4 analyser outlet of the secondary reformer is useful as indicating the operating condition of the primary and secondary reformer.

From the point of view of reforming section maintenance the burner, lining and thermocouple are consumable materials.

In future breakage of bricks may be observed. For temporary countermeasure the wall of the hot spot should be cooled with air or low temperature steam and not be covered with any castable or steel box as this causes total damage to the brick hangers.

It is recommended that the CW line to the water jacket be shifted to the direct line from the secondary CW line. This is discussed in detail in the section on the ammonia CW tower.

(b) CO Conversion Section/Methanation Section

No indication of any problem is observed.

(c) CO_2 Removal Section

The foaming problem is the most serious in this section, total filtration is preferred in order to remove the foaming materials. The usual cloth filter is less effective as it does not retain the fine particles and the foaming material remains muddy.

For clarifying this kind of muddy and fine particles the combination of filter aid and precoat filter is usually adopted.

One of the filters has been recommend in the report of M/S. Bresler Associates Inc.

Regarding the source of these foaming materials apparently the adhered paper box (used for packing the ceramic rings) and insects find their way into the storage tank, make up tank and the recovery pit and pipelines of sewers.

In order to solve the problem of foaming it is essential that the possibility of stray elements finding their way into the system must be eliminated.

The ΔP of the absorber allowed should be 2,000 mm H_2O maximum. When ΔP exceeds 1,500 mm H_2O it is necessary to change the Raschig Ring.

It is usually sufficient to change the rings in #1 and #2 beds. However before deciding the number of beds to be changed each bed should be checked and it should be confirmed that the ΔP is caused by #1 and #2 beds. This operation was undertaken by the team in January, 1980.

As for the packing materials it is understood that carbon steel rings are used for the bottom part of the regenerator. Various types of plastic packing materials is also said to be available.

The problem of plastic packing material is its tendency to foam at high temperatures. This problem may be solved.

Ceramic rings are difficult to transpart because of the possibility of breakage.

The following arrangement is recommended.

Absorber #1, #2 bed	- Ceramic R.R.
Absorber #3 bed	- Plastic packings
Absorber #4 bed	- Steel R.R. or Paul Ring
Regenerator #1, #2, #3	- Steel or ceramic
Regenerator #4, #5	- Steel

In order to utilize the steel rings the anti-corrosion system patented by I.C.I. is with considering.

The handling of CW for the GV Solution Cooler is set out in detail in the section on ammonia plant CW Tower.

For the Solution Heat Exchanger one of two of the tube bundles was replaced by a new tube bundle. The remaining old tube bundle should be replaced.

(d) Synthesis Section

The catalyst of the ammonia synthesis convertor has been in use for more than 7 years. Although this is not the end of its life still it is recommended that it be changed because it may be contaminated by oil. In addition a good opportunity to change the catalyst presents itself while changing the primary reformer tubes as both operations take more than 40 days to complete, during which the plant be shutdown, therefore it is better to coincide these.

An additional factor is that after rectification of other parts, if the catalyst is not changed at the same time, this will become a future bottleneck.

The adjustment of H_2/N_2 ratio should be undertaken based on the process analyser.

To take the absolute value of the analyser indication is not important but it is essential to find, on the analysis recorder chart, the point by which the pressure of the synthesis loop becomes the lowest.

(e) Urea Plant

The fluctuation of the High Pressure Decomposer and the High Pressure Absorber performance was observed.

One of the causes is due to the deviation of NH_3 and CO_2 ratio or the circulation ratio of carbonate solution.

It is said that the flow rate of NH_3, CO_2 and carbomate solution are not clear. The problem of such a ratio control is however common on plants using the reciprocating pump & compressor.

The temperature is the important indicator for the identification of the charging ratio. Operators should understand the function of each feedstock charging ratio and find the correct temperature for certain operation loads.

This is the same as the H_2/N_2 ratio in the ammonia synthesis loop.

Regarding the level of the High Pressure Decomposer it is recommended that T.V. observation shall be installed to watch the level in the sight glass. For this purpose two corner as will be required one for the top sight glass and one for the second sight glass.

Shifting the position of the nozzle of the LICA-201 to the spare nozzle is worth attempting as the spare nozzle is 250 mm lower than the present LICA nozzle.

For the CO_2 flow meter FI-102 A/B the orifice should be checked because the range of the FI-102 A/B is too high considering the common design of flow meter.

Regarding the problem of corrosion of the Air Heater these equipment are to be replaced from time to time and should be considered as a consumable material.

(f) Pure Water Plant

Our recommendations are set out in appendix and the draft had been submitted earlier in March, 1980.

The pure water consumption will be increased to more than 20 t/h when the mechanical cooling medium for the stuffing box of the rotary machine will be switched from the CW to PW and the plant load will increase upto 100%.

A large quantity of sludge was observed in the PW line when the pipeline blowed after the repairing of the PW plant in January and also sludge was observed inside the level control valve of the De-aerator in the BFW line.

In both cases it was recommended to blow sufficient quantity of water and hammering the PW and BFW line. There is however no trace of hammering on the surface of the pipes.

(g) Ammonia Storage Tank

The modification of the PIC system for the tanks is recommended to make the balancing of the level of two tanks easier and to recover the vent gas from the tanks.

4.6 The Condition of the Rotary Machine

(a) IDF

The capacity of the oil cooler of this machine is insufficient and the replacement by a larger cooler is planned by UFFG. Simultaneously the CW line is to be changed to a 4 inch line and the flow meter installed (existing flow meter to be repaired).

(b) FDF

The governer and the main stop valve of the steam turbine is to be replaced. The effluent points of the steam traps and drain valves are adversely affecting the machine. The oil cooler is to be replaced.

(c) Ljungstrom air heater for the auxiliary boiler

The cooling device of the bearing should be checked. The condition of the interior of the cold air line is to be checked.

(d) BFW Pump

As previously stated, the idling turbine driven pump is to be modified to motor driven.

The pipes of the BFW line should be flushed out by water or steam.

The GV solution pump should be operated with turbine driven pump and the motor driven pump as stand-by.

It is worth checking if the governor and other auxiliary equipment of the GV pump, BFW pump, IDF and FDF are interchangeable.

(e) GV Pump

The minimum flow line was checked for erosion and was confirmed to be in sound condition.

The GV line and BFW line are to be checked for erosion problem as mentioned earlier.

(f) Air Compressor

The efficiency or condition of performance should be checked by fully opening the suction valve. The use of the vent valve (HCV104) for pressure control is not correct, and causes loss of power. The correct way is to use the suction vane.

The isothermal coolers are to be washed by the steam bubbling in the basin although it was dirty it was not included in the plan during the overhaul.

The by-pass line of the vent air line should be closed to prevent fouling of the impeller and the isothermal coolers.

The compression ratio of each stage of the LPC blade (measured by utilizing the by-pass line of the drain separator of the isothermal coolers) is decreasing with each successive higher stage. This indicates internal leakage of the compressor. The labyrinth seal of the rotor as well as the labyrinth seal of both shaft ends are to be repaired.

It was the practice by UFFG to keep the by-pass valve of the FCV-150 slightly open when starting the compressor, the UNIDO team had the valve closed. Whenever the team had recommended to close the valve and had assurance from the operators that it was fully closed, it was found that by the closing action the valve handle moved only 1 cm or 2 cm still the air to the secondary reformer increased about 300 Nm^3/h and the inlet temperature of the by-pass cooler decreased to atmospheric temperature. The drain trap and its by-pass valve of the separator should be adjusted in the summer when the capacity of the air compressor appeared as a bottleneck.

(g) Synthesis Gas Compressor

The suction pressure of the synthesis gas compressor can be raised when the air compressor is improved and sufficient discharge pressure becomes available.

The pressure drop of the process gas across the reforming section and the CO conversion section is extremely low in comparison with the designed value. This advantage is to be utilized.

By increasing the suction pressure by 1-1.5 kg/cm^2 the capacity of the synthesis gas compressor can be increased by 5% and the steam consumption will decrease by 5 t/h.

The kick back valves (FOV-506 and 509) are to be closed whenever the synthesis load reaches 85%, that is when the suction flow indication of the synthesis gas compressor of 70,000 Nm^3/h is sufficient for the anti-surge, to prevent loss of steam. The tightness or correctness of position of these control valves should be checked during overhaul.

Regarding the recovery of synthesis gas which is being vented into the atmosphere, the gas can be recovered easily.

The seal oil quantity of sour oil to the sour oil separators should be measured at intervals by closing the block valve of the LCV for a number of predetermined minutes. The accumulation of oil in the impulse line of FT of ACV and the bottom of the heat exchanger should also be checked.

By measuring the quantity of oil to the sour oil traps the quantitative analysis can be done to determine whether or not oil is leaking into the synthesis loop and to identify the casing of oil leaking.

(h) Refrigerator

Loss of power and cause of the low efficiency of the chillers (heat exchangers) of the synthesis loop is due to the suction vane of the Regrigerator being opened only 40%, even though the plant load may be 92%, and the kick back valve is opened 50%.

The smooth movement and correct position of the individual vane should be checked. After checking, the openings of the suction vane should be adjusted to get the proper temperature of synthesis loop.

(i) CO_2 Booster Compressor

The intercoolers, the rotor and casing of compressor are damaged seriously by the corrosion.

The corrosion is supposed due to the leak of CW into No. 1 intercooler of compressor.

The pressure of CW is higher than the pressure of CO_2. Whenever the leak of CW into the tube is taken place, it is sent to high pressure side and dried, therefore the Cl in the CW shall be deposite on the tube surface and causes corrosion.

Hence it is recommendable to control the CW flow rate by the CW inlet valve and to open the CW outlet valve fully.

Those coolers are to be replaced.

Regarding the bearing of speed increase gear, the three compressors, Air Compressor, Refrigerator and CO_2 booster, are used the same type and for all the gears the bearing temperature of pinion side are very high. This phenomenon could be attributed to the oil supply scheme. The modification of oil system shall be consulted with manufacturer. Regarding the governers of above three compressors, the governer for the air compressor has been replaced during the last overhaul, the other two should be checked and replaced.

Regarding the lubricating oil,
it is said that, in the lubricating oil, the manufacturer has added the antiforamer.
Whether the antifoamer is added or not to be confirmed to supplier and shall discuss with

the service engineers about foaming tendency of L.O. which is using with those three compressors.

(j) CO_2 Main Compressor

The liners of the cylinder were replaced during last overhaul, therefore the life of piston ring, can be prolonged. Regarding the material of piston ring, two kinds of piston ring were observed, one was fragile and the other was strong. The material of piston ring shall be confirmed to manufacturer and select the strong one.

The intercoolers and by-pass coolers are damaged by the corrosion. One of the intercoolers and one of the by-pass coolers are to be replaced. And the removed coolers are to be repaired and be ready as the spare.

(k) Recirculating Solution Pump/Ammonia Plunger Pump

The observation report and recommendation had been submitted regarding the manifold, cylinder valve and valve plate for Recirculating solution pump and the gland packing, the starting procedure and the retightening procedure for ammonia plunger pump.

4.7 Instrument

Generally the superannuation of instrument is proceeding. This situation is not only Urea Plant, but also Ammonia Plant of which instrument in the control room was replaced on 1975 after the explosion in the control room.

Regarding the controller of Urea Plant, the total replacement is recommendable. The multiple recorder of Ammonia and Urea Plant are to be replaced because the moving parts of them are worn and the life of them is supposed remaining only 2-3 years.

The analysers are also the same. The analysers which are not working can not be repaired.

The particular corrosion of Urea Plant is observed on the local instrument. Those instrument demaged by the corrosion should be replaced as a set, because the partial replacement shall be taken more cost and less reliable.

There are several instruments which are to be modified and/or change the type to improve the reliability. In this modification, the instruments, relating to the emergency trip system, are also included.

Regarding the flow meters, the mistakes of manufacturing the orifices were found. The orifices in CW system shall be checked as a whole. The portable type ΔP measuring instrument shall be prepared for the adjustment of CW flow rate. The problem of flow meter in the steam line for steam turbine is described formerly.

Recently new instrument Air Compressor has been facilitated by UFFG. In this connection, team has surveyed the IA system regarding the required IA pressure, IA supply system and the pressure decreasing speed at the time of IA failure. It was found that two actuators for the control valves shall be changed and parts of IA supply system shall be modified to harmonize the IA supply system and to secure the plant safety at the time of IA pressure fluctuation.

- Emergency Trip System

  By the investigation through the past record of plant shutdown, it is found that the remarkable number of emergency trip was caused by the malfunctioning of emergency trip system.

  It was also observed one during team stay in Ghorasal. However the strange facts of the tendency of plant shutdown was observed as is written later in this report. On the other hand side, as far as we have observed the effort to find out the real cause and to improve the reliability of instrument was insufficient.

  It is supposed that the unreasonable or unidentified emergency plant trip can be eliminated by careful watching by the instrument people and by the operation people.

  In this plant a lot of alarm annunciators are illuminating. The alarm is facilitated to give the caution of the plant fluctuation at its early stage to the operators.

  There is no annunciation between alarm and trip, therefore if the alarm has been illuminating under

Table 4.1 Ammonia Plant Mainpanel Annunciator

Panen	Ann. Numbers Total Ann.	Spare Ann.	Using Ann.	87% Load Lighting Ann.	Result of Set Adjustment Improvement Ann.	85% Load (Actual) Lighting Ann.	90% Load (Expectation) Lighting Ann.	Remarks
No. 3	30	2	28	9	8	5	1	COA-17(*1)
No. 6	40	1	39	14	9	14	6	(NOTE-1)
No. 7	30	1	29	4	4	1	0	
No. 9	40	12	28	8	7	5	2	FIA-502L(*1) PRA-506L(*2)
No. 10	30	7	23	9	0	9	9	All Standby(*3)
No. 11	30	1	29	0	0	0	0	
No. 12	70	2	68	3	1	3	1	PIA-121L(*2)
No. 13	50	2	48	4	3	3	1	PIA-173L(*2)
TOTAL	320	28	292	51	32	40	20	

NOTE 1: PIA-113L(*2) PIA-110L(*2) PIA-146L(*1) G-LICA-401L(*1) G-PA-401L(*1) G-LICA-402L(*1)

*1 This model including spare is not manufactured any more

*2 To be changed pressure switch type

*3 PUMP STOP ANN all standby

the normal operation, then nothing gives the alarm to operators before trip.

Further, when the alarm are illuminating so many then the operators pay less attention to the alarm. The recommended modification to switch off the alarm shall be carried out.

- Maintenance

The maintenance condition of instrument is not satisfactory. It could be attributed to the lack of number of experienced and skillful technicians. As is well-known, the demand for the instrument technicians in Middle East countries is strong and the prenty number of skilled technicians of Ghorasal factory has gone to those countries; as described formerly.

Although the circumstances of instrument section, is not favorable, still if the technical level of instrument were left as it is, obviously the services by instrument should be failed and the stability and safety of the plants shall be reduced.

Hence to recruit instrument technicians, team expects the recommendation will be put in force. And at the same time, team believe the daily patrol of technicians is effective to find the instrument failure at, early stage.

The tools and spare parts are also not stocked sufficiently. The lists of tools and spare parts recommendable have been prepared in later chapter.

The recommendations for modification of instrument are explained with detailed specification in later chapter.

- Documentation

There is no systematic documentation in instrument section. The difficulties to find out the document of specification or drawing cause the time loss and careless handling and miss adjustment of instrument repairing.

The required documents are as follows:

(1) Instrument schedule
(2) Final equipment drawing
(3) Loop drawing
(4) Hook up drawing
(5) Cable schedule
(6) Sequence drawing
(7) Panel drawing
(8) Instrumentation drawing
(9) Overhaul record, repairing/maintenance report.

All above described documents should be prepared by reprodusable papers.

The documents shall be revised whenever the instrument will be changed.

The accumulation of the records as far the test result and overhaul investigation are important source of know-how, and these records shall be effective for the training of technicians.

For the documentation besides above described, the copy machine and enough quantity of papers and book rack are required.

4.8 The Interval of Overhaul and Other Problems

The main reason for the lower production in 1979-1980 fiscal year was due to the long interval between overhaul.

On arrival at site the team observed that the bearing temperature was high, especially the temperature of the bearing of the steam turbine and temperature of the bearing of speed increase gear was so high that the replacement of these bearings were essential and had been carried out at the time of the minor overhaul. This fact indicates the bearings could not bear the life of one and half years.

The cause of the trouble of high temperature were induced by the deterioration of the bearings themselves, lubricating oil and the oil coolers.

Taking the daily maintenance level and operation for machine maintenance into consideration, it is recommended that the interval of overhaul be reduced once a year which now prevails to one in two years.

At the same time, the manufacturers' experts should be brought to site to the overhaul as adviser which is essential to be sure of the reliability of the machine throughout the year.

The recommendation for the gas turbine generators is the same.

The recommendable expert organization for the overhaul is as follows:

Synthesis gas compressor	1
3 major compressors	2
3 major turbines	1
Urea pumps	2
Other compressor and turbines	1
Gas turbines	2
Power plant	2
Instrument	4
Welder	2
Inspector/supervisor	2
Process engineer	2
Manager	1
	22

The duration for the overhaul (excluding the duration for start and stop) is supposed 25 days for normal overhaul.

The important works in such a overhaul are overhaul of the major rotary machines, cleaning of heat exchangers and inspection of equipment. To prepare the spare parts is essential in order to reduce the duration of overhaul and to be sure of the reliability of the overhauled equipment.

The advice from the viewpoint of process side is very effective and essential to proceed the overhaul works without misunderstandings.

The work list, which was prepared and submitted by the team to UFFG in March, for the overhaul about the equipment and instrument shall be effective to study and decide the items of overhaul.

The loss of ammonia (NH_3) and urea is also one of the causes for lowering the production level .

Although the NH_3 consumption ratio per ton of urea of 0.616 is used to manage the daily production, this figure is too high for the usual plant and is not adopted normally. Even considering the very high loss rate of NH_3, the consumption ratio of NH_3 per ton of urea should not be more than 0.600.

The daily loss out of the NH_3 plunger pumps should be kept as low as possible by daily maintenance endeavour. The vent gas out of the refrigerator condensers and the NH_3 storage tanks, and the drained big amount of ammonia out of chillers should be recovered using the cooler, pump and lines which are facilitated for this purpose.

The causes of NH_3 loss out of the NH_3 preheaters has been rectified by the correct adjustment of emergency valves, modification of NH_3 preheater and replacement of NH_3 preheater.

Regarding the emergency shutdown of ammonia plant, there are several unexplained facts. During the team's stay at site, the plant has been tripped no less than 15 times. Out of these 15 occasions six occurred during the night a few days after the restart of production as given below.

[I]

On 7/Nov/1979	Plant tripped
10/Nov/1979	Plant restarted production
12/Nov/1979	Plant tripped again in night (Sunday)

[II],[III]

On 24/Jan/1980	Plant tripped
2/Feb/1980	Plant restarted production
2/Feb/1980	On the same day, plant tripped again on a Saturday night.
14/Feb/1980	Plant restarted production
16/Feb/1980	Plant tripped again in Saturday night

[IV]

On 14/Mar/1980	Plant tripped
16/Mar/1980	Plant restarted production
17/Mar/1980	Plant tripped again at night by the failure of the power generation plant

[V],[VI]

On 9/Jun/1980	Plant tripped
10/Jun/1980	Plant restarted production
12/Jun/1980	Plant tripped
12/Jun/1980	Plant tripped again during the start up of boiler in night.

Based on these facts it is apparent that a responsible person should attend the plant for at least a period of a week or at least untill upto the first Sunday night after the restart of production.

5. Recommendation for the Improvement

5.1 Ammonia Plant

5.1.1 CW Tower

The main modifications of CW system, including the urea plant are as below.

(1) Install New CW Tower

The plot is behind the IGG plant (East side of IGG).

The capacity is 3,000 t/h (2 cell).

The CW of this new tower shall be supplied to CO_2 Booster and CO_2 Compressor which are supplied from existing CW Tower of NH_3 plant.

The CW shall also be supplied to CO_2 G, IGG and Urea Boilers which are supplied from existing CW Tower of Urea Plant.

Isolate the New CW Tower at the inlet of each CW consumer.

(2) Increase Performance of Air Fan

Increase Performance of Air Fan by

(a) Repair the gear box (Spare set of 5 NOS. required)

(b) Reinforce the bed of Air Fan.

(c) Replace the blade and adjust the angle of blade of Air Fan.

The blade are damaged by the impingement attack with water droplet.

It is supposed that spare blade of 30% of total blades shall be prepared.

(3) Improvement of CW Tower

(a) Stack

The tower efficiency of NH_3 CW Tower is lower than those of Urea and CY CW Towers. However, the ampere of Air Fan, Packed scheme and Tower structure are very similar. Hence it is supposed the effect of the heat from the equipment of GV section, say CO_2 Direct cooler, to be considered as one of the factors.
Actually it was found that the wet bulb temp of atmosphere, on the road between the CW Tower and GV unit, was 2°C higher than it measured at laboratory when the wind was blowing from east.

To reduce the interference of GV unit, it is supposed to increase the height of Air Fan stack to the extent that the Tower can bear the weight is effective. However, the evaluation of the effect is difficult, it shall be consulted to the manufacturer.

(b) Filler

The filler (Packings) of tower is deteriorated by corrosion. The repair of spacer and frame of filler and the replacement of filler set itself are to be planned when the long term of plant shutdown is available.

The required amount of spacer and frame of filler and the spare of filler set is 30% of total respectively.

(4) The Modification of CW Line

Water Jacket

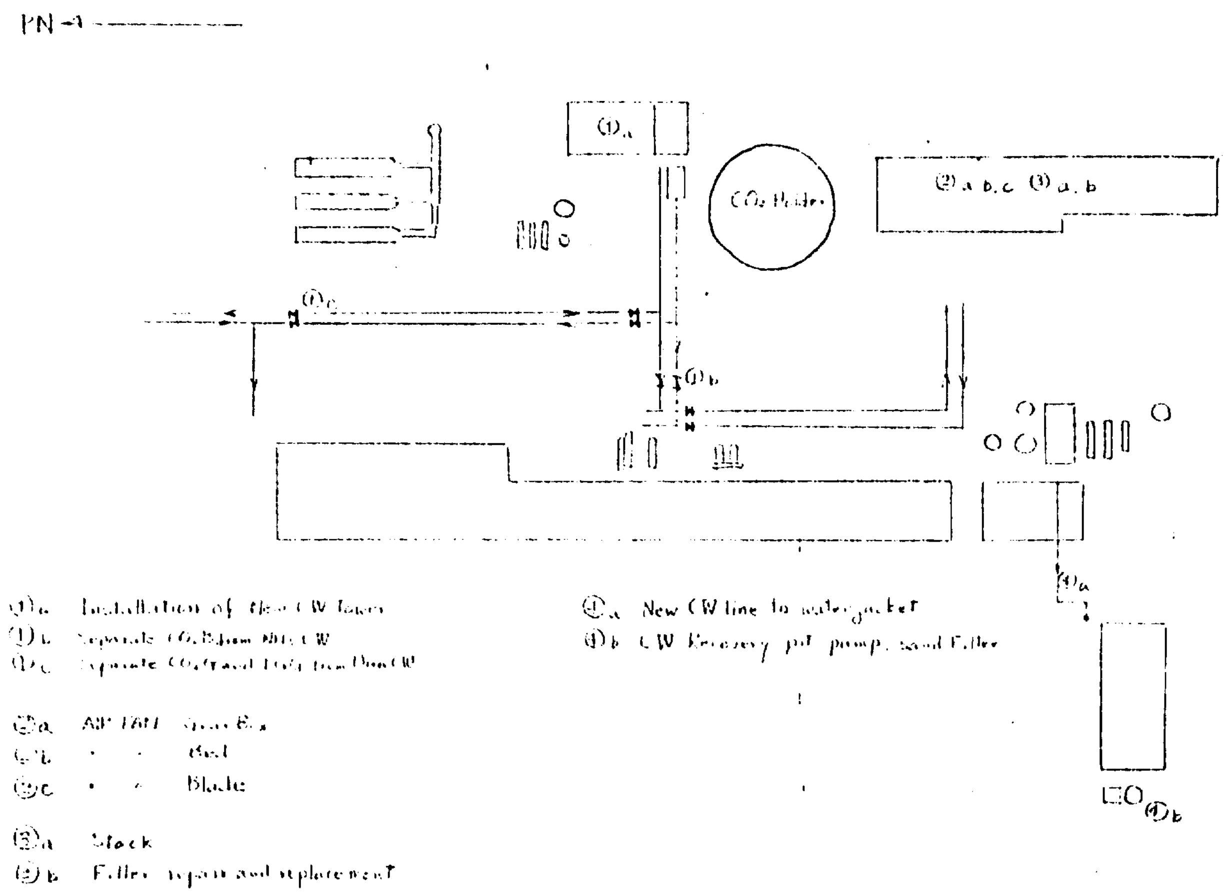
The CW line for water jacket is utilized the secondary (reuse) CW line, at present, and to maintain the pressure of CW to water jacket the valve openings of GV solution coolers are restricted and hence NH_3 condensers too.
To remove this operational difficulties, this CW line shall be changed the connection to primary CW line utilizing the CW line for the steam condenser of BFW-P.

And the water, desposed at present, shall be recovered by gathering the effluent of water jacket to the pit, which shall be installed at north east of Primary Reformer, and sent back to the CW Tower by pump via sand filter.

By this modification the make up water (TW) of 80 t/h for NH_3 CW Tower can be saved and this saved TW shall be used as the make up water of New CW Tower and of New Pure water unit.

(5) The modification plans about Air Fan and Filler of CW Tower should be applied with the CY and Urea CW Towers.

Modification of CW System



5.1.2 NH_3 Condenser

The CW Temperature after the modification is estimated as 34.5°C at the peak in summer.

On the other hand, the capacity of existing two NH_3 condensers is insufficient even the CW temperature is 33°C and the CW flow rate is 3,000 t/h.
And if the NH_3 condenser is increased, then the pressure is to be 17.5 kg by the condition of CW temp. 34.5°C and CW flow 2,400 t/h.

Consequently it is clear that for bearing the 100% load it is necessary to increase one more NH_3 condenser.

The new NH_3 condenser shall be put in near of the existing condensers and over the ammonia receiver.

To control the CW flow rate and to facilitate the discharge pressure control and tube cleaning of individual condensers, the inlet and outlet valves of CW and of NH_3 gas should be installed.

Further in order to control the GV solution temperature, the CW by-pass valve should be installed at near the NH_3 condensers.

5.1.3 Air Compressor

The observed fact is that the capacity should be increased by 10% of existing capacity to achieve 100% load operation including the extraction of IA.

The increase of capacity can be improved by the reducing of internal and outward leakage and the partial improvement of rotor and casing.

However, if the total change of rotor, casing and/ or bed of compressor are required, then the installation of booster shall be studied.

The required performance of booster is to increase the suction flow of Air Compressor, by 10% that is, to increase the suction pressure of Air Compressor by 10%.

The required power for the booster is 230 kwh/h considering the sufficient allowance.
The existing By-pass cooler can be used as the aftercooler of Booster.
The difficulties is the layout of booster.
The underground pipes be checked carefully before decide the plot of motor, booster and by-pass line.

The calculation sheet are in Appendix.

5.1.4 Waste Water Recovery

In dry season the treated water (TW) is very valuable. Because the Clarifier in Water Treatment plant is working by full load, even the plant load is 85%.

If plant load comes up to full, then the TW consumption may increase by 20 ~ 50 t/h.
The major consumer increased, are CW Towers, CO_2 Direct Cooler in GV section and in CO_2 G section.

Further to reduce the NH_3 and Urea loss in Urea plant about 20 t/h of Pure water is required.

Therefore maximum 70 t/h of water are to be saved.

For this purpose separation of the drinking water source from water treatment plant is the easiest countermeasure.

However, if the CW of Ammonia plant is recovered,then, it can recover the chemicals at the same time. There is the restriction of the extent to recover the water, because the concentration ratio (cycle) of CW is to be kept in the allowable range.

The water possible to recover is listed in Appendix.

As for the cycle and circulation rate the restricting condition of corrosion inhibitor should be carefully considered.

5.1.5 Recovery of Ammonia

In the vent gas and the fuel gas of Auxiliary boiler out of synthesis loop, ammonia gas of about 6.7 t/d is included.

The plan to recover the ammonia component from these gases has been studied.
The conclusion of the study is as follows.

(1) Assuming the price of ammonia as US$100.-/t, (2) the modification plan of the recovery of CY condensate will be put inforce and (3) the aqueous ammonia produced in this recovery unit can be sent to the rectifier (stripper) of the CY condensate recovery unit in Urea plant, then the plan is feasible.

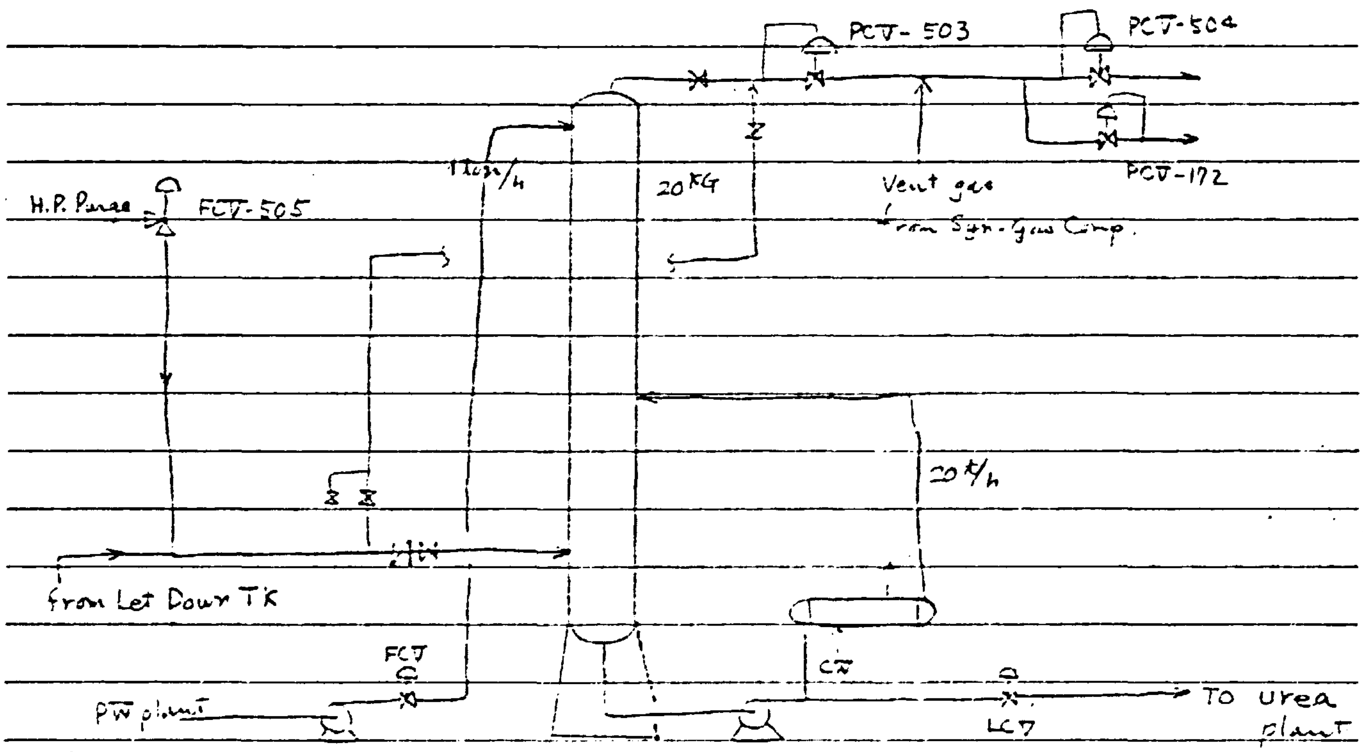
The another benefit of reduce NOx in the flue gas out of Aux. Boiler may not be evaluated at present.

The outline of the plan is as follows.
NH_3 gas in the High pressure gas and vent gas out of Let Down tank is recovered.

The recovered NH_3 quantity is 196 Kg/h (4.7 t/d).
NH_3 is reccvered as 20% aqueous ammonia solution in the absorber operated by 20 Kg.

The dimension of tower is roughly 15 m heigh and 1.2 m dia.

The flow diagram is as below.



The CW quantity and the electric power required in this unit is very small.

If the rectifier for this recovered aqueous ammonia is required, then the rectifier is 16 m height and 0.5 m dia. and reboiler is required.

When the vent gas of the refrigerator shall be recovered then the operating pressure shall be reduced and hence the absorber dia meter shall be larger and it is not economical.
It can be recovered by gas purger and by the ammonia condensers of urea plant.

The vent gas from C.P. is contaminated by oil and therefore it can not be introduced to this unit.

NH_3 Recovery Unit

Recovery Gas

1. H.P. Purge gas NH_3 158 kg/h (3,792 kg/d)

85% Load

	NH_3	H_2	N_2	CH_4	Ar	Total
Nm^3/h	214.	4,395.	1,336.	568.	167.	6,680
%	3.2	65.8	20.0	8.5	2.5	

100% Load

Nm^3/h	208.	5,674.	1,894.	649.	225.	8,650
%	2.4	65.6	21.9	7.5	2.6	

2. Let Down Tank NH_3 38 kg/h (912. kg/d)

85% Load

Nm^3/h	46.	154.	50.	41	9.	300.
%	15.2	51.3	16.5	13.9	3.1	

100% Load

Nm^3/h	50.	159.	55.	46.	10.	330.
%	15.2	51.3	16.5	13.9	3.1	

3. Refrigerator NH_3 76 kg/h (1,824. kg/d)

Nm^3/h	100.					100.
%	100.					

4. CP vent gas NH_3 9. kg/h (216. kg/d)

Nm^3/h	12.	328.	110.	37.	13.	500
%	2.4	65.6	21.9	7.5	2.6	

TOTAL NH_3 281 kg/h (6744. kg/d)

Nm^3/h	370	6,171.	2,059.	732.	248.	9,580
%	3.9	64.4	21.5	7.6	2 6	

The vent gas of synthesis gas compressor should be recovered connecting the pipe to between PCV-503 and PCV-504.

By this modification of simple pipeline change as is described formerly the heat correspond to NG of 0.47 million Nm^3/y can be saved.

Of course if the gas is not able to recover, for example, at the time of synthesis gas compressor turning, the existing vent line can be used by closing the valve to the fuel gas line.

5.1.6 Reformed Gas Waste Heat Boiler (RGWHB)

As is shown in the calculation sheet (Appendix)the recovery of heat is sufficient and the outlet gas temperature of reformed gas is low enough.

The fouling of tubes outer surface was negligible when it was investigated during the last overhaul.

As for the water side, it can not be said clearly if UFFG has the experience of silica, sludge and/or ion exchange resin carried with BFW to drum.*1
If confirmation is required, the pipe (bottom header of EC-107A) should be cut and checked.

---

*1 The trouble may come out as the form of hot spot (local heating or local burn out).

However, at present, the low temperature of outlet gas is indicating that, generally speaking, the tube bundle is sound.

During the overhaul, the tube bundle was investigated at its hottest point and the bulge of the tube was not found.

The cause of the bursting of the drain line at the bottom header is attributed to the problem of heat isolation.
The drain line and the nozzle (connecting point of line and header) should be carefully heat isolated. The tube skin of tube bundle is kept to low temperature by the cooling of water circulation. But, about this drain line there is no water circulation or water flowing, hence if the heat isolation of this portion was failed, then the burn out could come out.

Regarding the chemical cleaning procedure, if it is decided to carry out, the two difficulties are to be encountered.
One of the two is the removal of sludge and rust moved out of the tube surface and the other is the investigation procedure at the end of checmial cleaning.

Before to try the chemical cleaning, the new bundle should be prepared as spare.

5.1.7 Flue Gas Waste Heat Boiler (FGWHB)

It is supposed to increase the number of tubes of FGWHB in increase the heat recovery (increase the 100^k steam generation) is feasible.

By this modification following advantage can be obtained.

(a) 100k steam is increased by 5 t/h

(b) higher temperature of 100k steam

(c) better operation of FPH

(d) economy of the energy (low temp of venting flue gas) improved.

The final decision to put this plan in force, can be done only by manufacturer. Because the detail of know-how of this kind of WHB is only in manufacturer's hand.

Besides, the tube surface of existing FGWHB was fouled by the adhesion of white powder, it could be silica from bricks. The surface of the tube should be cleaned using the proper wire brush.

5.2 Urea Plant

5.2.1 High Pressure Decomposer (HD)

The necessity of the increase of heat exchanging surface of High pressure decomposer reboiler is observed, from the operating conditions and required increase is estimated as 100 m^2 by the calculation of heat balance against the 100% load operation.
Three plans have been studied about how to increase the heat exchanging surface.

As the conclusion, the plan drawn in Fig. 5-1 are recommended, because the construction cost is the cheapest.

The recommended surface of the additional reboiler is 200 m^2.

The surface area recommended is larger than the calculated result, it is from the idea that by adding extra surface the possible uneven flow distribution into paralleled reboilers will be compensated and further the difference of the construction costs between calculated and recommended is more or less negligible considering the difficulties of the construction.

Regarding the level indication of HD, the TV and shift the LIC position to spare nozzle are reccmmended.

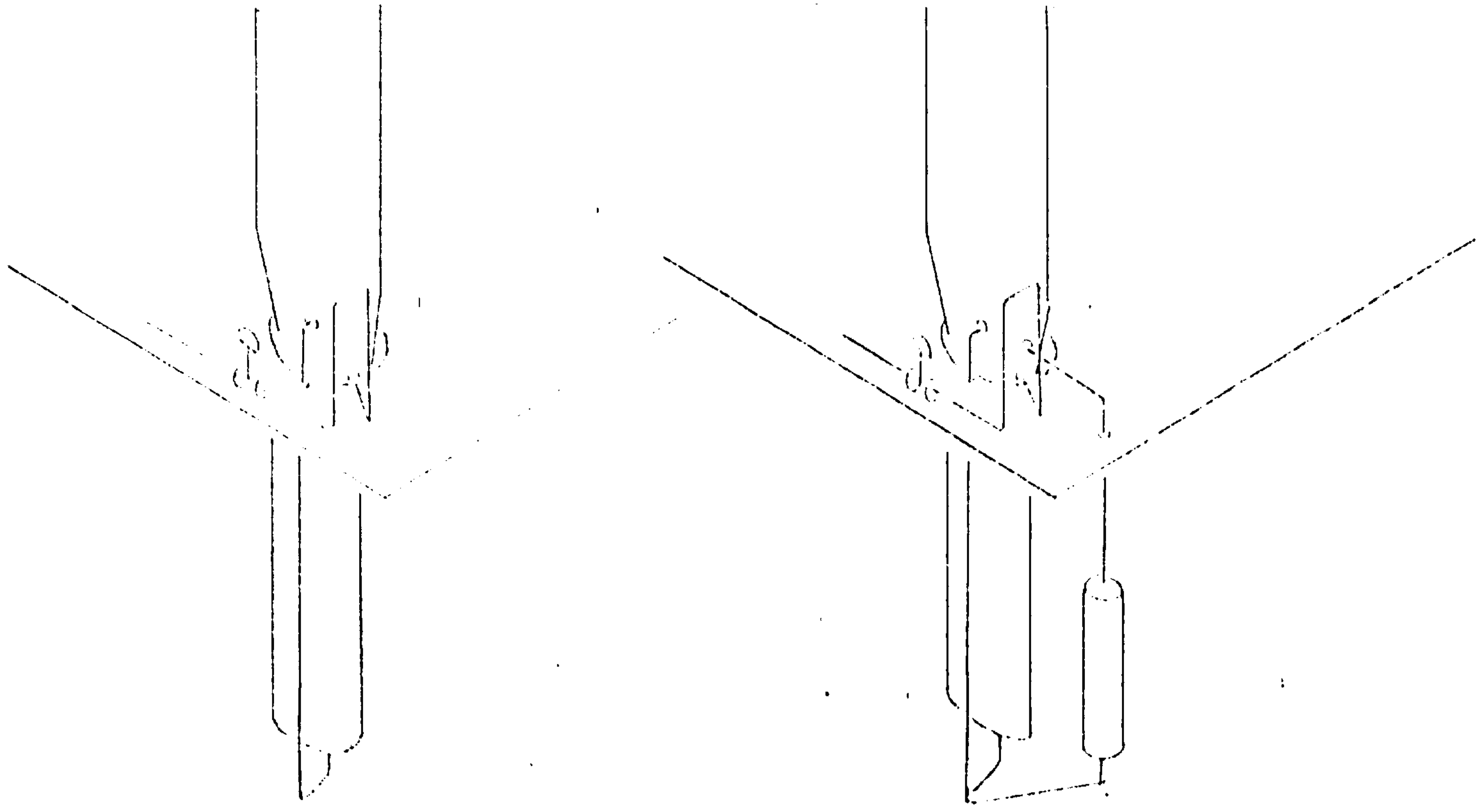


Fig. 5-1 Modification of HD Reboiler

5.2.2 Ammonia Condenser

The increase of one Ammonia condenser is necessary to achieve the full load production. Further to line up the Purge ammonia condenser in parallel with Ammonia condensers is recommended. By this modification the operation becomes simple and the total capacity condensing ammonia is not differed so much. (Calculation sheet is attached in Appendix)

By this modification the idling condition of purge ammonia condenser, which condition is attributed with too small the valve size at outlet of each condenser, can be improved.
The gas from the Ammonia Tank should be recovered and the line to recover it is already facilitated.

The CW for this new ammonia condenser is supplied from the CW spared by separating CO_2 generation plant.

The purge gas out of the ammonia condensers in Ammonia plant is also to be recovered by connecting the line to the inlet nozzle for the gas out of Ammonia storage tank.

Installation of the thermometer to the gas outlet line and CW outlet line to identify the condensers which is fouled, is recommended. Installation of the thermometer to the CW line of ammonia recovery condenser is also recommended to adjust the CW flow rate as minimum.

The leakage of ammonia are observed at the points where the tubes had been plugged to stop the leakage. The causes of the leak whether it is tube sheet or tube itself should be checked carefully and the treatment of tube inside surface before plugging should be done carefully and the leak test should be carried out by the maximum allowable pressure.

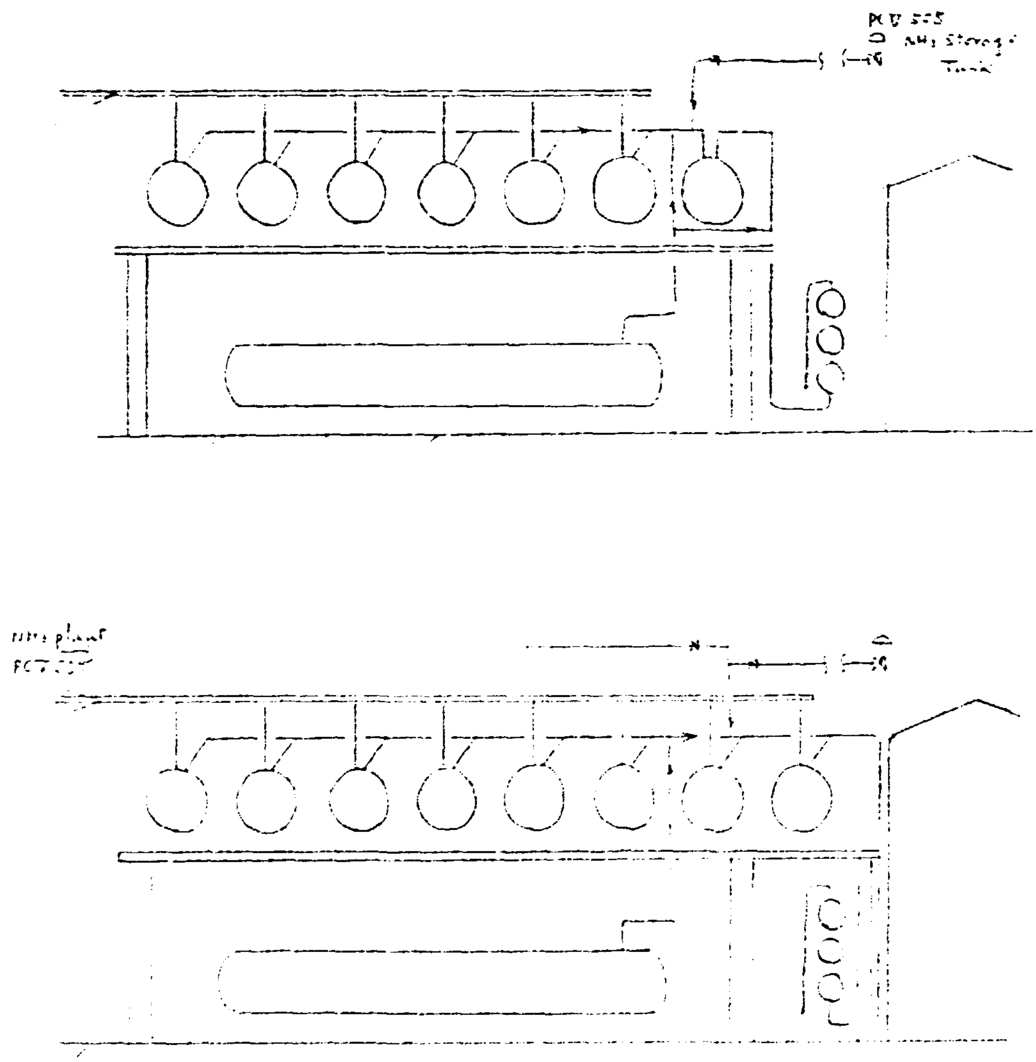


Fig. 5-2 Modification of Ammonia Condenser

	Nov. 20, 1980	Case - 1		Case - 2	Case - 3	Case - 4	
	NH_3	NH_3		NH_3	NH_3	NH_3	
	54.6 t/h	64.0		64.0	64.0	64.0	
	NC(5)	NC(6)		NC(7)	NC(8)	NC(7)	
	PNC	PNC				PNC	
	NRA	NRA		NRA	NRA	NRA	
CW Flow Total	4320 t/h	4200		3500	4320	4320	
Plant Load	89%	100		100	100	100	
NC Press.	15.7 kg	16.2		16.2	16.2	16.2	
	NC	NC	PNC	NC	NC	NC	PNC
NC Gas In	49°C	49	42.6	49	49	49	42.4
Out	33.2°C	42.5	42.2	42.4	41	42.4	40.9
Liq Out	31°C	40	40	40	39	40	39
Dew Temp	41.9°C	43	42.5	43	43	43	42.4
CW In	28.1°C	33.6	33.6	33.6	33.6	33.6	33.6
Out	33.2°C	37.1	37.1	37.5	37.3	37.3	37.3
Flow	721 t/h	600	600	500	540	540	540
Q	2959 tgal/h	2100	2100	1950	1998	1998	1998
Condense	54.06 t/h	47.87	7.98	51.87	60.48	53.13	7.56
NH_3 to PNC	0.54 t/h	16.13	-	-	-	-	-
NH_3 to NRA			8.15	12.13	3.52	10.87	3.31
U/ T n m	562/98°C	524/7.46	561/6.97	504/7.21	521/7.14	508/7.33	562.6.62
Fouling CW factor side	f = 1110	1000	1000	1000	1000	1000	1000
Estimated U in not season		518	567	510	514	514	561
Inert Gas Total	206.1 Nm^3/h	263	263	263	263	263	263

5.2.3 Recovery of Ammonia Loss

The treatment of condensate of Crystallizer

The ammonia and urea loss out of crystallizer is generally in considerable amount, the loss in Ghorasal urea plant is shown in Page 4-8.

The loss can be recovered by using the surface condensers.

In present process, the vapour out of Crystallizer (CY) is cooled and condensed by direct contacting with CW in the barometric condenser.
In this vapour NH_3 and Urea are carried 0.24 t/h and 0.22 t/h respectively and are mixed or contaminate the CW.
Urea in the CY CW causes the fouling trouble of CY CW Tower, and ammonia causes the pH trouble of vent water from CY CW pit. (See Fig. 5-3)

By the new process the vapour is condensed in the surface condenser, thus the condensate of CY vapour and CW is separated. (See Fig. 5-4)

The vapour is led to the separator, at the first, where the entrainment containing urea is washed by the condensate and the wash water is sent to dedusting system of prilling tower. The solution from the dedusting system is finally sent back to the process and hence urea is recovered.

The three staged surface condensers are followed in which the effluent gas is condensed.
The ejector effluent is also collected and mixed into the condensate.

The condensate, then, is pumped to the stripper via heat exchanger to separate the ammonia and condensate. The vapour out of stripper is recovered by sending it into Low pressure decomposer.
The condensate or bottom solution is recovered by using it as the process water but it is not totally. As is obviously understand, the water balance of urea plant forces to blow water produced by urea synthesis reaction and hence a part of urea contained in the blowing water is desposed.

The hydrolysis process to recover the urea in the solution is also available. However, the process is not recommendable, by the economical reason.

The question is the plot plan of surface condensers and required quantity of CW. The area between the rack of CY and Centrifuges may be sufficient and the CW can be supplied from CW towers combined CY and Urea.

It is recommendable to consult with the patent owner. The discussion should be involved the study to recover the aqueous ammonia from ammonia plant.

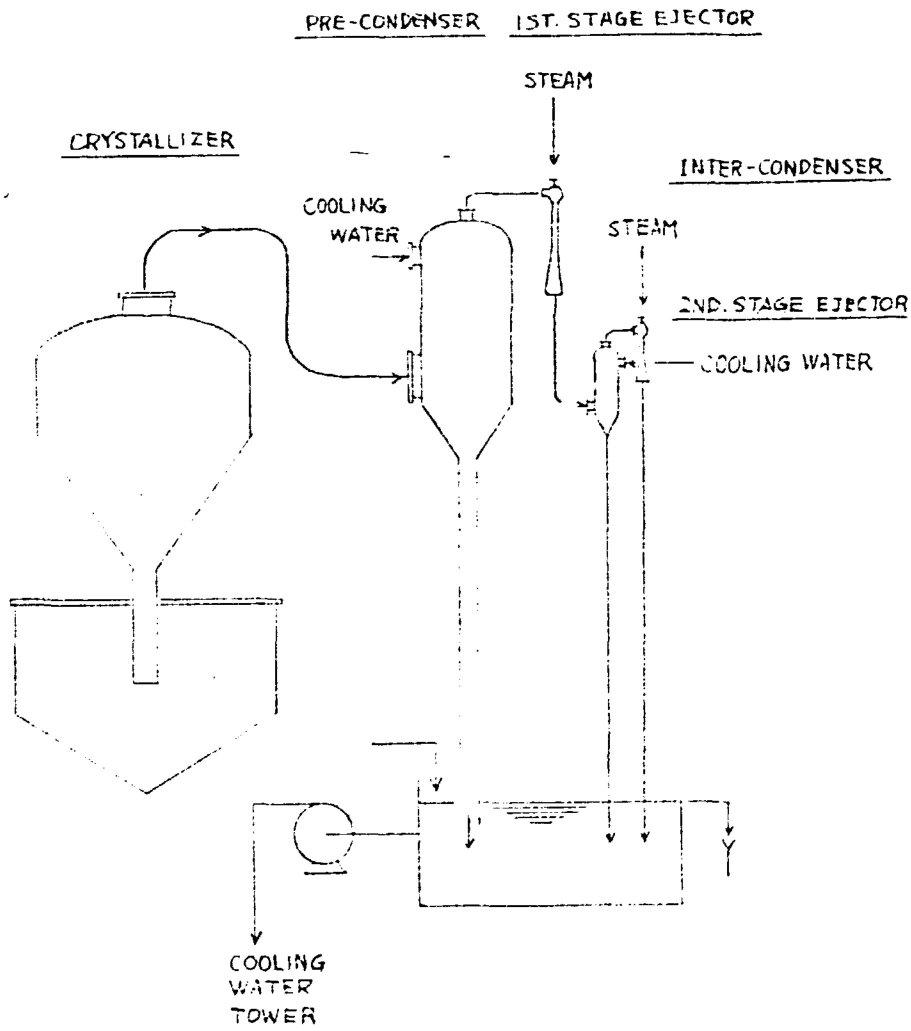


Fig. 5-3 Existing Vacuum Crystallizer System

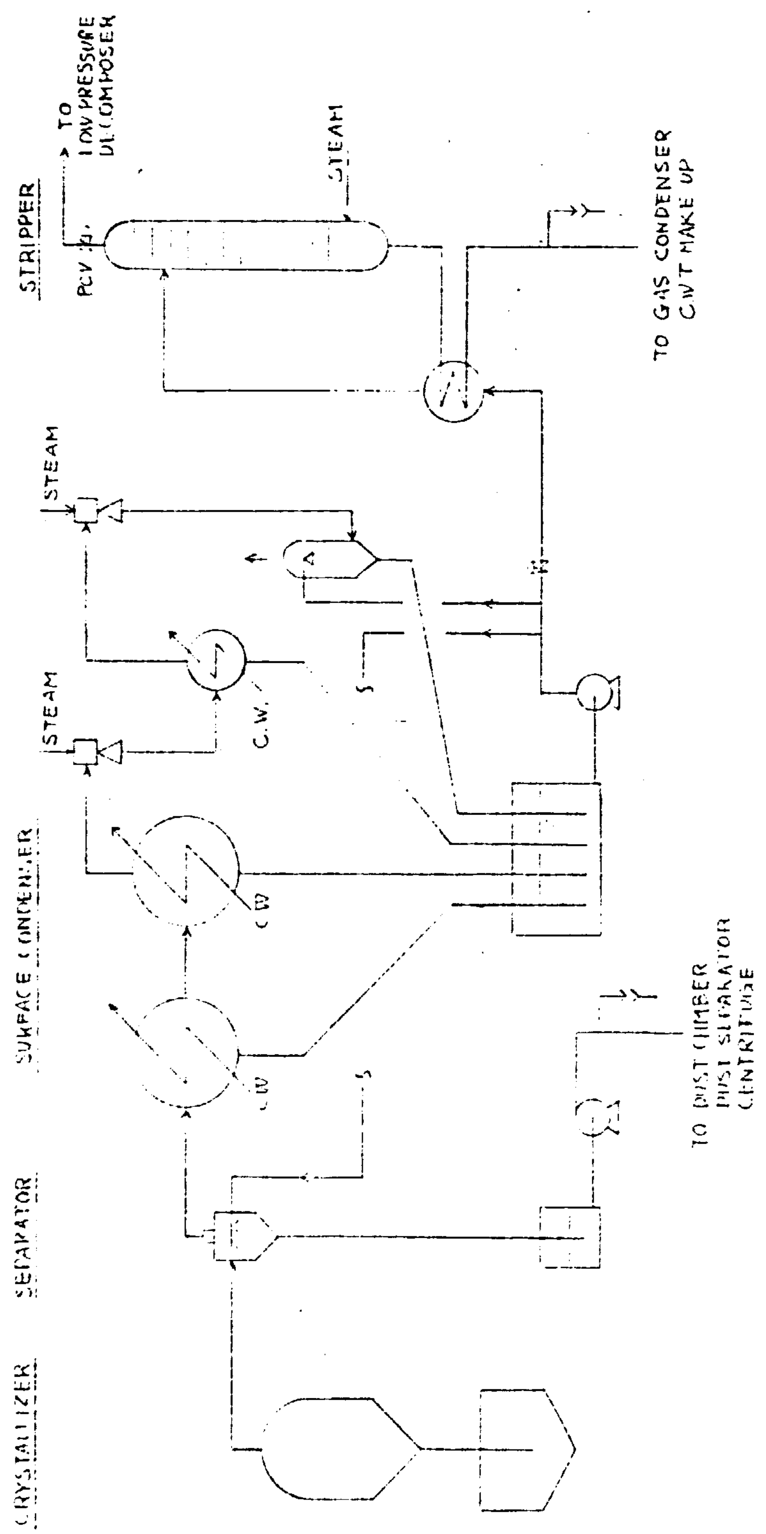


Fig. 5-4 New Abatement System for Vacuum Crystallizer

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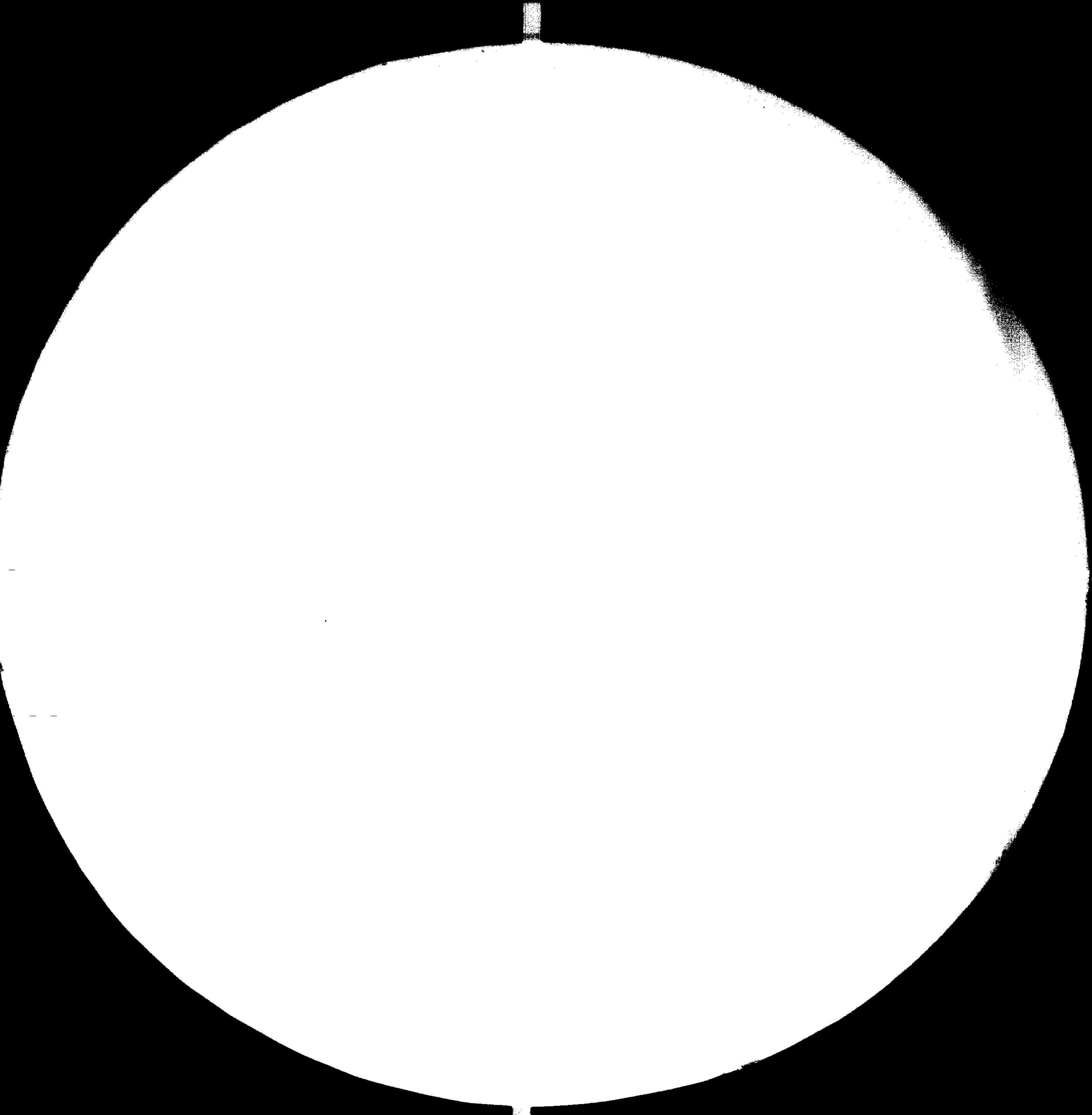

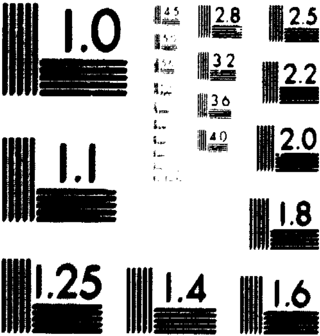

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5.2.4 Recirculation Pump (RC-P) and Ammonia Plunger Pump (NH_3PLP)

The centrifugal pump for RC-Pump is recommended. Because the cranks of existing RC-Ps, plunger type, are damaged seriously and the cost of spare parts is supposed considerable.

The operation and maintenance of centrifugal type RC-P are required special cautions, and the cost of pump, as well as, spare parts is not cheap. However, once the operation is stabilized the cost of maintenance and the loss of products are negligible, even though the special caution are required.
The fluctuation of the process, or the careless maintenance causes the serious damage of pump.
Those plants where operation is not stable frequently damage the pump, but the stabilized operation plants enjoy the long stabilized operation of the pump.(See Fig. 5-5)

The important points to be taken care are as follows:

(1) Keep the suction pressure for the required NPSH.

(2) Keep the correct working of flow meters.

(3) Keep the sound condition, avoid of cholking, of the by-pass line.

(4) Keep the stable discharge pressure, that is, keep the stable pressure of reactor.

Compared the risk to damage the pump with the benefit to solve the problem of maintenance cost of existing RC-pump and reduction of ammonia loss, team recommends application of the centrifugal type.
As for the spare parts, one set of impellar and three set of mechanical seal are recommended. Other details

are to be consulted with the manufacturer.

Regarding the ammonia pump, the centrifugal pump can be available.
However, to change the existing plunger pumps over the centrifugal is not recommended, at present.
Because the history of the pump is short.
The details are to be consulted with the manufacturer.

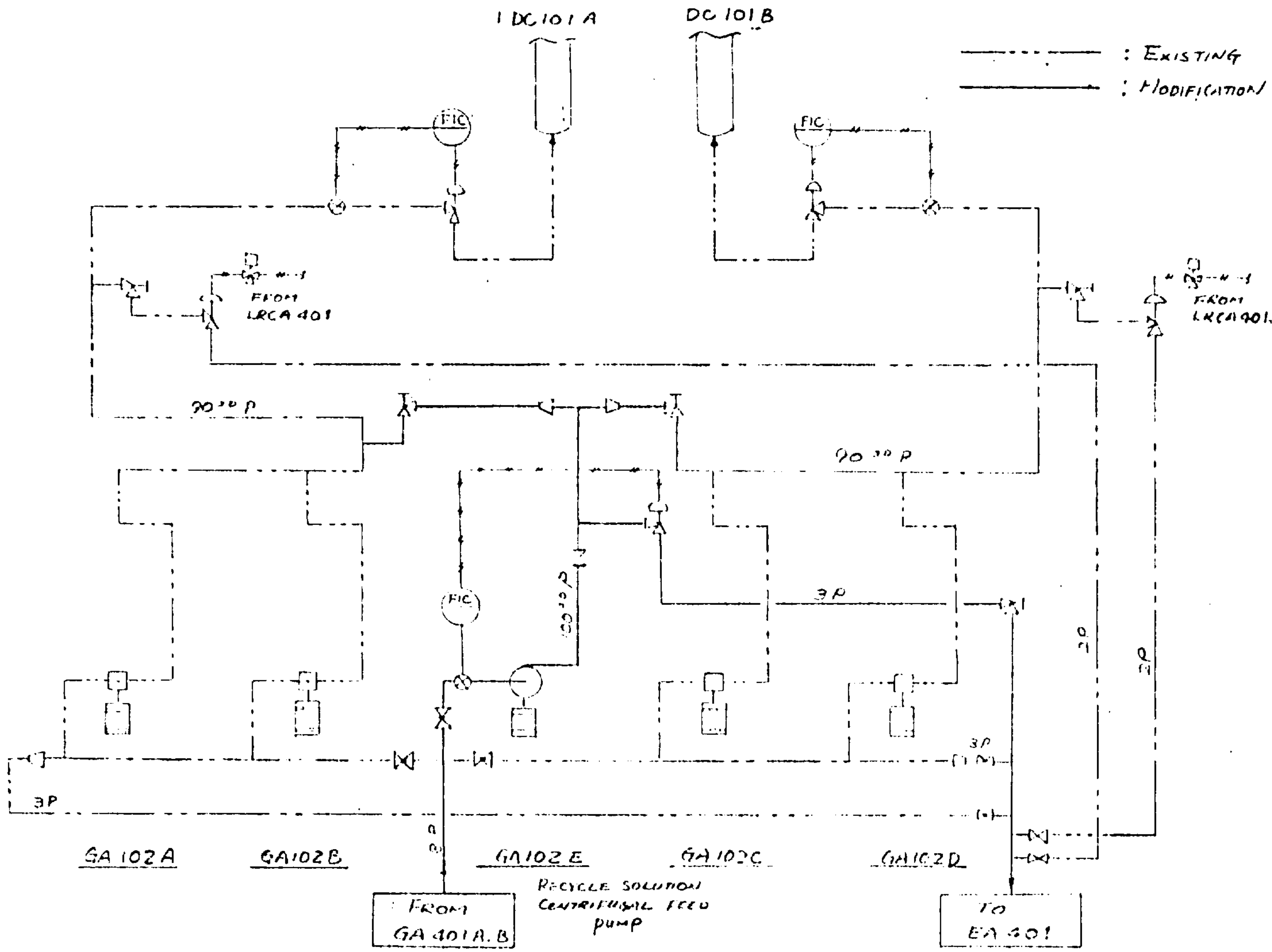


Fig. 5-5 (A) RC-P Modification to Centrifugal Pump

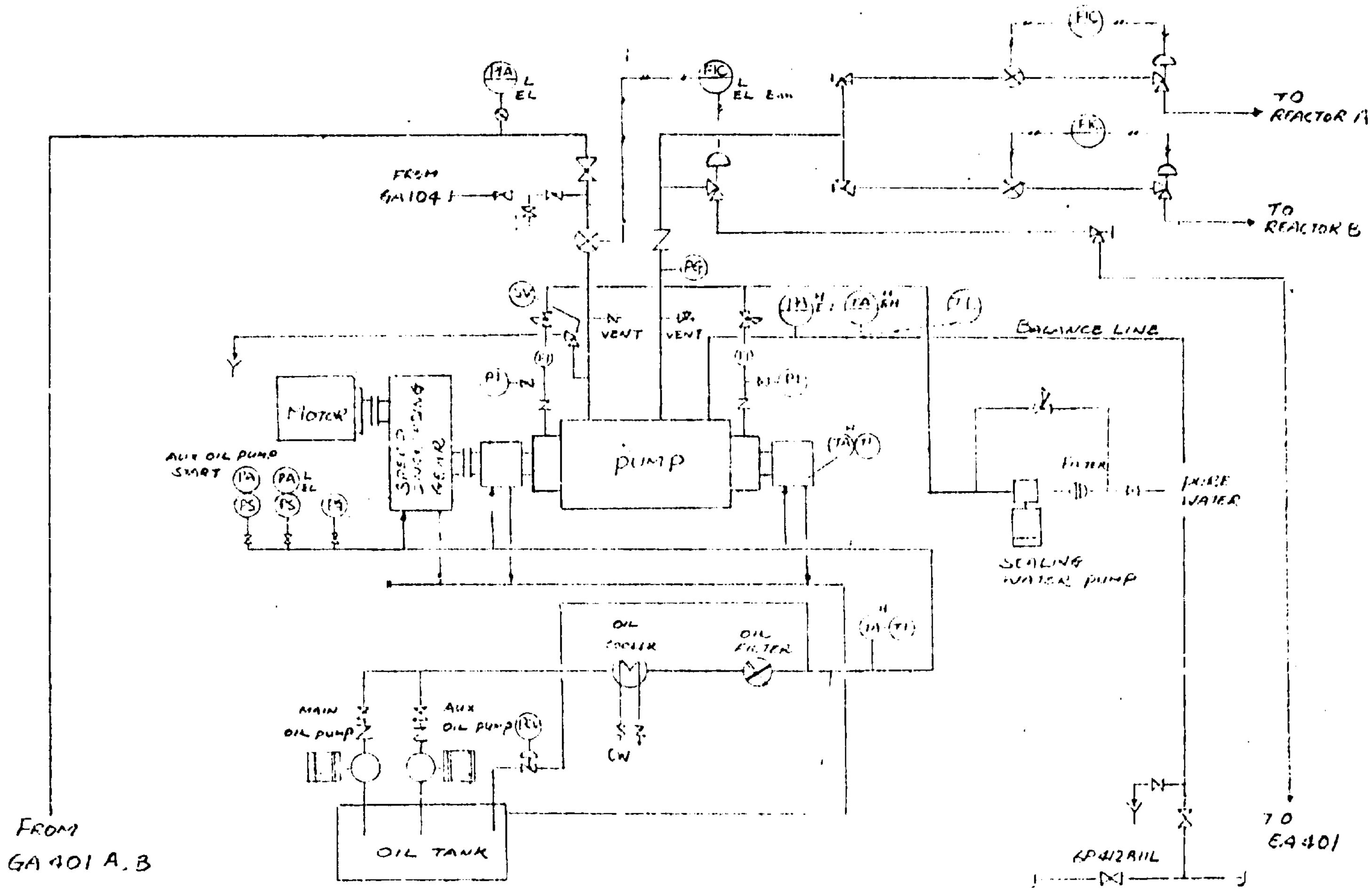


Fig. 5-5 (B) RC-P Modification to Centrifugal Pump

Table 5-1 Short Specification of Major Equipment

a) Recycle solution feed pump

Number required	1 + 0	
Type	Centrifugal	
Design capacity	85 m^3/h	
Design pressure	Suction	24 kg/cm^2G
	Discharge	240 kg/cm^2G
Driver	Case (1)	Steam turbine
	Case (2)	Motor

b) Sealing water pump

Number required	1 + 1	
Type	Plunger	
Design capacity	0.48 m^3/h	
Design pressure	Suction	atm.
	Discharge	30 kg/cm^2G
Driver	Motor	

c) Circ. pump for Cooler

Number required	1 + 1	
Type	Centrifugal	
Design capacity	108 m^3/h	
Design pressure	Suction	16.5 kg/cm^2G
	Discharge	25 kg/cm^2G
Driver	Motor	

d) Low pressure flooding pump

Number required	1 + 0	
Type	Centrifugal	
Design capacity	30 m^3/h	
Design pressure	Suction	atm.
	Discharge	28 kg/cm^2G
Driver	Motor	

Table 5-2 Required Equipment List for Centrifugal Carbamate Pump

( )=unit no.

Case (1)	Case (2)
Centrifugal pump (1)	Centrifugal pump (1)
Steam turbine (1)	Motor (1)
Oil cooler (1)	Oil cooler (1)
Oil tank (1)	Oil tank (1)
Oil pump (1 + 1)	Oil pump (1)
Oil head tank (1)	Sealing water pump (1)
Surface condenser (1)	
Condensate pump (1 + 1)	Circ. pump for Cooler (1 + 1)
Condensate cooler (1)	Low pressure flooding pump (1)
Ejector (1 + 2)	
Sealing water pump (1)	
Circ. pump for Cooler (1 + 1)	
Low pressure flooding pump (1)	

Table 5-3 Utility for Centrifugal Carbamate Pump

	Case (1)	Case (2)
Steam (37 kg/cm^{2}G, 360^{o}C)	10 t/h (for Total cond. turbine)	-
Power	10 kw (for Oil-P, Cond.-P, Seal W-P)	970 kw (for Motor, Oil-P, Seal. W-P)
P.W	0.48 m^3/h (for Mechanical seal)	0.48 m^3/h (for Mechanical seal)
C.W. (T=5^{o}C)	1,160 m^3/h (for Oil-C, Cond.-C)	20 m^3/h (for Oil-C)

NOTES: Case (1) Steam turbine driving R.C.-Centri. Pump.
Case (2) Motor driving R.C.-Centri. Pump

5.4 Instrument

5.4.1 Instrument Air (IA) Supply System

Recommendation are as follows.

(1) The normal IA supply source shall be the process air compressor.
Because when process air compressor is used, the IA pressure is stabilized and the flexibility against the IA line trouble is large.
On the other hand when the reciprocating new IA compressor will be used for normal operation the trouble of cylinder valves is inavoidable and, further, since the discharge pressure is controlled by unloader, the set point for alarm for low IA pressure is forced to be set lower comparing with process air compressor case. (See Fig. 5-6)

(2) The process air reservoir shall be put on line (Fig. 5-7)

This can increase the availability of emergency IA.

(3) The IA line and Utility air shall be separated. The prenty numbers of utility air nozzle are branched from IA line and it is affecting the pressure of IA. The utility air should be separated from IA line to reduce the IA consumption and fluctuation of IA. The old IA compressor can be used for the supply of utility air.

(4) The low pressure alarm of IA shall be set at 6.3 kg/cm^2G.
At present, it is 5,3 kg/cm^2G.
By this modification following action can be taken

against the IA failure.

i. Start up of New IA compressor

ii. By pass operation of FCV-152

iii. Shift the utility air to IA.

The capacity of old IA compressor is insufficient but it can provide the longer retention time before the Emergency trip when IA failure come out.

By present alarm set point of 5.3 kg/cm^2G, their is no sufficient time allowance for the countermeasure against IA failure.

Fig. 5-7 IA supply system at present

Fig. 5-8 Modified IA system

	Hold up	Pressure
New IA Reservoir	53. m^3	7. kg/cm^2G
Old IA Reservoir	48. m^3	7. kg/cm^2G
Process Air Reservoir	12. m^3	32. kg/cm^2G

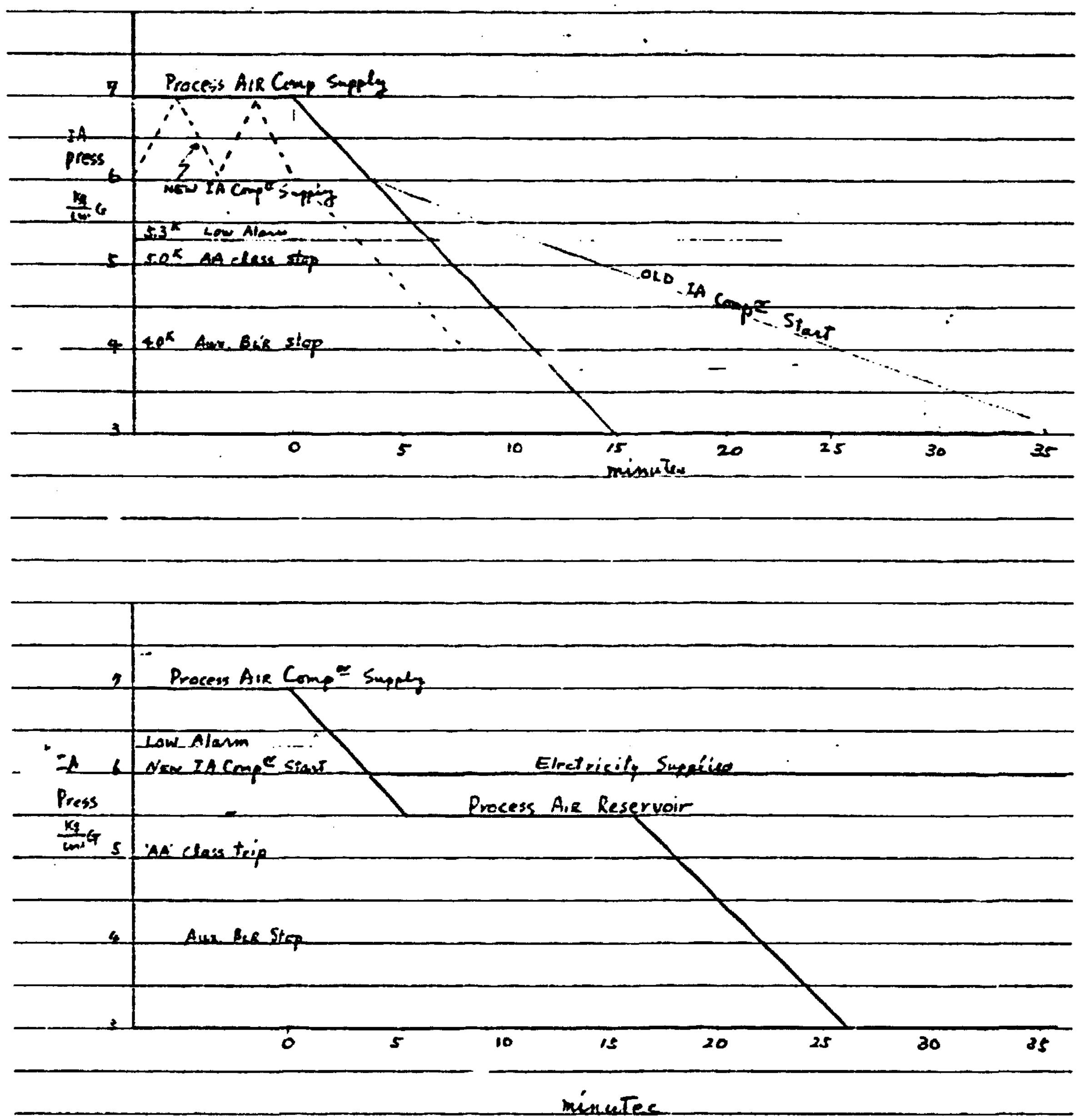


Fig. 5-6 Retention Time of IA

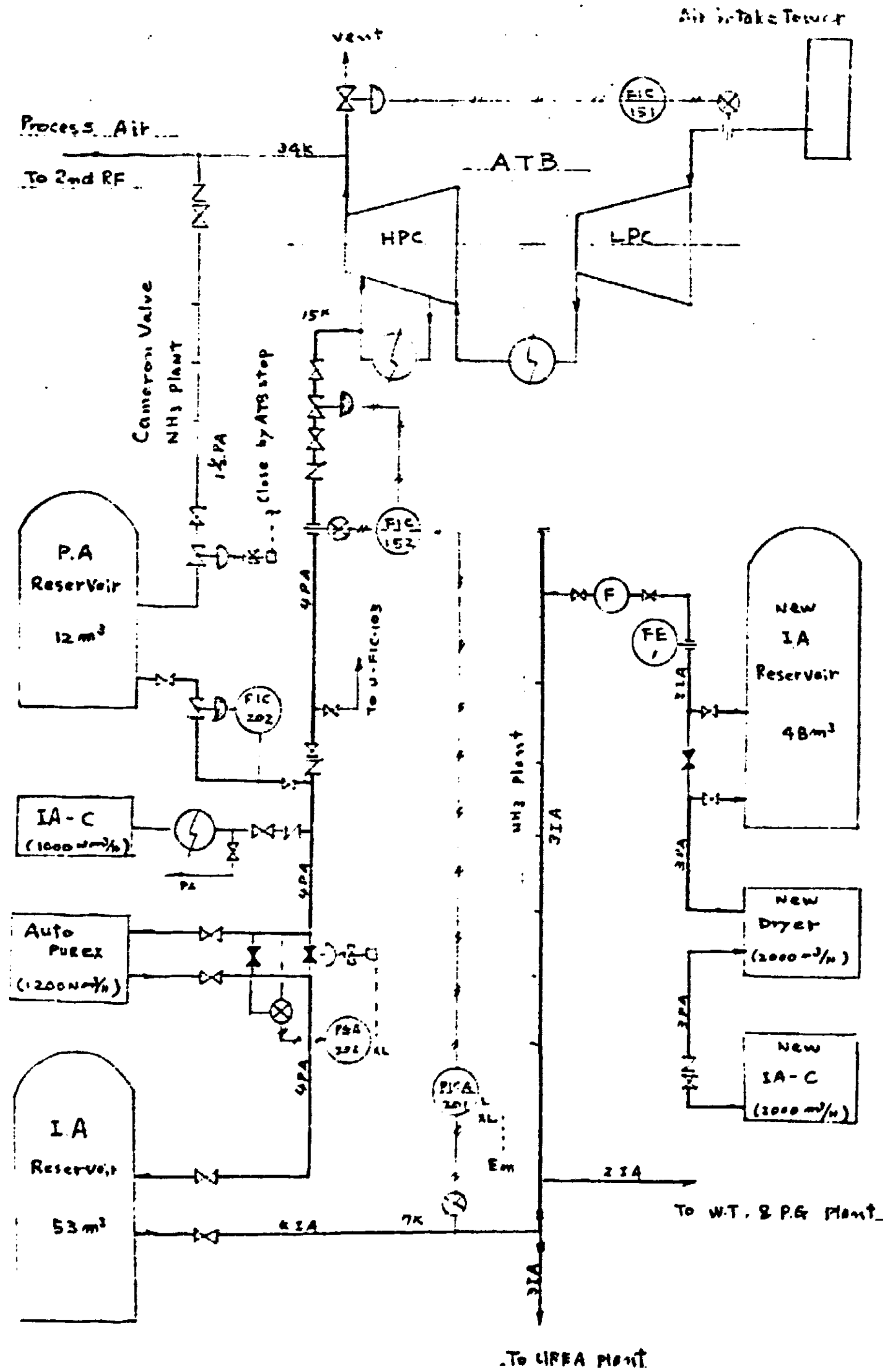


Fig. 5-7 I.A. Flow Diagram

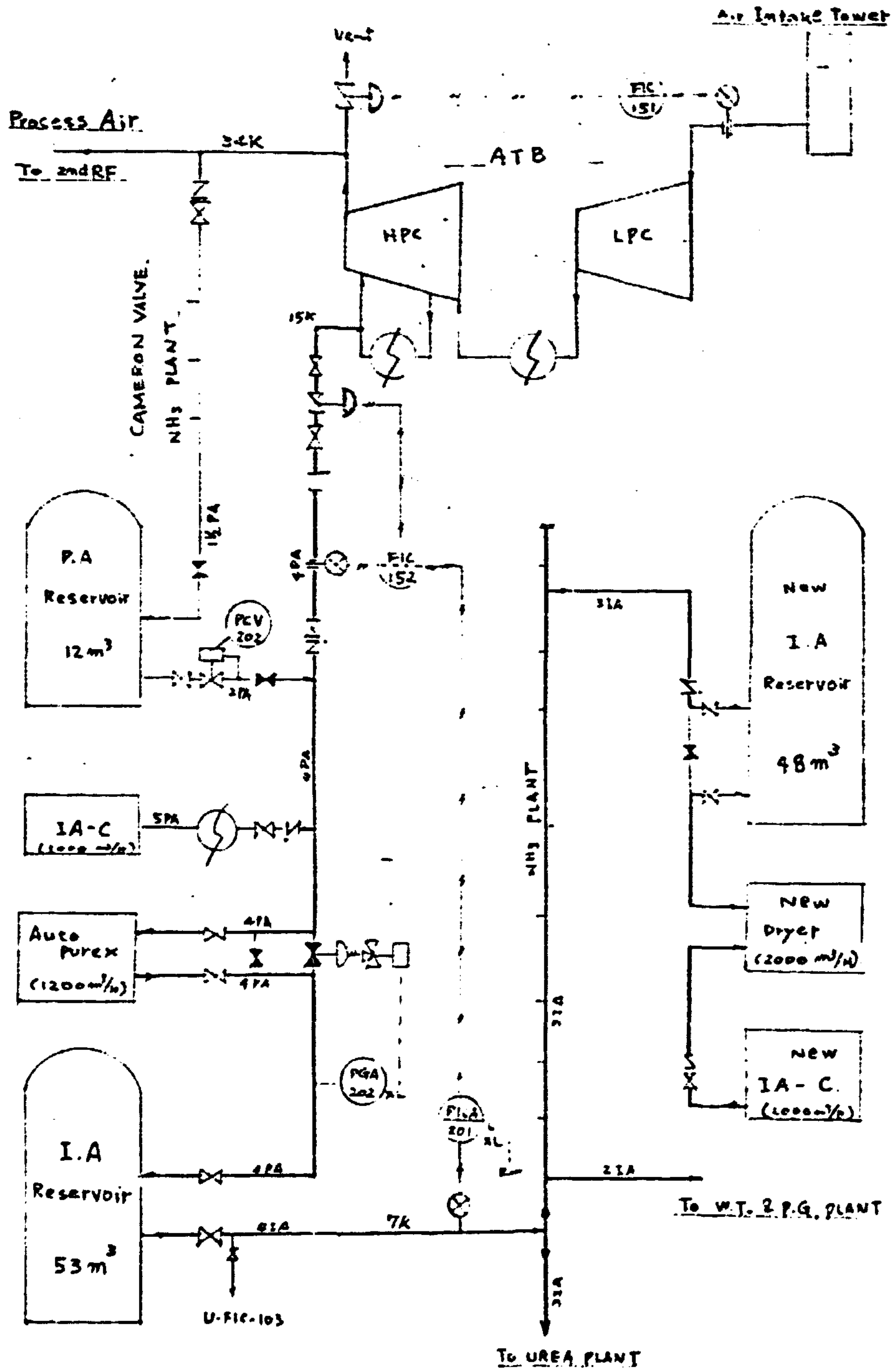


Fig. 5-8 I.A. Flow Diagram

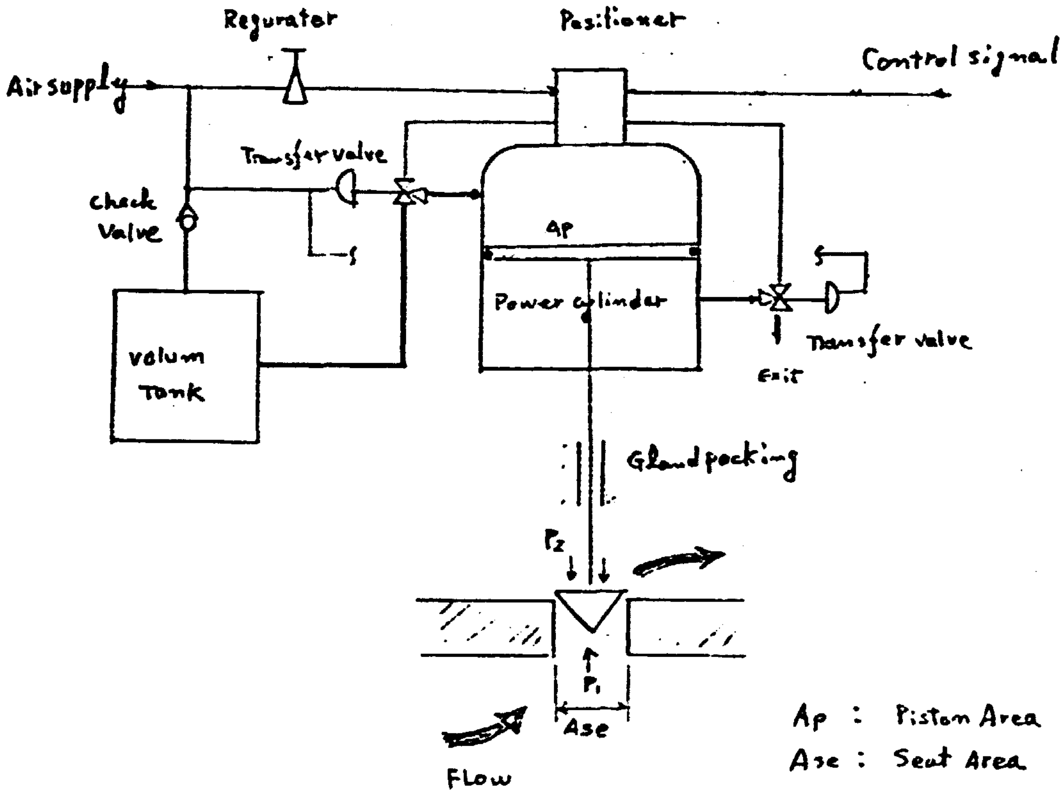
(5) Explanation of modification

The IA pressure failure causes the AA class plant trip and the set point of IA pressure for the trip of main process and of Aux. Boiler is 5.0 kg/cm^2G and 4.0 kg/cm^2G respectively.

The control valves require the IA pressure higher than 4.0 kg/cm^2G are listed in Table 5-4-1. All the valves listed in Table 5-4-1 are actuated by cylinder type actuator and these valves are used at the control points where power and/or the speed are required, change the words, these valves are used at the very important control points

The sketch and the action of actuator is shown in Fig. 5-9. All the valves of this type are designed that the process fluid flows from lower to upper of the port and hence the actuator should over come the force produced by the ΔP accross the valve.

This cylinder type valve has also the locking device to secure the plant safety.
The locking device lockes the valve at the certain point or, open or close fully, when the IA pressure comes down the set pressure of locking device and this action is independent from the control signal.
The set pressure of locking device, which is variable, should be harmonized with the set pressure of IA failure of emergency trip system of whole plant.



Thrust force (kg) = P_1(kg/cm^2) x Ase(cm^2) x 1.3

$$\text{Preload (kg/cm}^2\text{)} = \frac{\text{Thrust force (kg)}}{\text{Piston Area (cm}^2\text{)}}$$

Air supply (kg/cm^2) = Preload (kg/cm^2) + 0.8 (kg/cm^2)

The detail of the calculation procedure to estimate the required IA. press. is explained in Appendix.

Fig. 5-9 Outline of Cylinder Type Control Valve

Table 5-4-1 Required I.A. Press & Valve Action at I.A. Failure

Tag-No.	Air Supply Design	Allowable Press. (kg/cm^{2}G)	Type of Control Valve	Valve Position I.A. Failure	A Em Stop Action	Service
A-FCV-101	5.3*	5.0>	N	Close	Close	Process gas
A-FCV-110	5.1*	5.0>	N	Close	Close	Process gas
A-FCV-506	6.5*	5.0>	N	Close	Close	Process gas
A-FCV-509	5.8*	5.0>	N	Close	Close	Process gas
A-LCV-574A/B	5.0	5.0>	N	(Air to open)	Control	Process gas
A-LCV-575A/B	5.0	5.0>	N	(Air to open)	Control	Process gas
A-PCV-401	5.4*	5.0>	N	Close	*4	Process gas
A-PCV-522	5.9*	4.0>	N	Close	Control	Steam line
A-PCV-523	4.3*	4.0>	N	Close	Control	Steam line
A-TCV-508A/B	4.6	5.0>	N	Close	Control	Process gas
A-HCV-104	4.9	5.0>	N	Open	Open	Process gas
A-HCV-502A/B	4.6	5.0>	N	Close	Control	Process gas
A-HCV-503A/B	5.5*	5.0>	N	Close	Control	Process gas
A-HCV-504A/B	5 5*	5.0>	N	Close	Control	Process gas
A-PCV-111	5.0*	4.0>	T	Close	Control	Steam line
A-PCV-121	4.5*	4.0>	T	Lock	*1	Steam line
A-PCV-122	4.0	4.0>	T	Lock	*2	Steam line
A-EmV-121	4.5*	4.0>	T	Lock	Open	Steam line
A-EmV-122	4.5*	4.0>	T	Lock	Open	Steam line
A-FCV-172-2	4.0	4.0>	F	(Air to close)	Control	Process gas
A-PCV-108	4.0	4.0>	F	(Air to close)	*3	Process gas
A-HCV-105	4.0	4.0>	F	(Air to close)	Close	Process gas
A-HCV-506A/B	5.0	5.0>	K	(Air to open)	Close	Process gas
A-HCV-507A/B	5.0	5.0>	K	(Air to open)	Close	Process gas
A-HCV-508A/B	5.0	5.0>	K	(Air to open)	Close	Process gas
A-HCV-509A/B	5.0	5.0>	K	(Air to open)	Close	Process gas
A-FCV-209A/B	4.0	4.0>	K	(Air to close)	Control	Process gas

*1 PCV can be op. by open SS-505 & SS-507, PCV closed automatically at Em AA.

*2 PCV is closed at NOR. and can be controlled at Em. AA class.

*3 Changed from original, PCV can be controlled at anytime.

*4 Changed from original. There is no Em, action.

The valve action (or position) under the IA failure and process trip (A class trip) are described in Table 5-4-1.

The set point of locking device and the set point of process trip is also summarized in Table 5-4-2.

The valves which marked "*" are those not matching the valve trip and process trip, because the valve trip, point is higher than the process trip hence the valve trip comes out earlier than the plant trip that means, valve itself causes the plant shut-down before the trip of IA failure comes out.

The set point of type "T" valves used in Aux. Boiler was changed from original set point of 2.4 kg/cm^2G to 4.5 kg/cm^2g in 1973 and has been kept at 4.5 kg/cm^2G. The set point should be set at 4.0 kg/cm^2G or lower.

Further, the required thrust force of actuators same type of PCV-522, that is, Type "N" was calculated by the team. At the same time, the document issued by manufacturer and constructor were also checked.

The calculation results are shown in Table 5-4-2.
The calculation is basing on the data specified by the manufacturer or constructor.
The results are almost the same to the team's.
The valves marked "*" are not harmonized the set points of locking device with the set point of IA failure of process.

As for the valves marked "*", the process conditions was reviewed.

Table 5-4-2 "N" Type Control Valve

Tag No.	Maker's Presented Specification: Type of Actuator	Inner "B"	Seat Area (cm^2)	Size of Stem "B"	Stroke of Volve "B"	Press. kg/cm^2: P_1	ΔP	Thrustforce (kg): UNIDO	Constor	Preload Pressure kg/cm^2 Counted. P.L: UNIDO	Constor	Present P.L: UNIDO	Constor	Air supply kg/cm^2: UNIDO	Constructor	Remarks
A-PCV-401	D	6	126.7	1	2	24.9	11.9	4080	4100	3.4	3.4	3.4	4.7	4.4	5.4*	To be changed air supply & preload.
A-TCV-508A/B	T	6	126.7	2	2 1/2	149	0.5	24500	24400	3.8	3.8	3.8	3.9	4.6	4.6	OK
A-HCV-502A/B	T	6	126.7	2	2 1/2	148	0.5	24500	24400	3.8	3.8	3.8	3.9	4.6	4.6	OK
A-HCV-503A/B	D-D	4	62.1	1 1/2	2	148	0.7	12020	11900	4.8	4.8	4.8	4.8	5.6*	5.5*	To be changed air supply & preload.
A-HCV-504A/B	D-D	4	62.1	1 1/2	2	148	1.5	12020	11900	4.8	4.8	4.8	4.8	5.6*	5.5*	do
A-FCV-506	T	8	198	2 1/4	2 1/2	149	5.0	38100	35300*3	5.9	5.6	5.9	5.8	6.7*	6.5*	do
A-FCV-509	D	3	34.8	1	1 1/2	139	60	6350	6300	5.2	5.2	5.2	5.2	5.9*	5.8*	To be changed actuater
A-FCV-101	D	6	126.7	1 1/4	2	33.4	0.5	5580	5500	4.5	4.5	4.5	4.6	5.2*	5.3*	To be changed air supply & preload.
A-FCV-110	D	6	126.7	1 1/4	2	32	1.5	5220	5260	4.3	4.3	4.3	4.4	5.1*	5.1*	do
A-PCV-522	D	6	126.7*1	1 1/4	2	38	37	6210	6900*3	5.0	5.7	5.0	5.7	5.8*	6.4*	To be changed actuater
A-PCV-523	T	8	140.0*2	2 1/2	2 1/2	105	2.0	19050	16000*3	3.0	2.5	3.0	3.6	3.8	4.3	OK
A-HCV-104	C	4	61.3	1	1 1/2	32	32	2590	2570	4.1	4.1	4.1	4.2	4.9	4.9	OK

*1 Cont's Data is 140.0 Maker's DWG is 126.7 (4B)
*2 Cont's Data is 126.5 Maker's DWG is 140.0 (8B)
*3 Cont's Data is wrong counted

5.4.2 Actuator of Control Valves

(1) Recommendation

To harmonize the required minimum IA pressure for control valves with IA failure alarm and trip system, followings are recommended.

i. Modification of set pressure of IA supply to the actuator of control valves and of preload pressure of actuator.
The table of recommendable set point of IA supply and preload pressure is attached. (Table 5-4-3)

ii. Change the type of actuator for two control valves, PCV-522 & FCV-509. (Specification Table 5-4-4)

(2) Observation

The fluctuation of the pressure of high pressure steam was used to observed during the plant starting and stopping. The cause was investigated and found that the IA pressure supplied to the steam pressure control valve (PCV-522) was insufficient.
The PCV requirs high IA pressure which could not be provided by old IA compressor.

Starting on this observation, the required IA pressure of all control valves had been checked, and found that the required IA pressure of control valves and the set pressure of IA control system had not been harmonized.

Table 5-4-3 Modification of Actuater

Tag. No.	A-PCV-522		A-FCV-509	
Service	SH Vent		A-GB-501 By-pass Line	
Item	Present	Modification	Present	Modification
Type of actuater	"D" Motor	"DD" Motor	"D" Motor	"DD" Motor
Area of actuater	1,220 cm^2	2,500 cm^2	1,220 cm^2	2,500 cm^2
Counted preload press.	5.2 kg/cm^2	2.1 kg/cm^2	5.2 kg/cm^2	2.6 kg/cm^2
Present preload press.	5.2 kg/cm^2	2.5 kg/cm^2	5.2 kg/cm^2	3.0 kg/cm^2
Counted air supply press.	5.9 kg/cm^2	2.9 kg/cm^2	5.8 kg/cm^2	3.4 kg/cm^2
Present air supply press.	5.9 kg/cm^2	3.3 kg/cm^2	5.8 kg/cm^2	3.8 kg/cm^2
Volume booster	61H 2pcs	4,514 4pcs	61H 2pcs	4,514 4pcs
Volum tank	3,000 IN^3 (48ℓ)	6,000 IN^3 (96ℓ)	6,000 IN^3 (96ℓ)	6,000 IN^3 (96ℓ)

Table 5-4-4 Recommend for Air Supply & Preload

Tag No.	Type of Actuater	Design Press. (kg/cm^2)		Present Press. (kg/cm^2)		Recommend Press. (kg/cm^2)		Max. Allowable	Remarks
		P_1	ΔP	Preload	Air supply	Preload	Air supply	Δp of Control (kg/cm^2)	
A-PCV-401	"D" Motor	24.9	11.9	4.7	5.4	4.1	4.9	30	
A-HCV-503A/B	"D-D" Motor	148	0.7	4.8	5.5	4.1	4.9	125	
A-HCV-504A/B	"D" Motor	148	1.5	4.8	5.5	4.1	4.9	125	
A-FCV-506	Toggle Actuater	149	5.0	5.8	6.5	4.1	4.9	100	
A-FCV-101	"D" Motor	33.4	0.5	4.6	5.3	4.1	4.9	30	
A-FCV-110	"D" Motor	32.0	1.5	4.4	5.1	4.1	4.9	30	
*SX-Line	470	103	66~103	4.5	4~7	3.5	4~7	116	* Tag No. A-PCV-111, A-PCV-121, A-PCV-122, A-EmV-121, A-EmV-122

As the result, it was found that the data of manufacturer or constructors specification was presumed too much the safety and those can be modified.
The recommendation is listed in Table 5-4-4.

Regarding PCV-522 and FCV-509 can not be decreased the set point of locking device as well as IA supply pressure for actuator.
Hence the actuators for these two valves should be changed.
The specification of recommendable actuator is described in Table 5-4-3.

5.4.3 Modification of Instrument of Ammonia Plant

(1) Installation of CH_4 gas analyser

The process gas analyser for CH_4 compornent is to be installed on the inlet line of HTS. This analyser is very useful to watch the operating conditions of Reforming section.

Tag No.	A-CH_4R-201
Range	0.0 ~ 1.0%
Type	Infrared

Other specification is listed in UNI-AM-115 in Appendix of this report.

(2) Installation of H_2 gas analyser

The process gas analyser for H_2 component shall be installed on the suction line of synthesis gas compressor.

This analyser is to be used to check the correctness of process air charging rate of the Secondary Reformer.

Tag No.	A-H_2R-401
Range	60 - 80%
Type	Thermal conductivity

Other specification is in UNI-AM-115 in Appendix of this report.

(3) Modification of Pressure Switch (PSW)

The PSW listed in Drawing No. MP-6 (in Appendix) shall be replaced to improve its hysterisis. At present these PSW have too much the hysterisis that the alarm are always illuminating.

(4) A-CO_2R-302 Sampling Line Modification

The sampling line of above analyser shall be modified as per drawing.

The existing sampling system takes long time to reach the sample gas to analyser. It can be improved by this modification.

(5) The Installation of PIC on Refrigerator inert gas purge line

The installation of PIC is recommendable to control the refrigeration loop pressure automatically and minimize the loss of NH_3 by recovering it in ammonia condenser of Urea plant.

(6) The Installation of TR on new IA dryer

By this TR, operator can watch the operating condition of IA dryer that can control the quality of IA.
Without this TR the regeneration of IA dryer becomes blind operation so that mist formation in IA header may be taken place and cause the failure of instrument.

(7) Installation of flow meter on condensate line of GV system

The flow rate of condensate to Regenerator bottom from make up pump is not indicated, at present, so that makes it difficult to control the level of Regenerator.
By this installation of FI, the operation shall be much easier. (UNI-AM-101~104)

(8) Installation of FI on CW line

It is essencial to manage the CW flow rate of each equipment in this plant.
The CW flow meter, installed at present, is temporary and the D/P cell were gathered from stock or diverted from idling machine.

The flow meters should be installed with standardized instrument. (UNI-AM-120)

5.4.4 Modification of Instrument of Urea Plant

(1) Impulse line and detector

U-PT-101 A/B improvement of pressure transmitter

U-LT-207 A/B modification of impulse line
U-PT-303 A/B modification of impulse line
U-PT-304 A/B modification of impulse line
U-PT-306 A/B modification of impulse line

Above modifications are to improve the reliability. It is common difficulty of Urea plant that the impulse line or detector is used to be blocked by the solidification of urea.
The problem shall be improved remarkably by the modification recommended.
Especially the improvement of pressure transmitter of U-PT-101 A/B is very important for the stabilized operation of urea plant.

(2) Modification of gland packing of control valve

The leakage trouble of urea solution out of the gland packing of the control valves can be reduced remarkably by this modification.

(3) Oval meter for liquid ammonia

At present the production of urea is estimated with the consumption of liquid ammonia, therefore the oval flow meter of liquid ammonia in Urea plant is very important instrument for the management of UFFG.

By this modification (installation of standard flow meter) the production and consumption can be checked and hence it contribute to the investigation of plant operating condition and to the management of plant.

(4) LIC-201

At present, the level of High pressure decomposer is indicated only a few percent of level indicated when the site glass indicating the fully up of the level. Hence the automatic control of HD level can not be done. This phenomena may be attributed to the bubble in the urea solution and effect of the buffle plate.

There are the spare nozzles near by the existing displacer, and the elevation is 250 mm lower than the existing, when the spare nozzles are utilized then the level indicator might indicate the level properly to use the automatic control.
It is worth to try to shift the nozzle.

At the same time TV camera is recommendable to watch the level of the site glass from the control room.

5.4.5 Rehabilitation of Instrument

(1) Ammonia plant

i) The PGA (Pressure Gauge with switch) for the IDF and FDF should be replaced all.
The impulse line should also be renewed at the same time.

ii) Regarding the analyser, it is recommended to stop to use the gas chromatograph analyser and be replaced to infrared or thermal conductivity type.
The micro CO and CO_2 analyser are not recommended to renew, because the process analyser

for this purpose is seemed to be less reliable from our experience, even though several manufacturer are providing the machines. The gas chromatograph with methanation reactor for lavoratory use is the most suitable for this purpose and the catalyst activity should not be changed so rapidly as to be checked in every shift.

As for the pH meter and Conductivity meter, the existing type is very old type such as the manufacturers have stopped the manufacturing of them. The trouble due to the super annuation are used to observed and further the spare parts are not available. Those should be renewed.

5.4.6 Emergency System

Followings are recommended regarding the Emergency trip system.

(1) To delete the steam pressure and steam temperature trip inlet of each turbine. Those conditions are controlled by main control system and can not assume such conditions to cause the trip. Before this trouble comes to turbine, the Primary reformer should be shutdown.

(2) Install the by-pass switch and delay timer

The delay timer is to be installed to eliminate the trouble of the chattering of input signal. And the by-pass switch is to be installed to make easier the maintenance.

(3) LA-551A-H (Seal Oil Tank level of Refrigerator)

The level is controlled by LICA-557 and watched by high level alarm.
Even if the level becomes extra high, the Seal oil is only over flowed to oil separator, hence there is no reason to stop the machine.

*: The Tag No. of the trip to be deleted are listed in Appendix.
The deleted trip annunciator shall be removed from the trip annunciator location and put it to the usual alarm location changing the color of annunciator.

(4) FrA-106 (S/C)

Install the recorder and computer on the main panel. The set point of instrument signal is to be changed.
This instrument is very important for plant operation, still there is no indication.
The recorder should be installed and watched by operators.

The impulse line has the leakage, when it is rain the water change the temperature of the impulse line and increase the leakage thru valves bonnets and flanges. The impulse line and the insulation should be replaced thoroughly.

(5) LA-103 (WHB Drum level)

The type of detector shall be changed from displacer type to d/p cell type. The indication of

LA should be recorded on recorder together with LICA indication.

By installing new trip signal from LICA, only when the both LA and LICA cause the trip signal at the same time, then plant shall be tripped.

From the team's experience the d/p cell type is more stable comparing with displacer type.

(6) Install the delay timer in the sequence of FRCA 101 EL, FRA-106 EL and FRCA-303 EL, to eliminate the misaction of instrument by chattering. It is not necessary to stop the plant instantaneously. They have the time allowance for a few seconds.

As for the set of timer, 10 seconds is recommendable.

(7) A-PCV-108 (IDF Damper)

The solenoid valve for this actuator is isolated from the emergency loop. It should be restored.

(8) LA-171 (Aux. Boiler)

The detector shall be changed from existing displacer type to d/p cell type.
The recorder for the indication of LA-171 shall be installed.
LRCA-170EL shall be installed newly and only when the LRCA-170EL and LA-171EL shall have been actuated at the same time, then the plant shall be tripped.

The idea is the same to the system for WHB's level.

(9) Emergency trip system

Regarding the automatic action of Emergency trip system, the individual action for each class of Emergency trip is ready when it is reviewed from the stand point instrument side.

The steam let down station was improved and is capable to supply the steam enough quantity.

However, the difficulty to operate the B, C, and D class plant trip is existing in the control of steam system, and at present the trip sequence such as S/C, WHB drum level and Aux. Boiler level has not been on line.

The discussion to do the B, C, and D class trip on line should be raised after those trip sequence shall have been established.

Regarding the instrument mounted on the panel, the recorders of which moving parts have been worn are to be replaced.

As for the controllers, the recommendation for the replacement has been prepared considering the importantness on the process.

The industrial TV set are facilitated to watch the levels of 100 kg/cmG steam drums and these are very important to confirm the level, because the drums are far from the control room and to check the actual level by the level gauge on the drum is difficult at the emergency.
Therefore these TV set are to be renewed.
The TV set should be prepared three set considering one set of spare.

The flow meters on the CW line have been installed temporary use, those should be replaced to standarized form.
The original scheme adopted the orifice meter, but this type is weak against mechanical shock and the fouling.
Therefore the local d/p cell type indicator is recommendable.

Regarding the thermocouples, it is well-known that the thermocouples used over the temperature of 500°C are suffered the deterioration of againg. The thermocouples used in the Reforming section and ammonia converters are to be renewed.

There is no standard meter for oval type flow meters, therefore, the calibration can not be done. The transmitter has also been out of order. The oval flow meter and the loop should be replaced.

The specification of those instrument recommended, herein, to be replaced are prepared in the Appendix.

(10) Urea plant

The instrument on the main panel should be replaced as a whole, except the simple indicators, because those are old aged.

The local instrument are also to be renewed because the corrosion are proceeding.

The control valves used to suffered the corrosion and/or errosion shall be prepared the spares.

As for the oval meter, it is explained formerly.

The meric scale had been planed to be overhauled and calibrated.
However, the spare parts has not been prepared in time and not practised.
The meric scale should be overhauled under the super vision of the manufacturer.
The test chains for the calibration of meric scale are corroded.
Especially the test chain for the calibration of 30% should be replaced.

The flow meter for the CW line are temporary it should be renewed with the correct instrument.

The seat for the Emergency valve of the fuel gas line of urea boiler is the double seat made of Tefron. The double seat is used to cause the leakage and it should be changed to single seat.

The CO_2 analyser has been adopted for the flue gas of urea boilers.
The analyser shall be replaced and changed to magnetic oxygen analyser.

Content Appendix

[VIII] Modification Plan (Urea plant)

1) Recovery of ammonia and urea
2) Ammonia condenser
3) High pressure decomposer reboiler
4) Recirculation pump

[IX] Modification Plan (Instrument)

1) Ammonia plant
2) Emergency system
3) Urea plant

[X] Rehabilitation Plant (Instrument)

1) Ammonia plant
2) Urea plant
3) Spare parts

[XI] Pure Water Unit

[XII] CW Treatment

[XIII] Gas Turbine Generator