付属資料 11

— MINUTES —

THE FIRST FIELD SURVEY

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THE FIRST FIELD SURVEY

FOR

THE FEASIBILITY STUDY

ON

THE REHABILITATION OF NITROGEN FERTILIZER PLANT IN THE REPUBLIC OF ZAMBIA

CONFIRMED
BETWEEN

NITROGEN CHEMICALS OF ZAMBIA LIMITED
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

MARCH 1981

.....
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APPENDIX I.

Items to be opened and checked in the coming Shut-down.

1. INTRODUCTION

1.1 In accordance with the joint communique of His Excellency the President of Zambia and the Prime Minister of Japan, Japan International Cooperation Agency (JICA) is to undertake an evaluation study of the feasibility of the rehabilitation of the Nitrogen Chemicals of Zambia Limited.

The field survey shall be made in two stages, namely, the first for the operational studies while the plant is running and the second for the detailed equipment/machinery check-up to be done in the overhaul period which is expected for about a month starting 5th October, 1981.

These minutes cover the first survey for the operational studies and economical data/ information for the feasibility study.

1.2 The survey team organized by JICA has carried out work in Zambia with the aforesaid objectives from February 23, 1981 through March 18, 1981.

The work performed during their stay in Zambia consisted mainly of :

A. Economic situations and Demand/Supply of fertilizers in Zambia ;
B. Present situations and operating conditions of NCZ plant ;

C. Items of equipment to be inspected in the coming overhaul period ; and

D. Causes and reasons of lower production capacity.

1.3 Mr, Fukubayashi, Adviser, JICA left Zambia on February 26, 1981 and Mr. Ohno, Mechanical Engineer, left Zambia on March 3, 1981 after their mission had been fulfilled.

1.4 These minutes are to present a summary of the work performed in Zambia by the first survey team stating main items to be confirmed for subsequent evaluation studies and cooperation expected for further survey.

1.5 The first survey team has successfully performed its studies with full assistance and cooperation extended by NCZ and other Zambian organizations and authorities.

The first survey team acknowledges, and takes this opportunity to express its

appreciation for such assistance and cooperation of NCZ and other Zambian organizations and authorities.

2. GENERAL UNDERSTANDING OF THE PROJECT

2.1 Background information.

2.1.1 Existing plant

Nitrogen Chemicals of Zambia Limited was formed in September, 1967, the Share Capital of which stood at K12.88 million made up of K11.88 million held by INDECO in Ordinary Shares and K1 million held by Kobe Steel Ltd. of Japan in Preference Shares at the end of March, 1980.

The Plant was officially opened in May, 1970 with the capacity designed to give an output of 96 tons of NH_3 per day corresponding to an annual output of Ammonium Nitrate of about 60,000 tons.

In order to increase the operating flexibility of the Ammonia Plant, a stand-by gasifier was installed and commissioned in January, 1978.

Since April, 1973, the plant has been running satisfactorily producing about 25,000 tons of Ammonia per year and about 50,000 tons of Ammonium Nitrate per year which is decreasing year by year because of aging effect.

In August, 1979, a Carbon DioxideRecovery Plant with a capacity of 1,000 MT per annum added to the plant and is running normally.

About 50% of the Ammonium Nitrate is sold to Kafironda Ltd. as explosive grade while the remaining production is sold to NAM Board as fertillizer.

2.1.2 Expansion Projects

Integrated expansion to the existing plant has been completed and pre-commissioning activities have already started. Commercial operation is expected to start in January, 1982.

The expansion projects involve the following and will be integrated in the existing plant layout:

1) Expand the Capacity of Coal gasification and the Ammonia Plant by 220 tons of NH_3 per day or about 66,000 tons per year for 300 operating days per year. Of this capacity, 4,000 tons per year is proposed to the existing Nitric Acid and Ammonium Nitrate Plants in order to reach maximum output of the existing Ammonium Nitrate Plant.

The balance will be the raw material for ammonium nitrate and ammonium sulphate and to a lesser extent for compound fertilizers.

2) Expand the capacity of the Nitric Acid Plant by 212 ton per day. (about 70,000 tons per year for 330 operating days per year.)

3) Expand the capacity of the Ammonium Nitrate Plant by 242 tons per day. (about 80,000 tons per for 330 operatimg days.)

The major part of the product will be prilled and sold as ammonium nitrate fertilizer while the remainder will be used to produce compound fertilizers.

4) Install a new plant to manufacture Ammonium Sulphate of 151 tons per day (about 50,000 tons per year for 330 operating days.)

This is essentially for production of compound fertilizers while small portion may be sold as Ammonium Sulphate fertilizer.

One of the raw materials for Ammonium Sulphate, Sulphuric Acid, is proposed to be obtained locally from the Mines. INDECO Ltd. is planning to set up a Sulphuric Acid plant with an investment of K20 to K25 million to meet the Sulphuric Acid requirements of the plant.

5) Install a new plant for the manufacture of compound fertilizers of a capacity of about 427 tons per day (about 141,000 tons per year for 330 operating days per year.)

The raw materials not available in the plant (phosphates and potassium) are proposed to be imported.

2.1.3 The relationship between existing plant and expansion plant is as the chart attached.

2.1.4 The products balance including the existing plant and the expansion plant is as per the chart also attached.

2.2 The scope of the survey will be based on the following conditions:

1) Production capacity will be recovered to an adequate operation capacity in the range of the original rated capacity. (No consideration will be given to enlarge the original production capacity.)

2) The rehabilitation plan will enable stable plant operation (continued operation) with ordinary maintenance and overhaul but without large scale repair work after the rehabilitation project has been completed.

3. MARKET ASPECTS

The team has collected updated date and information with respect to projected demand/ supply of fertilizers and other factors affecting fertilizers in Zambia.

On the basis of these data and information, the team will attempt to make up a rehabillitation feasibility study when all other relevant equipment/machinery, construction and other expenses and costs are calculated based on the second field survey expected in October, 1981.

The data and information collected by the team are listed in Table 1.

TABLE 1

INFORMATION AND DATA FOR MARKET ASPECTS

No.	NAME OF INFORMATION AND DATA	ISSUED BY	REMARKS
1.	NAM Board Annual Report (1978)	NAM Board	
2.	Fertilizer Stock Position (1981)	〃	
3.	Demand and Supply of Fertilizer (1975－1990)	〃	
4.	Statement showing the quantity purchased, comparative landed costs and selling prices of Fertilizer. (1980)	〃	
5.	Laws of Zambia Cap. 356 "National Agricultural Marketing"	Government Printer	
6.	Sales Analysis (1975－1981)	N. C. Z.	

IV TECHNICAL ASPECTS

4.1 GENERAL

The survey and study performed by the first survey team cover a wide range of technical matters, among which the selection of equipment/machinery to be inspected in the coming overhaul period was given the special attention.

The survey has been performed by means of collection and review of data and information as far as available, field surveys in the NCZ Kafue plant, and discussions with the engineers/managers of NCZ Kafue plant and other concerned persons.

4.2 GENERAL CONDITIONS OF THE PLANT

4.2.1 Capacity and Operation days

The average production was 72.3 T/D of Ammonia, 141.4 T/D of Nitric Acid and 153.2 T/D of Ammonium Nitrate for the fiscal year 1980 which is around 76% of the rated capacity for Ammonia, 82% for Nitric Acid and 75% for Ammonium Nitrate.

The operation days and products are as per the table below : –

	RATED CAPACITY	1980 OPERATION DAYS	1980 PRODUCTION
	M T/D		MT
AMMONIA	95.3	278.7	20,153.7
NITRIC ACID	172.4	263.2	37,212.19
AMMONIUM NITRATE	205.5	248.0	37,995.69

As is seen the above , the capacity of Ammonia production could be recovered, the relative production of Nitric Acid and Ammonium Nitrate could possibly be increased to the corresponding levels.

4.2.2 General Conditions of the plant

Deterioration because of the aging effect is noticed all over the plant, especially in the

Coal Handling (301) Hydrogen Sulphide Removal (303) snd Ammonium Nitrate (501) sections where some equipment/machinery are removed because of wear and/or tear and resulting disadvantage is covered by inferior quality or operational inconvenience or shortened operation hours.

The Survey Team was of the opinion that Management can improve upon the plant house-Keeping as poor house-Keeping could cause dangerous occurances such as operator injuries and equipment/machinery failure.

Inspite of the chronic shortage of spare parts and supplies, the team was impressed by the continuous operation of the plant all these years, maintaining a reasonable degree of capacity utilization.

4.3

4.3.1 301 COAL HANDLING

Coal dust has accumulated all over the coal handling Plant site which not only worsens the working environment but also contributes to the shortened life expectancy of the equipment.

Coal dust can be a cause of plant fire, too,

The environment as above can be improved by installing dust collectors at each dust producing point as follows : (The capacity is expected to be around 100㎥/min for each point.)

1. Inlet of the ball mill
2. Inlet of the rotary dryer
3. Inlet of the lime supply
4. Inlet of the fuel coal to the dryer

In most cases, automatic control systems are not working and plants are manually operated. Instrument control systems need to be repaired and/or replaced.

Inventory of spare parts required for dusty operating environment such as bearings, oil seals packing etc. had better be maintained at higher level.

The capacity of the plant is supposed to be around 8 tons/hour but without the

proper operations of the weighers, this can't be confirmed.

The sample screen analysis of the pulverized coal shows a sudden change in the size distribution around 170 mesh, which probably is caused by screening method with 170 mesh and 200 mesh sieves. Wet method of screening is recommended for the sizes finer than 170 mesh.

4.3.2 302 GASIFICATION

1) General

The original coal specification on which the plant design was based was from Shiankandobo which was not available from 1970 due to the closure of the mine.

The guarantee test was done using Wankie coal, the specification of which is almost similar to the originai design figures.

The guarantee test proved thet the production was 110 ST/D using 1,515 Nm^3/Coal T of synthesis gas (out of which effective gas is1,302 Nm^3/Coal T) and coal consumption was 1.64 ST/NH_3ST which exceeds the expected figure of 1.60 ST/NH_3ST.

On the actual commercial operation, Maamba coal available in Zambia has been used. Maamba coal contains about 10% less carbon, and 35% more of ash compared to Wankie coal. Thus the capacity of gasification unit is reduced tremendously.

2) Operation and Capacity

Actual operational experience shows that the capacity of the plant is around 9, 000 – 9,500Nm^3/H if the period is short but it requires 9MT/H of coal. But after a week or so, gasifier pressure reaches 780 ㎜ WG which trips the plant operation. This is caused by clogging of gas passage by ash clinker.

For normal and stable operation, 8, 500 – 9, 000 Nm^3/H of gas produced from 8 MT/H of coal with the product of NH_3 around 85 MT/D are standard figures.

But, when the new coal handling plant is available and some counter measures could be worked out to prevent ash accumulation at the tubular boiler inlet, longer operation hours with 9, 000 Nm^3/H of produced gas seems to be possible.

4.3.3 303H_2S REMOVAL

1) General

This plant is designed and constructed to reduce H_2S 0. 92% contained in the Raw Gas

from Gasification plant down to 3 ppm or less.

The figures obtained in the guarantee test were : –

0. 36 – 0. 6% H_2S in Raw Gas and remaining H_2S at the exit was as designed.

After ten years of operation, sometimes the H_2S content in the gas leaving this plant exceeds 800 ppm which is caused by poor composition of the solution and increased HS^{-1} remaining in the solution. Sulphur in the solution is not removed properly and is causing clogging of the absorbers. Remaining HS^{-1} in the solution is corroding the equipment and the piping very heavily. Such heavy corrosion cannot be expected when the composition of the solution is maintained as designed.

Once the expansion plant (now under commissioning) is put in operation, this existing H_8S removal section may be put out of service and thus least extent of rehabilitation work may be required. (But once the plant equipment is put out of service, deterioration is intensified requiring incessant attention.) However, it should be emphasized that the composition of the solution should be maintained as designed to have the optimum operation.

2) Operation

Because of the poor composition of the solution, HS^{-1} cannot be converted to sulphur and remaining in the solution and HS^{-1} is, at the same time, reducing H_2S absorbing capacity of the solution. For example, when the pH is 8.2 and 5.5 ppm of HS^{-1} is remaining in the solution, H_2S can't be reduced below 100 ppm. HS^{-1} has to be maintained below 0.1 ppm.

To have a stable operation, it is essential that the composition of the solution should be as designed especially those of $NaVO_3$ and ADA.

3) Main points noticed in the Surevey

NCZ has been making good efforts to maintain the plant in operation, but corrosion cannot be reduced without the proper composition of the solution.

4.3.4 304–309 GAS PURIFICATION AND NH_3 SYNTHESIS

1) General

The present plant operation conditions in many places are not as per design specifications and as a result cause more corrosion/erosion or quick deterioration of the tower packings and catalysts. The plant operations can be imoroved upon by adhering to design conditions and ensuring the reliability of the control instruments.

The activities of the laboratory have improved to a great extent and full use should be made of its facilities.

Operating staff should be made more cost conscious and to reduce the equipment/machinery downtime, due emphasis should be given to preventive maintenance.

Every plant problem must be analysed and studied carefully and thoroughly to identify the cause and find a solution to avoid the recurrence of a similar problem.

2) Plant Capacity

The capacity as of February 24, 1981 is around 79 MT/D, which is a little less than design capacity and mainly caused by deterioration of the Primary Shift Converter catalyst, the differential pressure of the third layer of which is on the limit and no more flow can be allowed through the catalyst bed.

The plant capacity from 304 through 309 can be recovered once the third layer of the catalyst is renewed.

NOTE : The comment above is based on the following information and data.

(1) Differential Pressure of primary shift converter

(March 4, 1981)

R. G. 9,600 Nm^3/H steam 6,960 kg/H

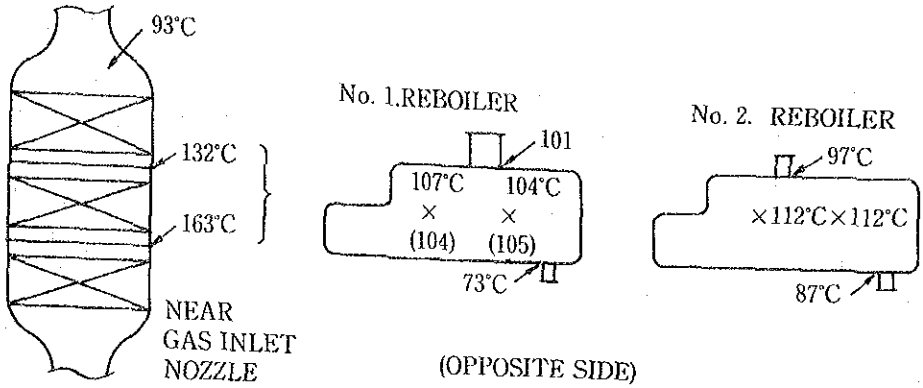
		1st run	2nd run
DP	1st bed	0.21	0.19
DP	2nd bed	0.29	0.31
DP	3rd bed	0.50	0.60
	TOTAL	1.00	1.10

(2) H_2S content (%)

	303 Sec. out	304 Sec. out
Fed. 28,81	0.012	0.052
Mar. 3,81	0.0052	0.051
Mar. 4,81	0.010	0.060

(3) Surface Temperatures (°C)

P.S. Converter.



(4) Suspended solid analysis in Potassium Carbonate solution.

(5) Saturator water analysis

(6) Vibration of 305 PO/A Carbonate solution pump.

(7) Operation Log Sheets maintained by NCZ

(8) Operation Log Book maintained by NCZ

(9) Background of NCZ prepared by NCZ

(10) Survey Report by KSL presented to NCZ in 1979.

(11) Maintenance work Report by KSL presented to NCZ in 1980.

3) Main points noticed while surveying the plant operations :

3.1 Cooling water quality

Cooling water as used now in the plant tends to cause scaling which is the cause of lower heat transfer, clogging of the cooling tubes and further causing corrosion.

The solution shall be : – (1) Treatment with chemical reagents

(2) Replacement of bundles with stainless steel.

3.2 Raschig rings in the saturator

The frequency of cleaning is high, on an average, once in a year. This is because of the clogging due to carry-over of coal dust from the gasification plant. The situation will improve when the expansion plant starts due to the operation of the electrostatic precipitator.

The material had better be changed to stainless steel, the specification of which shall be thoroughly and carefully studied considering the water quality and saturator performance.

3.3 Raschig Rings of 305 and 307 sections

The frequency of replacement is normal except the carbonate Absorber bottom bed.

The life expectancy of ceramic rings in this kind of plant is generally 4 to 8 years.

Carbonate Absorber bottm bed is replaced every year, probable cause of which is accumulation of sludge caused by corrosion. Anti-corrosion agent and solution filter is strongly recommended.

3.4 On Catalysts

The data and information collected during this visit shall be further studied for comments.

There might have been chances of abnormality high temperature while oxidizing the catalyst of No. 2 shift converter.

The recent practice is not to oxidize but cool - down the catalyst with N_2 gas and dump into air or water.

3.5 Corrosion of Carbonate CO_2 Removal No. 1 and No. 2 reboilers and related carbon steel parts are badly corroded, it was reported.

This is caused by abandoning the inhibitor since May, 1974. If no inhibitor is used, all the wet parts shall be changed to stainless steel.

Design condition of No. 2 Carbonate Reboiler is milder than that of No. 1 Reboiler, but it was corroded more than No. 1 Reboiler. The temperature on the surface of No. 2 Reboiler is higher than that of No. 1 Reboiler by about 5°C which means higher corrosion attack on No. 2 Reboiler because the solution near the tube sheet does not move and excessively condensed to cause corrosion.

The operation log sheet on Feb. 24, 1981 shows that the CO_2 content at the exit of Absorber is 0.55% which is extremely low and shows excessive regeneration of the solution (Design Figures is 0.8-1%).

The material of construction of that part had better be studied.

3.6 Corrosion on the tubes of 306 E02 Preheater A

The lower temperature on the tubes is considered the cause of corrosion. To minimize the trouble, it is recommended to change the material to stainless steel if the lower capacity operation or intermittent operation is inevitable.

3.7 Hot bolting of the Basket Cover Bolts of NH_3 converter.

Short passing of the shell cooling gas into the catalyst bed inlet was suspected as a cause of the lower capacity of the NH_3 converter.

But there was no clear indication of the reasoning even consulting the temperature charts for a few days of June 7th, 1975 and onwards.

The data shall be studied further.

4.3.5. 310 Compressor

(1) General

Compressors are running rather satisfactorily and the points noticed are as follows : —

1.1 Raw Gas Compressor (310 K01)

Inlet filter internal has been removed to avoid pressure drop caused by clogging of fly over carbon powder from Section 303.

Seal gas lines and balance gas lines had better be checked for clogging and renewed if necessary.

1.2 Nitrogen Gas Compressor (310 K02)

Vibrations of the compressor is somewhat excessive which has been said to be noticed after the annual maintenance in 1980.

Checkeing and re-alignment are required.

1.3 Synthesis Gas Compressor (310 K03)

Temperature of 2nd and 3rd stage suctions are higher than the original operating conditions in 1970.

Coolers of all the stages should be inspected.

1.4 Air Compressor (310 K04)

The coolers of all stages should be checked and inspected. These coolers are of finned tube type and no repair shall be possible.

All the drain traps on all stages should be replaced to have better draining capacity.

4.3.6 311 Air Separation

1) General

This plant has been operated almost without troubles for more than ten years.

Reserving heat exchangers and check valves were replaced in April, 1976.

The Expansion turbines are switched to others by turn every six months.

2) Operation

Operation has been maintained almost as identical to the original operation, but slight over cooling keeps the lower column pressure lower and purity of product oxgen is slightly poorer.

Operation is going on quite satisfactorily and this plant has suffered no shut-down ever caused by itself.

3) Main points noticed

No washing (with carbon tetrachloride) has ever been done for more than ten years should be done every five years.

Air Intake filter has been operated more than ten years and renewal had better be considered.

4.3.7 401 Nitric Acid

1) General

This plant is designed and constructed to produce 190 ST/D of Nitric Acid (Converted to 100%) (55% 310 MT/D) which was proved in the guarantee test that it produced 192−193 ST/D of Nitric Acid (Converted to 100%).

Raw material consumption also was proved in the guarantee test that NH_3 0.285 ST/HNO_3 ST (as 100%) Guarantee figure was exceeded (0.2808−0.2815 was the guarantee test result).

It has been more than ten years after the guarantee test but its capacity has been maintained. But due to many years of operation there are many points of corrosin, fallen trays and leakage in the cooler coils and heat exchangers, which will enforce the plant shut-down in two, three years of operation.

2) Plant Capacity and Production

The plant is not operated with 100% load because of the lower supply of ammonia.

It is run at 150−160 MT/D which is 88−95% of the rated capacity, but the capacity goes sometimes over 100% as 103−8% in 10−6 shift on Feb. 28 and slightly over 100% in 10−6 shift on March 2, 1981.

3) Main points noticed comparing the present operating conditions with those of the guarantee test.

a) Higher pure water temperature of V02 pure water tank.

This is caused by too much steam injection to the pure water tank V02 raising the economizer exit tail gas temperature to 95°C instead of 65°C (Original figure).

A newly installed condensate recovery tank at the economizer exit recovers the condensate as weak acid of around 18%, which is fed to T04 Absorption Tower with the weak acid of 34−37% from the separate source.

The gas temperature at the inlet of T01 is maintained at around 60°C by means of the

water cooler coil on V03 Separator.

b) Higher temperatures of both liquid and gas in T01, T02 and T03 Oxidation Towers and T04 and T05 Absorption Towers.

The temperature at the inlet of T01 is almost the same as design figure but the temperature of both gas and liquid are higher by 5 to 10°C in the down stream.

Product nitric acid temperature is 34°C instead of 24°C, which means lack of cooling even when the ambient temperature is considered.

Cooling coils should be repaired or replaced as soon as possible to maintain the inlet temperature to each tower at about 25°C—30°C.

c) Catalyst consumption is normal and $NO+NO_2$ in the effluent gas is maintained at 1000—1200 ppm which is about half the design figure and quite satisfactory.

d) Tail gas inlet temperature to 401 E04 is kept higher by means of a preheater installed by NCZ to lower the corrosion at the connection flange of E04 Tail Gas Heater and E05 Economizer but still there is some leakage through the corroded flange.

4.3.8 501 Ammonium Nitrate

1) General

Total production of Ammonium Nitrate has been maintained at 47, 000 Tons/year for these five years out of which the production for the year 1980/81 is far less because of shut down for two months (July, August) to facilitate the Tie—ins with the Expansion plants.

Steam consumption is not properly recorded but had better be done to reduce the utility cost.

Liquid NH_3 consumption may be more than expected in Adjustor Tank 501 V03 because the tank (V03) is stained by Ammonium blowing out of the man-hole. Some amount also is lost as aqueous ammonia in the PR surface condenser (501 E09).

Consumption of Nuflo—10 is normal (0.17—0.18%).

1. Plant Capacity

Porous product is produced far above the design figure of 39 T/D (June 1980 109 T/D, October 1980 94 T/D)
But the product temperature is not maintained at a proper level (cooling air temperature goes beyond 32°C and the transition point of the product of 32°C is left as it is) .

Production of fertilizer is far less than the design figures of 166 T/D, because the nozzles are not used in full number.

For example, in October 1980 for 5 days 6 nozzles, for two days five nozzles, for nine days four nozzles and others three nozzles.

Moreover, the shutdown time is long (almost everyday, there is shut down for some time).

The causes of the shut down could be :

(1) Cleaning of nozzles
(2) Cleaning of the bottom of T03
(3) Bridging of Hopper

The longest among the above is (1) and one operator is stationed on the prilling tower.

The cause of clogging of the nozzle is removal of the Filter (F01) .

3. Main points noticed in the plant survey :

3.1 Product Analysis (Porous)

Oil Absorption is very high and satisfactory.

Moisture is around 0.1% and also satisfactory.

Oil figures also are showing good quality.

(Fertilizer)

Moisture is around 0.2% and good enough. pH shows lower values (3.8 June 22, 4.0 October 6) and had better be maintained higher than 4.8.

This lower pH might have been caused by forgetting NH_3 charge to V32 tank.

3.2 Quality control

Analysis data is well filed and maintained.

But actual operation does not seem to be fully making use of the date available in the laboratory.

Especially at the point of bagging, the operators are expected to be very careful not to allow water contamination into the product, but they are working in very wet working conditions. This situation should be remedied.

The temperature of the product should also be well cared for. The inlet air temperature at the product cooler should be kept about 15°C to maintain the product below 32°C (transition temperature). Sometimes this temperature was as high as 60°C (Feb. and March 1981).

3.3 Design conditions and actual conditions.

When figures recorded on the log sheet show something different from the normal operating conditions, operators should immediately take action to rectify the abnormality.

3.4 The product is of extremely water absorbing nature and extreme care has to be taken not to allow water nearby.

Roofs, windows and walls have to be repaired not to allow rain in the building.

4.3.9. 601 Water Treatment

1) General

1.1 Coagulation unit and Filtration unit.

Chemicals and diluting water are not measured properly, (sometimes, overflow of diluting water is noticed) but the analysis of the water shows almost satisfactory figures.

If charging of Aluminum sulphate can be maintained at 50 ppm, the condition would be improved. Sample from the blanket zone of the precipitator should be controlled to have the sludge precipitation of 20−60 vol. % after 10 minutes.

Filtration unit is under repair now and once back in operation it would function as expected if the strainer plate is renewed, the strainer elements cleaned and the filtrating sand renewed.

1.2 Demineralization Unit

Higher SiO_2 and lower pH are noticed almost once a week. It may be caused by leaking of the back wash valve at the exit of the anion tower. This valve had better be checked and replaced if necessary.

1.3 Cooling Tower

Chlorine charging should be in such a way as to maintain 0.5 ppm for 4−6 hours a day.

Use of inhibitor to prevent slime accumulation in the circulation water line is recommended. Inferior quality of the cooling water is the main cause of fouling of the cooling equipment all over the plant.

2) Operation and Capacity

2.1 Coagulation unit and filtration unit.

The capacity of original design can be maintained if quantities of chemicals and diluting water are maintained properly.

2.2 Demineralization Unit

Flow rate is almost maintained at the design figure of 45−50T/Hr.

2.3 Coolig Tower

Capacity of the cooling tower itself is maintained at the design figures of 3, 400 − 3, 500 m³/Hr but because of too much leakage in the circulation lines, blow off is zero, which requires about 20% more (153 design to 180 m³/Hr actual) of make−up water.

3) Points noticed surveying.

3.1 Spare Parts

No spare parts except the speed reducing gear of the cooling tower fan.

3.2 Reagent make-up

While making up reagents in dissolving tanks, sometimes the operator does not keep watch of the mixing and charging. (Sometimes overflowing is noticed). Level gauges of the dissolving tanks are all damaged.

3.3 Reagent charge pump

Almost one third of the pumps have damaged gland, and thus the amount of reagents charged is less than expected.

3.4 Conductivity meter.

Conductivity meter in the demineralization unit seems to be out of order, it had better be readjusted.

3.5 Slow Rinse periods of Anion and Cation towers :

Both slow rinse period had better be elongated to 10 minutes for cation unit and 20 minutes for anion unit.

3.6 Timers for regeneration are out of order and should be repaired or replaced.

4.3.10 602 BOILER

1) General

Boiler was changed to pulverised coal burners with auxiliary oil burners after commercial operations started, which is supplying 32 kg/㎠ steam normally 12 T/H and maximum 13 T/H continuously and steadly.

2) Operation

To prevent corrosion by high sulphur in Maamba Coal, ammonia synthesis blow gas is introduced.

Operation has almost never been interrupted except the shut - down every two months to

remove clinkers on the top bricks of the furnace.

3) No special consideration may be given to the unit except the periodical inspection and checking (and maintenance as required)

4.3.11 604 WATER INTAKE

1) General

New pumps are now under operation and water intake capacity is sufficient to provide the flow required. Old pumps are ready for operation and can take the load at any time.

4.3.12 605 EFFLUENT UNIT

1) General

B-Effluent (effluent from Gasification) is pumped through the new effluent line to the lagoon without any trouble. Balance tank exit pH is fluctuating from 2-10 which should be maintained in the range of 6-8.5.

2) Capacity

Capacity is sufficient to cover the present operating conditions.

3) Points noticed while surveying

3.1 B-effluent should be analyzed and the record should be kept because this effluent is the most dangerous one.

3.2 Spare Parts

No spare parts are stocked at all. (Diaphragm for the valves, impellers of pumps, ion exchange resins, strainers, V-belts are to be stored as spare parts.)

4.3.13 INSTRUMENTS AND ELECTICALS

1) General

Importance of reliability of the instruments in the plant can't be cover-emphasized. To have the stable, safe and continuous operation of the plant, highly reliable automatic control is essential.

To maintain the instruments at a highly reliable level requires maintenance of the standard measuring instruments to which all field instruments are calibrated and people to work according to the standard procedures established to maintain the high level of calibration.

For that purpose, the tools and jigs for calibration and repair, if required, should be provided sufficient in quality and quantity, the spare parts should be maintained at a proper level and the people trained to the level required for each job.

At the same time, the job description should be revised if required, to establish a close cooperation of the production department, the engineering department and the technical department to enable efficient and effective instruments and electric equipment maintenance.

2) The points noticed in the field survey are :

2.1 The instruments on the panels seem to be not sufficiently reliable.

2.2 Recorders are not recording as expected, because of poor maintenance (cleaning etc.) of the ink pots, ink feed lines and the recording pens.

2.3 Many control valves are not maintained properly. Leaks are noticed through the gland, response time is not as short as expected.

2.4 Almost all cable trenches are filled with water and other contaminant liquid and covers are found missing or damaged at many points.

The former is because of the absence of drainage system for the trenches and the later due to expansion construction activities.

2.5 Necessary remedial measures should be initiated by the management as quickly as possible.

V. FINANCIAL AND ECONOMIC ASPECTS

Based on the financial and economic information which has been collected by the team and construction (rehabilitation) cost estimated by the team after coming survey, the team will make financial and economic analysis. All the information collected by the team at this time is shown in Table 2.

TABLE 2

INFORMATION AND DATA FOR FINANCIAL AND ECONOMIC ASPECTS

NO.	NAME OF INFORMATION AND DATA	ISSUED BY	REMARKS
1.	The 3rd National Development Plan (Annual Plan 1980)	NCDP	Government Printer
2.	Third National Development Plan (1979 - 1983)	〃	〃
3.	Zambia in Figures (1980 Edition)	Central Statistical Office	
4.	Consumer Price Statistics (No. 2 February, 1981)	〃	
5.	Zambia's Guide Line for the Next Decade	Government Printer	
6.	*Monthly Digest of* Statistics (1980, April/September)	Central Statistical Office	
7.	Manpower Survey (Second Quarter, 1977)	〃	
8.	Price Index of Building Materials (March, 1977)	〃	
9.	Quarterly Financial and Statistical Review. Bank of Zambia Vol. 10, No. 2 June, 1980	Bank of Zambia	
10.	*Bank of Zambia 1979* (Report and Statement of Accounts for the Year Ended December, 31st 1979)	〃	
11.	Guide to the Completion of an Application for an Import Licence (2B, 2C)	Ministry of Commerce and Industry	
12.	Laws of Zambia Cap. 594 "Taxation"	Government Printer	
13.	Laws of Zambia Cap. 351 "Agriculture"	〃	
14.	Capital Allowances for Business other than Mining and Farming	ZIMCO	Tax Advisor

NO.	NAME OF INFORMATION AND DATA	ISSUED BY	REMARKS
15.	Estimates of Revenue and Expenditure (1st Jan. 1981 to 31st Dec. 1981)	Government Printer	
16.	INDECO Annual Report (1976 - 1980)	Indeco Limited	
17.	Accounts (1976 - 1980)	NCZ	Chief Accountant
18.	Sales Analysis (1975 - 1981)	〃	〃
19.	Depreciation and Amortization Rates	〃	〃
20.	Statement of Cost of Production (1975 - 1981)	〃	〃
21.	Coal Purchases from (1975 - 1980)	〃	〃
22.	Statement of Production (1975 - 1979)	〃	〃
23.	Lime Purchases from 1975 - 1920 (Unslaked Lime)	〃	〃
24.	Lime Purchases from 1975 - 1980 (Industrial Slaked Lime)	〃	〃
25.	Catalyst Purchases from 1975 - 1980	〃	〃
26.	Schedule of Other Overheads	〃	〃
27.	Percentage Calculation used for Cost Calculation	〃	〃
28.	Schedule of Other Expenses up to December 1980	〃	〃

VI. Requsts for the preparatory action to be taken by NCZ for the second field survey.

6.1 Scheduling and preparations to open the equipment/machinery for inspection and study as listed in Appendix-1.

6.2 Provision of spare parts and consumable materials for the equipment/machinery for reinstallation after detailed check-up and survey as above.

6.3 The timing of the coming shut-down falls in the busiest period of the commissioning activities of the new expansion plant.

The second survey team which is expecting to visit the plant at that time should be given a full attendance and co-operation by a team of expert managers/engineers to accomplish their mission.

The expected numbers of the second survey team shall be : —

One :	Team Leader
One :	Sub-Leader
Five to Six :	Mechanical Experts

6.4 If there is any change in these minutes or the memorandum signed on February 25, 1981 between NCZ and JICA, the change shall be notified to each other as follows : —

NCZ : Mr. C. M. Kapihya, General Manager
P. O. Box 226, Kafue,
Zambia.
Telex : ZA 70030

JICA : MR. K. Adachi,
C/O Mr. N. Fukubayashi, Advisor,
Industrial Division,
Japan International Cooperation Agency,
№ 1 Nishi Shinjuku, 2-Chome,
Shinjuku-ku, Tokyo, Japan.

Telex : J22271 JICAHDQ

VII. Data and Information Provided by NCZ

1. NCZ Background Information (4 pages)
2. Annual Shut-down Periods 1971 – 1980 (1 page)
3. Plant Operation time for 1980 (Jan-Dec)
4. Plant Operation time for Oct. 1978 to Dec. 1979
5. Collective Agreement between NCZ and the National Union of Commercial and Industrial Workers (1st February, 1978)
6. Demineralised Water Analysis for 1978 – 1980
7. Liquid Ammonia Analysis for 1978 – 1980
8. Raw Water Analysis for 1978 – 1980
9. Effluent Analysis for 1979, – 1980
10. Nitric Acid (Composite) Analysis for 1978 – 1980
11. Ammonium Nitrate (Porous) Analysis for 1980
12. Coal Analysis for 1980

(Nos. 3, 4, 6 – 12 were prepared by Mr. Liayo, Acting Technical Manager)

APPENDIX I

Section 301 Coal Handling

NO.	EQUIPMENT NO.	QUANTITY	NAME
1.	301 W03	1	Weighing Feeder
2.	301 W04	1	〃
3.	301 D01	1	EBRO Type Rotary Dryer
4.	301 D01-R1	1	Gear Rcdueer for D01
5.	301 YO1	1	Belt Feeder
6.	301 Y02	1	Bucket Elevator
7.	301 Y08	1	Flow Cnnveyor
8.	301 G03	1	Hot Air Furnace
9.	301 G06	1	Grinding Media
10.	301 G09	1	Chutes, Ducts and Piping
11.	301 Z02	1	Aeration Unit
12.	301 W01 A/B	2	Weighing Feeder
13.	301 W02	1	〃
14.	301 Y09	1	Screw Conveyor
15.	301 Y10	1	Bucket Elevater
16.	301 Y11	1	Screw Feeder
17.	301 Y12	1	Screw Conveyor
18.	301 Y13	1	Flow Conveyor
19.	301 Y14	1	Pncumatic Conveyor
20.	301 K01	1	Roots Blower
21.	301 K02	1	Compressor
22.	301 K03	1	Air Purge Blower
23.	302 C01	1	Multi-Clone Dust Collector
24.	301 C02	1	Wet Scrubber with Exhaust Fan
25.	302 C03	1	Multi-Clone Dust Collector
26.	301 C04	1	Wet Scrubber with Exhaust Fan

Section 302 Gasification Section

NO.	EQUIPMENT NO.	QUANTITY	NAME
1.	302 G01	1	Gasifier with Immersion Shaft
2.	302 G02	1	Gasifier Outlet
3.	302 G03	1	Intermediate Piece
4.	302 G06	1	Ash Extractor
5.	302 G07	1	Connecting Tudular Boiler Cooling Washer
6.	302 G07-Z1	1	Refractory Bricks for Long Pipe
7.	302 G08	1	Expansion Joints

NO.	EQUIPMENT NO.	QUANTITY	NAME
8.	302 G08-Z1	1	Bricks for Ref. Exp. Joint
9.	302 G09-1-4	2	Burners
10.	302 K01-A/B	2	O_2 Blower
11.	302 K02-A/B	2	No.1 N_2 Blower
12.	302 K03	1	No.2 Blower
13.	302 K05	1	Air Purge Blower
14.	302 Z02	1	Expansion Joint
15.	302 G01-Z1	1	Gasifier Lining
16.	302 E02-Z3	1	Cleaning Device for Tubu. Boiler
17.	302 E02-Z4	1	Castables and Bricks for Branche
18.	302 E02	1	Connection Parts of Rad. Boiler and Tubular Boiler
19.	302 P01 A/B	2	Wash Water Pump
20.	302 P02 A/B	2	Feed Water Pump
21.	302 P03 A/B	2	Quench Water Pump
22.	302 P04 A/B	2	Light Oil Pump
23.	302 P05	1	Fuel Oil Pump
24.	302 N01-1AB, 2AB	4	Theisen Washer
25.	302 T02 A/B	2	Water Separator
26.	302 T02-Z1	1	Stone Ware Ring

Section 303 H_2S Removal Plant

NO.	EQUIPMENT NO.	QUANTITY	NAME
1.	303 T01	1	No.1 Absorber
2.	303 T02	1	No.2 〃
3.	303 T03	1	No.3 〃
4.	303 V01	1	Reaction Tank
5.	303 V02	1	Oxidizer
6.	303 V03	1	Slurry Tank
7.	303 V04	1	Balance Tank
8.	303 V05	1	Mixing Tank
9.	303 V06	1	Mist Separator
10.	303 V07	1	Washing Water Tank
11.	303 K01 A/B	2	Air Blower
12.	303 K02	1	Air Compressor
13.	303 P01	1	No.1 Absorber Feed Pump
14.	303 P02 A/B	2	No.2 〃 〃
15.	303 P03	1	Reaction Tank Feed Pump

NO.	EQUIPMENT NO.	QUANTITY	NAME
16.	303 P04 A/B	2	Oxidizer Feed Pump
17.	303 P05 A/B	2	Filter Feed Pump
18.	303 P06	1	Chemical Sol'n Feed Pump
19.	303 J01 A/H	8	Jet Ejector
20.	303 F01	1	Solution Heater
21.	303 E02	1	Evaporator
22.	303 P01	1	Filter Process

Section 304—309

NO.	EQUIPMENT NO.	QUANTITY	NAME
1.	304 E01 A	1	Primary Shift Preheater
2.	304 E02	1	No.1 Water Heater
3.	304 H01	1	Primary Shift Converter
4.	304 T01	1	Saturater
5.	304 V02	1	No.1 Desuperheater
6.	304 V03	1	No.2 〃
7.	304 P01 A/B	2	Water Pump
8.	305 E01	1	No.1 Carbonate Reboiler
9.	305 E02	1	No.2 〃 〃
10.	305 E03	1	Carbonate Overhead Condenser
11.	305 T01	1	Carbonate Regenerator
12.	305 T02	1	Carbonate Absorber
13.	305 F01	1	Side Stream Filter
14.	305 P01 A/B	2	Carbonate Solution Pump
15.	305 P02 A/B	2	Reflux Pump
16.	305 P04 A/B	2	Water Injection Pump
17.	306 E01	1	Secondary Shift Preheater A
18.	306 E02	1	〃 〃 〃 B
19.	306 E03	1	No.2 Water Heater
20.	307 E01	1	MEA Reboiler
21.	307 E03	1	MEA Overhead Condenser
22.	307 E04	1	MEA Sol'n Heat Exchanger
23.	307 E05	1	MEA Sol'n Cooler
24.	307 T01	1	MEA Regenerator
25.	307 T02	1	MEA Absorber
26.	307 V01	1	No.2 Condensate Separator
27.	307 P01 A/B	2	MEA Sol'n Pump
28.	308 E02	1	Methanator Cooler

NO.	EQUIPMENT NO.	QUANTITY	NAME
29.	309 E03	1	Water Cooled Condenser
30.	309 E09	1	Ammonia Condenser
31.	309 E10	1	Liquefier Condenser
32.	309 E11	1	Gas Purger
33.	309 K02-E1	1	Oil Cooler
34.	309 V04	1	Steam Drum
35.	309 P01 A/B	2	Water Pump
36.	Others as fllows :-		
	Safety Valves) Steam Traps) All Sections Spring Hanger) Valves)		

PIPING

304 Section:

Pipe thickness of the line between Separator and Mist Separator should be measured.

Carbon steel parts may have been corroded, because leakage is notified on the body of the check valve of 304 PO1 B.

305 Section:

CO_2 Gas Line: CO_2 is blown off the line near the top spring hanger of the Regenerator. Wall thickness should be measured.

Carbonate Sol'n Line: Carbon Steel line between Sol'n pump and Absorber shall be checked for thickness.

Reboiler Vapor Line: No. 2 Reboiler Vapor line bellows were removed. New one to be fitted. Vapor line to be opened and checked.

Reboiler Liquid Line: To be checked for accummulation of foreign materials.

306 Section:

Inlet line to No. 2 Water Heater:
Hot Water Line:
Both of the above to be checked for corrosion and thickness to be measured.

307 Section:

Corrosion on the MEA Sol'n line and CO_2 gas line has to be checked.

Section 310 Compression

NO.	EQUIPMENT NO.	QUANTITY	NAME
1.	310 K01	1	Raw Gas Compressor
2.	310 K01 E1	1	lst Stage Inter Cooler
3.	310 K01 E2	1	2nd Stage Inter Cooler
4.	310 K01 E3	1	3rd 〃 〃 〃
5.	310 K01 E4	1	By pass cooler
6.	310 K01 E5	1	Oil Cooler
7.	310 K01 F1	1	Suction filter
8.	310 K01 P2 A/B	2	No.1 Seal pump
9.	310 K01 P3 A/B	2	No.2 〃 〃
10.	310 K01 V1	1	1st Stage Drain Separator
11.	310 K01 V2	1	2nd 〃 〃 〃
12.	310 K01 V3	1	3rd 〃 〃 〃
13.	310 K01 V4	1	By pass 〃 〃
14.	310 K02	1	Nitrogen Gas Compressor
15.	310 K03	1	Synthesis Gas Compressor
16.	310 K03 E1	1	1st Stage Cooler
17.	310 K03 E2	1	2nd 〃 〃
18.	310 K03 E3	1	3rd 〃 〃
19.	310 K03 E4	1	Oil Cooler
20.	310 K04	1	Air Comprossor
21.	310 K04 E1 A—C	3	Inter Cooler
22.	310 K04 E2	1	After Cooler
23.	310 K04 E3	1	Oil Cooler

SECTION 311 Air Separation

NO.	EQUIPMENT NO.	QUANTITY	NAME
1.	311 F01	1	Air Filter
2.	311 F02 A/B	2	Filter before turbine
3.	311 F03 A/B	2	Liquid Air Filter
4.	311 V02	1	Check valve Box (O_2)
5.	311 V03	1	〃 〃 〃
6.	311 V04	1	〃 〃 (N_2)
7.	311 V05	1	〃 〃 〃
8.	311 V07	1	Silencer
9.	311 K01 A/B	2	Expansion Turbine
10.	311 K01 V4	1	Silencer
11.	311 E09	1	Defrosting Air Heater
12.	311 E10	1	〃 〃 〃 and Cooler
13.	311 K01 F1 A/B	2	Primary Filter
14.	311 K01 F2 A/B	2	Secondary Filter
15.	311 K01 P A/B	2	Lub. Oil pump
Section 401			
1.	401 E01	1	Ammonia Evaporator
2.	401 E03	1	Gas Cooler
3.	401 E04	1	Tail Gas Heater
4.	401 E05	1	Economizer
5.	401 E06	1	Condenser
6.	401 E07	1	Product Acid Cooler
7.	401 E08	1	Weak Acid Cooler
8.	401 H01	1	Burner
9.	401 T01	1	Oxidation and Bleaching Tower
10.	401 T02 A/B	2	No.1 Oxidation Tower
11.	401 T03 A/B	2	No.2 〃 〃
12.	401 T04	1	No.1 Absorption Tower
13.	401 T05	1	No.2 〃 〃
14.	401 B01	1	Mixer
15.	401 V03	1	Separator
16.	401 V06	1	Mist Separator
17.	401 P01 A/B	2	Feed Water pump
18.	401 P02 A/B	2	Weak Acid pump
19.	401 P03 A/B	2	Demineralized Water pump
20.	401 P04 A/B	2	Recycle Acid Pump

NO.	EQUIPMENT NO.	QUANTITY	NAME
21.	401 P05 A/B	2	Acid Pump
22.	401 P06 A/B	2	Product feed Pump
23.	401 P07 A/B	2	Cooling water pump
24.	401 P08 A/B	2	Liquid Ammonia pump
25.	401 P09 A/B	2	Cooling water recycle pump
26.	401 F02	1	Ammonia Filter
27.	401 F01	1	Air Compressor
28.	401 K02	1	Recovery Gas turbine
29.	401 K01 F1	1	Air Filter
30.	401 K01 P1	1	Lub. Oil pump
31.	401 K01 R1	1	Speed up gear unit
Section 501 Ammonium Nitrate			
1.	501 T01	1	Neutralizer
2.	501 T02	1	ANBA Prilling Tower (Nozzle)
3.	501 T03	1	Fertilizer 〃 〃 〃
4.	501 J01—1—2	2	Ejector
5.	501 E09	1	Surface condenser
6.	501 E01	1	NH_3 Evaporation by steam
7.	501 E02	1	NH_3 Evaporation by Air
8.	501 E03	1	NH_3 Heater
9.	501 E10	1	Falling Film Evaporator
10.	501 E05	1	Air Heater for ANBA Dryer
11.	501 E06	1	Air Heater for ANBA Cooler
12.	501 V01	1	Neutralizer Demister
13.	501 V03—B1	1	Adjuster Tank
14.	501 V04	1	Amm. Nitrate Solution Tank
15.	501 V05	1	Pr. Evaporator with Demister
16.	501 V25	1	Recovery tank
17.	501 V29	1	Air Demister
18.	501 D01	1	ANBA Dryer
19.	501 D02	1	ANBA Cooler
20.	501 D03	1	ANBA Coating Drum
21.	501 D04	1	Fertilizer Cooler
22.	501 D05	1	Fertilizer coating drum
23.	501 P02 A/B	2	Neutralizer circulation pump
24.	501 P03 A/B	2	Amm.Nitrate solution pump
25.	501 P04 A/B	2	Pr. evaporator Feed Pump

NO.	EQUIPMENT NO.	QUANTITY	NAME
26.	501 P05 A/B	2	Pr. Evaporator Circ. pump
27.	501 P06 A/B	2	ANBA Prill. Tower Feed pump
28.	501 P09 A/B	2	Fertilizer Prill. Tower Feed pump
29.	501 P11	1	Recovery pump
30.	501 P13 A/B	2	Recovery Feed Pump
31.	501 Y03	1	ANBA Bucket Elevator No.1
32.	501 Y04	1	〃 〃 〃 No.2
33.	501 Y06	1	Fertilizer Bucket Elevator
34.	501 Y07	1	Nuflo—10 Feeder for ANBA
35.	501 Y09	1	〃 〃 for fertilizer
36.	501 Y11	1	Bucket Elevator for Nuflo—10
37.	501 A02	1	ANBA Vib. Screen No.1
38.	501 A03	1	〃 〃 No.2
39.	501 A06	1	Air Washer for ANBA Dryer
40.	501 A08	1	〃 〃 〃 Cooler
41.	501 A09	1	Fertilizer Vib.Screen
Section 601 Water Treatment			
1.	601 C01	1	Precipitator
2.	601 T01	1	Cation Exchanger
3.	601 T03	1	Anion 〃
4.	601 T04	1	Cooling Tower
5.	601 F01	1	Automatic Valveless Filter
6.	601 P01 A/B	2	Coagulant and Alkali feed pump
7.	601 P04 A/B	2	Filtered water pump
8.	601 P05 A/B	2	Process water pump
9.	601 P06 A/B	2	Transfer pump
10.	601 P07 A/B	2	Demin. water pump
11.	601 P09 A/B/C	3	Cold water pump
12.	601 V01 A/B	2	Coagulant Feeder
13.	601 V04	1	Degasified water tank
14.	601 V05	1	Acid storage tank
15.	601 K01	1	Blower for Degasifier
16.	601 K02 A/B	2	Fan for cooling Tower
17.	601 C01 R1	1	Reducer for Precipitator
18.	601 C01—B1	1	Mixer
19.	601 V01 AB—B1	2	Agitator for coagulant Feeder

Section 602 Boiler

NO.	EQUIPMENT NO.	QUANTITY	NAME
1.	602 P01 A/B	2	Feed water pump
2.	602 P01 A/B	2	Feed water pump
3.	602 P03	1	Condensate pump
4.	602 K01	1	Primary forced draft fan
5.	602 K02	1	Secndary 〃 〃 〃
6.	602 K03	1	Induced Draft Fan
Section 604			
1.	604 P01 A/C	3	Water Intake pump
2.	604 P02	1	Vacuum Pump
3.	604 P03	1	Drain Pump
Section 605 Effluent Unit			
1.	605 C08	1	Balance Tank
2.	605 C09	1	C-Effluent Pond
3.	605 C10 A/B	2	D-Effluent Pond
4.	605 C11	1	Neutralizer
5.	605 P04	1	Acid Pump
6.	605 P05	1	No.1 Milk Pump
7.	605 P09 A/B	2	C-Effluent Pump
8.	605 P10 A/B	2	D-Effluent Pump
9.	605 P12 A/B	2	A-Effluent Pump
10.	605 B09	1	Neutralizer Mixer
11.	605 V04	1	No.1 Milk Tank
12.	605 K01	1	Mixing Blower
13.	605 K02	1	〃 〃
14.	605 K03	1	〃 〃
15.	605 Y01	1	No.1 Lime Feeder
INSTRUMENTS AND ELECTRICALS			
1.	301 WT.—2—5		Weighing Feeders
2.	301 Y14		Pneumatic Conveyor Valves
3.	302 HICV—22		Diaphragm valve
4.	302 PICV—12		〃
5.	302 PICV—13		〃
6.	302 HIC—24		Motor Valve
7.	302 HIC—9		Diaphragm valve
8.	304 FW—8		〃
9.	304 TCV—1		〃

No.	EQUIPMENT NO.	QUANTITY	NAME
10.	305 FCV—1		Diaphragm valve
11.	305 FCV—2		〃
12.	305 LCV—1		〃
13.	305 LICT—4		Level meter
14.	309 LIT—8		〃
15.	309 TE—1		CA Couple 12 Nos
16.	309 TE—2		〃
17.	310 DO1		Instrument Air Dryer
18.	310 K04		By pass valve
19.	310 PCV—1		Diaphragm valve
20.	310 PCV—2		〃 〃
21.	311		All Diaphragm valves
22.	311 RE 401/402		Revolution Pick up
23.	311 RCV—1		Motor Damper
24.	401 LCV—4		Diaphragm valve
25.	401 LCV—5		〃 〃
26.	401 LCV—6		〃 〃
27.	401 LCV—7		〃 〃
28.	401 TCV—32		〃 〃
29.	501 DR—1		Dosi Meter
30.	501 DRC—2		〃
31.	501 TI—4		Resistance Bulbs
32.	601		All Diaphragm Valves
33.	602 PCV—3		Diaphragm valve
34.	201 PCV—1		〃
35.	201 PCV—2		〃
36.	301 G05—M1		Ball Mill Motor starter
37.	309 K01 M1		Gas Circulator motor
38.	310 K01 M1		Raw Gas Comp. motor
39.	310 K02 M1		N_2 Gas Comp. Motor
40.	310 K03 M1		NH_2 Syn. Gas comp. motor
41.	310 K04 M1		Air Comp. motor
42.	603		Diesel Engine Generator
43.	〃		All Oil circuit breakers
44.	〃		All protection relays
45.	Electricals		All transformer local switches L.T. motors, battery charges etc.

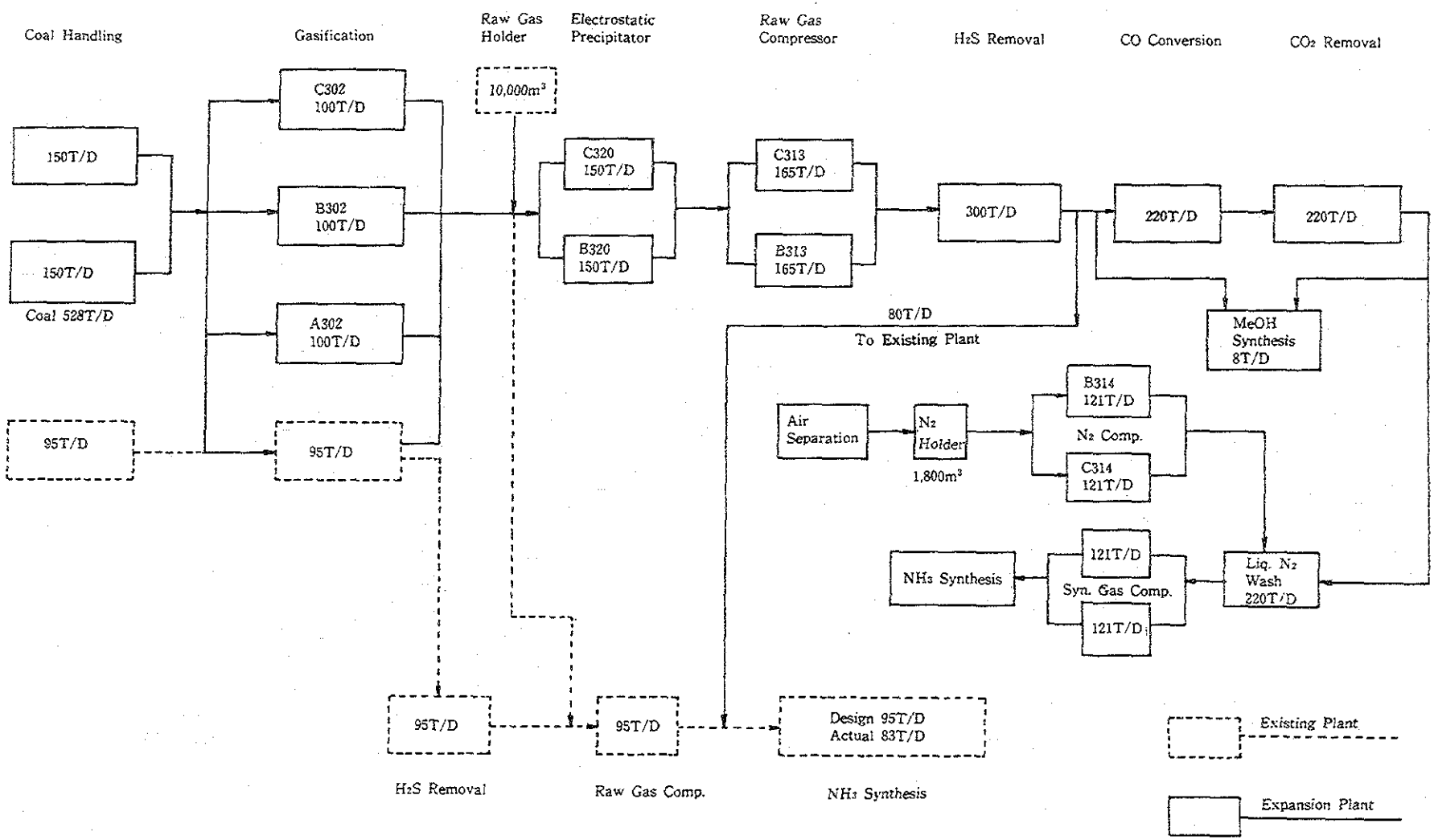
BASES OF PRODUCTS BALANCE

	THEORY	BUDGET	EFFICIENCY %	GUARANTEE
NH_3 / HNO_3	0.270	0.290	93.1	0.285
NH_3 / NH_4NO_3	0.213	0.230	92.6	0.220
HNO_3 / NH_4NO_3	0.788	0.83	94.9	0.807
NH_3 / $(NH_4)_2SO_4$	0.258	0.272	95.0 *	
H_2SO_4 / $(NH_4)_2SO_4$	0.742	0.781	95.0 *	

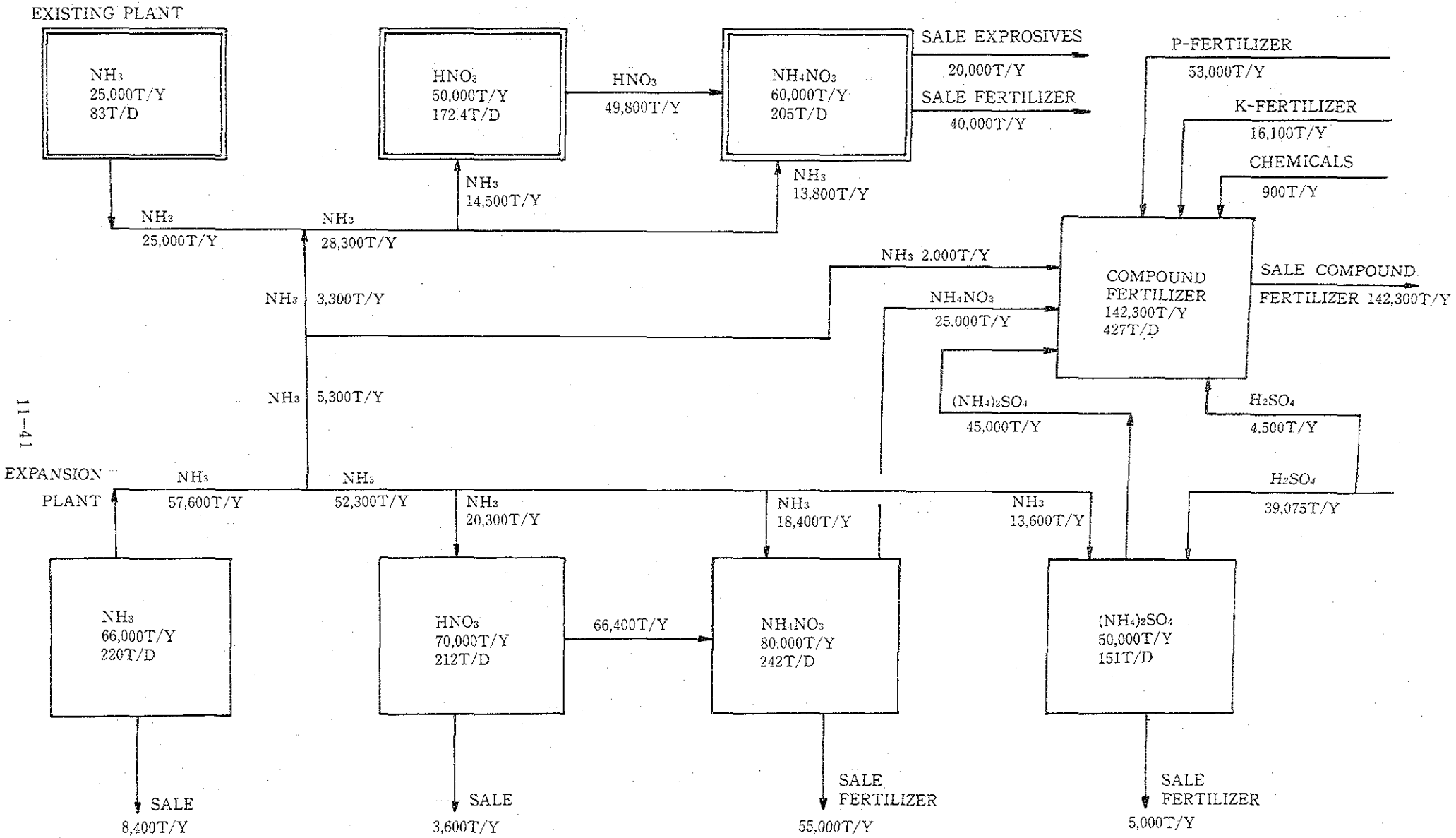
NOTE :

* EXPECTED AS 95%

Relationship between Existing Plant/Expansion Plant



PRODUCTS BALANCE OF KAFUE PLANT



— INTERIM REPORT —

THE SECOND FIELD SURVEY

INTERIM REPORT

on

Feasibility Study of
Rehabilitation of the Fertilizer of
Nitrogen Chemicals of Zambia Limited

30th October, 1981

The Second Survey Team
JAPAN INTERNATIONAL COOPERATION AGENCY

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I. INTRODUCTION :

1.1 In accordance with the joint communiqùe of the Zambian President and the Japanese Prime Minister issued when the former visited Japan in November, 1980, Japan International Cooperation Agency (JICA) is undertaking a feasibility study of the rehabilitation of the Nitrogen Chemicals of Zambia Ltd. (NCZ).

1.2 The study shall be done in two stages, i. e. the first field survey, which was done in February–March, 1981 and the summary was as given in the following documents.

(1) Memorandum for the feasibility study on the rehabilitation of Nitrogen Fertilizer Plant in the Republic of Zambia, February 25, 1981.

(2) Minutes, the first field survey for the feasibility study on the rehabilitation of Nitrogen Fertilizer Plant in the Republic of Zambia, March 1981.

The former summarizes the basic scope of the survey and over-all schedule of the study.

The latter presents the summary of the activities of the first survey team covering (i) market aspects, (ii) technical aspects and (iii) financial and economic aspects, and in the Appendix, equipment/machinery to be opened and checked in the coming shut-down are listed up.

1.3 The second field survey was done in the period from October 5, 1981 through November 2, 1981 covering the following.

(1) To check/inspect the equipment/machinery as listed in the Appendix 1 mentioned above.

(2) To collect data and information for :

(i) Availability and cost for the construction equipment and materials.

(ii) Local contractors and their activities.

(iii) Utilities available for site construction works.

(3) To discuss the prerequisite conditions and the range of financial and technical aspects of the study.

1.4 This Interim Report is to present a summary of the work performed in Zambia as mentioned in 1.3 above and to confirm the major elements and conditions for subsequent evaluation studies which will be carried out in Japan following the completion of the present works in Zambia.

1.5 The second field survey team would like to express their thanks to the assistance and cooperation extended toward the team by NCZ and other Zambian authorities / organizations.

II. GENERAL UNDERSTANDING OF THE PROJECT

2.1 Rehabilitation Plans

The plans shall be made up considering the two basic conditions i. e.

(i) Production will be recovered to an adequate operation capacity in the range of the original rated capacity. (No consideration will be given to raise the original production capacity).

(ii) The rehabilitation will enable the plant stable and continuous operation for a few years more with ordinary maintenance and overhaul but without large scale repair work.

Considering the above two conditions, and the commissioning of the expansion plant, which was officially opened by the President of Zambia on October 20th, 1981, the plan was established as follows : -

(1) 301 section (Coal handling) and 303 section (H_2S Removal) shall be rehabilitated only to a reasonable extent to serve as stand-by units.

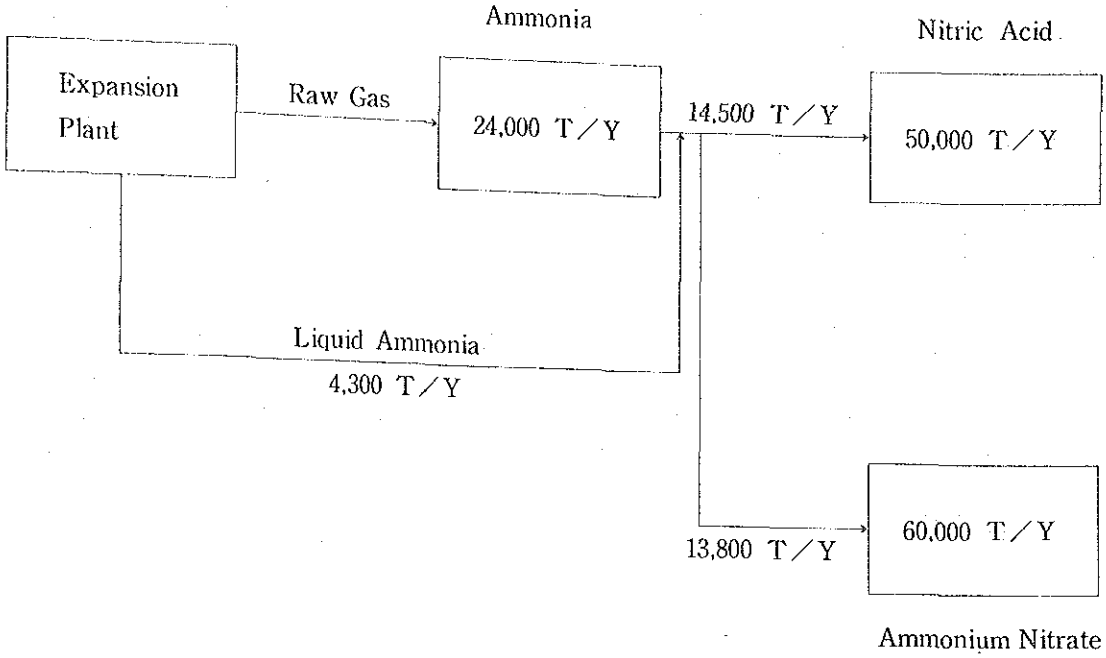
(2) 302 section (Gasification) will run together with other three gasification units. (Normally three running, one standing-by). This section shall be rehabilitated to have a maximum capacity. (about 80% of the original rated capacity, because of the inferior coal quality supplied now).

Note :There are four gasification units. One is the original, the second added by NCZ and the third and the fourth installed as a part of the expansion plant. All four units have the same capacity and they will be operated three out of four in a normal operation.

(3) 310K01, Raw Gas compressor shall be same as (1) above, i. e. this compressor shall be operated only when 303 section is to be operated.

(4) Raw Gas shall be supplied from the expansion plant equivalent to 24,000 metric tons/year of Liquid Ammonia.

(5) Liquid Ammonia shall be supplied from the expansion plant at the rate of 4,300 metric tons/year.



Feasibility calculations shall be made on the plan as above, but considerations shall be given to the case when 301 Coal Handling, 303 H_2S Removal and the Raw Gas compressor will be operated normally.

(i. e. not as stand-by)

2.2 Raw Material Supplies

Coal is supplied by Maamba Collieries, Limited which is a subsidiary of Nchanga Consolidated Copper Mines, Limited (NCCM) which is a member company of Zambia Industrial and Mining Corporation, Limited(ZIMCO). NCZ has the priority to have coal supply as another member company of ZIMCO.

The costs of coal, raw gas, liquid ammonia, chemicals and other materials are as shown in the Appendix II.

2.3 Schedule after the Second Field Survey

A study followed by financial and economical evaluations shall be made after the team's return to its office in Japan.

A draft report shall be ready in February, 1982 and will be submitted to Zambian Authorities in Lusaka for confirmation.

The final report shall be compiled within two months after confirmation of the draft report.

2.4 *Rehabilitation Time Schedule*

Though the details are yet to be worked out in the execution stage, by the concerned authorities/organisations, a tentative time schedule as the basis for the feasibility study is considered as follows : -

March 1982	: Feasibility study Report Produced.
March 1983	: Decision finalized and Financing provided.
September 1983	: Contract awarded.
March 1985	: Equipment/Machinery ready on site, Kafue
September 1985	: Mechanical completion.

III. TECHNICAL ASPECTS

The second field survey was done mainly in NCZ's Kafue Plant Site by checking/inspecting the opened/disassembled equipment/machinery.

The schedule agreed and established before the shut-down of the plant was not necessarily followed but all the places of equipment/machinery opened/disassembled were checked/inspected on the satisfaction of the survey team.

Before starting check/inspection of the plant, NCZ appointed the counterparts as mentioned below, and the survey team had a meeting with them every morning to discuss and confirm the day's works and every afternoon to confirm the day's results and to adjust the next day's schedule.

The counterparts were :

Mr. Chola,	Instrumentation
Mr. Livaku,	Fabrication
Mr. Buch,	Area I
Mr. Philipose,	Area II
Mr. Athavale,	Area III
Mr. Nyirenda,	Machine Shop
Mr. Rainu,	Electrical

NOTE :

Area I :	301, 302, 601, 602, and 605
Area II :	303, 304, 305, 306, 307, 308, 309, 310, and 311
Area III :	401, 501, and 502

The result of the field survey is as shown in the Appedix I - check and Inspection Report- The second survey for the Rehabilitation of Nitrogen Fertilizer Plant, Kafue Zambia, October 30, 1981.

Some pieces of equipment require further studies to meet the various design conditions and the field erection/installation conditions.

(e. g. Modification of 302-G01 Gasifier, Epoxy coating for 303 (H_2S Removal) equipment, 305 (Carbonate CO_2 Removal) piping material etc.)

The result of the studies shall be taken in the draft report to be produced in February, 1982.

The summary of the survey is as follows : -

Total Items checked/inspected :	325 items
Complete replacement	80 items (25%)
Replacement of Parts	118 items (36%)
No Rehabilitation	127 items (39%)

Note : Out of the 127 no rehabilitation items, 37 items shall be repaired by NCZ.

3.1 Scope of Work

The feasibility study shall be on the turn-key basis and cover the following : -

(i) Engineering
(ii) Procurement
(iii) Transportation
(iv) Erection and Installation
(v) Commissioning

Training of NCZ staffs shall be excluded, because NCZ had obtained skills and experiences through actual plant operation of more than ten years.

Consultancy / supervision for some special pieces of equipment and sometimes for financial arrangements and inspection of the imported items shall be considered in the feasibility study.Equipment/machinery and parts to be replaced in the rehabilitation works shall be stored

in the present store yard of NCZ.

For special alloys and catalysts, it is recommended to contact the manufacturer, because sometimes they may buy back the items. The feasibility study shall not consider this buy back.

Warranty shall be given by the manufacturer only for those completely newly made items and over all plant performance shall be guaranteed only by NCZ.

3.2 Codes and Standards

Code and standards together with the laws and regulations enforced in Zambia shall be observed in the plant in Kafue now.

But for the purpose of the feasibility study, generally accepted codes and standards shall be taken as the basis. They shall be firmly established when the rehabilitation works are actually executed in the engineering stage of the rehabilitation works.

IV. FINANCIAL AND ECONOMIC ASPECTS

Financial and economic studies shall be done in the following steps on the conditions listed in the Appendix II.

4.1 General

The work performed by the Evaluation Team with regard to financial and economic aspects consists mainly for : -

A. Clarification of cost factors and major assumptions used for the production cost estimate and financial analysis

B. Methodology for the financial and economic analysis
C. Setting-up of assumptions and criteria to be applied to the financial and economic evaluation.

The Team will make reasonable adjustments when using these factors.

4.2 Methodology for the Financial and Economic Analysis

4.2.1 Financial Analysis

Based on the financial plan and production cost projected by the Evaluation Team, the Team will prepare financial statements (i. e. income statement, cash-flow, and balance sheet). On the

basis of the projected financial statements the Team will conduct the following analysis :

- Internal Rate of Return (IRR) before tax
- Internal Rate of Return (IRR) after tax

These analysis will be applied to the following three cases :

(1) The existing plant which is not to be rehabilitated
(2) The existing plant which is to be rehabilitated
(3) The total analysis of the existing plant to be rehabilitated and the new plant.

Evaluation will be made on the three cases respectively and comparatively.

4.2.2 Economic Analysis

The Evaluation Team will assess the economic benefit to the Project on various aspects of the Zambian economics.

4.3 Conditions and Assumptions for the Financial Analysis

Conditions and assumptions to be taken for the financial analysis will be as per attached Appendix II.

V. NOTES ON THE RESULTS OF CHECK AND INSPECTION

Almost all the pieces of equipment/machinery deteriorated after more than ten years of operation. The external shells of towers except those in Nitric Acid and Hydrogen Sulfide Removal Sections remain rather in good conditions without serious corrosion or erosion, but the internal parts have almost been deteriorated and need to be repaired or completely replaced.

Heat exchangers were heavily fouled and corroded on the process stream side, especially those in the Gas Purification Sections were very dirty in the coal dust.

Those heat exchangers made of carbon steel operating with cooling water were corroded very badly, because of the inferior quality of cooling water.

Rotary machines were worn heavily. This is mainly caused by poor maintenance due to shortage of spare parts.

The equipment listed in Table 1. require some action (repair or replacement of parts) immediately.

The equipment listed in Table 2. require further study in implementing rehabilitation works. (Design Modification, materials study, flow line study etc.).

TABLE 1

EQUIP. NO.	NAME	REMARKS
301-G06	Grinding Media for Compeb Mill	Size distribution
302-G08	Expansion Joint	Replace
303-V03	Slurry Tank	Repair of roof plate
303 sec.	Piping (From V04 to V02)	Replace
305-P04B	Water Injection Pump	Replace driving unit
308-P01	Caustic Solution Pump	Replace mechanical seal
310-K01-V4	By-pass Drain Separator	To be replaced at once
310-K03-E1	1st Stage Cooler	Gas inlet pipe to be replaced at once.
310-K03-E2	2nd Stage Cooler	-- do--
310-K03-E3	3rd Stage Cooler	-- do --
401-E04	Tail Gas Heater	Repair of shell flange
401-E05	Economizer	-- do --
501-V25	Recovery Tank	Fixing
501-T02	ANBA Prilling Tower	Repair of lower part of Tower
501-T03	Fertilizer Prilling Tower	-- do --

TABLE 2

EQUIP. NO.	NAME	REMARKS
301-C02	Wet Scrubber with Exhaust Fan	Material
C04	-- do --	-- do --
C02	Wet Coal Bunker	Blocking (Bottom of Bunker)
C03	Hot Air Furnace	Coal Feeding System
W03	Weighing Feeder	Belt Material
302-E01	Radiation Boiler	Gas line connection
E02	Tubular Boiler	(Manhole to Manhole)
N01	Theison Washer	Material
303-T01	No. 1 Absorber	-- do --
T02	No. 2 〃	-- do --
T03	No. 3 〃	-- do --
V06	Mist Separator	Type of separator
E01	Solution Heater	Type of Heater
E02	Evaporator	Type of Evaporator
308-E02	Methanator Cooler	Material
309-E09	Ammonia Condenser	Heat Duty
E10	Liquifier Condenser	-- do --
310-K01-V	Drain Separator	Type of Separator
〃	Discharge Silencer	Type of Silencer

— Check and Inspection Report —

The Second Field Survey For The Rehabilitation of Nitrogen Fertilizer Plant, Kafue Zambia

30TH OCTOBER, 1981

JAPAN INTERNATIONAL COOPERATION AGENCY

Please refer to Appendix 8

"Result of Check / Inspection and Rehabilitation Work"

— "EQUIPMENT & MACHINERY" —

PENDIX II

NDITIONS AND ASSUMPTIONS FOR THE FINANCIAL ANALYSIS

All the data information available in NCZ is applied to calculating the following cost :tors. As for the cost factors, not available in NCZ. The Team will make reasonable sumptions or will study further on the basis of the field survey.

All the prices and cost of production are assumed to be constant from 1982 except the riable cost of production and other cost factors influenced by the deterioration of the facilities rehabilitation.

EXISTING PLANT

1.1 Rehabilitation schedule

Please refer to 2.4

1.2 Utilization rate of capacity

to be further studied

1.3 Sales plan.

(i) Unit Cost to be stated later,

(ii) Percentage of sales quantity for each ammonium nitrate product

Fertilizer	50%
Dense	20%
Porous	30%

1.4 Cost of Production

(i) Unit consumption

Coal to Ammonia	2.95 up to rehabilitation
	2.7 after rehabilitation
Ammonia to Nitric Acid	0.29
Ammonia to Ammonium Nitrate	0.23
Nitric Acid to Ammonium Nitrate	0.83

(ii) Variable Cost

	1981	1982	Up to Rehabilitation	After Rehabilitation
Coal K/T		52	52	52
Raw Gas K/T NH_3 (from new plant)				377.36
Liquid Ammonia K/T (from new plant)				735.02
Fuel	NOTE. 1.			
Chemicals		K31.29/T NH_3		
		K 0.23/T HNO_3		
		K 1.28/T NHY_4 NO_3		
Catalyst K/Yr	119,000	135,000	135,000	135,000
Electricity	NOTE. 2.			
Packing/ Ammonium nitrate K/T	17.8	19.5	19.5	19.5

(iii) Depreciation

1. Plant & Machinery

Original Cost K14,142,496 (1970)

Additional Investment K2,000,000 (1978)

Rate of Depreciation 7.5%

2. Buildings & Land

Original Cost K4,426,688 (1970)

Rate of Depreciation 2%

(iv) Other fixed Cost (K'000)

	1981	1982	Up to Rehabilitation	After Rehabilitation
Salaries & Benefits	4001	4361	4361	4361
Repairs & Maint.	1458	1575	1575	1575
Other Expenses	2290	2565	2565	2565

(v) Sales Expenses (K'000)

	1253	1253	1253	1253

1.5 Interest & Repayment

(i) Long Term debts

NOTE 3

(ii) Other debts

Bank Overdraft 4,487,152

Rate of Interest 11%

New Plant

2.1 Start of commercial operation 1982 January.

2.2 Utilization rate of capacity

1981	60%
1982	60%
1983	70%
1984	85%

2.3 Sales plan.

(i) Unit Cost To be stated in 3.1

(ii) Sales Volume (fiscal year) T/YR.

		1981	1982	1983	1984 & onwards
Nitric Acid		450	2,000	2,520	3,060
Ammonium Nitrate		7,400	32,300	38,070	46,228
Compound	C	1,400	6,200	7,797	9,468
	D	4,000	18,000	21,517	26,127
	R	6,200	29,000	34,150	41,468
	X	6,500	30,100	35,236	42,787
TOTAL:		25,950	117,600	139,290	169,138

2.4 Cost of Production

(i) Unit Consumption

Coal to Ammonia	2.71
Ammonia to Nitric Acid	0.29
Ammonia to Ammonium Nitrate	0.23
Nitric Acid to Ammonium Nitrate	0.83
Ammonia to Ammonium Sulphate	0.27
Sulphuric Acid to Ammonium Sulphate	0.83

(ii) Variable Cost (K'000)

	1982	1983	1984
Raw Materials	NOTE 4.		
Chemicals	1,764	1,868	2,075
Catalyst	882	934	1,038
Electricity	NOTE 2.		
Packings for Towers	209	221	246

(iii) Depreciation

(1) Plant & Machinery

Investment K274,400,000 =

Rate of Depreciation 7.5%

(2) Buildings & Land

Investment K20,000,000 =

Rate of Depreciation 2%

(3) Other investment K1,000,000 = every year for replacement of capital equipment.

(iv) Other fixed cost (K'000)

Salaries & Benefits	3,908
Repairs & Maintenance	2,000
Other Expenses	700

to be constant

(v) Sales Expenses K206,000 =

to be constant

2.5 Interest and Repayment

NOTE 3.

3. Others

3.1 Sales price (as of 1982)

Ammonia

Nitric Acid

A. N. Fertilizer

A. N. Dense

A. N. Porous

Compound C

D

R

X

3.2 Income Tax 50%

Tax holiday 5 years

NOTE 1. Fuel for the existing plant

Oil price 433 K/m³ for 1981,

476 K/m³ for 1982.

Consumption 38 m³/Day

(i) up to rehabilitation 7.5 DAYS/MONTH

11 MONTH/YEAR

(ii) after rehabilitation 4 DAYS/MONTH

11 MONTH/YEAR

NOTE 2. Electricity

(i) fixed cost	53,700 KVA × 2.20 K/YEAR
	+ 3,200 K/MONTH × 12
(ii) Variable cost	0.65 N/KWH
(iii) Consumption	
existing plant	8,450,000 KWH/MONTH
new plant	14,865,480 KWH/MONTH

NOTE 3. NITROGEN CHEMICALS OF ZAMBIA LIMITED

DETAILS OF LONG-TERM LOANS

NAME OF LENDER	BALANCE PRINCIPAL	INTEREST RATE (%)	GUARANTEED BY	REPAYMENT DETAILS
A. EXISTING LOANS				
1. Z. N. P. F. Ltd.	500,000	8½	Indeco Ltd.	Repayable in half yearly instalments in June & December over the next 3 yrs.
2. Z. N. P. F. Ltd.	10,000,000	8½	Floating charge over the Company's F/Assets	a) Principal repayable in full on 1. 4. 95 b) Interest be paid half yearly in June & December.
3. D. B. Z. Ltd. -CO_2 Loan	153,165	10½	Indeco Ltd.	Repayable in 16 quarterly instalments commencing June, 1979.
TOTAL EXISTING LOAN	10,653,165			
B. EXPANSION PROJECT LOANS				
1. D. B. Z. Ltd.	3,000,000	9 %	Indeco Ltd.	a) Principal repayable in 20 equal half yearly instalments commencing 30. 6. 81 b) Interest to be paid half yearly in June and December.
2. Z. N. P. F. Ltd	5,000,000	9 %	Indeco Ltd.	a) Principal repayment in 60 equal quarterly instalments commencing March, 1984. b) Interest be paid quarterly.
3. Standard Bank Ltd.	800,000	PR + 1½ 9 whichever is higher.	Indeco Ltd.	Repayable in 10 equal half yearly instalments commencing August, 1980.

4. Barclays Bank Ltd.	700,000	PR + ½, 9 whichever is higher.	Indeco Ltd.	Repayable in 10 equal half yearly instalments commencing March, 1980.
5. N. S. C. B. Ltd.	2,000,000	9 %	Indeco Ltd.	Repayable in 20 equal half yearly instalments commencing June, 1981.
6. Z. S. I. C. Ltd.	6,500,000	9 %	Indeco Ltd.	Repayable in 10 annual instalments commencing November, 1981.
7. Z. N. C. B. Ltd.	8,500,000	10 %	Ministry of Finance.	1) Principal repayable in 8 half yearly instalments commencing April, 1983. 2) Interest paid monthly.
8. Z. N. C. B. Ltd.	5,700,000	PR + 2.5	Ministry of Finance.	1) Principal repayable in 21 quarterly instalments commencing Sept. 1984. 2) The first interest payment in April 1982 and subsequently payable quarterly.
9. Barclays Bank Ltd.	11,000,000	11 %	Ministry of Finance	1) Principal repayable in 21 quarterly instalments commencing Sept. 1983. 2) Interest is payable monthly.
10. Standard Bank Ltd.	9,166,600	11 %	Ministry of Finance	Same as above.
13. Consortium MT. Loan	23,000,000	10,12 %	Ministry of Finance	1) Principal to be repaid in 21 quarterly instalments of K500,000 each commencing Sept. 1983. Balance K12,500,000 with the 21st Instalment. 2a) Interest is 10% on K9,500,000 and the balance interest rate is 12%. 2b) Payable quarterly.
14. Consortium S. T. Loan	8,500,000	PR + 2 with a minimum of 12.	Ministry of Finance	1) Principal repayable in full in March '81. 2) Interest payable quarterly.

15. G.R.Z.	92,200,000	10%	—	Principal repayable over 50 years including a grace period of 10 years.
TOTAL EXPAN	176,200,363			

NOTE: Loans not included in the above Summary are: —

A. 1) G.R.Z. Loan of K68,800,000 which is to be capitalised.

2) G.R.Z. Loan of K10,000,000 which is also to be treated as equity.

3) U.S. AID of K14,400,000 yet to be capitalised.

B. SULPHURIC ACID PROJECT LOANS

1) D.B.Z. K4.8 million Loan

2) Z.N.C.B. K1.2 million Loan

TE 4. RAW MATERIALS FOR THE NEW PLANT

	UNIT RATE (K / T)	
ıl	52	
phuric Acid	280	up to Jun. 1983
	203	after Jul. 1983
Ammonium Phosphate	420	
ple Super Phosphate	380	
rmal Super Phosphate	370	
tassium Chloride	350	
tassium Sulphate	410	
rax	520	
ating Agent	300	
gs	0.85	K per bag
ıfulo 10.	600	

APPENDIX III

CONTRACTORS VISITED

1. MINESTONE (ZAMBIA) LIMITED

   Mr. Don Sowden, Construction Manager

   One of the IMT Group companies. A contractor for General Erection works. Electric works sub-contracted to Drake & Gorham. (Ref. № 5 below). Main activity is in Civil Works. The best in Lusaka.

2. ELECTRICAL MAINTENANCE LUSAKA LIMITED

   Mr. J. V. Patel, Chief Buyer

   Delivered Honeywell instruments to NCZ Expansion Plant. Manufacturing parts of illumination equipment in their work-shop, which is equiped with lathes, boring machines, welding machines etc. and about 60 workers.

   They claim the ratio of sales by workshop and field works is 50/50.

3. BEHRENS LIMITED

   The General Manager could spare no time for interview and only the questionnaire shall be filled up which will be mailed later.

4. B. M. S. ENGINEERING LIMITED

   Mr. Ray de Selon, Works Manager

   A supplier of steel and pipes. The workshop is provided with lathes, boring machines, drilling machines etc. and manufacturing truck bodies.

   For erection/installation works, he recommended another member of his own group.

5. DRAKE & GORHAM (ZAMBIA) LIMITED

   Mr. Arne Luering

   A contractor for engineering and construction of electrical and air-conditioning works. A sub-contractor to MINESTONE (Z) LTD. for electrical works.

6. APOLLO ENTERPRISES LIMITED

   Mr. Alexander, Manager-Lusaka Branch Office

   The director was not in office and Mr. Alexander failed to give details. The questionnaire shall be filled and mailed later.

:WIS CONSTRUCTION (ZAMBIA) LIMITED

Mr. C. H. Golson, Managing Director

ainly Civil Works. Contracting earth works, building works and concrete works now. One the two biggest contractors in Lusaka. (The other is MINESTONE ref. No. 1 above).

hey have ten senior staffs (3 Civil Engineers, 6 Quantity Surveyors etc.)

ngineering design is done by customers and LEWIS contracts for construction execution.

LL-METAL ENGINEERING LIMITED

Mr. Nair-General Manager

roud of steel structure works, though they contract mechanical installation too.

'he bridge over the road in Livingstone was designed, fabricated and erected by ALL-IETAL.

:AMBIA ENGINEERING & CONTRACTING CO. LTD. (ZECCO)

Mr. Benet, Technical Director

:mploys 2,000 local labourers and contracts for air conditioning, steel works and concrete vorks.

NOTE : Site office of the mass media project was visited for comments on Zambian contractors.

Mr. Kawamura, Site Manager

Mr. Chack, Principal Construction Manager

The comment was that contractors in Zambia can't 100% be relied upon. Even when total contract on all risk is awarded, the client had better have his own supervisors and technicians to oversee the works. English consultants are recommended for the purpose, because the English ways of doing business (negotiations, discussions etc.) is prevalent in Zambia.