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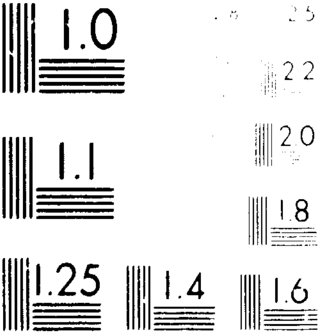
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org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UNICO

11511
(1 of 2)

THE FINAL REPORT
ON
OPERATION AND MANAGEMENT
OF FERTILIZER PLANTS
IN BANGLADESH.
(PROJECT NO. DP/BGD/78/002)
(CONTRACT NO. UNIDO 79/75)

UNICO INTERNATIONAL CORPORATION
TOKYO, JAPAN

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MR. T. IKEYA TEAM LEADER-TSP COMPLEX
UNICO INTERNATIONAL CORP./NISSAN CHEMICAL CO.

MAY, 1982

CONTENTS

In order to improve the capacity utilization of fertilizer plants in Bangladesh, UNIDO and the Government of Bangladesh have implemented this project. The urea fertilizer plant at Ghorasal and TSP Complex, Chittagong have suffered low capacity utilization after liberation. In accordance with the findings by the fact finding mission of UNIDO, which was sent to Bangladesh in 1978, the plan for a technical assistance program for both the Ghorasal urea plant and Chittagong TSP Complex were formulated. The present final report covers the major activities of the expert team in the field at TSP Complex, Chittagong, as well as major findings and recommendations for its future improvements.
The services of the expert team started in October, 1979 and were completed in November, 1981. A total of eighty-six man-months were expended during this period.

[Abstract]

The Project

The production facilities in Bangladesh suffered from various problems which made it difficult to maintain the production at a satisfactory level after the war of liberation in 1971. The capacity utilization of the fertilizer plants was only around 30-40% of nameplate capacity. On the other hand, the consumption of fertilizer in Bangladesh increased rapidly by development of modern agricultural technology. So the requirement of fertilizer in the country exceeds the supply capability of the domestic fertilizer plants.

In order to improve the capacity utilization of those fertilizer plants UNIDO and Government of Bangladesh formulated a technical assistance program in 1978 so as to identify the bottlenecks of capacity utilization, to improve production by debottlenecking, and to assist plant management to improve technological level of the personnel of the Complex by an intensive training program conducted by expatriate experts.

The plants included in the project are:

Urea Fertilizer Factory Ghorasal	200,000t/y	Ammonia
	340,000t/y	Urea

(The project for this factory was completed in 1980)

TSP Complex Chittagong

		Design Capacity	Attained Capacity
Sulphuric Acid Plant	I	100 t/d	87 t/d
Sulphuric Acid Plant	II	400 t/d	344 t/d
Phosphoric Acid Plant	I	32 t/d(as P_2O_5)	28 t/d
Phosphoric Acid Plant	II	135 t/d(as P_2O_5)	128 t/d
TSP Plant	I	100 t/d	85 t/d
TSP Plant	II	430 t/d	403 t/d

Work Concluded

UNICO International Corp. (an industrial consultant firm) of Japan in association with NISSAN Chemical Industries, Ltd. (a fertilizer and petrochemicals manufacturer) of Japan were awarded the contract for the technical assistance program in June, 1979.

The experts on sulphuric acid, phosphoric acid, and the TSP process together with experts in maintenance work of those plants were sent to the TSP Complex to conduct detailed assessment, prepare a trouble-shooting plan, assist BCIC personnel to implement an improvement plan and proceed with training through the practical job execution and classroom work. The duration of the service in the field was 25 months and during that period total 86 mon-months of the service of experts were expended.

Achievement

As described in the main text of the report, most of the operational and equipment maintenance problems have been elimanated during the period of the project and the capacity utilization of the complex improved to a satisfactory level (86-110 percent of design capacity) as reported in Chapter 4 page 6, but as actual production achieved in 1980-1981 remained at around 46% of design capacity.
The present limitation of production is not a technical problem in the plant but the problem of raw material supply and low lifting of product from the plant.

Conclusion and Recommendation

The capacity utilization of the TSP Complex can be maintained at above 85% of its nameplate capacity provided the lifting of product, the supply of raw material and interruption of electricity supply does not limit the production.

In order to improve capacity utilization up to 100% through the year to prevent deterioration of machines and equipment and to improve economy of the plant operation the following recommendations should be implemented.

1) In-plant training to improve the technological level of staff should be continued.
   The further development of preventive maintenance and inventory control is required.

2) A long term maintenance plan including revamping of deteriorated machines and equipment should be prepared and executed.

3) A comprehensive modernization and rationalization program which should include the introduction of new projects such as by-product gypsum utilization, introduction of new product such as DAP/MAP or NPK compound fertilizer etc. should be formulated and implemented.

Abbreviation

UNIDO	United Nations Industries Development Organization
BCIC	Bangladesh Chemical Industries Corporation
UNICO	UNICO International Co., Japan
Nissan	Nissan Chemical Industries, Ltd., Japan
UFFG	Urea Fertilizer Factory, Ghorasal
BADC	Bangladesh Agricultural Development Corporation
BITAC	Bangladesh Industrial Technical Assistance Center
ERD	External Resources Division
TCM	Toyo Umpanki Co., Ltd., Japan
TSP	Triple Superphosphate This word sometimes means "Triple Superphosphate Factory at Chittagong" in this report.
SA	Sulphuric Acid
SA-1	Sulphuric Acid Plant-1
SA-2	Sulphuric Acid Plant-2
PA	Phosphoric Acid
PA-1	Phosphoric Acid Plant-1
PA-2	Phosphoric Acid Plant-2
TSP-1	Triple Superphosphate Plant-1
TSP-2	Triple Superphosphate Plant-2
DAP	Diammonium Phosphate
P-rock	Phosphate Rock

S	Sulphur
DM water	Demineralized Water
LP steam	Low Pressure Steam
RA	Return Acid
CPA	Concentrated Phosphoric Acid
P.P. lining	Polypropylene Lining
P.V.C.	Polyvinyl Chloride
P	Pressure Drop
L/G	Liquid Flow/Gas Flow
Re	Reynold Number
RPM	Revolution Per Minute
AT	Absorbing Tower
DT	Drying Tower
SF	Sulphur Furnace
CV	Convertor
DAR	Deaerator
GF	Gas Filter
PT	Pump Tank
HE	Heat Exchanger
WHB	Waste Heat Boiler
ECO	Economizer
BFW	Boiler Feed Water
S-pit	Sulphur Pit
S-filter	Sulphur Filter

TGA	Temperature Gauge with Alarm
NFB	Non Fuse Breaker
CV Value	Coefficient of Valve Flow in Instrument
PR thermo-couple	Platinum versus Platinum-Rhodium thermocouple
CA thermo-couple	Chromel-Alumel thermocouple
PM	Preventive Maintenance
BM	Breakdown Maintenance
PPM section	Plant Preventive Maintenance Section
SAME	Sub Assistant Mechanical Engineer
MPC	Material Planning Control Section

I. Introduction

1. Background of the Project

The production facilities in Bangladesh had suffered from various problems which made it difficult to maintain the production at a satisfactory level after the liberation war in 1971.

The increase of agricultural products by the utilization of modern agricultural technology was strongly encouraged to attain self sufficiency in food supply. Fertilizer and agricultural chemicals are considered to be one of the tools for achieving such modern agricultural technology. So the requirement of fertilizer has increased at a paster rate, and exceeded the domestic supply.

The gap between demand and supply had been filled by importation of fertilizer. But the foreign currency required for such expenditure was a serious problem for the country.

In order to improve the capacity utiliza fertilizer plants in Bangladesh, extensive efforts were made by the Government of Bangladesh and BCIC. The Natural Gas Fertilizer factory at Fenchuganj was rehabilitated by the modernization and intensive turnaround maintenance under the financial assistance of the Government of Japan.

A technical assistance program to identify the nature of problems which are obstructing the high capacity utilization, and to prepare the improvement plan to eliminate such problems for the Urea Fertilizer Factory at Ghorasal and the TSP Complex at Chittagong were implemented by BCIC under the financial assistance from the World Bank. In these years, many highly experienced staff of BCIC had left the corporation to work abroad, particularly in oil-producing Arab countries, and this resulted in a significant shortage of expertise within BCIC, obstructing the efforts to implement several improvement plans quickly, and to improve and maintain the technology level of the newly-recruited staff.

In order to expedite the implementation of improvement plans, as had been suggested as a result of the above technical assistance programs and to assist the management of BCIC, for the improvement of capacity utilization in both the Urea Fertilizer Factory at Ghorasal and TSP Complex at Chittagong, UNIDO and the Government of Bangladesh decided to introduce another technical assistance team, who will station personnel in those factories, to assist the management of the factories for the implementation of such general improvement plans and execution of training program for the staff through on the job training and classroom instruction.

UNICO International Corp. (an industrial consultant firm) of Japan in association with NISSAN Chemical Industries, Ltd. (a chemical and fertilizer manufacturer in Japan) was awarded the contract for the above technical assistance program (hereafter called the Project). The field service for the Ghorasal plant was started in October, 1979 and was completed in December, 1980. The field service for TSP Complex was started in October, 1979 and completed in November, 1981, (since the final report for the service at the Ghorasal plant had already been submitted last May, hereinafter the description will be limited to the service for TSP Complex).

2. Outline of the Project and the Nature of This Report

A) Aim of the Project

The aim of the Project consists of two major categories:

1) The primary aim of the project is to improve the capacity utilization of the plant through assessment of existing conditions, preparing an improvement plan, assisting plant management in implementation of the improvement plan and assisting plant management in improving the technological level of the personnel of the plant. Followings are the objectives which belong to this category:

a) To make recommendation and advice how the best 85% capacity utilization of the TSP Complex at Chittagong can be achieved and implemented.

b) To establish a managerial and technical training programme for the personnel of the factory so that they will be able to properly maintain and operate the factory by the end of the Project.

c) To provide advice and guidance to personnel of the plant in the operation and maintenance of the plant over a long-term period.

2) The second category of the aims is very specific technical subjects which are selected by the management of the TSP Complex as the top-priority tasks to be tackled by the Project team. (These

aims are indicated in Table III-1 of Chapter 3.)

The solution of these specific troubles, which had been the bottlenecks of the production, were to be undertaken in parallel with the improvement of general conditions of the plant.

B) Related Parties

Execution body	UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION/BANGLADESH CHEMICAL INDUSTRIES CORPORATION
Project Owner	UNITED NATIONS DEVELOPMENT PROGRAM/GOVERNMENT OF BANGLADESH
Field Work Coordination	UNDP DACCA OFFICE
Contractor	UNICO INTERNATIONAL CORP., JAPAN
Associate	NISSAN CHEMICAL INDUSTRIES, LTD., JAPAN

C) Nature of the Report

During the period of the field service, the bi-monthly progress reports were prepared for reporting the work undertaken and the recommendation provided by the experts, and the reports were submitted to the parties concerned.

This final report is prepared to put together all the major findings, achievements and recommendation made by all the experts participated the project during the whole period of service in TSP Complex, Chittagong. Most of the studies were already reported in the bi-monthly reports. But several comprehensive discussions are also added in this report.

This draft report will be reviewed by UNIDO and BCIC before the debriefing of the Project by the team leader to UNIDO. Any suggestion and comment from UNIDO and BCIC on this draft report will be incorporated in preparation of the final report which will be prepared and distributed to all the related parties.

3. Outline of the Project

Project Site TSP Fertilizer Complex Chittagong
BCIC

Assigned Expert (Total Served Man/Months 86)

1979 ← → 1980 → 1981

Name	Assignment	Duration (Figure above line = M.M. ( ) = Man Day) 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11	Total M.M.		Total Man Day
T. Ikeya	Team Leader Process	$8\frac{17}{30}$ (261) $6\frac{24}{30}$ (205) $7\frac{10}{30}$ (224) / 20 6 29 21 20 29	22	$\frac{20}{30}$	690
Y. Fujiki	Mechanical	$8\frac{[illegible]}{30}$ (255) $6\frac{8}{30}$ (188) $6\frac{19}{30}$ (199) / 11 21 17 22 15 29	21	$\frac{2}{30}$	642
K. Araya	Instrument	$7\frac{[illegible]}{30}$ (219) $3\frac{26}{30}$ (118) / 23 28 27 22	11	$\frac{2}{30}$	337
H. Matsunami	Instrument	$4\frac{8}{30}$ (128) $4\frac{23}{30}$ (143) / 21 28 20 9	8	$\frac{29}{30}$	271
K. Aratani	Mechanical	6.00 (182) 4.00 (120) / 20 19 1 31	10	0	302
T. Endo	Process	$3\frac{4}{30}$ (94) $1\frac{19}{30}$ (50) $1\frac{9}{30}$ (39) / 23 24 20 8 21 29	6	0	183
H. Ito	Process	$1\frac{19}{30}$ (49) / 4 21	1	$\frac{18}{30}$	49
I. Sarashina	Process	$1\frac{21}{30}$ (52) / 20 10	1	$\frac{21}{30}$	52
M. Akiba	Electrical	$2\frac{23}{30}$ (83) / 8 29	2	$\frac{22}{30}$	83
TOTAL			85	$\frac{24}{30}$	2,609

4. Major Work Conducted

The details of the specific work conducted by the expert team in the TSP plant are described in Table II-2 of the main text of this report but the nature of the work can be summarized as follows:

a) To review the management system for production and maintenance activities in the factory.

b) To check the operating condition of the plants and present conditions of equipment in the plants.

c) To locate the bottlenecks which are limiting the capacity utilization.

d) To prepare appropriate debottlenecking plans.

e) To provide recommendation to implement the proposed debottlenecking plans.

f) To cooperate with TSP management for implementation of debottlenecking plans.

g) To cooperate with TSP staff for troubleshooting of day-to-day problems in plant operation and maintenance work.

h) To introduce an improved inventory control system for spare parts.

i) To prepare specific recommendation to improve plant operation so as to have 85% or more capacity utilization, and cooperate with TSP personnel for the implementation of such recommendation.

j) To prepare specific recommendation to improve capacity utilization up to 100% of design capacity.

k) To study the scheme to increase plant capacity beyond that of the original design.

l) To assist BCIC to develop a new project plan which will improve the financial condition of the factory by introducing new products.

m) To establish efficient productive (preventive) maintenance system to minimize failure of equipment which causes the lowering of on-stream days of the plant.

Note: During the course of the finalization of the contract, BCIC requested specifically that the experts to be provided in the plant should be from practical field, and implementation of the improvement plan should proceed with significant participation by TSP plant personnel.

The specific aims of the project given by BCIC were selected as the priority tasks to be tackled by the experts in cooperation of plant personnel.

However, it is to be pointed out that a significant part of the work of the experts was devoted in solving operational and maintenance problems other than specifically requested since those problems directly resulted in production loss of the factory.

II. Results, Discussion and Recommendation

1. Results

A) Foreword

After the two years service provided at the TSP Complex, the plant performance has improved significantly and the technological level of plant personnel has also improved significantly. It is to be emphasized here that those improvements were possible because of the extensive joint effort between the management of TSP Complex and the experts. Without such valuable effort by the management, improvement of the plant performance could not have been achieved.

B) Annual Production

Annual Production in financial years between 1974-1981.

Year	MT TSP	Percentage Against Capacity (%)
1974-1975	32,850	21.4
1975-1976	40,690	26.4
1976-1977	38,000	24.7
1977-1978	41,270	26.8
1978-1979	62,290	40.5
1979-1980	71,120	46.2
1980-1981	71,461	46.4

Notes: 1) The improvement of production in 1978 resulted from the reactivation of TSP-I Complex.

2) The expert team was stationed in the plant from October, 1979 to November, 1981.

C) Production Capacity of Each Plant (Daily Capacity)

The plant operated with maximum load in May, 1981 to determine the capacity condition in spite of stacking of products at full capacity in the storage.

The following result shows that each plant is possible to run with above 85%, and also at approximately 100% load if idle hours are excluded.

Plant	Nameplate Capacity (t/d)	Operated Max. Load (t/d) with Few Days Average	% to Nameplate Capacity (A)*	(B)*
		(taken from page 4-10)		
SA-2	400	344.5	86.1	86.1
PA-2	135	128.5	95.1	95.1
TSP-2	430	403.3	94.0	108.7
SA-1	100	87.3	87.3	92.5
PA-1	32	28.1	87.8	102.5
TSP-1	100	84.6	84.6	105.1

Notes: *: (A) = operated load (t/d) x 100/capacity (t/d)
= operated load %.

(B) = A x 24/(24 - unexpected idle hours)
= attainable load %.

**: The present bottleneck of SA-2 is the excessive pressure drop through the catalyst bed and this problem will be solved by screening of the catalyst at the next turnaround maintenance.

D) On-stream efficiency

At present the plant operation is interrupted very often by low lifting of product (shortage of space in product storage), shortage of raw material and power failure (external power source). These make it very difficult to calculate on-stream days of the plant itself in a year. The performance during one of the relatively long continuous production periods, in September, 1981, excluding power failure, low lifting and raw material shortage (Refer to Table IV-3 of main text), is shown below:

SA-II	97.6	SA-I	94.0
PA-II	84.4	PA-I	87.7
TSP-II	78.2	TSP-I	91.6

It is believed that these figures are the representative of present conditions.

E) Major debottlenecking achieved

a) SA-2 (Sulphuric Acid Plant No. 2)

i) Relocation of thermometer in sulphur burning furnace. The burn out of the thermometer has caused very frequent plant shutdowns. The on-stream efficiency of the plant is improved to around 5%.

ii) Elimination of acid carryover from the drying tower could minimize the plant shutdown. This carryover causes corrosion of equipment. The improvement of on-stream efficiency is estimated to be around 3%.

iii) The excessive pressure drops in the gas filter and absorber demister were eliminated. The plant capacity has improved around 10%. The pressure drop through converter catalyst is still high. But the present plant can achieve around 90% of the design rate.

b) PA-2 (Phosphoric Acid Plant No. 2)

i) Replacement of acid feed control valve by newly designed one was made. The previous one had trouble from frequent acid leak and poor performance. The shutdown of the plant, by replacement of this valve, was eliminated, and the on-stream efficiency has improved to 6-8%.

ii) Operating conditions for running two concentrators in parallel have been established. This will improve overall plant production at least 2-3% in a year.

iii) Improvement of pre-mixer bottom lining. The failure of the lining had caused frequent shutdown of the plant. The improvement could improve on-stream efficiency to around 5%.

iv) The improvement of the performance of control instruments by better calibration procedure and better adjustment. These will contribute to the increase of production to 2-3% in a year.

c) TSP-2 (Triple Superphosphate Plant No. 2)

i) Elimination of overheating of the motor for the ball mill. The continuous running of the mill was not possible because of overheating of the motor, but reducing the number of balls in the mill could eliminate this problem without reducing the mill capacity. The on-stream efficiency of the mill was improved to more than 20%.

ii) Improvement of phosphate rock feeding system. The previous design of the rock feeding system could not maintain smooth and stable operation. The application of a rotary valve and other modifications could result in improvement of on-stream efficiency of the plant to at least 8-10%.

iii) Modification of the conveyor system (pan conveyor, bucket elevator and flow conveyor). Several modifications and readjustments were conducted to reduce the failure of equipment. The improvement achieved by this time could be around 3% of on-stream efficiency.

d) SA-1 (Sulphuric Acid Plant No. 1)

i) Improvement of acid cooler capacity. Because of the shortage of cooling capacity, the absorber operation was continued at higher temperature than the normal design conditions. This high temperature caused very rapid corrosion of the pump and other equipment subjected to the high temperature acid. The improvement conducted this time could lower the acid temperature by 20°C, and this will minimize the shutdown of the plant by corrosion problem in absorber system. The improvement of on-stream efficiency is around 5%.

ii) The production capacity was raised by increasing SO_2 content in the sulphur burner outlet. The pressure drop of process gas through the total plant increased gradually after overhauling, and the maximum flow rate can be obtained by changing a blower.

In order to minimize the lowering of production, the change of operating conditions have been studied, and the increasing of SO_2

content in the process gas was done. By this way the production capacity will be increased by 10% even the period the blower capacity is the bottleneck of the production.

iii) The overall steam balance in the plant was improved to secure the required amount of steam to be used for the turbine of air blower. This improvement could improve the annual production at least to around one percent.

e) PA-1 (Phosphoric Acid Plant No. 1)

i) Modification of slurry overflow line from flush cooler. Original design of the flush cooler had problem of the slurry overflow to condenser because of the shortage of capacity of overflow line to digester. A larger size slurry overflow line was installed, and the problem was eliminated. This improvement could reduce the loss of P_2O_5 in the plant significantly (6-8%). In addition, the operation of cooler under higher vacuum, which results in higher capacity, becomes possible.

ii) The improvement of instrument arrangement for rock feeding system. The rock feeding system had several interlock system which apt to be functiond without real necessity. The system was reviewed to be simplified, and modification were conducted to make the system more reliable and stable. The modification could improve the on-stream efficiency of the plant to 8-10%.

2. Discussion

A) Basic problem (Non-technical)

The present low capacity utilization of the TSP Complex is apparently caused by non-technical factors. The plant was forced to shutdown 90 days in 1979-1980 and 119 days in 1980-1981 for low lifting and shortage of raw materials (Refer to 4-3 of main text). Unless these bottlenecks are eliminated, the improvement of production capability by making a significant investment may not be justified.

The present international price trend of phosphate fertilizer and raw material (phosphate rock and elementary sulphur) causes serious concern in relation to the economic viability of production of phosphate fertilizer from imported phosphate rock and elementary sulphur in Bangladesh.

This causes a difficulty in determining the additional investment to be made for the improvement of production at the TSP Complex. The problem of shortage of raw material also could be attributed to the difficulty of judgment on the level of the price which can be justified for obtaining the raw material instead of spending such money for importing low-price product.

Now, reliable data are available which will enable to determine the required investment to improve capacity utilization including construction of the granulation unit, which should minimize the low lift problem, and the production cost of phosphate fertilizer in the TSP Complex.

There are several rational plans to improve financial conditions of the TSP Complex by introducing new products as ammonium phosphate, etc.

It is strongly felt that the necessity of a techno-economic detailed study for the preparation of a modernization-rehabilitation plan of the TSP Complex, to determine the definitive improvement scheme. The detailed study shall include long range assessment of economic competitiveness of the product from the TSP Complex after the optimum capacity increase and incorporation of a new project for alternative way of supplying phosphate fertilizer to Bangladesh.

B) Basic Problem (Technical)

According to the findings of the expert team at the plant, the main cause of low capacity utilization is frequent failure of equipment in the plant, and such failure should be minimized by implementing the efficient productive (preventive) maintenance work of the plant and improving technical level of maintenance work on equipment.

During the two years field work, it has been recognized that the improvement of quality of maintenance or implementation of introduction of productive maintenance work were not attained smoothly due to the difference of working customs, difficulty of obtaining parts and materials, etc.

It is strongly felt that continuous effort by the TSP management for a long period, with appropriate technical and financial assistance from the BCIC head office and other international institutions, are indispensable to achieve the required improvement.

3. Recommendation for Solving Outstanding Problems

A) The continuation of improvement of the technological level of technical personnel of the TSP Complex.

In order to improve capacity utilization of the plant to 100% of the designed capacity, the following aspects of technology should be further improved and be maintained at satisfactory levels:

1) Preventive (Productive) Maintenance System including appropriate inventory control system of spare parts.

2) Acceleration and strengthening of the in-plant training of skilled maintenance technicians to compensate for draining of skilled technician to oil producing countries.

3) Improvement of technology of process/mechanical engineers to the level which makes it possible to conduct development of new projects and to conduct design for process and equipment modification.

B) Firming-up of the long-term plan for debottlenecking, rationalization and modernization of the TSP Complex.

The present problems such as shortage of raw materials, very slow lifting of the product from the plant and the lack of financial resources to procure spare parts and service in a proper and timely manner might be minimized by well planned arrangements by concerned parties.

However, the significant change of conditions in relation to the economy of TSP production using imported sulphur and phosphate rock made it difficult to determine how far the additional investment or how much expense can be justified to eliminate those problems.

Therefore, a feasibility study for long-term operation of the plant which identifies the optimum scheme including new product project(s) and to determine the extent of appropriate future investment should be done promptly.

C) The continuation of the debottlenecking of the plant facility as recommended in the following chapters of this report.

At present the production is not limited by the physical capacity of the plant, but when the limitation of raw material supply and low lifting of the product are eliminated, the implementation of further debottlenecking shall become very important to the factory.

Main Recommendation and their Implementation in the field are shown from page 1? to page 19.

Table II-1 Main Recommendation & Implementation

Plant No.	Subject of main problems	Request No. from BCIC	Recommended date	Implementation date	mark	Recommen
SA-2	1. Burning out of sulphur furnace outlet thermo-couple (frequently happened, sometimes daily, weekly)	7-a	5-12-'79	Dec.'79	◎	Pull thermocouple to protect burni length is 100 mm.
	2. S. pit Steam loss from sulphur pit	10-a	23-12-'80		△	(1) Dig & holes b pump up water (2) Installation steel plate
	3. Entry of corrosive acid mist from DT to all equipments (Drain from DT outlet was 2 L/day)	8-b	Feb.'80	Feb.'80	◎	Distributor cover and 320 holes wer Operation of only proved to be enou calculation.
	4. Frequent corrosion problem of AT, DT Mazuda pumps (impeler life is only 10 to 30 days)	8-b	25-2'81 25-3-'81 30-1-'81	Proposed to BCIC, ERD Emb. of Japan	o	Investigated mate Pilomet-II and fo considering.
	5. Bulging of absorption tower (AT) due to swelling of steel by penetrated acid.	8-b	Aug.'80	Aug.'80 Aug.'81	●	°Set the steel be °Calculation as t °Arrangement to c specialist
	6. Attack the stack with acid mist from AT (drain from the stack was 8 l/d)	2-b		Feb.'80 Jan.'81	◎	°Set distributor °Plug 320 holes °Stop over-flow f
	7. Check ΔP(pressure drop) of all equipments to establish the 100% load operation.	11	8-5-'81		●	Compare the date time (A), high lo '81 (B) and after
	8. Huge sound & vibration from CV cooling fan (much irritating & annoy to all personnel)		3-1-'81	Jan.'80	◎	Change suction fr

SECTION 1

◎ Completed
o Under preparation or processing
● Under construction
Δ Long term or future problem
∇ Difficult to implement at present

in Recommendation & Implementation

Implementation date	mark	Recommendation	Result of implementation	Remarks
)ec.'79	◎	Pull thermocouple by 250 mm length to protect burning. (Inserted length is 100 mm.)	Perfect 2 years no trouble.	Inserted length of thermocouple is 100 mm. This length is enough to measure and no burning-out happens
	Δ	(1) Dig & holes beside S-pit to pump up water penetrated out (2) Installation of concrete lined steel plate to separate water		
Feb.'80	◎	Distributor cover was attached and 320 holes were plugged. Operation of only one pump was proved to be enough from detail calculation.	Perfect Drain is now nil.	Equipment life will be doubled comparing with the situation before.
Proposed to ECIC, ERD Emb. of Japan	o	Investigated materials for DT, Pilomet-II and for AT, Illium-G are considering.		We are trying to apply the Japanese grant for financing. Now it depends on ERD's (external Resources Div.) decision.
Aug.'80 Aug.'81	●	°Set the steel belt by detail °Calcula+ . n as temporary measure °Arrangement to call the maker specialist	Swelling is now temporarily stopped.	
Feb.'80 Jan.'81	◎	°Set distributor cover °Plug 320 holes °Stop over-flow from slit	Drain became almost zero. Lining corrosion is almost stopped now.	Previous stack lining was already corroded and repairing is required.
	●	Compare the date of commissioning time (A), high load time in May '81 (B) and after cleaning (C)	Δp mm Ac GF AT-demister (A) 259 100 (B) 605 570 (C) 243 320	°At yearly shut down time, these filters and demisters should be cleaned. °CV catalyst should be screened at overhaul °S-filter should be equipped in order to prevent ΔP increase.
Jan.'80	◎	Change suction from square to cone.	° Good minimized	Human problem is big.

SECTION 2

Plant No.	Subject of main problems	Request No. from BCIC	Recommended date	Implementation date	mark	Recommendat[illegible]
PA-2	1. SA feed control valve (corrosion, false control, acid leakage occured)	6-c	5-5-'80	Order May '80 fix. Apl. '81	◎	Suggested all speci[illegible] procurement. (materi[illegible]
	2. P-rock constant feed system (powder flashing, fluctuation of feed)	3-b	May '80		o	Calculated & design[illegible] rotary valve system[illegible]
	3. Most of instruments were out of order (Multi-thermometer liq-level controllers, pressure gauge, etc.)	6-a	Jun. '81		◎ o	°Every 3 years over[illegible] °Attempt for repair[illegible] °Keeping instrument [illegible]
	4. Oiling system for pan filter center valve (Erosion at center valve was observed and oil pipes are checked.)	6-a	Aug. '80	Oct. '80	◎	Rearrangement of oi[illegible] and change of the o[illegible] position.
	5. PA loss minimizing (Waste PA discharged when vessels are made empty.)	2-a	5-3-'81		Δ	Utilize unused pond [illegible] tion of these PA.
	6. Unstable water charge for cake washing	11	8-6-'81		o	1. Charge all water [illegible] (& separate this [illegible] LICA-2501). 2. Set precut pipe [illegible] first zone.
	7. Actual repairing and calibration of (1) FRCSA-2301 (SA-flow meter) (2) FRCA-2302 (RA-flow meter)	2-c	11-6-'81 15-6-'81	Jun. '81 June. '81	◎	Calibration with wa[illegible] tank for flowrate c[illegible]
	8. Parallel operation of 2 concentrators (shortage of water supply)	6-a	8-6-'81		o	°Careful operation [illegible] °Re-use of concentr[illegible] condenser water fo[illegible] sending.

SECTION 1

Implementation date	mark	Recommendation	Result of implementation	Remarks
rder May '80 ix.Apl. '81	◎	Suggested all specification for procurement. (material-teflon)	Now running with best condition.	This can be used as semi-parmanent.
	o	Calculated & designed to set a rotary valve system.		Under preparation
	◎ o	•Every 3 years overhaul •Attempt for repairs step by step •Keeping instrument clean	90% repaired	At least every 3 years checking is needed by maker's specialist in future.
Oct. '80	◎	Rearrangement of oil tube lines and change of the oiling pump position.	Perfect. Became no trouble	Life of center valve has increased and oil consumption decreased.
	Δ	Utilize unused pond for collection of these PA.		Effluent of waste slurry will be minimized.
	o	1. Charge all water to V-2506 (& separate this line from LICA-2501). 2. Set precut pipe for pan filter first zone.		P_2O_5 recovery will be up about 0.3%.
Jun. '81 June. '81	◎	Calibration with water meter & tank for flowrate confirmation.	Good error (1) + 1.0% (2) + 0.1% (this is allow[illegible]le)	Workable job by BCIC instrument engineers and operators.
	o	•Careful operation first •Re-use of concentrater vacuum condenser water for gypsum sending.	Succeeded in parallel operation two times. More trial will be done.	At overhauling time, river water pond pump pipe should be cleaned and/or checked inside.

Plant No.	Subject of main problems	Request No. from BCIC	Recommended date	Implementation date	mark	Recommen...
TSP-2	1. Ball mill motor over heating (By only 6 hrs running, this motor surface temp. went up to 70°C. Continuous running was impossible.	2-a	Feb.'80	Feb.'80	◎	°Removal of 30% o... porary measure. hauling is neces...
	2. Mill screw conveyor motor oil trouble (Oil leakage continuously occured)	2-a	Dec.'79	Dec.'79	◎	°Reverse setting ... °Change of one se... new one.
	3. P-rock constant feed was impossible. (Big trouble of flushing and fluctuation)	3-b	24-3-'81 23-4-'80	Aug.'81	◎	°Fabrication of a ... (Its specificati... method was sugge...
	4. Pan conveyor daily trouble (dusty & broken)	5-b	18-2-'81	Apr.'81 Nov.'81	◎ Δ	°1st step making straight °Finally change ...
	... t spare bagging machine (now 2 series) ...en one is reparing, capacity becomes ...lf.)	4			∇	Setting method w...
	6. Dusty bagging system	4	29-2-'80	March '80	○	Complete rearra... filters and air
	7. Lifting and warehouse capacity shortage of bagged TSP		25-2-'81 20-3-'81 30-1-'81	Application for ERD	Δ	°Increase of sto... new type of mac... °Quick loading t...
	8. P-rock recovery by pond fabrication	2-a	14-6-'80 24-6-'80	July '80	◎ Δ	Recovery method rock from dust ...
	9. Daily broken of bagging elevator shear pin (Very big trouble, 15 times/M arisen and 158 hrs were lost.)				◎ ●	°Oiling to wheel °Backet link was... link is under p... (Link means a p... chain.)

SECTION 1

Implementation date	mark	Recommendation	Result of implementation	Remarks
·b.'80	◎	°Removal of 30% of balls as temporary measure. In future overhauling is necessary by maker.	Quite successful. This temp. remians below 62°C at continuous running and grinding was enough.	Also 1,570KWH/d of Power is sav·d. Limited overhauling was done by maker's engineer (motor bearing was changed.)
·c.'79	◎	°Reverse setting of the casing °Change of one sealed bearing to new one.	Perfect No oil leakage No trouble	Completely OK
·g.'81	◎	°Fabrication of a rotary valve. (Its specification and fabrication method was suggested.)	Now constant feeding is established.	Constant feed makes reaction good.
·r.'81 ·v.'81	◎ Δ	°1st step making the system straight °Finally change to belt conveyor.	Expecting very good condition	Heat resistant belt & plaloy roller is under procurement for No.1,2 Pan conveyors to be changed.
	∇	Setting method was recommended.		After granulation plant is completed, 3 sets will be needed.
·rch '80	○	Complete rearrangement of bagging-filters and air sucking system	Almost perfect, with occasional exceptions	Periodical maintenance is necessary as demonstrated.
· plication ·r ERD	Δ	°Increase of stock capacity by using new type of machine. °Quick loading to truck or wagon		Now trying to procure the loading machine by Japanese grant
·ly '80	◎ Δ	Recovery method of collected P-rock from dust collecter.	Some similar methods were done.	
	◎ ●	°Oiling to wheel and chain °Backet link was loosened. New link is under procurement. (Link means a plate at the side of chain.)		Reconditioned link should be kept as spare.

Plant No.	Subject of main problems	Request No. from BCIC	Recommended date	Implementation date	mark	Recommen...
SA-I	1. AT stack gas (•for old distributor, many modifications) (•for new distributor, some rearrangement)	2-b	28-3-'80	Mar.'80	◎	•Correction of the •Cleaning of acid blinding
			29-4-'80	Apl.'81	◎	•Removal of tower •Preparation of n butor
	2. Cooling tower design	1-c	15-5-'81 28-6-'81		Δ	•Recommended self tem & prepared t cation.
	3. Improve SO_2 conversion to SO_3	11	Jan.'80	Feb.'80	o	•Added 450 liter conveter
	4. Capacity increase by changing operation condition of sulphur furnace	8-a	Dec. '80	Feb. '81	◎	•Temperature shou to 1050°C so SO to 8.5°C.
	5. Lowering of AT DT circulation acid temperature previous / recommended temp. AT 90°C below 70°C DT 70°C " 55°C	8-b	31-7-'80	Jul '81	◎	Four alternative posed: 1. utilize 1 set c cooling area = 2. use tube well w 3. Increase cooli for AT 4. SO_3 gas coolin
	6. Increase steam generation and also operation load (justify DAR operation)	5-d	19-5-'81	Jun.'81 (Half of the work)	◎ o	•Heat of SF inlet ferred to DM wat •For DAR, LP ste plied
	7. Technical idea of operation load increasing for 150% load	3-a			Δ	The basic idea w the specificati
	8. Improvement of process control system Electrical & instrument panel replacement	6-a b 7-a	Feb.'80 Feb.'81			•Decision of inst tion and electr method.

SECTION 1

Implementation date	mark	Recommendation	Result of implementation	Remarks
ar.'80	◎	°Correction of the disbributor hole °Cleaning of acid against hole blinding	After hole correction, situation was good but holes were blinded again with old type.	This distributor was frequently blinded.
l.'81	◎	°Removal of tower channeling °Preparation of new type distributor	With new one, no blinding but corrosion problem is observed depend on acid temp.	Now new type one was set with satisfaction, but material should be changed.
	Δ	°Recommended self circulation system & prepared the tender specification.		In order to save water consumption it is necessary.
eb.'80	o	°Added 450 liter V_2O_5 catalyst to conveter	Conversion ratio increased to 0.3%.	
eb. '81	◎	°Temperature should be up from 950 to 1050°C so SO_2% also from 7.5°C to 8.5°C.	With same vol of air, capacity increased by 6%	Also now decreasing of SF inlet air temp. is trying.
ul '81	◎	Four alternative method are proposed: 1.utilize 1 set of SA-2 DT cooler cooling area = 100 m^2 2.use tube well water 3.Increase cooling pipe 4 layers for AT 4.SO_3 gas cooling	No.3 recommendation was implemented and AT temp. becaume 73°C	Cooling area increased 24 m^2/4 layers.
an.'81 (Half of the work)	◎ o	°Heat of SF inlet air can be transferred to DM water °For DAR, LP steam should be supplied	0.43 t/H of steam will increase by this.	SF inlet has 250°C temp. This should be cooled and this heat 300 Mcal/H is changeable to DM water heating.
	Δ	The basic idea was submitted and the specification calculated.		
		°Decision of instrument specification and electrical panel setting method.	These 2 panels are under procurement.	

Plant No.	Subject of main problems	Request No. from BCIC	Recommended date	Implementation date	mark	Recommenda
PA-I	1. Panel shifting in the control room (Electrically dangerous)	6-a	Dec. '79	Dec.'79 to Feb.'80	@	Utilize empty room the panel layout t tion easy.
	2. Overflowing from flush cooler (Slurry was sometimes brought up to condenser at -340 mm Hg vacuum)	1-a	Aug.'80	Oct.'80	@	1. Add one more 1 pipe 2. Use defoaming occasionally
	3. More intensive digester cooling method (Slurry temp of 85°C should be below 80°C)	1-a	23-12-'80		Δ	By air bubbling • Using a fan wh needed when gr is completed. • Or Using star as common by
	4. Collect the waste slurry that is discarded daily	2-a	7-3-'81		o	Make pit to coll pump up to retur
	5. Capacity increase method up to 150% load (32 T/D → 50 T/D)	3-a	23-12-'80		Δ	1. Rock feeder s changing spro 2. Set additiona (total vol. 5 3. Slurry coolin 4. Some change c instrument
	6. P-rock feeder modification 25 times trouble occurred per month.	3-b	6-6-'81	June'81	o	1. Change trans 2. Complete sea

SECTION 1

Implementation date	mark	Recommendation	Result of implementation	Remarks
Dec.'79 to Feb.'80	@	Utilize empty room and change the panel layout to make operation easy.	Become beautiful and smooth operation is achieved.	Morale of operators were also stimulated.
Oct.'80	@	1. Add one more 12 inch over flow pipe 2. Use defoaming reagent occasionally	Almost solved. Vacuum can be up to 400 mm Hg (Normally 360mmHg is used.)	Another attempt was proposed but this method will be the best.
	Δ	By air bubbling • Using a fan which will not be needed when granulation plant is completed. • Or Using start-up fan of SA-I as common by piping from SA-I		
	o	Make pit to collect this and pump up to return.		
	Δ	1. Rock feeder speed up by changing sprocket 2. Set additional digester (total vol. 50 m^3) 3. Slurry cooling by air 4. Some change of pump & instrument		Detail refer to VII.1.iv).
June'81	o	1. Change transmitter 2. Complete seal against dust	Trouble decreased to 2-3 times/month	It is expected that troubles are solved by these methods.

Plant No.	Subject of main problems	Request No. from BCIC	Recommended date	Implementation date	mark	Recommend
Common	1. Dusting problem from each joint position of unloading belt conveyor system (6 positions are there)	11	2-4-'80 Mar.'80 Mar.'80 13-2-'81	April'80	◎ o	1. Make 60° slope position using 2. Conveyor cover 3. Procure vulcani to make seamle 4. Make chute for
	2. Inventory control system for instruments and machinery	10-b	Oct.'80	Oct.'80	◎ Δ	Preparation of in procuring method
	3. Safety in working (1) Explosion at acid containing equipment welding (2) Support for SA tank roof passway, towers, S-pit. (3) Wears & places suitable for working	8-a	Feb.'80		◎ Δ	1. Prevention met generation. 2. Additional pla be set. 3. Supply uniform factory
	4. Laboratory system checking	5-d	9.7.'80		◎	1. Rearrange the complete docum cleaning of in working table 2. Rehabilitation analyzer etc. 3. Establishment division 4. Bringing up of and engineers introduction
	5. Recommendation for establishment of the future related industries (Aim : stop import, further export products)	–	Jun.'80 Aug.'81			1. Synthetic det 2. Purified SA p 3. Introduction phosphate 4. Consultation system change

SECTION 1

Implementation date	mark	Recommendation	Result of implementation	Remarks
April'80	◎ O	1. Make 60° slope system at joint position using rubber and steel 2. Conveyor cover should be fixed 3. Procure vulcanizer and use it to make seamless belt 4. Make chute for S-rock dropping	1. Trial was done for 1 position and result was quite satisfactory. Application for other position are now under preparation. No. 2,3,4 are under preparation	1. After completion of all six, clean factory and saving of S and P-rock are expected.
Oct.'80	◎ Δ	Preparation of inventory list and procuring method of spare parts	For instrument of plant 2, they are completed	This method is very much appreciated.
	◎ Δ	1. Prevention method of hydrogen generation. 2. Additional plate cover must be set. 3. Supply uniforms, clean the factory	1. Gas purge method at welding time etc. (on job training) 2. Almost completed 3. Partially completed	1. There are some examples of accident causing dead of personnel from explosion.
	◎	1. Rearrange the chamber system, complete documents and complete cleaning of inside desk, working tables, chambers, etc. 2. Rehabilitation of electric analyzer etc. 3. Establishment of research division 4. Bringing up of the technicians and engineers by actual introduction	1. Completed as the first job. One modification is going on. 2. Applied some parts Special condition chamber for this equip. was arranged.	Items 3,4 are very much required for future.
		1. Synthetic detergent 2. Purified SA production 3. Introduction of DAP and Nitric phosphate 4. Consultation of unloading system change in Jetty.	1. Only import detergents are used and no domestic production in this country 2. Normal SA costs 2Tk/kg and now imported reagent used here is 150 Tk/kg. Design is completed. 3. After establishment of NH_3 factory, DAP will be the best product.	

Plant No.	Subject of main problems	Request No. from BCIC		Implementation date	mark	Recommenda[illegible]
Common	6. Training for engineers and workers 1) For managers & engineers	7-b	9 times	Feb.Mar. '81	◎	Main items • Methods of ind[illegible] lation and che[illegible]
	2) For engineers & SA operators		10 times	Jan.Feb. Mar.Apr. '80		• Sulphur, oil b[illegible] tion • Reich measurin[illegible] • How to know th[illegible] concentration
	3) For PA TSP operators		4 times	Jan.'80		• Theory of PA p[illegible] • Circumstance o[illegible] product
	4) For mechanical workers		7 times	Mar.Apr. '80		• System of pre[illegible] nance • How to use in[illegible] materials • Method of pum[illegible] piping
	5) For instrument workers			Feb.Mar. Apr.'80 Mar.'81		• Principle of [illegible] • How to make c[illegible] • Repairing met[illegible]
	7. Operating manual review	8-a		24-1-'81	◎	Mainly for SA-2[illegible]
	8. Measuring methods of SA acid circulating volume			4-2-'80 16-1-'80 5-6-'80	◎	Just after star[illegible] pump, measure b[illegible] levels within 2[illegible] tinuously.
	9. Establishment of the operation brain team to prospect the future of this factory.				△	After formation[illegible] they can do for[illegible] ning, desitn, t[illegible] researches, et[illegible]

SECTION 1

Implementation date	mark	Recommendation	Result of implementation	Remarks
Feb.Mar. '81	◎	Main items • Methods of industrial calculation and chemical kinetics	• Calculation methods were shown on 10 subjects and a booklet was made.	All engineers attended will be able to design and to make industrial calculation.
Jan.Feb. Mar.Apr. '80		• Sulphur, oil burning calculation • Reich measuring method • How to know the actual acid concentration	• Heat & mass balance calculation was taught using the figure of actual operation.	
Jan. '80		• Theory of PA production • Circumstance of world PA product	• Taught regarding actual problems • Mass balance calculation	
Mar.Apr. '80		• System of preventive maintenance • How to use industrial materials • Method of pump assembly & piping	• Comparison with the situation of other countries • Alloy & stainless steel cast-iron • On job training	
Feb.Mar. Apr.'80 Mar.'81		• Principle of Pressure gauge • How to make calibration • Repairing method in actual	• Bourdon tube U-tube • Exercise, calculation • On job training	There is a problem that well trained workers are apt to quit the factory.
24-1-'81	◎	Mainly for SA-2, PA-2	• Amended and important points were picked up.	
4-2-'80 16-1-'80 5-6-'80	◎	Just after starting the circu. pump, measure both PT actual levels within 2.5 minutes continuously.	Very helpful method, this is to be applied when the measuring is needed.	After doing it, make this to graph and the actual vol. can be decided
	Δ	After formation of this team, they can do for product planning, desitn, trouble shooting, researches, etc.	Listing up of the members, layout, etc. are now under preparation	This team must also manage documentation and filing works.

Table II-2 Shutdown by shortage of rock and non-lifting of Bagged TSP

	Shortage of raw materials			By non-lifting	Grand total
	P-rock	S	Sub-total		
'75-76	31 days May 30 days Jun.	-	61 days		61 days
'76-77	-	31 days Oct 30 days Nov. 31 days Dec. 16 days Jan.	108 days		108 days
'77-78	5 days May 30 days Jun.	-	35 days		35 days
'78-79	31 days Jul. 16 days Mar. 7 days Apr. 25 days May	-	79 days	10 days	89 days
'79-80	8 days Feb. 6 days Mar. 30 days Apr. 12 days May	14 days Oct. 5 days Nov.	75 days	15 days	90 days
'80-81	-	6 days Jan 28 days Feb. 31 days Mar. 6 days Apr.	71 days	48 days	119 days
Total	231 days	198 days	429 days (Per year 71.5 days)	73 days	502 days

III. Activities of the Team

1. General

TSP Complex Chittagong consists of plant 1 and plant 2, each having Sulphuric acid plant, Phosphoric acid plant and Triple Superphosphate (TSP) fertilizer plant, located in Chittagong city, Bangladesh. Plant 1 has started operation in 1967 and plant 2 in 1974. Plant layout is shown in Appendix III-1.

In spite of full efforts of BCIC and TSP management, many operational and management problems occured successively. As a result, production was not satisfactory as shown in Chapter II section 3.

In order to assist BCIC and TSP management, UNIDO decided to dispatch "Operation and Management Assistance Team" and UNICO group was awarded the contract for this service. Nissan Chemical as associate of UNICO lendered the service to TSP Complex, Chittagong.

2. Main Task

The contract between UNIDO and UNICO describes the detail of the job to be done by the team. It can be summarized as follows:

- o Investigation for the cause of production bottlenecks and abnormal shut-down.
- o Recommendation and consultation for measures to remove such bottlenecks and abnormal situation.
- o Assistance for implementation of those measures

- o Instruction for proper preventive maintenance system
- o Introduction of proper procurement and inventory system
- o Training of BCIC staff to be able to keep the sound plant operation after this assistance program is over.
- o Achievement of more than 85% capacity utilization when necessary countermeasures are implemented.

After the finalization of the contract between UNIDO and UNICO, a meeting between UNIDO, BCIC and UNICO group was held at BCIC head office in Dacca and at that time it was requested by BCIC that more actual implementation were to be taken up than preparing many reports and more practical items were to be given as tasks for the assistance team. This request was accepted at the meeting and as practical items so-called "Overall Schedule" was proposed by BCIC. This Overall Schedule is attached here as Table III-1.

3. Team Organization and Duration

In order to carry out the tasks mentioned in section 2 above, 9 persons from Nissan Chemical were sent to Chittagong and stayed from October 1979 to November 1980 serving 85.9 man-months for this service in total.

Their names, kind of job and period of staying at site are given in Table III-2.

4. Performance

Always facing inevitable difficulties caused by difference in custom, labor problems, financial problems, etc., the team has given a lot of recommendation and training of the workers under joint work with TSP management and many of them were inplemented successfully. These main work are recorded and more detailed explanation about the content are given in Table II-2 and Chapter V.

Generally speaking, the work of the team proceeded in the following steps.

1) Investigation and check of the situation and causes of the problems

2) Finding out the way of solving such problems by comparison with similar examples, detailed calculation or testing at site

3) Recommendation how to implement

4) Assistance for preparing tender inquiry by deciding specifications when some equipment or parts must be purchased

5) Instruction for modification when work can be done at factory site

6) Assistance for obtaining foreign grant, etc., when large financing is necessary. In Table III-3, items for which Japanese finance is applied.

But it is to be said here that two big problems, raw material shortage and poor lifting of the product, and instability of employment and lack of enthusiasm by some workers have hindered the activities of the team to some extent in spite of utmost cooperation received from the TSP management.

At factory, casual plant troubles happen time to time and the team set top priority in solving such casual troubles because keeping the continuous plant operation is the most important item in factory management. Actually much time was taken in this work for the team but the detail of such jobs are not mentioned in this report together with minor recommendation and their implementations.

Table III-1 Overall Schedule Requested by BCIC, its Implementation and Results

No. Re-quested	Items	Recommendation & Implementation (as implement @ done, o doing or procuring ● long term task)	Reference No. in this report	Result
1-a	Improvement of cooling system of slurry in PA-1	◎ 1. Set 200 mmø additional rubber hose for flush cooler outlet to prevent over-flowing. ◎ 2. Make defoaming agent spray system for flush cooler. o 3. Change sucking duct of digester to 500 mmø.	V 3 vi)	1. Incr 310 2. Occa
1-b	Improvement of agitators efficiently in PA-1	This item was omitted by TSP side.		
1-c-I	Alternative arrangement for cooling tower	● Submitted cooling tower specification.	V 2 ix)	It will require
1-c-2	Alternative arrangement for cooling system of SA-1	◎ Established additional 2 stages of acid cooler for cooling AT acid from 95°C to below 75°C.	V-2 x)	Complet factory
2-a	Improvement of measures for prevention of loss of milled rock (TSP-1,2)	◎ 1. Investigation of wet system dust collector, and its inside modification by TSP side. ◎ 2. Washed dust collecting method modification. o 3. Installation of dust collecting chamber before scrubber (TSP-2). ● 4. Transfer existing bag filter in stead of wet system. ● 5. Designed & recommended to install special cyclone for TSP-1.	V 4 iii) V 4 iii) V 4 iii)	1. Good obta pers 2. Reco easy 3. 10 T coll 4. Afte plan

SECTION 1

: BCIC, its Implementation and Results

:ion & Implementation : implement) doing or procuring iong term task)	Reference No. in this report	Result	(Imple- ment) %	Remarks
mmø additional rubber hose n cooler outlet to prevent wing. oaming agent spray system n cooler. icking duct of digester mø.	V 3 vi)	1. Increased vacuum from 310 mmHg to 360 mmHg. 2. Occasionally used.	80	1. 300 ø rubber hose is now being arranged to fix.
m was omitted by TSP side.				
ooling tower specification.	V 2 ix)	It will be used as tender requirement.	50	
additional 2 stages of for cooling AT acid from low 75°C.	V-2 x)	Completed with satis- factory result.	100	1. Low temperature ope- ration is helpful for prevention of corrosion and pollu- tion problem.
:ation of wet system dust r, and its inside modifica- TSP side. iust collecting method ation. :tion of dust collecting before scrubber (TSP-2). existing bag filter in wet system. : & recommended to install cyclone for TSP-1.	V 4 iii) V 4 iii) V 4 iii)	1. Good result was obtained by TSP personnel 2. Recollecting became easy. 3. 10 T/M will be collected. 4. After granulation plant is completed.	50	1. For future, dry collection method is best. Probable supplier is Nissan Engineering or Hitachi Zosen in Japan.

SECTION 2

No. Requested	Item	Recommendation & Implementation	Ref.No. in this report	Result
2-b	Effluent disposal & pollution control improvement (SA-1,2)	◎ 1. Prevention of acid entrainment from DT (SA-2).	V-2 i)	1.2. Quite good: drain of 10-20 became almost now.
		◎ 2. Prevention of stack attack & effluence from AT (SA-2).	V 2 ii)	
		(Both 1 and 2 by decreacing acid scattering from acid distributors)		3. Modification cooler carrie
		◎ 3. Minimization of effluent from SA-1 stack gas.	V-5 viii)	4. Now preparing at first.
		o 4. Recovery of slurry effluent by pit utilization (PA-1,2).	V 5 viii)	5. Good suggesti Implementatio be made.
		o 5. Installation of dust collecting chamber before scrubber (TSP-2).		
		◎ 6. Application of slope system to raw material conveyors junction point.		6. Dusting was m by which slop was successfu as an example
2-c	Improvement of the concentration system & capacity increase of PA-1	◎ 1. Actual attempt to full load operation PA-1	VII 1 iii)	First attempt of operation was 86
		• 2. Installation of additional condenser, equipment & instrument.		
		• 3. Recommendation for capacity increase to 150% load. 32 T/D → 50 T/D	VII 1 iv)	Tender specificat completed.
3-a	Assessment of the capacities of PA-1 and trial for 100% load.	Refer to 2-C item 1.	VII 1 iii)	Detailed data we and 5 important for good operati were suggested.

SECTION 1

& Implementation	Ref.No. in this report	Result	(Implement) %	Remarks
acid entrainment from stack attack & m AT (SA-2). by decreacing acid rom acid distributors) of effluent from SA-1 slurry effluent by pit (PA-1,2). of dust collecting re scrubber (TSP-2). of slope system to conveyors junction	V-2 i) V 2 ii) V-5 viii) V 5 viii)	1.2. Quite good: Acid drain of 10-20 lit/D became almost zero now. 3. Modification of acid cooler carried out, 4. Now preparing for PA-1 at first. 5. Good suggestion Implementation will be made. 6. Dusting was minimized by which slope system was successfully done as an example.	80	1.2. Acid flashing was stopped due to placing covers as per suggestion of UNICO. 3. Stack gas was minimized by UNICO suggestion. It should be applied for other five conjunctions.
pt to full load opera- of additional condenser, instrument. ion for capacity increase → 50 T/D	VII 1 iii) VII 1 iv)	First attempt of full load operation was 86% to 92%. Tender specification is completed.	70	Other 3 days performance was found 82.2 - 91.5%. This item is a long term project.
1.	VII 1 iii)	Detailed data were taken and 5 important points for good operations were suggested.	70	

SECTION 2

No. Re-quested	Items	Recommendation & Implementation	Ref.No. in this report	Result
3-b	Suggest feed rate and procedures for uniform qualities of output with the change of rock phosphate and grade (TSP-1,2) (Mainly TSP-2 had heavy problem. So it was attacked there mainly, No. 1-5.)	@ 1. Establishment of simplified calculation formula. @ 2. Removal of trouble of constant feeder by accepting rotary valve. o 3. Procurement of plaloy roller instead of pan conveyor for trouble free continuous production. @ 4. Effective reaction using cone mixer instead of ribbon mixer. @ 5. Improvement of existing equipment. • No.1 pan conveyor should be straight. • Oiling for each roller to prevent daily trouble. • Improvement of the dusty atmosphere. @ 6. Removal of daily troubles of PA-1 rock feeder by changing the sequence. @ 7. New establishment of TSP-1 PA charge indicator & totalizer.	 V 3 i) V 5 ii) V 4 i) V 3 vii) V 3 viii)	1. Calculation b[illegible] easy. 2. After modific[illegible] well. 3. Trial by usi[illegible] rollers was [illegible] 4. Excellent wo[illegible] staff. Pl[illegible] running well. 5. Daily troubl[illegible] tremely decr[illegible] times/week m[illegible] oiling syste[illegible] 6. 23 times/mon[illegible] were decreas[illegible] month. 7. Feeding cont[illegible] calculation easy. It is for PA-1 and
4	Improvement of trouble free operation of weighing machine and incorporation of one stand-by packer scale in bagging plant	@ 1. Adjustment, trimming and cleaning of all equipment. @ 2. Investigation of trouble causes of existing bagging machine together with description of its specification. • 3. Preparation of installation drawing of stand-by machine and estimation of installation cost. • 4. Introduction of new type weighing machine of "Load Cell type" instead of Merrick Scale. o 5. Recommendation to check and adjust the accuracy of existing Merrick 4 times/year with test chain.	V 4 vi)	3. After estab[illegible] granulation recommendat[illegible] implemented[illegible] 4. Catalogue a[illegible] of Load Cel[illegible]

SECTION 1

ion & Implementation	Ref.No. in this report	Result	(Implement) %	Remarks
ment of simplified cal- formula.		1. Calculation became quite easy.	80	
f trouble of constant accepting rotary valve.	V 3 i)	2. After modification it worked well.		• Same system will be effective for PA-2.
nt of plaloy roller instead nveyor for trouble free s production.	V 5 ii)	3. Trial by using 6 plaloy rollers was successful.		• More plaloy rollers are now under procurement.
reaction using cone tead of ribbon mixer.		4. Excellent work of TSP staff. Plant is now running well.		• Cone type was designed and implemented by TSP.
nt of existing equipment. n conveyor should be t.	V 4 i)	5. Daily troubles were extremely decreased to 1-2 times/week mainly by oiling system.		
for each roller to prevent rouble. ment of the dusty ere.		6. 23 times/month troubles were decreased to 1-2/ month.	100	Sequence check & modification were very hard work.
f daily troubles of PA-1 er by changing the .	V 3 vii)	7. Feeding control & product calculation became quite easy. It is very helpful for PA-1 and TSP-1.		
blishment of TSP-1 PA ndicator & totalizer.	V 3 viii)			
t, trimming and cleaning ipment.	V 4 vi)		50	
tion of trouble causes of bagging machine together ription of its specifica-				
on of installation drawing by machine and estimation lation cost.		3. After establishment of granulation plant, this recommendation will be implemented.		
tion of new type weighing f "Load Cell type" instead k Scale.		4. Catalogue and information of Load Cell type are submitted.		It is considered to be procured in next chance.
ation to check and adjust cy of existing Merrick ear with test chain.				

SECTION 2

No. Re-quested.	Items	Recommendation & Implementations	Ref.No. in this report	Results
5-a	Improvement of rock flow elevator of PA and Reaction-2 (PA-2, TSP-2)	◎ 1. Correct arrangement & operation of equipment to minimize the derail & other troubles (3 times/month) o 2. To change whole links to new ones once a year and kept old one as spare after reconditioning. ◎ 3. Detection of the cause of troubles (ampere fluctuation etc.) and modification (installation of air slide feeder etc.)	V 3 v)	1. Wheel mis-an justified and decreased to 6 M. 2. Now some of under prepara BITAC Co. as 3. Good result trouble decre
5-b	Modification of pan conveyor for carrying green TSP Den to curing house No.2 (TSP-2)	◎ 1. 1st step : Change S-type pan conveyor to straight type for No.1 pan. ◎ 2. 2nd step : Careful maintenance by oiling, early repairing and prevention of dust rising. o 3. 3rd step : Model change to belt con. system using non-corrosive plaloy rollers.	V 4 i)	1. It was done (Each part is fatigued.) 2. Trouble decre 7/week to 1- 3. All of procu procedures w already take

SECTION 1

...ion & Implementations	Ref.No. in this report	Results	(Implement) %	Remarks
...rangement & operation of ... to minimize the derail ...roubles ...month) ... whole links to new ones ...ar and kept old one as ...er reconditioning. ... of the cause of troubles ...luctuation etc.) and ...tion (installation of air ...der etc.)	V 3 v)	1. Wheel mis-angle was justified and trouble decreased to 1-3 times/ 6 M. 2. Now some of links are under preparations by BITAC Co. as spare. 3. Good result (ampere down, trouble decreased.)	85	This arrangement is apt to be wrong and careful fabrication is needed.
: Change S-type pan conveyor to straight type for No.1 pan. : Careful maintenance by oiling, early repairing and prevention of dust rising. : Model change to belt con. system using non-corrosive plaloy rollers.	V 4 i)	1. It was done completely (Each part is now fatigued.) 2. Trouble decreased from 7/week to 1-2/week. 3. All of procurement procedures were already taken.	75	Huge sound and dusty atmosphere were greatly put down. Ultimately rubber conveyor velt has been installed of No.1 pan conveyor. Replacement of No.2 pan conveyor in progress.

SECTION 2

No. Re-quested	Items	Recommendation & Implementations	Ref.No. in this report	Results
5-c	Improvement of dryer exhaust fan. Elimination of heavy load by dust on impellers (TSP-2) (This item was omitted by TSP.)	● 1. Increase of dryer outlet cyclone efficiency by cleaning of inside. ◎ 2. Correct firing & brick reparing of furnace. ◎ 3. Uniform cleaning of fan impeller.		This dryer & be changed w plant is co jobs were n small work
5-d	Improvement of laboratory system (Different from original item)	◎ 1. Rearrnagment and complete refreshment by cleaning and reparing of inside desks tables and chambers. ◎ 2. Adjustment of electric analyzer and measuring equipment. ◎ 3. New arrangement of document and manual file cabinet. ◎ 4. Staff training for skillful works ◎ 5. Instruction of special kind of works. ● 6. Establishment of research division & electro-engineer.	VII 3	At first t looked lik chamber. Nowadays, the labora out by TSP Good disci uplift and this situa continued.

SECTION 1

...tion & Implementations	Ref.No. in this report	Results	(Implement) %	Remarks
... of dryer outlet cyclone ...y by cleaning of inside. ...iring & brick reparing of ...leaning of fan impeller.		This dryer & fan system will be changed when granulation plant is completed. So big jobs were not done and only small works were done.		
...ent and complete refresh- ...leaning and reparing of ...sks tables and chambers. ...t of electric analyzer ...ring equipment. ...ngement of document and ...le cabinet. ...ining for skillful works ...on of special kind of ...ment of research ... & electro-enginee	VII 3	At first the laboratory looked like an uncontrolled chamber. Nowadays, the arrangement of the laboratory is carried out by TSP staff themselves. Good discipline caused good uplift and it is hoped that this situation will be continued.	90	Some parts of analyzer were supplied for improvement. Good recommendeation but implementation is not easy. (long term problem)

SECTION 2

No. Requested	Items	Recommendation & Implementation	Ref.No. in this report	Results
6-a	Improvement of existing constraint of all process control instruments in both TSP-1,2 and suggest modifications, replacement and specification of additional instruments and source of supply.	◎ 1. Replacement of PA-1 instrument panel for effective use and to avoid the dangerous situation.	V 3 x)	1. Very fine an by the exper 2 months.
		• 2. Expansion of PA-1 instrumentation including every necessary instrument system for the near future when plant load is increased.	V 3 ix)	2. This expansio dispensable a
		o 3. Suggestion for SA-1 electrical & instrument panel procurement and layout.	V 2 xi) V 2 xii)	3. This will be the planning
		◎ 4. Introduction of SA feeding control valve of PA-2 (unstable operating and frequent SA leakage were continued for about half year.)	V 3 ii)	4. Life of this semi-perman quite good.
		◎ 5. Solution of P-rock feeder frequent trouble in PA-1 (See 3-b-No.6 also)	V 3 vii)	5. Electric sec This has re solution.
		◎ 6. Installation of concentrated PA sending totalizer & indicator for TSP-1. This serves as product calculator & moment indicator.	V 3 viii)	6. It was quite convenient.
		◎ 7. Detail check & complete cleaning of orifice portion of saving valve to have correct indication SA-2.		7. Done with g
		◎ 8. Correct calibration and adjustment of PA-2 instrument (SA flow, RA flow meter, etc.)	V 3 iii)	8. Each error able range
		◎ 9. Clarification of the turbine instrument sequence of SA-2.	V 2 vi)	9. Very helpfu & repairing
		◎ 10. Application of a hand-made hydrometer for continuous measuring of RA specific gravity in PA-1.	VII 3 ii)	10. Used this m convenientl
		◎ 11. Change the method of SF thermocouple in SA-2.	V 2 v)	11. Solved freq problem to c

SECTION 1

...n & Implementation	Ref.No. in this report	Results	(Imple-ment) %	Result
...t of PA-1 instrument panel ...ive use and to avoid the si·uation.	V 3 x)	1. Very fine and big job done by the expert taking almost 2 months.	95	This request (6-a) is vast, obscure and endless item. It was done and felt satisfaction for the efforts.
of PA-1 instrumentation every necessary instrument ... the near future when ... is increased.	V 3 ix)	2. This expansion will be indispensable at that time.		It is regret, most of skilled crews have left the company and this will be a serious problem for TSP complex.
... for SA-1 electrical & ... panel procurement and	V 2 xi) V 2 xii)	3. This will be fully used for the planning as real method.		
...on of SA feeding control ...A-2 (unstable operating ...nt SA leakage were con- ... about half year.)	V 3 ii)	4. Life of this valve will be semi-permanent contrelling quite good.		
...f P-rock feeder frequent ... PA-1 (See 3-b-No.6 also)	V 3 vii)	5. Electric sequence was changed. This has resulted the complete solution.		
...on of concentrated PA ...talizer & indicator for This serves as product ... & moment indicator.	V 3 viii)	6. It was quite successful and convenient.		
...ck & complete cleaning ... portion of saving valve ...rrect indication		7. Done with good result.		
...libration and adjustment ...strument (SA flow, RA flow ...c.)	V 3 iii)	8. Each error is within allowable range of ± 1.0 %.		Calibrations were done from time to time. Good performance is not easy.
...ion of the turbine instru-...nce of SA-2.	V 2 vi)	9. Very helpful for understanding & repairing by TSP staff.		
...n of a hand-made hydrometer ...uous measuring of RA ...ravity in PA-1.	VII 3 ii)	10. Used this method conveniently.		TSP personnel were trained how to apply these ones.
... method of SF thermo- ... SA-2.	V 2 v)	11. Solved frequent burning problem to completely zero.		After modification, the frequency was minimized.

SECTION 2

No. Re-quested	Items	Recommendation & Implementation	Ref.No in this report	Re
6-b	To attend specific main-tenance troubles and traninig to instrument crews	o ◎ 1. The expert actively attended most of troubles to solve them completely.	VI 5	1. Aim of tra ing at act
		Not only main trouble shooting as shown in this report, but also other various troubles which attended by the expert to solve and to train crews on actual job. Also a specific maintenance method was as which is given in this report.	V 5 i)	° Suggestion the causes ° Instructio and check ° Confirmati various ca
		@ 2. Training to instrument crews Class and on job training was held from February 1980 to March 1981 to be understood easily by every attendant crews	VII 2	2. ° Principle ° Principle ° How to cali ° Repairing
6-c	Implementation of new instruments and calib-ration	@ 1. Application of the new type SA control valve (teflon) and detail calibration in PA-2	V 3 ii)	1. See 6-a-4.
		@ 2. Replacement of existing panel of PA-1	V 3 x)	2. See 6-a-1.
		o 3. Planning of new instrumentation system for SA-1 and PA-1	V 2 xi) V 3 xi)	3. These will time of ex
		● 4. Recommendation of new type equipment; Load cell type for P-rock weigher		

SECTION 1

...on & Implementation	Ref.No in this report	Result	Imple- ment %	Remarks
... actively attended most of ...o solve them completely. ...main trouble shooting as ...this report, but also ...ious troubles which attended ...pert to solve and to train ...actual job. ...ecific maintenance ...s as which is given in ...rt.	VI 5 V 5 i)	1. Aim of training by attending at actual troulbe venues ° Suggestion of finding out the causes to crew ° Instruction how to repair and check the cause ° Confirmation of figure by various calibrations	85	
... to instrument crews ... on job training was held ...uary 1980 to March 1981 to ...stood easily by every attendant	VII 2	2.°Principle of pressure gurge ° Principle of thermometer ° How to calibrate & calculate ° Repairing method at venues		
...on of the new type SA control ...flon) and detail calibration	V 3 ii)	1. See 6-a-4.	60	
...nt of existing panel of PA-1	V 3 x)	2. See 6-a-1.		
... of new instrumentation system ... and PA-1 ...ation of new type equipment; ... tvpe for P-rock weigher	V 2 xi) V 3 xi)	3. These will be used at the time of expansion.		

SECTION 2

No. Requested	Items	Recommendation & Implementation	Ref.No. in this report	Result
7-a	Removal of existing constrains in electrical equipment and suggest remedial measure	o 1. Recommendation & implementation for electrical installation of SA plant.	V-2-xii	Panel installat (Wiring is not
		o 2. Recommendation for high temperature rise of motors for SA-1 process water pumps (B & D)	V-2-xiii	The cause was m Rewinding will after.
		⊙ 3. Solution of high temperature of motor for PA-2 crystailizer exhaust fan	V-3-xi	The temperatur bearing decrea 78 °C to about enough to run tinuously for
		o 4. Solution of ball mill 750 KW motor troubles	V-4-v	The temperatur surface temper from about 75 °C. Continuou grinding is pos
		● 5. Pointing out of electric inadequate facilities	V-5-i	During long sh these implemen be carried on
		o 6. Recommendation for electrical spares.	V-5-x	Electrical sp procured on th tion.

SECTION 1

...tion & Implementation	Ref.No. in this report	Result	Imple-ment %	Remarks
...ndation & implementation ...ctrical installation of ...nt.	V-2-xii	Panel installation finished. (Wiring is not yet implemented.)	70	
...ndation for high temperature ...r motors for SA-1 process ...umps (B & D)	V-2-xiii	The cause was made clear. Rewinding will be done hereafter.		
...on of high temperature of ...tor PA-2 crystallizer exhaust	V-3-xi	The temperature of load side bearing decreased from about 78 °C to about 70 °C. It is enough to run the motor continuously for a long time.	-	Condition mainly improved due to the ideas of TSP.
...on of ball mill 750 KW ...troubles	V-4-v	The temperature of the shell surface temperature decreased from about 75 °C to below 62 °C. Continuous running and grinding is possible.		The reduction of balls results 1570 kWh/d power consumption without affecting grinding capacity, but the motor itself should be overhauled to eliminate the cause of overheat problem.
...ng out of electric inadequate ...ties	V-5-i	During long shut down time these implementations are to be carried on step by step.		Complete implementation will take more than 5 years.
...ndation for electrical ...	V-5-x	Electrical spares will be procured on this recommendation.		

SECTION 2

No. Re-quested	Items	Recommendation & Implementation	Ref. No. in this report	Result
7-b	To attend specific main-tenance troubles and train up crews	◎ 1. Please refer to 8-b. ◎ 2. Training • Chemical kinetics for managers, engineers • Mechanical for engineers • Process for operators • Instrument (see 6-b) • Electricity (On actual job)	VII 5	They were so mu[illegible] learn and now th[illegible] some theoretica[illegible]
8-a	Revision of operating manuals	◎ Operating manuals of SA-2, PA-2, TSP-2 were investigated. They are so well prepared that it was proposed to amend only a few points and to list up the important points for easy understanding.	VII 1 vii)	Listing up of im[illegible] is very helpful.

SECTION 1

...on & Implementation	Ref. No. in this report	Result	Imple-ment %	Remarks
...er to 8-b. ...inetics for managers, ... for engineers ...or operators ... (see 6-b) ...y (On actual job)	VII 5	They were so much earger to learn and now they can make some theoretical calculation.	90	Long term training plan is necessary.
...manuals of SA-2, PA-2, ... investigated. They are ...epared that it was proposed ...nly a few points and to ... important points for easy ...ing.	VII 1 vii)	Listing up of important point is very helpful.	70	For plant-I clear manuals are not available.

SECTION 2

No. Requested	Items	Recommendation & Implementation	Ref. No. in this report	Approx. down-t before implementation times av	hrs/ time	aft impl tati time
8-b	Measures for reduction of down time	All of these are result of joint work with TSP member. In every implementations co-work is indispensable. Among these works, only big ones are listed here.				
	Improvement in the consumption of raw materials & utilities.	1. Prevention of complete removal of SF thermocouple burning. SA-1	V 2 v)	4	3	0
		*2. DT one pump running system SA-2	V 2 i)			
		3. Modification of P-rock silo screw motor PA, TSP-2		2	4	0
11	Improvement of increase of on stream day.	4. Introduction of SA feeding control valve PA-2	V 3 ii)	3	3.5	0
		5. Brick lining of premixer bottom TSP-2	V 3 iv)	1.5	30	0
		*6. Solution of dust problem in bagging. TSP-2	V 4 ii)	2	5	1
	(8-b & 11 are as these two are inseparatably combined related each other in many cases.)	7. Oiling to bag, elevator TSP-2	V 4 iv)	12	9	(0.5
		Oiling to Pan conveyor TSP-2	V 4 i)	17	10	(0.8
		(These two are under procurement for renewal.)				
		8. Adjustment and some modification of flow conveyor PA-2, TSP-2	V 3 v)	4	8	0
		9. Solution of ball mill motor overheating by taking out 30% of Balls TSP-2	V 4 v)	20	5	0
	A. The purpose of items with * mark is neither down time reduction nor consumption saving. These profit came out as by-product.	10. Modification of mill-dust collector & recovering method TSP-2	V 4 iii)			
		11. Collection of fine dust before scrubber by dust chamber TSP-2				
		12. Sequence change of P-rock feeder PA-1	V 3 vii)	25	4	[illegible]
	B. Figures in the parenthesis are expected value after completion of all implementation.	13. Introduction of plaloy roller for belt conveyor TSP-2	V 5 ii)	3	7	(0.
		14. Prevention of S,P-rock fly-out at belt conveyor joint-position by modification to slope system				
		After application of this for 3 portions				
	C. Down-time before implementation is the data of 1-3 months before implementation.	15. Collection of effluent slurry PA-1				
		16. Reduction of specific consumption by CV ratio increasing SA-1				
		Reduction of product loss by adjustment of filter water PA-2				
		Total saved loss time & material		Some of down-t overlapped be some troubles simultaneousl		

SECTION 1

	Ref.No. in this report	Approx. down-time per month						Saved material (including assumption)	Expected amount of saving x 10^3 TK/M	imple-ment. %
		before implementation		after implementation		saved time by implementation				
TSP s		times	hrs/time av	times	hrs/time	times	hrs			90
	V 2 v)	4	3	0		4	12			
	V 2 i)							power 31,500 KWH/M x 1.15 TK =	33.0	
		2	4	0		2	8			
	V 3 ii)	3	3.5	0		3	10			
	V 3 iv)	1.5	30	0		1.5	45			
-2	V 4 ii)	2	5	1	5	1	5	TSP 3.5 T/M x 4,350 TK =	15.2	
	V 4 iv)	12	9	5 (0.5)	9	4	63			
	V 4 i)	17	10	8 (0.5)	10	9	90			
	V 3 v)	4	8	0.5	8	3.5	28	P-rock 1 T/M x 1,800 TK =	1.8	
by	V 4 v)	20	5	0		20	100	Power 32,000 KWH/M	33.6	
	V 4 iii)							P-rock 2 T/M	3.6	
by								P-rock 8 T/M	(14.4)	
	V 3 vii)	25	4	2	4	23	92			
	V 5 ii)	3	7	(0.5)		(2.5)	17			
conveyor system								S-rock 1 T/M x 4,200 =	4.2	
								P-rock 2 T/M x 1,800 =-	3.6	
								(S. 3T/M P. 4T/M)	(19.8)	
								30% PA 7 T/M x 1,700 =	11.9	
ratio								SA 5 T/M x 2,740 =	13.7	
of								30% PA (4 T/M)	(6.8)	
		Some of down-time are overlapped because some troubles occur simultaneously.				79	470		112.8 (+41.0)	

SECTION 2

No. Re-quested	Items	Recommendation & Implementation	Ref.No. in this report	Result
9-a	Improvement of maintenance of bulk handling vehicles & suggest improved vehicles	◎ 1. Preparation of daily & monthly check list to be used customarily & conveniently ◎ 2. Suggestion at repairing work of hydraulic gear pump and adjustment of every spare parts. o 3. Preparation of all necessary document such as operation manuals, serve manuals, parts list o 4. Procurement of modern shovel loader (grant is applied for)	V 5 v)	1,2 Completed we troubles are but long tra necessary fo 4. List of appli nese grant is
9-b	Improvement of the constraints in the conveying system. Suggest remedies and replacement	◎ 1. Investigation for each conveying system. o 2. Detailed recommendation for new systems, i.e., belt-quality, vulcanizer, plaloy roller, etc. ● 3. Preparation of basic specification for new jetty unloading system and cost estimation. o 4. Replacement of pan conveying system to another system ◎ 5. Adoption of oiling system to elevators and pan conveyors	V 5 ii) V 5 iii)	1. Checked & lis spec. 2. Very long li by new system 3. This will be tender docum 4. Plaloy is now ment 5. Troubles decr more
10-a	Preventive maintenance formulation, improvement of existing system, reduction of unscheduled shut down	◎ 1. Organization of PM section by some re-arrangement of existing system to responsibilities. o 2. Instruction to operators to take part in minor mechanical works such as lubrication, cleaning of equip and instruments, etc. o 3. Adjustment of all stand-by machinery ready to run and preparation of suitable parts and tools. ◎ 4. Research for debottlenecking method about frequently broken portions and detection of weak point.	VI 3	1. This system h 2. Rather long t necessary in this system 3. Gradually ma improved. 4. Considerably improved.

SECTION 1

·n & Implementation	Ref.No. in this report	Result	Imple-ment %	Remarks
:. of daily & monthly check used customarily & con- at repairing work of :ear pump and adjustment ·are parts. :. of all necessary document :ration manuals, serve :rts list :t of modern shovel loader :pplied for)	V 5 v)	1,2 Completed well and actual troubles are decreasing but long training will be necessary for completion. 4. List of application for Japanese grant is submitted.	75	Procuremnet action will be taken up of the grant is available.
:ion for each conveying :commendation for new .e., belt-quality, :, plaloy roller, etc. .:. of basic specification :ty unloading system and :ation. :: of pan conveying system r system ·f oiling system to elevators :nveyors	V 5 ii) V 5 iii)	1. Checked & listed up each spec. 2. Very long life is expected by new system. 3. This will be used as world tender document. 4. Plaloy is now under procurement 5. Troubles decreased to 1/4 or more	70	On the other hand, it is being tried to introduce new lifting and stocking system of finished TSP product under Japanese grant.
:on of PM section by some re- :: of existing system to :lities. :n to operators to take part :chanical works such as :n, cleaning of equip and :s, etc. : of all stand-by machinery un and preparation of arts and tools. or debottlenecking method uently broken portions ion of weak point.	VI 3	1. This system has started. 2. Rather long term will be necessary in order to make this system complete. 3. Gradually many points are improved. 4. Considerably many points are improved.	70	

SECTION 2

No. Re-quested	Items	Recommendation & Implementation	Ref.No. in this report	
10-b	Improvement in the existing system of inventory control	◎ 1. Investigation of existing system and rearrangement of filing and actual stock systems ◎ 2. Procurement of some items showing a good example of arrangement. o 3. Recommendation to keep these in good conditions and in easily under-standable simple system.		1. This work 2. We ha syster examp be st be pr

SECTION 1

..ation & Implementation	Ref.No. in this report	Result	Imple- ment %	Remarks
..gation of existing system and ..gement of filing and actual ..ystems ..ement of some items showing a ..ample of arrangement. ..ndation to keep these in good ..ons and in easily under- ..le simple system.		1. This work was done by joint work with TSP staff. 2. We have shown the instrument system of Plant-2 as good example. Many parts are to be stored and some more must be procured.	70	

SECTION 2

Table III-2 TSP TEAM DURATION (MM= Man-

Name	Assignment	Duration (Figure above line = M.M
		1979: 10 11 12 / 1980: 1 2 3 4 5 6 7 8 9 10 11
T. Ikeya	Team Leader Process	8 17/30 (261) 20 — 6; 6 24/30 29 —
Y. Fujiki	Mechnical	8 11/30 (255) 11 — 21; 17 —
K. Araya	Instrument	7 6/30 (219) 23 — 28; 3 26/30 (118) 27 — 22
H. Matsunami	Instrument	
K. Aratani	Mechanical	6.00 (182) 20 — 19
T. Endo	Process	3 2/30 (94) 23 — 24; 1 19/30 (50) 20 — 8
H. Ito	Process	1 18/30 (49) 4 — 21
I. Sarashina	Process	
M. Akiba	Electrical	
TOTAL		

SECTION 1

:M DURATION (MM= Man-Month)

igure above line = M.M. ( ) = Man Day)

1980 6	7	8	9	10	11	12	1981 1	2	3	4	5	6	7	8	9	10	11	Total M.M.	Total Day
		6 29			$6\frac{24}{30}$	(205)			21	20		$7\frac{10}{30}$	(224)				29	$22\frac{20}{30}$	690
			21	17	$6\frac{6}{30}$		(188)			22	15	$6\frac{16}{30}$	(199)				29	$21\frac{2}{30}$	642
27	$3\frac{26}{30}$		(118)	22														$11\frac{2}{30}$	337
					21	$4\frac{8}{30}$	(128)		28	20	$4\frac{21}{30}$	(143)			9			$8\frac{29}{30}$	271
							1	4.00 (120)			31							10 0	302
(50)	8				$1\frac{9}{30}$ 21	29 (39)												6 0	183
	$1\frac{18}{30}$ (49)	4	21															$1\frac{18}{30}$	49
										20	$1\frac{21}{30}$ (52)	10						$1\frac{21}{30}$	52
															8	$2\frac{22}{30}$ (83)	29	$2\frac{22}{30}$	83
																		$85\frac{24}{30}$	2,609

SECTION 2

Table III-3 DETAILS FOR JAPANESE GRANT FOR TSP COMPLEX

Name of Equipment	Name of Manufacturers	Specification	No. of Unit
1. TCM Tractor Shovel with Backhoe Attachment	TOYO UMF[illegible]NKI CO., LTD.	1) Model STD 15, W/Backhoe, steel cabin	2
		2) Spare tires with Rim (1 unit 4 pcs.)	2
		3) Spare Bucket Type No.3	2
		4) Recommendable Parts for 2 Years	2
		Total	
2. Baggage Conveying System (Portable wood conveyor for finished TSP stacking and lifting)	Maker HOKUSHO CO.,LTD. Agency SEIWA-SANGYO KAISHA, LTD.	1) Type PL-70 (for level) 7m length	1
		2) PU-70 (for level & slope) 7m length	3
		3) CS-306 (for turn)	1
		4) Dust cleaner (HITACHI GS/2200)	1
		5) Cord reels & other attachments	1
		Total	
3. Plain Paper Copier Canon NP-60	Maker CANON CO.,LTD. (Agency, IIZUKA SHOJI)	1) Model NP-60	1
		2) Toner (6 bottles/carton x 8 cartons)	1
		3) Premix (6 bottles/carton x 25 cartons)	1
		4) Others 8 items	[illegible]
		Total	
4. Acid Proof Pump (MAZDA Co. is now re-searching for long life. So cost will be somewhat altered.)	MAZDA seisakusho NISSAN engineering Ltd.	1) AT, DT Pump for MAZDA pump AT : Illium-G, DT : Pilomet-11	2
		2) Centrifugal 3 inch pump OJIRON, 550/min.	1
		Same spare parts 4 items x each 3 pcs.	[illegible]
		Total	
5. Carrier Roller for Belt Conveyor (Resin made plaloy roller)	NISSAN Chemical Ind., Ltd.	1) Carrier Roller 90N 750 (750 width)	11[illegible]
		Bracket	3[illegible]
		2) Carrier 90N 600 (600 width)	11[illegible]
		Bracket	3[illegible]
		3) Carrier 90N 500 (500 width)	11[illegible]
		Bracket	3[illegible]
		Total	
6. Acid Conductivity Meter (H_2SO_4 99.5-96.5 %)	DENKI KAGAKUKEIKI (Agency KONAN Trading Co.)	1) Recording Controller, model 4641. 5550 (YEW)	
		2) Conductivity Converter, model MB-32A20	
		3) Detector unit, model MC-61T	
		Total	
		Total - FOB	(x [illegible]
		Expected C&F	(x [illegible]

SECTION 1

	No.of Units	FOB (Japanese Yen) Unit Price	Total (x10³ Yen)
ckhoe, steel cabin	2	6,695,000	13,390
im (1 unit 4 pcs.)	2	300,000	600
No.3	2	120,000	240
s for 2 Years	2	278,150	557
			14,787
vel) 7m length	1	1,000,000	1,000
vel & slope) 7m length	3	1,160,000	3,480
urn)	1	1,040,000	1,040
CHI GS/2200)	1	330,000	330
attachments	1	590,000	590
			6,440
	1	391,000	391
arton x 8 cartons)	1	72,800	73
carton x 25 cartons)	1	183,250	183
		247,740	248
			895
ZDA pump T : Pilomet-11	2	1,750,-00	3,500
pump OJIRON, 550/min.	1	890,000	890
items x each 3 pcs.	1	695,000	1,135
			5,525
750 (750 width)	116	13,926	1,616
	30	9,140	274
0 width)	116	11,950	1,387
	30	8,071	242
0 width)	116	10,750	1,247
	30	7,706	231
			4,997
r, model 4641. 5550 (YEW)	1	631,600	632
ter, model MB-32A20	1	421,100	421
l MC-61T	1	652,700	653
			1,706
OB	(x 1,000 YEN)		34,349
C&F	(x 1,000 YEN)		40,000

A) Total FOB (x 1,000 YEN)

1) 14,786
2) 6,440
3) 895
4) 5,525
5) 4,997
6) 1,706

Total 34,349

Excluding Freight charge and trading company charge of Japan

B) Total C&F

C&F will amount to about 40 million Yen

This will be estimated after being determined by Japanese Government.

C) Upto present step, this estimation of 6 equipments is done by Nissan Chemical Industries, Ltd. in Japan.

IV. Improvement of the Plant Performance

1. Total TSP Production

Total TSP production from 1974 to 1981 (budgetary year: July to June) is repeated below. Taking the total plant capacity of TSP-1 and 2 as 152,000 MT/year, capacity utilization rate is calculated.

	MT TSP	%
1974 - 1975	32,850	21.4
1975 - 1976	40,690	26.4
1976 - 1977	38,000	24.7
1977 - 1978	41,270	26.8
1978 - 1979	62.290	40.5
1979 - 1980	71,120	46.2
1980 - 1981	71,461	46.4

It is clearly observed that recently the capacity utilization rate has increased remarkably, but those absolute figures are extremely low for a chemical plant and hereafter the causes of this low production rate, are analysed.

As reference, monthly production of sulphuric acid, phosphoric acid and TSP since the team started service is given in Table IV-1.

2. Shut-down from Raw Material Shortage and Product Non-lifting

Table II-3 shows the number of plant shut-down days from 1975 to 1981 for raw material shortage and high inventory level of product TSP. Raw material is classified into phosphate rock and sulphur.

Regarding raw material shortage, probably many causes will be existing for this, i.e., shortage of foreign currency, shortage of material with the suppliers especially for sulphur, rapid price increase and hard negotation in this regard, difficulty of arranging ocean vessel, etc. It is clear that BCIC and TSP management are trying their best in solving problem and the expert team also tried to help them. Anyway, this problem is beyond control of the management assistance team.

There are also many reasons for poor lifting of the product. Poor transportation capacity, poor disbribution channel for farmers, less preference of farmers for powder form of product, high production cost in comparison with imported fertilizers, etc. Granulation plant is going to be installed in near future and product type problem will be solved.

The biggest influence on high production cost is attributed to high cost of imported raw materials as mentioned in Chapter II Section 4-C). This can be helped to some extent by keeping high operation rate, but it cannot be expected because low operation rate will not be the largest reason for high production cost. Anyway, TSP management and the team member tried to increase storage capacity for both bagged and bulk product, but often the plant was forced to shut-down for high inventory level.

3. Adjusted Production Rate

The shut-down mentioned in the above Section 2 is caused from the reasons which have no relation with plant performance and this is beyond the control of the assistance team. To know the actual plant performance, it will be advisable to recalculate the production rate by excluding the shutdown days for such reasons.

Taking 330 days/year as normal stream day of the plant and deducting shut-down days for raw material shortage and product non-lifting for each from 330 days, adjusted stream days are calculated, and multiplying normal daily capacity to this adjusted stream days, adjusted yearly plant capacity is calculated. Adjusted production rate can be calculated from actual yearly production and adjusted yearly plant capacity as follows:

Year	Adjusted stream days	Adjusted capacity T/Y	Production T/Y	Adjusted Production rate
1975 - 76	269 days	124,000	40,690	32.8 %
1976 - 77	222	102,000	38,000	37.2
1977 - 78	295	136,000	41,270	30.4
1978 - 79	241	111,000	62,290	56.1
1979 - 80	240	110,000	71,120	64.3
1980 - 81	211	97,000	71,461	73.5

From this result, it can be seen that the production of the plant itself was remarkably improved since 1979 - 80 when the team has started the service ad the figure of production rate of 74% is not so awfully bad. Moreover, as can be seen in Table IV-1, when raw material shortage or high product inventory level are foreseen, normally operation rate is lowered intentionally to keep the plant in operation as long as possible. Above table is considered the days when plant is completely shut-down for those two reasons and decrease of the production rate for those reasons were not taken into consideration.

4. Daily Production Record

To know the actual capability of the production, high load operation was tried in May 1981 and the result is shown below:

Plat	Nominal Capacity	Maximum Load Achieved	Achieved Production Rate	Achieved Production Rate after Idle Hour Adjustment
SA-2	400 T/D	344.5 T/D	86.1%	86.1%
PA-2	135	128.5	95.1	95.1
TSP-2	430	403.3	94.0	108.7
SA-1	100	87.3	87.3	92.5
PA-1	32	28.1	87.8	102.5
TSP-1	100	84.6	84.6	105.1

The detailed data of this high load operation is given in Table IV-2. As can be seen in this table, some plants must be stopped during high load test runs. Production rate after idle hour adjustment means the production rate under the assumption that the plant was operated without stop, i.e., the real possible plant capacity when there is no plant trouble.

As can be seen from these figures, each plant can be operated almost satisfactorily except for sulphuric acid plant, when there is no plant trouble. The main reason for low production rate of SA-2 was due to the pressure drop of the total plant, which was as high as 2,600 mm Aq, but from this pressure drop, 350 mm aq was reduced by cleaning of gas filter and demister and now better production rate is expected.

5. Other Problems

As mentioned above, the plant performance was improved technically since the team has started the service but the situation of the plant operation is still not satisfactory from various reasons. The biggest two reasons are raw material shortage and non-lifting of the product about which was mentioned before. The non-lifting problem is quite serious and the expert team sincerely hope that this problem will be solved by installing the granulation plant.

Besides, there are some important problems which are not directly related with the activity of the team but has great influence to the operation of the plant. Such problems are described briefly below:

i) Instability of employment

Many workers as well as engineers and technicians are apt to quit BCIC when they are trained and accumulate experiences. They want to go abroad, especially to Middle East, looking for higher salary.

To maintain sound plant operation, experienced and skilled employees, especially mechanical and instrument technicians, are indispensable. But under such circumstances BCIC always train new employeed without any contribution in improving the technology level of their employee and some measures to stabilize the employment must be undertaken.

ii) Morale of the workers

Contrary to the busy and responsible work of managers and top management, it was felt that morale of some

general workers in their daily work is not satisfactory. This may be related with the phenomena mentioned in i) above, i.e., many people are working considering only to move to another job looking for better working condition. The same measure could be taken to solve these two problems i) ii).

iii) Difficulty in procurement

Spare parts are consumed day by day in chemical factory and the team recommended modern inventory control system. The consumed spare parts must be filled up at once, the procurement in BCIC does not proceed smoonthly. It takes a very long time to procure, and sometimes wrong material or parts of other producer's machines are procured.

This causes big trouble to the plant operation. For example, very large number of instruments are not in operation for lack of necessary parts or spare sets and the plants are operated in blind condition.

This may be again due to shortage of foreign currency, but it will be indispensable to solve this problem to maintain sound plant operation.

Table IV-1 Monthly Production (from Oct. 1979 to

Year	Month	SA-1 Product(T)	SA-1 load %		PA-1 Prod. (T)	PA-1 load %	TSP-1 Prod. (T)	TSP-1 load %	SA-2 Prod. (T)	SA-2 load
[Capacity (T/D)]		[100]			[32]		[100]		[400]	
1979	11	316			89		521		-	
	12	-			-		-		4,352	
Total (year)		10,929	( )=only run time		3,132		9,591		54,790	( )= run t
1980	1	1,155	37.3	(77)	348	35.1	1,008	32.5	8,497	68.5
	2	1,859	64.1	(78)	519	55.9	1,542	67.5	8,608	74.2
	3	1,111	35.8	(76)	410	41.3	1,250	40.3	7,571	61.1
	4	-	-	-	-	-	-	-	-	-
	5	2,015	65.0	(68)	517	53.9	1,596	51.5	4,251	34.3
	6	2,333	77.8	(87)	511	52.1	1,806	60.2	10,140	84.5
	7	1,697	54.7	(86)	477	48.1	1,496	48.3	7,389	59.6
	8	541	17.5	(81)	123	12.4	361	11.6	1,006	8.1
	9	-	-	-	-	-	-		1,213	10.1
	10	1,302	42.0	(69)	356	35.9	1,033	33.3	8,997	72.6
	11	797	26.6	(81)	206	21.5	616	20.5	7,099	59.2
	12	2,794	90.1	(94)	749	75.5	2,280	73.5	7,811	63.0
Total (year)		15,604			4,216		12,988		72,582	
1981	1	2,249	72.5	(81)	489	49.3	1,667	53.8	5,771	46.5
	2	-	-		-		-		-	
	3	-	-		-		-		-	
	4	1,001	33.4	(70)	258	26.9	692	23.1	6,355	51.3
	5	1,744	56.3	(82)	402	40.5	1,283	41.4	8,226	68.9
	6	196	6.5	(77)	346	36.0	1,096	36.5	8,108	67.6
	7	207	6.7	(68)	-	-	-	-	3,277	26.4
	8	1,885	60.8	(80)	207	20.9	598	19.3	2,011	16.2
	9	2,027	67.6	(77)	454	47.3	1,598	53.3	7,974	66.4
	10	2,025			224		629		7,367	

SECTION 1

SA = 100% acid
PA = 100% P_2O_5
TSP = Green TSP
Load % = Prod/(T-day.cap)

...nthly Production (from Oct. 1979 to Nov. 1981)

TSP-1 ... (T)	TSP-1 load %	SA-2 Prod. (T)	SA-2 load %		PA-2 Prod. (T)	PA-2 load %	TSP-2 Prod. (T)	TSP-2 load %	Remarks
...]		[400]			[135]		[430]		
...521		-			-		-		Rehabilitation
-		4,352			1,403		3,654		1/10 - 4/12
...591		54,790	( )=only run time		17,900		54,874		
...008	32.5	8,497	68.5	(73)	2,909	69.5	9,107	68.3	
...542	67.5	8,608	74.2	(79)	2,682	68.5	8,420	67.5	
...250	40.3	7,571	61.1	(73)	2,284	54.6	6,974	52.3	P-rock shortage
-	-	-	-	-	-	-	-	-	26/3 - 17/5
...596	51.5	4,251	34.3	(75)	2,036	48.6	5,509	41.3	
...306	60.2	10,140	84.5	(91)	3,310	81.7	10,743	83.3	
...496	48.3	7,389	59.6	(65)	2,057	49.2	6,004	45.0	
...361	11.6	1,006	8.1	(51)	285	6.8	1,336	10.0	Lifting shortage
-		1,213	10.1	(63)	728	18.0	1,786	13.8	5/8 - 25/9
...033	33.3	8,997	72.6	(75)	2,619	62.6	8,147	61.1	SA-1, AT.DT repairing
...616	20.5	7,099	59.2	(64)	2,236	55.2	7,025	54.5	18/11 - 2/12
...280	73.5	7,811	63.0	(65)	2,547	60.9	7,068	53.0	
...988		72,582		(66)	23,693		72,121		
...667	53.8	5,771	46.5	(58)	1,746	41.7	6,747	54.4	
-		-			-		-		Sulfur shortage
-		-			-		-		27/1 - 2/4 (TSP-II) - 23/4 (I)
...592	23.1	6,355	51.3	(63)	2,829	69.9	8,520	66.0	
...283	41.4	8,226	68.9	(79)	2,731	65.3	7,446	55.9	
...096	36.5	8,108	67.6	(73)	2,955	73.0	10,076	78.1	SA-1 Boiler leakage
-	-	3,277	26.4	(68)	1,118	26.7	3,221	24.2	Lifting shortage
...598	19.3	2,011	16.2	(75)	655	15.6	1,298	10.5	15/7 - 22/8
...598	53.3	7,974	66.4	(71)	2,640	65.2	7,997	62.0	
...529		7,367			2,081		6,702		

SECTION 2

Table IV-2 High Load Operation Result

Plant	SA-2 (400 T/D)			PA-2 (135 T/D)			TSP-2 (430 T/D)			
1. Date (May, 1981)	7	8	9	25	26	27	19	20	21	
	(Measured at 11:00 AM)									
2. Storage tank A (ton)	1,022	1,362	1,445	30% tank level						
				350t	300	273	P-rock consumption			
Difference D_1		340	83	(Δt_1)	-50	-27	173.3	138.0	135.0	
Storage tank B (ton)		290	555	as 100% ($\Delta t_1'$)	-14.0	-7.5				
Difference D_2		-	265							AT
Storage tank C	DT-PT 46%	50	50	50% tank level						11.
				386t	515	630	CPA consumption			11
Difference D_3	(%x1.57)	+6.3	± 0	(Δt_2)	129	115	471.6	375.7	367.5	10..
Storage tank E (ton)	AT-PT 47%	50	50	50% acid sent						Ave
Difference D_4	(%x1.62)	+4.9	± 0	(Δt_3)	162.5	150.4				(10.
				$\Delta t_1'+(\Delta t_2+\Delta t_3)\times 0.5$	131.8	125.2				e. T/ x
3. Total Production (Z) T/D	$(D_1+D_2) \times 0.985 + D_3 + D_4$			in 50% plant						
		346.1	342.8		131.8	125.2	471	375	367	
	(av. 344.5)			(av. 128.5)			(av. 404.3)			
4. Production Rate %		86.5	85.7		97.6	92.7	109.5	87.2	85.3	
	(av. 86.1)			(av. 95.1)			(av. 94.0)			
5. Idle hrs (x hrs)		0	0		0	0	4.7-4	8.7-4	8.5-4	
							(4hrs are regular stop hour			
6. Production rate after idle hour adjustment (Z/cap) x 24/(24-X)		86.5	85.7		97.6	92.7	112.8	108.4	105.0	
	(av. 86.1)			(av. 95.1)			(av. 108.7)			

SECTION 1

	TSP-2 (430 T/D)	SA-I (100 T/D)	PA-I (32 T/D)	TSP-1 (100 T/D)
	19 20 21	24 25 26	24 25 26	15 16
.5 .4 .2	P-rock consumption 173.3 138.0 135.0 CPA consumption 471.6 375.7 367.5	Production is measured from increase of PT level during 30 min. repeated 3 times. 1cm = 149kg (AT), 30kg OT PT level increase (cm) 24: AT 11.5, 11, 10.25; OT -, 12.5, 13 25: AT 9, 10.5, 9.25; OT 13, 13.5, 13 26: AT 9.5, 9.25, 9.25; OT 12, 12, 14.3 Average (10.8 8.5) (9.6 13.2) (9.3 12.8) e.g., $T/D = (10.8 \times 0.149 + 8.5 \times 0.03) \times \frac{24}{0.05} = 89.47$ T/D on May 24th, 1981	In this plant production calculation was based on P-rock feed (t/d). This rock should be charged 104 t/d as 100% load. P-rock consumption (t/d) 98.90 85.52 89.64	By each counter
.2	471 375 367 (av. 404.3)	89.4 87.6 84.9 (av. 87.3)	30.4 26.3 27.6 (av. 28.1)	84.6 84.5 (av. 84.6)
.7	109.5 87.2 85.3 (av. 94.0)	89.4 87.6 84.9 (av. 87.3)	95.1 82.2 86.2 (av. 87.8)	84.6 84.5 (av. 84.6)
	4.7-4 8.7-4 8.5-4 (4hrs are regular stop hours)	1.8 2.1 0	1.8 4.7 3.7	8.6-4 8.8-4 (4hrs are regular stop hours.)
.7	112.8 108.4 105.0 (av. 108.7)	96.6 96.0 84.9 (av. 92.5)	102.8 102.2 102.4 (av. 102.5)	104.6 105.6 (av. 105.1)

SECTION 2

[Remarks for reasons

Table IV-3 Production, Plant Shut-down Hours and Their Reasons for September 1981

Date	SA-2			PA-2			TSP-2			SA-1		
	Prod. T/D	Idle hr	Reason	Prod. T/D	Idle hr	Reason	Prod. T/D	Idle hr	Reason	Prod. T/D	Idle hr	Reason
1	282			91.0			420.3	7.5	W	75.8		
2	242	4.8	L	88.5	8.3	O	178.5	17.0	E	79.3		
3	273			111.0	6.3	W	330.1	11.1	W	65.2	3.3	L
4	300			134.5	7.0	W	380.4	9.1	M	75.7		
5	270			98.0	18.3	W	199.7	16.4	W	72.7		
6	300			70.0			276.3	13.2	W	64.1	7.5	P
7	235	5.5	L	93.5	6.7	O	318.8	11.5	W	61.5	5.1	E
8	220	5	E	135.5	11.7	M	293.3	11.5	W	65.3	3.8	O
9	300			129.5	3.2	O	336.2	11.9	C	10.0	19.3	W
10	300			93.5	1.5	W	249.4	15.3	W	32.1	13.5	M
11	291			62.5	19.5	W	384.8	10.5	W	74.8		
12	270			127.0	9.5	O	355.3	10.5	W	50.9	7.9	E
13	276	2.4	P	118.0	0.5	P	357.0	10.0	W	75.6	0.3	P
14	300			83.5	13.5	W	346.6	10.7	C	73.2	0.7	E
15	300			42.0	18	M	108.4	19.7	M	38.4	10.6	W
16	300			79.5	4.3	L	182.8	16.8	W	84.6	0.2	P
17	270			106.0			263.5	13.7	W	84.5		
18	250	1	M	132.0	8.3	O	393.1	8.6	P	83.7		
19	309			61.5	11	W	165.8	17.5	W	84.9		
20	276	0.9	P	138.5	6.3	W	350.1	10.3	P,W	74.0	2.6	P,L
21	208	7.8	P	25.0	17.1	P	63.8	21.5	P	55.2	6.5	W,P
22	170	7	W	77.0	10	W	233.7	14.8	W	80.0		
23	276			-	24	W	51.0	22.0	M	78.1		
24	288			49.5	3.5	L	172.0	17.3	W	77.3		
25	276			126.0	8.7	W	405.9	7.1	C	62.1	4.9	L
26	276			125.0	7.3	W	401.6	8.3	W	77.6		
27	140	10.2	P	86.5	11.0	P	233.9	14.8	P	35.7		
28	276			71.5	12.0	W	295.4	12.1	C	80.8		
29	270			84.0	8.1	M	142.5	19.0	W	82.4		
30	230	2.0	P	-	24	W,P	6.3	23.2	P,M	71.6	1.6	P
	7,974	46.6	(16.3hrs) (97.6%)	2,640	279.6	(81.6hrs) (84.4%)	7,997	389	(92.1hrs) (78.2%)	2,027	83.8	(40.5 (94.

( ) Idle hours excluding waiting and power failure and % is the operating rate based on this idle hou

SECTION 1

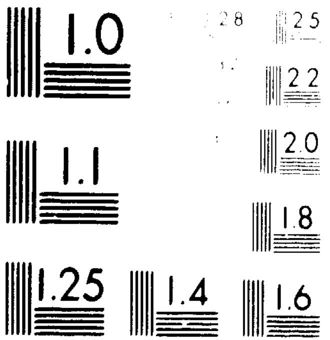
ptember 1981

[Remarks for reasons] L : Leakage
E : Electrical and instrument
P : Power failure
W : Waiting due to full storages
M : Mechanical
C : Cleaning
O : Others

TSP-2		SA-1			PA-1			TSP-1			Lifted Bagged TSP T/D
Idle hr	Reason	Prod. T/D	Idle hr	Reason	Prod. T/D	Idle hr	Reason	Prod. T/D	Idle hr	Reason	
7.5	W	75.8			26.0	2.6	C	78.8	15.3	W	267
17.0	E	79.3			16.0	2.0	C	64.5	16.8	M,W	290
11.1	W	65.2	3.3	L	27.0	2.4	L	89.6	14.3	C,W	246
9.1	M	75.7			23.5	8.3	C	69.9	16.3	W	284
16.4	W	72.7			-	9.4	P,W	11.3	22.7	W	249
13.2	W	64.1	7.5	P	7.0	11.5	W	28.6	21	W	-
11.5	W	61.5	5.1	E	8.5	13.6	L	37.5	19.8	W	-
11.5	W	65.3	3.8	O	19.1	12.5	M	31.5	20.5	W	153
11.9	C	10.0	19.3	W	21.0	0		87.8	14.3	W	243.5
15.3	W	32.1	13.5	M	15.5	10.0	C,W	54.0	18	W	-
10.5	W	74.8			-	23.0	W	-	24	W	209
10.5	W	50.9	7.9	E	5.5	3.0	P	-	24	W	-
10.0	W	75.6	0.3	P	19.5	8.7	W,P	58.5	17.5	W,P	-
10.7	C	73.2	0.7	E	16.8	8.6	E	63.0	17	W	-
19.7	M	38.4	10.6	W	11.9	8.8	W	40.5	19.3	W	-
16.8	W	84.6	0.2	P	26.8	0.7	O,P	68.2	16.4	W,P	372
13.7	W	84.5			24.8	2.3	C	69.8	16.3	W	527
8.6	P	83.7			27.0	0.6	E	33.8	20.3	W	249.5
17.5	W	84.9			17.5	9.0	W	126.0	6.0	W	344
10.3	P,W	74.0	2.6	P,L	13.2	3.5	P	27.0	21.0	W,P	318
21.5	P	55.2	6.5	W,P	14.8	10.5	P	57.8	17.6	W	4
14.8	W	80.0			7.5	11.7	W	18.0	22.0	W	123
22.0	M	78.1			27,6	3.8	M	97.5	17.2	W	337
17.3	W	77.3			17.1	3.3	C	47.3	18.7	W	295
7.1	C	62.1	4.9	L	15.8	2.6	L	24.8	21.3	W	95.5
8.3	W	77.6			12.0	20.8	W	69.8	16.3	W	-
14.8	P	35.7			-	18.4	W	-	24	W	-
12.1	C	80.8			9.5	5.8	C	9.0	23	W	57.5
19.0	W	82.4			19.5	7.4	W	81.0	15	W	-
23.2	P,M	71.6	1.6	P	10.6	8.5	W,P	57.0	18	W	-
389	(92.1hrs) (78.2%)	2,027	83.8	(40.5hrs) (94.0%)	453.5	233.3	(63.4hrs) (37.7%)	1,598	550	(15.6hrs) (91.6%)	4,609

operating rate based on this idle hours.

SECTION 2


1.0
2.8
2.5
2.2
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1.1
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1.25
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1.6

V. Recommendation and its Implementation

1. General

Detail of the recommendation and their implementation which the team has made is described from this chapter on.

Main recommendation is listed in Table II-2 and in general this can also be classified as follows:

A) Increase of the Equipment Life

1) Protection of equipment from corrosion

Sulphuric acid plants were suffering from corrosion by acid mist accompanied by gas, but the situation was remarkably improved by modification of the mist separation method. It is believed that the plant life is now extended from four to five years under previous conditions to the normal life of more than 10 years.

2) Correct assembly for rotary equipment

Correct assembly of rotary equipment is the basis for good plant maintenance, and the life of equipment depends on the assemblage. Improper assembly was often found in the plant and the expert devoted to correct those and to instruct the workers how to assemble correctly on the job training.

Following items are large equipment of which assemblage was corrected.

- o SA-2 air blower bearing
- o PA-1 vacuum pump
- o TSP-2 Motor of ground rock cyclone screw
- o PA-2 exhaust fan of premixer, digester
- o PA-1 screw conveyor circuit system
- o Shovel loader, crane

3) Introduction of new equipment and new idea

By application of new idea or equipment, plant life can be greatly extended. Applied examples are as follows:

- o Shortening of the length of thermo-couple of sulphur furnace in SA-2. Almost daily burning out could be prevented.

- o Adoption of teflon material for sulphuric acid control value of PA-2. Almost no replacement will be required from now.

- o Application of brick lining for premixer bottom of PA-2 to prevent erosion.

- o Adoption of new material for pump impellers of SA-2. (Not yet implemented)

- o Application of Plaloy roller for belt conveyor rollers. (Several were used as trial and now under procurement.)

- o Guidance of hand made tool, e.g. hydrometer, manometer

4) Prevention from dust and rain

By improving conditions of plants, equipment, instrument, etc., against dust and water, their life will be prolonged.

o	TSP-2	dust collecting and oiling to pan conveyor
o	Bagging-2	adjustment of bag filter dust collect system
o	SA-2	roof setting to S.F. outlet against rain
o	PA-1	motor protection from drain falling

B) Debottlenecking of the Plants

Plant performance was remarkably improved by debottleneckings such as:

- o Prevention of over heating of TSP-2 ball mill motor by reduction of ball weight by 30%, resulting in power saving of 1,570 KWH/D.
- o Modification of pan conveyor system of TSP-2.
- o Establishment of phosphate rock constant feed system in TSP-2 and PA-2 using rotary valve system.
- o Shifting of SA-1 and PA-2 electrical and instrument panel.
- o Efficiency increase of SA-1 acid cooler.

- o Electrical modification of PA-1 phosphate rock weigher system
- o Modification of PA-1 flush cooler by addition of overflow line.
- o Modification of TSP-2 cone mixer.
- o Modification of belt conveyor conjunction point to prevent material scatter.

C) Recovery of Original Function by Reconditioning

Some machinery and equipment could resume their original function by reconditioning:

- o Bag filter of bagging machine-2
- o Concentration plant of PA-2
- o Reduction of gas flow resistance in SA-2
- o Calibration of instruments in PA-2

D) Establishment of various systems

- o Rationalization of unloading system
- o Simplification of procurement system
- o Establishment of new inventory system of spare parts and material
- o Establishment of vehicle checking system

- o Improvement of preventive maintenance system

- o Formation of task force team for production, planning, designing, etc.

E) Others

- o Application of foreign grant for procurement of new equipment

- o Consultant for future project such as synthetic detergent using SO_3 gas, purified sulphuric acid, DAP and nitro phosphate fertilizer, etc.

- o Assist for new design of unloading system in Jetty.

2. Sulphuric Acid Plants (SA-1, SA-2)

A) Solution of Acid Entrainment Problem for All Equipment (SA-2)

1) Influence

Air for SA plant comes from DT (drying tower) after drying goes to SF (sulphur furnace).

When air passes through DT, acid fume and entrainment passes to SF and all other equipment, if acid flow is insufficient or not properly distributed.

These acid fume and insufficiently dried air make big harm resulting in corrosion. Of course, equipment life is extremely shortened.

This acid entrainment was found and Manager specially requested also to solve this phenomenon.

These problems are not easy to solve, but it was promised by the expert to solve within one month.

2) Solution Method

Also see APPENDIX V-1.

a) Check of pump capacity and acid flow rate. Actually this measurement is very difficult, but it must be checked by some method from time to time to maintain sound operation. The expert suggested a method to check and calculate by pump-tank level down from the moment of pump starting to the moment of acid coming back through cooler and tower.

Only 2.5 minutes was available, and this short time is fully utilized to measure the pump capacity in detail and the proper flow volume was obtained.

Proper L/G (Liquid flow/gas flow kg/m^2 hr) is 7 - 10.

As a result, it is recommended to use only one pump (2 pumps were used before at ordinary operation time) which is adequate. This measuring method can also be applied for other plant.

b) Adjustment of acid distribution

It is found that lots of acid jumping from distributor, and acid leakage from 320 holes of pins to fix down-commer to distributor and gap between two troughs. It is suggested to make covers over the distributor, plug some of the holes and blind the gap to prevent such occurrence.

This work was completed and it has brought a very fine result.

3) Result

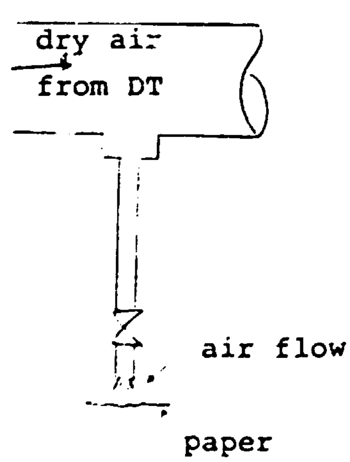
a) Acid entrainment has decreased as shown below.

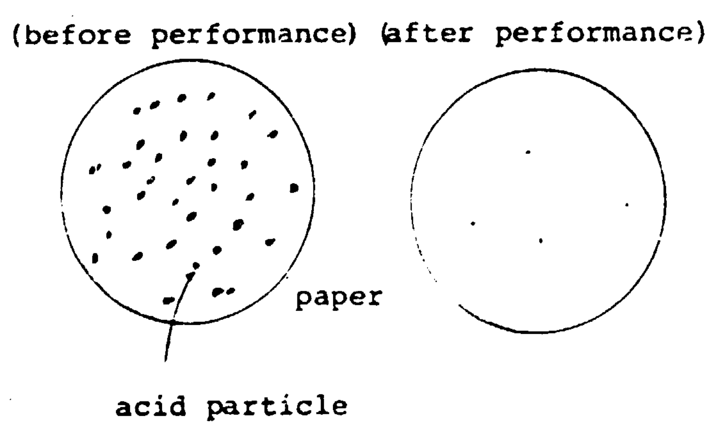
b) Acid drain from each equipments became nil and so the equipments will be maintained well and their lives will be prolonged very much.

c) Additional effect

One pump running has also brought the saving of 35,000 KWH/M power consumption.

Measuring of acid entraining volume by test paper.





B) Prevention of Stack Attack and Effluence

Please refer to APPENDIX V-2.

1) Situation

In spite of relining of the stack inside with cement by rehabilitation team (original plant maker), this lining was gradually collapsed. The complaint was sent to the maker from TSP management, but clear answer did not come back. On the other side, the protect method was asked for the abroad tenders but easy method was not found.

2) Countermeasure

It is recommended as the first action to prevent acid entrainment from AT (absorbing tower). This was the main cause. The drain was not only attacking the stack but also increasing polluted effluents. The drain coming out from the bottom was 12 lit/d. The action was taken to prevent the acid overflowing and leakage from AT acid distributor tray as tried for DT. Especially tray covering and block up of 8 slit made big effect.

3) Result

The stack turned into almost in dry state and no acid comes out through the drain, so the stack is maintained considerably safe. But anyway the collapsed lining should be repaired by acid proof cement or other methods.

C) Correct Arrangement of Main Blower Bearing and Gear Coupling (SA-1, SA-2)

1) Introduction

The air blower in sulphuric acid plant is the most important equipment. During expert's staying time, vibration troubles happened two times, that is, one was SA-1 Blower on 15 Jan., 1981, and the other was SA-2 Blower on 15 Dec., 1980.

2) Solution method

Please refer to APPENDIX V-3.

a) At SA-1 trouble, we assumed some reasons of this trouble.

- o Large bearing clearance (Existing 0.27 > 0.15 standard)
- o Miss assembling of gear coupling (thermal alignment and gear marking)
- o Loosening of set bolts of bearing
- o Unbalance of impeller with dust

The actions were taken by expert on about all these items, and it is presumed that items 1 and 2 were the main cause.

b) At SA-2 troulbe, vibration of No. 4 bearing was increasing gradually, and on 15 Dec. 1980 it became 82 μ. This figure was extremely high, so expert decided to stop the blower for internal inspection of the bearing No. 4. It was found that some fragments of white metal and finally the bottom metal of the bearing was completely broken. The stocked spare bearing was measured and found it was properly machined. So it should be set carefully.

The appropriate preparation of spare parts was the excellent service of TSP maintenance section, and this important and difficult work could be performed without maker's assistance.

The vibration decreased from 82 μ to 25 - 30 μ.

3) Result

At SA-1, the vibration could not be stopped at first, and succeeded at the second time. This work required the highest ability of maintenance work. The significance of these work in SA-1 and SA-2 were so great that the expert did by himself with utmost care. These work may not be called as simple maintenance work, because such work are generally carried out by vendors, but it is quite advantageous that maintenance people can handle such work, too.

D) Trouble Shooting of AT & DT Pumps (SA-1, SA-2)

1) Introduction

In SA-2, "CHS. S. LEVIS" pumps and "MAZDA" pumps, and in SA-1 "LEVIS" pump are used for the circulation of AT & DT acid.

These pumps are vertical type. Sometimes they were stopped from vibration, shotage of discharge quantity and other reasons.

The impeller, shaft sleeve and immersed bearing are attacked by severe corrosion and erosion, and their lives were very short.

2) Solution Method

Please refer to APPENDIX V-4 and V-5.

a) SA-1 AT circulation pump is Levis pump, and all immersed parts of this pump were corroded, damaged, and all spare parts were exhausted. At first, until the spare parts could come, chromium-cast-iron immersed bearing and shaft sleeve was made in BITAC, according to the standard composition of Ojiron. (Nissan Kiko, Japan)

And at that time, it was found by the expert that the center alignment in assembling was not correct and this was one of the reasons of this vibration and corrosion trouble.

The expert instructed the maintenance people to assemble carefully and keep suitable clearances at proper points.

Meanwhile, the pump casing and others which had some holes from corrosion had to be made. To make sketches and design the volute from the corroded casing of the Levis pump was very difficult work, but these new parts made in BITAC are used satisfactorily.

*BITAC = Bangladesh Industrial Technical Assistance Center.

b) MAZDA pumps in SA-2

The shaft of MAZDA pump is centered with two bearings at two points, and there is an immersed bearing that is made of Rulon.

Rulon is Teflon co-polymer and soft, so centering of shaft is very important, but it was found pretty large warp in the assembled body and the shaft itself. Because of the difficulty of assembling the pump in horizontal position, the centering of shaft could not be done precisely, and this poor centering caused excessive vibration of pump.

Also as mentioned below, the impeller was quickly corroded and this was one of the cause of vibration. Due to the vibration of pumps, the immersed bearing and shaft sleeve were broken.

A vertical stand was made for vertical assembling, and the pump could easily be assembled and checked the centering of shaft by dial gauge.

By this method, the life of shaft sleeve and bearing was extended.

The most difficult problem of this pump at present is the erosion and corrosion of impeller made of Carpenter 20, that is attacked by high temperature 98% sulphuric acid. On the other hand, the impeller of Levis pump is perfect against-corrosion. Both pumps were checked and it is found that MAZDA impeller was surely Carpenter 20, and Lesiv impeller was Illium 98 modified.

Checking the recent data in Japan and other countries, it is now recommended to use Illium G or Illium 98 for AT pump and PILOMET-11 for DT pump, because in Bangladesh, where procurement of spare parts is difficult, expensive but durable material is recommendable.

3) Result

Know how to produce Chromium-cast-iron was given to BITAC. This will be very useful for Bangladesh acid industries. (See APPENDIX V-5.)

Countermeasure of MAZDA pump impeller is now in progress and the life of this pump will be completely improved after the new material for impeller is applied. The important parts of Levis pumps are made of high class stainless steel. The shaft is supported by the bearing and shaft sleeve is made of the same material in high temp. acid. So now, there are sometimes seizing troubles in these points and high class stainless parts are broken when they are disassembled.

In future some countermeasures will be necessary for this trouble.

E) Solution of Frequent Burning of SF Thermocouple (SA-2)

1) Situation

When the expert reached the factory in 1979, SF (sulphur furnace) thermocouple was frequently damaged. This is the most important thermometer for the plant and moreover very expensive instrument. Without this meter, operation becomes completely blind and it causes a critical state, so it is a vital problem. It is not clear why this thermocouple was so frequently damaged in this plant.

2) Recommendation

The expert investigated the material and operation condition. This couple has 350 mm length inside SF. It was possible to shorten the length. As this thermocouple was in a big turbulent gas flow (Re = 142,000), it was decided to pull up by 250 mm because the couple element with 100 mm inside SF is sufficient for correct measurement. The modification was completed on 19th Dec. 1979.

3) Result

After its implementation, the result was quite satisfactory. During two years of operation no trouble has occurred and it will continue more in good condition. The expert trusts that this debotlenecking is one of the most important improvement and the effect is quite excellent without any expense.

F) Clarify and Recommendation for Turbine Instrument

Please refer to APPENDIX V-6.

Instrument wiring was checked in May 1981, when false functioning of panel announciator took place. But at that time it was not clear which pressure switch was actuated by what condition and the expert did not have enough time to clarify it.

As it is very important to clarify this, in cooperation with instrument staff, in August 1981 two small sheets of turbine instrument drawings, which were not very clear, were scaled up, and checked the wiring between local panel and central panel and completed turbine instrument diagram.

The turbine trip sequence were checked on 25th of July making a condition to trip, but annunciator of central panel did not work. By keeping on checking, at last it worked by reconnecting the wiring of final relay for annunciator, except overspeed limit switch (this limit switch works mechanically and cooperation of mechanical specialist is necessary to repair it.) Following items must be executed as early as possible.

Followings are the recommendation regarding this problem:

1) All of heat resisting wire (form detector to joint box) should be changed.

2) All of pressure switch and TGA should be checked with regular interval.

3) Stop the leaking out of air of solenoid valve.

4) Magnetic switch of aux. oil pump is very noisy.

5) Bulb of over speed trip lamp is broken.

6) Door hinge of local panel should be repaired.

7) Interlock for electric could not be checked, though, should be cleared.

8) Function that reset bar for overspeed (XS-1102) and XS-1103 should be cleared by discussing with mechanical specialist. There is no bolt and nut of lever which is hitted by over speed pin.

9) TGA of turbine blower is not connected.

G) Minimization of the Noise of Air Cooling Fan (SA-2)

1) Situation

This fan must be used for cooling of HE (heat exchanger No. 2) at above 50% load of SA-2. A very big sound and vibration arose from the suction filter when it was running. This is much annoying to all factory people that everybody was anxious to minimize.

2) Recommendation & implementation

More than 60,000 Nm^3/H air is sucked from air filter which is square type 1.5 m x 2 m and was directly connected to 750 mm diameter duct. It was detected that this was the cause and the expert recommended to modify to cone type connection (1.4/0.75 m dia. 0.8 m length) and it was completely modified.

3) Result

Noise and vibration were minimized so much and people appreciated this result. Also there was some saving in electric power consumption (approx. 5.5 KWH/d). On the other hand, a silencer was installed for PA-2 P-rock conveying air. This noise also reduced to half.

In future design, these methods should be taken into consideration.

H) Load Up Method (SA-1)

1) Situation

In general, SA plant has some allownace for plant capacity even if gas flow resistance (Pressure drop) increases a little. But in SA-1 it has almost no excess. If the resistance of converter and gas filter increases, for example, up to 10%, it is quite difficult to maintain the plant load at design capacity.

This SA-1 is designed to run at high pressure, and operating at 3,200 mmAq. The air blower is run by self-generated steam turbine, so there is limitation to increase gas flow rate.

Of course, the resistance gradually increases in long operation. It can be said that pressure drop increases too rapidly at SA plant in Chittagong due to frequent power failure and poor sulphur quality, and plant capacity decreased to about 85% as it has no extra allowance.

2) Theory and counter measure

Only one way is to increase SO_2 content instead of decrease of gas flow.

a) Capacity (Q) is directly proportional to gas flow rate (W) Nm^3/H and SO_2 content (C),

$$Q \text{ t/hr} = WCE\ 98/22{,}400 \quad (E : \text{efficiency})$$

b) SO_2 content is almost directly proportional to difference between furnace inlet air temp. (t_1°C) and outlet gas temp (t_2°C) as follows: (this is somewhat affected by furnace structure)

$$C = K\,(t_2 - t_1) + B \qquad \begin{array}{l} K : \text{coefficient} \\ B : \text{constant} \end{array}$$

c) Gas flow rate decreases by additional resistance.

d) Method

Please refer to APPENDIX V-7.

In order to compensate the decrease of gas flow rate, (C) should be increased.

Following two steps trial run are expected to be effective to put back C x W at the level of original 100% load operation.

o Step-1: increase of t_2 as much as possible.

- Step-2: decrease of t_1 by cooling of furnace inlet.

	Original basis	Basis for trial run
t_2	950°C	1,020°C
t_1	250	190
$t_2 - t_1$	700	830
C	7.5%	8.9%
W	12,400	10,500
C x W	930	934

3) Result

- Step-1 was successfully taken by increasing only sulphur charge step by step with careful observation.

- Step-2 was conducted by taking off the SF inlet duct insulation which was theoretically unnecessary.

- Approximately 100% load was obtained. Theory is simple, but actual action was quite tough.

I) Self Circulation of Cooling Water (SA-1)

1) Situation

Out of 14 tube wells, 10 have already been abandoned. Therefore, the crisis of water shortage sometimes used to occur.

It is requested to establish the water self-circulation system for SA-1 acid cooler. Two methods are recommended.

2) Specification of cooling tower for procurement

The first recommendation is to establish an off-the-shelf compact cooling tower and its specification is mentioned here for tender inquiry.

a) Purpose. Cooling of water for sulphuric acid cooler by self circulation method.

b) Flow rate of recycled water 150 m^3/H

Cl content of water is approx. 700 ppm.

c) Hot water temperature 45°C

d) Cooled water temperature 33°C

e) Ambient air temperature 30°C (max. 37°C min. 12°C)

Relative humidity 80% (min. 60%)

f) Available space 3 m x 7 m or 7 m x 7 m x 3 m (height)

g) Voltage of power 420 V

h) Required parts
   1) Circulation pump 150 m^3/H x 20 m head
   2) Circulation water strainer
   3) Flow meter 200 m^3/H
   4) pH meter

i) Max. wind velocity 67 m/sec.

j) Max. rainfall 50 mm/Hr

3) Establishment by local engineering

Heat & mass balance, capacity etc. were calculated for the local engineers, shown in APPENDIX V-8. If each material is available, it will also be possible to make it locally.

J) Increase of Acid Cooler Cooling Area (SA-1)

1) Situation

In normal operation, desirable acid temperature of AT (absorbing tower) & DT (drying tower) is below 75°C and 50°C respectively.

But it is difficult in SA-1 plant to maintain these temperature due to the following reasons.

- o Limitation of cooling capacity
- o Corrosion of inside fin of cooling pipe
- o Shortage of tube well cold water

So the temperature of these towers used to attain up to 95°C and 70°C respectively, and sometimes 109°C and 80°C.

At high temperature, 98% acid is very corrosive. For example, new AT acid distributor was corroded within 2 months of operation. Therefore, counter measure should have been taken to minimize corrosion.

2) Recommendation & implementation

Please refer to APPENDIX V-9.

All possibilities were studied and three kinds of case studies were conducted.

a) Installation of new 4 sets of AT acid irrigation cooler

Increase of cooling area: 24 m^2

b) Installation of new 2 units of simple sirocco fan at the bottom of irrigation cooler

Spec. of fan: 43,000 Nm^3/H, 50 mmaq

c) Conversion of 2 sets of SA-2 DT cooler into SA-1 acid cooler.

SA-2 plant has some surplus cooling area, so it is possible for PA-1 to utilize 2 sets of SA-2 only by piping. Cooling area of 2 sets of SA-2 DT cooler is 160 m^2.

In this case, SA-1 total acid will be cooled from 100°C to 82°C. This 82°C acid is cooled to 55°C by SA-1 proper cooler. Case (c) has difficulty to use many cast iron pipe.

The entire surface of existing cooling pipe was cleaned.

3) Result

Case a) was implemented and the temperature of AT and DT acid went down and maintained at 75°C and 65°C respectively since Sept. 1981. These implementation will be also effective to protect all materials against corrosion.

K) Recommendation for Instrumentation of SA-1

The possibility of improvement of instrument panel of SA-1 were studied, and expert team's comments and recommendation are as follows:

1) Temperature measurement in sulphuric acid plant is the most important, but existing temperature measuring system in SA-1 is too poor.

It is strongly recommended that the whole of temperature measuring system in SA-1 should be replaced. If it is difficult, at least temperature recorded and wiring from thermocouple to recorder should be replaced.

- Temperature recorder

Scale range:	0 - 800°C
Type of element:	CA
Period of measuring:	Maximum 60 sec.
No. of measurement:	12 points
Power supply:	AC 100V & 50 Hz

- Compensating wire

Any type but sealed type.

2) 6-points temperature indicator (TI-113) is not necessary. 12-points temperature indicator with selector switch is sufficient. Specification of TI-115 1) & 2) are as follows:

Indicator

Scale range:	0 - 300°C
Type of element:	CA
Power supply:	AC 100 V & 50 Hz

Select switch

No. of selection:	Minimum 12 points
Mounting:	Panel
Contact:	Make before break

3) The conductivity measuring instrument, (which does not contain electrode, made by Denki Kagaku Keiki Co., Ltd. of Japenese equivalent is more suitable for acid analizer than the Solu-meter made by Beckman Instrument Inc. As the instrument made by the former is almost maintenance free. This type of instrument was recommended in January, 1980.

4) The electrode holder of pH transmitter (PHR-110E) should be immersion type. If it is flow-through type, sampling pump should be required. If it is immersion type, it can easily be installed in the cooling water channel without using of sampling pump.

5) Voltage of power supply should be AC100V 50 Hz., because most of instruments in this factory are AC100V 50 Hz of power supply.

6) Scale units of all instruments should be in metric system. Examples are as follows:

LRCA	- 101	- 350 -	+350	mm
LIA	- 102	0 -	900	mm
PRCA	- 103	0 -	30	kg/cm^2
PICA	- 104	0 -	2	kg/cm^2
PICA	- 105	0 -	30	kg/cm^2
FR	- 106	0 -	10	t/H
FR	- 107	0 -	20,000	Nm^3/H
FS	- 108	0 -	6,000	kg/H
FS	- 109	9 -	700	kg/H

7) Transmitter of Furnace inlet air flow meter proposed by Foxboro is not suitable. It should be the type of 15A (low differential pressure transmitter).

8) Small steam condensers are necessary as follows:

LICA-101	Boiler drum level	1 pc'
LICA-102	Deaerator level	1 pc'
FR-106	Main steam flow	2 pc's

9) Following valves are necessary to install control valves and transmitters.

LICA-101	1/2"x JIS20K screwed,	2 pc's
LICA-101	1" x JIS20K Flanged,	3 pc's
LICA-102	1/2" x JIS10K Screwed,	1 pc'
PRCA-103	1/2" x JIS20K Screwed,	2 pc's
PRCA-103	2" x JIS20K Flanged,	3 pc's
PICA-104	1/2" x JIS10K Screwed,	1 pc'
PICA-104	6" x JIS10K Flanged,	3 pc's
PICA-105	1/2" x JIS10K Screwed,	1 pc'

PICA-105	2" x JIS10K Flanged,	3 pc's
FR-106	1/2" x JIS20K Flanged,	4 pc's

It is recommended for piston valve, for example ESPERO valve of Ichinose Valve Ltd. of Japan for above valves.

10) It is better that manometer for pressure gauge should be installed at the local as per APPENDIX V-10.(1).

Scale of manometer should be engraved "mm". Manometers and fabrication materials should be purchased.

11) Next items are not mentioned in the quotation of the Foxboro. But after completion of this improvement, following items will become the weak points. So it is strongly recommended that following items should be completed in the next year.

a) Deaerator pressure controller (PIC-1]

This should be replaced by the same type as that of the low pressure steam pressure controller but the range should be 0 - 0.7 kg/cm^2.

b) Replacing of self-pressure control valve for steam line.

PCV - 137	Melting coil steam
PCV - 138	Jacket steam
PCV - 141	Turbine outlet steam

c) The temperature of inlet and outlet acid of oleum cooler should be measured.

d' All following local pressure gauges should be replaced and measuring pipe and valve should be replaced by 1/2" size. Because existing size is too small, and does not have enough strength.

PG-136	PG-139	PG-140
PG-143 te	PG-155	

e) Dilution water flow meter (Fl-115) should be replaced by armored flowmeter with transmitter, and its indicator should be installed on the instrument panel.

f) Manometer for tank level (Tank-0-meter) should be replaced by the type of differential pressure transmitter with purge-set, then indicators can easily be installed on the instrument panel, (Ll-117, 118, 119, 120).

12) Stock of spare for 5 pieces of receiver gauge on the panel is good for next step of improvement.

13) When existing turbine drives B.F.W. pump is replaced by the motor driven B.F.W. pump, boiler drum level control valve must be installed at the outlet line of the said B.F.W. pump.

It is standard practice to install boiler drum level control valve at the discharge of B.F.W. pump.

Please refer to following APPENDIX.

a) APPENDIX V-10 (2): Instrument flow sheet.

b) APPENDIX V-10 (3): Service condition

c) APPENDIX V-10 (4): Essential specification for purchase

L) Recommendation & Implementation for Electrical Installation of SA

It was understood that the electrical installation of SA plant was one of the big constraints in the electrical equipments at this factory.

It is a good decision to remove the constraints and to install new load center and control center for SA plant. Because, by this changing of load and control center, all electrical installation must be changed. It is strongly recommended for quick execution of installing of above panels.

1) The expert team has a few recommendation against the panel drawings preparing for installation. The recommendation is as follows:

a) Some of name plates are not suitable in its letters engraved. The suitable engraved letters are shown in APPENDIX V-11(1).

b) The manufacturer of control center did not respond to the order. For example, two of spares N.F.B. were not installed. It can be understood by comparing with APPENDIX V-11(2) and V-11(3). APPENDIX V-11(2) is the order and APPENDIX V-11(3) is a proposal of manufacturer.

c) The arrangement of manufacturer of control center is different from the design and not suitable. It is presumed that the original design is of good arrangement. A new arrangement of control center is shown in APPENDIX V-11(4). The arrangement, shown in APPENDIX V-11(4) is recommended. Furthermore, the expert studied the future needs of electrical equipments, and designed future arrangement of control center. The said design is shown in APPENDIX V-11(4). It is believes that recommended arrangement shown in APPENDIX V-11(4) is also suitable for future arrangement shown in APPENDIX V-11(5). If these recommendation are executed, some pages of manufacturer's drawing for approval must be changed as per APPENDIX which are as follows:

Drawing of Manufacturer	APPENDIX
P_1	V-11(6) - 1/5
P_2	V-11(6) - 2/5
P_3	V-11(6) - 3/5
P_4	V-11(6) - 4/5
P_5	V-11(6) - 5/5

d) The engraved letters of name plate of Izumi Denki Corporation is not mentioned and the range of one ampere meter is different from design by Fuji Electric Co., Ltd.

So necessary recommendation is shown in APPENDIX V-11(7).

Drawings of panel layout, cable trench and cable rock are also shown in APPENDIX V-11(8).

Especially, the existing boiler feed water pump driven by steam appeared better than that driven by electric motor, but one of boiler feed water pumps should be driven by electrical motor for starting.

2) Load center and control center were installed and tested by T.S.P. electrical engineers and technicians in October and November 1981. The expert instructed and trained the staff on the job on the following points.

a) Schedule for installation.

b) Treatment, adjustment and testing of equipment.

c) Setting of over current tripping device for ACB and earth leakage relay.

d) Matters that demand special attention for wiring.

M) Recommendation for High Temperature Rise of Motors for SA-1 Process Water Pumps (B & D)

1) Situation

a) The motor for SA-1 process water pump (B)

The motor and pump were newly procured and installed. After installation while these were under testing, the temperature rise of the motor was abnormally high.

(Specification of motor)

Squirrel-cage three phase induction motor,

Type: Open type, HP: 25, Volt: 400
AMP: 35, Pole: 2,
Rating: Cont, Insulation class: E

b) The motor for SA-1 process water pump (D)

The motor and pump were not new. When the motor was running for the pump, the temperature rise of the motor was abnormally high.

(Specification of motor)

Squirrel-cage three phase induction motor,

Type: Open type, HP: 25, Volt: 380/440
AMP: 32.5, Pole: 2,
Rating: Cont, Insulation class: E

2) Investigation

Running condition of the motors were checked, and doubted stator winding as a cause of high temperature rise. So no load current and stator winding resistance were measured, and checked those of standard motors.

Those data are as follows:

	No Load Current (A)	Stator Winding Resistance Between Lines (Ω)
The motor for pump (B)	about 1.6	about 1.4
The motor for pump (D)	about 2.7	about 1.4
Standard motor (3ø, 400V, 50 Hz 25 HP, 2 Pole)	about 10	about 0.34

Consequently it is concluded as follows:

a) Stator winding of the motors for pumps (B & D) was not suitable winding to that of 25 HP. It was smaller than winding of 25 HP.

b) The motor for pump (B) was not a new article.

3) Recommendation

a) The motor for pump (B)

i) Stator winding should be rewinded. It is necessary to consult with motor specialist how to rewind the motor.

ii) After rewinding, if it is possible, it is better to test the following and know the motor characteristics and temperature rise.

- o Measuring of stator winding resistance
- o No load test
- o Lock test
- o Temperature test

b) The motor for pump (D)

It is necessary to check the temperature rise of the original motor. If it is normal, the motor should be rewinded similar to the original. If it is not normal, it is necessary to consult with motor specialist how to rewind the motor.

3. Phosphoric Acid Plants (PA-1 and PA-2)

A) Constant Feed of Phosphate Rock (PA-2, TSP-2)

1) Introduction

Constant feed of phosphate rock is indispensable to keep the continuous smooth running and the quality of product. Especially, fluctuation of rock feed causes large loss of material in TSP-2.

In the existing system, flushing and bridging sometimes occures in the bin of ground rock and the feed equipment.

2) Solution method

After studying the plant operating conditions of the same system in Japan, it is recommended to attach Rotary Valve and Agitator to ground rock bin as mentioned in APPENDIX V-12 in detail. In TSP-2, the ribbon mixer was changed to cone mixer, so that the rotary valve will be very effective to maintain stable continuous operation.

3) Result

This implementation was completed on TSP-2 at first. At the beginning, the feeding capacity was only 7 T/H against the necessary quantity of 10 T/H. The expert worked hard to detect the cause of this peculiar phenomena and at last found that it was due to the air disturbance below the rotary valve. After taking an action to let this air escape, the capacity turned out to sufficient, and constant feeding is completely established as follc s:

° Test result

Machine index	Discharge quantity (kg/10 sec)				Av.	T/H
0.5	34.3	46.2	42.3		40.9	14.7
0.7	58.6	50.2	60.0	53.7	59.8	21.5
	54.2	68.0	74.2			

° Operation result

Oct 27th '81 — 7.8 hours (continuous) — 79 ton --- 10 T/H

B) Installation of New Sulphuric Acid Control Valve (PA-2)

1) Introduction

One of the most important factor in PA production is stable flow rate of sulphuric acid. But previous control valve had frequent troubles and was completely damaged by corrosion.

After observation in detail, the specification mentioned in (2) was recommended.

2) Specification of sulphuric acid control valve

Type	SUNDERS EP DIAPHRAGM
Model	BOPV-3460-TF
Maker	NIPPON DIA VALVE (JAPAN)
Body Size	2 inches
Body Type	FLANGE
Material body	CASTIRON + TEFZELLINING
Material Diaphram	TEFLON
Calculated CV	30
Failure Position	Close
Valve Action	Air to open
Input signal	0.2 - 1.0 kg/cm^2
Positioner	Required
Accessories	Regulator with filter
Service Condition	
Fluid	98% H_2SO_4
Flow Rate	Nor. 9 m^3/H, Max. 11 M^3/H
Temperature	40°C
Inlet Pressure	0.9 kg/cm^2
Pressure Drop	0.5 kg/cm^2
Specific Gravity	1.8 - 1.84
Viscosity	11 cp

3) Result

New control valve was procured on the basis of above mentioned specification and has been working under good control since April, 1981.

This specification is quite suitable and also the life will be semi-permanent.

C) Recommendation for Instrument of PA-2

Plant staff in charge of PA-2 pointed out the difference of flow rate between indicator of instrument and calculated figures based on the analysis of phosphate rock as follows:

Tag. No.	Name	Calculated Value	Indicating Value
WICSA-2301	Phosphate rock weigher	18.3 T/H	16.4 T/H
FRCSA-2301	98% sulphuric acid	9.0 m^3/H	10.1 m^3/H
FRCA -2301	Return acid	37.2 m^3/H	51.5 m^3/H
FRCA -2302	Dilution water	5.1 m^3/H	6.6 m^3/H

These instruments were checked in detail and repaired several parts of them. In view of maintenance, several recommendation are also attached hereto.

1) WICSA-2301

o Totalizer of Rock Weigher

Totalizer of panel was not working smoothly as shown in APPENDIX V-13(1). Data of front panel were smaller than that of Disc in local. Especially on May 25 and 26, these differences were big. This was caused by shortage of supply of lubricant oil to gear and loose fitting connection of cables. After repairing on May 28, this trouble disappeared.

o Overhaul by engineers of vendor

Chain test of Rock Weigher indicated that there was the same difference as shown in above table. Therefore, operators are requested to consider the calibrated curve between the indicator of panel and flow rate. It is strongly recommended to conduct the overhaul by engineers of vendor who check all items including knife edge, disc roller, differencial transformer and tacho-generater.

2) FRCSA-2301

Loop between converter and recorder was checked by calibrator and confirmed to be normal as shown in APPENDIX V-13(2).

Then, the reduction of sulphuric acid tank level was compared with the integrator of FRCSA-2301 as shown in APPENDIX V-13(3) and (4) regarding flow rate of sulphuric acid, and the difference found was so small as not to cause inconvenience in operation.

3) FRCA-2302

The loop of FRCA-2302 was also checked by calibrator and confirmed to be normal. Regarding electrode, teflon lining condition, coil conduction, coil insulation and cable insulation, detail check was conducted, but there was no defect. Finally, the reduction of Return acid tank level was compared with the indicator of FRCA-2302 as shown in APPENDIX V-13(5) and some differences was found, which was smaller than the difference of above table's data. Therefore, process engineer was requested to reconsider the parameter of process design, and calculate again. Periodically this flowmeter is to be calibrated by using Return Acid Calibration Tank instead of Return Acid Tank.

4) FRCA-2303

Cleaning of float and tapper tube of detector and checking of loop were conducted. After changing of transmitter to new one, flow rate of D.M. water was 6.3 m^3/hr. The difference between calculated and indicated value became smaller than that given in the earlier table. This line can be connected to Return Acid Calibration Tank and calibrated, if necessary.

5) PRCA-2501

The range of this instrument is between -760 mmHg and -610 mmHg at gage, and its type is half range type. Therefore, during plant shut down time, forced balance lever and diaphragm of transmitter suffer from immoderate power and the maintenance of these is not so easy.

It is recommended to change its range between -760 mmHg and 0 at gage. Judging from operation of other plants, it is considered that such change of range does not affect the maintaining P_2O_5 content of product acid in this plant.

D) Improvement of Premixer Bottom (PA-2)

1) Situation

This vessel is lined with rubber and so its corrosion resistance is very strong. But before January, 1980, PA-2 premixer bottom was frequently eroded and its life was sometimes less than 1 month.

2) Implementation

The changing of agitater revolution speed was investigated and the reversing of slurry flow by modification of blade angle, was also considered. These would be effective but installation is not easy.

So it is recommended to attach the secondary lining of the surface of rubber by gypsum, sulphur or bricks. These ideas came out from the expert and Bangladesh engineers.

Acid brick lining seemed to be the best, so it was conducted carefully in January, 1980.

3) Result

The life has been successfully extended. Periodical checking is necessary. This method can be applied to other vessels, if required.

E) Improvement of Flow Conveyor (PA-2, TSP-2)

1) Introduction

There were many troubles of chain breakage in flow conveyors. The trouble was dominant in two flow conveyors (O-2207, O-2202), and was one of the worst mechanical troubles causing production shortage.

It took a long time to complete the counter measure.

2) Solution method

Please refer to APPENDIX V-14(1)-(6).

a) At first, the materials and the accuracies of all parts of chain were checked, and the shortage of accuracy of chain was found. The drawings of the chain were made and mentioned the standard of allowances in these parts. TSP was requested to check the accuracy of links ordered to BITAC with these drawings.

b) Simultaneously, it is recommended to rearrange the assembly of flow conveyors on the basis of the operation and maintenance manual. Adjustment of headshaft, periodical check of the moving parts, and careful start and stop based on the operation manual were effective to decrease the troubles. But these could not be solved completely.

In June, 1980, all chains of O-2207 were replaced with new chains made by BITAC. Since then, the frequency of troubles of O-2207 is almost zero.

The troubles of O-2202 were discussed with the vendor in Japan and more studies were conducted. The fluctuation of amperage was found high, even with no load running.

It is, therefore, requested to rearrange the whole assembly of O-2202 and simultaneously to modify the air slide of the ground rock to obtain constant feed to the conveyor and to settle one baffle plate in the inlet chute of the conveyor.

The purpose of these modifications was to maintain the constant feed of rock and to minimize the involved air of the conveyed rock.

At the same time, all links were changed to new ones. The troubles of O-2202 were solved after taking these measures.

3) Result

Through this work, it is strongly felt that the following items should be kept in mind.

a) To solve the problem, the instruction manuals should be read carefully again and again.

b) To procure the spare parts, the drawings must be prepared and the standard specification for quality inspection must be prepared.

c) The whole chain should be changed before their life say 1 - 1.5 years. Reassemblage of chains should be conducted carefully and spare parts are to be put in storage in good condition.

F) Prevention of Overflow Trouble in Flush Cooler (PA-1)

1) Situation

In this cooler, slurry is cooled from 82°C to 79°C under the vacuum of approx. -340 mmHg.

But slurry was sometimes introduced to the condenser due to overflowing under this vacuum. This causes interruption of operation, corrosion problem and loss of phosphoric acid.

So it was difficult to operate at high vacuum which was more efficient to cool. The defoaming reagent, which is effective for prevention of overflow, is expensive in this country. As definite and economic counter measure, the location of overflow and size of overflow pipe were considered.

2) Recommendation & implementation

After investigation of several ideas, the action was taken.

Slurry discharge area should be expanded more than 3 times. In fact, the additional 200 mmø discharge hose which was equivalent to 2 times of original area was set and it was the biggest in this factory. 300 mmø rubber hose will be better for this discharge pipe and so it is under preparation.

3) Result

- o Vacuum increased up to -360 mmHg
- o Outlet slurry temp. decreased to 77 - 78°C
- o 100% load operation is barely possible

G) Improvement of Rock Weigher in PA-1 Plant

Trouble of rock weigher happened 25 times during one month operation of May 1981 and plant shut down time was 55 hrs. It is assumed that these troubles were caused by upper side solenoid valve, its cylinder and limit switch.

After checking functions of these three parts in detail, it was found that these parts were not necessary. These parts were idly existing because sequence was not suitably changed though the weigher was mechanically modified to some extent. Therefore, the detail drawing of rock weigher's sequence was prepared which is shown in APPENDIX V-15 and recommended modified sequence.

On June 17, 1981, existing sequence was changed to new system without any trouble, and also balancing limit switch was fixed tightly to prevent another trouble. Modified sequence has been working smoothly since then.

H) Establishment of Phosphoric Acid Flow Meter in PA-1, TSP-1

Product acid flow meter of PA-1 was taken out long time ago. Number of product acid tank is only one, and receiving of acid from concentration unit and the supplying to TSP-1 are conducted simultaneously in the same tank. Therefore, process engineer has not been able to calculate the volume of product acid correctly.

New flow meter was installed using used instruments as far as possible. Also a pneumatic recording totalizer and Rotameter kept in store as a stand-by was established. This made it possible to measure the consumption of concentrated phosphoric acid in TSP-1 and to calculate the production rate of PA-1 as shown in APPENDIX V-16(1).

Existing Rotameter made of glass is changed with new Rotameter made of stainless steel 316 due to corrosion. New Rotameter is designed at 1.8 as specific gravity of liquid, but specific gravity of concentrated phosphoric acid is 1.65 so that compensation is required as shown in APPENDIX V-16(2).

Implementation was completed in September, 1981 and so engineers of PA-1 and TSP-1 can easily obtain the correct data regarding production rate and unit consumption of raw materials.

I) Expansion of PA-1 Instrumentation

It is desired to increase the capacity of PA-1 to 50 MT/D from 32MT/D. If this is undertaken, the control room will become narrow as there is in adequate space. The control room should be transferred as per APPENDIX V-17(1). At the same time rehabilitation of instrumentation and electrical installation should be done.

1) Instrument flow sheet is shown as per APPENDIX V-17(2).

2) Tag No. system (Table Tag No.-Name) is shown as per APPENDIX V-17(3). No. of 200 is emptied because SA-1 is numbered 100. They are grouped in two categories, one group is simple (PG-, and TG) and the other is more complicated instrument.

3) Ampere meters to be installed on the panel board are listed in APPENDIX V-17(4). The skeleton of electrical power installation is shown in APPENDIX V-17(5).

4) Temperature recorder should be Model ERB12-30-34 of YEW, this is strong and accurate.

Specification is as follows:

Temperature recorder

Type	Electrical recorder
Model No.	ERB 12-30-34
Scale range	0 - 150°C
Input signal	Resistance bulb (Pt 100 ohm 3 W)
Electrical source	AC 100 V, 50 Hz
No. of recording	10 points
Period of recording	1 minute
Quantity	1 (One)
Tag No.	TR-201

5) Specimen of specification of panel board is shown as per APPENDIX V-17(6).

J) Transfer of Instrument Panel in PA-1

Due to dangerous condition, it was recommended that Instrument Panel of PA-1 should be shifted as shown in APPENDIX V-18, and it was conducted completely with some difficulties.

It made sufficient space in the control room.

It improved the operational efficiencies.

Most of instrument crews worked hard and obtained on the job training.

After sifting the existing instrument panel, some improvements and modifications may be possible.

The expert would like to recommend as follows:

1) Sulphuric totalizer should be set in order to know its consumption. Now this has been prepared to set new panel of SA-1.

2) Magnetic flow meter is better than armored area flow meter like return acid flow meter. A-mored area flow meter is suitable for clean liquid flow only.

4) Wiring of announciator is not good. Alarming system of motor stopping can not be repaired without cutting off the whole instrument electric supply. It must be improved as attached schematic drawings.

5) Hot water preparation system for filter is not good, so hot water flow meter cannot work. It is better that hot water tank and pump should be installed and temperature of tank should be controlled by adding low pressure steam into it automatically, if necessary.

5) Density measuring system of 2nd wash acid is out of order. It is better that return acid density meter should be placed in the by-pass line of return acid. As mentioned in VII.3.ii), handmade hydrometer was applied in return acid line. This is very useful and its life will be semiparmanent.

K) Solution of High Temperature of Motor for PA-2 Crystallizer Exhaust Fan

1) Situation

a) Specification of motor

Squirrel-cage three phase induction motor

Type:	Totally enclosed externally fan-cooled type		
Output:	110 KW, Volt: 400, AMP: 200		
Pole:	8,	Rating:	Cont,
Insulation class:		E	
Load side bearing:		NU 320	
Opposite side bearing:		6318	

b) The temperature of load side bearing had been abnormally high for more than one year, and the load side bearing was often changed. In October 1981 maximum temperature was about 78°C, though it was changed on the fifth of September, 1981. So it was strongly requested to lower the temperature.

2) Recommendation & Implementation

a) In order to solve this problem, running condition and repairing history of the motor were checked, and the fitting problem between bearing box and bearing outer race was suspected to be the most likely cause. Consequently it is recommended to disassemble the motor and check the fitting and if inadequate, to repair it. The allowance for the fitting and tolerance for dimension of bearing box were shown.

c) When the motor was disassembled, the inside of the motor and the bearings were good, but the bearing box of load side had been repaired before and the fit between bearing box and bearing outer race was too much tightened.

So till the fit became adequate, the bearing box was cut in a lathe. And then the bearings for new ones was changed and assembled the motor on the 31st of October.

3) Result

The temperature of load side bearing was maximum about 70°C on the 11th, 12th, 13th of November. It was improved by about 8°C, as the ambient temperature before and after repairing was nearly equal. And it is now possible to run the motor continuously for a long time.

4. TSP Plants (TSP-1 and -2)

A) Change of Pan Conveyor System (TSP-2)

a) Introduction

This is concerning to the two pan conveyors, O-3108 & O-3109, the down stream conveyors of the Den. All parts of these conveyors were worn out severely by corrosion and abrasion and called for maintenance attention. Moreover, the conveyor, O-3108 had large inclination for conveying products to the slicer, M-3101, but the slicer could be by-passed according to the process change.

b) Solution method

Please refer to Appendix V-19.

For above mentioned reason, it is recommended to change these conveyors to belt conveyors attached with Plaloy Rollers (See V-5 ii). Meanwhile TSP mechanical section decided to change this pan conveyor (O-3108) to the straight one, decreasing its inclination. This modification was very successful for easy maintenance and cleaning. As the second step, TSP factory are now progressing to change these pan conveyors, (O-3108, O-3109) to belt conveyors.

c) Result

It will be very effective for the reduction of maintenance work to change these pan conveyors to belt conveyors, and the leakage of sticky green TSP will be decreased and the condition of TSP-2 section will be extremely improved. This will be directly connected to the production increase.

B) Challenge to Solve the Dust Problems (TSP-2)

1) Situation

Mainly these positions have caused huge dust problems.

a) Bagging section dust collecting system (as shown in APPENDIX V-20)

- o Non working of bag filter and filter element fallen out.
- o Trouble of limit switch & cylinder
- o No fixing of gaskets & packings
- o Poor air sucking due to dust accumulation in duct

b) Dryer section

At the cured TSP feeder some people are working in dusty place and needed improvement.

c) Reaction section

At the conjunction of Den and Conveyor, fine TSP dust was scattering.

d) Ground rock feeding section

Due to unstable flowing of rock, much ground rock was leaked and overflowed.

2) Recommendation & Implementation

- Regarding (b) it is recommended to suck the dust to dryer by the method of sucking. But this section will be removed by the granulation plant planning. So this method is pending.

- About (c), vacuum collecting method was applied by branched small duct from main duct of Den.

  Then this portion is considerably improved and 48 kg/d of scattered TSP dust was collected.

- About (d), see V.3.1)

- About (a)

  In order to implement completely, all expert members have worked hard inside each equipment during continuous 1 month.

  Then it was detected, pointed out, repaired and removed the actual defects on 11 items mentioned above.

  So after finishing this work, the result is quite good but the follow-up like these jobs is necessary to maintain the mechanism of bag filter.

Anyway this section will be much modified by the granulation plant. On the other hand, a modern TSP loading conveyor is in the process of procurement from ERD (as Japanese grant delivery).

C) Improvement of Ground Rock Loss (TSP-1, TSP-2)

1) Introduction

It could be seen that two stacks discharging white effluent of dust in the TSP factory, TSP-1 and TSP-2 milling section. This condition was important both for the loss prevention of phosphate rock and the pollution control. From these two points of view, it was tried to improve these equipment.

2) Solution method

Please refer to APPENDIX V-21.

a) TSP-2

At first, the manual and the mechanism of this scrubber were checked. The expert team's recommendation is as follows:

- Modification of double dampers.
- To repair and clean "Venturi Parts."
- To clean spray nozzle and supply sufficient water to both scrubbers and keep the water level of scrubbers.

This result was not sufficient.

Then the expert checked the operation condition and recognized the fact that the vent air volume of within 150 - 200 Nm^3/min was enough (formerly 400 Nm^3/min), because the water content of raw phosphate rock was <1.5%.
(Design value 2.5%).

As decreasing the vent volume, 2 cyclones of 4 were blinded to increase the efficiency. All inner apparatus of the two-dust collectors were modified by the TSP maintenance staff, and 5 No.s Venturi parts were decreased to 3 Nos.

The results of these improvements were satisfactory.

According to the test sampling data at inlet point of exhaust fan, the dust content in the vent air was about 6.13 gr/m^3 and 7.18 gr/m^3.

It is also recommended for "Bag Filter" as the long term improvement.

b) TSP-1

In case of TSP-1, the existing system is a cyclone, and the efficiency is very low. The particle distribution of dust was studied. These were mainly between 15u and 25u. It is very difficult to expect high efficiency of ordinary cyclone with this particle size distribution, and the use of multiclone and line-clone was studied.

Ultimately the extraction type cyclone with positive pressure is recommended.

3) Result

This problem was solved in TSP-2, and is in progress in TSP-1.

The result of recommendations is yet to be seen.

D) Removal of Bucket Elevator Trouble-in-Bagging Section (TSP-2)

1) Introduction

The bucket elevator in TSP bagging section (O-3303) is very troublesome. This problem is probably caused by the deterioration of all parts because of serious fatigue. The troubles are breakage of shear pin, link, bucket, connecting bolt, rail, etc.

2) Solution method

Please refer to APPENDIX V-22.

The expert inspected and found some causes of these troubles.

e.g., (1) Fatigue of link parts
(2) Lack of cleaning inside and outside of the elevator
(3) Leakage of TSP into the pit of the elevator
(4) Lack of lubrication, etc.

Maintenance work has been continued, and cleaning and lubrication was improved. But all fatigued links must be changes to the new ones. These links are now being produced in BITAC.

And it is recommended to adopt "Shock Relay" instead of shear-pin to avoid many breakage troubles of inside parts.

3) Result

Now the complete reparing is scheduled after arriving of BITAC links, then these troubles will be decreased considerably.

E) Solution of Ball Mill 750 KW Motor Troubles (TSP-2) (P-rock Grinding Machine)

1) Situation

After the rehabilitation in 1979, the shell surface temperature of this big motor had gradually increased up to 75°C. So this mill was frequenctly forced to stop after 5 - 8 hrs running only in order to arrest the temperature rise. It was estimated that motor capacity had fallen down due to dust accumulation, etc. These troubles were serious and so it was very much desired to solve.

2) Investigation

Motor overhauling is the best way, but at present this is very difficult and a very big work. It was investigated to reduce the inside balls and also the original maker was contacted. But they only alarmed that the efficiency will also decrease. But it was decided to recommend reduction of ball with prudent calculation and expert's experiences.

Motor temperature increases based on the formula of $Q = Ci^3R$ (i = ampere, Q = motor heat). It is believed that grinding efficiency would not be decreased by continuous rock feeding and continuous running.

3) Recommendation

30% of balls inside the mill should be reduced as follows. The mill efficiency and the motor temperature would be kept within safety range.

Ball Diameter	Present Weight	Reduction Weight	Remained weight (inside)
70 mm	14.0 T	4.25 T	9.75 T
60	14.0	4.25	9.75
50	16.8	5.10	11.70
40	11.2	3.40	7.80
Total	56.0 T	17.0 T	39.00 T

4) Result after implementation

This implementation was done successfully in April, 1980 and the troubles were almost completely over as follows. Overhauling of this motor is yet to be done in the near future.

Its results

a) Motor temperature has been kept below 62°C mainly 53 to 60°C.

b) Continuous operation is now going on.

c) Ground rock mesh, 200-mesh under = 82%. It is not necessary to increase balls any more.

d) Ampere decreased from 140A to 120A (3,300 V). As a result 1,570 KWH/d of power consumption were saved.

e) Replacement of slip ring was carried out by this maker. (APPENDIX V-23)

F) Installation of Packer Scale and Weighing Machine (TSP-2)

1) Introduction

There is one complete stand-by packer scale stored in the warehouse. This item was to be used effectively to decrease the troubles in Bagging Section. Thereby trouble-free operation of weighing machines could be achieved.

2) Solution method

Please refer to APPENDIX V-24.

The actual bagging capacity (TSP-1 & TSP-2) and present condition were checked. These capacities were sufficient for the target if the bagging system were kept in good condition. But maintenance side felt some difficulties to find the required time of maintenance. So it is recommended to set the stand-by packer scale parallel to the existing one. (See Appendix Drawing).

About Merrick scales, it is recommended to purchase the new type belt scale "Load-Cell Type" and its Tender Specificaton was submitted.

For the Jetty Unloading Merrick Scale, it is recommended some modifications of 4 Jetty bankers to keep the constant conveying of raw materials that is necessary to get the accuracy of Merrick scale. Periodical maintenance and adjustment is suggested for Merrick scale.

3) Result

The installation of the stand-by packer scale is suspended until the new granulation plant plan is finalized.

About the belt scale, one "Load Cell" type scale shall be purchased for Jetty unloading, and the replaced Merrick scale will be used to weigh raw sulphur to SA plant.

5. Others

A) Pointing Out of Deteriorated Electric Facilities

Please refer to APPENDIX V-25.

In addition to daily maintenance of electric facilities, attention must be paid to safety to prevent electric shock and electric fire. In view of maintenance and safety, all electric facilities of TSP plants were checked, and pointed out deteriorated items as shown in APPENDIX V-25.

There are so many items, but fortunately they have not yet caused long shut down of plant. Therefore, each problem must be settled immediately step by step.

On the other hand, if transformers, important motors and electric panels get into trouble, its influence is so big that such important facilities are to be checked in detail in scheduled shut down time.

B) Introduction of Plaloy Roller for Belt Conveyor

1) Introduction

The belt conveyor is one of the most important equipments in the fertilizer plant like TSP factory. In this factory, there are many important belt conveyors, i.e.,

a) The long conveyors of Jetty lines

b) The many important conveyors of Production lines

And conveyor trouble is one of the worst problems in this factory. There are many cases of such troubles, and one of them is the trouble of carrier roller and return roller. Due to insufficient seal of bearing to dust, bearing is apt to be damaged and the roller cannot run smoothly. In that case, back side of the conveyor belt is quickly worn down.

Repair of roller unit is very difficult, and troubled roller is sometimes replaced with new one.

2) Solution method

Please refer to APPENDIX V-26.

Many examples using plastic roller in Japan was studied, and the comparative data is prepared which is shown in APPENDIX V-26(1). Finally, it is recommended to adopt "Plaloy Roller" made of plastic. It is free from maintenance because it has no mechanical bearing, and expected life is 2 - 4 years. Test using 6 samples of "Plaloy Roller" supplied by the expert has been conducted successfully at seven points in the TSP factory.

These results came up to expert's expectation as shown in APPENDIX V-26(2) and now management of TSP factory intends to change the mechanical roller to plastic roller such as "Plaloy Roller" step by step.

3) Result

The resin roller which is completely free from maintenance with long life is more suitable in developing country than mechanical rollers, and the cost is economical.

Adoption of resin roller makes it possible for maintenance people to spend their time to more important work and to extent the life of conveyor belt.

C) Investigation and Estimation of Belt Conveyor System

Please refer to APPENDIX V-27.

1) Introduction

This information was prepared for the application of World Bank according ~~to~~ the request of TSP complex.

The unloading conveyor belt of Jetty is very important, and the troubles which occur sometimes cause large expense to the TSP complex such as the demurrage.

2) Solution Method

The present condition and history of each conveyor was checked and recognized the big difference regarding the life of conveyor belt as shown in APPENDIX V-27. Its life depends on the materials such as rubber and canvas. Many points to be repaired and modified were also mentioned. As to carrier and return rollers, resin roller type was also recommended in this information.

3) Result

TSP factory has been making efforts to use the homemade belt. It is expected that their efforts will be successful in the implementation of these items with large co-operation with the concerned sections.

D) Improvement in the Existing System of Inventory Control

1) Introduction

For managing a factory, inventory control is one of the most difficult items. Management of TSP factory is trying to improve it.

2) Solution method

Please refer to APPENDIX V-28.

a) Management of TSP factory is now revising the code system of articles and trying to give the common code numbers to Ghorasal, Fenchuganj and TSP factory in Chittagong district. After the completion, many parts will be utilized commonly in these factories.

b) Procedure of purchase, the flow of slips, and the condition of stocked articles were fairly good. But the expert recommended several points as follows:

- o The warehouse of the TSP factory is seemed to have sufficient space, but some important articles, for examples, bearing, switch cover, etc. were stocked sometimes outdoors without any cover and protection.

  On the other hand, quite a lot of numbers of articles should be regulated. So it is recommended to review the warehouse, and store the important articles indoors as much as possible.

- o Warehouseman is requested to obtain the necessary technical documents such as drawings and inspection data from the vendor and arrange them. This is very useful for maintenance, correct approval and storage.

- o Sometimes the plant suffered from the lack of small spare parts. Even a small article happens to cause the shut down of the whole plant due to its shortage. It takes an unbelievable long time to obtain it abroad. It is important to find the formal way to get the urgent articles surely and immediately.

3) Result

The inventory control system of this factory will be completed in the near future with much improvement in detailed points.

E) Improvement of Maintenance of Vehicles

1) Introduction

TSP factory has 19 units of shovel loaders which consist of 12 units of large type and 7 units of small type. They are working in the very dusty and corrosive atmosphere, causing many troubles, and sometimes production of TSP was disturbed.

2) Solution method

Please refer to APPENDIX V-29.

a) At first, maintenance people were running after daily troubles. Checking of these troubles showed that preventive maintenance was essential to improve the condition. For the implementation, the co-operation of driver is indispensable.

The system of preventive maintenance of shovel loader was prepared.

i.e., Daily Check List
2 days Check List
Periodical Check List

In order to decrease dusting, the expert investigated the weak points at several stages by check lists.

b) The examples of List and History Sheet of Shovel Loader was submitted, and the expert tried to introduce the preventive maintenance. The specifications and the history of troubles were prepared.

c) It is recommended that the new type of shovel loader with a sealed cab should be free from troubles of dust and new type of solid tires, the life of which is very long. The new shovel loader has an attachment of "back-hoe" that is very useful to crumble the piles of both green TSP and loose TSP.

The procurement of this new shovel loader is now under the application for Japanese grant.

3) Result

For the implementation of these recommendation, TSP factory increased one staff and is now making efforts to practice ~~it. So~~ the expert's recommendation will meet with good result in the near future.

F) Compilation of History Sheet of Important Equipment

1) Introduction

To manage equipments and to establish the preventive maintenance system, mechanical engineers must arrange the detailed specifications and the necessary documents regarding important equipments. Then, the spare parts of each equipment must be managed. All mechanical engineers can obtain good information from these documents easily and immediately in case of mechanical trouble.

2) Solution method

As shown in APPENNDIX V-30, history sheet contains Item No., Serial No., Name of Manufacture, specification, required documents, etc. Regarding Item No., TSP-2 plants have complete system. Such system is not available in TSP-1 plants.

Now, the expert team has finished 57 items. But there are not sufficient data in relation to spare parts. Especially in TSP-1 plants many documents have been lost. The expert team tried to collect then as much as possible, but only few data could be available.

3) Result

The history sheet of 57 items was prepared. TSP engineers are requested to take over this work. These documents will be utilized effectively for both daily maintenance and preventive one. There is no end in this work, because new information is always to be added to history sheet if there are some modifications and troubles.

G) Introduction of Chromium-cast-iron

1) Introduction

In suphuric acid plant, many kinds of special acidproof materials are used. Chromium-cast-iron is one of such very good acid-proof material for high temperature and concentrated sulphuric acid.

This material is sometimes very effective to solve corrosion problem. In Bangladesh, ordinary cast iron is produced (e.g. in BITAC), but chromium-cast-iron is not produced.

In the TSP sulphuric plant, many corrosion problems happened, and it takes about one year to purchase it from abroad. The necessity to produce such items within the country is strongly felt.

2) Solution method

Please refer to APPENDIX V-5.

The composition and mechanical characters of this material, were submitted.

Mixing point and method of Chromium-is the most important in the production process. BITAC stocked only ordinary Ferro-Chromium as raw material, so some matters that required special attention in the production were pointed out.

By this method, some parts of acid pump and piping materials were manufactured. To improve the quality of products it was recommended to use EXO-FCrH instead of Ferro-Chromium and to add steel scrap, and inject Calcium Silica.

The catalog of EXO-FCrH and Calcium Silica were provided. This is the key-point to improve the chromium-cast-iron.

3) Result

In BITAC, pipe, pipe fitting, pump's parts, etc. were made. The size of products is limited and the quality is not sufficient, but these products will be very effective as acid proof material made in Bangladesh. BITAC will also import these special raw materials and improve the quality of the products.

H) Settlement of Pollution Problems

1) Situation

There are some pollution problems in this factory given below:

a) There are lots ~~of raw~~ material scattering such as sulphur and phosphate rock in their transportation by belt conveyor. Especially, height difference between the two belt conveyors at connecting point is too large that there are much spilling of powders at those points.

b) Effective catch of dust of ground rock in final Dust Collector of Milling Section is not so easy in the original system.

c) Sometimes some slurry effluent may be discharged when cleaning of slurry tanks takes place. It has been discarded, but P_2O_5 loss in such slurry effluent should be minimized.

d) Condition of SA-1 stack gas was extremely bad, so that immediate improvement was quite important prior to preparation of new distributor.

2) Recommendation and Implementation

a) Regarding prevention of spillage at the connecting point of belt conveyor, it is recommended to attach the sliding plate to connecting point of belt conveyor as shown in

APPENDIX V-31(1). This attachment worked quite successfully in April 1980 at the point of main gate where heaviest spillage occurred. This method can be applied to other four points. Then, 7 ton of rock equivalent to TK10,000, per month could be saved.

b) To catch the dust ~~of~~ ground rock effectively in Dust Collector of Milling Section, improved system is recommended as shown in APPENDIX V-31(2). Regarding the dust of dryer exhaust gas of TSP-2, the expert recommended Bag filter as dry method as mentioned in V 4 C), which will be adopted at the same time when construction of granulation plant would take place. Therefore, temporary method for recovery of TSP dust as shown in APPENDIX V-31(3) is recommended.

c) To recover P_2O_5 of waste slurry, it is suggested to improve the existing concrete pit as shown in APPENDIX V-31(4) and (5). In addition, the expert recommended the method to collect phosphoric acid slurry efficiently in view of prevention of corrosion structure as shown in APPENDIX V-31(6).

d) In order to improve the condition of SA-1 stack gas, there were many items which are to be repaired as shown in APPENDIX V-31(7) and (8). Such items were effective till change of distributor.

As mentioned above, settling of these pollution problems has another merit such as the recovery of raw materials and products.

I) Recommendation for Inventory Control of Spare Parts of Instrument of TSP-2

1) The measure of inventory control

There are three measures in the subject of inventory control of spare parts of instrument.

a) To keep the complete instruments

b) To keep the partial parts of instrument

c) To keep the essential complete instruments and some of partial parts.

It is easy to keep the complete instruments, but costly. It is partly difficult to keep the partial parts of instrument, and the cost depends on the management of inventory control. Sometimes the measures (b) becomes costly due to the exessive stock of parts. The most reliable and also economic system is to keep the essential complete instrument and some partial parts, i.e., measure (c). But in this method, it is difficult to decide how much complete set and how much partial parts are to be kept as inventory. This is always the theme of inventory control.

2) The step of inventory control

The steps to be taken for inventory control are as follows:

a) To list up all instruments used.

b) To classify all of them following the type of instrument.

c) To decide what are the essential partial parts.

d) To decide the standard or base stock amount for both complete set and partial parts.

   i) In order to maintain good inventory control, it is important to study the instruments used in the factory. Tag No. system helps to study the instruments used in the factory, and also helps to maintain the said study. Tag No. system is shown as per APPENDIX V-32(1). It is necessary to always maintain the table of Tag No. Name. If any modification or new installation has been done, the table of Tag No. Name should be revised immediately. The example is shown as per APPENDIX V-32(2), under the name of "The Table of Instrument TSP-2". The specification in the table of instrument is not necessarily lengthy and to be written to classify the instruments.

   ii) Classification of instruments following their type is very important to minimize the base stock, and to make the inventory control cost low. The example of classification is shown as per APPENDIX V-32(3).

iii) The essential parts are decided as follows:

a. Partial parts of control valve

The control valve directly treats the process fluid, so this parts are quite essential. When the loop of instrument becomes out of order, but if only control valve can be properly operated, we can do some arrangement, and arrangement like this is sometimes required. For this reason, partial parts of control valve are quite essential. These partial parts are shown as per APPENDIX V-32(3), the pages from 13 to 16.

b. The parts made of glass and float of flow meter

The parts made of glass is often broken suddenly. If the float of flow meter is eroded or corroded, the flow meter indicates incorrectly. If any erosion or corrosion of float can be found out, float should be changed immediately. These partial parts are listed as per APPENDIX V-32(3) the page of 17.

c. Miscellaneous essential parts are shown as per APPENDIX V-32(3). These selections and decision of base stock quantity are rather difficult. Some of them are consumable, and some of them are used in big quantity. Such work depends on only experience. But the parts shown in the APPENDIX V-32(3), the page 21 and

22 are not necessarily kept in the store. In ordering these parts, it is necessary to inform the exact manufacture No. or serial No. to the maker. Because only maker knows whether the modification or minor change has done or not.

3) Results of checking ~~the present~~ stoek of TSP-2

The condition mentioned above is written in the APPENDIX V-32(3). To speak by ~~one~~ word, "too much stock". Instrument personnel always said "No stock", "No spare parts" actually at the time of need it can not befound".

Necessary spares to procure are shown as APPENDIX V-32 (4).

Example of "too much stock" is as follows:

a) Universal controller of Model No. M/58P4 and M/58P5.

These controllers are almost maintenance free, but present stocks are as follows:

Model No.	Working	Stock	Base stock
M/58P4	7	16	1
M/58P5	2	4	1

b) Generally, no spare of complete control valve is required for TSP plant, but 5 control valves are in the store, 2 control valves are in the instrument section.

c) Pressure transmitter and d/p cell transmitter

Almost 100% of spare instruments are stocked.

Item	Name	Working	Stock	Base Stock
4	Pressure transmitter	1	0	0
5	- do -	1	1	1
6	- do -	1	0	0
7	- do -	6	3	1
8	- do -	2	1	0
9	- do -	1	2	1
10	- do -	1	0	0
13	d/p cell transmitter	5	5	1
14	- do -	1	1	1
15	- do -	2	4	1
16	- do -	1	1	1
17	- do -	2	4	1
18	- do -	1	1	1
19	- do -	6	4	1
20	- do -	2	2	1
21	- do -	1	0	1

d) PR thermocouple

This is installed at the sulphur furnace outlet, but only one. Present stock is 9 of thermocouple with protecting tube, 20 sets of thermocouple element.

e) CA thermocouple with protecting tube

Item No.	Length	Material	Working	Stock	Base Stock
2	2850/2700	SAMDVICK-P4	4	12	4
3	650/500	- do -	1	0	1
4	2850/2700	SUS304	2	5	2
5	1950/1800	- do -	2	11	2
6	1150/1000	- do -	1	3	1
7	600/450	- do -	9	11	9

Only item 7 is reasonable. This may be due to no study and classificatin of thermocouples.

f) Resistance bulb (Pt 100 ohm) with protecting tube

Item No.	Connection	Material	Working	Stock	Base Stock
11	1" flange	SUS304+ KelF	2	11	2
12	- do -	SUS316+ KelF	4	19	4
13	2" flange	SUS304+ KelF	6	16	6
14	- do -	NAS-144M	2	1	2
15	1" flange	SUS304	2	2	2

These stocks are in terrible quantity, moreover 10 of element are stocked. There were 10 of resistance bulbs with protecting tube (2" flange. SUS304), but these are not useful. So two of resistance bulb (1" flange SUS304) was made by using above resistance bulb and suitable protecting tube. They become the spare~~s of i~~tems 15.

g) The stock of pressure gauge and thermometer is too small.

h) Generally, there is insufficient stock in the miscellaneous instruments. But in case of spare system of ball mill, stock is too much.

Usually, it is not necessary to stock the complete rota-meter. About FI-4113, there are two complete meter in the store and one complete meter in the instrument section.

i) Partial parts of control valve

The stock of lower body of control valve is too much. Recently procured in spite of sufficient stock.

Item No.	Spec.	Working	Stock	Base Stock
48	40 mm Neoprene	2	14	4
49	50 mm Neoprene	3	26	6
51	65 mm Neoprene	2	19	4
52	80 mm Neoprene	1	13	2
53	100 mm Neoprene	1	2	2

j) Parts of rota-meter

There are almost sufficient tapered glass but all of them is without O-Ring (for gland packing). Assembling is partly difficult.

k) Miscellaneous parts

The 46 of pilot relay of model M40C are working now, stock of it is 56. This stock is too much. But the pilot relay of model M40D is nil.

The stock of pen for M/54 is too much.

Item No.	Name	Working	Stock	Base Stock
30	1st panel	20	156	20
31	2nd panel	6	56	6

l) Chart paper

The stock of chart paper is also in terrible quantity. But second hand chart paper is used in the plant. Moreover, chart paper of exact specification is not stocked.

4) Purchase of spare instrument and parts

In case of complete instrument, the specification to order shown as per APPENDIX V-32(5) will help.

In case of partial parts, check of the exact manufacture No. or serial No. and writing it down in the purchase document is necessary. It is, of course, much better if more detailed specification can be given.

The stored Rack No. should be writter in each cardex. Many code Nos. were assigned to one instrument or parts. Many of them have been correctred and some cf code Nos. should be cancelled according to APPENDIX V-32(6).

J) Recommendation for Electrical Spares

Please refer to APPENDIX V-33.

1) Arrangement for the quotation of electrical spares for Maint 503 and Maint 537

   TSP invited Hitachi Ltd. to quote for supply of electrical spares for Maint 503 and Maint 537 several times since 1980, but by May, 1981 Hitachi Ltd. didn't offer the quotation. By the request of TSP, the expert team pressed Hitachi, Ltd. to quote for those in Japan and the quotation was offered in September, 1981 and in Japan the expert team received the explanation on detail of electrical spares.

2) Recommendation for quantity and specification of electrical spares for Maint 503 and Maint 537

   The above subject was discussed with TSP engineers and consequently agreed concerning recommendable quantity and specification as shown in APPENDIX V-33(1) and V-33(2).

3) Recommendation for electrical spares for motor control center

The present types of magnet switch, no fuse breaker, etc. are changed from the types of those at the time when motor control center was erected. It is very necessary to know in general what to select from ~~the pr~~esent types for motor control center. So this problem was discussed with Hitachi, Ltd. and consequent recommendation is shown in APPENDIX V-33(3).

K) Miscellaneous Items

1) Collection of technical information regarding special materials

a) High temp. castable refractories, plastic refractories and acid-proof castable refractories.

This TSP factory utilizes one kind of castable refractories, which may not withstand at high temperature. It will be convenient for engineers of TSP to have the knowledge regarding new high temp. castable refractories, plastic refractories that is useful for work at site, and acid-proof castable refractories.

b) Paint

In chemical plants like TSP, there are many troublesome points in case of selecting the paint to be the best suitable to the plant. And the life of paint depends mainly on treatment of surface to be painted.

The overall documents on these points, and the several examples to be executed in Japan were prepared which is shown in APPENDIX V-34(1).

c) Corrosion-resistant coating for Floor, Foundation, Pit, etc.

Corrosion resistant coating is important for civil works of TSP factory, and its technical information will be very helpful for the future.

2) Preparation of document for Rotary Dryer (M-3207)

The rotary dryer is one of the most important equipments in this factory. The documents related to maintenance and adjustment were obtained from the vendor, and translated into English as shown in APPENDIX V-34(2). This will be effective to check the troubles, especially to adjust the thrust rollers of this dryer.

3) Safe welding of sulphuric acid plant's equipment to avoid explosion

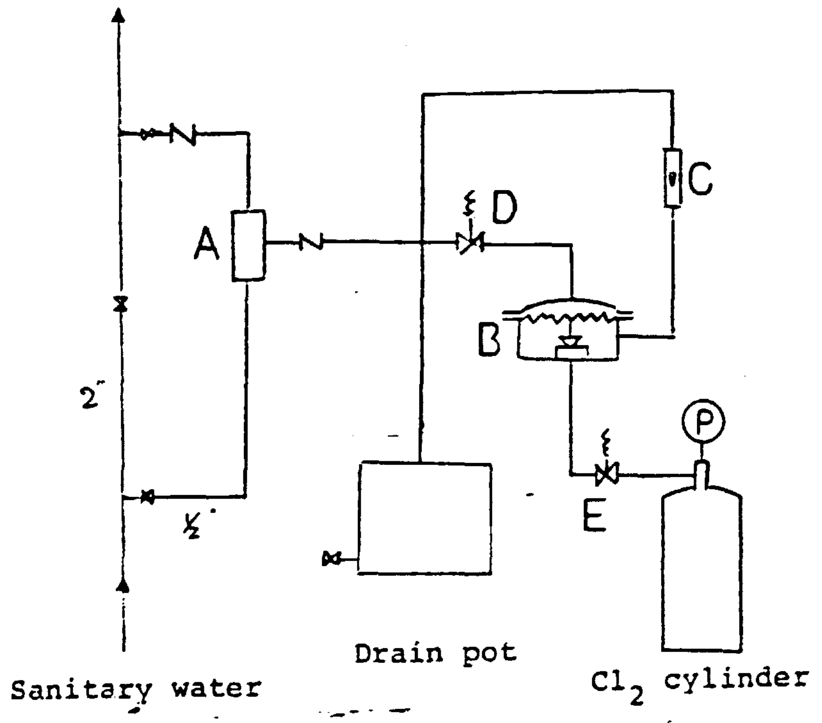
In case of welding of equipment sticked with sulphuric acid. i.e., vessel or pipe with stuffy conditions, there is the possibility of explosion even if it seldom arises, and so this phenomenon must be kept as common knowledge.

Hydrogen gas will be gradually generated at welding due to sticked acid and such accumulated gas will explode. Of course, explosion is very rare, but the expert experienced a big accident.

So, every engineer and skilled man must avoid gas accumulation by sifficient opening of the equipment to be welded. Now this method is thoroughly applied.

4) Chlorination of sanitary water

The expert was ~~requested to~~ give information regarding chlorination. There are many methods in Japan. The following method is one example, in which Cl_2 content is in general 2-4 ppm after treating.



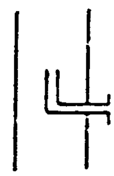
A : Ejector
B : Pressure control valve
C : Rotor meter
D : Vacuum control valve
E : Pressure regulator

Expected flow rate in TSP plant

Water	:	30 T/H
Cl_2 gas	:	60 g/H (= 20 lit/H)
Cl_2 content of treated water	:	2 ppm

[Remarks]

This method will be applicable. As the temporary method, it is possible to eliminate D and B. Direct charge of gas to main pipe can be replaced by A as follows. Instead of C, small type of air flow meter will be utilized.



VI. Recommendation for Factory Management

1. Personnel System

The following personnel problems in the plant were deeply felt by the expert team.

Of course these are not easy ~~to be~~ immediately solved but in order to improve this factory it is hoped that these problems will gradually be solved.

(1) Continuous training for Instrument and Mechanical crews.

(2) Supplying the working uniform for operator, maintenance and laboratory crews for good working condition.

(3) Making good disciplines and relations between each class.

2. Establishment of Factory Task Force

The necessity of task force is strongly felt, because every manager has a lot of work and responsibilities. It seems that every problem comes to top management for the solutions and also for the calculations. It is therefore recommended to establish a task force who can make the operation schedule, design and calculation of the new project, improvement method, and running trouble shooting method. Young engineers of task force will work harder to conduct them and also collect or align good documents. If it is done so, the top management would be helped very much. And managers could spend more time for new ideas and/or future problems.

3. Preventive Maintenance System

A) Introduction

In the modern factory, preventive maintenance is the main current of maintenance job. According to ILO guidance, the TSP factory arranged organization of preventive maintenance ~~in 1979~~ as follows and is now making efforts to promote it.

- Maintenace Section
  - General Maintenance
  - Running Maintenance
  - Work shop
- P.P.M. Section
  - P.M. planning
  - Inspection
  - Lubrication

But the experts observed that this organization came to a deadlock in both the daily maintenance work and the preventive maintenance work in TSP factory, though this system is working well in many countries. It is doubtful whether this system is suitable for TSP factory or not from various reasons. To be free from Breakdown Maintenance and establish preventive maintenance system, some modifications in this system is suggested.

B) Solution Method

Please refer to APPENDIX VI-1(1) - (3).

1) To promote the maintenance work, co-operation of operators and maintenance person is essential. Operators are always near to the equipment, so that their informations about the condition of

equipments are very important. For this purpose, "Daily check list of operator" for all sections was made. Now, this system is brought in practice and operators send these lists to the maintenance section every day.

2) Lubrication of machines was done by P.P.M. section in several plants, ~~and this~~ work occupied large part of PPM job. Lubrication work in a factory like TSP, seemed to be done by operators. So it is recommended to change the duty to the operation side, and finally the lubricators were distributed to each operation section.

3) Such minor mechanical jobs as tightening of belts and opening of a manhole are very simple work and can be done by operators. In the TSP factory, these jobs were conducted by maintenance people who must do more skillfull work and always have many works. So it is recommended to provide some necessary tools to operators and asked them to do minor mechanical jobs by themselves. Accordingly maintenance person can do their essential original jobs.

4) There is the Running Maintenance System in this factory. Maintenance person who were distributed in every shift consist of 4 S.A.M.E. and 24 technicians in total. Their duty is co-operation with operators and minor mechanical work in the shift. As mentioned before, it is believed that in a factory like TSP all maintenance work should be done as a rule in the day time, and except the day time minor mechanical works should be done by operators.

It is recommended to change maintenance persons to the general shift. At first step, 4 S.A.M.E., and 8 technicians were rearranged to the general shift. Step by step, other P.M. technicians shall be rearranged to the general shift.

5) Fundamentally, the defects in the existing organization is felt. ~~The~~ maintenance system which was divided into two sections, PPM and Maintenance, has been gradually loosing the close connection with each other. Originally recent maintenance mind must be based on P.M. which should be based on B.M. technology. So P.M. section and daily maintenance section are not to be separated. They must be unified in one section and pursuit their work on the basis of P.M. mind and technique.

So it is recommended for PPM section to be included in Maintenance Section.

C) Result

There is not a specified organization for maintenance. They must find the most suitable one for their factory and the distribution of the personnel. The recommendation mentioned in item B)(5) has already started, and so all maintenance people are expected to do their jobs in this new organization and control daily troubles in P.M. mind. Other items are now in progress, and these effects will be expected.

4. Suggestion for Mechanical Engineers

A) Introduction

The expert team tackled many mechanical troubles from high technical grade to low technical grade. It was felt that some minor technical problems could have been solved by the application of simple knowledge of engineers but normally such attempt was not tried.

In addition, it is strongly felt that the engineers working in mechanical engineering field must follow the principles of mechanical engineering. Somtimes, it is allowed to by-pass or against to the principles for solving problems within limited time and resources. However, all the engineers should try to avoid such compromize and try to apply the principles for solving any type of technical problems. This way of thinking is the main road to improve the technical level of each person and the P.M. system.

B) Solution method

Please refer to APPENDIX VI-2.

1) The simple flow sheet of basic works of mechanical engineers is prepared. When a trouble happens, at the first step, all documents about the machine must be studied and checked, e.g. check lists, drawings and manuals. And the existence of spare parts, and also their dimensions must be checked. Even experts sometimes neglect this step and take actions prohibited in the manuals.

2) Mechanical engineers must keep stocked spare parts to be used immediately when a trouble happens. They must anytime check the existing spares and documents. They must always understand all about these spare parts.

3) In this brief flow sheet one can find the work "Draw and Sketch", "~~Dimention~~ion and Allowance", and "Actual Measurement Data". In mechanical field, these must be used to convey one's opinions to the others exactly.

These are indispensable in following cases.

a) Order to the machine shop in the factory.

b) Order to maker.

c) Approve the ordered spare parts.

When one order something to a maker, one must request "Inspection Data", and keep it with the received goods. Good makers have their own inspection section and deliver their products on the approval of this section only. These documents will be the basis of P.M. of this factory.

C) Result

This sheet was distributed to all mechanical engineers of the TSP factory. The experts expect the smooth basic action of mechanical engineers in the near future.

5. Recommendation for Instrument

In view of factory management of instrument, there are so many factors as shown in APPENDIX VI-3(1). Judging from expert's experience, several important items are mentioned here.

A) Daily maintenance and its allotment

Daily maintenance is such simple work as supply of oil, cleaning, adjustment and changing, but those jobs are important for prevention of decrepitude of the instrument and maintenance of the accuracy. After teaching the simple knowledge of instrument and the daily maintenance technique to operator, it is better to allot to operation side a part of daily maintenance. Good relation between maintenance and operation minimizes frequency of plant shutdown by detecting the trouble earlier. Cleaning of recorder's pen-edge, manometre and scaling is to be conducted by operation side. Of course, it is necessary for instrument engineer to go to each panel room and know the condition of instrument and patrol the important instrument once a day.

B) Acceptance Test and Maker's Test Report

All instruments and apparatus should be passed through acceptance test.

In case of control valve, one must check type of valve, a kind of lining, valve lift length, CV value, valve size, positioner, working pressure, operating air pressure, material of valve and body acting direction, and so on. Due to packing problem, instruments are separately sent from maker, after maker's inspection. Sometimes some of them suffer loss or damage during transportation and so this must be checked.

Perfect inspection is executed by maker before shipment. Therefore, it is necessary to obtain such inspection data or maker's test report which is very useful in case of analyzing trouble or repairing.

In addition to such data, maker's final drawings are also to be obtained.

C) Overhaul by Maker

Advantage of overhaul by maker is as follows:

1) Maker makes efforts to recover the original situation in addition to repair.

2) maker knows the inherent character of his own instruments, and so he can overhaul and calibrate with suitable method. One can learn special technique about those instruments.

3) One can get the new information regarding instrument and technology.

Generally speaking, overhaul by maker may be a little expensive, but it is advisable to conduct it at least once per three years.

D) Inventory Control

It is necessary to keep some stock for quick action of maintenance. But problem is culculation method for quantity of reasonable and reliable stock. Inventory control depends on maintenance method, level of maintenance technique, established condition, kind of instrument and running time and so on.

1) The basis for judgement of reasonable stock

- o Frequency of trouble

  The first factor of judgement is frequency of trouble which is connected with spare parts. Frequency of trouble is to be checked in half a year. According to such data, preventive maintenance is conducted in scheduled shutdown time before breakdown. It is easy to estimate the consumption of each parts.

- o Term for procurement

  One must check the term for procurement to prevent the plant shutdown due to storage of spare parts.

- o Production system

  To decrease the influence of plant shutdown, it is better to store the complete unit instead of spare parts.

- o Allowable plant shutdown time

2) The countermeasure for minimum stock

o Unification of instruments and spare parts

Unification includes the following items.

Maintenance parts and devices are stored in common. Maintenance method and technique is unified. Route for procurement is simple.

Upon those items, one can reduce the quantity of spare parts and maintenance labor. Therefore, it is not always the best method to ask world tender and to purchase the cheapest in case of procurement of instruments and spare parts.

E) Catalogue, Manual and Technical Document

In case of selection of the instrument, these documents are effective as one of guidance. Therefore, it is better to collect the maker's catalogue via trade company. Manual is also important for freshmen to know the principle and standard of calibration and so these manuals are prepared in a position for everybody to read it. Such manual is also to be translated to Bangali so that every person may understand the contents easily.

F) Maintenance Book and Specification File

The expert asked history of instrument trouble occured in passed one year. But the data written a few month ago was not clear regarding trouble phenomenon, cause and countermeasure. When one make the plan, he must analyze history of instrument at the initial stage.

Therefore, it is a basic work in maintenance job to write maintenance book carefully. The statistical table of trouble and analysis of history can introduce the future plan.

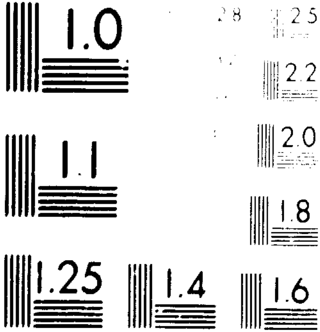
Specification file including history of instruments loop's specification remains so that everybody may check the whole specification when one purchases the parts and spare of instrument, he can easily write the specification including accessories according to such specification file.

G) Analytical Sheet for Failure Cause

In order not to repeat the same trouble, one must find the cause and take the complete countermeasure. Therefore, it is effective to write "Analytical Sheet for failure cause" as shown in APPENDIX VI-3(2) and to distribute it to relative section to confirm the countermeasure.

H) Specification Sheet

Supply of incomplete specification sometimes delays the quotation of maker. One must inform the necessary items in detail as much as possible by referring to maker's catalogue. Regarding detector, transmitter and control valve, one must describe every condition in the specification sheet including the fluid condition as shown in APPENDIX VI-3(3) - (5).


1.0
2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

VII. Other Works

1. Process Analysis

A) Inspection Data of Sulphuric Acid Plant

1) At first, sulphuric acid plants (SA-1 and SA-2) of this factory are compared with other sulphuric acid plants regarding main equipment in order for every engineers of this factory to understand this factory process for further improvement as shown in Table VII-1(1) and (2). Mass Balance of SA-1 and SA-2 are also prepared in Table VII-2(1)(2).

2) Distribution of pressure drop of gas flow is one of the most important parameters in operation of sulphuric acid plant. Regarding SA-2, The data taken 7 years ago are compared with the recent one as shown in APPENDIX VII-1. Judging from these data, increase of pressure drop is dominant in Hot Gas Filter and AT demister. Removal of pressure drop in these equipment was suggested and conducted successfully. Screening of catalyst will be conducted at the next overhaul for further improvement.

3) In order to justify operation condition of SA-1, several kinds of calibration and observation were conducted as mentioned in APPENDIX VII-2 and APPENDIX VII-3.

B) Result of SA-1 150% Load Investigation

The design planning of SA-1 load increase to 150% is desired. Its possibilities for each equipment was investigated. Then the draft of the plan is mentioned here. But the detail design will be finally done by a vender if they are requested.

Please refer to APPENDIX VII-4.

C) PA-1 100% Load Condition

1) Main improving points

Please refer to APPENDIX VII-5(1).

a) Enlargement of slurry discharge pipe of flash cooler

In order to make the stable operation and to prevent the slurry sacking into condenser, additional discharge pipe was set. This makes good results for constant stable operation.

i.e. Vacuum -330 -380 mmHg
Temperature difference of inlet and out slurry is 7°C.
(inlet 78 - 80°C outlet 71 - 74°C)

Digester temperature can be constantly kept at about 80°C on 100% load.

No.	Equipment	Specification	Necessity of procurement
1	Sulphur	2,093 kg/H pump cap. 2,430 kg/H	OK
2	SO_2 vol	1,465 Nm^3/H	
3	SF air vol	Cool down to 50°C SO_2% = 11%	SF inlet duct cooling by HE load down, insulation tape out.
4	SF load cap	Heat load= 136 < 180 - 230 Kcal/m^3 hr. (normal value)	OK. safety after air temp. down
5	CV	Increase catalyst in each layer & make up 5th bed	1. New cat. 7.7 m^3 2. Transfer HGF to 5th bed.
6	WHB	1B 2B	
		Steam gen. 6,730 kg/H 1,370 (kg/m^2.hr) 47.5 34.4	Total steam 8,100 kg/H OK (limit is 65)
		Generate capacity	OK
		Q(= Mcal/H)=3,127 628	
7	HE	Become internal cooler for cooling from 465°C to 440°C Q = 145 Mcal/H	Do natural cooling or bring simple fan.
8	5th bed CV	Set HGF as 5th bed CV ratio 96% to 97.5%	Utilize HGF after HE
9	ECO	Gas cool 450 to 250°C vol 16,200 Nm^3/H	Establish ECO holding 130 m^2 heat area
		Water temp. 90°C to 215°C	
		Water volume 8,530 kg/H	
10	AT	AT acid cooler should be increased. Existing AT pump can be used for this AT.	Make additional AT 1,940ø x 4,100 Hmm, 4 sets acid cooler is required.
11	Air Blower (Nm^3/H)	Total air vol = 16,900 Capacity = 15,300	For actual vol (capacity) test to measure is necessary.
12	Test for confirmation of air volume	For determination of existing air blower & AT capacity	Test to measure actual vol (capacity) is necessary.

[Note] Detail calculation is attached as APPENDIX VII-4.

b) Improvement of defoaming agent charge method

When much foaming occures in the flash cooler, defoaming agent is supplied with new spray system. At this time volume of agent used is about 100 lit/hr. This volume is allowable to return to the digester system. Allowable volume of the ~~defoaming~~ agent is between 200 ml/hr. and 400 ml/hr.

This is only used for emergency time and now continuous using is not necessary.

2) Result of the high load operation

The data is shown in APPENDIX VII-5(1).

load %	Continuous Operated hrs.	Date	Main result	Other problems
100 - 103%	14.5	11 Dec, 1980	Smooth operation digester temp. is 80°C and kept on constant.	1) Slurry feed pump is not sufficient. 2) Rock feeder is limited.
93 - 98 %	23.3	16 Dec, 1980		1) Rock feeder is limited.

The high load operation is possible with above (a) and (b) methods after completion of the feed pump and rock feeder.

3) Effectiveness of precut in filter

Filter of PA-1 has precut zone to prevent dilution of acid by water contained in filter cloth, but line of precut was connected with the first filtrate line by mistake. It is not clear why this wrong connection was made. Correction of this wrong connection, i.e., connection of this line with the second filtrate line instead of the first filtrate line was conducted on April 1981. P_2O_5 decrease of the first filtrate is 1.66% as average on May 1981 in comparison with 2.30% of January 1981 as shown in Appendix VII-5(2).

D) Recommendation for 150% Load of PA-1

Based on the 100% load test and the detailed calculation, the increasing method for 150% load (say 50 t/d P_2O_5) is herein recommended.

Main points of implementation are mentioned here. The details are shown in APPENDIX VII-5(3).

		Specification	
		Existing	Recommend for 50 T/D
1	Set the additional digester	a) 100 m^3 θ = 8 hrs	b) Add 50 m^3 a + b = 150 m^3 $\theta = \frac{150}{19.9}$ =7.5 hrs
2	Concentrater		50 T/D plan Refer to the "Improve recommend of PA-1 concentration system" on dated Aug 28, 1980
3	Slurry Cooler	a) Remove heat required 629 Mcal/H.	b) Additionally 516 Mcal/H of heat must be removed by air cooling. (a) + (b)=1,145 Mcal/H
4	Air Cooling Blower	-	a) using SA-1 starting blower 142 m^3/min. (actual use 100 m^3/min) 1,000 mm Aq. b) Using TSP-2 dryer Fan after granulation plant established. 440 m^3/min 250 Aq.
5	Exhaust Fan	226 m^3/min. 250 mm Aq	a) Pulley changing 350 m^3/min. 250 mm Aq b) Add 120 m^3/min. 300 mm Aq
6	Pump a) Slurry feed for filter. b) Slurry feed for slurry cooler c) Filtrate feed for washing of filtration recycle acid, 1st wash acid, 2nd wash acid, concentrator feed	290 lit/min. 2 m^3/min. 242 lit/min. 170 " 182 " 83 "	420 lit/min. 1 + (1) 2 m^3/min. 1 + (1) 320 lit/min. 250 " 230 " 130 "
7	Filtrate storage tank	a) 120 m^3	b) Add 155 m^3 a + b = 275 m^3 θ = 275/5.7 = 48 hrs.

		Specification	
		Existing	Recommend for 50 T/D
8	Instrument		
	a) Flow meter		
	o 98% H_2SO_4	FRC 2.6 m^3/H	4.5 m^3/H
	o Recycle acid	FRC 13.6 m^3/H	20 "
	o Slurry (at slurry cooler)	-	FI 120 "
	o Water (at inlet condenser)	-	FI 40 "
	o Water (at inlet condenser)	-	FI 4 "
	b) Thermometer		
	o 1st condenser outlet water	-	TG 0 - 100°C
	o Inter condenser outlet water	-	TG 0 - 100°C

E) Bottlenecks for 100% Load Run of PA-2

It is possible to run at 100% load as feed rate in PA-2. But running efficiency is very low due to many troubles. Low running efficiency may prevent achievement of target of annual production.

- First of all, running ~~efficiency~~ efficiency is to be increased. For this purpose, all plant engineers are requested to take the prompt action to each recommendation which is mentioned here.

- In order not to repeat troubles, the engineers are requested to prepare the technical report which includes reasons and countermeasure of trouble. Such technical report is to be circulated to the level of operator.

1) 100% load run

100% load run on feed basis was conducted on May 1981. Summary is as follows. Detailed data are shown in APPENDIX VII-6(1).

		Total		Average per day	
Date		1 - 31	6 - 31	1 - 31	6 - 31
Feed Rock		8,045 t/m	7,301 t/m	260 t/d	280 t/d
30% Acid	Wet basis	9,255 t/m	8,410 t/m	298 t/d	323 t/d
	P_2O_5 basis	2,438 "	2,223 "	78 "	86 "
50% Acid	Wet basis	5,461 "	5,097 "	176 "	196 "
	P_2O_5 basis	2,691 "	2,512 "	86 "	97 "
Feeding time of 30% Acid		hr/m 475.9	hr/m 429.1	hr/d 15.3	hr/d 16.3
Running efficiency of 30% Acid		63.9 %	71.5 %	-	-
Percentage of capacity utilization of 30% acid plant per running day		90.9 %	93.4 %	-	-
per average day		58.2 %	65.8 %		

During test run, rock feed has been conducted at 100% load. But running efficiency is very low due to mainly mechanical troubles. Reasons for shutdown was also shown in APPENDIX VII-6(1). Therefore, percentage of capacity utilization per average day is only 65.8% in spite of high 93.4% capacity utilization per running day.

Anyway, running time must be increased. Even if plant load is maintained at 100% load, percentage of capacity utilization per average day depends on on-stream efficiency. Whole day's continuous running without stoppage was only four in May, but it proved capacity utilization of about 94% for phosphoric acid plant. This means 85% capacity utilization when on-stream efficiency is over 90%.

This 90% running efficiency means that stoppage time per day must be within 2.4 hours. Regarding 100% load of concentrated phosphoric acid production, there is no problem if river water is supplied sufficiently.

P_2O_5 decrease in filtration is changed to 0.44% from 1.47% and solid content of 1st filtrate is also extremely decreased.

2) Good performance with one digester

Judging from the following P_2O_5 recovery and decomposition ratio of May, 1981, one digester is tolerable at 100% load with using Morocco Rock.

Average P_2O_5 Recovery on filter cake basis	97.79%
Average final Decomposition ratio	98.75%
Average Decomposition ratio at Outlet of digester	82.92%
Average Crystalline water of filter cake	19.08%

This attempt is very useful to maintain another digester as a stand-by for repair and inspection of agitator, etc.

For different rocks the same approach would be made if chances come.

3) Shortage of cake washing water

Due to shortage of cake washing water, cooling water was always supplied to V-2410 (3rd seal tank) and sometimes process water was added to V-2407 (2nd seal tank) as shown in APPENDIX VII-6(2).

If it is possible to supply sufficient process water to V-2506 (Condensate receiver) or V-2402 (hot water tank), one can expect lower W-P_2O_5 in cake and higher P_2O_5 recovery.

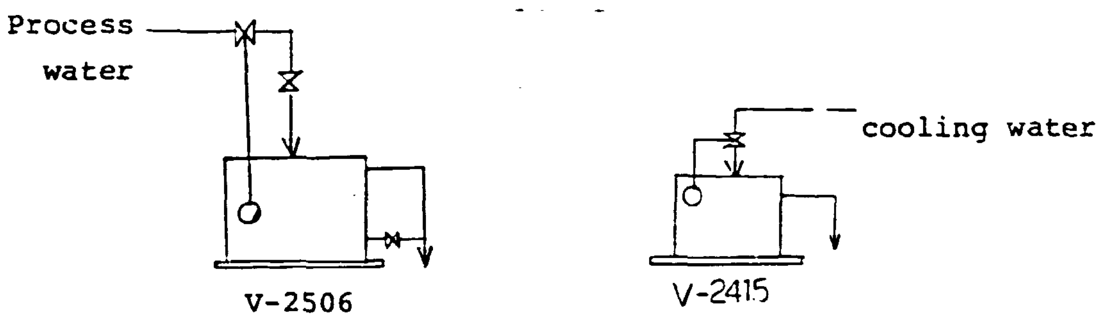
Average decomposition ratio	98.75%
Average P_2O_5 recovery	97.79%
Difference	0.97%

In experience, its difference may be decreased to 0.5% and so it is expected more than 98% P_2O_5 recovery in case of normal flow rate.

Moreover, when process water is fully used for cake washing water, pressure fluctuation is caused and this gives bad effect for the stable operation of concentration. It is recommended to switch the process water for concentrator to cooling water.

4) Saving of process water and cooling water

It is effective to prepare level control valve (Float type) to V-2506 and V-2415 as original design basis in order to prevent overflow of water.



Following three kinds of process water is not recovered.

- o Process water to level control box for DRCA-2301
- o Seal water of K-2402 (Cloth Drying Fan)
- o Seal water of K-2403 (Vacuum pump)

Such wasted water is to be recovered to V-2506 or V-2405 if cost of water is expensive.

5) Shortage of river water

In order to maintain 100% load in PA-2 Plant, running of two concentrators is requested due to the balance of production capacity between 30% acid and 50% acid.

Due to shortage of river water to condensers as colling water, it is impossible to run two units of concentrator. As test run of 100% load, it was tried to operate two units of concentrator for a short period twice by using two units of washing water pump, as follows:

Running time of two units -

May 26th	15--22	7 hrs
May 27th	24--900	9 hrs
	Total	16 hrs

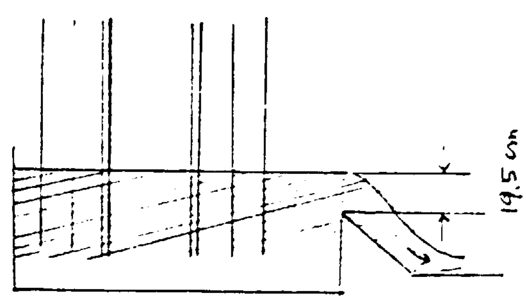
PIA-2302 (Pressure of river water): 1.7 kg/cm^2G

PIA-2333 (Low pressure steam):- 0.14 kg/cm^2G

FRC-2301 A:	6.0 t/hr.
FRC-2301 B:	5.5 t/hr.
	Total 11.5 t/hr.

Water level of overflow from weir: 19.5 cm

Seal leg of condensers



Production of C.P.A.

Date	Product at wet basis t/d	P_2O_5 content C.P.A. wt%	Product as 100% P_2O_5 t/d	P_2O_5 content of 30% acid %
24 May 1981	247	50.90	126	27.24
25	220	49.83	109	27.63
26	278	49.60	139	27.69
27	254	49.50	126	28.78
28	240	50.47	121	28.36

In case of lower P_2O_5 content of 30% acid production, capacity of concentrator is decreased due to increase of evaporated water. For example, production of 30% acid was stopped on May 10th due to shortage of storage capacity for 30% acid. Therefore, P_2O_5 content of 30% acid is also to be kept as high as possible.

It is requested basically to check the balance of river water and to compare the actual flow rate with designed flow rate in detail.

6) P_2O_5 decrease in filtration and precut

P_2O_5 decrease in filtration due to water contained in filter cloth is approx. 1% for PA-2 as shown in APPENDIX VII-6(3). To increase the production capacity of concentrated phosphoric acid, this P_2O_5 decrease is to be minimum and it may be possible by preparation of precut in filter.

In Nissan Toyama Plant, effect of precut in pan filter was confirmed with following data. Ratio of precut is 5°.

Precut none					Precut available				
Date	P_2O_5 of Crystal-lizer	P_2O_5 of 1st fil-trate	P_2O_5 decrease in fil-tration	Solid content of 1st filtrate	Date	P_2O_5 of crytal-lizer	P_2O_5 of 1st fil-trate	P_2O_5 decrease in fil-tration	Solid content of 1st filtrate
19/1/76	29.85%	28.81%	1.04%	-	25/4/77	30.67%	30.32%	0.35%	-
12/5/76	31.23	29.04	2.19	-	28/9/77	30.49	29.76	0.73	-
31/7/76	28.91	27.86	1.05	-	1/10/77	31.38	30.94	0.44	-
23/10/76	30.63	29.26	1.37	-	3/10/77	31.00	30.34	0.66	-
7/2/77	30.95	29.49	1.46	-	16/10/77	31.61	31.25	0.36	-
25/3/77	30.97	29.96	1.01	-	17/10/77	31.68	31.46	0.22	0.34%
1/4/77	31.17	29.85	1.32	-	18/10/77	32.24	31.60	0.64	0.43
8/7/77	30.60	29.29	1.31	-	19/10/77	32.12	31.79	0.33	0.39
12/7/77	29.88	27.47	2.41	-	20/10/77	32.18	31.92	0.26	0.32
13/7/77	29.03	28.18	0.85	-					
14/7/77	30.03	28.22	1.81	-					
15/8/77	29.89	28.11	1.69	-					
25/8/77	32.27	30.72	1.55	0.93%					
26/8/77	30.82	29.36	1.46	0.75					
$\bar{x}$	30.44	28.97	1.47	0.84		31.46	31.04	0.44	0.37

7) Others

Following items are also important for PA-2 operation, so that recommendation for these items are mentioned in APPENDIX VII-6(4).

- o Preparation of instruction sheet for specific work
- o Exchange of filter cloth
- o Cleaning of digester exhaust gas line
- o Cleaning of cooling air pipe
- o Seal in crystallizer exhaust gas line
- o Complete cover of trough
- o Continuous washing of pan backside
- o Heat balance of PA-2

F) Increase of Running Efficiency of TSP Plants

1) TSP-1 Plant

o Perfomance of May 1981 is as follows:

Production of green TSP	1,268 t/m
Running time	144.2 h/m
Running efficiency (from 9th *)	65%
Production rate per hour at running time	9.0 t/h.

o Shutdown time and reason

	Total shutdown hours	
Shortage of concentrated phosphoric acid	291.3 h/m	(81.4%)
Trouble of Cone Mixer	46.2	(12.9%)
Others	20.3	(5.7%)
Total	357.8	(100%)

* TSP-1 started on 9th May, 1981 after a long shut down due to shortage of raw material.

Main reason of shutdown in TSP-1 reaction section is due to shortage of concentrated phosphoric acid. Construction of acid piping line between TSP-1 and PA-2 is very effective for increase of running efficiency of TSP-1.

In view of high annual production rate, raw material such as sulphuric acid and concentrated phosphoric acid is to be offered mutually between TSP-1 and TSP-2.

2) Reaction Section of TSP-2

Performance of May 1981 is as follows.

Production of Green TSP	7,632 t/m
Running time	305.5 h/m
Running efficiency	40%
Production rate per hour at running time	28 t/h.

The Plant is repeatedly-stopped due to a troubles as mentioned here in May 1981.

	Total shutdown time	Times
Shortage of labour	78 hrs	7
Troubles of cone mixer	50	12
Troubles of Conveyor		
0-3111	14	6
0-3110	13	4
0-3109 & 0-3108	42	8
0-3106	14	4
0-3107	47	5
0-2209	17	2
Others	163.5	
Total	438.5	

Troubles of Cone mixer is considered to be initial trouble due to recent introduction as new mixer and now they have already ceased.

Troubles of Conveyor ocurred frequently, so that our recommendation mentioned in V 3 E), and V 4 A) are to be taken immediately.

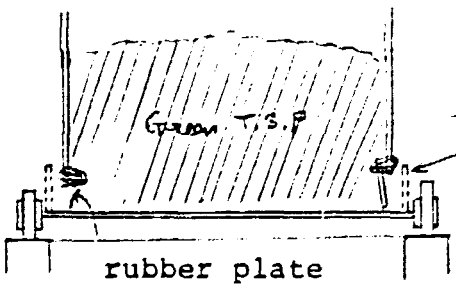
In order to improve running efficiency, following items are also recommended.

a) Revolution speed of cutter

Revolution speed of cutter is confirmed to be 52 RPM on June 3rd, 1981. Design basis is 17-40 RPM. The reason of changing the evolution speed is not clear. For prevention of dusting at the outlet of Den, revolution speed was changed to 35 RPM without any troubles.

b) Side plate in Den

Some quantity of TSP is leaked from the gap between rubber plate and Den plate as follows: Side plate is to be attached as in TSP-1.



3) Drying section of TSP-2

Performance of May 1981 is as follows:

Production per month	5,820 t/m
Running time per month	350.9 h/m
Running efficiency	47%
Stable production rate per hour at running time	20 - 21 t/h

Production rate per hour is 20-21 t/h, so that running efficiency is to be increased to obtain high production rate:

Main reasons and shutdown time are as follows:

Reaction	Shutdown time	Times
Shortage of Labour	40 h/m	5
Shortage of Green TSP	24	1
Trouble of conveyor		
O-3205	166	7
Modification belt	10	3
O-3210	7	4
O-3209	12	1
Trouble of exhaust fan	70	2
Trouble of thrust roller of dryer	24	1

The expert and TSP engineers took many actions for these items which were mentioned in the relevant subject.

G) Review of Operation Manuals

The existing operation manuals were well done and review of these based on latest operating conditions requests only a little amendment regarding SA-2 as shown in Table VII-3. In the course of review, the important points for operation of SA-2 and PA-2 were picked up as shown in Table VII-4 and Table VII-5 in order to compensate inconvenience due to its big volume.

Newly prepared manuals for laboratory and TSP-1 are

1) Determination of total chloride in phosphate rock

2) Calculation method for TSP-1 product

and these are attached as APPENDIX VII-7(1) and (2).

2. Training

The following 4 training courses were conducted. These were held on only necessary subjects to manage the factory efficiently.

Others, of course, should be entrusted to universities, training centers, etc.

Course	Subject	Days	Object (& member)
1. Chemical kinetics	For industrial calculation ° mass & heat balance ° heat transfer ° design of heat exchanger ° gas flow resistance ° evaporation ° combustion	9	° Manager ° Engineer ° Senior chemist ° Superintendent (13-23 members)
2. Mechanical training	° Step of maintenance ° Industrial materials ° Pump assemble and setting ° Piping design ° Setting machine & foundation ° Sketch and design	7	° Mechanical engineer ° Superintendent ° technician (5-16 members)
3. Instrument & Instrumentation	° Theory of pressure ° Pneumatic recorder & transmitter ° Temperature & thermorecorder ° Instrumentation ° Flow meter & calculation ° Measurement of liquid level ° Controller ° Control valve	31	° Instrument engineer ° Technicial ° Apprentice (5-12 members)

	° Controller maintenance ° Inventory control ° System of turbine ° Procedure of actual repairing		
4. Process and operation	° Ratio of air/oil at oil burning ° Calculation of sulfur burning ° Reich test mehtod of SO_2 analysis on job ° How to know SA acid circulation ° Theory of PA product ° Mass & heat balance	14	° Chemical engineer ° Chemist ° Operator (8-12 members)

Some parts of contents of training related to chemical kinetics are attached as APPENDIX VII-8.

5. Electricity

The expert actively attended not only to main trouble shooting as shown in this report but also to other various troubles. And they trained crews on these actual jobs and about testing a protective relay as a special item.

3. Recommendation for the Laboratory

A) Improvement Programme of Laboratory

The expert has assessed the present positions and requirements of laboratory. The main apparatuses /appliance of Laboratory are not in shortage but working condition should be changed. Some improvements/modifications/replacements would be necessary to facilitate Laboratory work as follows.

		Action
1)	Complete cleaning of all drawers, boxes, desks and drought chamber.	Labortory
2)	To make a new sample counter in western side of the main Laboratory. A small extended shed over thiscounter is necessary.	Civil Engineer Mechanical Eng.
3)	To make one wooden file-box to keep results and data sheet in convenient order.	Manager (MPC)
4)	To repair/replacement of air coolers of balance room and store room which have been lying disordered.	Electrical Eng.
5)	Re-arrangement of Laboratory store room and placement of material in order.	Laboratory

6)	Procurement of L.P. gas for using in Bursen burner for Glass works. (Bursen burner is available in the Laboratory which is to be set to work with L.P. gas.)	M.P.C.
7)	To procure 2 Nos of Exhaus Fan for Fuming cup board (Acid proof, P.V.C. covered.)	M.P.C.
8)	To clean and re-arrange the sampling room (Grinding & Sieving room)	Laboratory
9)	To prepare one show case with glass fittings for arranging reference literatures, manuals and valuable documents, tool kits & delicate spares.	M.P.C.
10)	Extension of one laboratory room to accommodate special analytical work for research and development.	Civil Engineer
11)	Procurement of spare parts of laboratory instruments (List of spare will be prepared & processed)	M.P.C.
12)	One electrical and instrument specialist is essential for laboratory. Minimum one person should be trained up in this line either at Dacca or in foreign country.	Admn./Trg.

13)	All water sinks and fittings of laboratory are to be repaired and replaced.	Civil Engineer
14)	Preparation and fixing of tables for reagent bottle. Labelling and placement of reagent bottles in order are essential.	Laboratory
15)	One head-tank aspirator bottle should be used for feeding demi water to different analytical/titration vessels. Setting of branched stop cock would be helpful to use water at multiple points of analysis from the same aspirator tank.	Laboratory
16)	Working space/accommodation of laboratory is insufficient. One office room is needed for laboratory.	Manager (Admn)
17)	All results of final products (TSP) should be expressed graphically to make quality control system.	Laboratory

The details & allocation are shown in APPENDIX VII-9.

B) Home Made Manometer and Hydrometer

1) Home made manometer

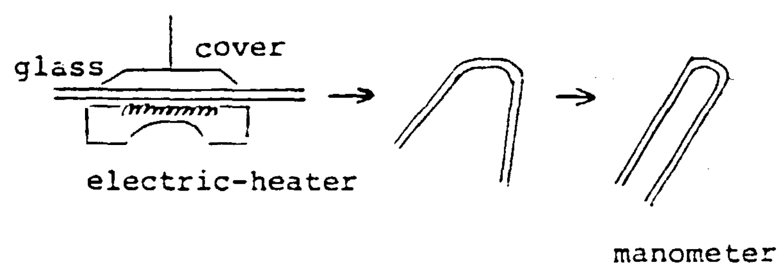
It is quite important to make home made apparatus, such as manometer in laboratory. But in this laboratory, gas burner required to do it is not available.

Electric heater was used in order to bend glass as shown below.

This method is very convenient in this factory.

Especially SA-1 requests to establish pressure measuring system in order to maintain good operation, as SA plant engineers should know the pressure at each equipment. As minimum, 7 manometers are now required. Now they are able to make them easily with this method.

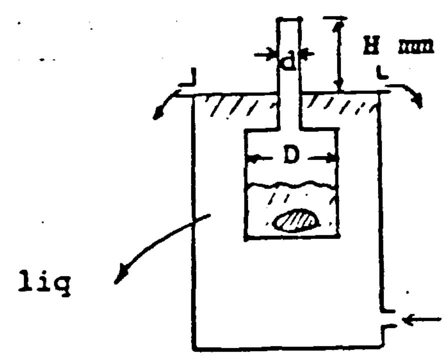
Also 1.5 kg mercury is required to apply these manometers.



2) Home made hydrometer

Hydrometer gives convenient data for operation of chemical plants. In phosphoric acid plant, hydrometer made of glass is easily corroded due to fluorine in acid. But in this country, procurement of adequate hydrometer is somewhat difficult. Therefore, ~~the~~ expert made one sample of home made hydrometer to measure the density of return acid in PA-1 as shown here. As continuous measuring method, this is very convenient.

Materials and procedures are mentioned in APPENDIX VII-10.



4. Consultation for Future Industries

In this corporation, many studies regarding new project for new products have been conducted by directors and managers of BCIC.

The expert team prepared the information as to production methods and technical calculations to develop these plans.

The following products are now all imported. Demand of these product is not so high at present but these will increase in the near future.

A) Alkyl benzene sodium sulphate. (as raw material of synthetic detergent)

$$R.H. + SO_3 = RSO_3H$$

$$RSO_3H + NaOH = RSO_3Na$$

RSO_3H is now imported to produce RSO_3Na which is raw material of synthetic detergent. If this production is possible in this country, exportation of product to neighbor countries is much expected.

B) Purified Sulphuric Acid

Purified sulphuric acid is made from demineralized water and SO_3 gas from converter in special equipments by establishing of the small plant such as SO_3 absorbing tower, tank pump, piping, etc. as shown in APPENDIX VII-11.

Industrial sulphuric acid costs about 2 Tk/kg, but purified SA costs about 100 Tk/kg. This is now all imported at high price. Production cost is not so expensive because SO_3 gas and DM water are already available here, and the requested equipments are little.

C) DAP (Diammonium Phosphate)

Ammonia plant will be constructed near here, so that production of DAP will be convenient to this TSP factory.

Production of DAP is not so difficult as that of TSP. Therefore, the "Preliminary Information for Diammonium Phosphate Plant" based on Nissan process is prepared which is shown in APPENDIX VII-12.

D) Ammonium Nitrate Phosphate

Ammonium nitrate phosphate is produced as follows:

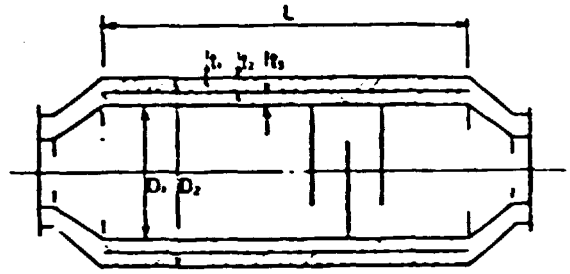
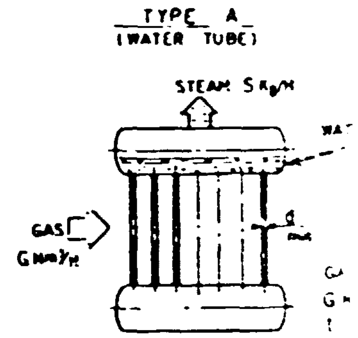
$$3Ca_3(PO_4)_2.CaF_2 \rightarrow 6H_3PO_4 + 10Ca(NO_3)_2 + 2HF$$

$$6H_3PO_4 + 4H_3PO_4 + 10Ca(NO_3)_2 + 2HF + 20NH_3 \rightarrow 10\ CaHPO_4 + 20NH_4NO_3 + 2HF$$

The "Preliminary Information for Nitrophosphate Granulated Fertilizer Process" based on Nissan process is also prepared which is shown in APPENDIX VII-13.

In both processes of DAP and nitrophosphate mentioned above, NPK fertilizer is easily produced by addition of potassium. In this TSP factory, production of DAP may be preferable in view of raw material and their experience.

Table VII-1(1) Comparison of Main Equipments of Sulphuric Acid Plan

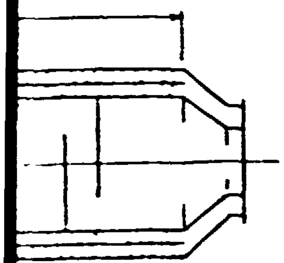
	SF	
	 C : capacity SA T/D S : Sulfur t/H V : furnace vol m^3 Q : furnace heat load $Mcal/m^3hr$ B : Baffle plate No. Unit of length : mm	 N : tube No. A : heat area m^2 Q : heat cal M cal/H

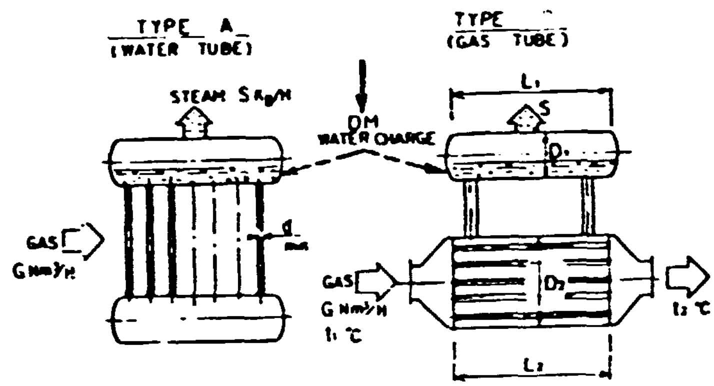
		D_1	D_2	L	t_1	t_2	t_3	Type	L_1	L_2	D_1
BANGLA	SA-2	3,410	4,100	8,400	9	230	115	A	5,130		1,116
	SA-1	2,057	2,743	6,096	9?	330		B 1 2	1.8 "	4,570 1,830	1,070 "
INDIA	SPIC	1,850	2,150 (air zone 2,630)	15,000	(10)	350		B		5,500	
JAPAN	NICHIRIN (Double contact)	3,510	4,200	10,800	10	350		A	4,150	3,705	1,250
	NAGOYA	2,300	3,020	8,150	12	118	230	A	2,400		753

		C	S	V	Q	B	S	G	V
BANGLA	SA-2	400	5.60	76.7	178	3	20.2	35,200	
	SA-1	100 (SF in air 260°C)	1.40	20.2	238 (Only S 153)	2	1 5.19 2 1.19	13,200 12,800	8.0 11.2
INDIA	SPIC	470	6.56	40.3 (shell cooling system)	398		23.8	41,300	8.9
JAPAN	NICHIRIN	1,000	13.80 (two SF system)	104.5	164	3	25.3 x 2	45,500 x 2	8.8
	NAGOYA	175	2.45	33.8	161	1	3.7	13,700	6.8

SECTION 1

P	WHB





ad Mcal/m^{3}hr

N : tube No.

A : heat area m^2

Q : heat cal M cal/H

V : gas velocity Nm/Sec.

M : tube material

α : unit generate steam (S/A) kg/m^2/hr

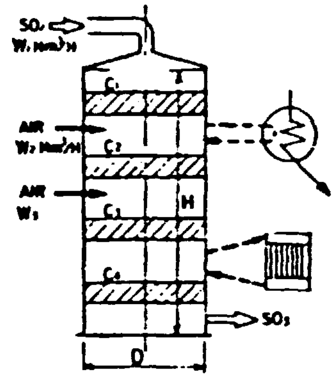
L	t_1	t_2	t_3	Type	L_1	L_2	D_1	D_2	d^{OD}	N	t_1	t_2
.400	9	230	115	A	5,130		1,116		50.8	723	1,025	430
,096	9?		330	B 1 2	1.8 "	4,570 1,830	1,070 "	1,350 1,170	" "	204 144	1,020 593	440 450
,000	(10)		350	B		5,500		2,200	50.8	638	1,035	435
,800	10		350	A	4,150	3,705	1,250	4,500	50.8	802	1,120	430
,150	12	118	230	A	2,400		753		50.8	240	1,150	730

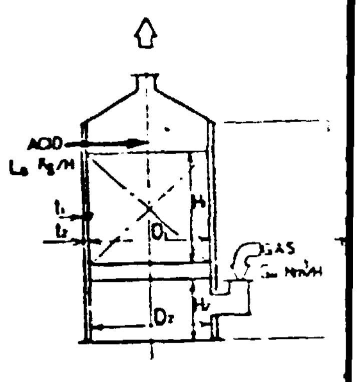
V	Q	B	S	G	V	A	Q	α	M
.7	178	3	20.2	35,200		355	7,789	56.9	STB35 -SH
.2	238 (Only S 153)	2	1 5.19 2 1.19	13,200 12,800	8.0 11.2	146 41	2,737 666	35.5 29.0	STB35
.3 ell cooling system)	398		23.8	41,300	8.9	561	9,140	42.7	
4.5 m)	164	3	25.3 x 2	45,500 x 2	8.8	515 x 2	11,900 x 2	49	STB35EG
3.8	161	1	3.7	13,700	6.8	58	2,380	64	STB35

SECTION 2

Table VII-1(2) Comparison of Main Equipments of Sulphuric Acid Plant

	CV	A





Catalyst vol C_1, C_2, C_3, C_4 (m^3)

V: Gas flow vel at 1st layer (Nm^3/sec)

R: Cal vol ratio C/SA product(lit/t/D)

cooling type for 2nd bed

q: Air quench

B: Boiler

SH: Super heater (steam)

A : tower area m^2

L : Acid flow t/H, L_o/A kg/m

G : gas flow (G_o/A) x 1.32

L/G : Acid gas flow ratio

Q : Gas retention time (seco

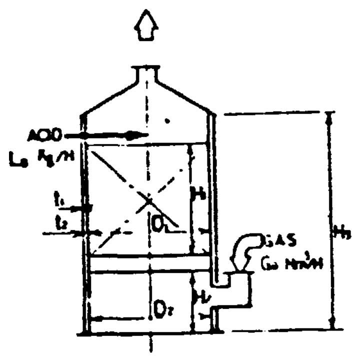
Sort of patching = R : Rasc / S : Inte

		Type	Catalyst C_1	C_2	C_3	C_4	ΣC	R	H_1 m	H_2 m	H_3 m	t_1
BANGLA	SA-2	q	11	12	25	27	75	187	5.75	2.4	9.8	9
	SA-1	B	3.2 new all	3.53 (0.3)	3.8 (1.35)	4.5	15.13	151	3.12	1.98	7.3	
INDIA	SPIC	q	15.9	22.8	31.8	45.3	115.8	246	5.35	2.55	8.2	12
JAPAN	NICHIRIN (Double contact)	SH	29	42	43	40	154	154	4.20	2.78	9.2	12
	NAGOYA	q										

		W_1	W_2	W_3	V	D	H	A	L_ox10^3	L_ox10^3
BANGLA	SA-2	35,200	11,760	11,660				34.[illegible]	885	24.8
	SA-1	13,200	- WHB	2,045 (4c,400)		3.2[illegible](ICV) 3.5[illegible]	7.37	5.35	180	30.8
INDIA	SPIC	41,300	12,500	HE (3c in 6,570)		7.46 7.8($^4_3$CJ)		24.[illegible]	864	34.4
JAPAN	NICHIRIN	92,00	($\bar{3}$H)			9.6	13	28.3	1,120	39.6
	NAGOYA	14,700	17,700	HE			13			

SECTION 1

CV	AT



H : PACKING HEIGHT

,C_4 (m^3)
: layer (Nm^3/sec)
SA product(lit/t/D)
d bed

am)

A : tower area m^2
L : Acid flow t/H, L_0/A kg/m^2hr
G : gas flow (G_0/A) x 1.32 kg/m^2hr
L/G : Acid gas flow ratio
Q : Gas retention time (second)

Sort of patching = R : Raschig ring
S : Interock saddle

Catalyst C_3	C_4	ΣC	R	H_1 m	H_2 m	H_3 m	t_1	t_2	D_1	D_2	R or S
25	27	75	187	5.75	2.4	9.8	9	55	6.52	6.21	R
3.8 (1.35)	4.5	15.13	151	3.12	1.98	7.3		105	2.74	2.74	S
31.8	45.3	119.8	246	5.35	2.55	8.2	12	55	5.71	-	R
43	40	15[illegible]	154	4.20	2.78	9.2	12	103	6.0	-	S

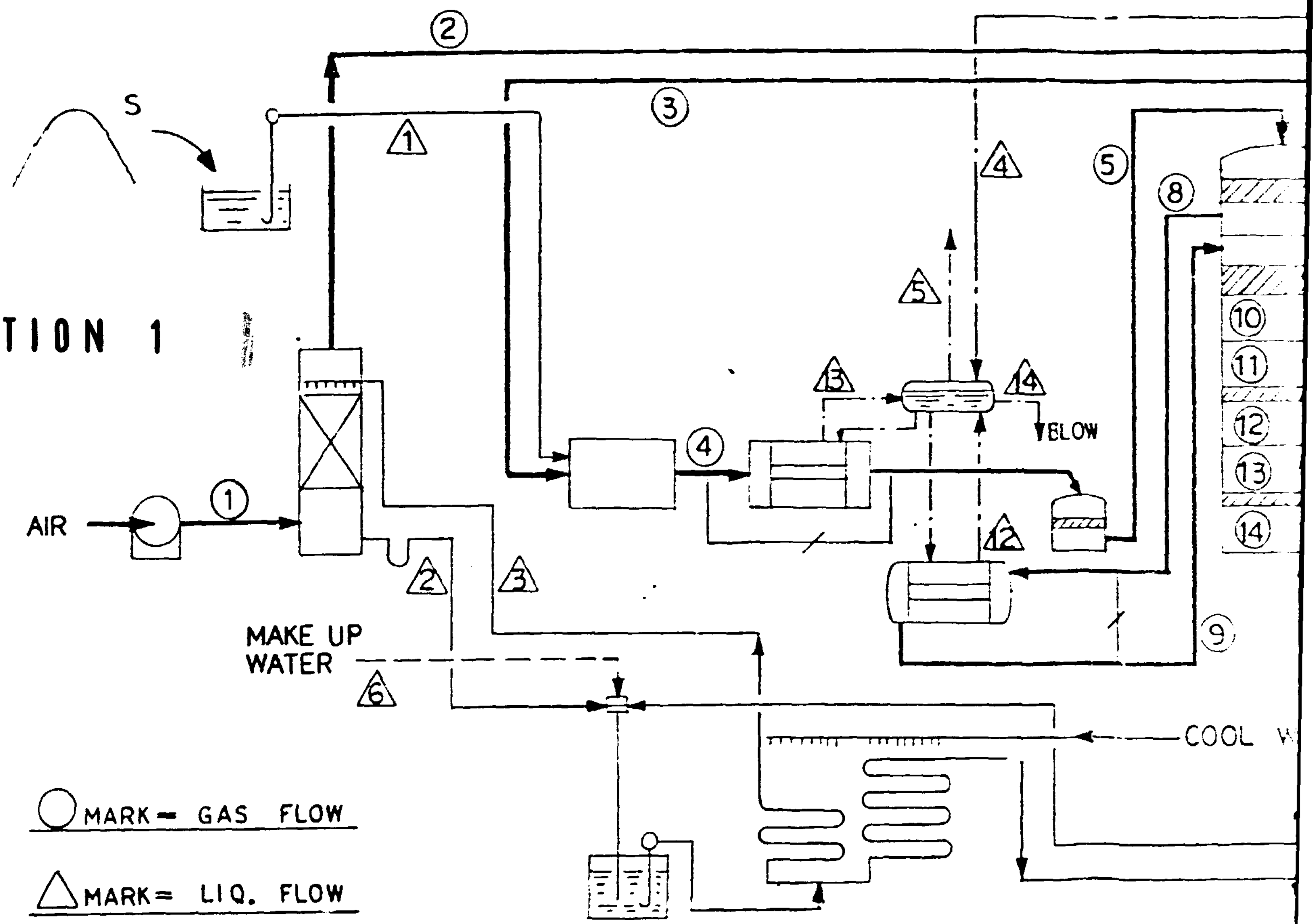
W_3	V	D	H	A	L_0x10^3	L_0x10^3	G_0x10^3	G	L/G	θ
,660				34.[illegible]	885	2[illegible].8	56.7	2,180	11.3	9.2
,045 (,400)		3.2[illegible](ICV) 3.5[illegible]	7.37	5.35	180	30.8	15.0	3,384	10.9	3.0
HE in ,570)		7.4[illegible] 7.8($^4_3$CJ)		24.[illegible]	864	34.4	58.2	3,024	11.3	6.2
		9.6	13	28.3	1,120	39.6	134.1	4,739	8.4	4.8
HE			13							

SECTION 2

Table VII-2(1)

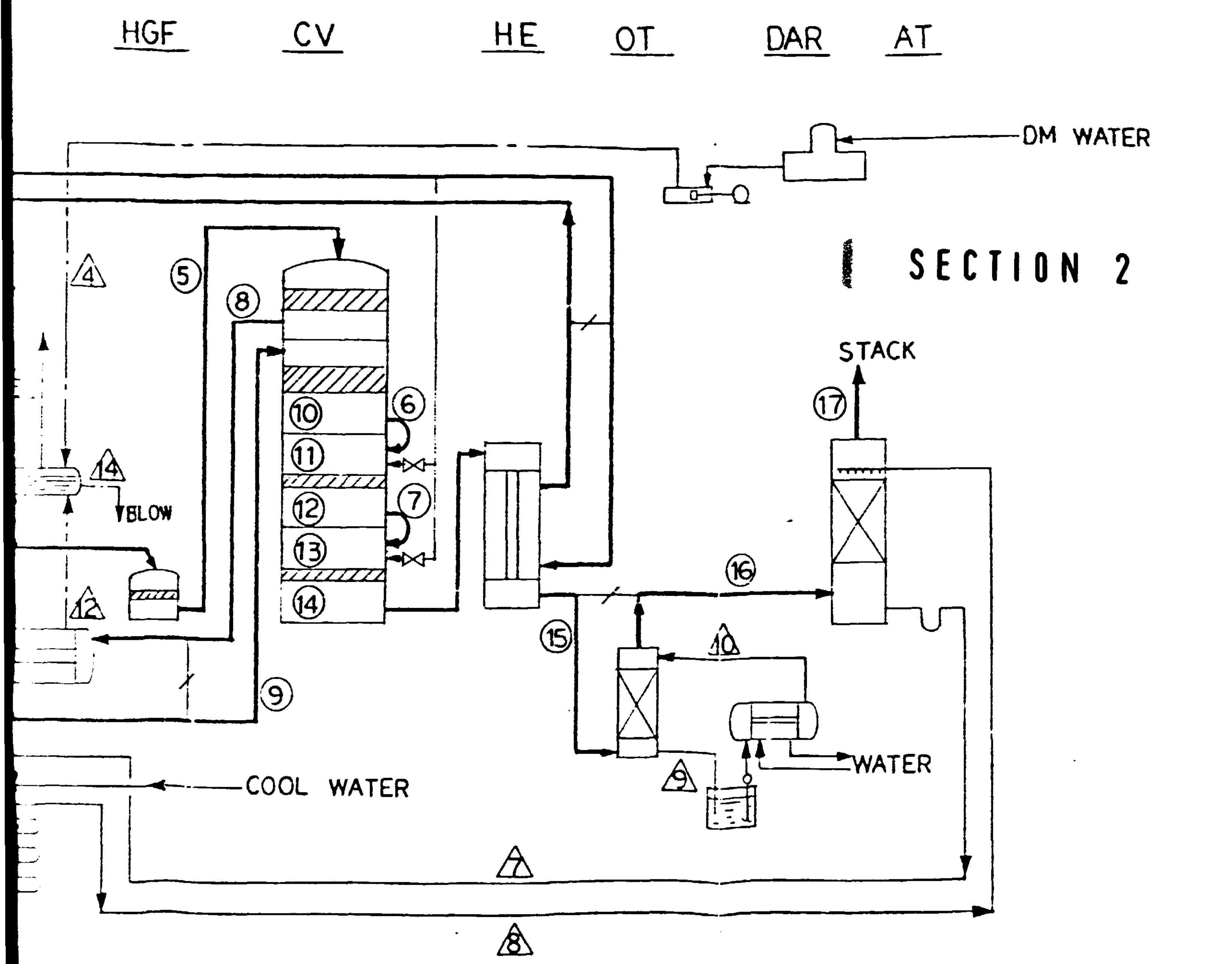
SA－1 MASS BALANCE

SECTION 1



		NO.	1	2	3	4	5	6	7	8
GAS FLOW	TOTAL GAS VOL.	Nm³/H	15,650	DO	13,200	13,200	DO	2,045	400	12,900
	SO_2	Nm³/H	0	0	0	(7.5%) 990	DO	0	0	(2.4%) 317
	SO_3	Nm³/H								673
	TEMP.	°C	50	60	260	1,000	450	60	60	600
LIQ. FLOW	FLOW WEIGHT (ACID)	Kg/H			120,000		6,060	6,380	180,000	

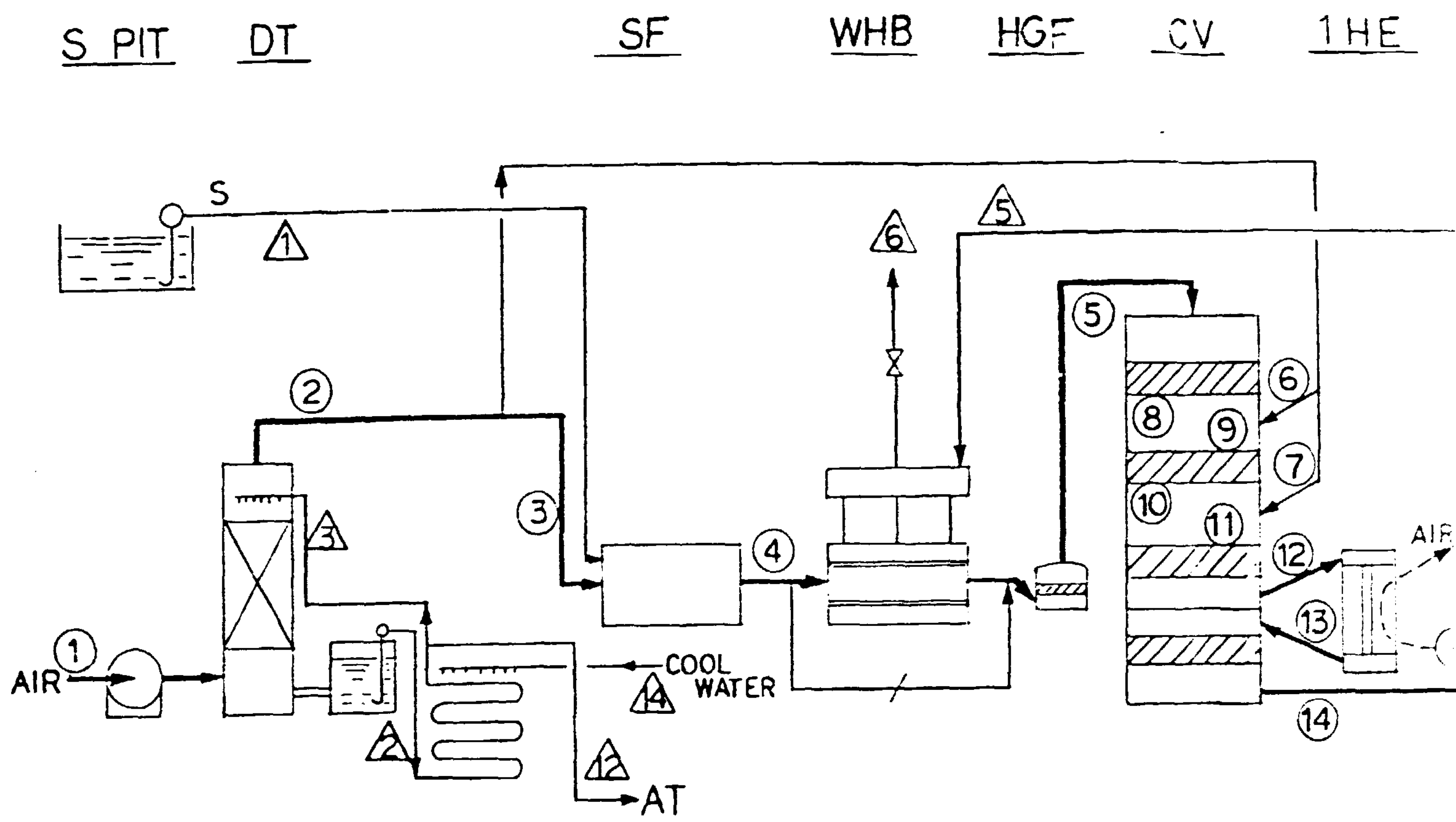
SS BALANCE (100T/D)



	7	8	9	10	11	12	13	14	15	16	17
45	400	12,900	DO	12,800	14,840	DO	15,200	15,200	DO	15,000	14,000
0	0	(2.4%) 317	DO	(1.1%) 145	DO	89	DO	30	DO		
		673	DO	845	DO	901	DO	960	DO		
50	60	600	445	520	450	466	452	457	280		
80	180,000					5,190	1,190	320			

Table VII-2(2)

SA-2 MASS BALANCE (4C



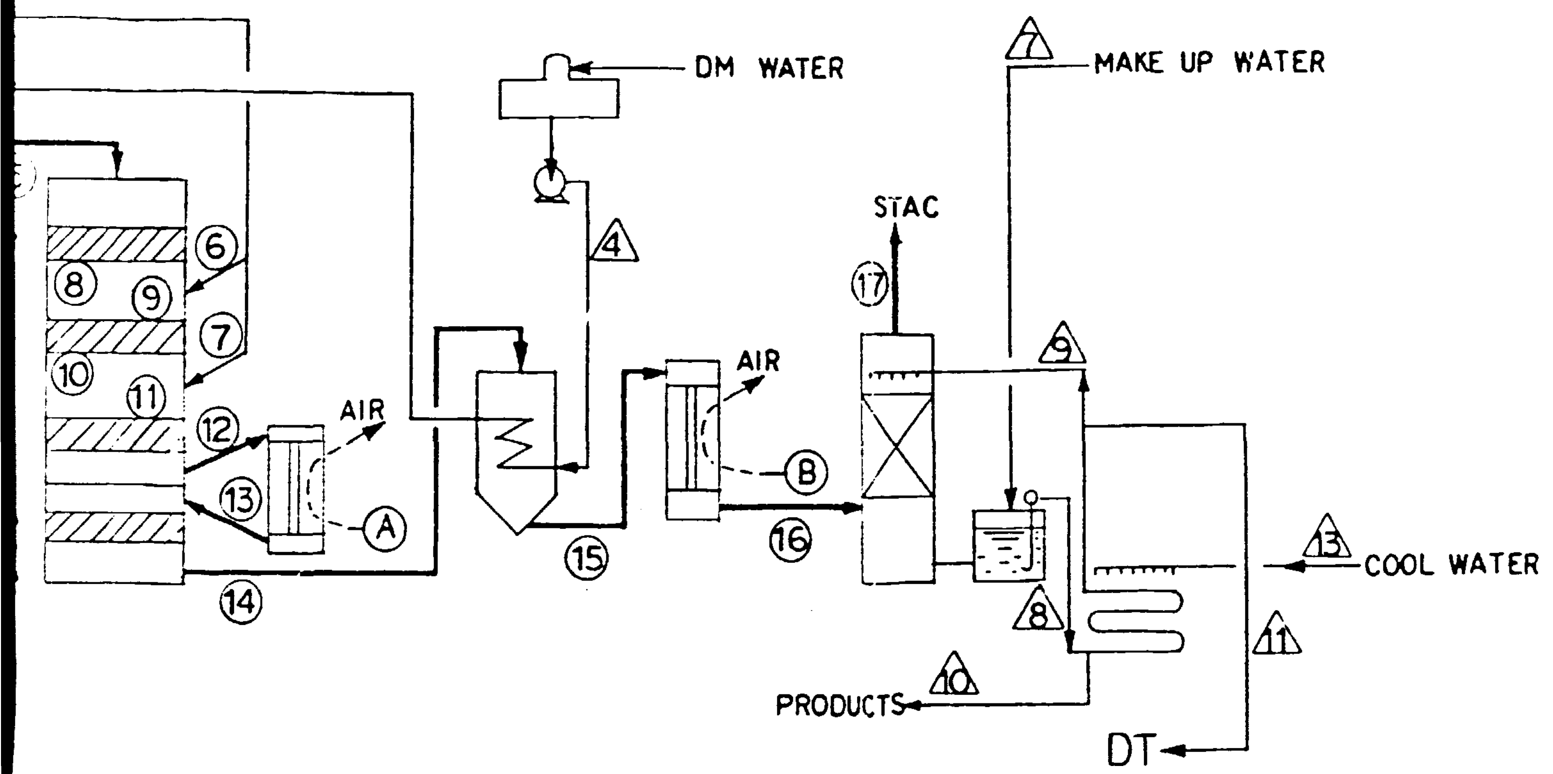
◯ MARK = GAS FLOW

△ MARK = LIQ. FLOW

		NO.	1	2	3	4	5	6	7	8	9
GAS FLOW	TOTAL GAS VOL.	Nm^3/H	58.618	DO	35,208	DO	DO	11,755	11,655	33,988	45
	SO_2	Nm^3/H	—	—	—	3,863	DO	—	—	1,546	[illegible]
	SO_3	Nm^3/H	—	—	—					2,370	[illegible]
	TEMP.	°C	(H=88%) 34	41	DO		420	41	41	603	
	OTHERS		(H_2O= 2030Kg)			SO_2 11 %				CV RATING 60 %	
LIQ. FLOW	FLOW WEIGHT	Kg/H	5,703	936,970	894,630	23,100	DO	22,000	1,327	929,370	885.
	TEMP.	°C	140	47.8	40	100	200	214	32	828	
			(IDEAL 5,442 Kg)				P. 22 Kg/Cm²	P. 20 Kg/Cm²	(TOTAL WATER TO SA 3,354Kg/H)		

ALANCE (400 T/D)

CV 1HE ECO DAR 2HE AT



7	8	9	10	11	12	13	14	15	16	17
11,655	33,988	45,743	45,271	56,926	56,718	DO	56,680	DO	DO	52,790
—	1,546	DO	580	DO	155	DO	76	DO	DO	40
	2,370	DO	3,358	DO	3,792	DO	3,873	DO	DO	19
41	603	476	534	445	464	433	435	238	171	70
	CV RATING 60 %		CV % 85		CV % 96	HEAT TRANS-FER(KCal/H) 859×10^3	CV % 98	HEAT TRANSFER (KCal/H) $1,110\times10^3$		
1,327	929,370	885,000	17,120	42,340	44,370	430,000	330,500			
32	828	65	828 → 45	65	40	32 → 45	32 → 40			
TOTAL WATER TO SA 3,354Kg/H						$\Delta q\times10^3$ KCal 5,585 + 357 (EVA.)	$\Delta q\times10^3$ KCal 2,644 + 58 (EVA.)			

		A	B
VOL.	Nm³/H	17,750	
TEMP. (°C)	IN	34	34
	OUT	180	140

Table VII -3 Amendment of Operation Manual for SA-2

No.	Page	Item	Original	Correct[illegible]
1	13	2-1	Max. temp. 13°C	Min. temp. 13°C
2	13	2-2	SO_2 1 kg - mol = 21.9 Nm^3	Right, but in industria[illegible] is used (error only 2 [illegible]
3	4	0	O_2 quantity concerned in reaction	...... in reaction at [illegible]
4	11	Top	...the operator should make sure of the result of each change on gas strength before	each change on SF temper[illegible]
5	12	Center	S. pump should be stopped, and the blower a minute later.	Two minutes later
6	10	New item	Operation stop time	Only S. pump should be [illegible] in order to prevent th[illegible]
7	17	Top	Boiler glass gauge blow down (it is not clear)	See "the important poi[illegible] It is mentioned in deta[illegible]
8	21	Bottom	Do not lower the 4C inlet gas temp. below 410°C	425°C (410°C is too l[illegible]
9	23	f		Add following item: In case of taking out [illegible] should be taken and se[illegible]
10	25	1	Cause of drain	Add following item : (V) Steam leakage of [illegible] from distributor
11	28	b	In this item, it is not mentioned how to know the acid flow rate	Add following item : Measurement of the le[illegible] 2.5 minutes after jus[illegible] is possible from the [illegible] of first and last 0.5 [illegible]

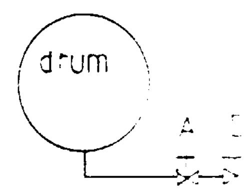
SECTION 1

r SA-2

iginal	Correction
	Min. temp. 13°C
21.9 Nm^3	Right, but in industrial calculation generally 22.4 Nm^3 is used (error only 2 %)
rned in reaction	...... in reaction at SF. (Sulfur Furnace)
hould make sure of the result of s strength before	each change on SF temperature before
stopped, and the blower a	Two minutes later
ne	Only S. pump should be running after S cock is established in order to prevent the pump choking
e blow down (it is not clear)	See "the important point of operation manual No.6". It is mentioned in detail.
4C inlet gas temp. below 410°C	425°C (410°C is too low)
	Add following item: In case of taking out catalyst, sample of each catalyst should be taken and sent to the maker to analyze it.
....	Add following item : (V) Steam leakage of S gun steam jacket. DT acid flushing from distributor
s not mentioned how to know	Add following item : Measurement of the level down of pump tank during 0.5 to 2.5 minutes after just starting the pump. The calculation is possible from the level and time. Cutting off the data of first and last 0.5 minutes(PT level 1% - 1.61t acid).

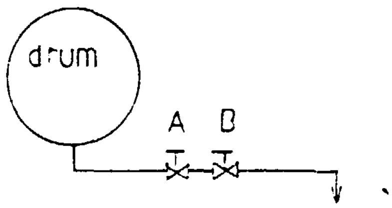
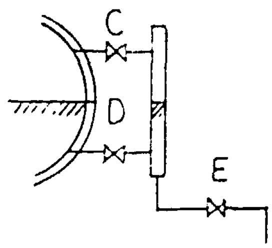
SECTION 2

Table VII-4 Important Points of Operation Manual for SA-2

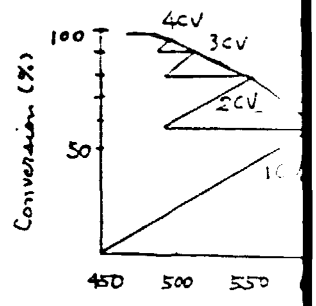
No.	Section	Item	Reason of
1	S. melter	Necessary to keep the level of molten S. (This face has some protectors.)	On sulfur - air in
2	S. pump	This is interlocked with air blower, but make sure this pump stopping when blower is stopped.	Prevent over-heat,
3	S. furnace	Relations between flame temp. and SO_2 concentration	Temp. (°C) SO_2 (%)
4	Boiler level	Drum water level should be kept and trip system is 1) Low level alarm 60 mm below standard 2) Blower trip 100 mm below standard	Boiler tubes are
5	Boiler b blow	Blow down every day with following procedure. Step / Seat tise type / Sliding-plunger type First open / A / B Next open / B / A First close / B / A Last close / A / B	 Closing time = grad (To avoid water ham
6	Boiler gauge glass cleaning	Blow down every day with following procedure. Step: 1 / 2 / 3 / 4 / 5 / 6 Valve open & close: Close C and D / Open E / Open C gradually / Steam flush in 20 sec / Close E / Open D gradually	

SECTION 1

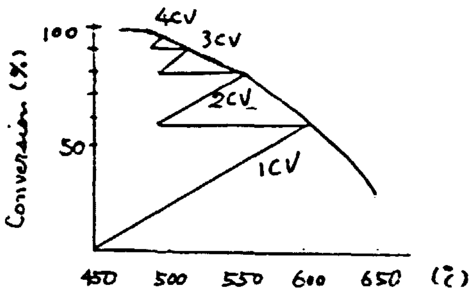
. for SA-2

	Reason of Specification	Reference Page
molten S. .)	On sulfur - air interface most corrosion occurs.	9
lower, but make sure this topped.	Prevent over-heat, sublimation, explosion	10
and SO_2 concentration	Temp. (°C) 943 1,024 1,104 SO_2 (%) 10 11 12	12
t and trip system is w standard w standard	Boiler tubes are quickly melted at empty firing.	16
ving procedure. Sliding-plunger type B A A B	 Closing time = gradually and tightly (To avoid water hammer).	16
ving procedure. 3 Open C gradually 4 Steam flush in 20 sec 5 Close E 6 Open D gradually		17

SECTION 2

<table>
<tr><th>No.</th><th>Section</th><th>Item</th><th>Reason</th></tr>
<tr><td>7</td><td>CV gas temperature (°C)</td><td>Standard temperature is as follows :
<table>
<tr><th></th><th>SF</th><th>1C</th><th>2C</th><th>3C</th><th>4C</th><th>2HE</th></tr>
<tr><td>In</td><td>-</td><td>430</td><td>480</td><td>450</td><td>433</td><td>238</td></tr>
<tr><td>Out</td><td>1,050</td><td>603</td><td>560</td><td>470</td><td>438</td><td>180</td></tr>
</table></td><td>
</td></tr>
<tr><td>8</td><td>Air volume</td><td>DT inlet 58,400 Nm^3/H
SF inlet 35,200 "</td><td></td></tr>
<tr><td>9</td><td>Acid temp.</td><td>DT inlet 40°C (desirable)
AT inlet 65°C (")</td><td>Maximum effect for
Maximum effect for protection.</td></tr>
<tr><td>10.</td><td>PT Acid</td><td>Normal PT level - 1,100 mm (level % : 75)</td><td>In case of pump s
20%. It is almos
duct from bottom</td></tr>
<tr><td>11</td><td>Turbine</td><td>1. Check the manual for each equipment.
2. Blow off drain completely.
3. Warm up with steam gradually.</td><td></td></tr>
</table>

SECTION 1

<table>
<tr><th></th><th>Reason of Specification</th><th>Reference Page</th></tr>
<tr><td>as follows :
<table><tr><th>2C</th><th>3C</th><th>4C</th><th>2HE</th></tr><tr><td>480</td><td>450</td><td>433</td><td>238</td></tr><tr><td>560</td><td>470</td><td>438</td><td>180</td></tr></table></td><td></td><td>20</td></tr>
<tr><td>3,400 Nm³/H
5,200 "</td><td></td><td></td></tr>
<tr><td>0°C (desirable)
5°C (")</td><td>Maximum effect for drying
Maximum effect for absorbing and material protection.</td><td></td></tr>
<tr><td>0 mm (level % : 75)</td><td>In case of pump stop, level increase is about 20%. It is almost full. Level of gas inlet duct from bottom is 1,400 mm.</td><td></td></tr>
<tr><td>each equipment.
etely.
adually.</td><td></td><td></td></tr>
</table>

SECTION 2

Table VII-5 Important Points of Operation Manual for PA-2

No.	Section	Reference Page	Item	
1	Rock Grinding	1-70 1-80	Particle size of ground rock Standard fineness -100 Tyler Mesh 90% (min) -200 Tyler Mesh 70% (min)	If the fineness of fe fineness can be tolera ratio at the outlet of able to save unit consu
2	Digestion	1-82	Decomposition with one unit of digester	In case that decomposi digester is over 80% be bypassed and held
3	Digestion	2-30 2-32	Prevention of clogging in exhaust gas duct from digester	In order to maintain are requested to chec opening of the dampe
4	Digestion	1-90 2-41 2-43	Control of crystallizer slurry temperature Typical temperature gradient 67 - 59 - 55 (°C)	By adjustment of exha minimum leakage from of cooling air pipe, maintained.
5	Digestion	2-29 2-34 2-41	Start-up and shut-down of agitator	All agitators of PA pl breakage of shaft and is under the lower ed
6	Digestion	2-67	Instruments	Chain test of Rock Wei meter with Return Aci during scheduled shut-
7	Filtration	1-92 1-98 2-49 1-4* 2-11*	Shortage of cake washing water	Supply of process wat Tank should be avoide shortage of cake wash to decrease of washin
8	Concentration	2-3* 2-7*	Shortage of river water for Concentrator Condensers	Shortage of river wat breakage of vacuum du sufficient river wate

* Asterisked pages belong to manual of Concentration Section.

SECTION 1

.l for PA-2

Item	Content
f ground rock . ss -100 Tyler Mesh 90% (min) -200 Tyler Mesh 70% (min)	If the fineness of feed rock which is coarser than the standard fineness can be tolerable to maintain more than 80% decomposition ratio at the outlet of digester, such coarse fineness is acceptable to save unit consumption of electricity.
ith one unit of digester	In case that decomposition ratio of rock using one unit of digester is over 80% at the outlet of digester, the other can be bypassed and held as a standby.
logging in exhaust gas duct	In order to maintain suitable temperature of digester, operators are requested to check the gas duct periodically and to adjust opening of the damper.
stallizer slurry temperature ture gradient - 55 (°C)	By adjustment of exhaust gas damper of each crystallizer, and minimum leakage from manhole and trough, and scheduled cleaning of cooling air pipr, sufficient cooling of slurry is to be maintained.
ut-down of agitator	All agitators of PA plant are to be stopped to prevent the breakage of shaft and bearing when level of slurry of liquid is under the lower edge of agitator blades.
	Chain test of Rock Weigher and calibration of return acid flow meter with Return Acid Head Tank should be conducted periodically during scheduled shut-down time.
e washing water	Supply of process water to 3rd Seal Tank in stead of Hot Water Tank should be avoided. Even if decomposition ratio is high, shortage of cake washing water prevents high P_2O_5 recovery due to decrease of washing ratio.
er water for ndensers	Shortage of river water for Concentrator Condensers causes breakage of vacuum due to incomplete condensation. Supply of sufficient river water for 100% load is to be confirmed.

tration Section.

SECTION 2

UNICO

11511
(2 of 2)

THE APPENDIX TO
THE FINAL REPORT ON
OPERATION AND MANAGEMENT
OF FERTILIZER PLANTS
IN BANGLADESH

(PROJECT NO. DP/BGD/78/002)
(CONTRACT NO. UNIDO 79/75)

UNICO INTERNATIONAL CORPORATION
TOKYO, JAPAN

11511
(2 of 2)

The Appendix to The Final Report on Operation and Management of Fertilizer Plants in Bangladesh

(PROJECT NO. DP/BGD/78/002)
(CONTRACT NO. UNIDO 79/75)

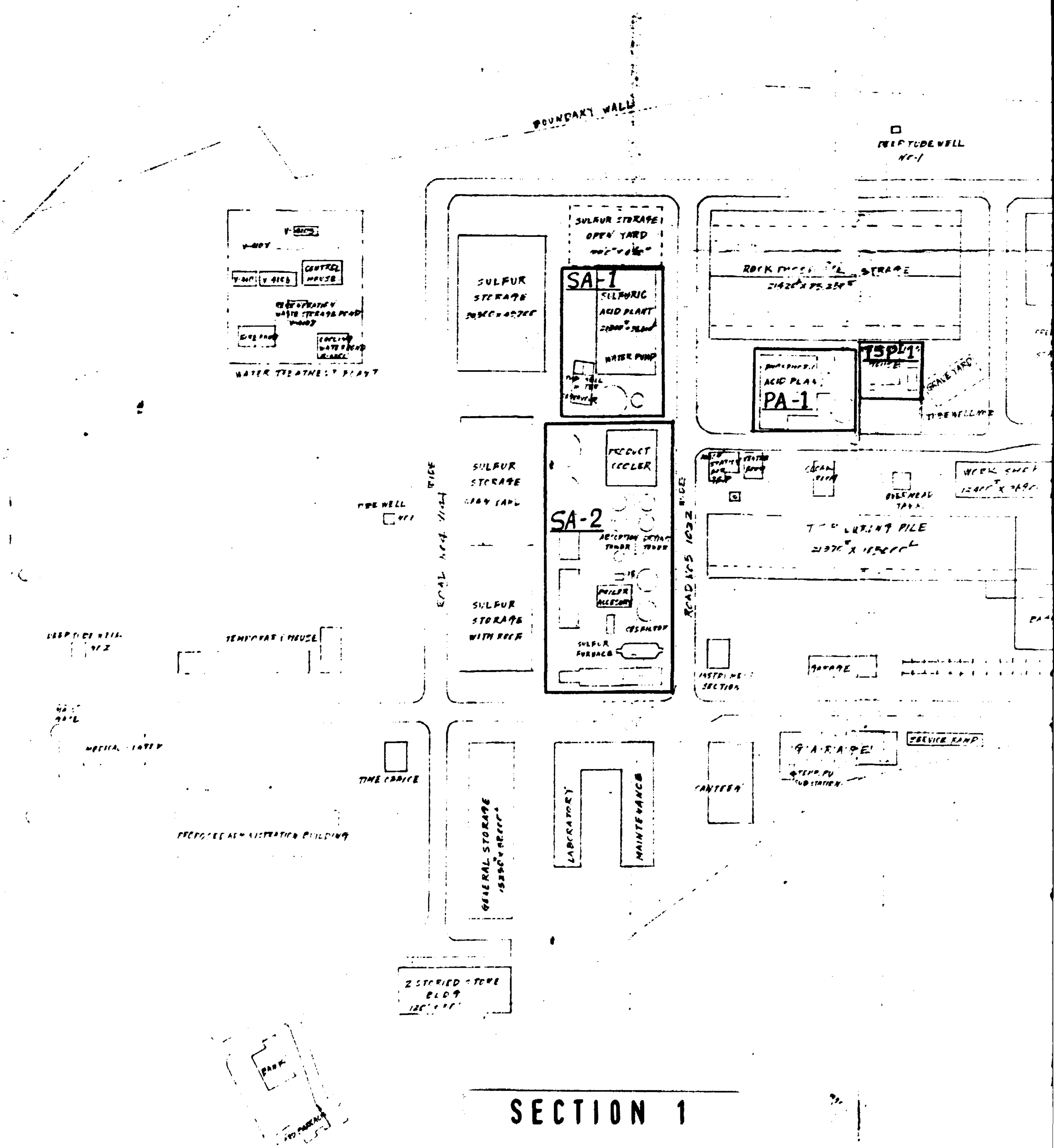
Mr. T. Ikeya Team Leader-TSP Complex
UNICO International Corp./NISSAN Chemical Co.

May, 1982

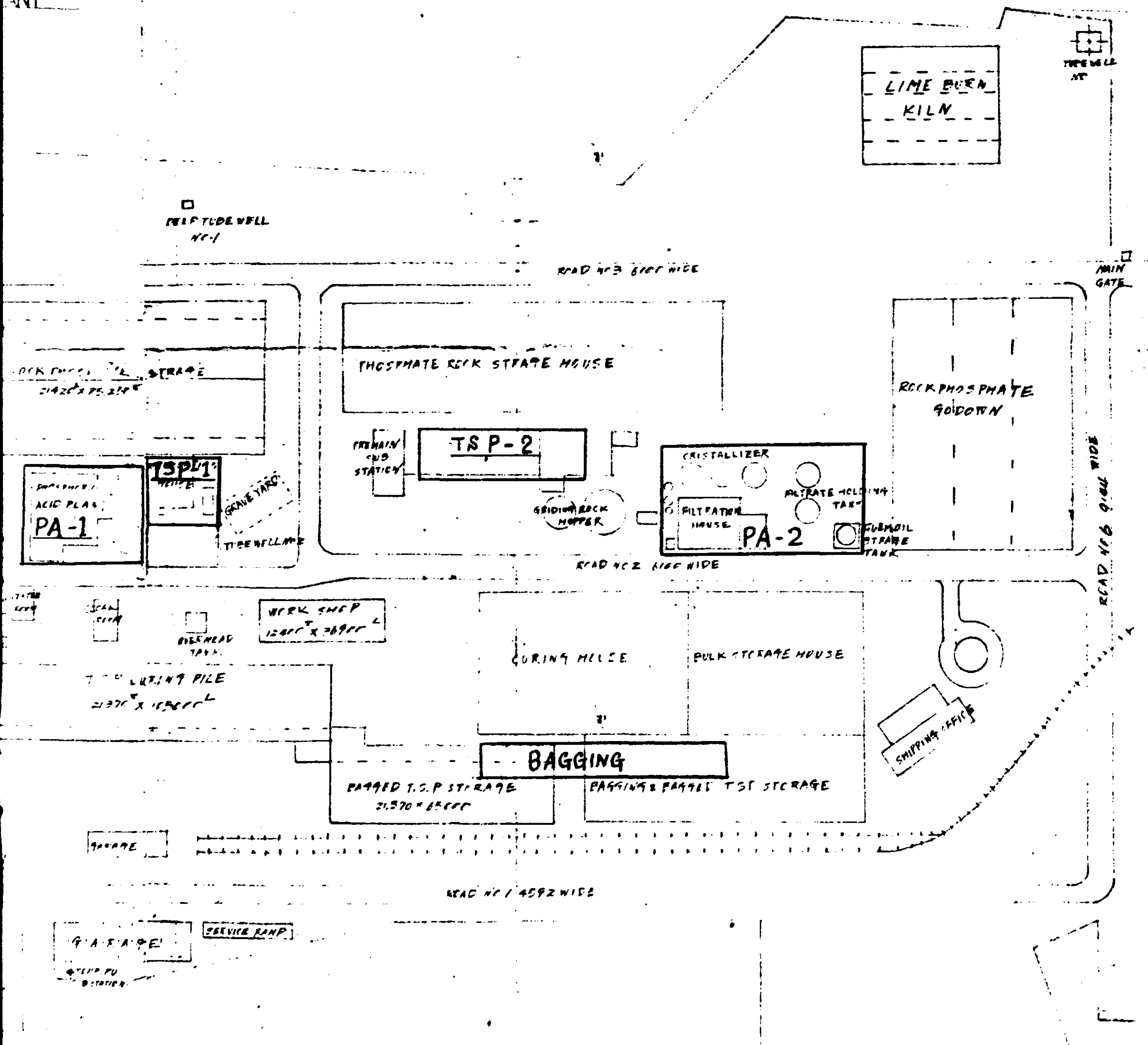
CONTENTS OF APPENDIX

(Following chapter is the same chapter of the related chapter in the main report.)

APPENDIX III-1 LAY OUT OF TSP FERTILIZER PLANT



SECTION 1


LIME BURN KILN
TUBE WELL
DEEP TUBE WELL NO-1
ROAD NO 3
MAIN GATE
PHOSPHATE ROCK STORAGE HOUSE
ROCK PHOSPHATE GODOWN
TSP-2
PA-2
PA-1
TSP-1
CRISTALLIZER
FILTRATION HOUSE
FILTRATE HOLDING TANK
FUEL OIL STORAGE TANK
GRINDING ROCK HOPPER
GRAVE YARD
TUBE WELL
ROAD NO 2
ROAD NO 6
WORK SHOP
OVERHEAD TANK
CURING PILE
CURING HOUSE
BULK STORAGE HOUSE
SHIPPING OFFICE
BAGGING
BAGGED T.S.P STORAGE
BAGGING & BAGGED TSP STORAGE
GARAGE
ROAD NO 1
SERVICE RAMP
GARAGE

SECTION 2

APPENDIX V-1(1) AT ACID DISTRIBUTOR

	SA-2	SA-1
At diameter	6,500 mmø	2,743 mmø
area	33.2 m^2	5.9 m^2

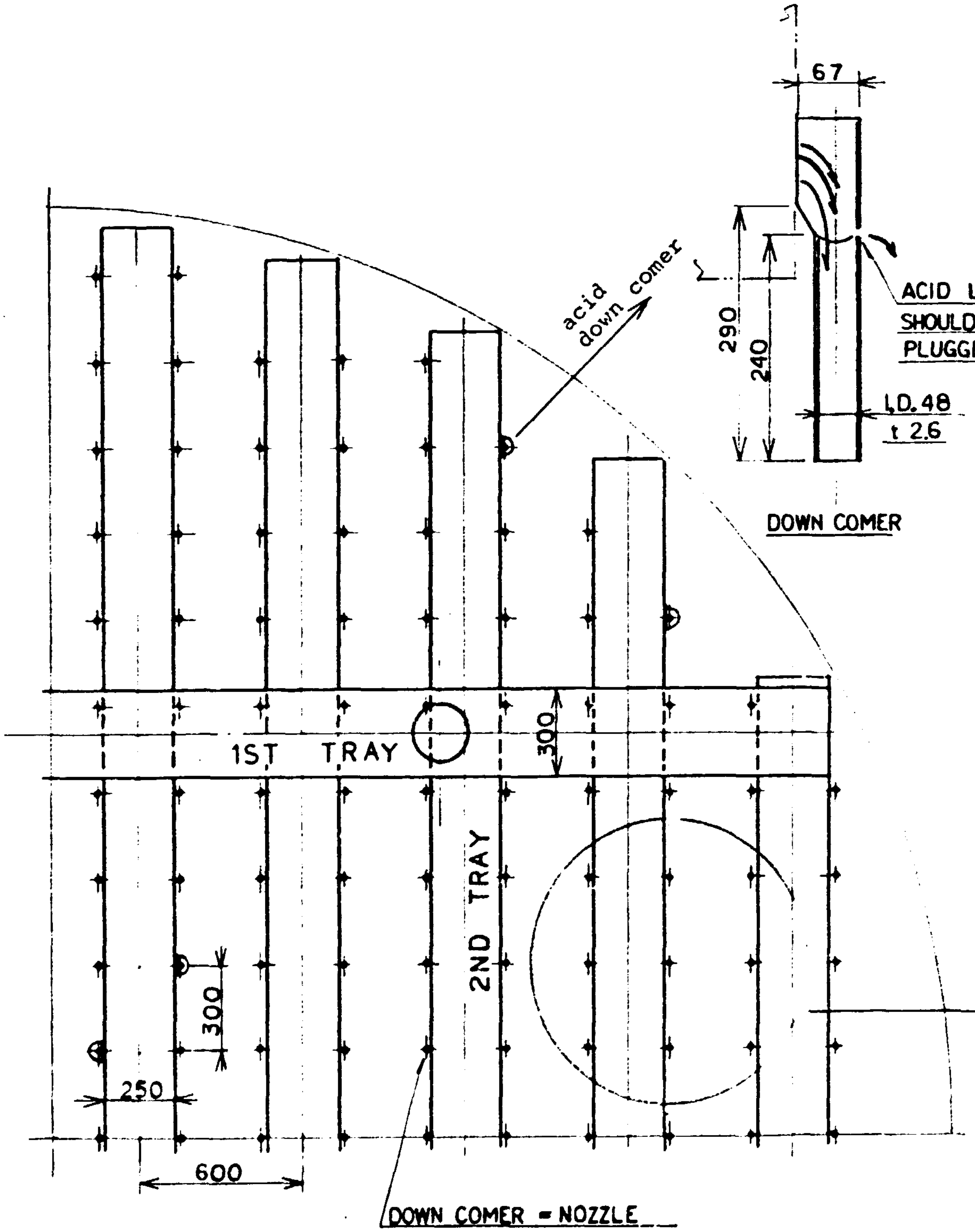
o Acid vol

o No. of no

o Acid flow

o Acid flow nozzle(kg

o No. of no area (pie



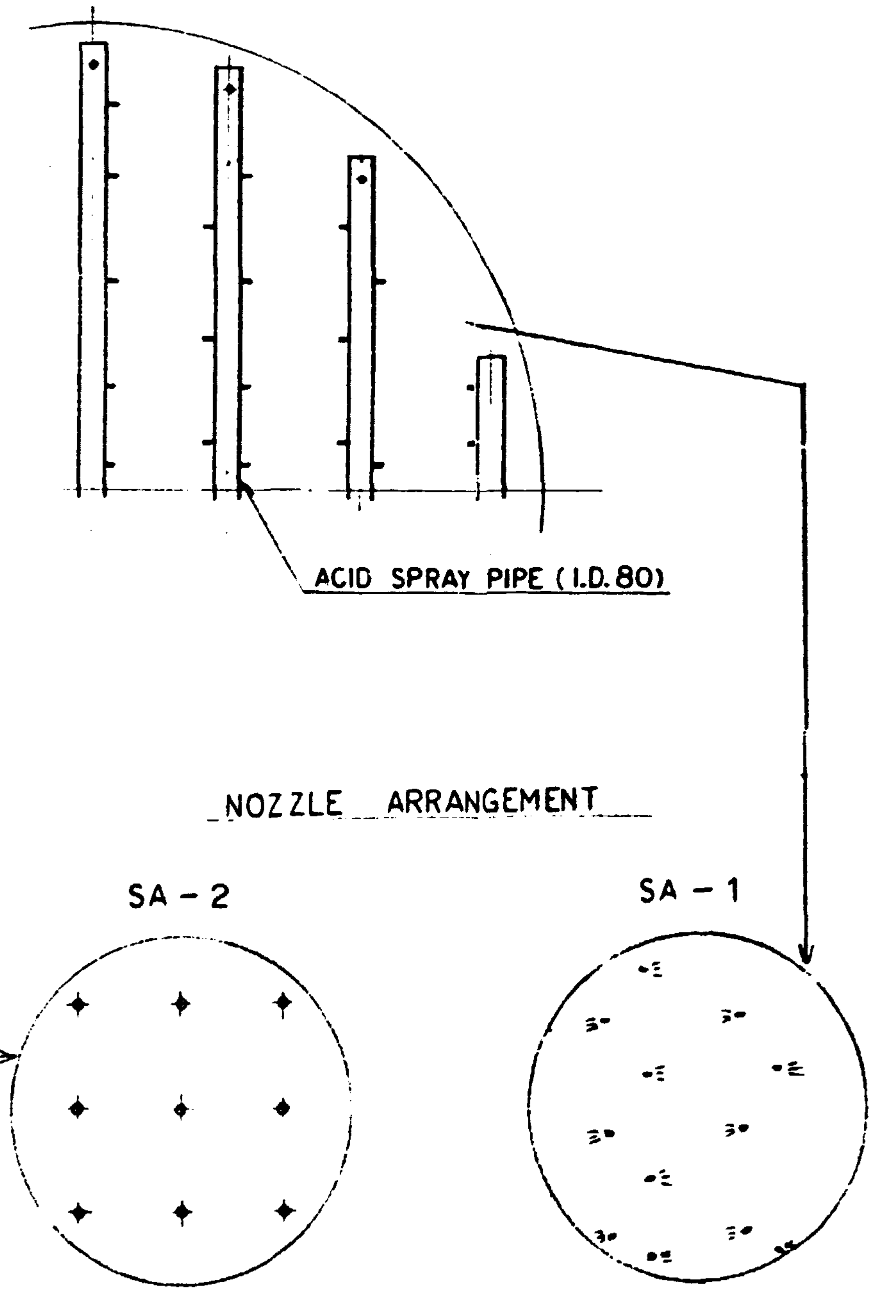
SA-2 At distributor
(Tray system, natural head flow)

SECTION 1

	SA-2	SA-1
o Acid vol (t/H)	920	160
o No. of nozzle	320	88
o Acid flow ratio(kg/m^2mini)	462(=220GPM/m^2min)	452(=215GPM/m^2min)
o Acid flow per each nozzle(kg/nozzle.mini)	48	30
o No. of nozzle per area (pieces/m^2)	9.6	14.9

ACID LEAK
SHOULD BE
PLUGGED

0.48
2.6



SA-1 AT distributor
(Pipe spray system, pump pressure flow)

SECTION 2

APPENDIX V-1(2) DT ACID CIRCULATION (SA-2)

1. Pump

No.1

mazuda

200ø

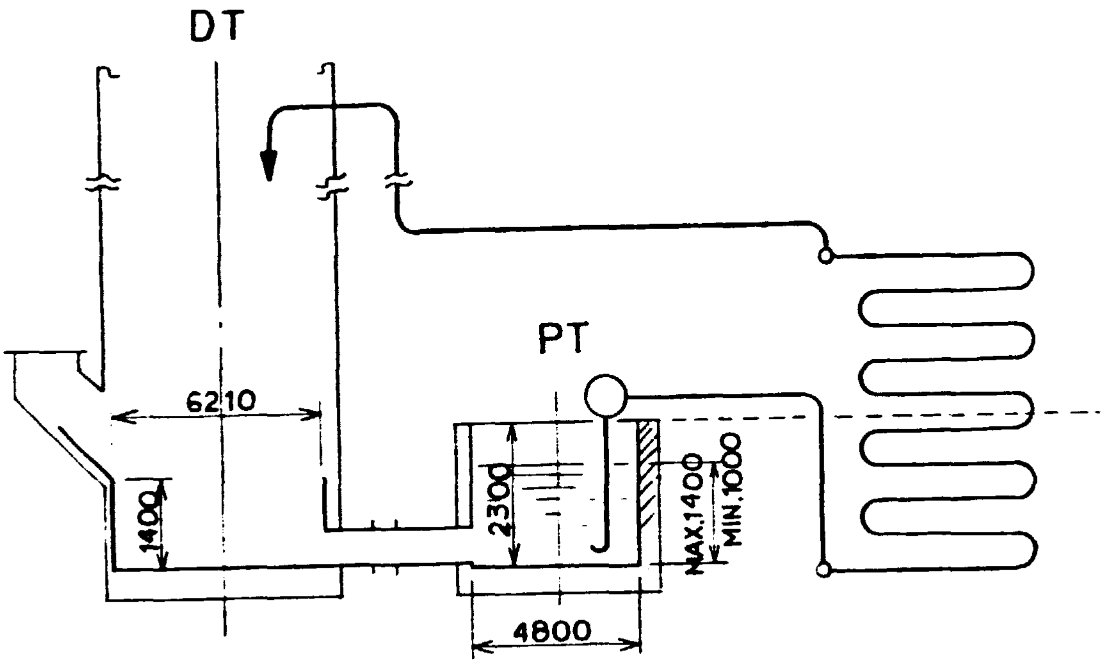
28.5 m

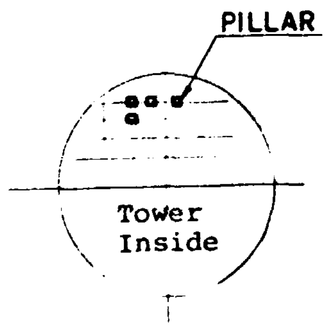
4.7 m^3/min

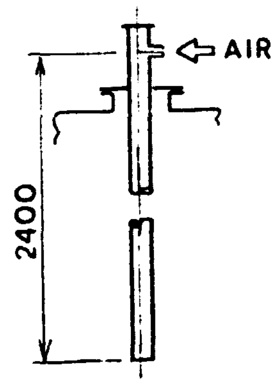
1,450 rpm

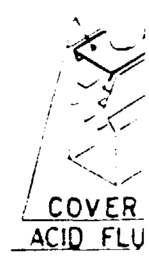
75 KW

nor. 125A









VIE

Press = 3,640 (mmH_2O)/1.8
= 2,000 (mmSA)

1% of level indication (LI) is equivalent to 20 mm

Total area $A = (6.21^2 \times 0.785 - 3.6) + 4.8^2 \times 0.785 = 44.8\ (m^2)$

$V = 44.8 \times 1.8 \times H = 80.64 \times H$ (ton)

LI = 100%
H = 2,000 mm

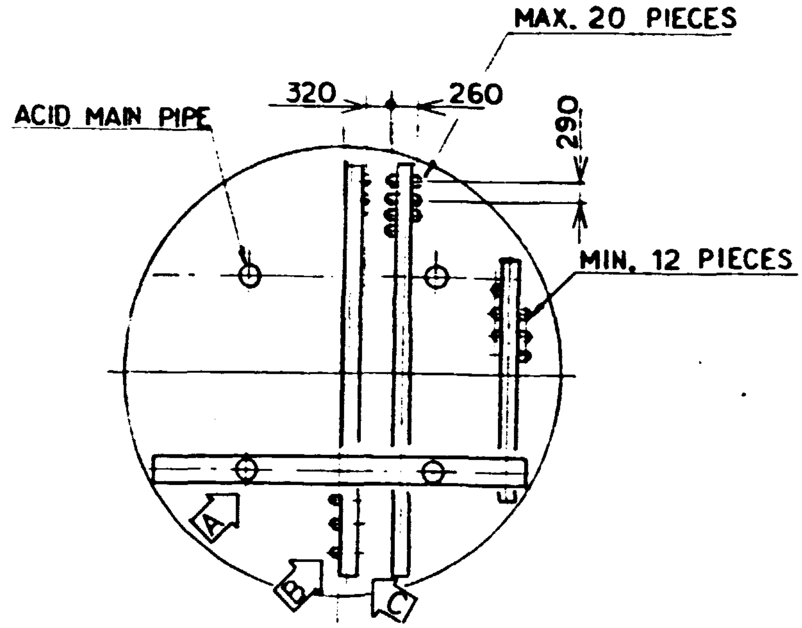
$\rightarrow$ V = 80.64 x 2 = 161.3 t at 100%
1% of level indicator (LI) is equivalent to 1.61 (t) of S.A.

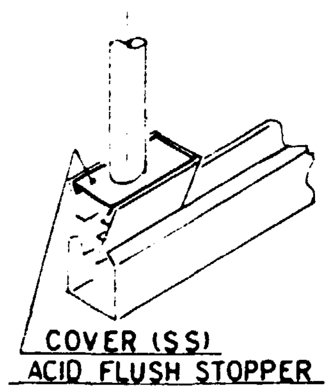
SECTION 1

1. Pump

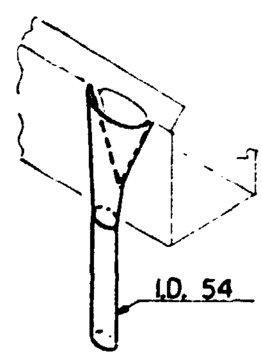
No.1	No.2
mazuda	Lewis
200ø	-
28.5 m	-
4.7 m^3/min	-
1,450 rpm	1,455
75 KW	75 (4p)
nor. 125A	

2. Destributer

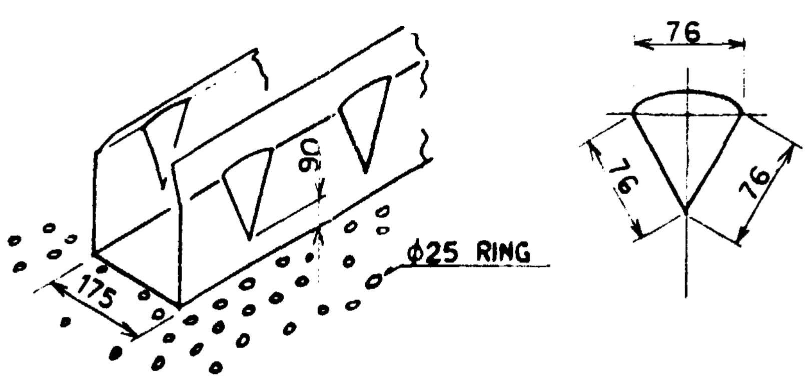




VIEW A



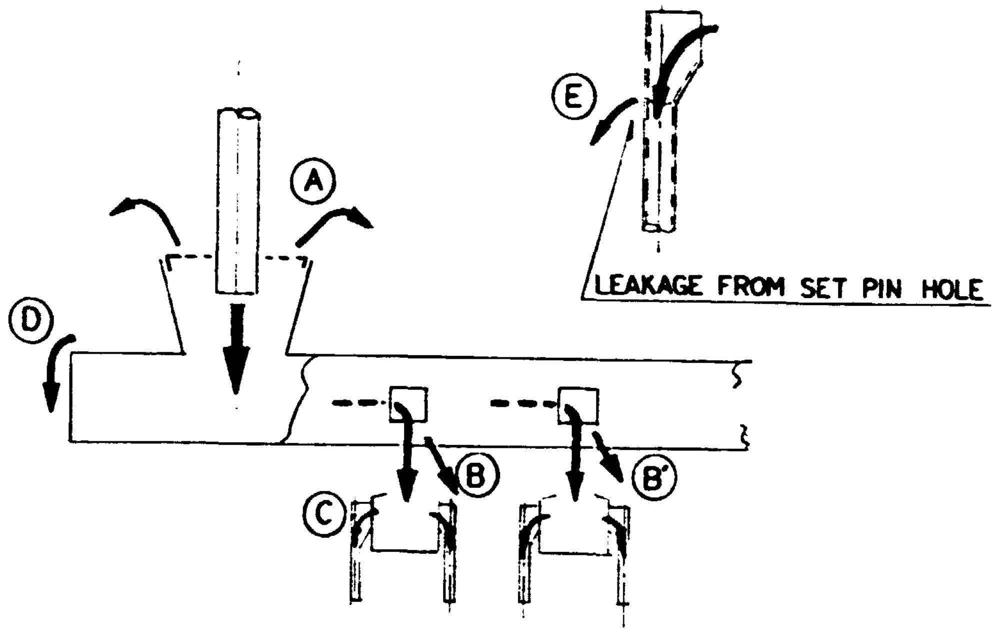
VIEW B



VIEW C

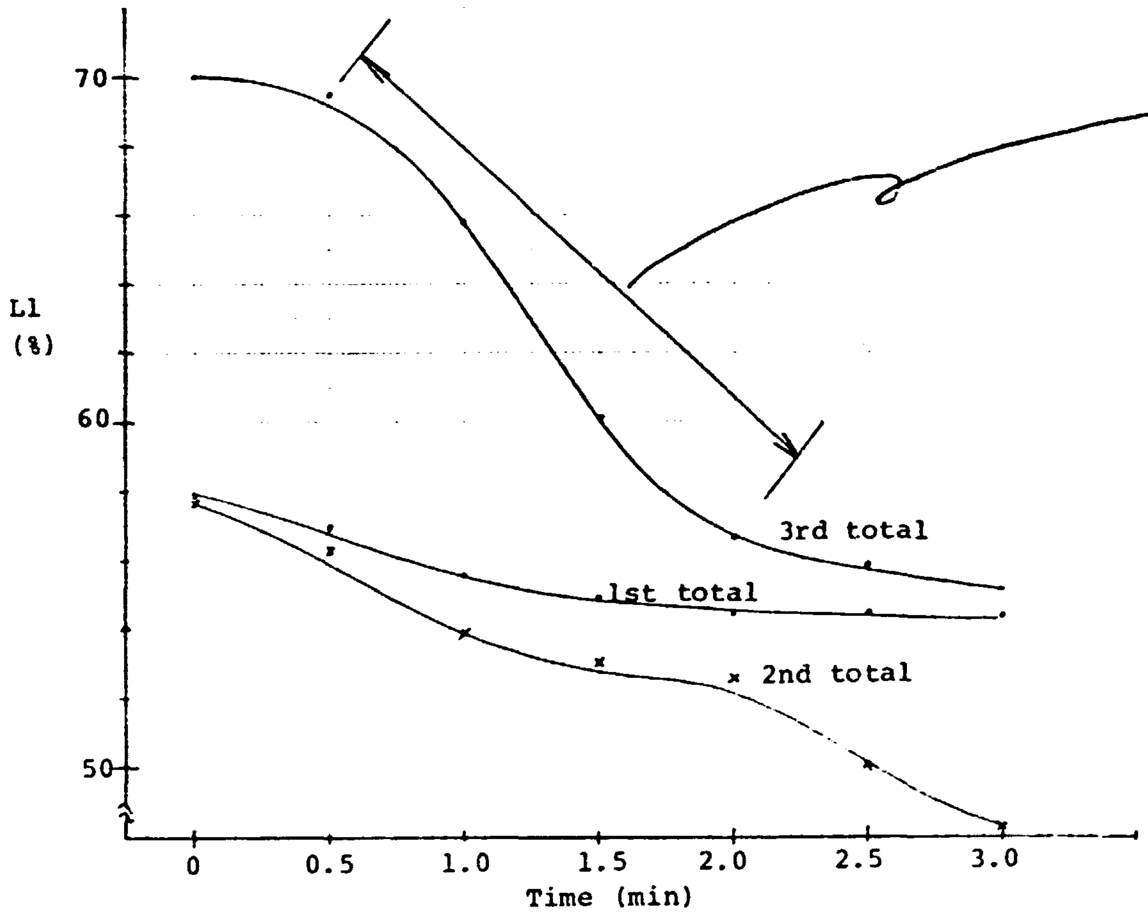
SECTION 2

3. Checking of acid over flow



Position	Running of only No.1 pump	Running of both No.1 and No.2 pump
A	There are many acid flashing, but it is completely stopped by cover.	
B	Some over	Many over
B'	Little over	Some over
C	Several pipes are half closed with dirty material.	Several closed pipes were collected and no over flow, but it is sometimes necessary to stick.
D	Sometime little over	Sometime over
E	Little leak	Some increasing of leakage

APPENDIX V-1(3) DT PUMP TEST (SA-2)



Pump up volume =

Vol(m^3/hr) = 8.

Consideration

1. Basis

air volume = 58,600 $(Nm^3/H) \longrightarrow$ 75,800 (kg/H)

acid volume= 700 (t/H)

DT area = 30.3 (m^2)

2. Calculation

$$G_1 = \frac{75,600}{30.3} = 2,495 (kg/m^2\ hr)$$

$$L_1 = 700/30.3 = 23,100\ (kg/m^2\ hr)$$

$$L_1/G_1 = \frac{23,100}{2,495} = 9.26$$

3. Comparison of

Plant capac

- o Japan 1,0
- o " 2
- o "
- o India 4
- o BCIC 4

SECTION 1

Pump up volume $= \dfrac{69.4(\%) - 56.6\ (\%)}{2.0(min) - 0.5(min)} = \dfrac{12.8(\%)}{1.5(min)} = 8.53\ (\%/min)$

$Vol(m^3/hr) = 8.53^{\%} \times 1.61^{t} \times 60^{min} = 824\ (t/H)$

(measuring error may be 15%)

$824 \times 0.85 = 700$ (t/H) (minimum flow)

385 (m^3/H)

[pump cap 282 (m^3/H)]

3. Comparison of L/G

Plant capacity		L/G
o Japan	1,000 t/d	9.45
o "	200	9.0
o "	40	6.87
o India	470	10.0
o BCIC	400	9.26

4. Result

This plant with 1 pump has almost same L/G as other plants. So test operation with 1 pump should be conducted for several days. During this period, analyze H_2O and acid mist, and also fix more covers of trays.

SECTION 2

APPENDIX V-1 (4) DETERMINATION OF SA-I ACID CIRCULATION

1. Checking of SA-I pump capacity

i) Specification

- Specification of pump

Flow rate	:	600 G.P.M. ⟶ 2.72 m^3/min.
Head	:	50 ft
Revolution speed of impeller	:	1,450 r.p.m.

- Specification of PT (Pump tank)

Diameter D = 131.7"= 3,345 mmø

Area A = 8.78 m^2

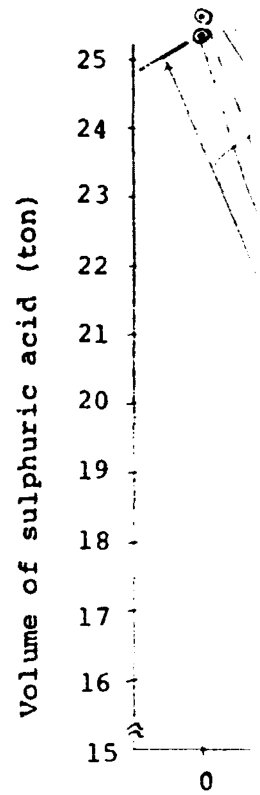
Increase of 1mm in tank level is equivalent to volume of 8.78 lit or 16.0 kg.

ii) Data of Test

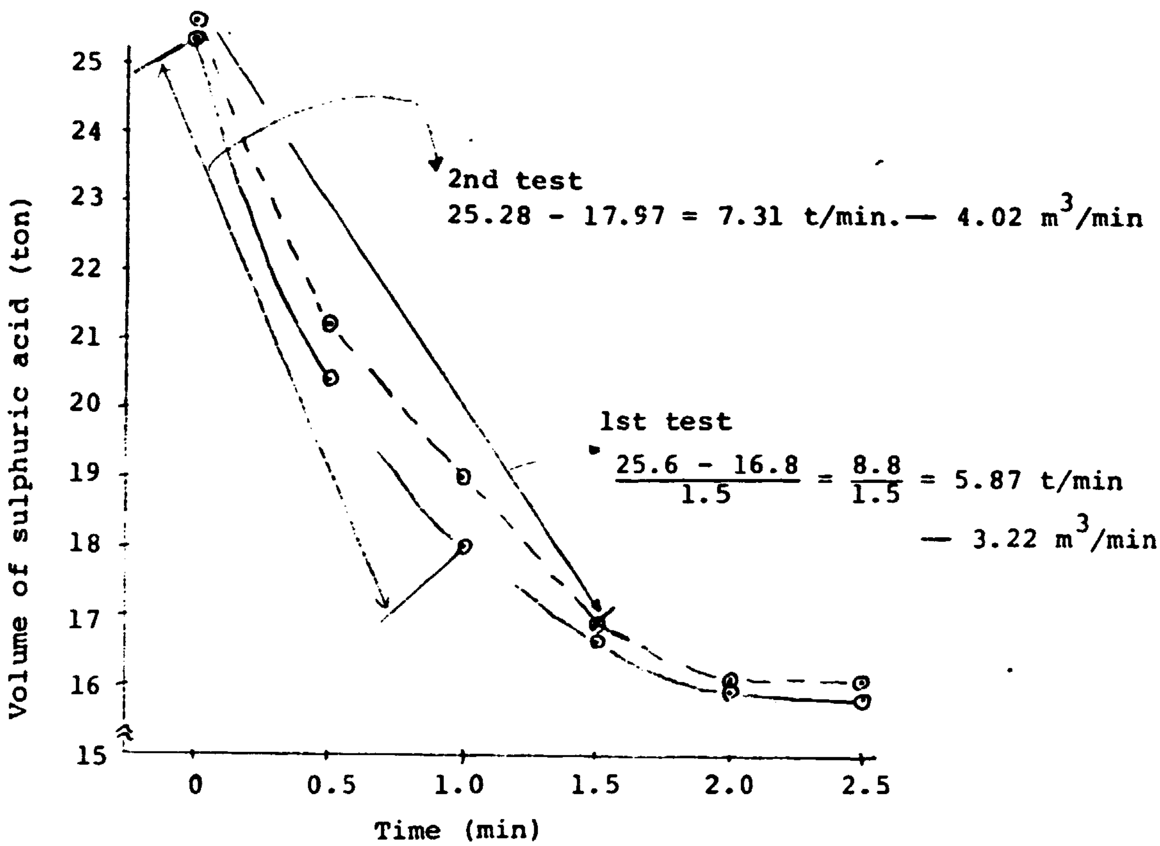
Time (min)	Pump Tank Level			Volume of S.A. in P.T.	
	1st test (Tank)	2nd test (Tank)	2nd test (LI indicator)	1st test	2nd test
0	1,600 mm	1,580 mm	1,540 mm	25.28 ton	25.6 ton
0.5	1,325	1,275	1,340	20.40	21.2
1.0	1,190	1,123	1,170	17.97	19.0
1.5	1,[illegible]0	1,037	1,040	16.59	16.8
2.0	1,001	990	980	15.84	16.0
2.5	1,001	990	980	-	-

Amperage of motor : 27 A

SECTION 1



iii) Calculation



2\. i) Determination of pump capacity

av. flow rate = $\frac{3.22 + 4.02}{2}$ = 3.62 m^3/min.

Lo (pump up vol from spec) = 2.72 m^3/min.

4.90 t/min = 294 t/H to be used

ii) AT dimension

D (dia) = 2.743 m patching height H = 4,125 m

A (Area) = 5.91 m^2

SECTION 2

iii) Gas vol (SO_2 FS out = 8.5%, $SO_3 = \frac{8.5}{1.2} = 7.0\%$)

$$G_o = \frac{100}{24} \cdot \frac{22.4 \times 1{,}000}{98 \times 0.975 \times 0.985 \times 0.07} = 14{,}170\ Nm^3/H$$

18,420 Kg/H

$G = G_o/A = 3{,}116\ Kg/m^2Hr$

iv) L/G = 9.5 (should be decided) normal plant

$L = 9.5 \times 3{,}116 = 29{,}600\ Kg/m^2Hr$

AT total vol. V_1 (t/H) = L.A = 175 t/H to AT

DT total vol. V_2 (t/H) = 294 - 175 = 119 t/H to DT

DT and AT flow ratio (L/G = 119/18.4 = 6.5 not so bad)

$$\frac{DT}{AT} = \frac{V_2}{V_1} = 0.68$$

AT inlet valve 100% open

DT inlet valve 65% open

v) AT. gas retention time Θ sec (speed U m/s)

$$U\ m/s = \frac{14{,}170 \times 373/273\ m^3/H}{3{,}600 \times 5.91\ m^2} = 0.91\ m/sec$$

$$\Theta = \frac{4.13\ m}{0.91\ m/s} = 4.5\ sec$$ (5.6 ~ 8.6 sec in other plant)

APPENDIX V-2(1) DECREASE OF SA-2 ACID DRAIN FOR PREVENTION of STACK ATTACK AND EQUIPMENT

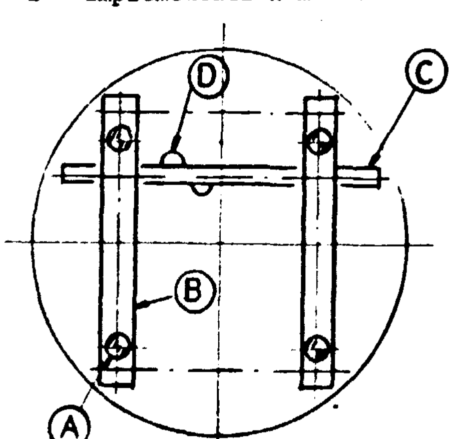
[Aim] Acid drains cause deterioration of every equipments. So severe control of acid circulation and distribution is necessary.

1 Date of implementation

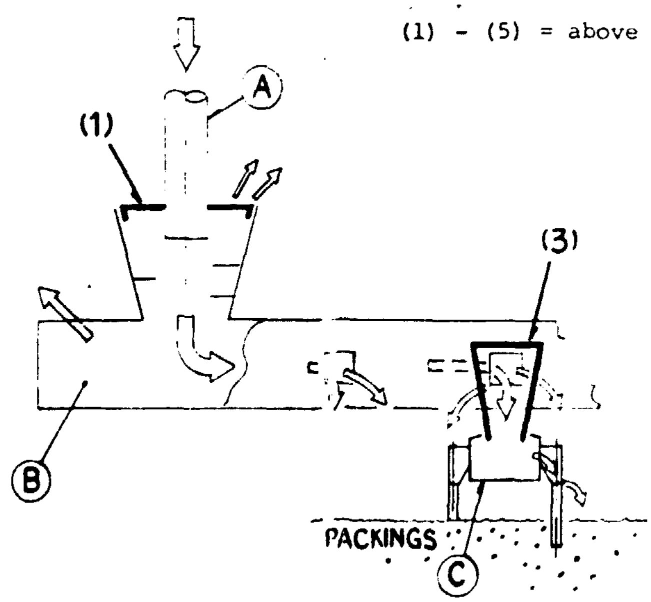
Step	Completed day	Item	Re...
(1)	7-12-79	Stoppage of the main acid flushing from AT DT distributers with cover	Covers decreased many ac...
(2)	10-2-80	After calculation of suitable DT acid flow rate and checking actual acid volume in case of 1 and 2 pumps, operation with one pump was conducted.	Generated drain volume of ... zero after adjustment.
(3)	15-2-80	Complete adjustment of DT acid flashing to prevent the drain.	
(4)	3-8-80	Setting of the cover and 40 slit stoppers in AT distributer.	10-13 lit/D → (continuously) (not dangerous condition
(5)	24-1-81 20-7-80	Plugging of DT downcomer pin hole with PVC rod. Welding of AT down comer pin hole	Drain is nil.

2 Implementation method

(1) - (5) = above ste...



Ⓐ MAIN ACID PIPE
Ⓑ 1ST TRAY
Ⓒ 2ND TRAY
Ⓓ DOWN COMER



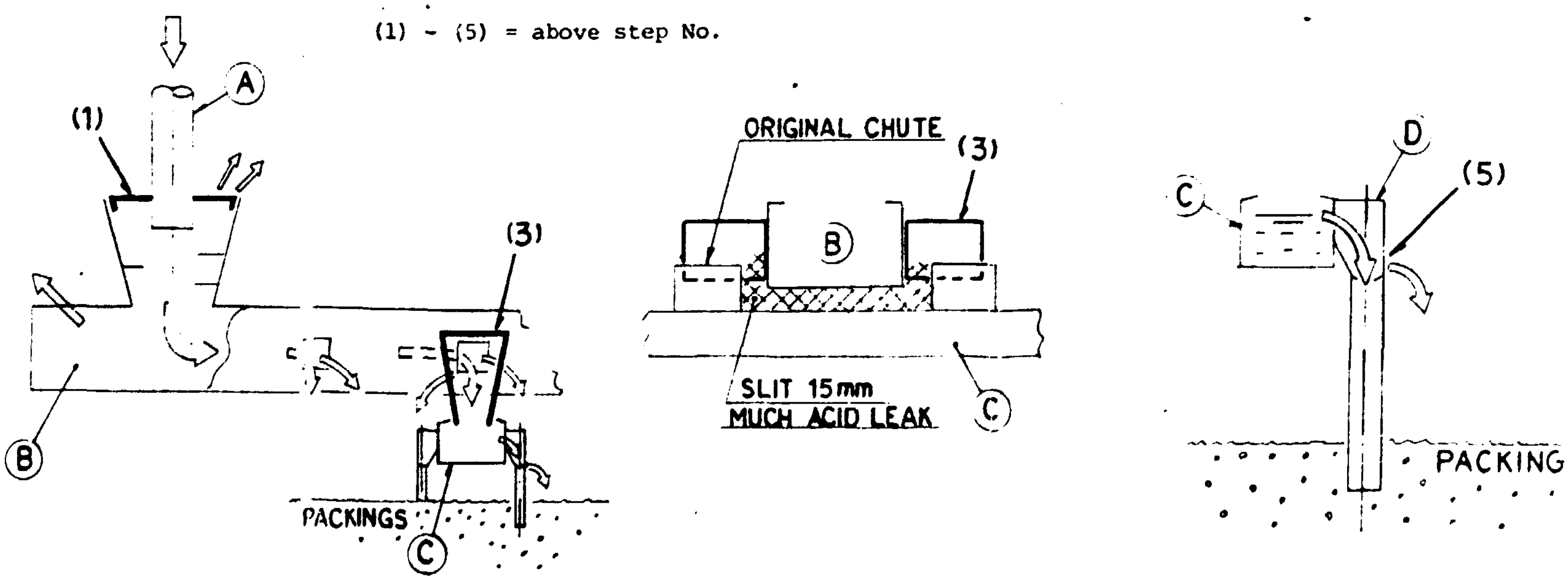
SECTION 1

'REVENTION of STACK ATTACK AND EQUIPMENT CORROSION

:pments. So severe
is necessary.

	Result
: from AT DT distributers	Covers decreased many acid drops and mists
:cid flow rate and se of 1 and 2 pumps, cted.	Generated drain volume of 10 lit/d decreased to almost zero after adjustment.
:shing to prevent the	
toppers in AT	10-13 lit/D → below 1 lit/D (continuously) (not possible to measure) dangerous condition → almost safety condition
with PVC rod.	Drain is nil.

(1) ~ (5) = above step No.

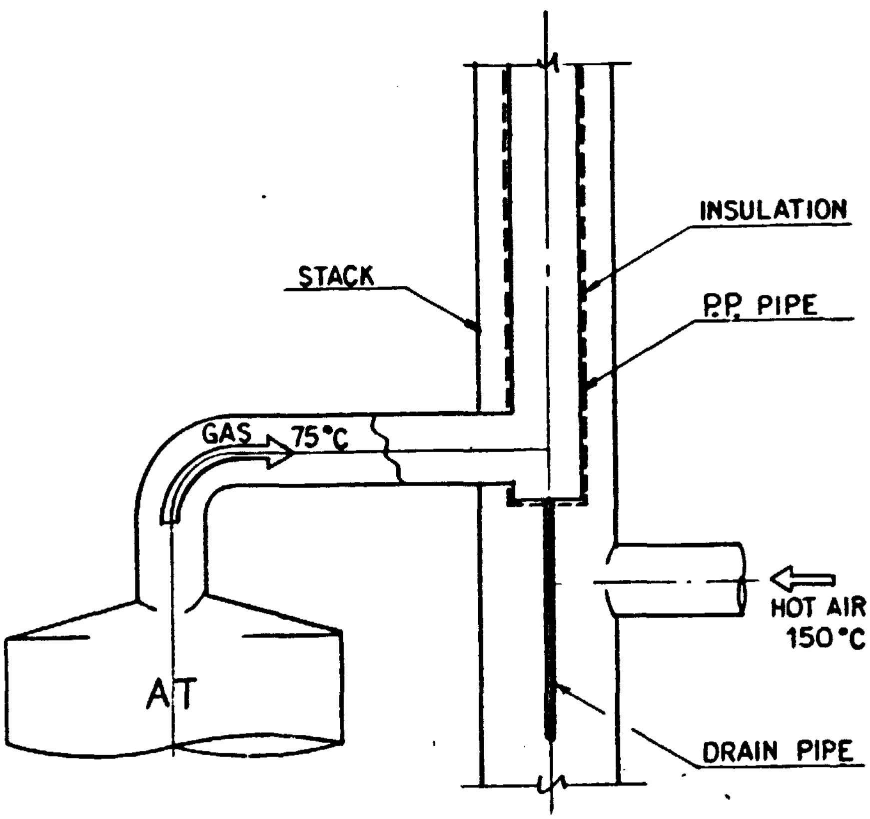


SECTION 2

APPENDIX V-2(2) COMMENT ON SA-2 STACK P.P. LINING

1. The expert studied the letter of Mr. A. Bizlsma concerning P.P (polypropylene) lining for SA-2 stack. He had some confidence for P.P. lining and also suggested to apply it in SA-2 Plant.

2. In his report, reply to expert's query was mentioned. It seems to be the following structure.



3. He also mentioned that the total cost of P.P lining will be considerably cheaper than that of the cement method, the life will be more than 5 years and installation can be carried out by TSP personnel in a few days. And he also added some other advantages.

4. It is an interesting method and will be helpful. But the expert has still some following warning points to be cleared.

   i) To show the achievement list if he has no difficulty.

   ii) To show the heat deforming temperature, because regarding character of P.P., sometimes it's makers show some different data.

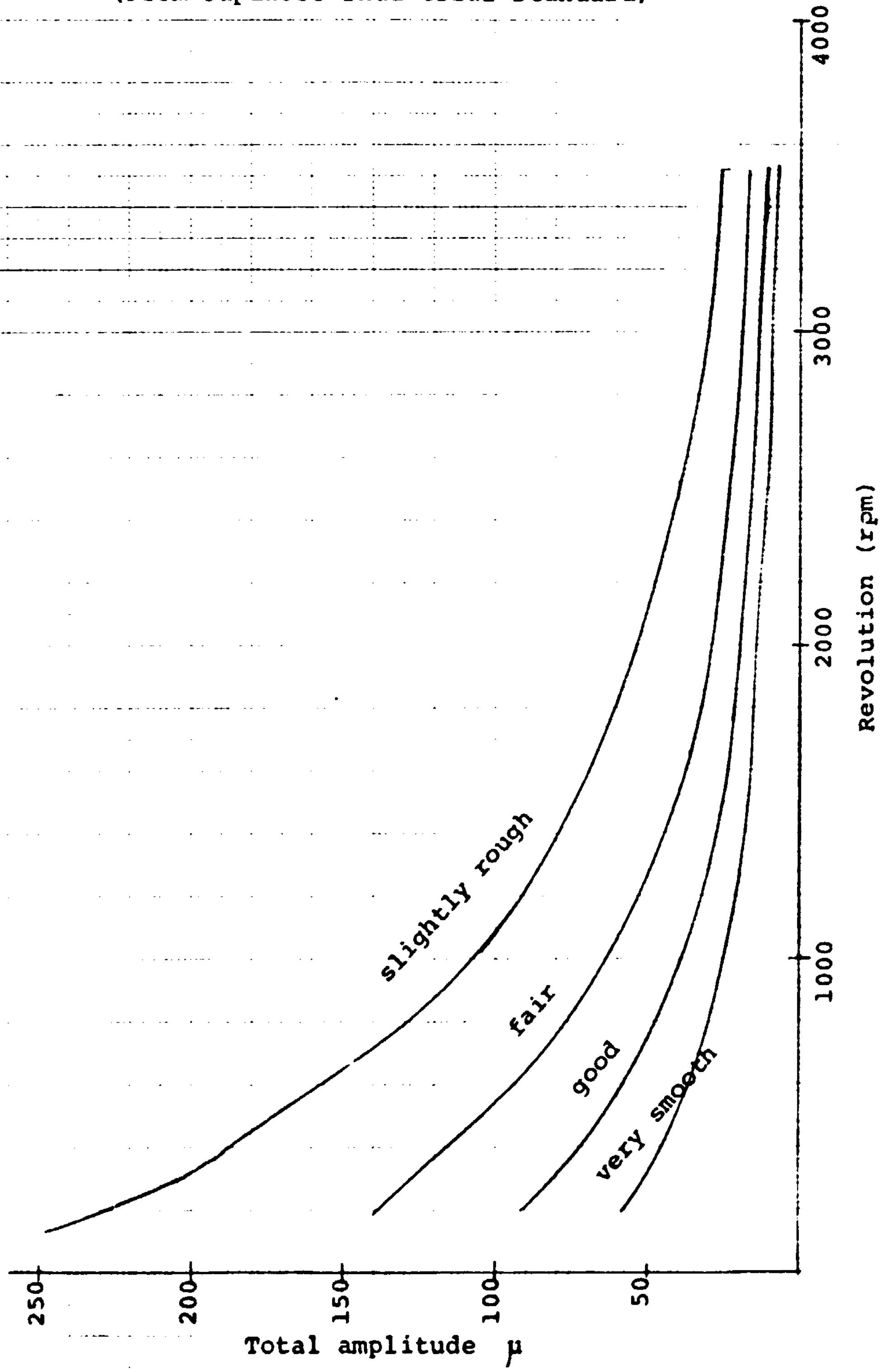
   iii) To prepare thermometer for the inlet of hot air.

   iv) To consider little water spray system to cool hot air if necessary.

   v) To show brief idea in advance how to support this pipe to chimney and how to set it up and to weld it.

APPENDIX V-3 STANDARD OF VIBRATION FOR BLOWER

(From Japanese Industrial Standard)



APPENDIX V-4(1) MAINTENANCE OF AT ACID CIRCULATION PUMP

1. Checking of the pump, which was reassembled only from outside.

   - Corrosion and erosion of impeller is very severe, so it is better to change the impeller. (Regarding vibration and capacity)

   - Many kinds of shape are used as the bolts and nuts. It is afraid whether these materials are right ones.

   - The gaps of all important parts is to be measured carefully and recorded.

2. Checking of the pump, which was taken off after running outside.

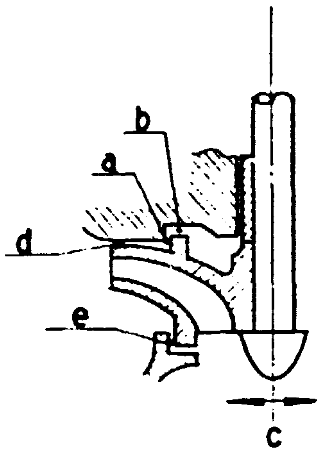
   - Corrosion and erosion of impeller and impeller nut is extraordinarily high. It must be changed. Life and material of these are to be checked.

   - Several numbers of bolts and nuts dropped by corrosion. These materials are to be checked.

3. Recommendation

   i) The plant must have some maintenance manuals and drawings for these pumps, which are partially obtained from the maker. But the maker usually does not submit the sufficient drawings. Regarding the important equipment, one must measure and sketch some important points, for example, gaps between impeller and casing. These records and sketches are very useful for repair afterwards.

For this pump, one must check the following items.



a: gap of mouth ring
b: gap of mouth ring
c: vibration of shaft
d: gap of casing
e: gap of cover

ii) One must measure and record new spare parts which are to be replaced. These records ae very useful for repairs and studying corrosion rate.

iii) One must check the deformation of the center of shaft. For this purpose and other measurements, it is better to settle the pump vertically, and turn the shaft by hand.

iv) It is necessary to measure and record the corrosion rate of the parts under acid level.

v) Connection of outlet pipe must be conducted very carefully, otherwise vibration sometimes occurs.

vi) Test run with water at the site is impossible, so one must arrange carefully and record details for future.

viii) Materials of impeller and impeller nut

	MAZDA	LEWIS
Column	FC-CR	Process Iron
Impeller nut	SUS-32	LEWMET Ni-Cr
Impeller	Carpenter-20	LEWMET Ni-Cr
Bolt nut	SUS-32	—

APPENDIX V-4(2) AT CIRCULATION PUMP (SA-2)

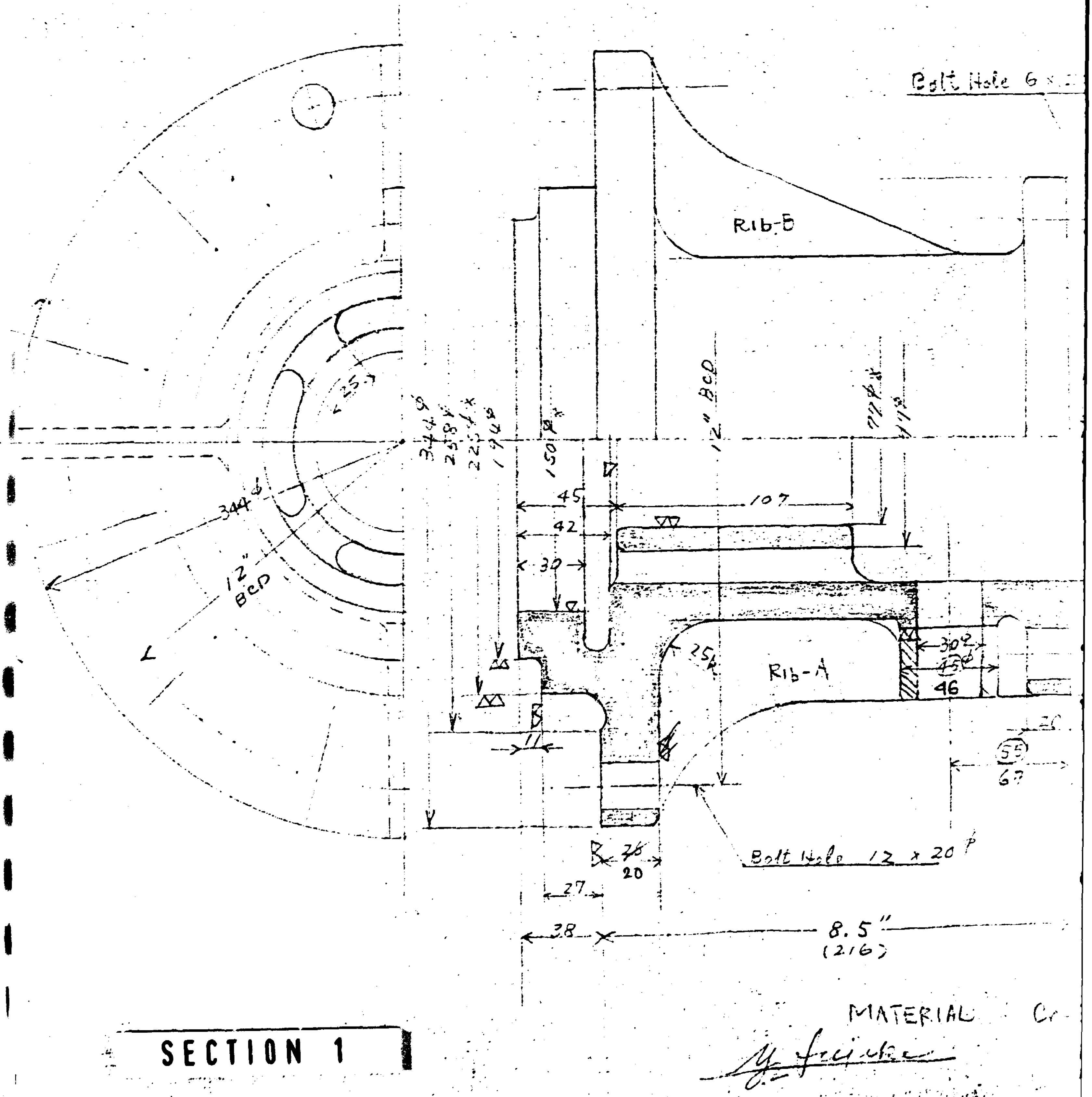
The variations of center of shaft was measured.

The expert has used two frames and two shafts. The results show that maximum is 1.1 mm and minimum is 0.4-0.5 mm, but now this minimum combination must be assembled. This pump has a soft bearing made of Teflon. Allowable pressure of Teflon bearing is very low.

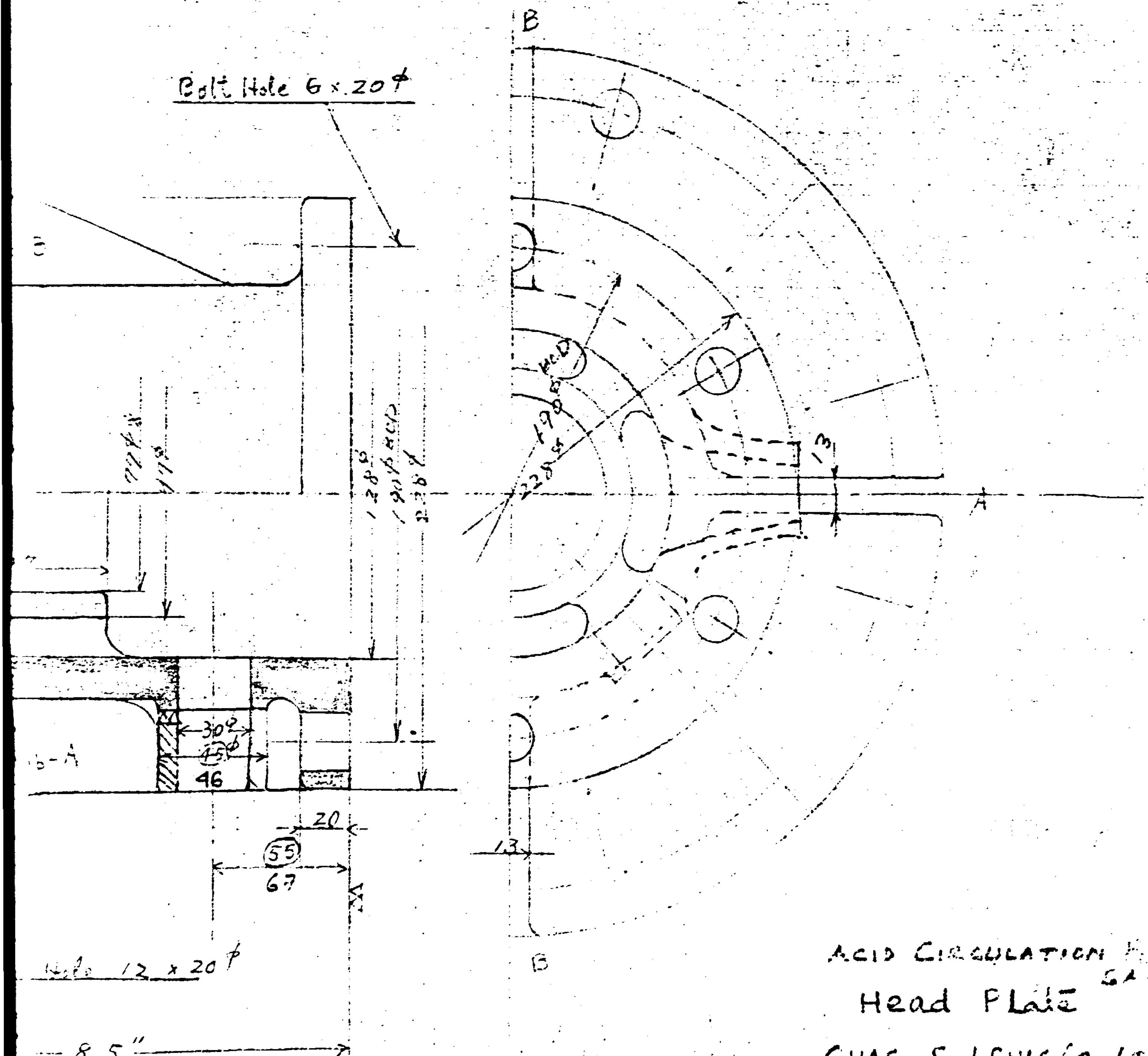
Allowable pressure: Teflon PV 3-10 kg/cm^2, S
Cast iron PV > 100 kg m/cm^2.S

Besides, the impeller was much corroded, so it has much unbalancing force. In these irregular case, it is recommended to use a solid type bearing (chromium-cast-iron).

V-4(3) Head Plate of SA-1 Acid Circulation Pump



SECTION 1



ACID CIRCULATION PUMP
SA-1

Head Plate

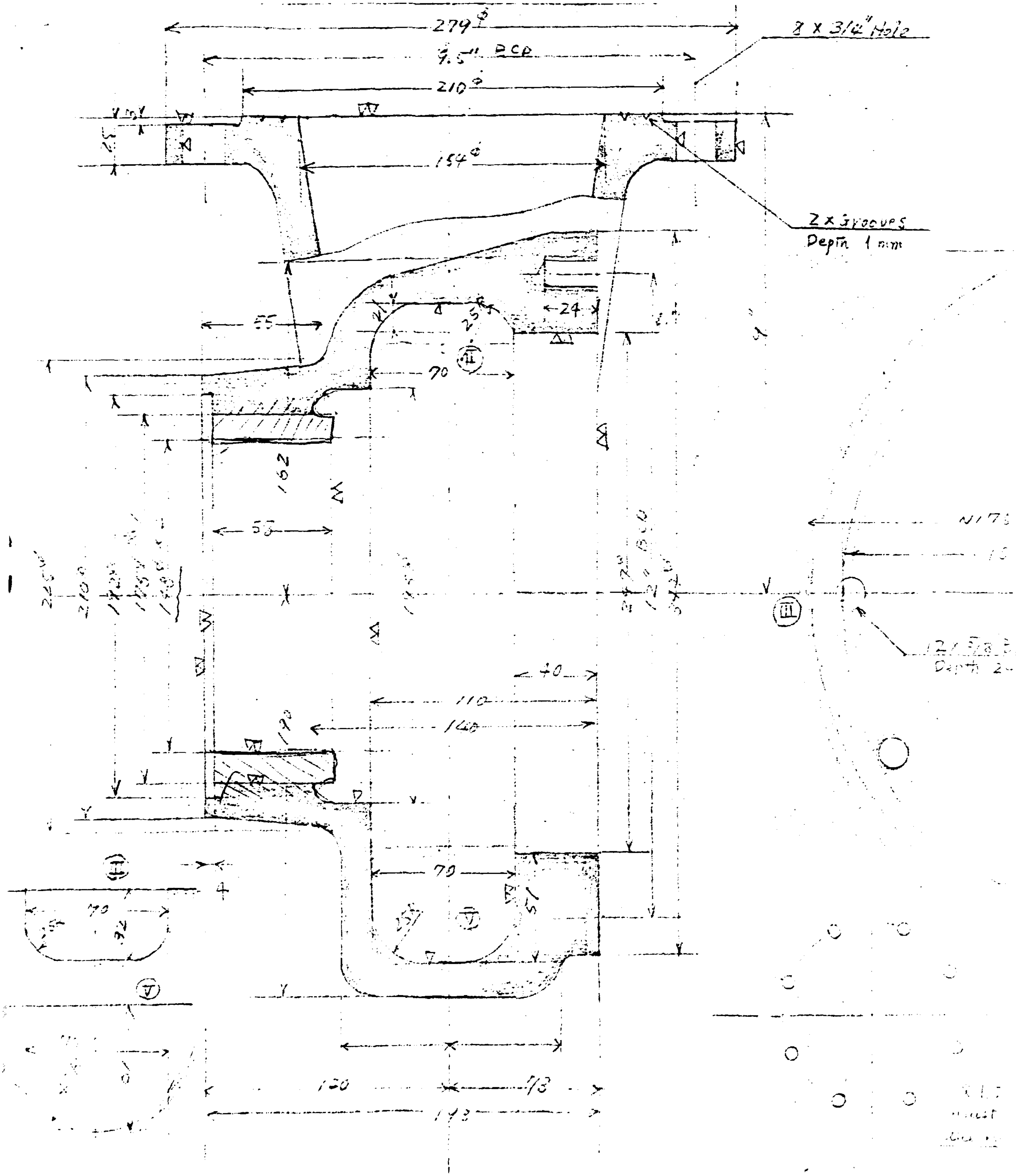
CHAS. S. LEWIS Co. LTD

※ : This figures include machining allowance.

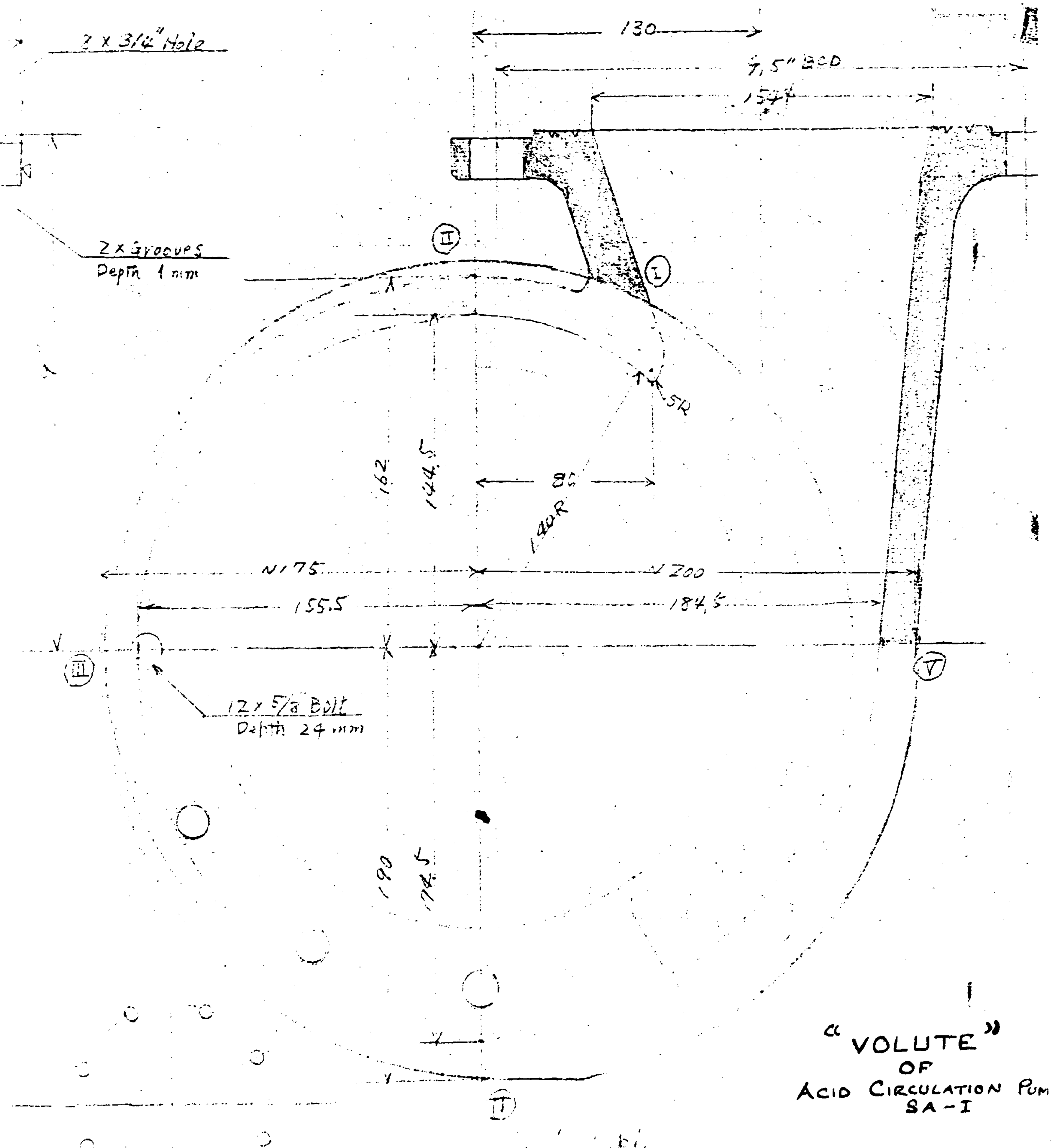
MATERIAL : Cr-Cast Iron (C̄ IRON)

SECTION 2

V-4(4) Volute of SA Circulation Pump



SECTION 1



"VOLUTE"
OF
ACID CIRCULATION PUM
SA-I

X 1,2 : This diameter must be changed by the new case-ring

APPENDIX V-5(1) INFORMATION FOR BITAC REGARDING CHROMIUM CAST IRON PRODUCTION

1. Contents of "Ojiron" produced in Japan

T.C.:	3.1 - 3.5%	Si:	1.4 - 2.4%
Mn:	0.4 - 0.6%	Cr:	0.6 - 0.8%
P:	0.06 - 0.08%	S:	0.08 - 0.1%

2. Structure

Phase:	Ferrite
Carbon:	Λ type according to ASTM standard (Uniform type)
Chromium:	Special structure of chromium carbide is in the phase.

3. Mechanical strength

Tensile strength:	25 - 28 kg/mm^2
Hardness (Hs):	28 - 32 (Shore)
Bending strength:	45 - 50 kg/mm^2
Deflection:	7 - 8 mm/mm

4. Equipment

Cupola furnace (Nissan orders to 2 makers, and these two makers use a cupola furnace)

5. Hardness is low (Hs 24 - 25) and crystal is too large

It is thought that C and S contents are pretty high, probably C = 4%, Si = 3%, T.S. = 10 - 20 kg/mm^2.

To prevent it, "Steel scrap", about 15-20% was added. It is necessary to get small grain size, larger strength and hardness. In this case, one must inject some material when one takes molten metal from the cupola furnace.

(Injection material: Calcium Silicide, CaSi)

6. The temperature of the discharge metal, say, 1530°C, is sufficient.

7. Chromium adding method

   There are two methods.

   i) To use special ferro chromium

      Before molten metal is discharged into the ladle, one put the fixed quantity of chromium in the ladle. The capacity of the ladle is enough in case of 50 kg.

      Slag may flow up from the molten metal, and this slag must be taken off. The yield of chromium is about 80 - 90%.

   ii) To use ordinary ferro chromium

      From the first stage, ferro chromium and other materials are mixed and melted in the cupola furnace. One can also mix ferro-chromium in the ladle, but at this time one must crush ferro-chromium in small particles. (The size of particles is between small bean and sand size.)

8. Cause of the blow hole

   It is not due to the lack of sand mold drying. It depends on the condition of molten metal. Drying is not important.

9. Anyway, production of good chromium cast iron is very difficult. Equipment, technical level, raw materials, injection materials, etc. are very important points. The expert will support BITAC efforts, so that they should do their best.

APPENDIX V-5(2) ADDITIONAL INFORMATION FOR BITAC

The expert received some catalogs from Japan, in which following data are mentioned.

1. No.1 Injection material

Name : Calcium silica No.1

Composition : Ca 30%, Si, 55-65% C $<$ 1%, P $<$ 0.05% (as weight)

Used weight : About 0.3-0.5% of molten metal

Price : Market price in Japan ¥650 - 700 /kg

2. No.2 Chromium that makes up heat

Name : EXO-F Cr H

Compositoin : Cr 50-55%, C 7%, T-Si 10%, p 0.05%

Using method

i) Molten metal $<$ 200 kg
add total EXO to the surface of the molten metal, or put 1/2 EXO beforehand in the ladle and add the rest 1/2 EXO according to the discharge of metal.

ii) Molten metal $>$ 200kg

Cr yield : about 95%

Price : Market price in Japan ¥ 450 /kg

Features : o Cr melts quickly with its own make-up heat, and the temperature of the molten metal does not drop.

o Cr yield is very steady, so the adjustment of the compositions of Cr-cast iron is very easy.

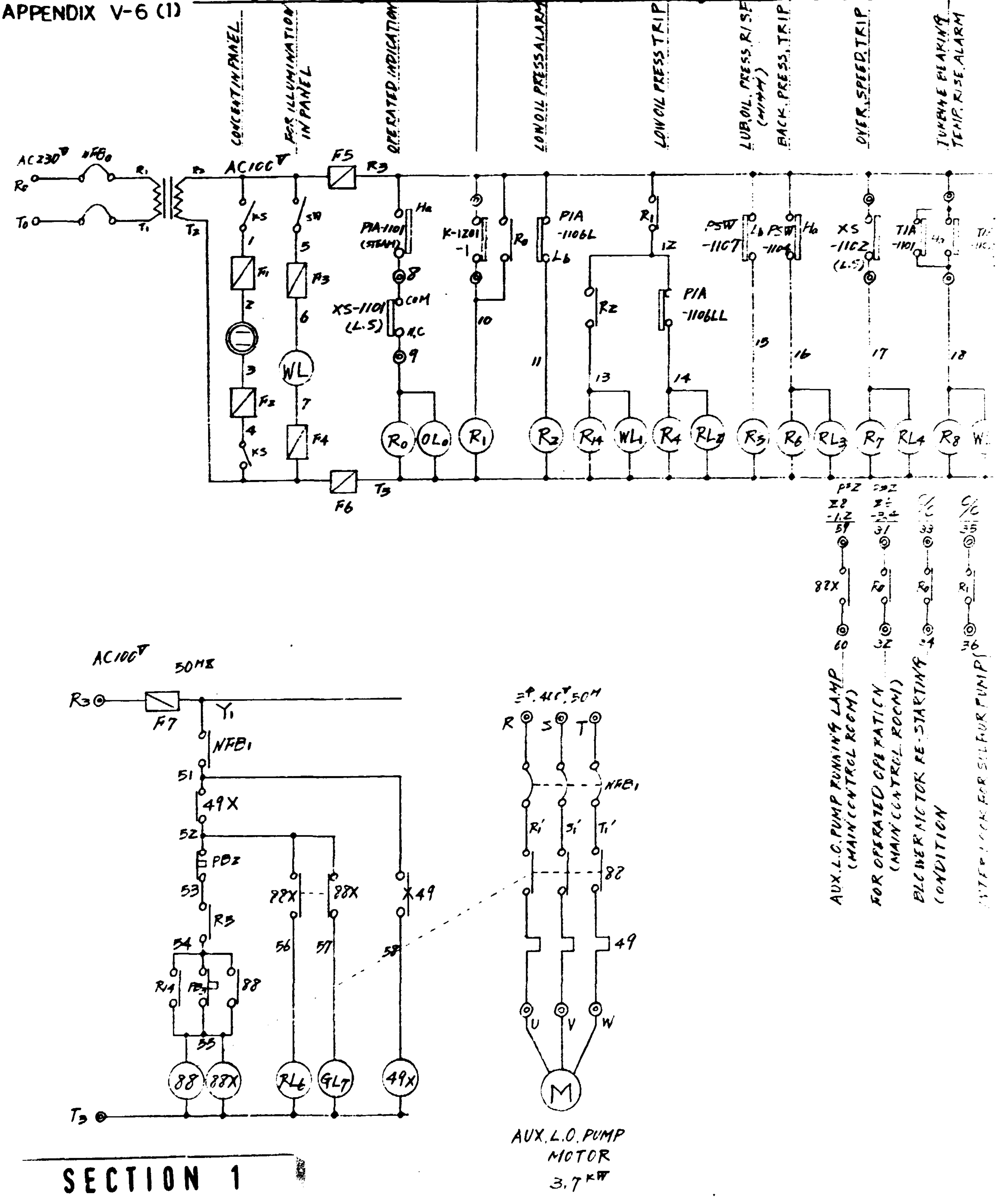
- Flux contained in this material covers the surface of the molten metal, so it takes only 10 - 20 seconds to melt the chromium.

- 3.5% as Cr content is possible.

Maker : Nippon Heavy Chemical Industry Co., Ltd.

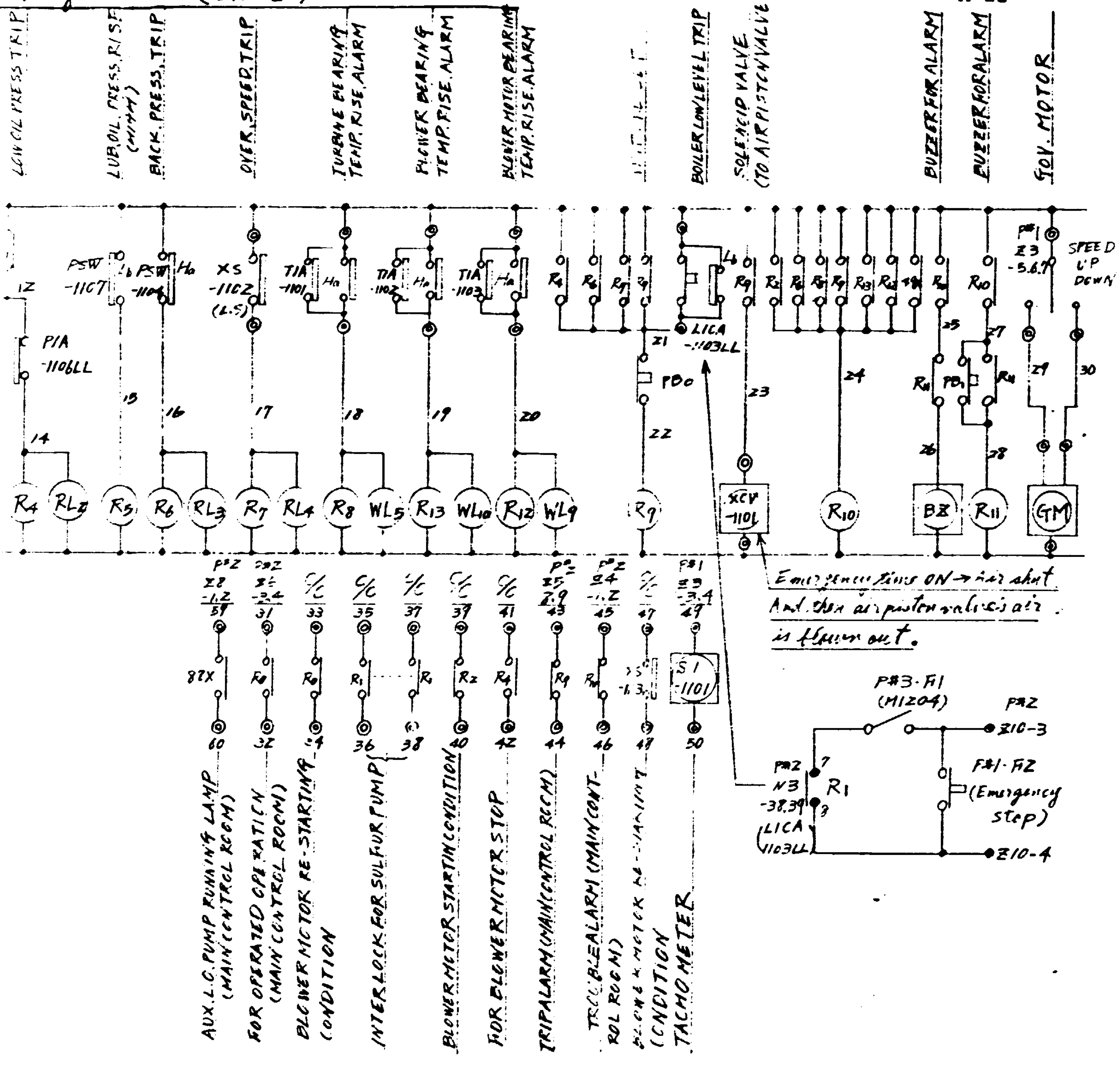
Clarification of steam turbine panel sequence. (SA-2)

APPENDIX V-6 (1)



SECTION 1

Sequence. (SA-2)

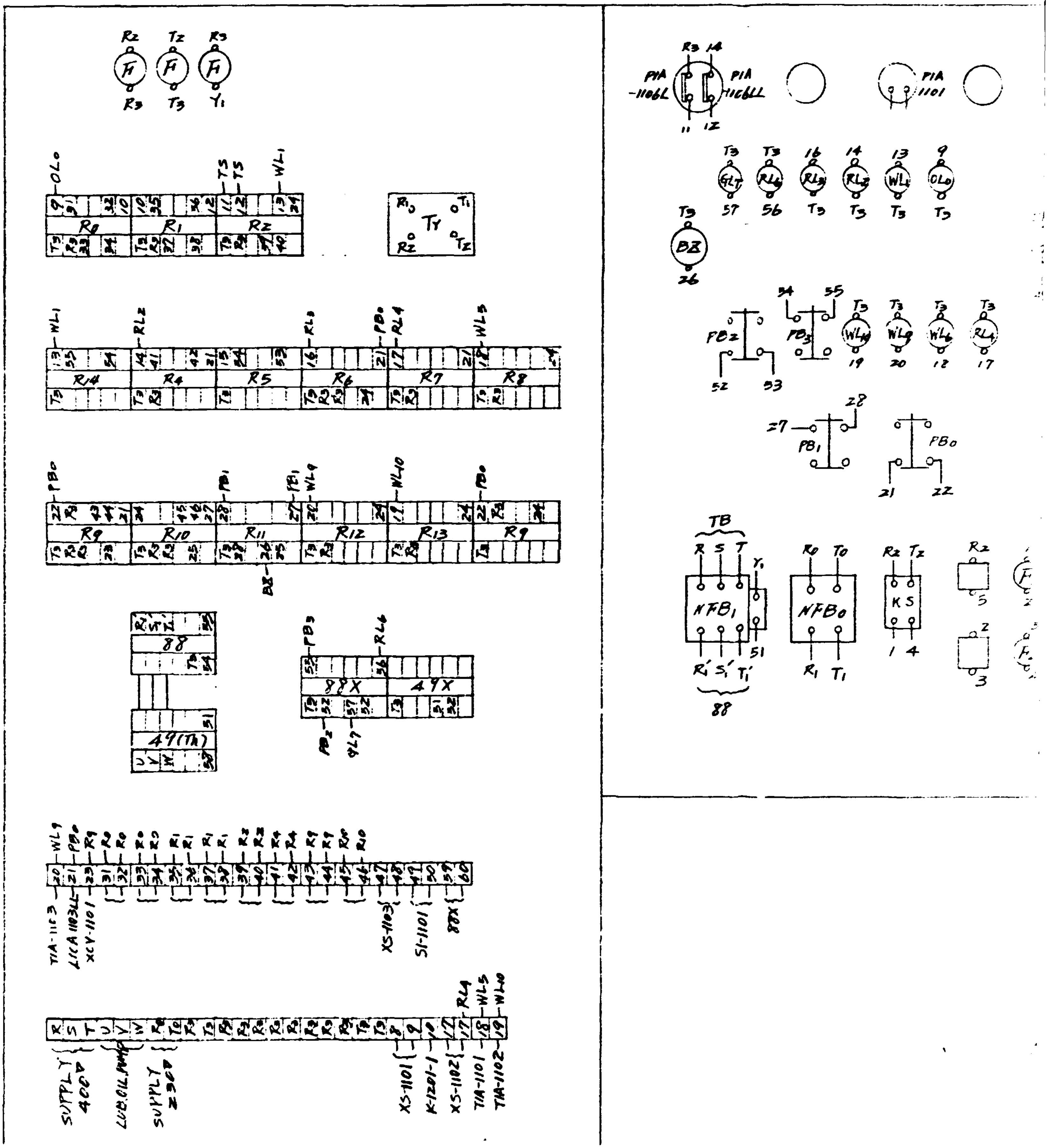


SECTION 2

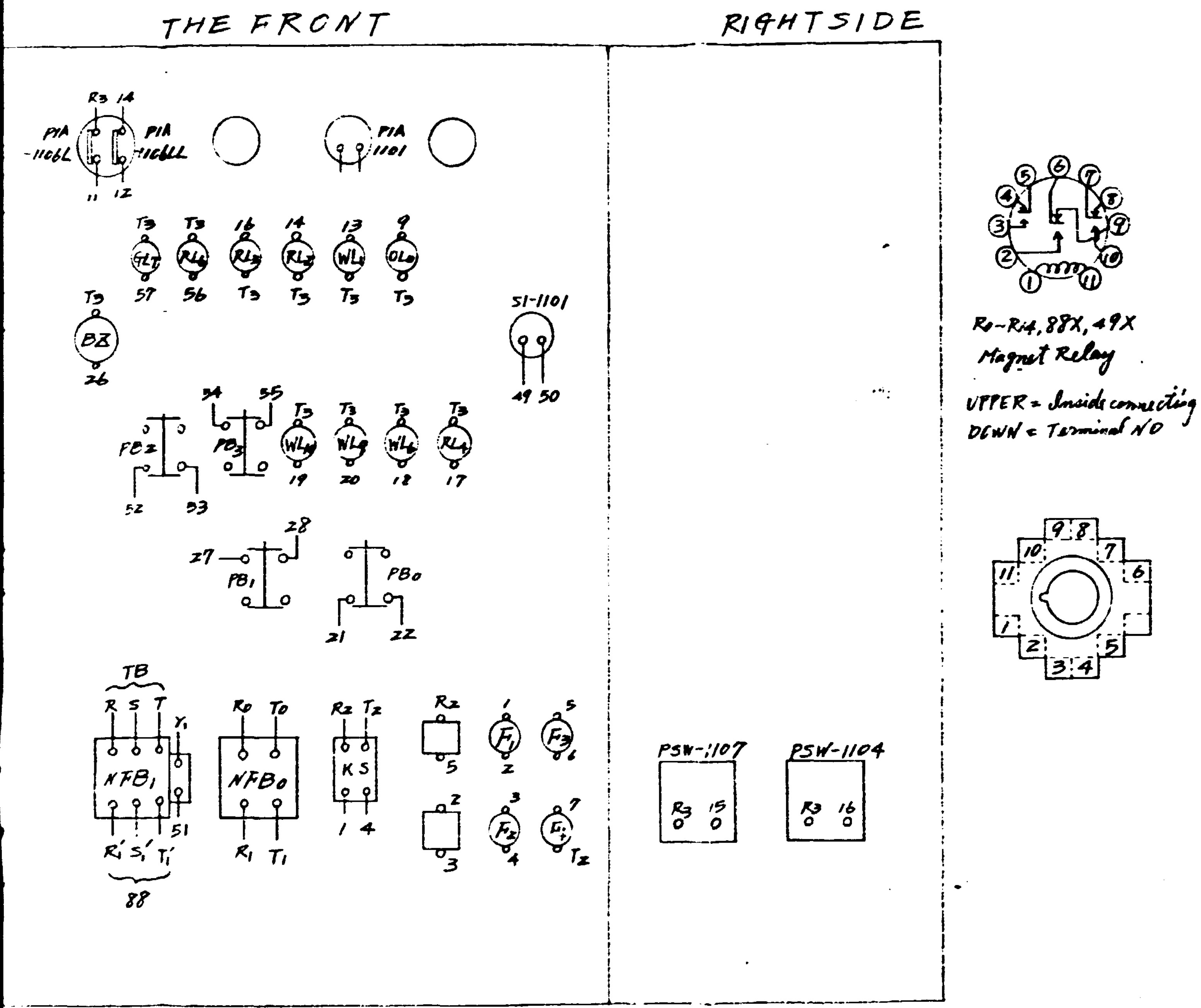
STEAM TURBINE

LOCAL PANEL SEQUENCE (SA-II)

LEFT SIDE THE FRONT



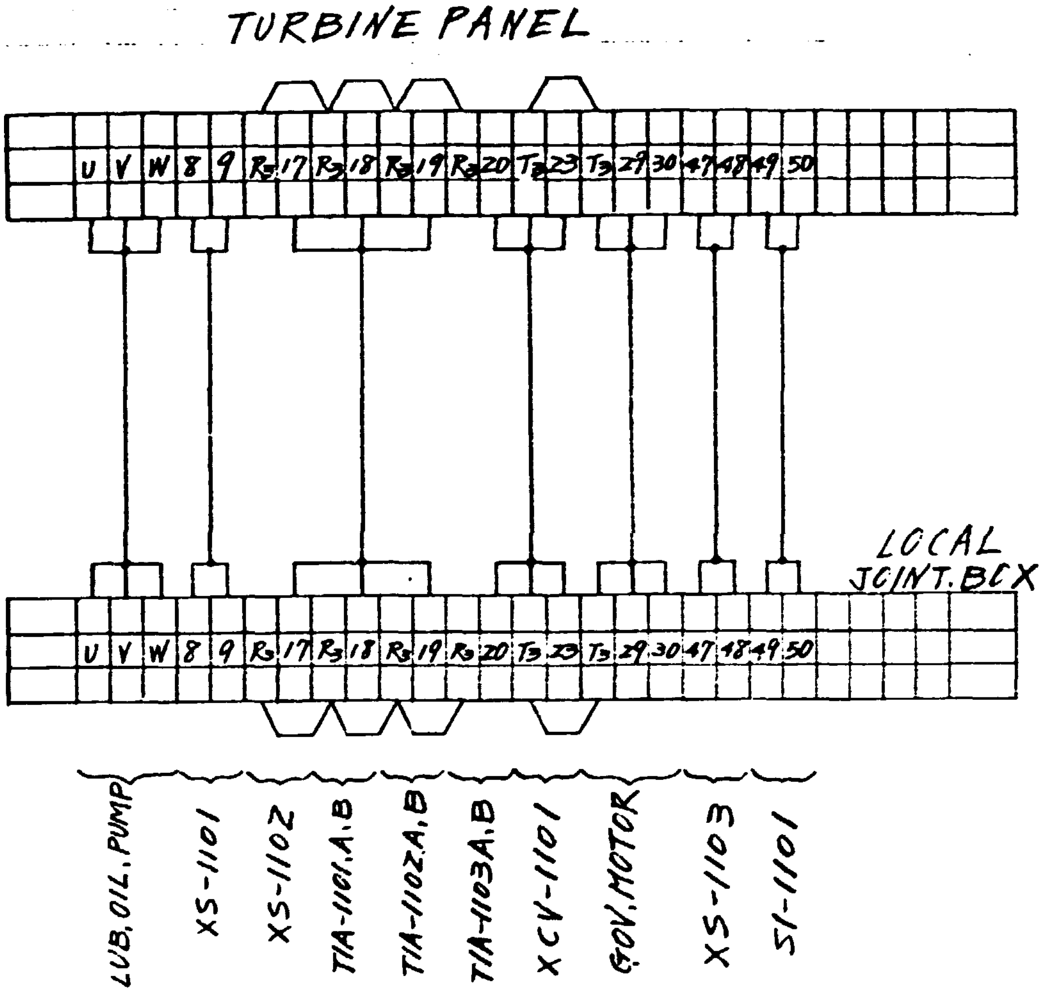
SECTION 1



SA-II TURBINE BLOWER

BACK CONNECTION OF LOCAL PANEL

APPENDIX V-6(3)



SECTION 1

SA-II Turbine Blower interlock

o Operating condition

1. P/A-1101 Main steam pressure (set 5^K)

2. XS-1101 Emergency valve open limit SW ON

o Turbine trip factor

1. Over speed trip (XS1102)

Tripping speed = 15 $\pm\frac{2}{6}$ % above rated speed (3000 RPM)

2. Steam back pressure trip high (PSW-1104)
above 2.5^K ON, bellow 2.15 OFF.

3. Low oil pressure trip (PIA1106LL) bellow 0.8^K ON

o Trouble factor

1. Low oil pressure (P/A-1106L) bellow 1.2^K ON

2. Steam back pressure (PSW-1104) same as above NC.

3. Turbine bearing temp. rise alarm (T/A-1101)

4 Blower bearing temp. rise alarm (T/A-1102)

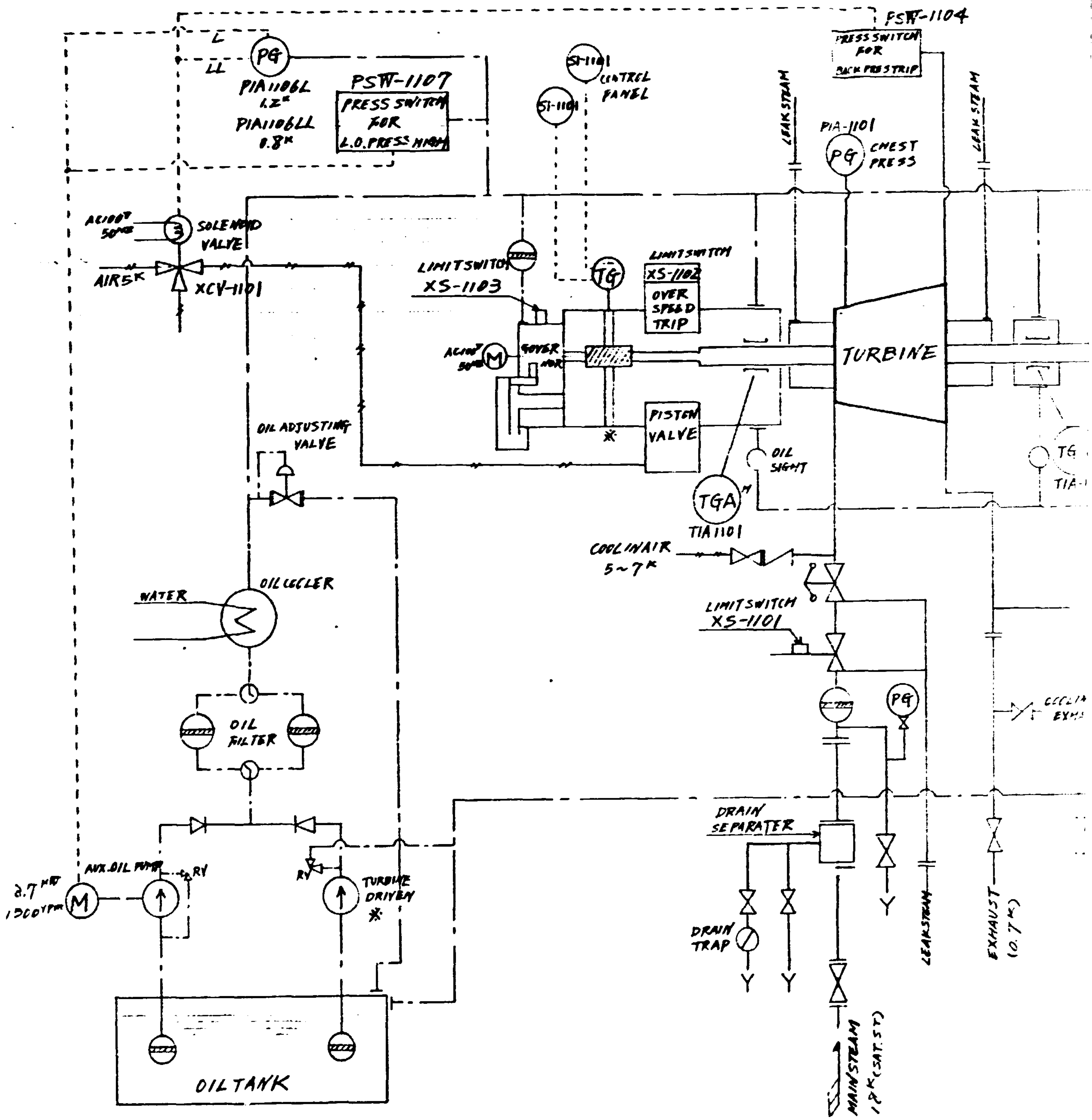
5. Motor bearing temp. rise alarm (T/A-1103)

6. Lub. oil motor trip (49X)

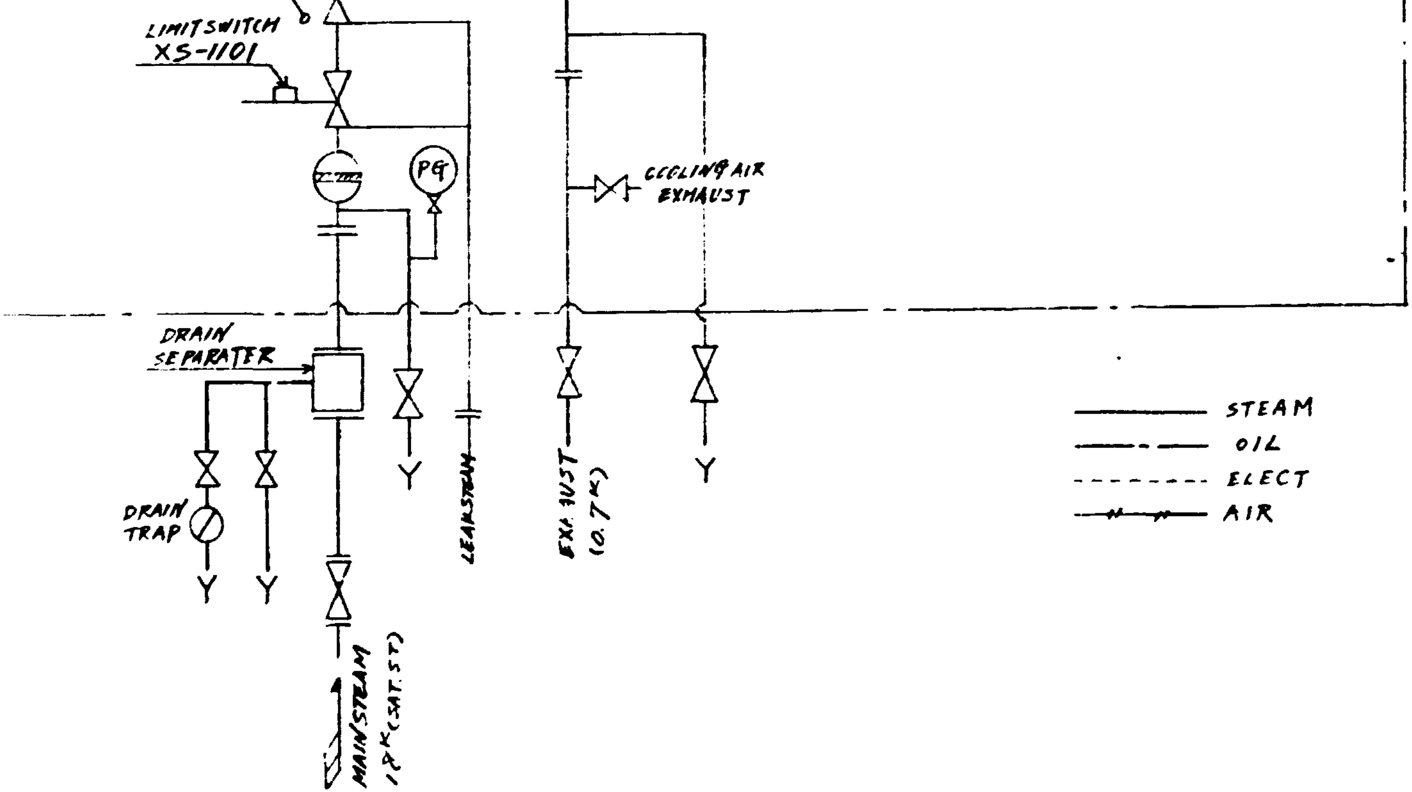
o Turbine running time, if oil pressure down bellow 1.2^K, oil pump start automaticaly by PIA-1106L (R14) and then, if oil pressure rise up above 2.2^K (original set), oil pump stop automaticaly by PSW-1107 (R5)

SECTION 2

APPENDIX V-6 (4)

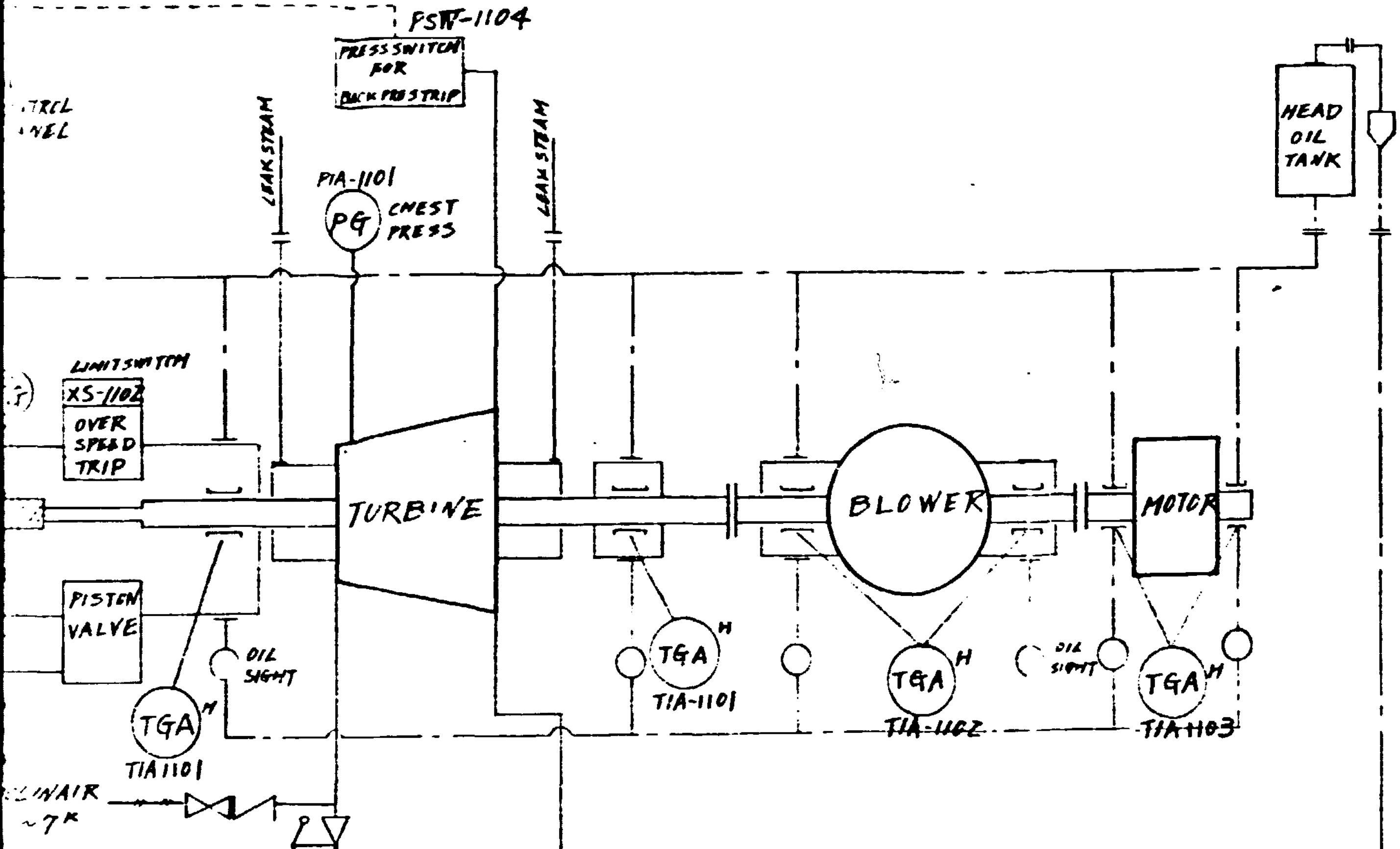


SECTION 1



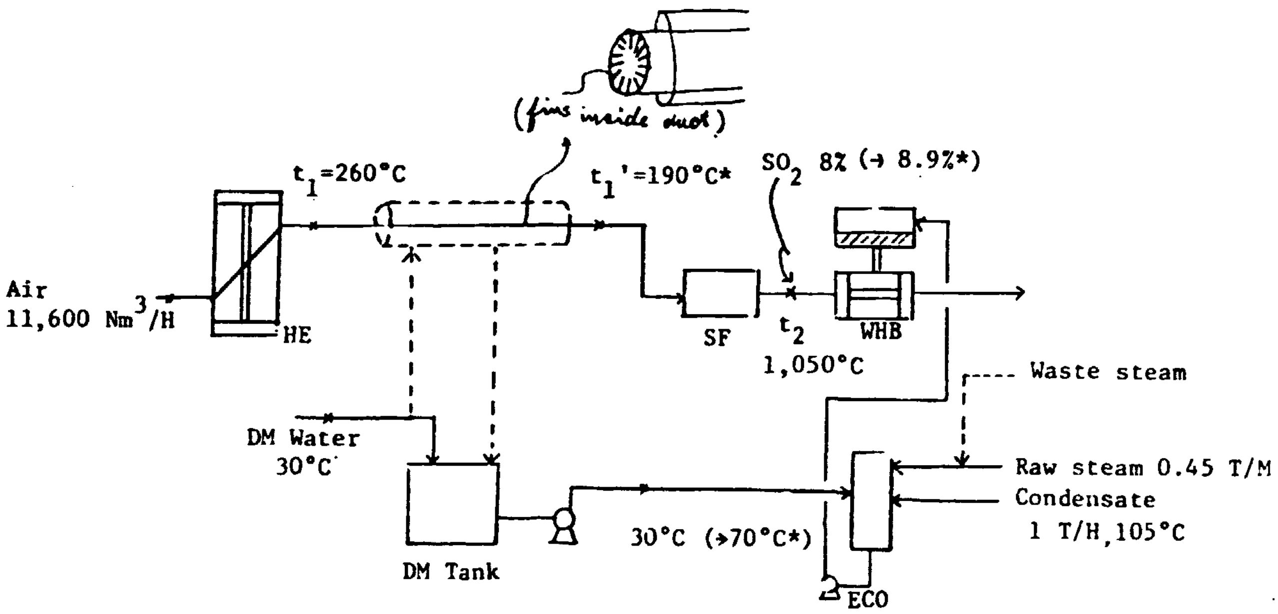
SA-II TURBINBLOWER FLOW SHEET

SECTION 2


FSW-1104
PRESS SWITCH FOR BACK PRES TRIP
LEAK STEAM
PIA-1101
PG
CHEST PRESS
LEAK STEAM
HEAD OIL TANK
LIMIT SWITCH
XS-1102
OVER SPEED TRIP
TURBINE
BLOWER
MOTOR
PISTON VALVE
OIL SIGHT
TGA
H
TIA1101
TIA-1101
TIA-1102
TIA-1103
OIL SIGHT

APPENDIX V-7 INCREASE OF SO_2 GAS CONTENT (SA-I)

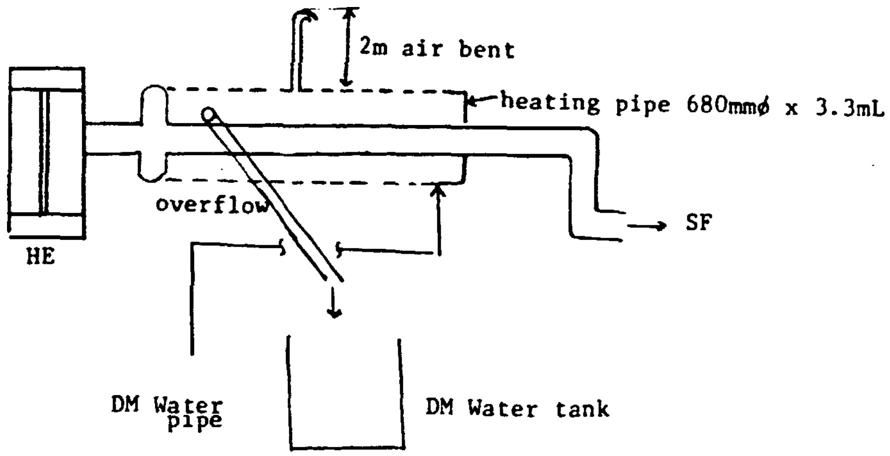
Present conditions of SA-I at 85% load are as follows



In order to increase load up to 100%, it is recommended the following modifications, which are indicated by dotted line and figures marked with asterisk in the above flow sheet.

1. Reduce the SF inlet temperature from 260°C to 190°C by taking off the inlet duct insulation and cooling the DM water fed to deaerator, and keep SF outlet temperature at 1,050 °C. Upon this method, SO_2 content naturally increases from 8.0% to 8.9% at same air volume. About 11% of load-up is expected.

2. Reduction of steam consumption in deaerator may be 350 Kg/H by heating DM water from 30°C to 70°C as follows.



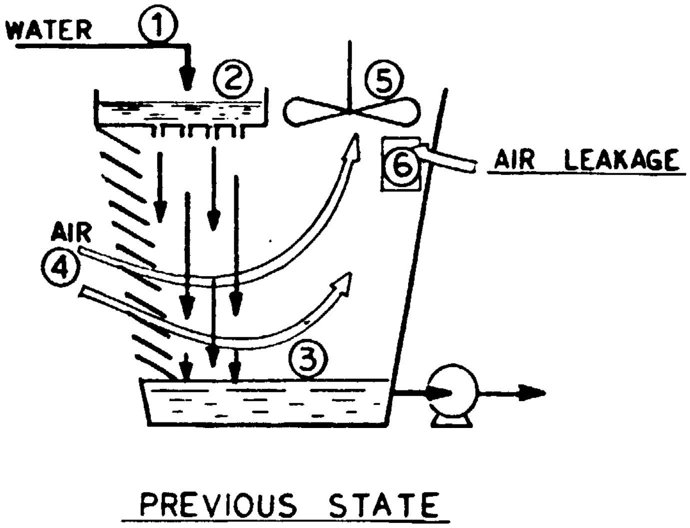
3. Supply of waste steam from the turbine to deaerator also can save 300 Kg/H raw steam.

4. Such saved steam (350 + 300 Kg/H) can be supplied to air blower turbine at the recovery ratio of 70%. Steam flow rate to it is now about 6 T/H.

5. The saved steam 450 kg/H corresponds to approx. 7 % of the present flow rate. Total effects of No.1 and No.4 will devote to operation of 100% load.

APPENDIX V-8(1) IMPROVEMENT OF COOLING SYSTEM

1. Cooling Tower



	Previous temp.	Requested temp.
①	41°C	41°C
③	33.5°C	32.5°C

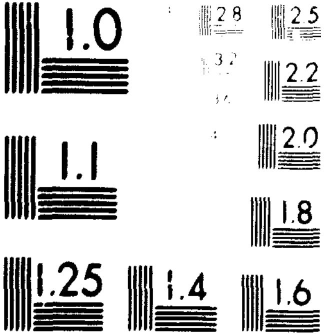
- Flow rate of water

  900 m^3/hr

- Air condition

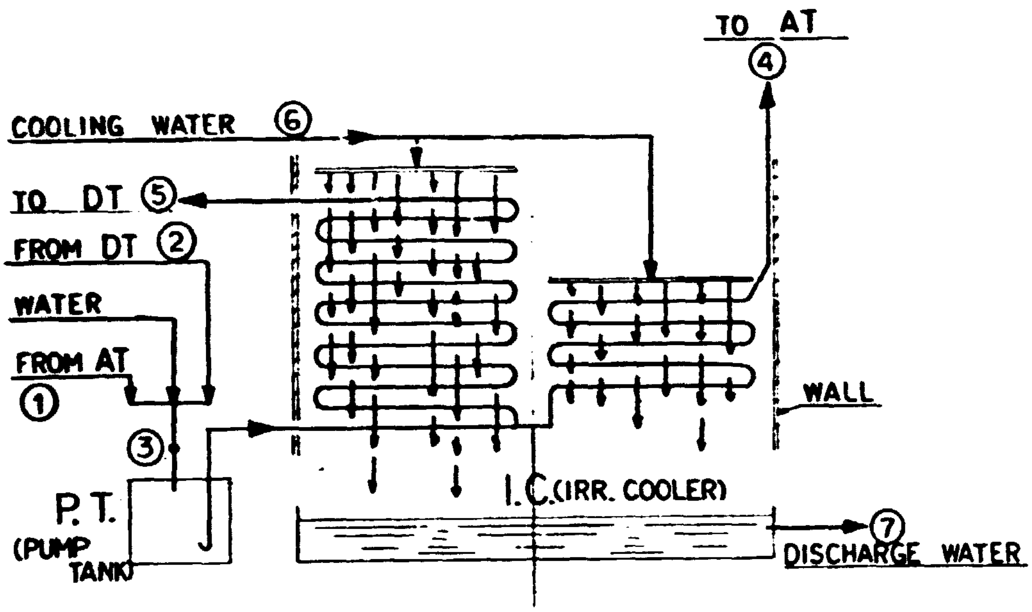
Temp	32°C
Relative humidity	70 %

Countermeausres	Temp. of cooled water
② Uniform distribution of water by cleaning of trough ⑥ Repair of broken wall and door to prevent big air leakage ⑤ Investigation of impeller's revolution speed and impeller's angle	32.5 °C (improved figure)

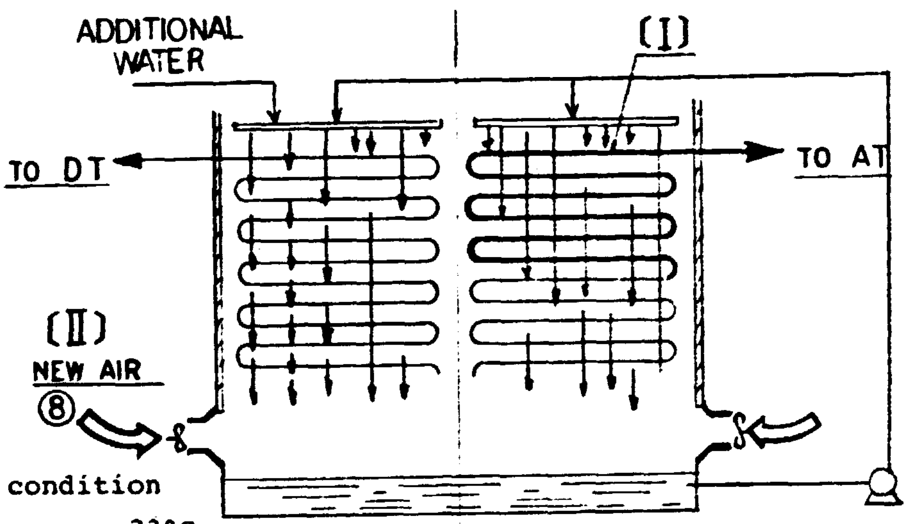


MICROCOPY RESOLUTION TEST CHART

2. Recommendation for SA-1 Cooling System of Circulated Acid



EXISTING STATE



Air condition
temp. 33°C
humidity 70%

RECOMMEND METHOD

t=temp. Q=cal m=mass	① m_1 (t/H)	① t_1 °C	② m_2 (t/H)	② t_2 °C	③ Q_3 (Ncal/H)	④ t_4 °C	④ Q_4 (Mcal/H)	⑤ t_5 °C	⑤ Q_5
Present conditions at 80% load	180	107	120	85	11,560	95	6,413	75	[illegible]
Expected condition after implementation at 100% load	180	100	120	78	10,900	80	5,400	60	[illegible]

Two cas
were cal
operate

Recommendati

[I] Increas

Co
Nc
Te

[II] Improve

Increa
siroccc
coolinc

Spec.

[III] 2 sets
SA-1 pl

SECTION 1

Two cases regarding mass & heat balance of acid cooling were calculated and mentioned below. It is possible to operate at more than 85% load.

Recommendation

[I] Increase of cooling area

	present	after implementation
Cooling area of AT	25 m^2	55 m^2
No. of set of cooler	5 set	11 sets
Temp. of AT acid inlet	95°C	80°C

GE WATER

[II] Improvement of cooling efficiency

Increase of cooling air with additional new 2 units of simple sirocco fan. In this case, existing wall is utilized as a cooling tower.

O AT

Spec. of sirocco fan : 43,000 Nm^3/hr x 50 mmAq

[III] 2 sets of SA-2 DT coolers are converted to the cooler of SA-1 plant.

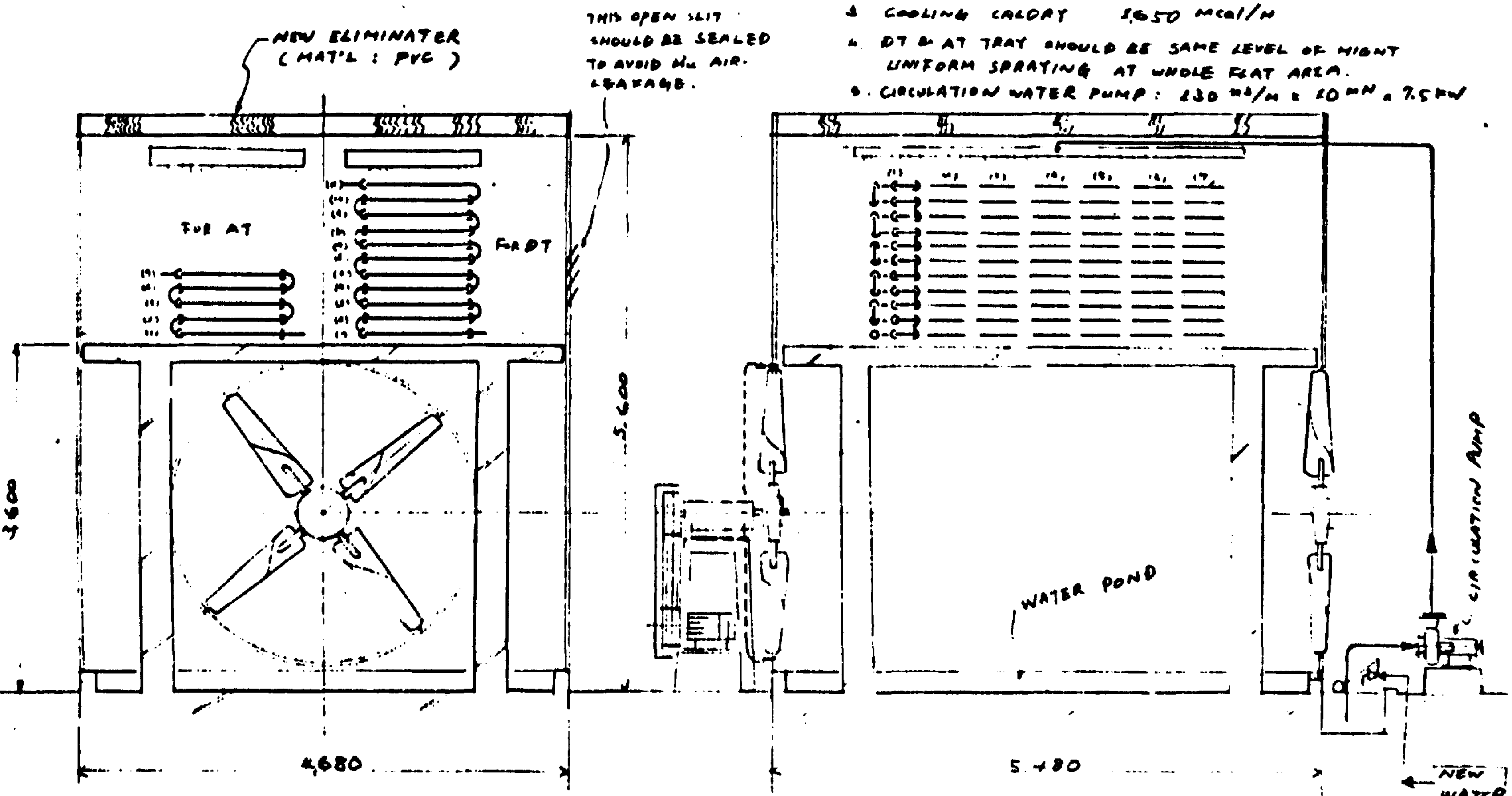
	3	4		5		effect	6		7	evaporated	8
t_2°C	Q_3 (Ncal/H)	t_4°C	Q_4 (Mcal/H)	t_5°C	Q_5 (Mcal/H)	$Q_3-(Q_4+Q_5)$	m_6 (t/H)	t_6°C	t_7°C	water T/H	Nm^3/H
85	11,560	95	6,413	75	2,925	2,220	185	32.0	43.5	0.17	
78	10,900	80	5,400	60	2,700	2,780	185 (200)	32.0	43.5	1.21 (0.89)	85,300 (62,700)

SECTION 2

IMPROVEMENT OF WATER COOLING SYSTEM
FOR ACID COOLER (PA-1)

DESIGN CONDITION
1 NEW FAN 2 SET
SPEC. FAN DIA. 3000 mm
ROTATION 400 rpm
POWER 15 KW
AIR VOL. 175,000 m³/h at 32°C 75% moist
2 NEW SUPPLIED WATER : 3 T/h
3 COOLING CALORY 1650 Mcal/h
4. DT & AT TRAY SHOULD BE SAME LEVEL OF HIGHT
UNIFORM SPRAYING AT WHOLE FLAT AREA.
5. CIRCULATION WATER PUMP : 230 m³/h x 20 mH x 7.5 KW

DATED : 25th MAY 1981	
DESIGNED BY	T. IKEYA (Team Leader)
DRAWN BY	K. ARATANI



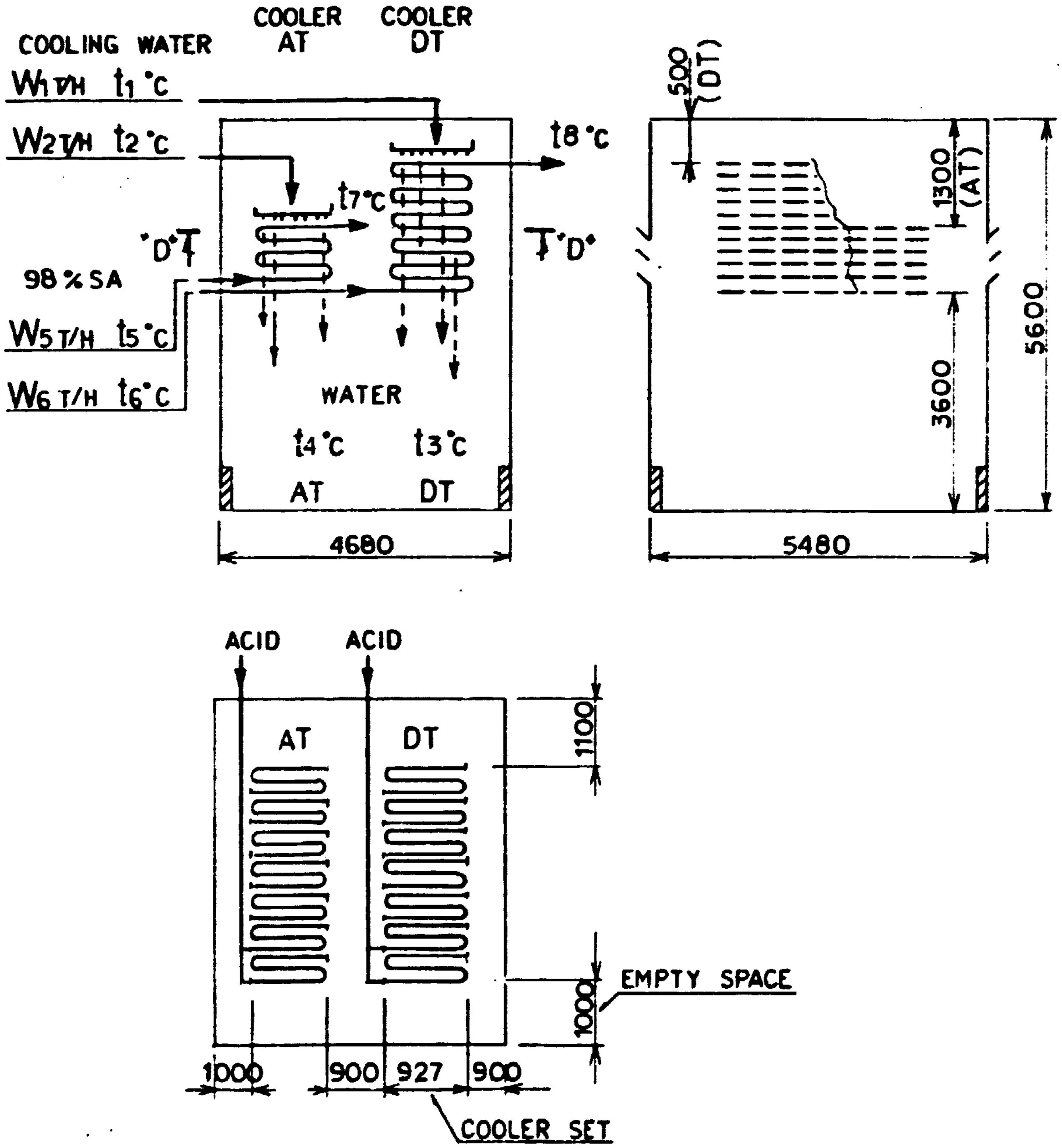
(Note) Circulation Sulfuric acid flow rate and Temperature

AT	145 T/h	(93°C → 82°C)
DT	105 T/h	(93°C → 66°C)
Total	250 T/h	

Note : DETAILS DEPEND ON THE TENDER'S SPECIFICATIONS.

APPENDIX V-8 (2) RECOMMENDATION OF SA-1 WATER COOLING SYSTEM FOR ACID COOLER

1. Present condition



SECTION 'D'-'D'

SECTION 1

2. Calculation

		Design	ΔQ Kcal/hr	
Water	W_1 (t/H)	64.1	$\Delta Q_1 = W_1 Cp\ (t_3 - t_1)$	Total Q = 1,670 Mcal/H
	t_1 (°C)	29.4	$= 64.1\ (46 - 29.4)$	
	t_3 (°C)	46	= 1,064 Mcal/H	
	W_2 (t/H)	54.6	$\Delta Q_2 = 54.6 \times (40.5 - 29.4)$	
	t_2 (°C)	29.4	= 606 Mcal/H	
	t_4 (°C)	40.5		
Acid	W_5 (t/H)	143.3	$\Delta Q_3 = W_5\ Cp\ (t_5 - t_7)$	
	t_5 (°C)	93	$= 143.3 \times 0.363 \times (93 - 82)$	
	t_7 (°C)	82	= 572 Mcal/H	
	W_6 (t/H)	102.3	$\Delta Q_5 = 102.3 \times (0.363 \times 93 - 0.352 \times 66)$	
	t_6 (°C)	93	$= 102.3 \times (33.76 - 23.23)$	
	t_8 (°C)	66	= 1,077 Mcal/H	

3. Evaporated water (V) and required air (X)

Air condition 30°C, 75%

H_1 (saturated) = 0.028 Kg/Kg air

H_2 (75 %) = 0.021 Kg/Kg air

Q (Mcal/Hr) = 580 (Kcal/Kg) x X(Kg/Hr)

$$X = \frac{1,670 \times 10^3}{580} = 2,880 \text{ Kg/Hr}$$

SECTION 2

Required air volume V (Nm^3/hr)

$$V = 1.293 \times (H_1 - H_2) = X$$

$$V = \frac{2,880}{1.293 \times 0.007} = 318,000 \ (Nm^3/hr)$$

In case of air condition that temp. is 30°C, humidity is 70 %.

Required air volume

$$V' = \frac{2,880}{1.293 \times (0.028 - 0.02)} = 278,000 \ Nm^3/hr$$

4. Number of Cooler

Pipe diameter = 100 mm O.D.

i) AT

$N_1 = 5 \times 7 = 35$

ii) DT

$N_2 = 11 \times 7 = 77$

5. Specification for new system

i) Exhaust fan

for example; 2 units of exhaust fan at the top or bottom of cooling tower

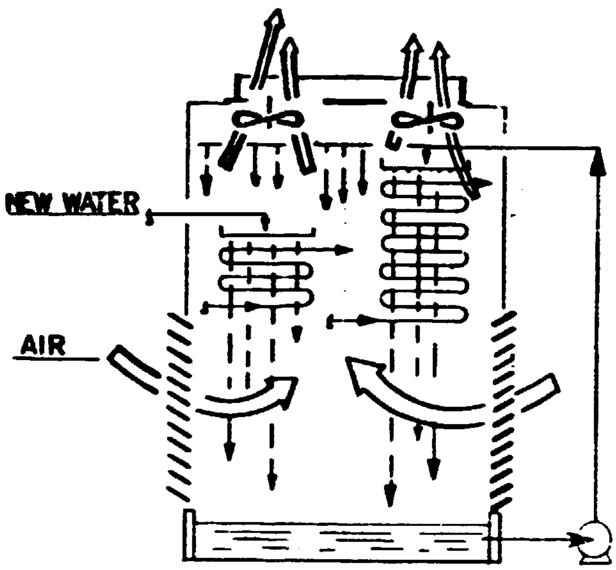
Total air volume	:	400,000 Nm^3/hr
Motor	:	Water proof
Type	:	Plate fan

ii) Circulation pump

Flow rate	:	200 m^3/hr
Head	:	10 m
Motor	:	Water proof

iii) Water distributor with wood

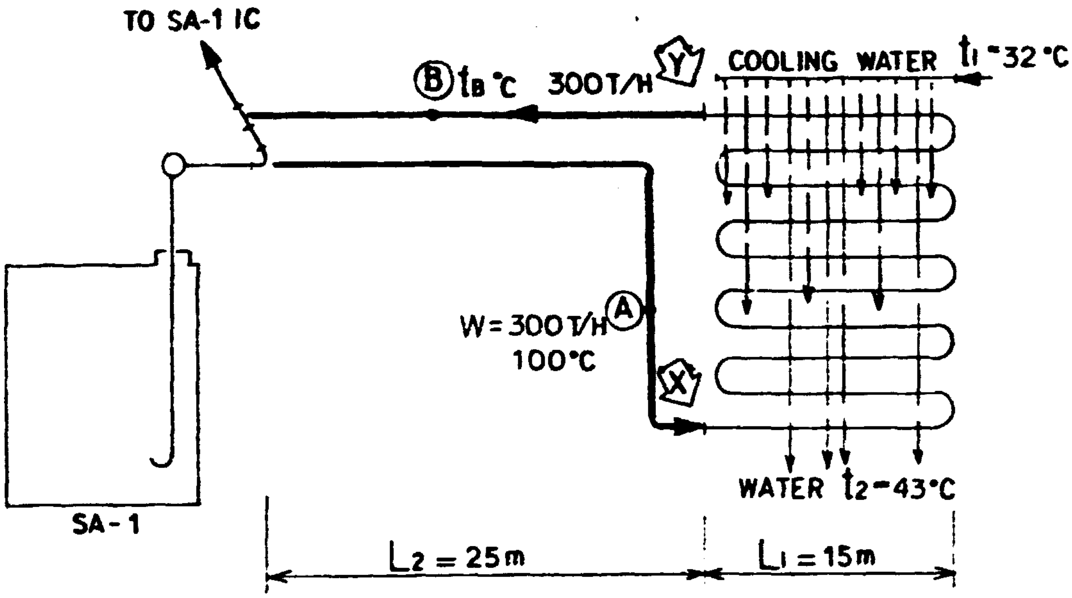
iv) Slit window



APPENDIX V-9 INCREASE OF SA-1 ACID COOLER COOLING AREA

1. Schematic flow

This flow is based on the recommendation [III] of APPENDIX V-8(1). Only 2 sets of SA-2 DT cooler will be used as cooler of SA-1 plant. The capacity of SA-2 cooler is sufficient if 2 sets are transferred.



2. Calculation

i) Increase of cooling area

Diameter of cooling pipe (D) : 170(mmOD)

Total length of cooling pipe (L_3) : L_1 x 10 x 2 = 300 (m)

Cooling area (A) $A = \pi \times DL_3 = 3.14 \times 0.17 \times 300 = 160 (m^2)$

ii) Over all co-efficiency of heat transfer

$U = 230\ (kcal/m^2 hr °C)$

SECTION 1

iii) Acid and water temp

Acid	:	100(°C)	t_B(°C)
water	:	43(°C)	32 (°C)

$$\Delta t_m = \frac{(100 - 43) + (t_B - 32)}{2} = 12.5 + \frac{t_B}{2}$$

iv) Transferred Heat (Q) [Mcal/h]

$$Q = W \cdot C_p \cdot (t_A - t_B) = U \cdot A \cdot \Delta t_m$$

$$Q = 300 \times 0.36 \times (100 - t_B) = 230 \times 160 \times (12.5 + \frac{t_B}{2}) \times 10^{-3}$$

$$t_B = \frac{10,340}{126.4} = 81.8 \text{ (°C)}$$

$$Q = 300 \times 0.36 \times (100 - 81.8) = 1,966 \text{ (Mcal/h)}$$

Total cooling capacity

Total cooling capacity in SA-1 plant requests 2,780 Mcal/h.

2,780 - 1,966 = 814 Mcal/h

This 814 Mcal/h is very easily cooled by the existing cooler of SA-1 plant.

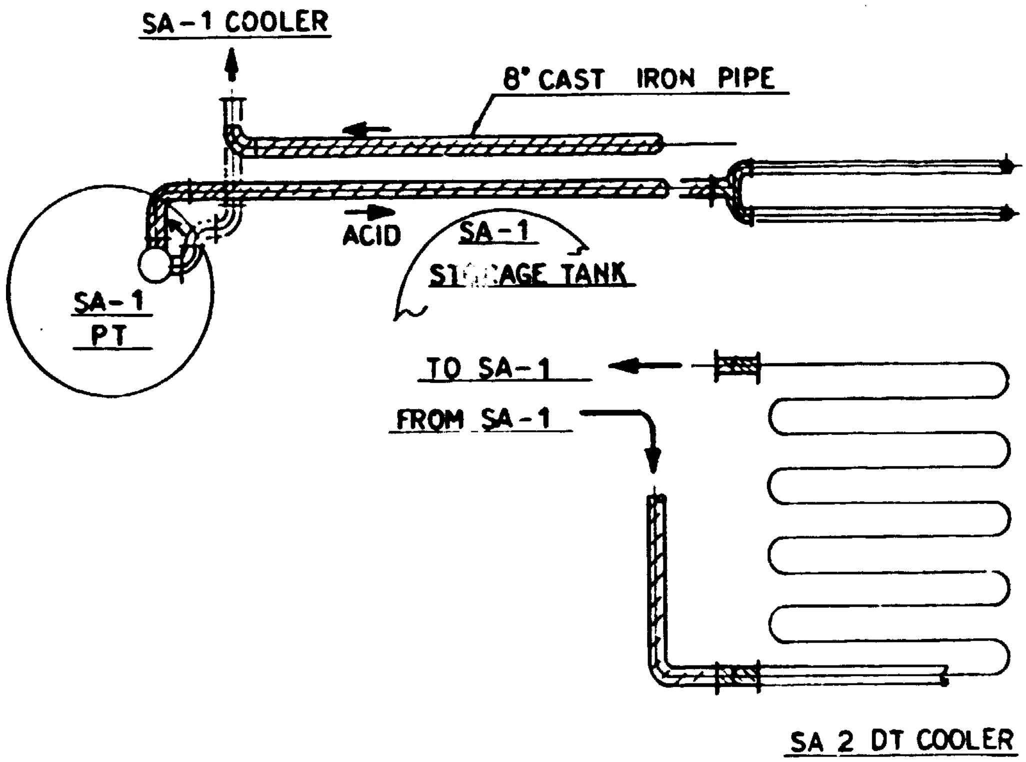
:r

(m)

0 (m^2)

SECTION 2

3. Implementation



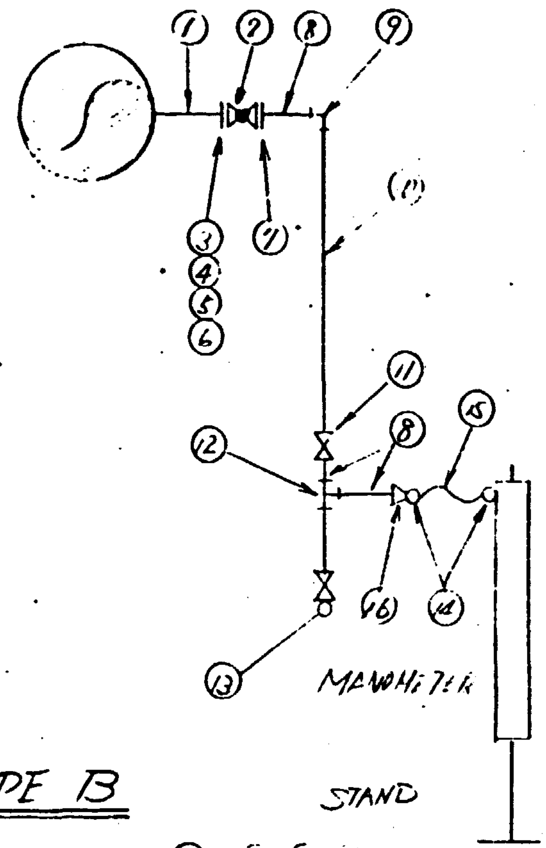
i) Estimated cost for piping & assembly

			Cost (TK)
Straight pipe	8" cast iron x 45 m length		177,000
Bend	8" cast iron x 5 pieces		41,700
Y branch		2 pieces	22,000
Scaffolding & fabrication			60,000
		Total	300,700 (TK)

ii) Cost of this method is about 1.5 times of other recommendations (I) or (II) mentioned in APPENDIX V-8(1), but this method will be very effective.

APPENDIX V-10(1) TYPE OF MANOMETER

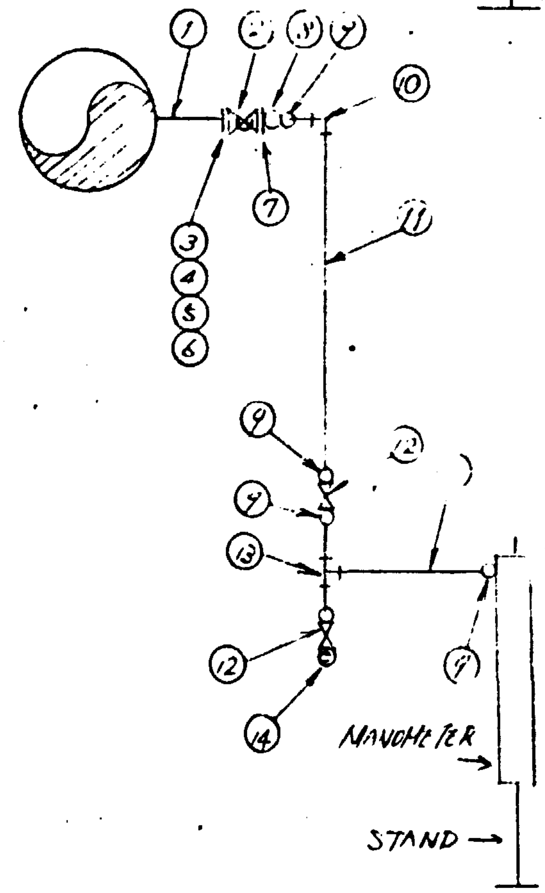
TYPE A



TYPE A MATERIALS

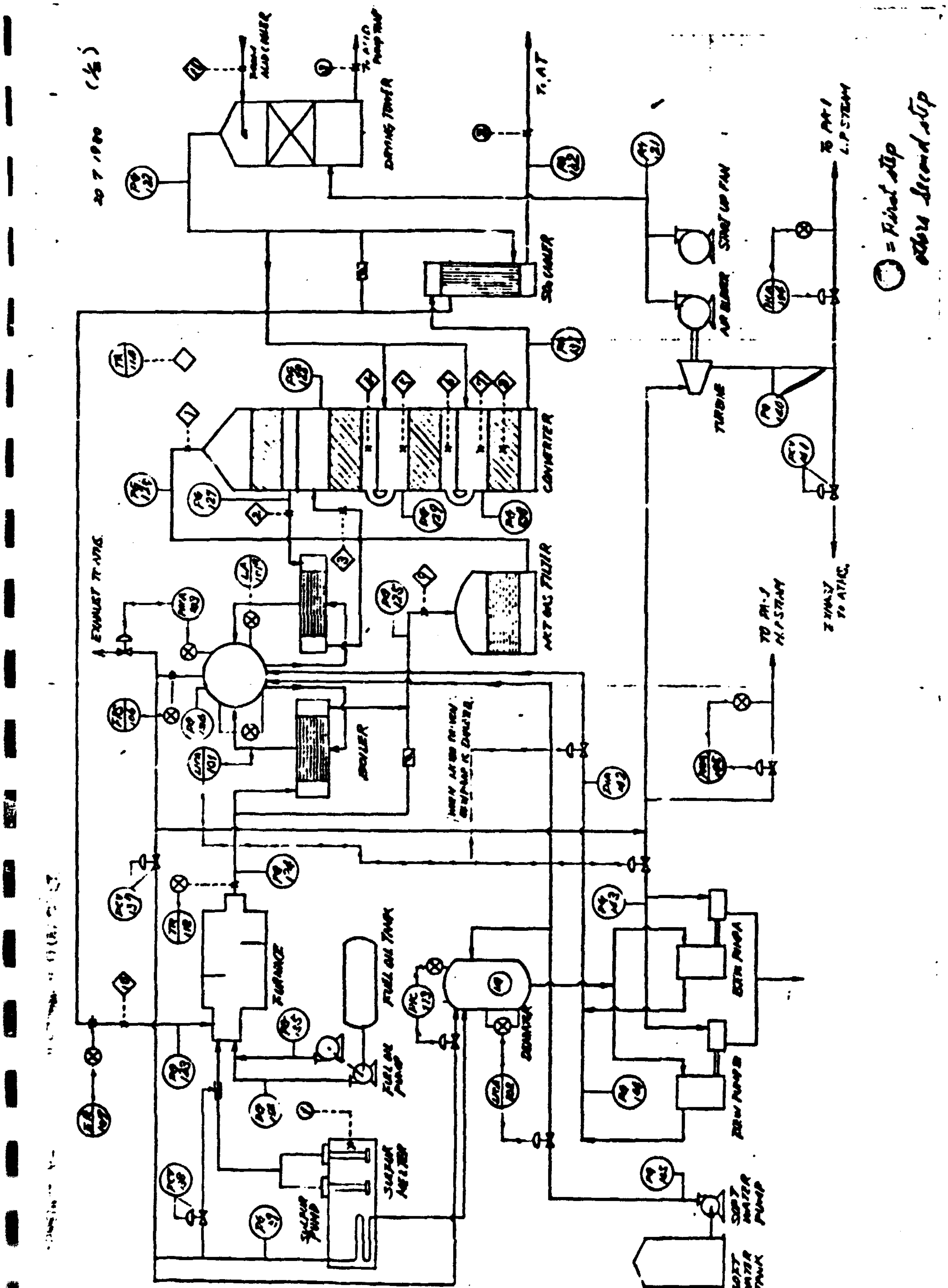
1.	PIPE	1/2"	SUS304	–
2	BALL VALVE	1/2"	SUS304	1
3	FLANGE	1/2"	SUS304	1
4	BOLT	3/8"	SS41	8
5	NUT	3/8"	SS41	8
6	GASKET	1/2"	Val° 1500	2
7	FLANGE	1/2"	SUS304	1
8	NIPPLE	1/2"×100		3
9	ELBOW	1/2"		3
10	PIPE	1/2"	GP	–
11	VALVE	1/2"	SCREWED	2
12	TEES	1/2"		1
13	BLIND PLUG	1/2"	SUS304	1
14	CONNECTOR	1/4PT	SUS304	2
15	HOSE	6φ	VINIL	1m
16	REDUCER	1/4×1/2		1

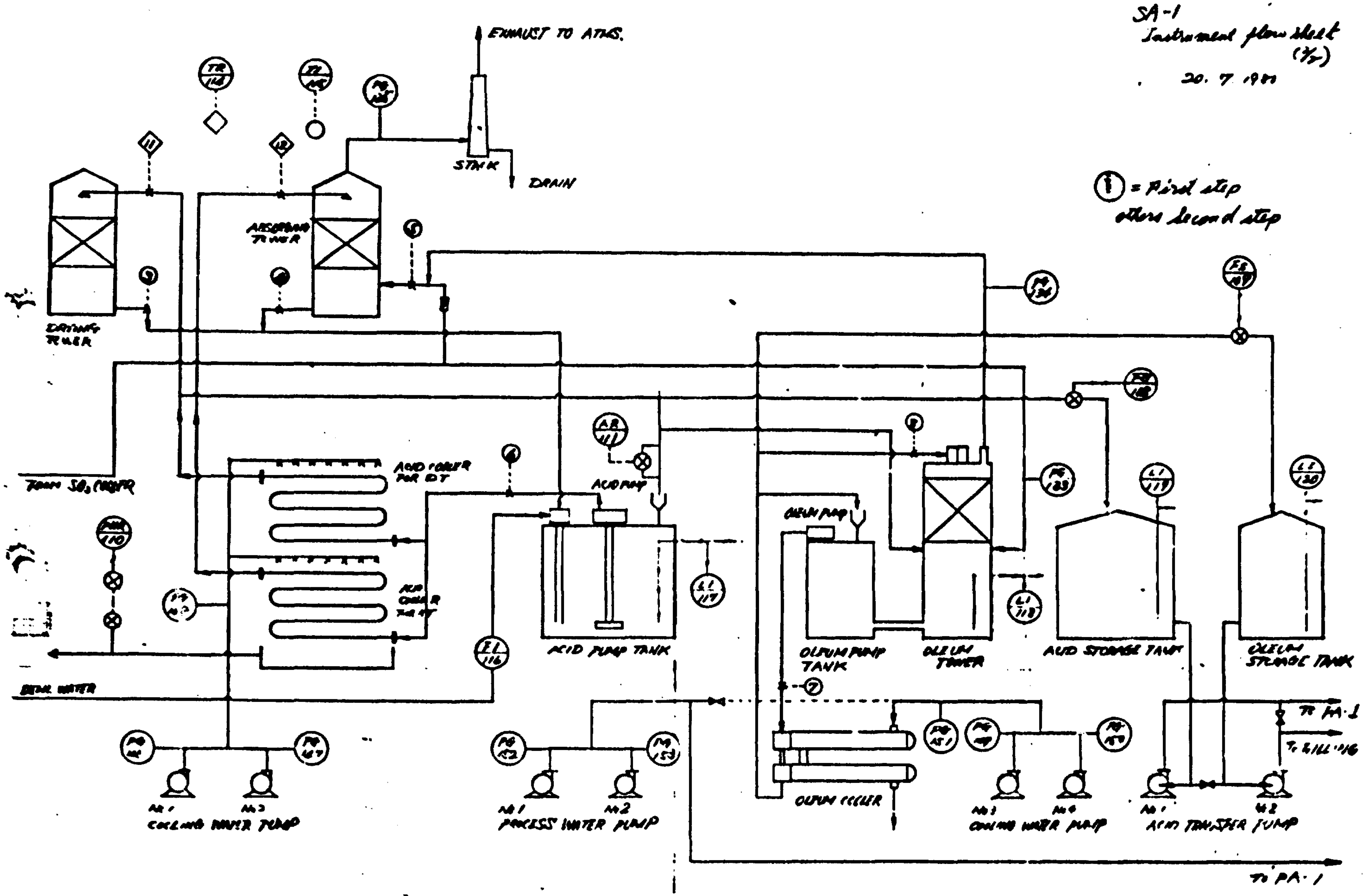
TYPE B



TYPE B MATERIALS

1	PIPE	1/2"	SUS304	–
2	BALL VALVE	1/2"	SUS304	1
3	FLANGE	1/2"	SUS304	1
4	BOLT	3/8"	SS41	8
5	NUT	3/8"	SS41	8
6	GASKET	1/2"	Val° 1500	2
7	FLANGE	1/2"	SUS304	1
8	BUSHING	1/2×1/4	SUS304	1
9	HALF UNION	6φ×1/4	SUS304	5
10	ELBOW UNION	6φ	SUS304	3
11	PIPE	6φ×4φ	SUS304	–
12	VALVE	1/4×1/4	SUS304	2
13	TEE UNION	6φ	SUS304	1
14	BLIND PLUG	1/4	SUS304	1
15	STRAIGHT UNION	6φ	SUS304	1




SA-1
Instrument flow sheet
(3/7)
20. 7. 1981
= First step
others Second step
EXHAUST TO ATMS.
STACK
DRAIN
DRYING TOWER
ABSORBING TOWER
FROM SO3 COOLER
ACID COOLER FOR DT
ACID COOLER FOR AT
ACID PUMP
ACID PUMP TANK
OLEUM PUMP
OLEUM PUMP TANK
OLEUM TOWER
ACID STORAGE TANK
OLEUM STORAGE TANK
OLEUM COOLER
DEMI WATER
No.1 No.2
COOLING WATER PUMP
No.1 No.2
PROCESS WATER PUMP
No.3 No.4
COOLING WATER PUMP
No.1 No.2
ACID TRANSFER PUMP
TO PA-1
TO FILLING
TO PA-1

APPENDIX V-10(3) SERVICE CONDITION

Regarding APPENDIX V-10(3) and (4), here only samples are attached due to big volume. All original data of these APPENDIX were already submitted to TSP factory.

1. LICA-101V (Boiler drum level)

Fluid	Water
Flow rate Nor.	6.3 m^3/H
Max.	9.5 m^3/H
Temperature	105°C
Inlet pressure	20 kg/cm^2G
Pressure drop	4 kg/cm^2
Specific gravity	995 kg/m^3
Viscosity	0.27 cp

2. LICA-102V (Dearator)

Fluid	Water
Flow rate Nor.	5 m^3/H
Max.	7.5 m^3/H
Temperature	21°C
Inlet pressure	1.2 kg/cm^2G
Pressure drop	0.9 kg/cm^2
Specific gravity	1,000 kg/m^3
Viscosity	1 cp

3. PRCA-103V (Boiler drum pressure)

Fluid	Steam
Flow rate Nor.	3,000 kg/H
Max.	4,500 kg/H
Temperature	205°C
Inlet pressure	16 kg/cm^2G
Pressure drop	16 kg/cm^2
Specific gravity	8.66 kg/m^3
Viscosity	0.0162 cp

APPENDIX V-10(4) ESSENTIAL SPECIFICATION FOR PURCHASE

1. Self controlled valve
   Tag No. PCV - 137
   Control of secondary pressure
   Material: Body: SC - 49
   Trim: SUS304, Stellite face
   Rating: JIS 20 kg/cm^2 (ANSI 300 lb)

2. Self controlled valve
   Tag No PCV - 138
   Control of secondary pressure
   Material: Body: FC - 20
   Trim: SUS304, Stellite face
   Rating: JIS 10 kg/cm^2 (ANSI 50 lb)

3. Self controlled valve
   Tag No PCV - 141
   Control of primary pressure
   Material: Body: FC - 20
   Trim: SUS304

4. Deaerator pressure control (PIC - 113)

   A. Controller
      Type - Pneumatic indicating controller
      Range - 0-0.7 kg/cm^2g
      Air conn Tapped 1/4 NPT
      Mounting Pracket for 2" pipe mounting
      Accessory Regulator with filter

   B. Transmitter
      Type Pneumatic indicating transmitter
      Range 0-0.7 kg/cm^2g
      Air conn. Tapped 1/4 NPT
      Element SUS 304
      Accessory Regulator with filter

APPENDIX V-11 RECOMMENDATION FOR CORRECTION OF SA-1 PANEL

(1) NAME CORRECTION FOR VENDOR APPROVAL

Before Correction		After Correction	
Unit No.	Name	Name	Unit No.
1D	Feed Water Pump-1	Cooling Water Pump-1	1D
1E	Feed Water Pump-2	Cooling Water Pump-2	2D
2B	Feed Water Pump-3	Cooling Water Pump-3	3D
2C	Feed Water Pump-4	Cooling Water Pump-4	4D
3E	Feed Water Pump-5	Process Water Pump-1	1E
3F	98% Acid Pump	[illegible]d Circulation Pump	5D
4C	Feed Water Pump-6	Process Water Pump-2	2E
5E	Feed Water Pump-7	Process Water Pump-3	3E
2E	Control Tr.	Control Tr. for Inst.	2G
4A	Oil Burner Fuel Pump	Burner Fuel Pump	4A

APPENDIX V-11(2) ARRANGEMENT OF ELECTRICAL SECTION'S DESIGN

1A Oleum Pump (4kw)	2A Sulfur Pump-1 (4kw)	3A Sulfur Pump-2 (4kw)	4A Oil Burner Fuel Pump (5.5kw)	5A Soft Water Pump (4kw)
1B T.Lub. Oil Pump (0.4kw)	2B Acid Transfer Pump-1 (2.5kw)	3B Control Source (2.5kw)	4B Control Transformer (1.5kva)	5B Acid Transfer (2.5kw)
1C Control Source (7.5kw)	2C Control Transformer (4kva)	3C Lighting Source (5kw) (5kw)	4C Lighting Source (10kw)	5C Welding Source (20kw)
1D Feed Water Pump-1 (20kw)	2D Feed Water Pump-2 (20kw)	3D Feed Water Pump-3 (20kw)	4D Feed Water Pump-4 (20kw)	5D Feed Water Pump-5 (20kw)
1E Feed Water Pump-6 (20kw)	2E Feed Water Pump-7 (20kw)	3E 98% Acid Pump (20kw)	4E Start up Fan (16kw)	5E Spare for Motor (20kw)
1F Acid Compressor (1.2kw)	3F Spare for Motor (4kw)	3F Spare for Motor (2.5kw)	4F Spare NFB (7.5kw)	5F Spare NFB (5kw)
1G	3G	3G	4G	5G

APPENDIX V-11(3) ARRANGEMENT OF MANUFACTURER

1A Oleum Pump (4kw)	2A Acid Transfer Pump-1 (2.5kw)	3A Spare for Motor (4kw)	4A Oil Burner Fuel Pump (5.5kw)	5A Space
1B T. Lub Oil Pump (0.4kw)	2B Feed Water Pump-3 (20kw)	3B Sulfur Pump-2 (4kw)	4B Lighting Source (10kw)	5B Soft Water Pump (4kw)
1C Control Source (7.5kw)	2C Feed Water Pump-4 (20kw)	3C Control Source (2.5kw)	4C Feed Water Pump-6 (20kw)	5C Acid Transfer Pump-2 (2.5kw)
1D Feed Water Pump-1 (20kw)	2D Tr. Primary (10A)	3D Lighting Source (5kw)	4D Start pu Fan (16kw)	5D Welding Source (20kw)
1E Air Compressor Pump-2 (20kw)	2E Control Transformer (4kva)	3E Feed Water Pump-5 (20kw)	4E Tr. Primary (5A)	5E Feed Water (20kw)
1F Air Compressor (1.2kw)	3F	3F 98% Acid Pump (20kw)	4F Control Transformer (1.5kw)	5F Spare for Motor (20kw)
1G Sulfur Pump-1 (4kw)	3G	3G Spare for Motor (2.5kw)	4G	5G Space

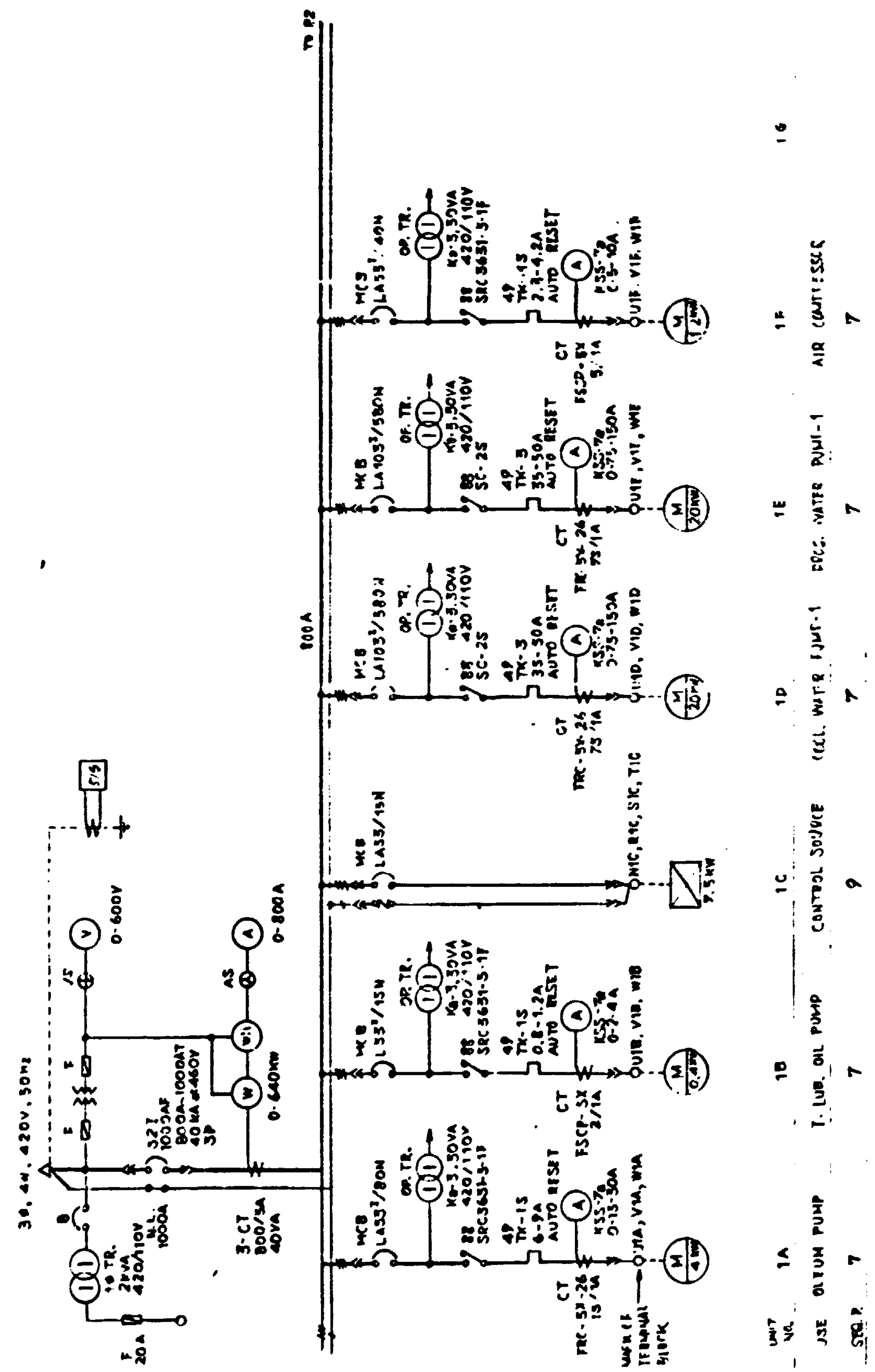
APPENDIX V-11(4) ARRANGEMENT FOR APPROVAL

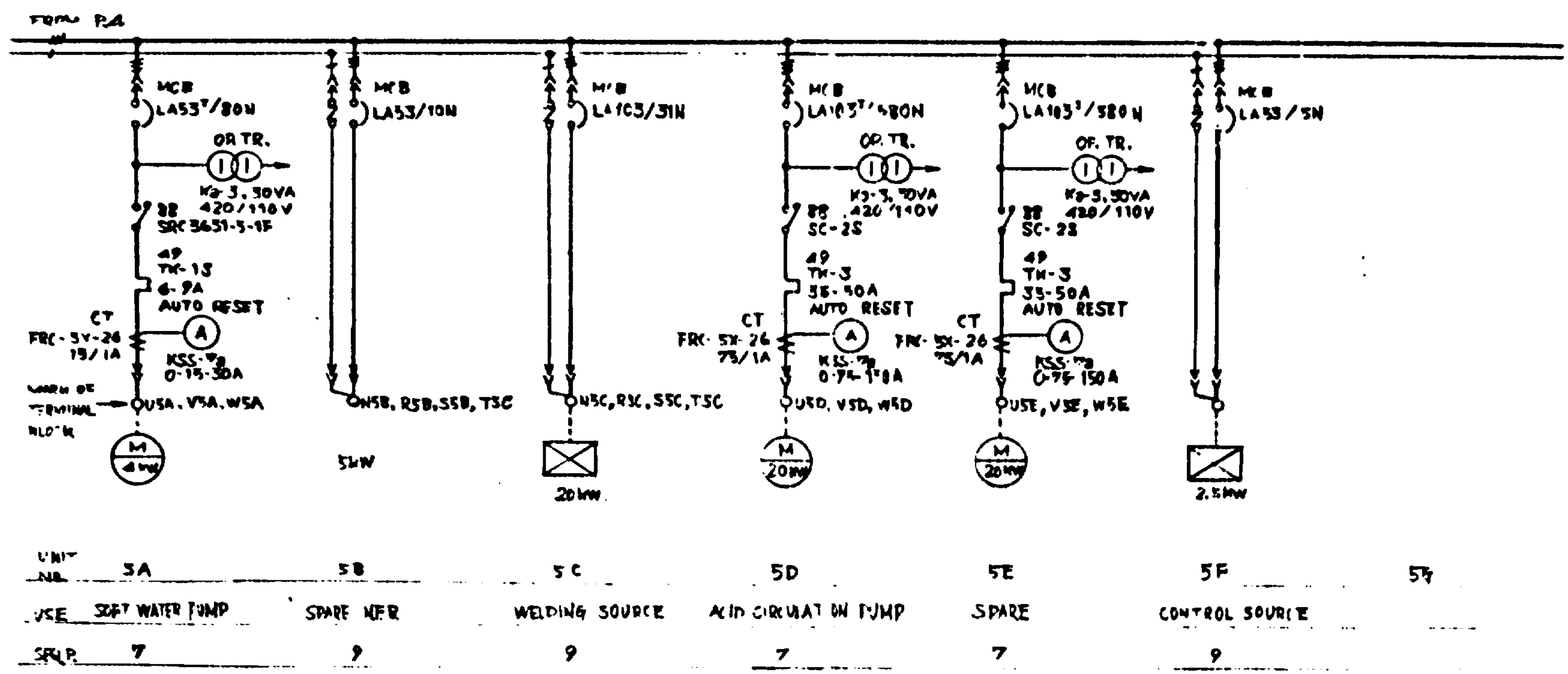
1A Oleum Pump (4kw)	2A Sulfur Pump-1 (4kw)	3A Sulfur Pump-2 (4kw)	4A Burner Fuel Pump (5.5kw)	5A Soft Water Pump (4kw)
1B T. Lub. Oil Pump (0.4kw)	2B Acid Transfer Pump-1 (2.5kw)	3B Acid Transfer Pump-2 (2.5kw)	4B Spare for Motor (2.5kw)	5B Spare NFB (5kw)
1C Control Source (7.5kw)	2C Spare NFB (7.5kw)	3C Lighting Source (5kw)	4C Lighting Source (10kw)	5C Welding Source (20kw)
1D Cooling Water Pump-1 (20kw)	2D Cooling Water Pump-2 (20kw)	3D Cooling Water Pump-3 (20kw)	4D Cooling Water Pump-4 (20kw)	5D Acid Circulation Pump (20kw)
1E Process Water Pump-1 (20kw)	2E Process Water Pump-2 (20kw)	3E Process Water Pump-3 (20kw)	4E Spare for Motor (20kw)	5E Staft up Fan (15kw)
1F Air Compressor (1.2kw)	2F Tr. Primary (10A)	3F Tr. Primary (5A)	4F Spare for Motor (4kw)	5F Control Source (2.5kw)
1G Space	2G Control Tr. for inst. (4kv	3G Control Tr. (1.5kv	4G Space	5G Space

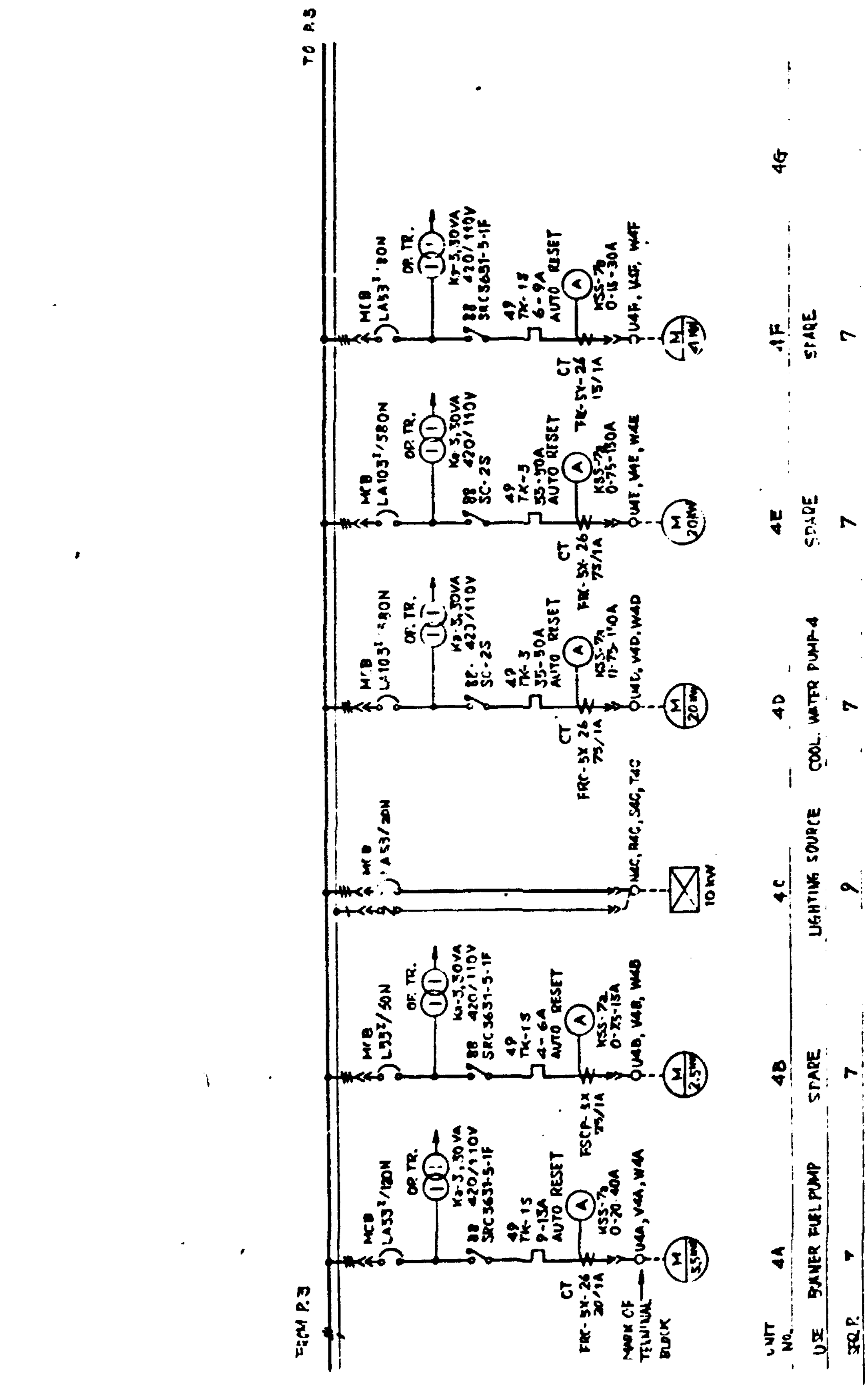
APPENDIX V-11(5) ARRANGEMENT FOR FUTURE

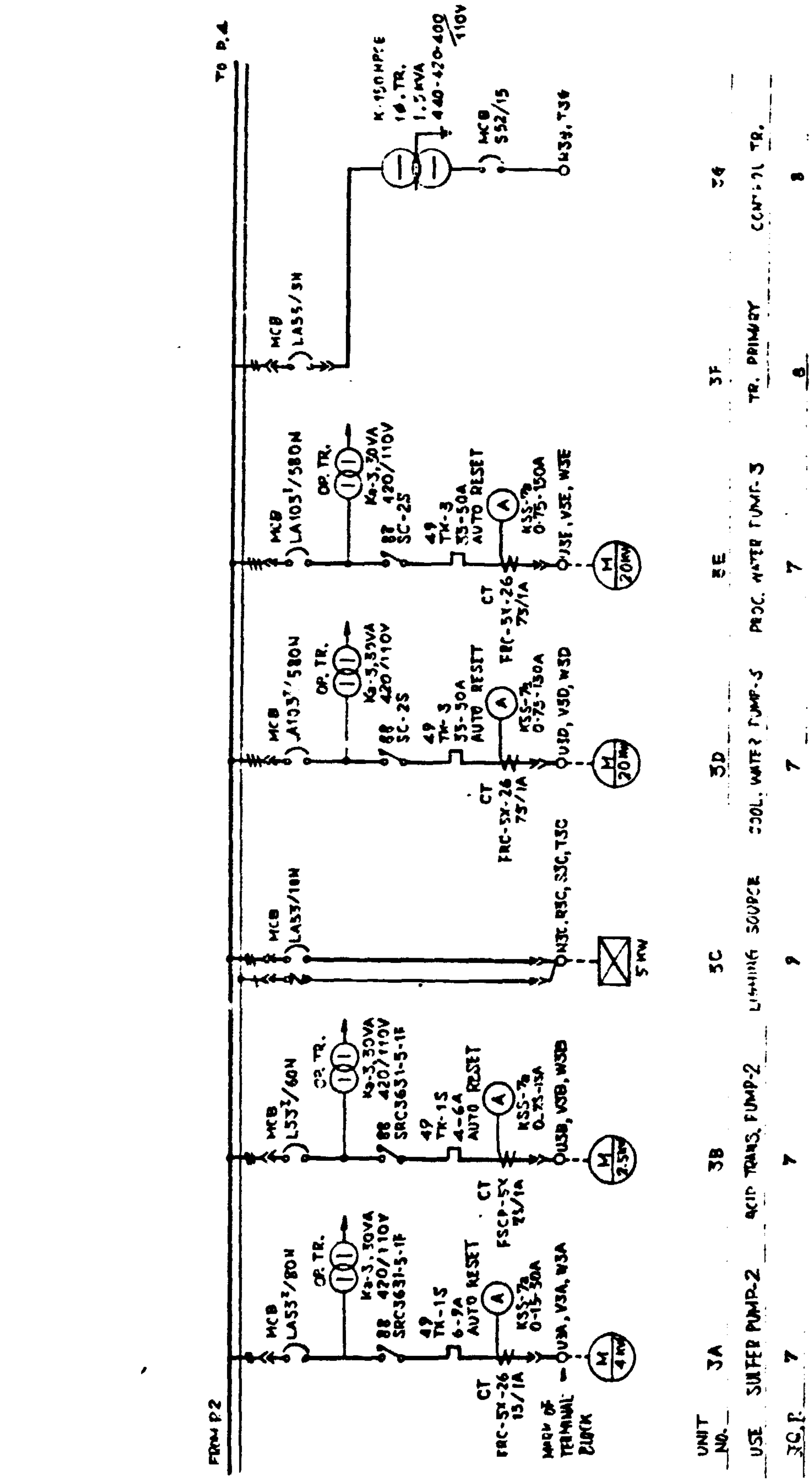
1A Oleum Pump (4kw)	2A Sulfur Pump-1 (4kw)	3A Sulfur Pump-2 (4kw)	4A Burner Fuel Pump (5.5kw)	5A Soft Water Pump (4kw)
1B T.Lub.Oil Pump (0.4kw)	2B Acid Transfer Pump-4 (2.5kw)	3B Acid Transfer Pump-2 (2.5kw)	4B Acid Transfer Pump-3 (max=2.5kw)	5B Spare
1C Sulfur Agitator-1 (max=7.5kw)	2C Sulfur Agitator-2 (max=7.5kw)	3C Lighting Source (5kw)	4C Lighting Source (10kw)	5C Welding Source (20kw)
1D Cooling Water Pump-1 (20kw)	2D Cooling Water Pump-2 (20kw)	3D Cooling Water Pump-3 20kw)	4D Cooling Water Pump-4 (20kw)	5D Acid Circula-Pump (20kw)
1E Process Water Pump-2 (20kw)	2E Process Water Pump-2 (20kw)	3E Boiler Feed Water Pump-1 (max=20kw)	4E Boiler Feed Water Pump (max=20kw)	5E Start up (16kw)
1F Air Compressor (1.2kw)	2F Tr. Primary (10A)	3F Tr. Primary (5A)	4F Spare for Motor (4kw)	5F Control Source (2.5kw)
1G Space	2G Control Tr. (4kv)	3G Control Tr. (1.5kv)	4G Space	5G Space

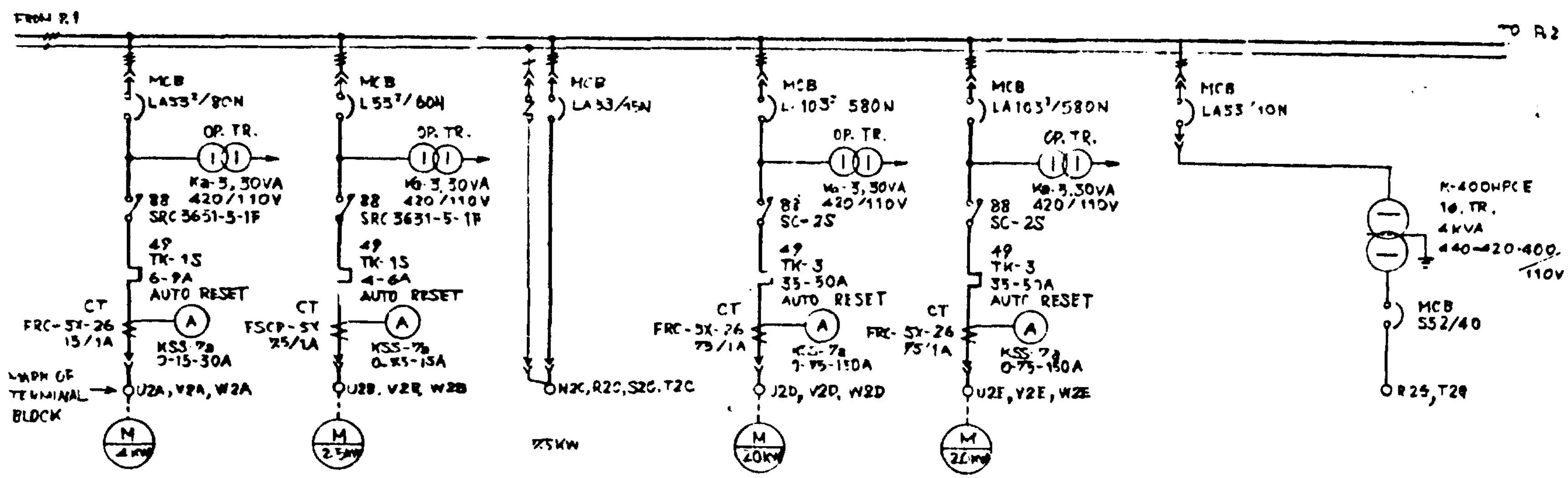
APPENDIX V-11(6) SEQUENCE FOR SA-1 PLANT




FROM P.A
MCB
LA53T/80N
OR TR.
K3-3, 50VA
420/110V
88
SRC 3651-5-1F
49
TH-13
6-9A
AUTO RESET
CT
FRC-5Y-26
15/1A
KSS-T8
0-15-30A
TERMINAL
USA, VSA, WSA
M
4kW
MCB
LA53/10N
NSB, RSB, SSB, TSC
5kW
MCB
LA103/31N
USC, RSC, SSC, TSC
20kW
MCB
LA103T/480N
OP. TR.
K3-3, 50VA
420/110V
88
SC-2S
49
TH-3
35-50A
AUTO RESET
CT
FRC-5X-26
75/1A
KSS-T8
USD, VSD, WSD
M
20kW
MCB
LA103T/580N
OF. TR.
K3-3, 50VA
420/110V
88
SC-28
49
TH-3
35-50A
AUTO RESET
CT
FRC-5X-26
75/1A
KSS-T8
0-75-150A
USE, VSE, WSE
M
20kW
MCB
LA53/5N
2.5kW
UNIT NO.
5A
5B
5C
5D
5E
5F
USE
SOFT WATER PUMP
SPARE MFR
WELDING SOURCE
ACID CIRCULATION PUMP
SPARE
CONTROL SOURCE
SPLP
7
9
9
7
7
9


FROM P.3
TO P.5
UNIT No.
USE
SEQ.P.
4A
4B
4C
4D
4E
4F
4G
BURNER FUEL PUMP
SPARE
LIGHTING SOURCE
COOL. WATER PUMP-4
SPARE
SPARE
MARK OF TERMINAL BLOCK
MCB
OP. TR.
AUTO RESET
CT
10 kW


FROM P.2
TO P.4
MCB LASS³/80N
OP. TR.
Ka-3, 30VA 420/110V
88 SRC3631-5-1F
49 TK-1S 6-9A AUTO RESET
KSS-7a 0-15-30A
CT FRC-5X-26 15/1A
MARK OF TERMINAL BLOCK
U3A, V3A, W3A
4kW
MCB L33³/60N
88 SRC3631-5-1F
49 TK-1S 4-6A AUTO RESET
KSS-7a 0.75-15A
CT FSCP-5X 25/1A
U3B, V3B, W3B
2.5kW
MCB LA53/10N
N3C, R3C, S3C, T3C
5kW
MCB A103³/580N
88 SC-2S
49 TK-3 35-50A AUTO RESET
KSS-7a 0.75-150A
CT FRC-5X-26 75/1A
U3D, V3D, W3D
20kW
MCB LA103³/580N
88 SC-2S
49 TK-3 35-50A AUTO RESET
KSS-7a 0.75-150A
CT FRC-5X-26 75/1A
U3E, V3E, W3E
20kW
MCB LA53/5N
K-150HPCE 1φ TR. 1.5kVA 440-420-400/110V
MCB S52/15
U3H, T34
UNIT NO. 3A 3B 3C 3D 3E 3F 34
USE SULFER PUMP-2 ACID TRANS. PUMP-2 LIGHTING SOURCE COOL. WATER PUMP-5 PROC. WATER PUMP-3 TR. PRIMARY CONTROL TR.
7 7 9 7 7 8 8



UNIT No.	2A	2B	2C	2D	2E	2F	2G
USE	SULFUR PUMP	ACID TRANS PUMP 1	SPARE NFB	COOL. WATER PUMP-2	PROC. WATER PUMP-2	TR. PRIMARY	CONTROL TR. FOR INST.
SEC.P	7	7	9	7	7	8	8

APPENDIX V-11(7) ADDITIONAL APPROVAL FOR IZUMI DENKI CORPORATION

1. Engraved Letters of Name Plate

Quantity of Name Plate : 21

No.	Range	Letters	No.	Range	Letters
1	0-2-4	T.Lub.Oil Pump	12	0-50-100	Start up Pan
2	0-5-10	Air Compressor	13	0-60-120	Cool Water Pump-1
3	0-7.5-15	Acid Trans Pump-1	14	-do-	Cool Water Pump-2
4	-do-	Acid Trans Pump-2	15	-do-	Cool Water Pump-3
5	-do-	Acid Trans Pump-3	16	-do-	Cool Water Pump-4
6	0-15-30	Oleum Pump	17	-do-	Proc Water Pump-1
7	"	Sulfur Pump-1	18	-do-	Proc Water Pump-2
8	"	Sulfur Pump-2	19	-do-	Acid Circl Pump
9	"	Soft Water Pump	20	-do-	(Not Engraved)
10	"	(Not Engraved)	21	-do-	(Not Engraved)
11	0-20-40	Burner Fuel Pump			

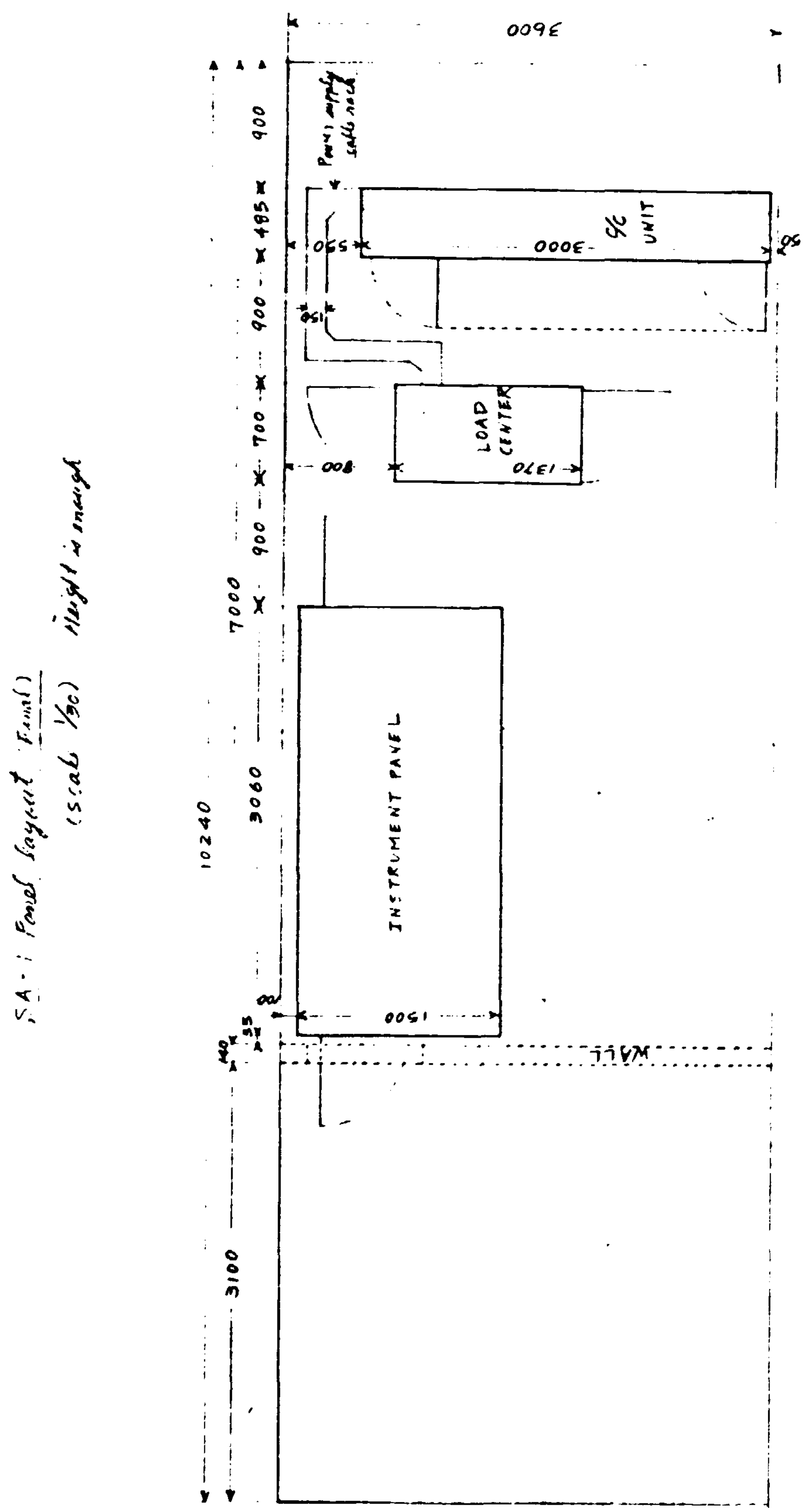
2. Changing of Specification

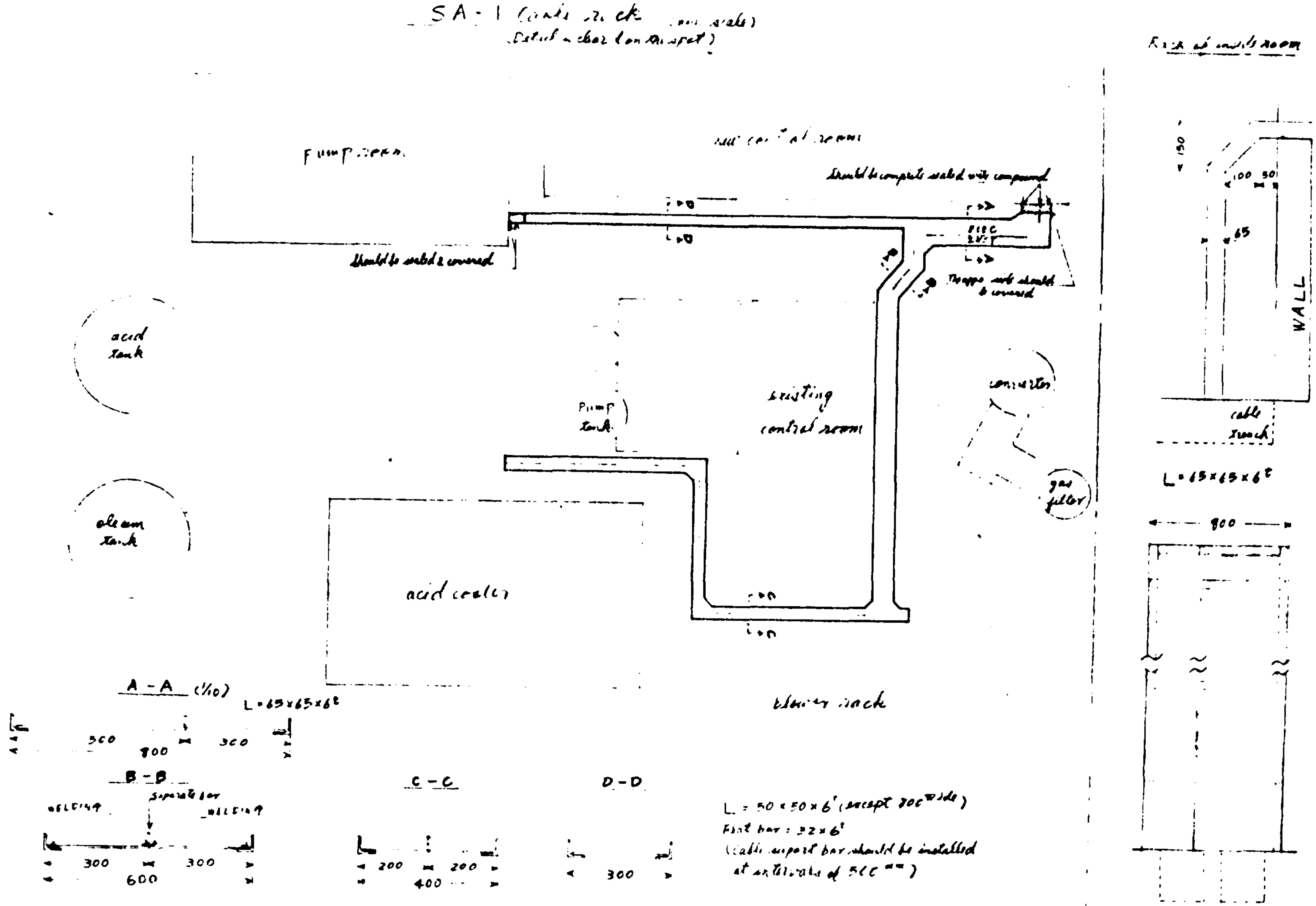
Ampere Meter

Range 0-3-6A Should be 0-2-4A

(Quantity : One)

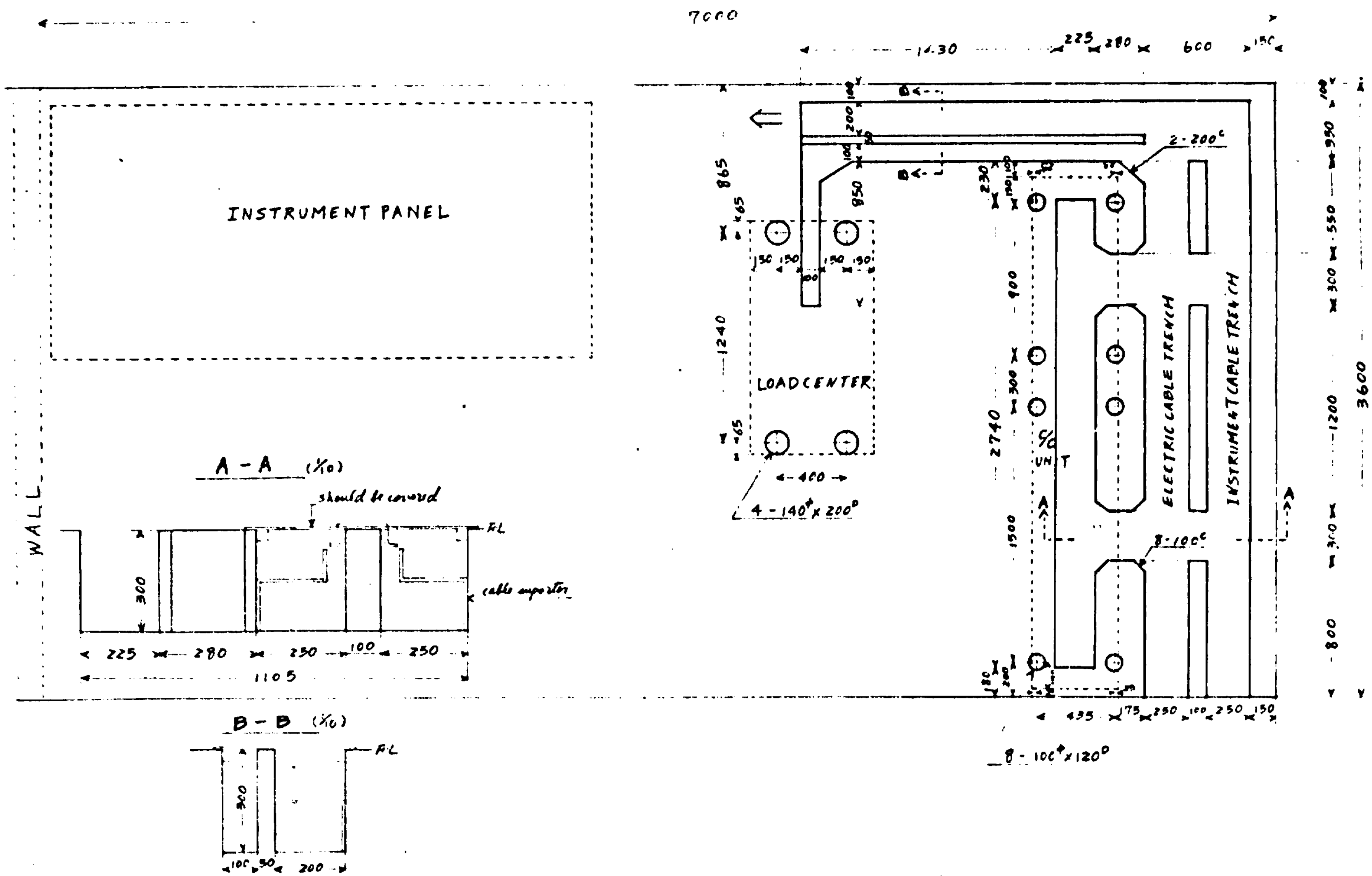
APPENDIX V-11(8) SA-1 PANEL LAYOUT





SA-1
Pump room
Should be welded & covered
Should be completely sealed with compound
acid tank
oleum tank
Pump tank
existing control room
converter
gas filter
acid cooler
A-A (1/10)
L=65×65×6t
300
800
B-B
WELDING
separate bar
300
600
C-C
200
400
D-D
L=50×50×6t (except 800 wide)
Flat bar: 32×6t
WALL
cable trench
150
100
50
65

SA-1 Control room cable trench (scale 1/20, 1/10)



APPENDIX V-12 CONSTANT FEED OF PHOSPHATE ROCK (PA-2, TSP-2)

The existing conditions were investigated in order to improve the phosphate rock feeding system in TSP-II (PA-2 and TSP-2) on mechanical aspect, and the following points are noticed:

(1) In PA-2 and TSP-2 plant, flow quantity of ground phosphate rock to constant feed weigher fluctuates very much due to rock flashing and/or bridging in the ground rock bin.

(2) In case of rock-flashing, the indicator of rock weigher shows over full scale and constant quantity which is set at the certain flow rate in accordance with the plant load, can not be maintained.

(3) In case of rock-bridging, rock weigher also is out of automatic self control.

To avoid the problem, the installation of the rotary valve with a revolution variator and the agitator in the ground rock bin is recommended.

The detail specification of rotary valve was mentioned in Fig. 1 attached here.

The recommendation for installation of the agitator was also mentioned in Fig. 2.

The purposes meant in the above mentioned documents are as follows:

(1) To unify the phosphate rock in the bin by agitation (to prevent the occurrence of the flashing and bridging)

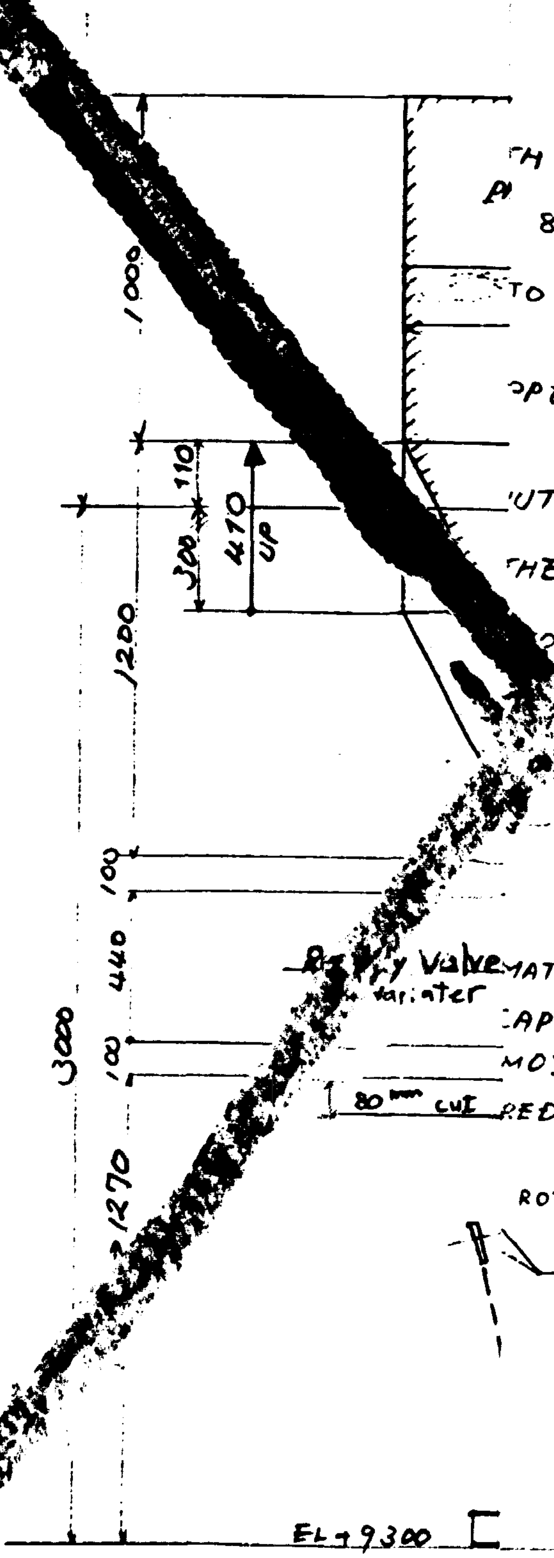
(2) To feed the rock definitely t the weigher by rotary valve to ensure the flow control of weigher.

FIG.1 TSP-2 GROU

Dated 24th March 81

REF. : I

UNIDO PROJECT
K. Aratani



...H OF EXISTING SCRE... ...VEYOR
P...
80 mm CUT)

...TO BE SHIFTED U... (410mm UP)

...PED IN TH... ...N

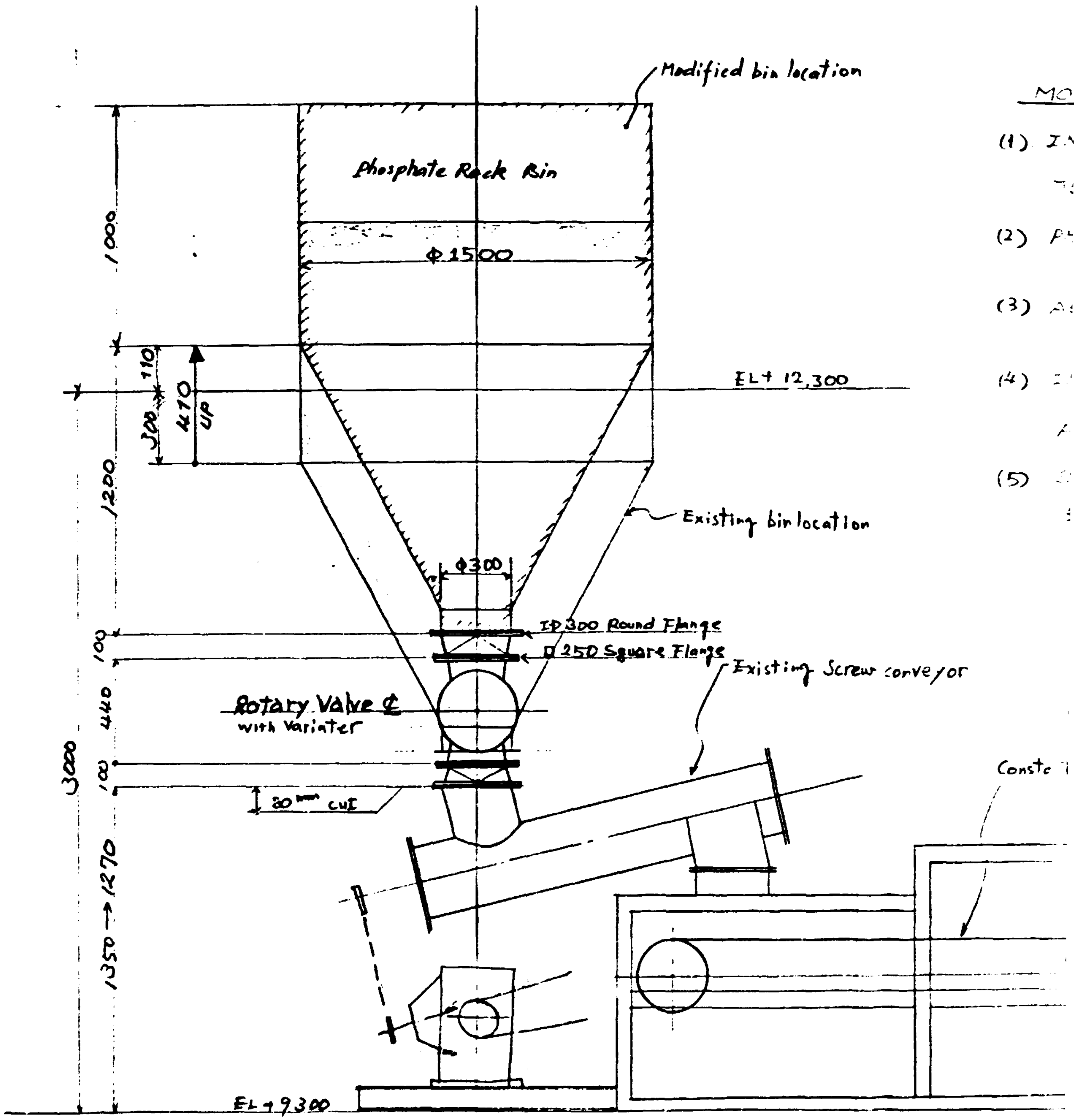
...UTE LE... ...H OF BIN TO BE
...THE E... ...NG FLOW-CONVEYOR
...CT ON THE BOTH

ROT... ...ALVE SPECIFICATION

MATERIAL HAND... : GROUND PHOSPHATE ROCK
CAPACITY: 5 ... T/H (S.G = 0.9)
MOTOR : 0.75 K... 400 V × 50 HZ
REDUCER : VARIA... SPEED
TYPE HAM... 1/29
ROTER REVOLUTION : 8... rpm

FIG.1 TSP-2 GROUND ROCK FEEDING SYSTEM

REF. : Item No. 3 - (b)



SECTION 1

A-56

Dated 24th March 81

UNIDO PROJECT

K. Aratani

...n location

MODIFIED POINTS

(1) INLET NOZZLE LENGTH OF EXISTING SCREW CONVEYOR TO BE SHORTENED (80 mm CUT)

(2) PHOSPHATE ROCK BIN TO BE SHIFTED UP (410 mm UP)

(3) AGITATOR TO BE EQUIPPED IN THE BIN

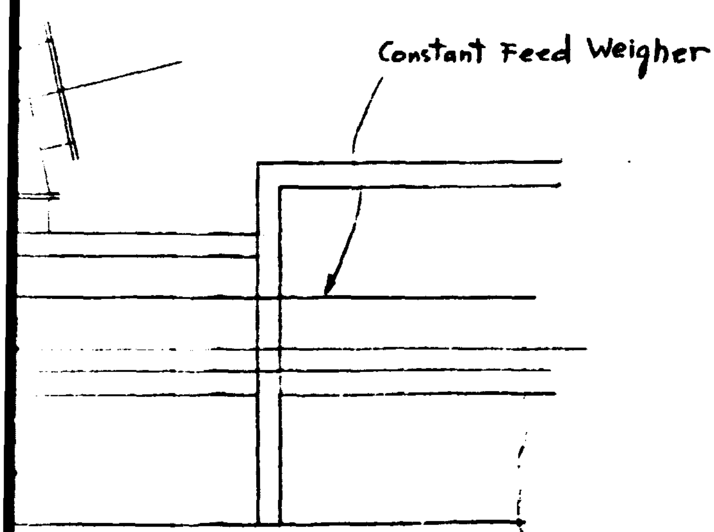
...12,300

(4) INLET/OVER FLOW CHUTE LENGTH OF BIN TO BE ADJUSTED TO FIT THE EXISTING FLOW-CONVEYOR

(5) SQUARE TO ROUND DUCT TO BE SET ON THE BOTH SIDES OF ROTARY VALVE.

bin location

...isting Screw conveyor



ROTARY VALVE SPECIFICATION

MATERIAL HANDLED : GROUND PHOSPHATE ROCK

CAPACITY : 5 – 14 T/H (S.G = 0.9)

MOTOR : 0.75 KW x 400 V x 50 HZ

REDUCER : VARIABLE SPEED

TYPE HAM1-83- 1/29

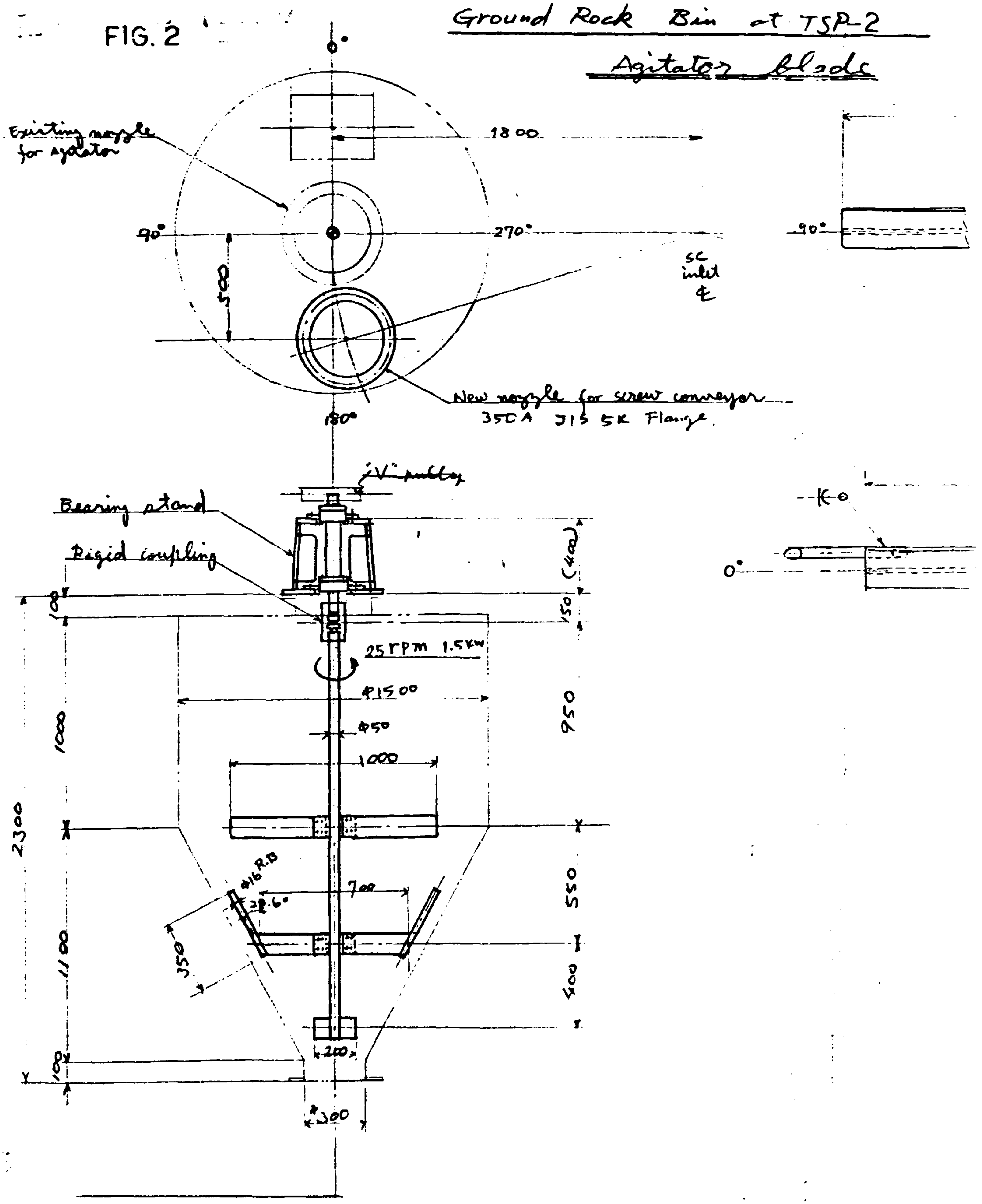
ROTER REVOLUTION : 8 – 26 rpm

SECTION 2

FIG. 2

Ground Rock Bin at TSP-2

Agitator Blade

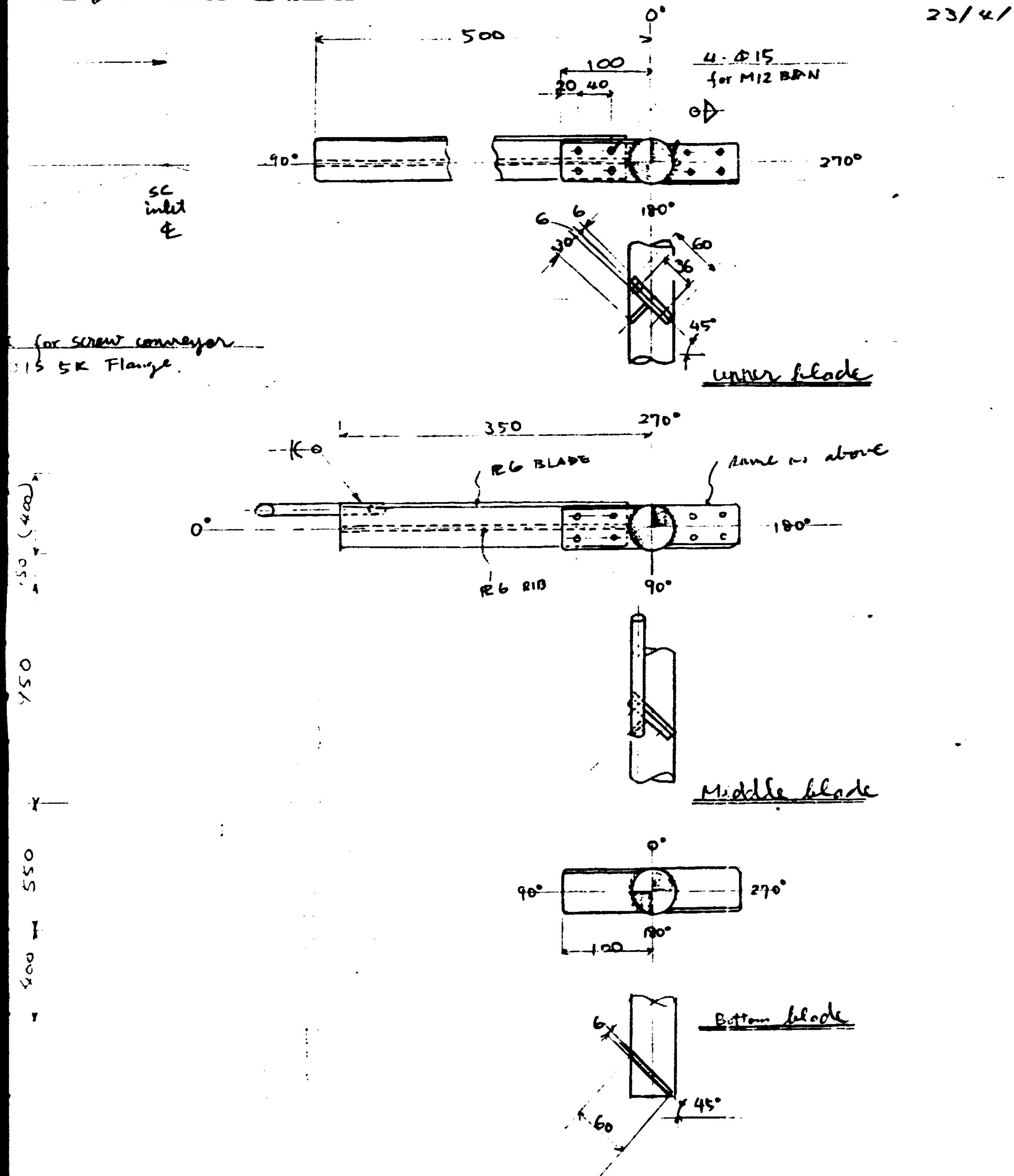


SECTION 1

Rock Bin at TSP-2

Agitator blade

23/4/80



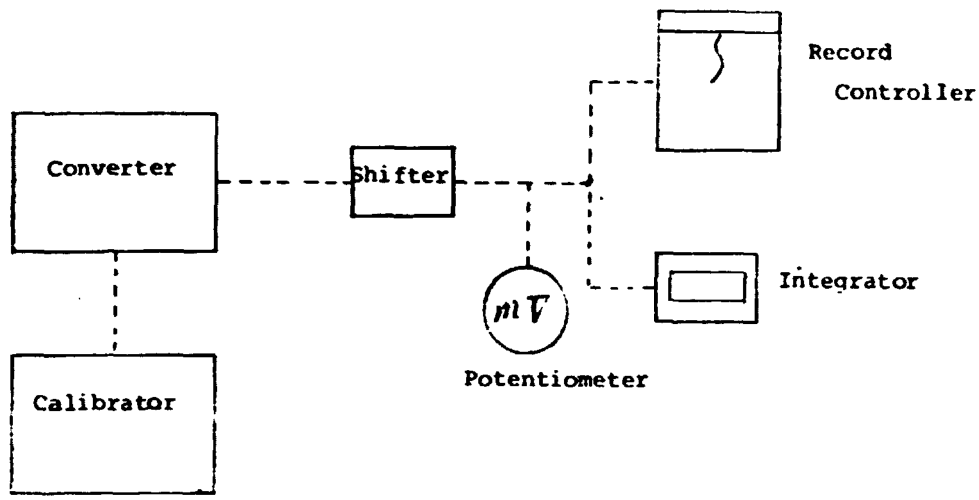
APPENDIX V-13(1) CALIBRATION OF TOTALIZER OF PA-2 ROCK WEIGHER (WICSA-2301)

Date	DISC (t) STANDARD		FRONT PANEL *			Reliability	BACK PANEL (c)	
	Reading	Difference A	Reading (t)	Difference (t) B	Difference (count)	A/B	Reading	Difference (count)
5/20	5,567.4		3,244.36				421	
		280.6		279.98	13,999	100.2		14,015
5/21	5,848.0		3,524.34				14,436	
		161.0		160.82	8,041	100.1		8,048
5/22	6,009.0		3,685.16				22,484	
		111.6		111.90	5,595	99.7		5,595
5/22	6,120.6		3,797.06				28,081	
		258.6		257.14	12,857	100.6		12,932
5/23	6,379.2		4,054.20				41,013	
		793.6		793.02	39,651	100.1		39,663
5/25	7,172.8		4,847.22				80,676	
		288.2		271.06	13,553	106.3		14,430
5/26	7,461.0		5,118.28				95,106	
		372.0		268.50	18,425	100.9		18,527
5/27	7,833.0		5,486.78				113,633	
		370.4		368.56	18,428	100.5		18,547
5/28	8,203.4		5,855.34					
	(after repair and adjustment)					av.101.05		
5/28	8,203.4		5,869.12					
		178.8		178.46		100.2		
5/29	8,382.2		6,047.58					
		22.6		22.56		100.2		
5/30	8,404.8		6,070.14					
		567.0		567.80		99.9		
6/2	8,971.8		6,637.94					
		275.6		275.50		100.0		
6/3	9,247.4		6,913.44					
		90.6		90.52		100.1		
6/4	9,338.0		7,003.96					
						av.100.08		

* Difference of count is converted to the figure of reading (t) at the ratio of 0.02 because 1 count (=1 pulse) is equivalent to 0.02 ton.

APPENDIX V-13 (2) CALIBRATION OF FRCSA-2301

1. Loop for Check



2. Check Data

Calibrater set	Recorder Point		Potentiometer		Integrator	
	Standard	Reading	Standard	Reading	Count (5)	1 Hr Convert (6)
100 %	12 m^3/h	12 ⊕	10.0 mV	10.05 mV	3 count = 90 sec	12.0 m^3
75	9	9.1	7.5	7.57	3 count = 119 sec	9.07
50	6	6.1	5.0	5.08	3 count = 180 sec	6.0
25	3	3.1	2.5	2.58	1 count = 120 sec	3.0
0	0	0	0.0	0.08	I kept waiting for 5 min., but counter did not move.	

Potentiometer has ⊕ side error about 0.05 mV.

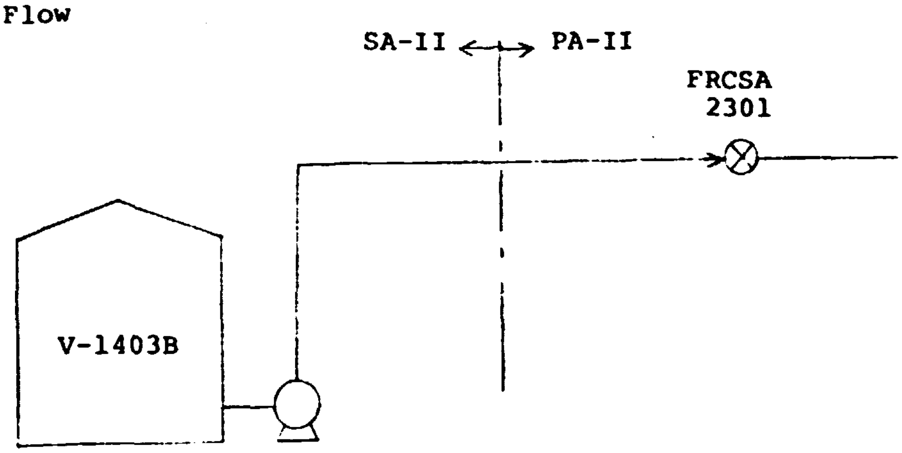
(5)(6) c.f. 1 count = 0.1 m^3

∴ case of 100%

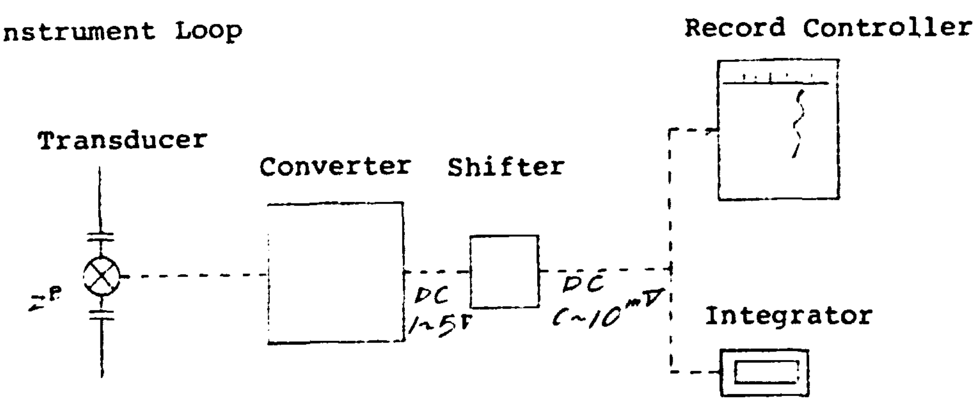
$$1 \text{ Hr convert} = (3{,}600 \text{ sec.} \div 90 \text{ sec.}) \times 3 \text{ count} \times 0.1 \text{ m}^3 = 12 \text{ m}^3$$

APPENDIX V-13(3) FLOW AND LOOP OF FRCSA-2301

1. Flow



2. Instrument Loop



Date & Time	V-1403 Reduction Level	V-1403 Calculated volume ①	FRCSA-2301 Recorder's Indicater	FRCSA-2301 Integrator ($\times$ 0.1m^3)	② Difference (m^3)	③ Error (%)	Reliability ④
10/June 9:00	Standard mark		10.8 m^3/h	61,965			
10:00	-106 mm	11,005 m^3	10.9	62,075	11.0	-0.038	0.999
11:00	-107	11,108	10.9	62,182	10.7	-3.40	0.963
11/June 9:00	Standard mark		11.02	63,132			
10:00	-102 mm	10,589	11.3	63,242	11.0	+3.43	1.038
11:00	-104	10,797	11.3	63,351	10.9	+0.859	1.009
12:00	-105	10,900	11.3	63,463.5	11.25	+0.751	1.032
					Average	+0.751	1.008

① Calculated Volume :

D = Tank Diameter = 11.5 m

Area = $\pi \times \left(\frac{D}{2}\right)^2$ = 103,816

Volume = Area x reduction level

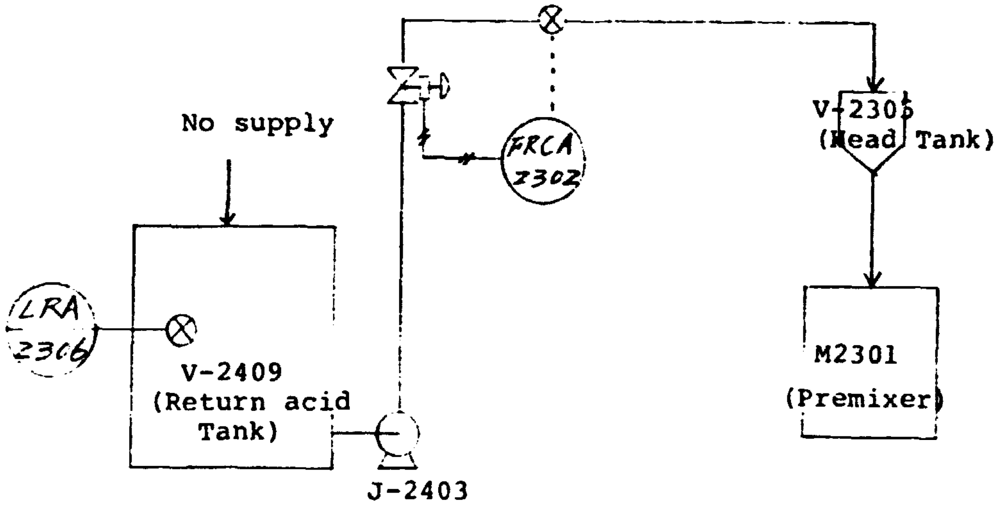
③ Error $= \frac{② - ①}{\text{SPAN}} \times 100$ (%) $= \frac{② - ①}{12} \times 100$ (%)

SPAN = 12 m^3/h

④ Reliability (between V-1302B and FRCSA-2301) $= \frac{②}{①}$

APPENDIX V-13(5) CALIBRATION OF FRCA-2302

1. Test Flow



2. Test Data

- o Date : 12th of June, 1981
- o Time : 11:24 to 11:39 (Just for a quater of an hour)
- o Fixed flow rate : 40 m^3/h (there was some fluctuation)
- o Level reduction of LRA-2306 : 83% to 54% (29% reduction)
- o V-2409 capacity : 33 m^3
- o 15 minute's total flow : 33 x 0.29 = 9.57 m^3
- o Flow rate 9.57 x 4 ≒ 38.28 m^3/h
- o % error : $\frac{40 - 38.28}{60}$ x 100 = 2.82 (%)

  (span : 60 m^3/h)

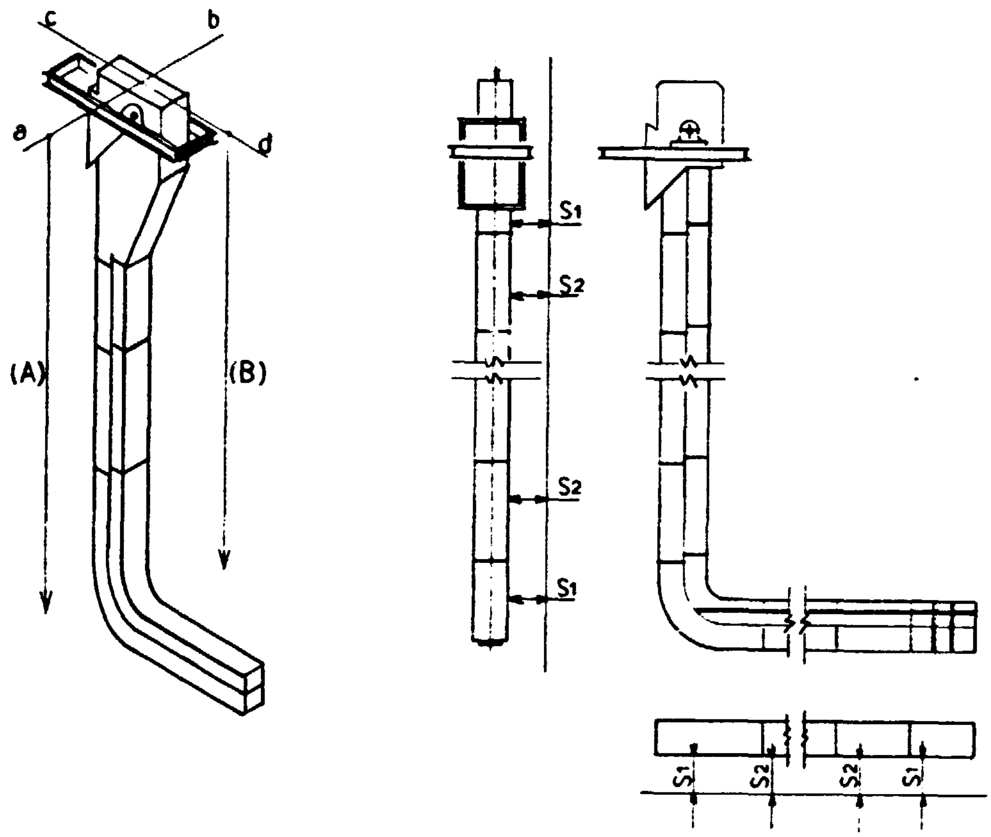
APPENDIX V-14(1) INSPECTION OF FLOW CONVEYOR O-2202 AND O-2207

1. Specification of Flow Conveyor ITEM-O-2202 and ITEM-O-2207

Specification	O-2202	O-2207
Material handled	Ground phosphate rock	Ground Phosphate rock
Bulk density kg/m^3	1,290 (Dry)	900 (Dry)
Size of material (200 mesh pass)	70 %	80 %
Temp °C	50	60
Shaft Centers (lift)	15,643 mm	15,170 mm
(horizontal)	3,260 mm	10,127 mm
Capacity t/h	Max. 24 Nor 20	Max. 15 Nor.11
Power of motor KW x P	11 x 6	11 x 6
Speed of conveyor m/min	18	15.5
Strength of chain kg	19,500	19,500
Type of att for con. chain	$F_6 - V_2$ 32	$F_6 - V_2$ 24
Material of conveyor chain	SCM-3, SS-50	SCM-3, SS-50

2. Checking of Flow Conveyors (Instruction)

i) The warp of the conveyor centers



At the setting time, S_1-S_n were measured by the string. It is useful to check the distances again.

Allowance of vertical and horizontal straightness (Instruction)

Total length of casing	S_1	S_2	S_3
Up to 10 M	2 mm		
10 - 20 M	2 mm	3 mm	
More than 20 M	2 mm	3 mm	4 mm

ii) The level of the head shaft (Instruction)

This level is the most important to assure long life. If the level of this shaft is not correct, insert the liners under the pillow blocks and if the right angle of shaft is not insured, adjust it by putting wedges with hammer.

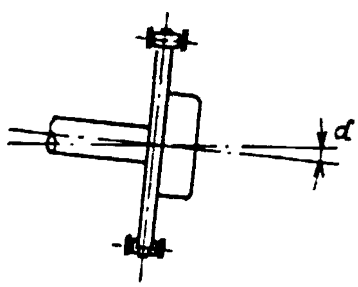
iii) Shear pin (Safety Device)

It is recommended to set "Shock Relay". The maker "TSUBAKIMOTO" Catalog says as follows:

> A wholly electrical safety device which shuts off the power circuit as soon as it detects an over load. It works far quickly and more accurately than the conventional shear pin system. It is an option part fitted to FC Flow, LC Flow and BC Bucket Elevator.

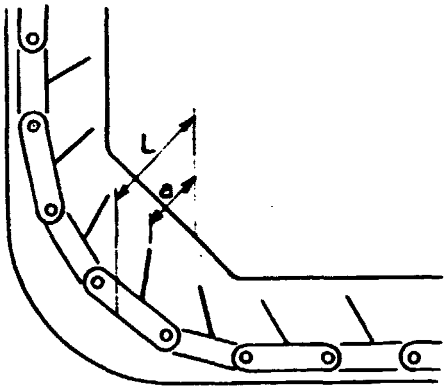
iv) Test run under no load

(a) Under no load, remove the cover of tail casing and check whether the conveyor chain runs along the center of tail wheel.



If it is not correct as shown in the left figure, one must adjust it.

(b) Adjustment of Take up



A = 1/2L
Chain tension should always be kept under the condition (a = 1/2L) in the left figure.

(c) To check existing all chains and sprockets is necessary.

o Wearing	Roller, Rail, Pin, Sprocket, etc.
o Deforming	Chain, etc.

(d) Spare parts fabricated by BITAC.

The hardness of materials had already been checked. The result was good. But it is better to check the accuracy and other characters of the spare parts.

v) Test run under load

The following test data is to be obtained at the erection time.

o Voltage V　　o Chain speed　　o Ampere A

o Conveying capacity　　o Wattage W

o R.P.M. of the lead shaft R

vi) Operation and Maintenance

One should recognize several important points in the following instruction:

(a) When one stop the operation of conveyor, never stop the conveyor until the material in the casing has been completely discharged. Otherwise, the remains of material in the casing will impose a larger tension on the conveyor chain when it starts again.

(b) Inspect occasionally whether the material is collected too much in the rear of tail casing or not. If material is collected, remove it to make the casing clean.

(c) Adjust the take up at the following interval

Within one week after starting:	one time/day
Within one month after starting:	two times/week
Thereafter:	two times/month

(d) One should often inspect the running condition of conveyor chain from the inspection door. If one find any deformation of skeletonized flights, he should immediately heat the deformed part of flight and change it to the regular shape.

(e) Lubrication schedule

Lubrication schedule on a basis of 8-hour operation a day.

Part to be lubricated	Oil or grease to be used	Interval of lubrication
Gear motor	Refer to instruction of gear motor	
RS roller chain	SAE 10	Drop feed or brush daily after 1st month. There-after two times a month.
Pillow plocks	Grease	Replace grease once every month.

(f) Repair or modification of take up parts

The take up parts of both conveyors are now weared and not correctly adjusted, and so one should repair these parts according to the drawing.

If one can not get good result, he must apply the new method as suggested earlier.

APPENDIX V-14(2) LINK OF ROCK FLOW CONVEYOR (0-2207)

Spare parts of Link of 0-2207 were checked as follows:

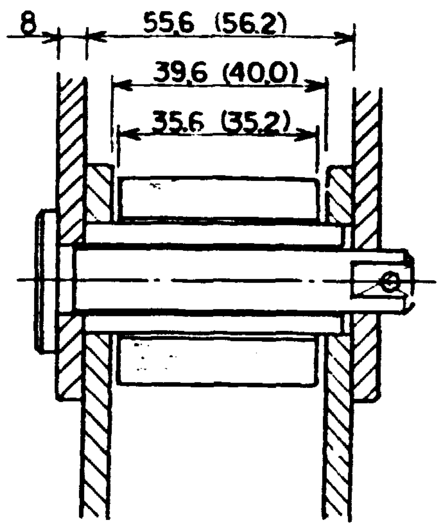
1. All links are covered with rust. Spare parts must be protected from rust with some oil spray.

2. The expert do not have any data regarding the original link, so it can not be decided whether these links are good or not. But the deviations of measured figures from the drawing are seemed to be a little large.

3. It is found that the following unsuitable points regarding machining (Each number corresponds to the figure of next page.)

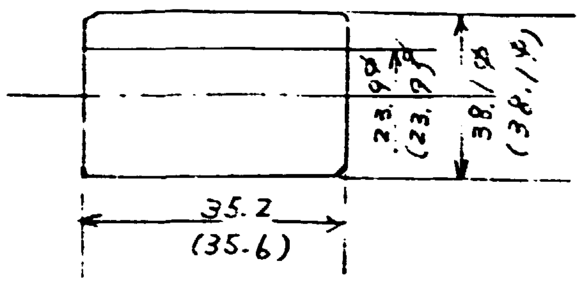
No.	Unsuitable item
1	There is some radious on the corner. So the plate fitted at this point should have larger corner.
2	Machining is not good.
3	Welding is bad, and welding deposit is out of the plate edge.
4	Cutting angles of both sides of a plate are not 90°.
5	Machining of this point is not good.

4. The life of "Link" depends on its accuracy.

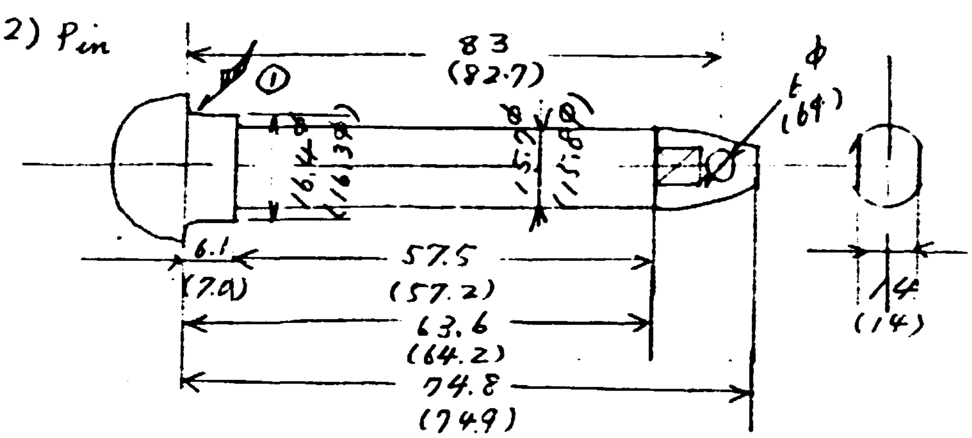

8
55,6 (56,2)
39,6 (40,0)
35,6 (35,2)

LINK OF FLOW CONVEYOR (O-2207)

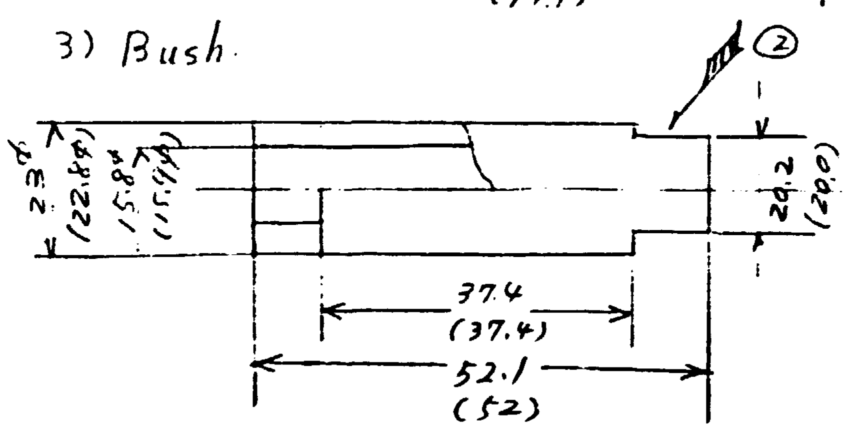
1) Roller



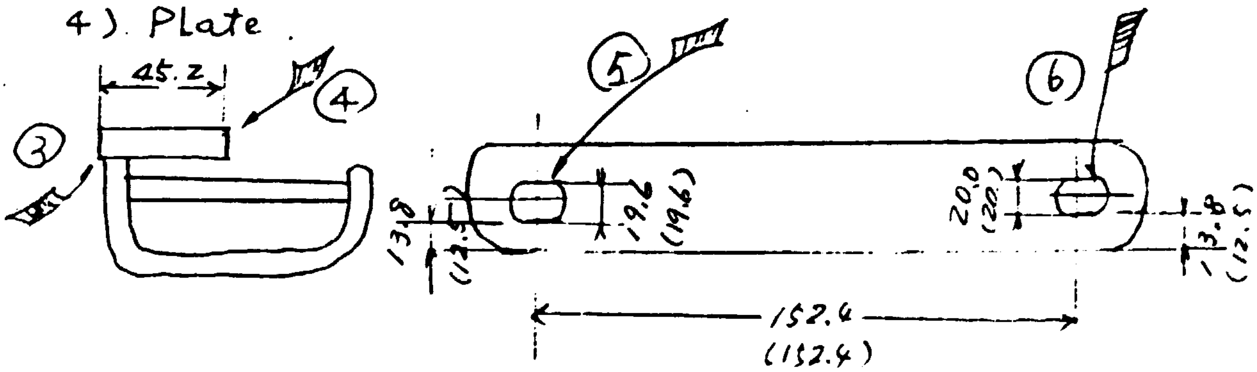
2) Pin



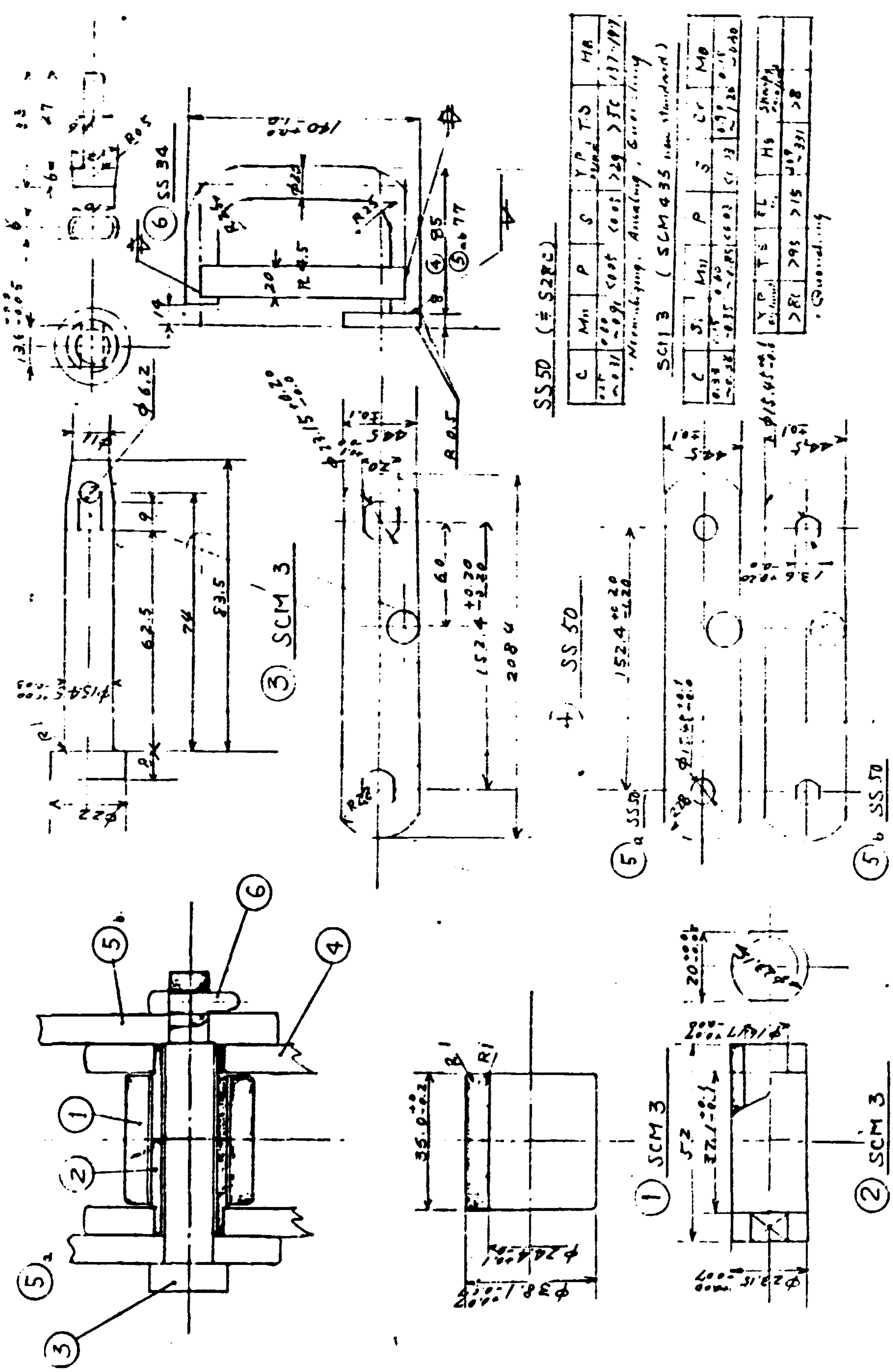
3) Bush



4) Plate



APPENDIX V-14(3) ALLOWABLE LIMIT OF FLOW CONVEYOR LINK (O-2207)



APPENDIX V-14(4) RECOMMENDATION FOR ROCK FLOW CONVEYOR

1. Specification

Please refer to APPENDIX V-14(1) 1.

2. First recommendation (5 May 1980)

For details of content of each *No., please refer to APPENDIX V-14(1).

No.	Item	Countermeasure
i)*	Wrap of conveyor centers	May be not so deformed
ii)*	Level of head shaft	Checked O.K.
iii)*	Test run under no load	
(a)	Tail wheel	Checked O.K.
(b)	Adjustment of take up	—
(c)	All chains and other parts	Checked O.K.
iv)*	Operation and maintenance	
(a)	Complete discharge at shut-down time	Should be done
(b)	Adjustment of take up	—
(c)	Checking of operating condition from insepction door	Checked O.K.
v)*	Repair or modification of take up parts	—
vi)	Accuracy of the chain made by BITAC.	"Approval Standard of chain" is prepared.

3. Troubles in May, June and July, 1980.

O-2207(TSP-II)	Causes	Plant shut down time
14.5.80	Pin sheared	18 hours
2.6.80	Pin sheared	12 hours
4.6.80	All links are replaced (BITAC made)	6 hours
O-2202(PA-II)		
23.5.80	Pin sheared	5 hours
6.6.80	Blocked	1 hour
17.6.80	Pin sheared	9 hours
14.7.80	Pin sheared Drive chain damaged Sprocket damaged	

4. Troubles between July and October, 1980.

O-2207		
17.7.80	Blocked	1 hour
30.10.80	no trouble	
O-2202		
13.7.80 - 14.7.80	Drive/Driven Sprocked repaired	26 hours
15.7.80	Link repaired	24 hours
19.7.80 - 20.7.80	Link	21 hours
21.7.80	Abnormal sound	2 hours
24.7.80	Long shut down	
15.9.80	Blocked	$1\frac{1}{2}$ hours
20.9.80	Link repaired	8 hours
9.10.80	Bearing repaired	6 hours
1.11.80	Blocked	13 hours

5. Key points to be considered

i) Examples of flow conveyor in Rasa Industry in Japan

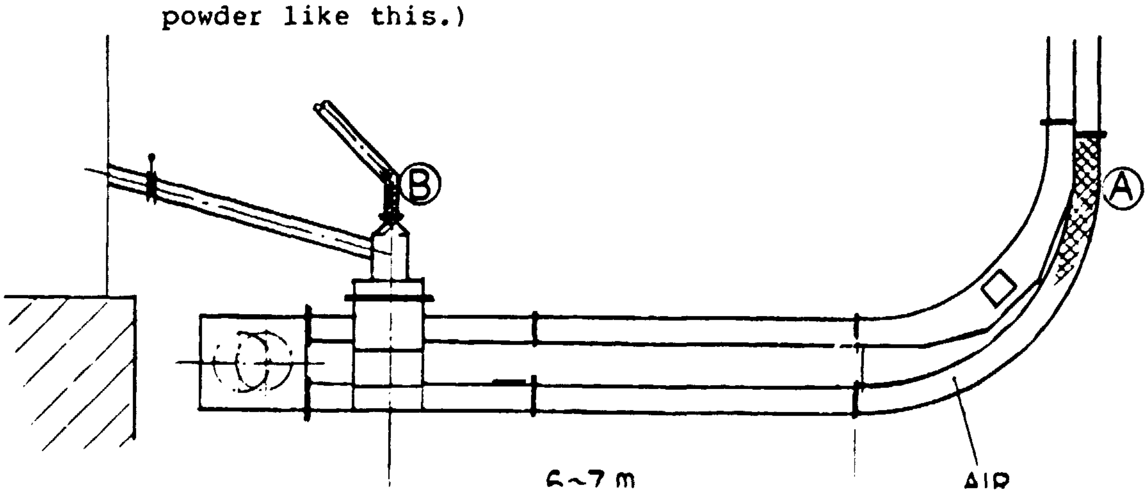
- o Rasa changes all links conce a year.
- o Rasa had many troubles in flow conveyors, so it wanted to change the flow conveyors to the bucket elevators.
- o The expert's observation during leave is as follows:

"Rasa" had many troubles (3-5 times/month), and this was due to the high water content (6-7%) of the rock which was stocked outdoor.

Rasa expects the lower moisture content in rock (for example 1.5%) which does not affect the troubles. Therefore, Rasa will not adopt the bucket elevator.

ii) The expert checked experience of NISSAN's factories in Japan

- o Both Toyama plant and Nihon Rinsan plant have no problem regarding the flow conveyor.
- o Troubles occur for about 2 times per year.
- o In Nihon Rinsan plant, there was some trouble in one phosphate rock conveyor. This trouble may draw out the view of "Tsubakimoto" company, mentioned here.
- o The causes of this trouble are the imperfect separation of air included in charged powder and the ununiform feeding. (Especially in the case of these powder like this.)



* Powder cannot be elevated at this point A, as air is compressed.

° Check the blockade of the exhaust pipe B.

° For these rocks, 6-7 m horizontal case is desired to separate included air.

° For these rocks, the feeding to the upper case is desired.

° For these rocks, "Tsubakimoto" will recommend bucket elevator preferably.

iii) Budget for exchaging the flow-conveyor to the bucket elevator.

Mr. Deb's Estimation	"Tsubakimoto"
TK 300,000	TK 600,000
+ α 30,000	+TK 300,000
TK 330,000 (BITAC made)	TK 900,000

It is not easy to make a bucket elevator, because the technical level of BITAC regarding these equipments are not clear.

6. Recommendation

Main causes of troubles are now considered to be the fluctuation of power. Other causes have been solved step by step. There are two directions to go.

i) To change the existing flow conveyors to the conbination of bucket elevators and screw conveyors.

ii) To improve the present conditions of there two flow conveyors in Maintenance

(a) Exchange all the links with the adjusted ones periodically. (Each 6 months)

(b) Accuracy of links must follow the "standard" for approval.

(c) Periodical checks

Periodical arrangement and adjustment (Take-back, deformation of link, etc.)

(d) Noisy parts (0-2202 casing) must be repaired.

(e) Purchase of shock relay.

(f) To try constant feed, and extrude air from feeding material. (This modifications are now studied.)

in Operation

(a) Do not start without discharging, all rock from the flow conveyor.

(b) To extrude air from the feed rock, and check the vent pipe for this purpose.

(c) To try constant charge of the feed rock

As mentioned in Item 4, troubles of 0-2207 were almost solved, so one must improve more according to Item 6 ii). If this problem cannot be solved with item 6 ii), item 6 i) will be adopted.

APPENDIX V-14(5) IMPROVEMENT OF O-2202

1. Present condition of O-2202

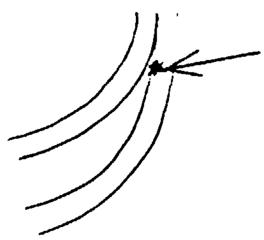
Date	
(1) November 1	Link trouble
(2) November 6	"
(3) November 8	Motor trouble
(4) November 15-16	Link trouble
(5) December 2-3	"

2. Ampere fluctuation of the motor (o-2202)

Normal run : 12 Amp - 14 Amp max. 18 Amp.

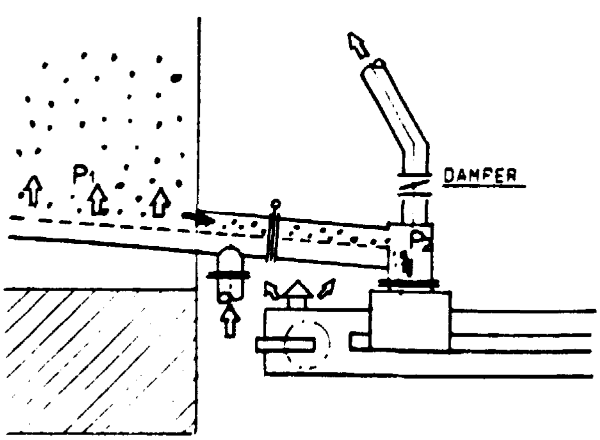
No load run : 10 Amp - 14 Amp.

But in case of O-2207, ampere fluctuation is between 12 and 13. So we consider that the causes of fluctuation may be machanical. We repaired bended part of the rail, but there was a little improvement. Improved fluctuation is between 10 and 13. We cannot satisfy this figure, because this should be between 10 and 11 Amp. It is necessary to repair bended part of plate, that is deformed as shown in Figure.



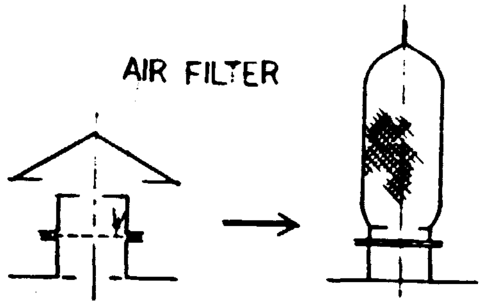
The noise in another points shall be stopped completely by repair.

3. Other modifications

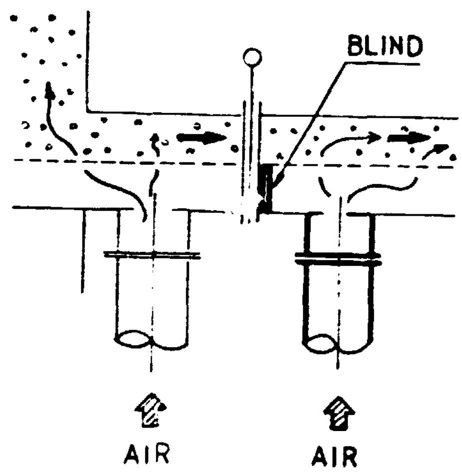


To operate air slide, pressure (P_1) is necessary, so we must operate the dampher, and pressure (P_2) occurs. So air seems to go easily to the flow coneyor. For this reason, we recommend as follows.

i) Clean the air filter. If the result is good, this air filter should be changed to the simple bag filter.



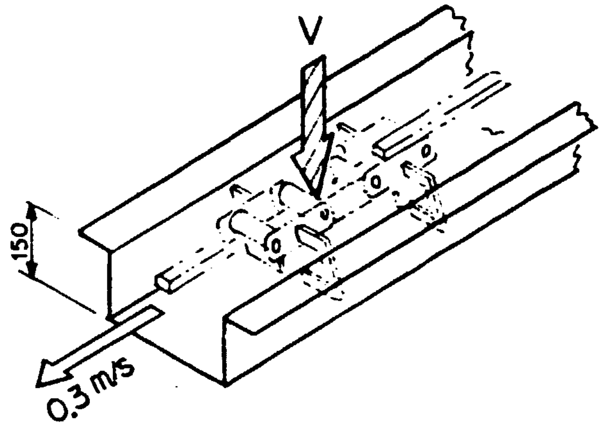
ii) Now, air for both air slide and air bubbling in the tank is supplied from one common pipe. This air should be supplied separately from two pipes and controlled by each valve as the minimum volume.



iii) Flow conveyor speed

18 m/min = 0,3 m/second = 30 cm/second

Time required to pass the inlet ; $\frac{450}{300}$ =1.5 sec.

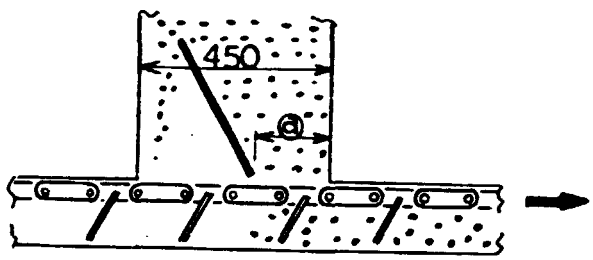


V=Velocity of inlet(vertical)

$= 0.3\ m/s \times \frac{150}{450}$

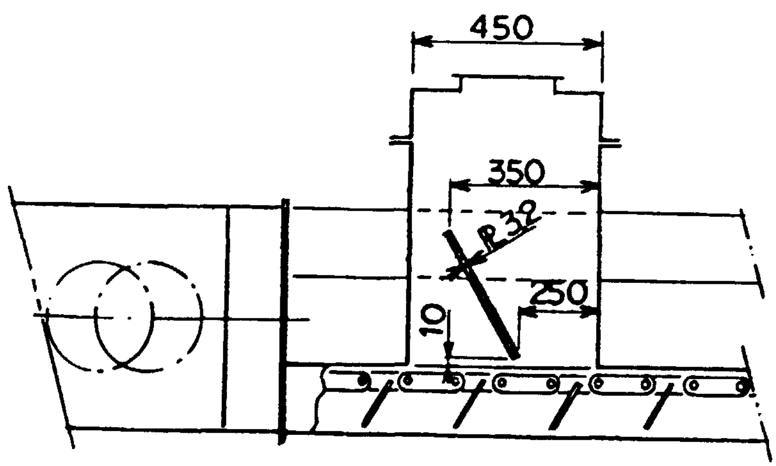
$= 0.1\ m/s$

The expert thinks that the width 450 mm is too much, he want to try the continuous flow of ground rock at the inlet of the flow conveyor with buf-fered plate.



Decrease of the width (a) to 250 mm will be good.

$V=0.3\ m/s \times \frac{150}{250} = 0.18\ m/s$



APPENDIX V-14(6) IMPROVEMENT OF ROCK FLOW CONVEYOR (O-2202 and O-2207)

1) This item has already mentioned in 2 reports [APPENDIX V-14(1) and V-14(4)] and now this item has been improved step by step. One of the these flow conveyors that troubled many times (O-2207) is now running in good condition. So this probelm is remained in O-2202.

2) Present condition of O-2202

No.	Date of trouble	Point of Trouble
1	November 1	Link broken
2	" 6	-do-
3	" 8	Motor temp.
4	" 15-16	Link trouble
5	December 2-3	-do-
6	Jan	-do-

There has been no trouble in O-2207 since July 17, 1980, when all links were changed.

3) First recommendation (APPENDIX V-14(1)

(1) To measure the warp of the conveyor center

(2) To check level and right angle of the head shaft. This is the most important to assure long life. (From the manual of flow conveyor)

(3) Check points under no load

3-1 To check the condition of the tail wheel running

3-2 To adjust the take up to keep adequate tension of the links

3-3 To check all parts of links

(4) Check points in operation and maintenance

4-1 The conveyor should not be stopped until the material in the casing has been completely discharged.

4-2 To adjust the take-up at the following intervals

Within 1 week after start	one time/day
Within 1 month after start	two times/weeks
Thereafter	two times/months

4-3 To inspect the running condition of conveyor chain from the inspection door.

(5) Repair or modification of the take up

(6) Accuracy of the links made by BITAC

The example of "Approval standard of Links" was submitted. TSP must order BITAC the precise links and they will be able to make good ones.

4) Second report (APPENDIX V-14(4))

(1) Rasa Industry submitted a useful suggestion that its factory changes the all links once in a year. This may be one of the main reasons of O-2207 flow conveyor. But many flow conveyor troubles in Rasa seemed to be because of the high water content of materials.

(2) The maker's 'Tsubakimoto'(s) opinion

The causes of this trouble are imperfect separation of air included in charged powder and ununiform feeding of this powder. They requested 6-7 m horizontal length of casing for these conveyors of like this powder. Moreover they recommended to charge the powder into the upper casing instead of the lower casing. But these recommendations cannot be adopted for the location of this conveyor.

(3) Budget for changing this conveyor to bucket type is too expensive.

5) Conclusion

There is large ampere fluctuation in O-2202

On normal running	12 - 14 Amp.
	Max. 18 Amp.
On no load running	10 - 14 Amp.
(In O-2207 ampere fluctuation	12 - 13 Amp.)

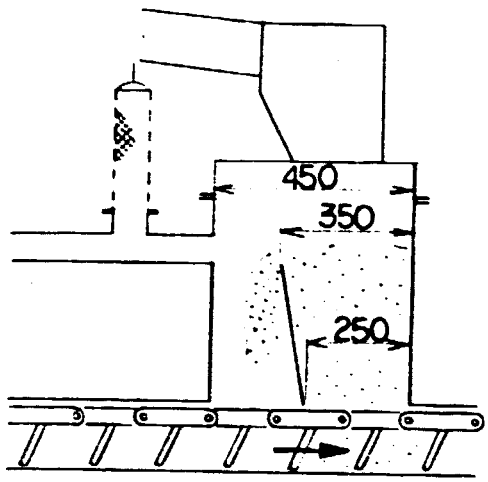
At first one must try to decrease this fluctuation on no load running, because these are caused on irregular mechanical friction or touch. One must check and repair as follows.

(1) Right angle of the head shaft was put extremely out of order.
(2) Links are weared out.
(3) The plate of 90° curved casing is deformed and large noise is generated.
(4) Check the whole assembly of the flow conveyor.

TSP must change all links to new one, and the above mentiond repairing works will take about 4 days.

Next is about the constant feed and air occlusion. To operate air slide, some pressure is necessary, so one must operate the damper above the inlet of the flow conveyor.

Air goes easily into the flow conveyor if there is no powder seal. Compared with O-2207, this is in worse condition because inlet area is too large.



Recommendation (See the above figure)

(1) To settle a new buffer in the inlet of the flow conveyor.

(2) To strengthen the vent filter

Where At present

Flow conveyor speed = 18 m/s

= 0.3 m/s

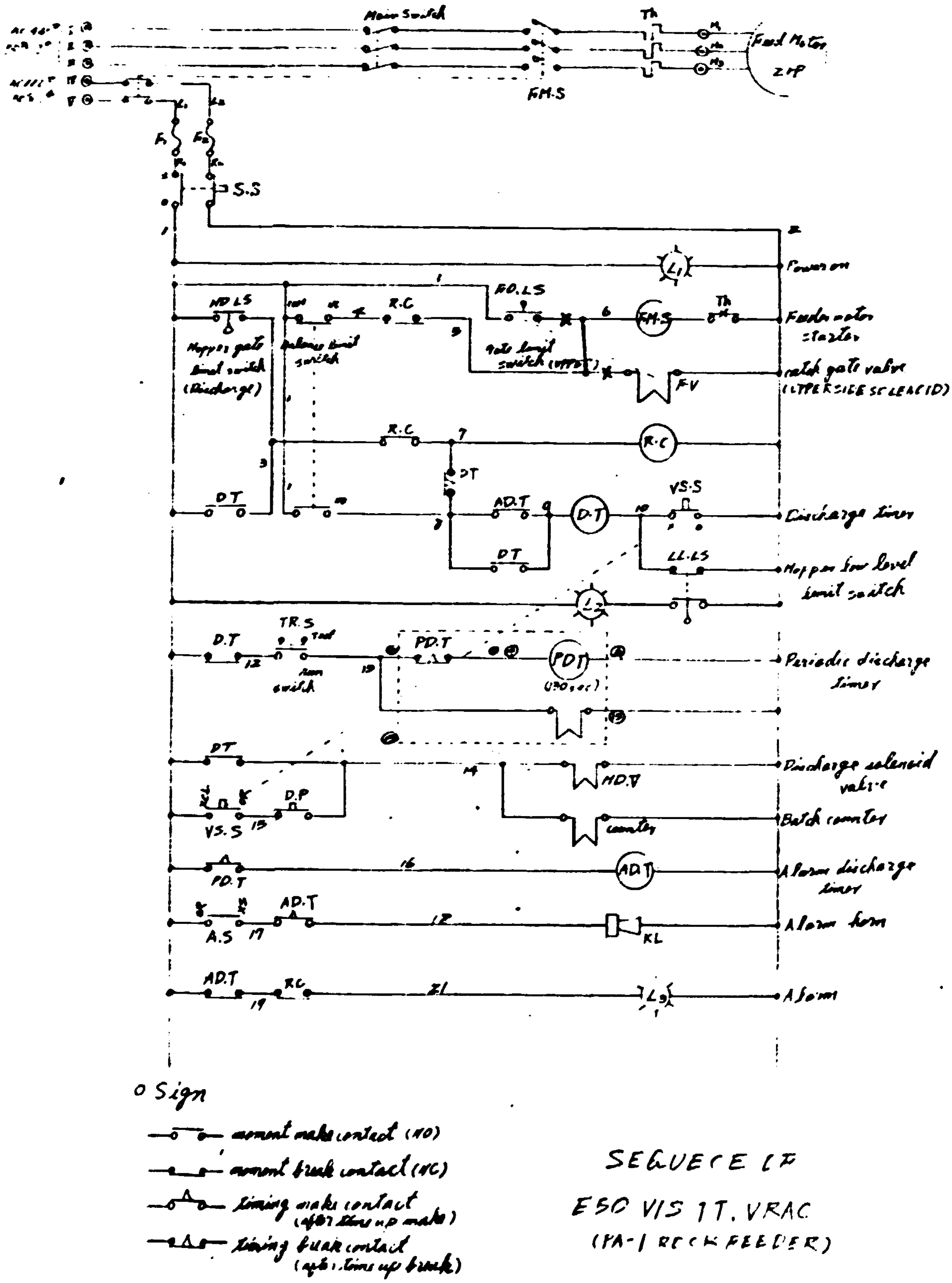
Time to pass theinlet = 450mm/300mm=1.5 sec.

After modification

Time to pass theinlet = 250mm/300mm=0.83 sec.

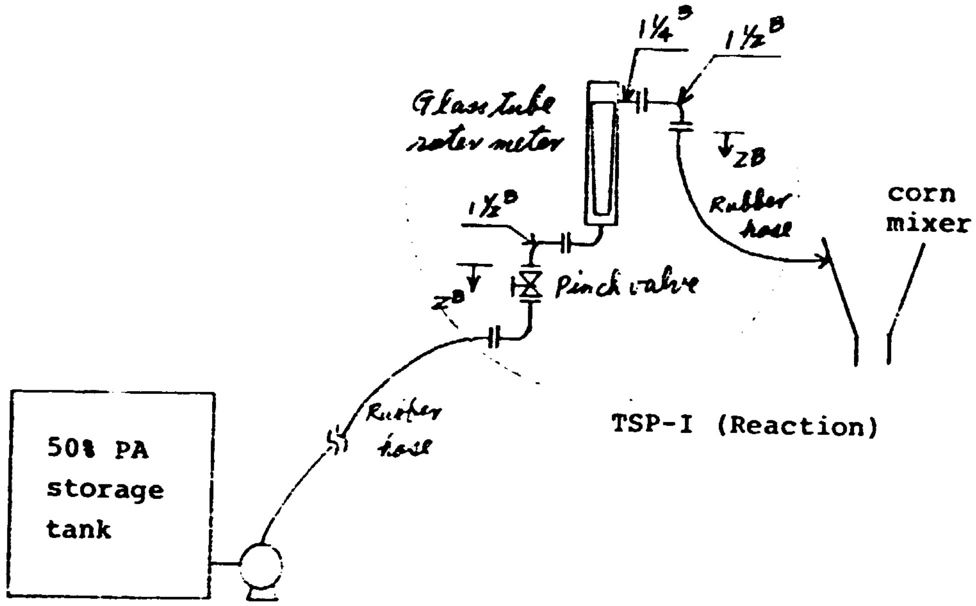
Finally after good running, the whole links should be changed periodically, e.g., 2 times/year to the good arranged one.

APPENDIX V-15 SEQUENCE OF ROCK WEIGHER IN PA-1 PLANT

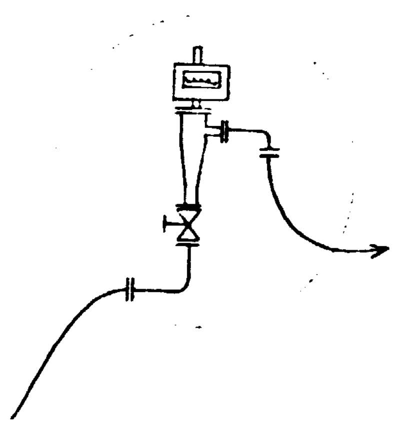


APPENDIX V-16 (1) SCHEMATIC FLOW OF FRS-103

1. Existing Line

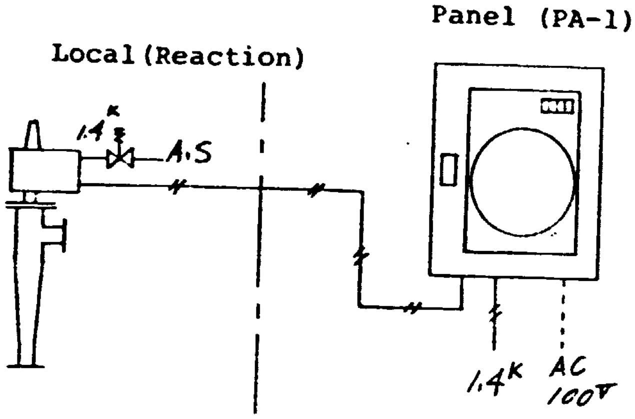


2. New Flow Meter



APPENDIX V-16(2) FRS-103 LOOP

1. Loop (FRS-103)



2. Specific Gravity Compensate (Indicater)

$$\frac{Q_1}{Q_0} = \frac{\cancel{CA\sqrt{\frac{2gV_f}{A_f}}}\sqrt{\left(\frac{\gamma_f}{\gamma_1}-1\right)}}{\cancel{CA\sqrt{\frac{2gV_f}{A_f}}}\sqrt{\left(\frac{\gamma_f}{\gamma_0}-1\right)}}$$

Q_1 = flow rate of $\rho = 1.65$ m³/h
Q_0 = " $\rho = 1.8$ m³/h
$\gamma_1 = 1.65$ (SP.GR)
$\gamma_0 = 1.8$ (Designed SP.GR)
$\gamma_f = 8$ (Float SP.GR material = SUS316)

$Q_1 = Q_0 \times 1{,}057 = Q_0 \times 1.06\ m^3/h$

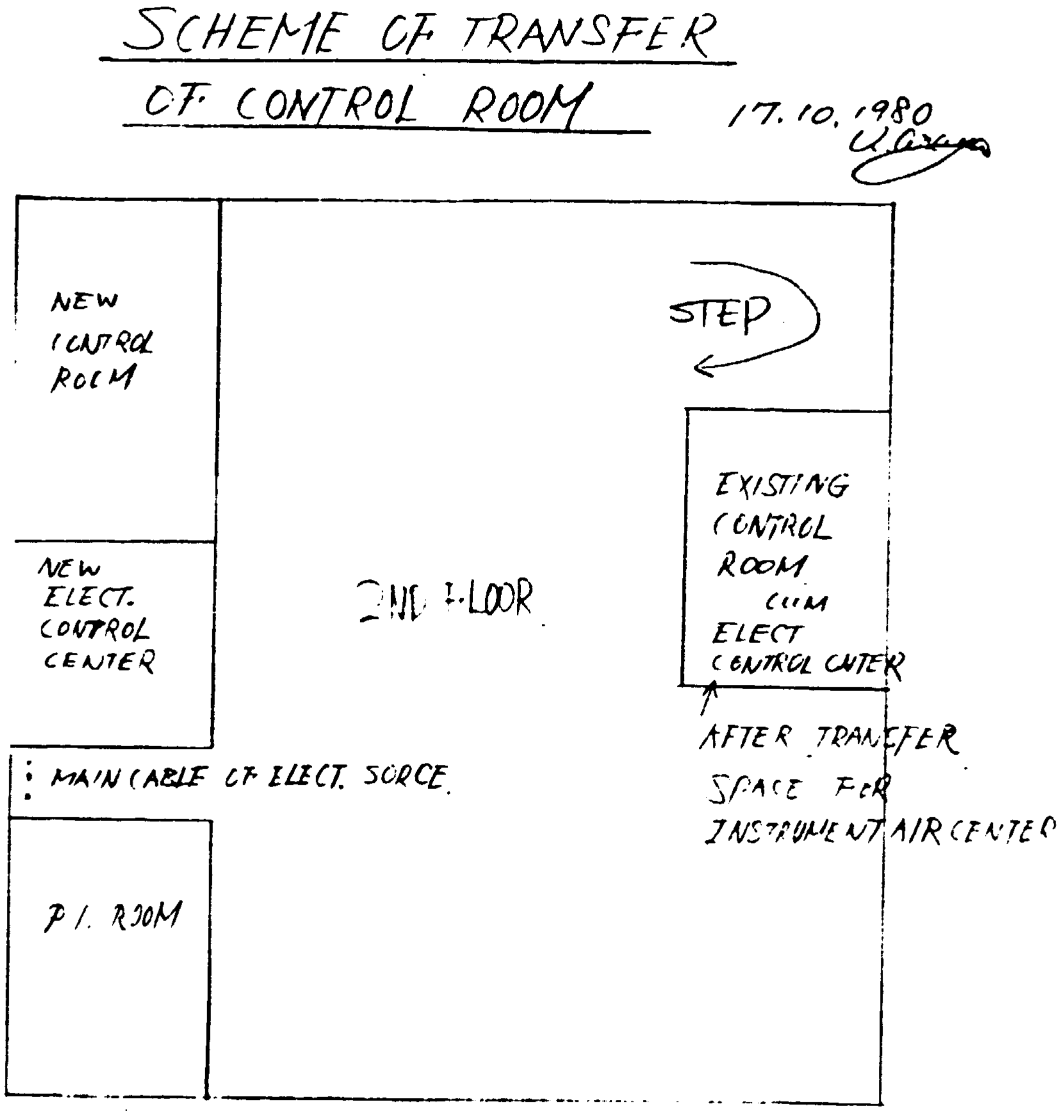
Q_0 = original graduation (0.12 - 12 m^3/h)

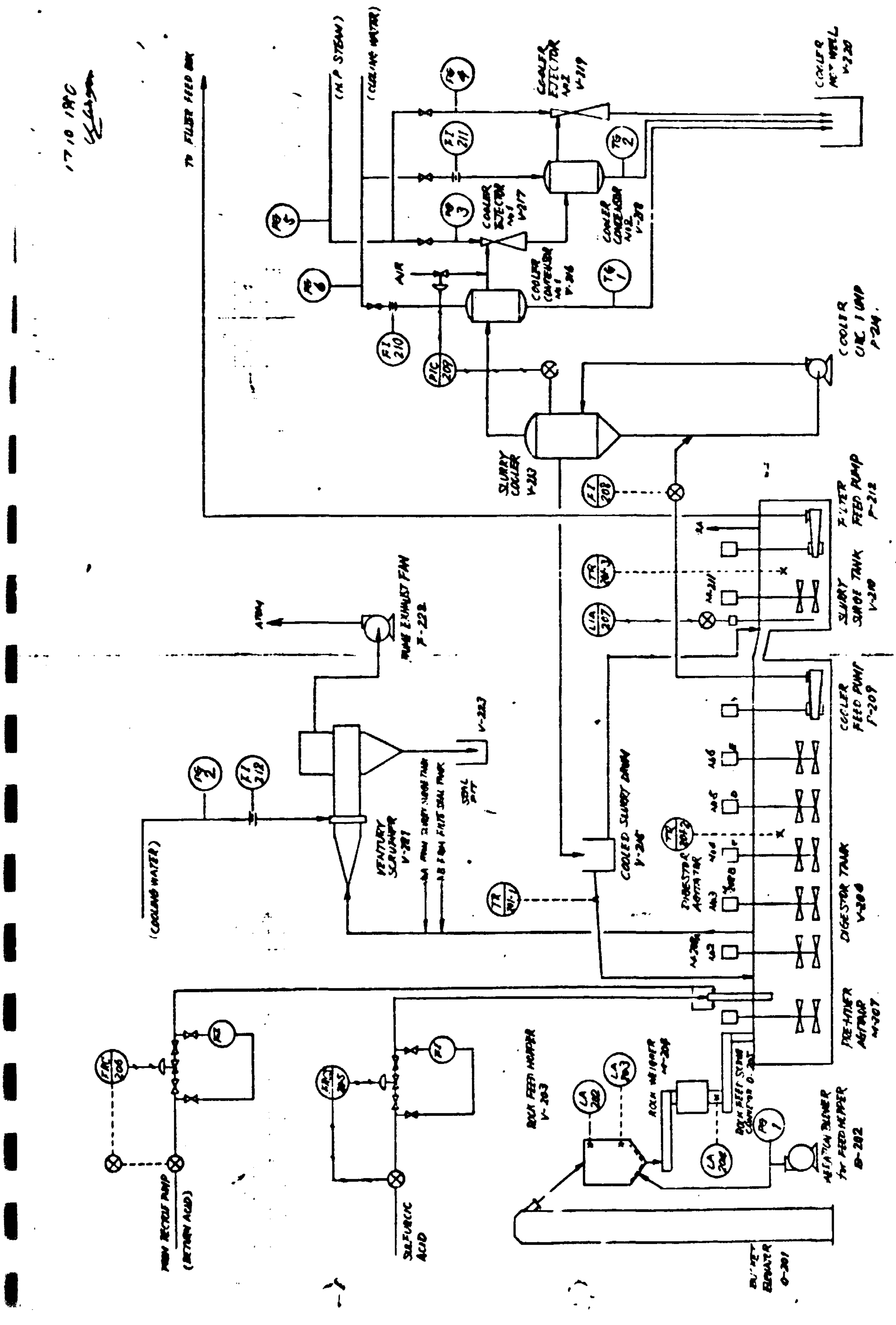
If flow rate is shown 12 m^3/h, corrected flow rate (50% PA actual flow rate) is 12.72 m^3/h (=12 x 1.06)

3. Factor of Totalizer

Count of totalizer x 0.127 m^3

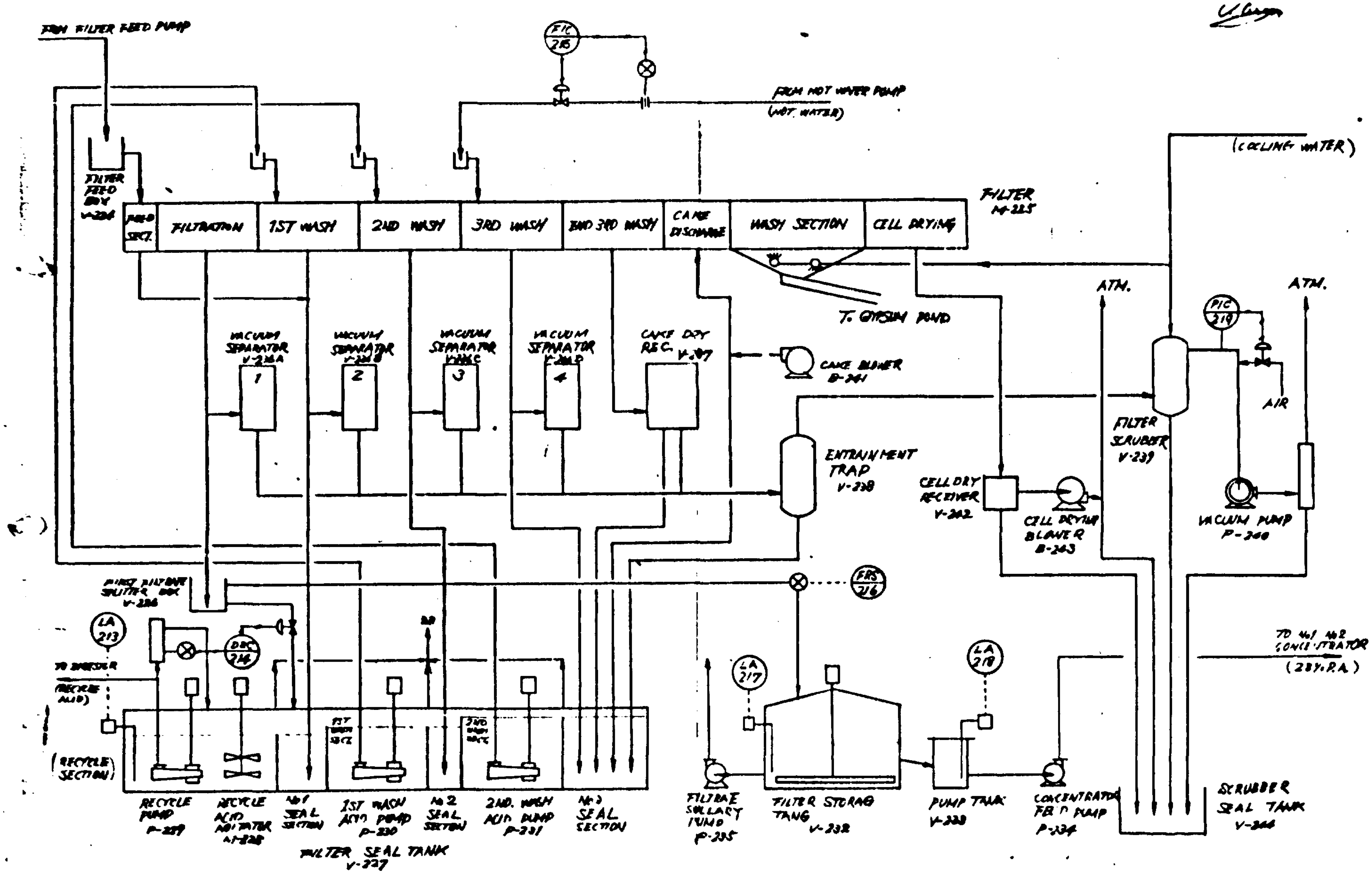
APPENDIX V-17(1) SCHEME OF TRANSFER OF CONTROL ROOM

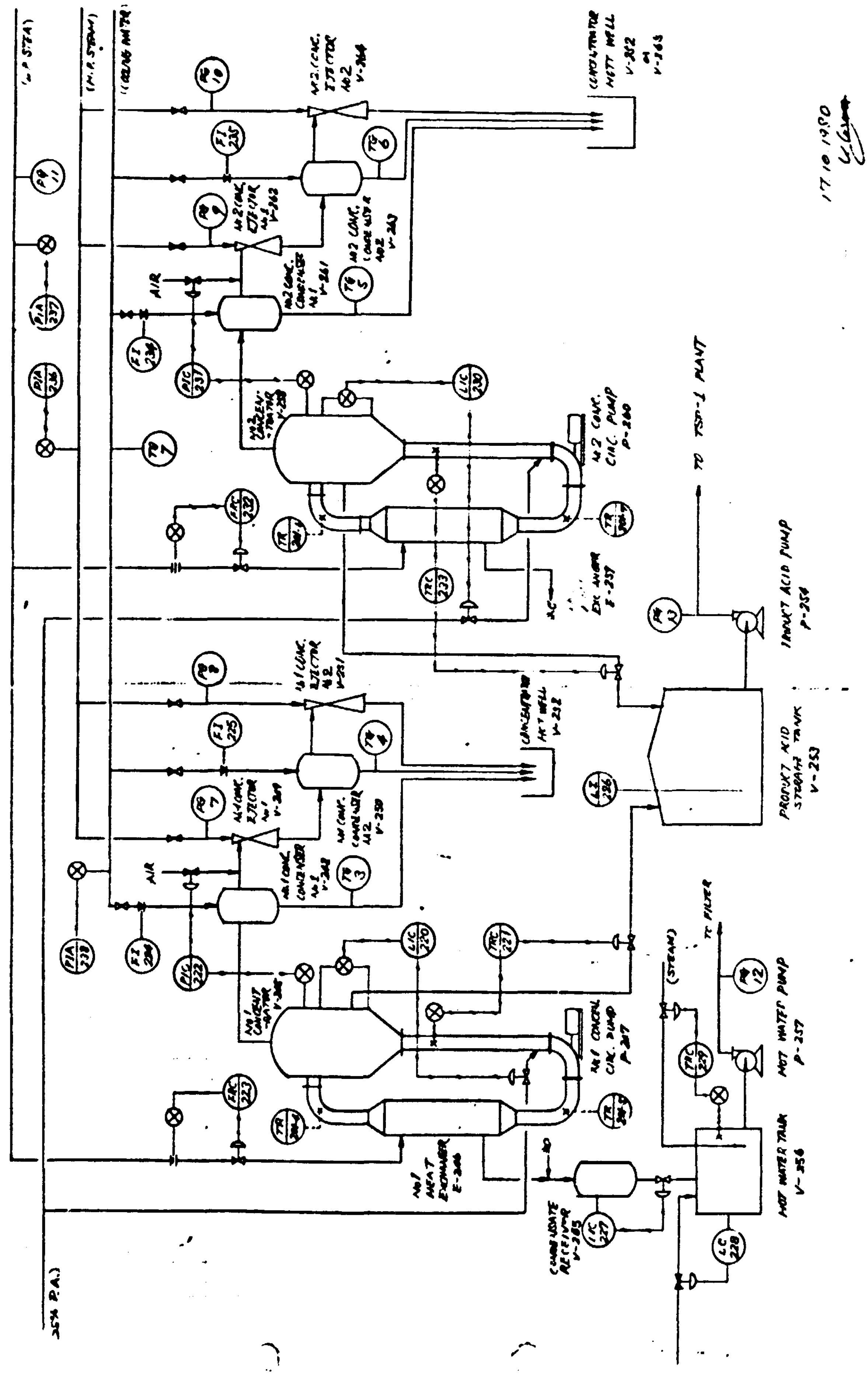



TO FILTER FEED BOX
(H.P. STEAM)
(COOLING WATER)
COOLER CONDENSER
SLURRY COOLER
COOLER CIRC. PUMP
FILTER FEED PUMP
SLURRY SURGE TANK
COOLER FEED PUMP
COOLED SLURRY DRUM
DIGESTOR TANK
PRE-MIXER AGITATOR
ROCK FEED HOPPER
ROCK WEIGHER
ROCK FEED SCREW CONVEYOR
AERATION BLOWER FOR FEED HOPPER
BUCKET ELEVATOR
SULFURIC ACID
(RETURN ACID)
(COOLING WATER)
VENTURY SCRUBBER
FUME EXHAUST FAN
ATM
AIR
SEAL PIT

1. INSTRUMENTATION FLOW SHEET (2/3)

17.10.1980




TO TSP-1 PLANT
PRODUCT ACID STORAGE TANK V-253
PRODUCT ACID PUMP P-254
HOT WATER TANK V-256
HOT WATER PUMP P-257
AIR
AIR
25% P.A.)
17.10.1980

APPENDIX V-17(3) THE TABLE OF TAG NO. AND NAME IN PA-1 PLANT

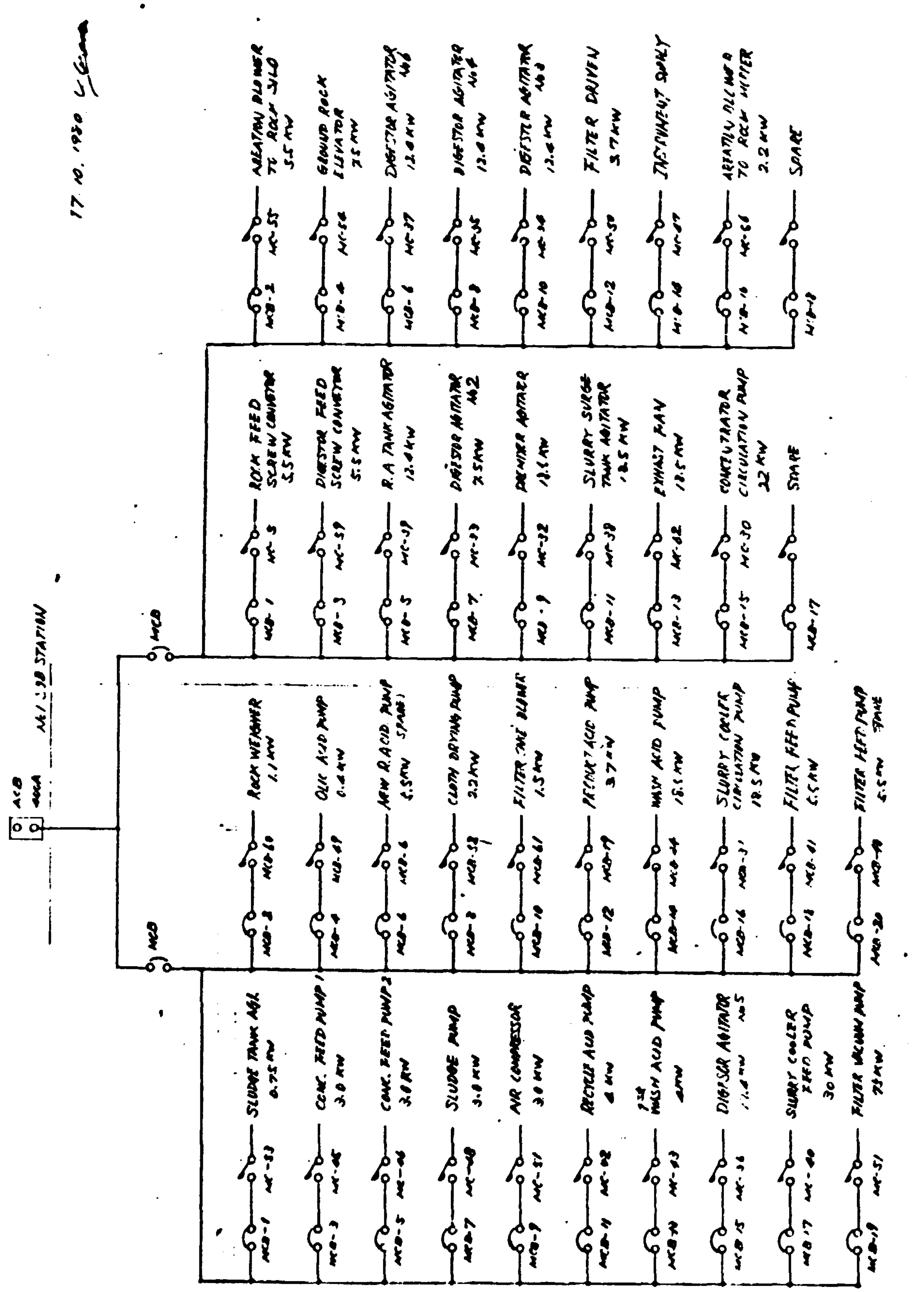
	Tag No.	Name
1	TR-201	Temperature recorder
2	LA-202	Rock feed hopper higher level
3	LA-203	Rock feed hopper higher level
4	LA-204	Rock feed screw conveyor filled up
5	FRCS-205	Sulfuric acid flow
6	FRC-206	Return acid flow
7	LIA-207	Slurry surge tank level
8	FRC-208	Slurry cooler feed slurry flow
9	PIC-209	Slurry cooler pressure
10	FI-210	Cooler condensor No.1 water flow
11	FI-211	Cooler condensor No.2 water flow
12	FI-212	Ventury scrubber water flow
13	LIA-213	Filter seal tank level
14	DRC-214	Return acid density
15	FIC-215	Hot water flow
16	FRS-216	Filtrated acid flow
17	LA-217	Filter storage tank level
18	LA-218	Pump tank level
19	PIC-219	Filtration pressure
20	LICA-220	No.1 concentrator level
21	TRC-221	No.1 concentrator temperature
22	PIC-222	No.1 Concentrator pressure
23	FRC-223	No.1 concentrator steam flow
24	FI-224	No.1 concentrator condensor No.1 water flow
25	FI-225	No.1 concentrator conddensor No.2 water flow
26	LI-226	Product acid storage tank level
27	LIC-227	Condensate receiver level
28	LC-228	Hot water tank level
29	TRC-229	Hot water tank temperature
30	LICA-230	No.2 concentrator level
31	PIC-231	No.2 concentrator pressure
32	FRC-232	No.2 concentrator steam flow
33	TRC-233	No.2 concentrator temperature
34	FI-234	No.2 concentrator condenser No.1 water flow
35	FI-235	No.2 concentrator condenser No.2 water flow

	Tag No.	Name
36	PCV-236	H.P. steam pressure control
37	PIA-237	Cooling water pressure
38	PIA-238	L.P. steam pressure
39	PIA-239	H.P. steam pressure
40	TG-1	Cooler condensor No.1 temperature
41	TG-2	Cooler condensor No.2 temperature
42	TG-3	No.1 concentrator condensor No.1 temperature
43	TG-4	No.1 concentrator condensor No.2 temperature
44	TG-5	No.2 concentrator condensor No.1 temperature
45	TG-6	No.2 concentrator condensor No.2 temperature
46	TG-7	Cooling water temperature
47	PG-1	Aeration blower for feed hopper pressure
48	PG-2	Scrubber inlet cooling water pressure
49	PG-3	Cooler ejector No.1 steam pressure
50	PG-4	Cooler ejector No.2 steam pressure
51	PG-5	Controlled H.P. steam pressure
52	PG-6	Cooling water pressure
53	PG-7	No.1 concentrator ejector No.1 steam pressure
54	PG-8	No.1 concentrator ejector No.2 steam pressure
55	PG-9	No.2 concentrator ejector No.1 steam pressure
56	PG-10	No.2 concentrator ejector No.2 steam pressure
57	PG-11	L.P. steam pressure
58	PG-12	Hot water pressure
59	PG-13	Product acid pump delivery pressure

APPENDIX V-17(4) LIST OF AMPERE METER TO BE INSTALLED ON THE PANEL

1	Premixer agitator	M-207
2	Digestor agitator No.2	M-208A
3	Digestor agitator No.3	M-208B
4	Digestor agitator No.4	M-208C
5	Digestor agitator No.5	M-208D
6	Digestor agitator No.6	M-208E
7	Slurry surge tank agitator	M-211
8	Recycle acid tank agitator	M-228
9	Filtrate storage tank agitator	-
10	Cooler feed pump	P-209
11	Filter feed pump	P-212
12	Slurry cooler circulation pump	P-214
13	Recycle pump	P-229
14	First wash pump	P-230
15	Second wash pump	P-231

APPENDIX V-17(5) PA-1 ELECTRICAL SOURCE SKELETON



APPENDIX V-17(6) SPECIFICATION OF INSTRUMENT PANEL

1. Generality

Location	:	Control room
Type	:	Self standing
		Enclosed type with silkscreen semigraphic plate.

2. Size

Width	:	1,200
Height	:	2,400
Depth	:	1,200
Number	:	Option of guster

3. Material

Front board	:	3.2 mm, Carbon steel
Graphic board	:	2.3 mm, "
Side board	:	2.3 mm, "
Back board	:	2.3 mm, "
Ceiling board	:	2.3 mm, "
Channel base	:	100/50/5 mm, Carbon steel

4. Accessories

Door	:	Right and left both
Inside lighting	:	20 watts 1 set
Clock	:	1 set (dry cell)
Anchor bolt & nut	:	should be attached
Hunger bolt	:	"

5. Color

Surface	:	Munsel N 7.0
Graphic board	:	Munsel N 7.0
Inside	:	Munsel Y 2.5
Channel base	:	Munsel N 7.0

6. Installation

Name plate	:	See annex paper	
Instrument	:	TR-201	
		FRCS-204	LIC-216
		FRC-205	TRC-217
		LIA-206	PIC-218
		PIC-207	FRC-219
		FIC-209	LIC-224
		DRC-211	TRC-225
		FRS-212	PIC-226
		TRC-223	FRC-227
		LI-220	FRS-228

Annunciator	Lamp	:	
	Audible unit	:	1 set
	Flickerrelay	:	1 set
	Reset button	:	1 set
	Test button	:	1 set
	See	:	Annex paper

7. Piping Air Supply

Inlet pressure	:	5 kg/cm^2G
Connection	:	1/4 kg/cm^2G
Filter	:	2 sets
Reducing unit	:	2 sets
Pressure gauge	:	1 set (primary)
Stop valve	:	1/4" BC
Tubing material	:	copper 6/4 mm

Signal

Tubing material	:	Copper 6/4 mm

8. Wiring

Source

Powder	:	AC 230V $\pm$ 15% 50Hz
Switch	:	N.F.B.
Transformer	:	230 V/100 V See N.B.
Voltage stabilizer	:	100 V
Wiring material	:	Vinylchloride insulated

Signal

Wiring material	:	Vinylchloride insulated

N.B. 1) One set of transformer and voltage stabilizer should be installed for the panel. Above set is used for the source of instrument except electro-magnetic flow transmitters.

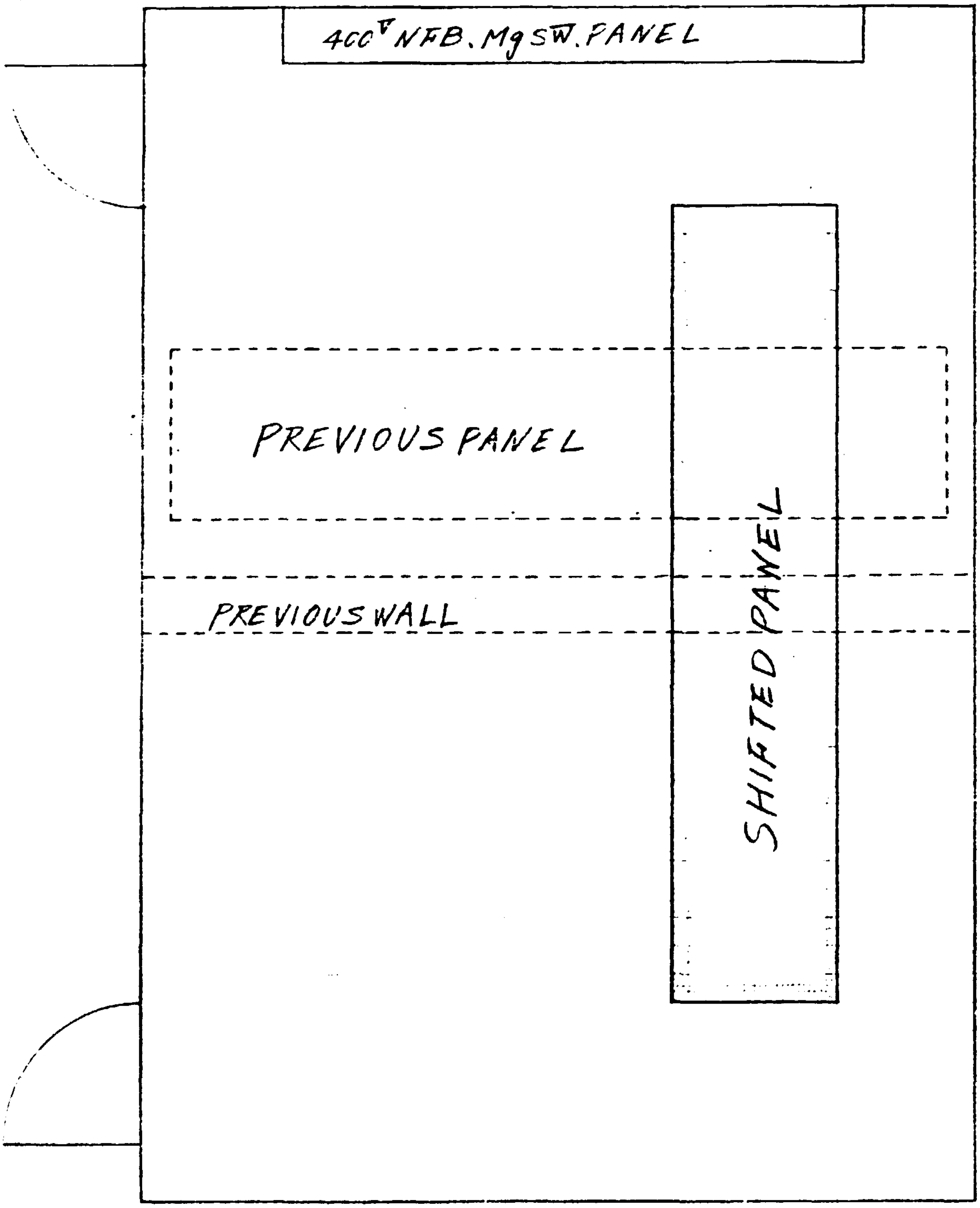
2) For the electro-magnetic flow transmitters, another set of transformer and voltage0stabilizer should be installed at the outside of the instrument panel.

APPENDIX V-18(1) TAG NO. AND NAME OF INSTRUMENT LOOP

Tag No.	Name of instrument loop
TR-101	Multipoint temperature
1E	Cooled slurry drum
2E	Digestor tank
3E	Slurry surge tank
4E	Heat exchanger outlet
5E	Heat exchanger inlet
6E	Concentrator inlet
TRC-108	Hot water temperature
FRC-101	Sulfuric acid flow
FRT-101	Sulfuric acid total flow
FRC-102	Return acid flow
RFC-103	Filtrate acid flow
FRC-104	Hot water flow
RFC-105	Concentrator inlet steam flow
FI-106	Scrubber inlet water pump
LAH-101	Rock feed hopper higher level
LAL-102	Rock feed hoppe lower level
LAH-103	Rock screw conveyor filled up level
LAH-104	Slurry surge tank higher level
LAL-105	Slurry surge tank lower level
LAH-106	Recycle acid tank level
LAH-107	Filtrate storage tank level
LC-112	Calandria condensate level
LI-113	Phosphoric acid (50%) tank level
PIC-101	Slurry cooler pressure
PIC-102	Filter pressure
PIC-103	Concentrator pressure
PG-101	Rock feed hopper acration
PG-102	Slurry cooler pressure
PG-103	Slurry cooler ejector steam
PG-104	Scrubber inlet water
PG-105	Cell drying blower
PG-106	Entrainment trap

PG-107	Cake blower
PG-108	Concentrator
PG-109	Calandria steam
SCR-101	Return acid ensity
XA-101	No.1 digestor agitator stop (AA-1)
XA-102	No.2 digester agitator stop (AA-2)
XA-103	No.3 digester agitator stop (AA-3)
XA-104	No.4 digester agitator stop (AA-4)
XA-105	No.5 digester agitator stop (AA-5)
XA-106	No.6 digester agitator stop (AA-6)
XA-107	Cooler feed pump stop (AP-2)
XA-108	Slurry agitator stop (AA-7)
XA-109	Filter feed pump stop (AP-3)
XA-110	Slurry cooler cir. pump stop (AP-5)
XA-111	Recycle pump stop (AP-7)
XA-112	Recycle acid agitator (AA-8)
XA-113	First wash acid pump stop (AP-8)
XA-114	Second wash acid pump stop (AP-9)
XA-115	Filtrate storage agitator stop (AA-9)

APPENDIX V-18(2) PA-1 PANEL SHIFT DRAWING



APPENDIX V-18(3) PA-1 INSTRUMENTATION SCHEMATIC DRAWING

Regarding this APPENDIY, the expert already submitted to TSP factory the whole documents. 4 pages are attached as examples.

PA-1 Instrumentation

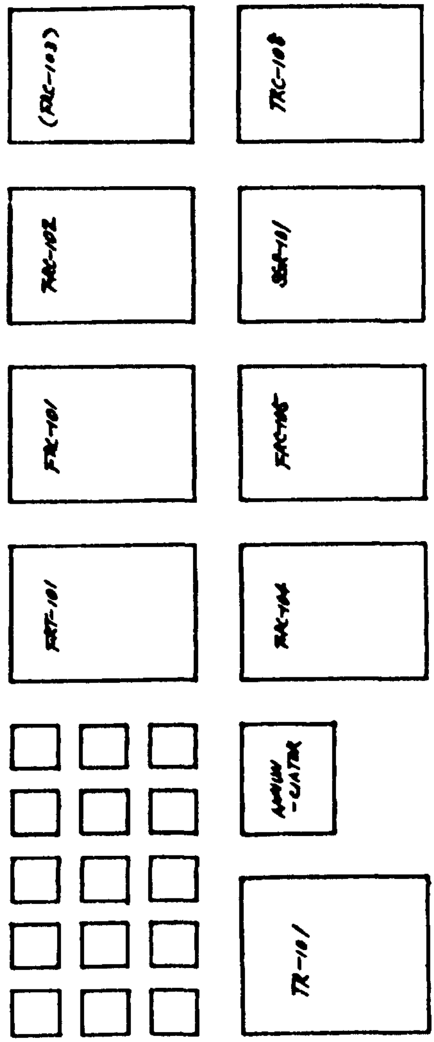
Schematic Drawing

CONTENTS

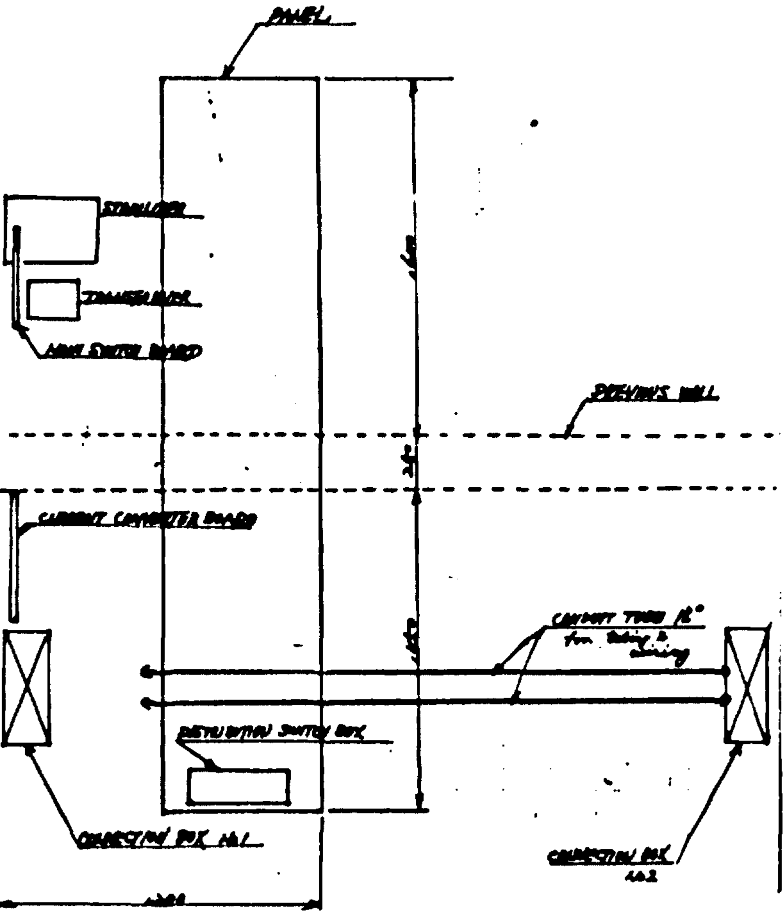
by K. Arai

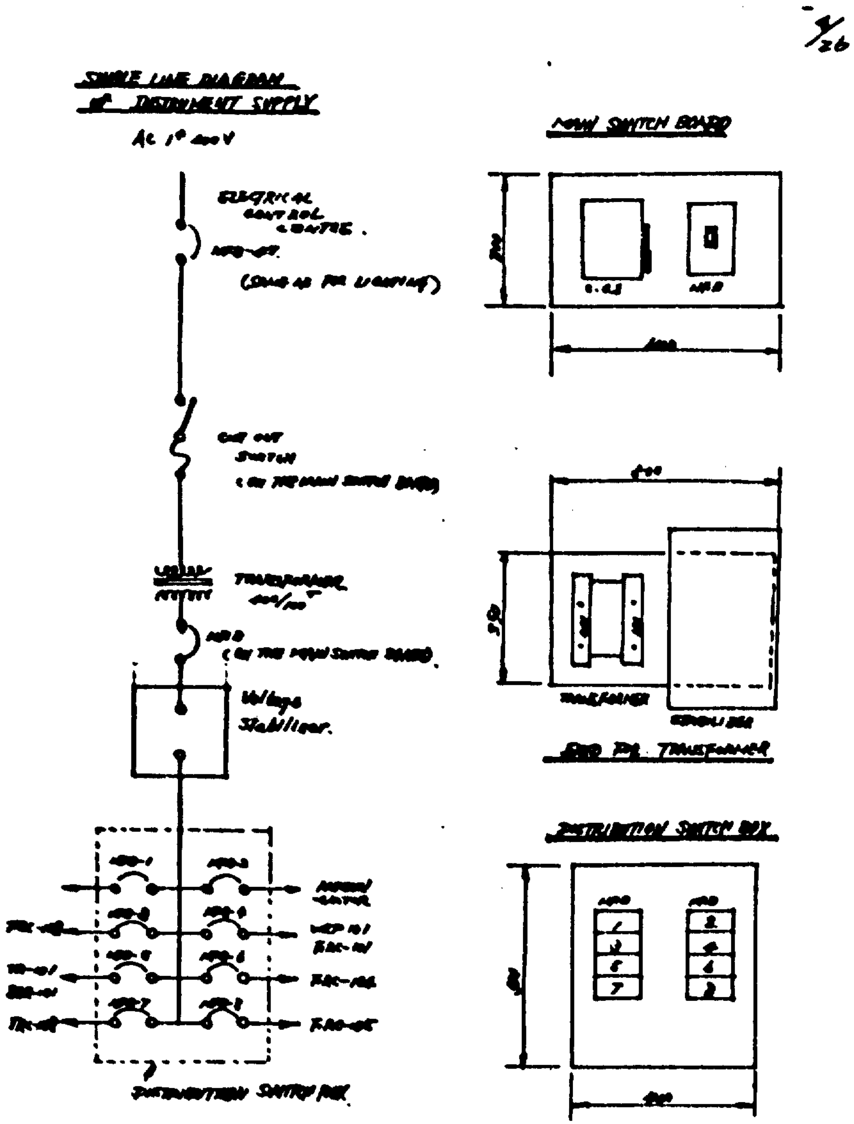
PANEL FRONT VIEW. (free scale)

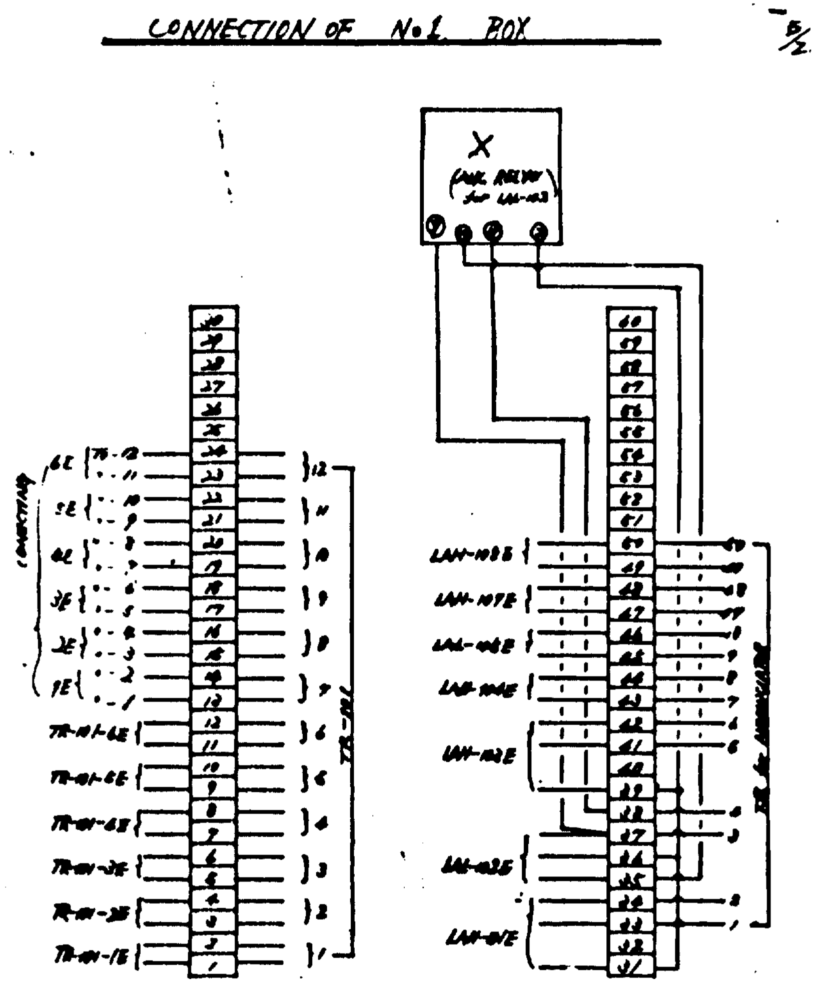
2/26



ARRANGEMENT of PANEL & OTHERS




SINGLE LINE DIAGRAM OF INSTRUMENT SUPPLY
MAIN SWITCH BOARD
TRANSFORMER
STABILIZER
DISTRIBUTION SWITCH BOX
Voltage Stabilizer.


CONNECTION OF No.1 BOX

CONNECTION of No 2 Box

6/26

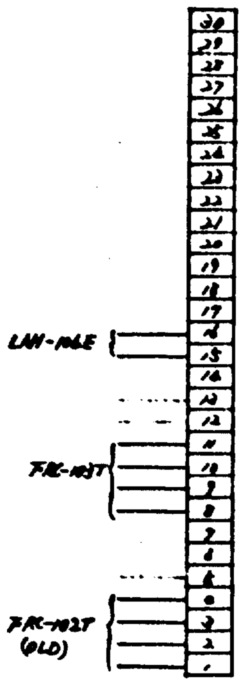
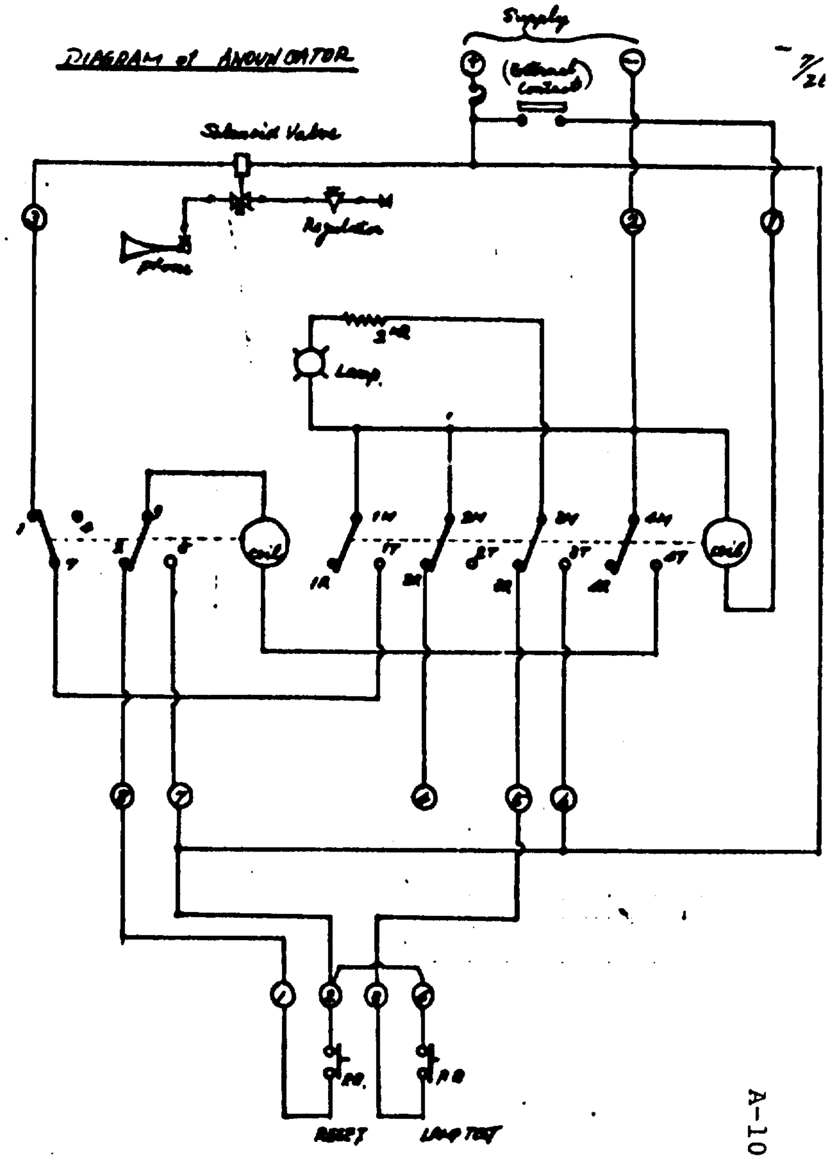
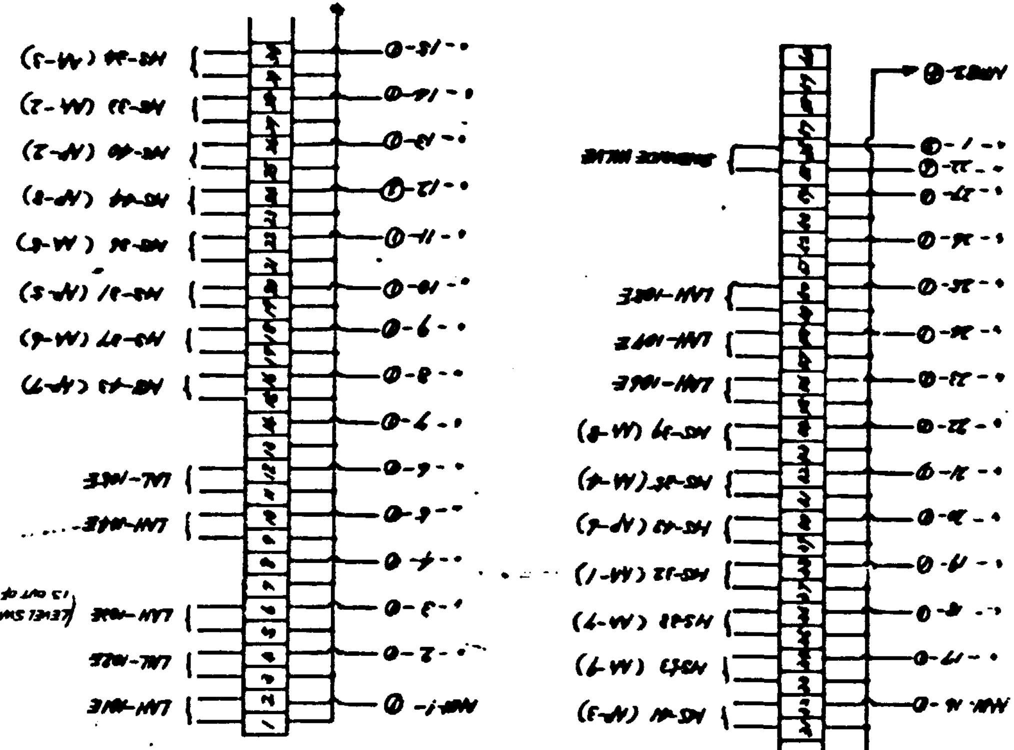


DIAGRAM of ANNUNCIATOR

7/26





ARRANGEMENT of T.B. of ANNUNCIATOR

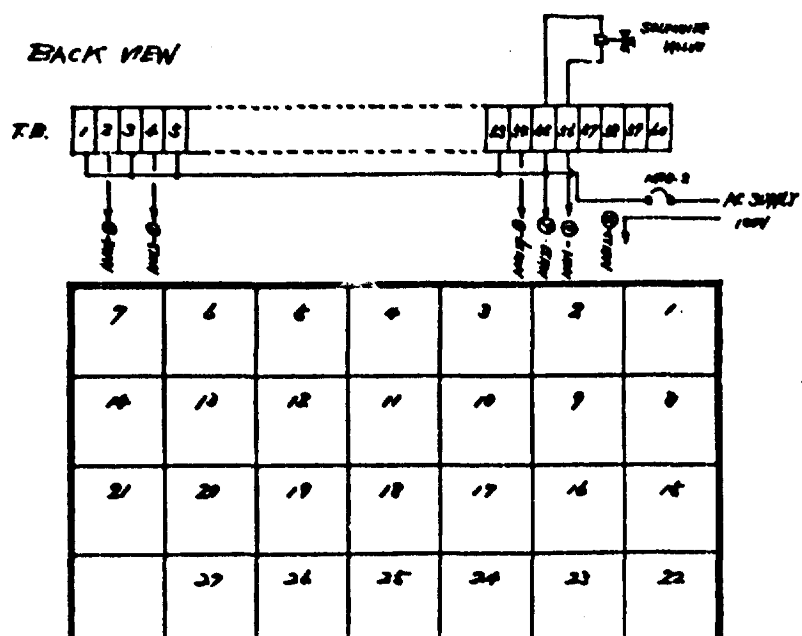
ARRANGEMENT of ANNUNCIATOR

9/26

FRONT VIEW

1 LAH-101	2 LAL-102	3 LAH-103	4	5 LAH-104	6 LAL-105	7
8 AP-7	9 AA-6	10 AP-5	11 AA-5	12 AP-8	13 AP-2	14 AA-2
15 AA-3	16 AP-3	17 AA-9	18 AA-7	19 AA-1	20 AP-6	21 AA-4
22 AA-8	23 LAH-106	24 LAH-107	25 LAH-108	26	27	

BACK VIEW



APPENDIX V-19 MODIFICATION OF PAN CONVEYOR SYSTEM

This item has already been investigated and the drawing is prepared for modification. In this investigaton, the expert has noticed the following problems in the condition of corrosive adhesive green TSP:

(1) Severe wear and tear of conveyor rail and wheel bush due to metal contact friction.

(2) Frequent shear of link pin due to increse of frictional resistance.

(3) Hardened TSP adherence on the pan.

(4) Tough repair work due to high lift.

In order to solve the above mentioned problems, the following points are recommended in the said drawing.

(1) O-3108 which is installed between den and slicer, is to be replaced with new belt conveyor as shown in attached figure.

(2) Lifting height is to be lowered from the existing one, as low as possible.

(3) For the completion of the above purpose, slicer is to be by-passed because this equipment did not work sufficiently and is not used till now.

(4) O-3109 which is installed between slicer and existing belt conveyor O-3111, is to be eliminated and O-3111 is to be elongated towards the end pulley.

However, the existing belt conveyor also had the trouble, concerning the carrier/return roller. These rollers bearing are damaged frequently due to incursion of TSP dust through the labyrinth seal.

In order to solve this trouble it is recommended to use the new type roller (Plaloy roller).

Plaloy roller has the following advantages.

(1) Maintenance free
(2) Self-lubrication
(3) Long-life

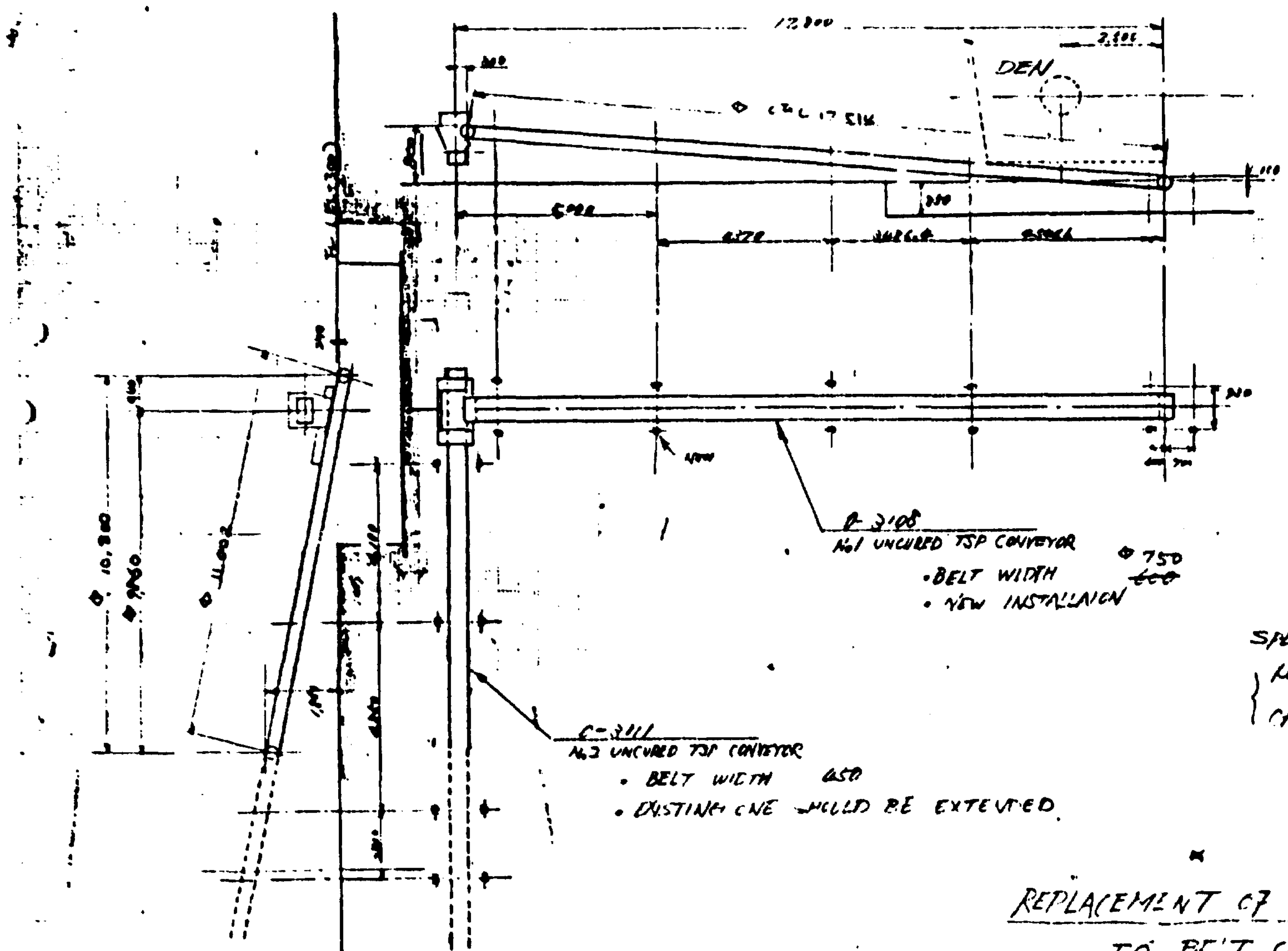
And this roller had been set for test run on the existing belt conveyor in severe operating conditions. As the result indicated a good performances, application of Plaloy roller in the modification of G-3108 was decided.

As the first step for modification, mechanical section of TSP Complex has improved the existing bending pan conveyor to the inclined straight one. As the second step, 0-3108 should be changed to belt conveyor with Plaloy roller.

For the preparation of the implementation, the specification of O-3108 and O-3109 is prepared herewith.

Reference : Specification Comparisons

	0-3108 No.1 uncured conveyor		0-3109 No.2 uncured conveyor	
Conveyor & Type	Original; Pan	Modification; Belt	Original; Pan	Modification; Belt
Roller Type	Cast iron wheel with steel bush and pin	Resin roller with SS wire	Cast iron wheel with steel bush and pin	Resin roller with SS wire
Length (C to C)	16,900 mm	17,857 mm	15,700 mm	11,486 mm
Lift	8,450 mm	2,080 mm	2,850 mm	1,700 mm
Speed	25 m/min		25 m/min	
Driving device	11 KW, 6 P, 1/30 Geared motor	Existing motor to be used	7.5 KW, 6 P, 1/30 Geared motor	Existing motor to be used



SPECIFICATION REQUIRED.

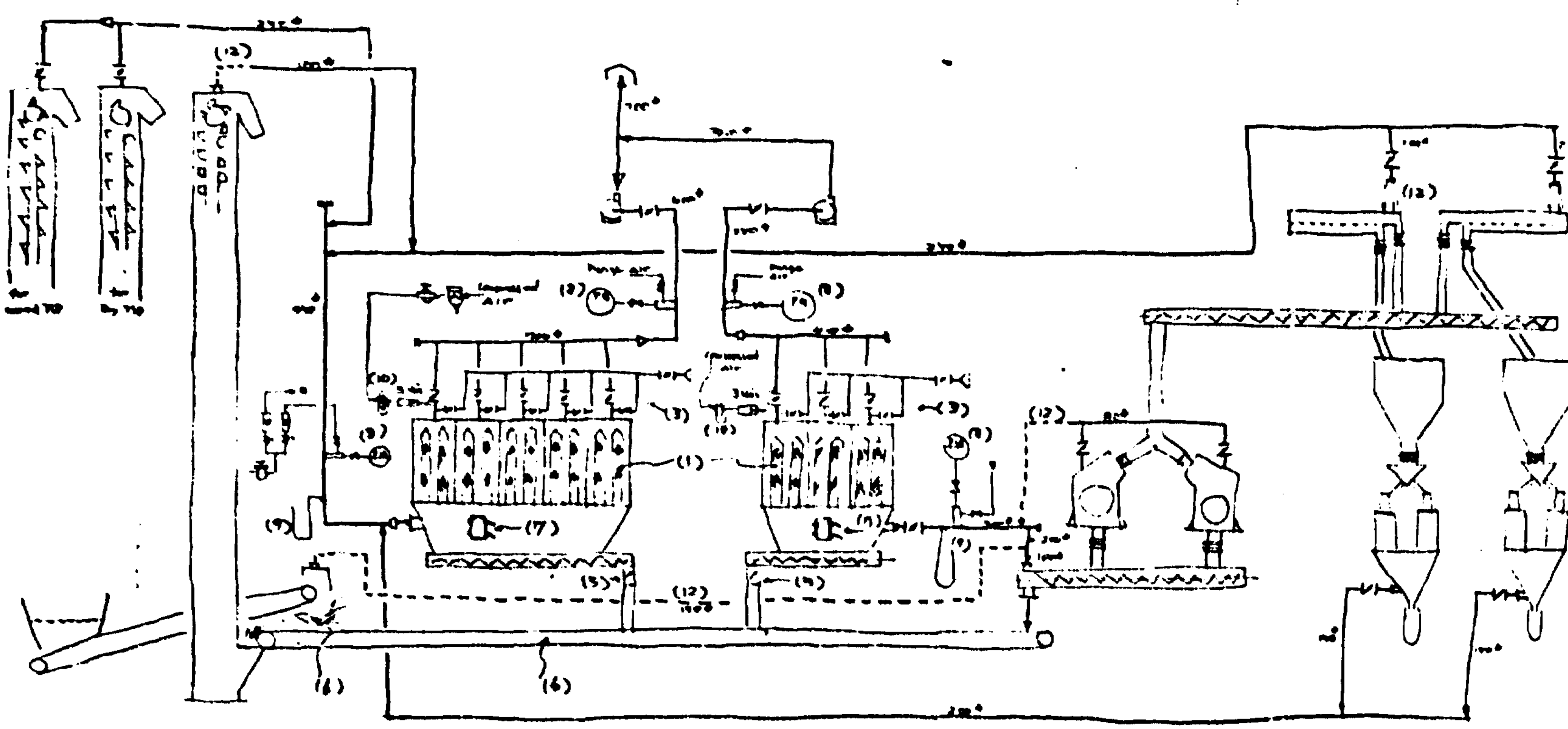
MATERIAL TSF $\rho = 0.75$

CAPACITY MAX 4 %, NCF 24 t/h

REPLACEMENT OF PAN CONVEYOR (TSP-2) TO BELT CONVEYOR

Rev. 10-4-80 by K. Andani

3/4/80



Below items are important to operate the Bag Filter effectively.
Each work must be completed by the section indicated with parentheses

(1) Cleaning and repair of the filter clothes. (Ope.)	(9) Installation of local manometer for dust inlet of the Bag Filter (Inst.)
(2) Re-study of the operation manual (Ope.)	
(3) Adjustment of the changing damper (Mech. & Inst.)	(10) Installation of oiler for air cylinder (Inst.)
(4) Cleaning of the duct piping (Mech.)	(11) Checking of sequence (Elect.)
(5) Overhauling and repair of the double dampers (Mech.)	(12) complete connecting of duct piping (Mech.)
(6) Complete covering of the return conveyor (Mech.)	
(7) Change of the gaskets for man-hole cover of Bag Filter (Mech.)	
(8) Checking of the pressure gauges : 4 No's (Inst.)	

APPENDIX V-21(1) CHECKING POINTS OF DUST COLLECTOR

The expert would like to make some questions and ask for some tests also in order to solve these problems as soon as possible.

1. From when did one find something remarkably unusual about this dust collection?

   Did the kind of rock change at that time, or did the size of ore and water content of ore change remarkably?

2. At first one must check the cyclones (V-2206A, V-2206B), especially rotary valves. One must clean up rotary valves periodically (eg. once a week) from near cleaning holes. If these are no cleaning holes, one must set them.

   If these cyclones were out of order, circulating mass of product might increase, then the mass of particles in the exhaust air might increase.

3. Second point: The branch point of the exhaust (10) air is too near from the fan (K-2201), so the state of exhaust air at that point is in confusion and carried out particles are increased. But this point cannot be improved easily.

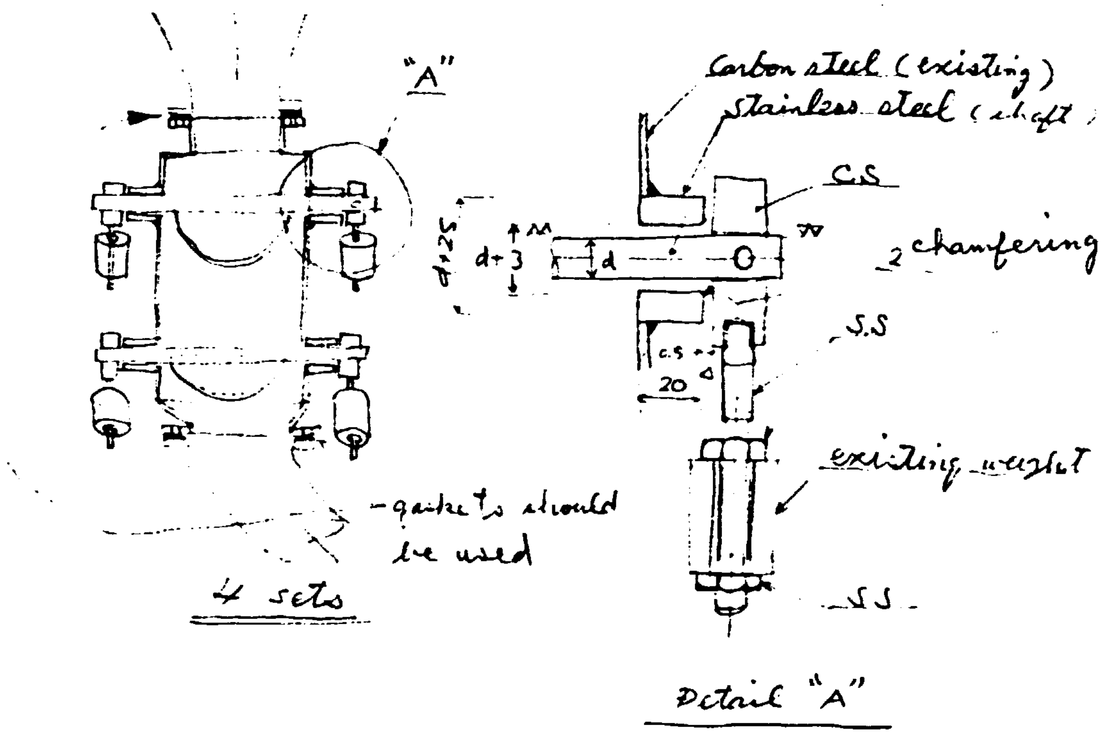
4. Third point: One must check the four cyclones, especially the dampers, whether these are operating correctly or not. If they are not in good condition, the expert want to check the present condition inside the bottoms of cyclones in the stopping time. Four cyclones must operate in equal condition. These cyclones must be checked and cleaned from cleaning holes.

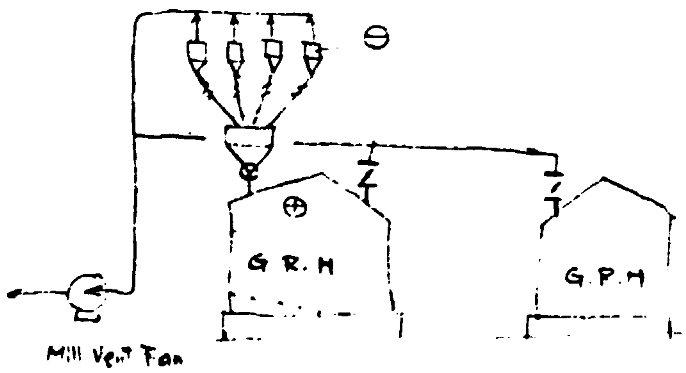
As one knows, efficiency of cyclone drops so much, when the particles of dust becomes very small, efficiency of cyclone has to be very low. (Particle $< 5\ \mu$ cannot remove by Tindal's phenomena.) The expert is now calculating about it.

5. Fourth point: We must check and test the scrubbers (V-2207A, V-2207 B). We must study the instruction of these equipments. When the mill plant stops, we must check the distribution of washing water and the quantity of washing water.

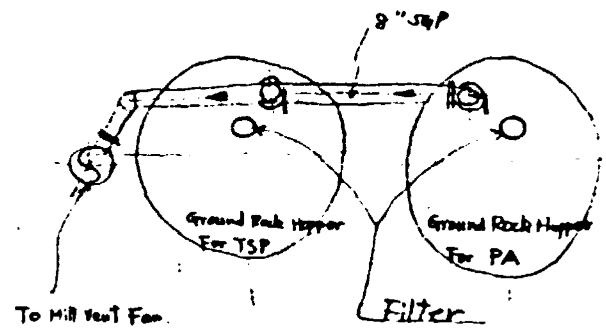
APPENDIX V-21 (2)   COUNTERMEASURE FOR MILL DUST PROBLEM

1. Modification of double damper (V-2208)



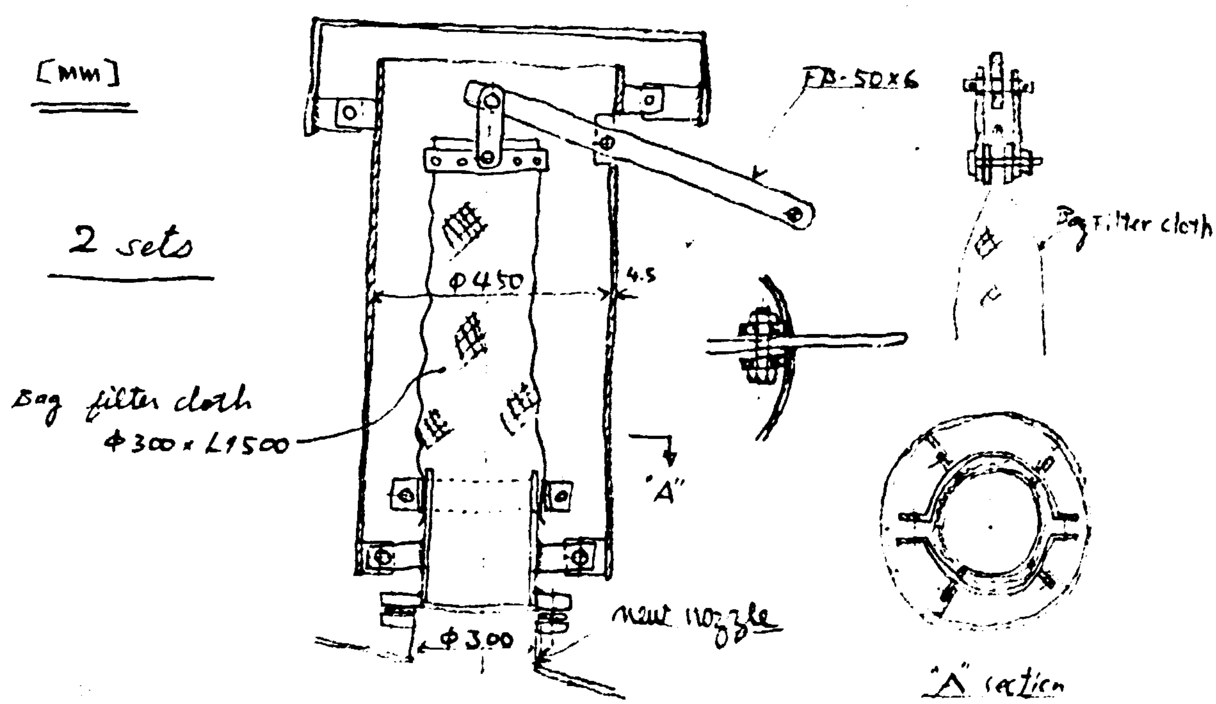


2. Modification of the exhaust piping from Ground Rock Hopper

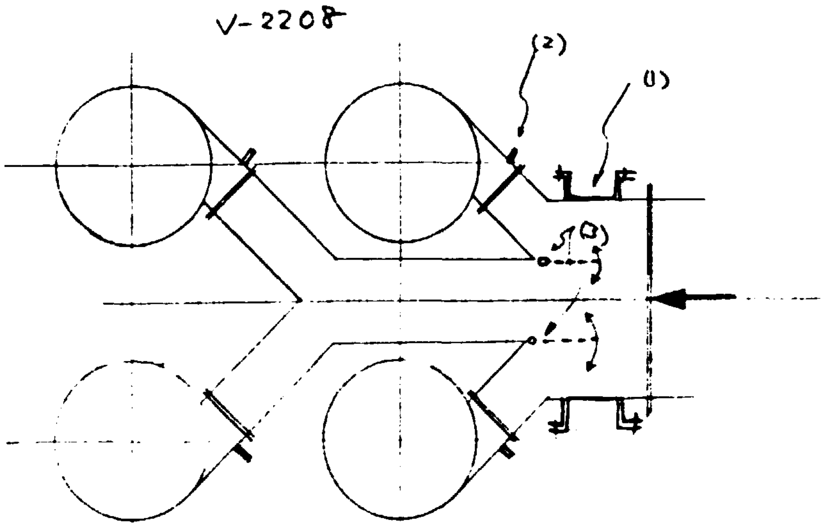


This piping is blocked by the dust, therefore, the air from Storage Aeration Blower can not be sucked to the Mill Vent Fan through the piping. The pressure in the tank is positive, and one in the cyclone is negative. In this condition, aeration air flows into the cyclone from its bottom. The air accompanied with dusts flows out from the outlet of the cyclone, and so separation efficiency is decreased.

In order to reduce the pressure in the tank, the filter please be installed as follows:

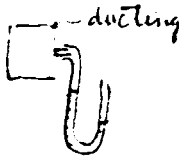


3. In order to distribute the vent air equally



i) Attach the man-holes (2 sets)

ii) Provide the manometers which are made of vinyl tubes.



(4 sets)

iii) This dampers should be cleaned so that operators can move them.

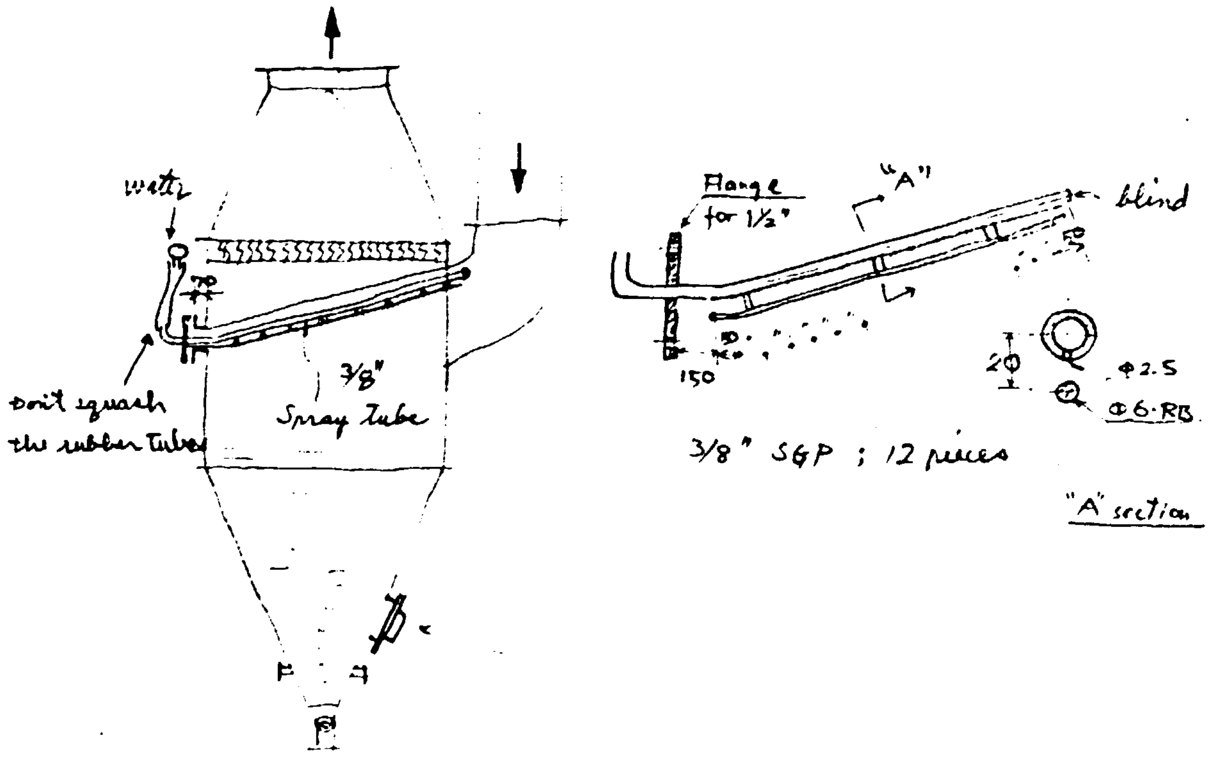
4. V-2207 Mill Vent Dust Collector

This is in bad condition.

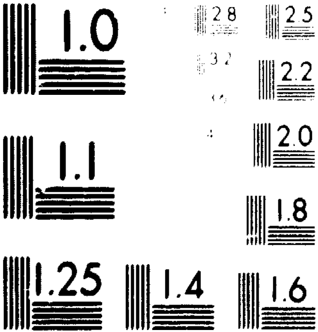
i) Cleaning is necessary

Throw all man-holes open, take off so much muds and rusts in the collectors at this time, bolts and nuts are so corroded that they should be replaced.

ii) Spray tubes are completely blocked by rusts. Replace to new spray tubes.

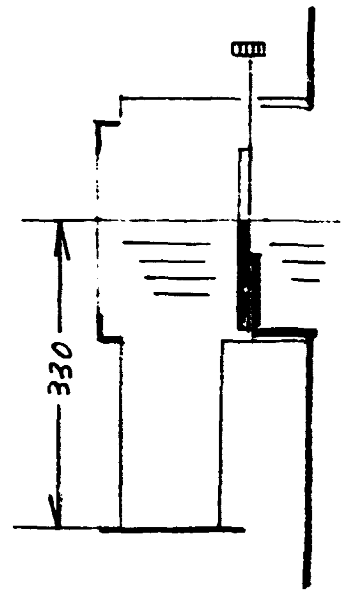


iii) Attach one new man-hole for cleaning.


1.0
2.8
2.5
3.2
2.2
1.1
2.0
1.8
1.25
1.4
1.6

5. Instruction Manual of Mill Vent Dust Collector

i) Running



a) Level of water

300 - 350 mm, from the bottom of level gauge

b) During running, water should be always jetted from the spray tubes

(Spray tube SGP 3/8B 1.5ø x 30 x 20 original)

ii) Stoppage & Running

Long-term stoppage : After the fan is stopped, running should be done for about 10-20 minutes.

iii) Preservation Control

If the liquid level drops, this leads to a great trouble. The liquid level should be checked once in a week.

In case of periodic inspection, after all the muddy water is discharged, the manhole in the center of tank should be opened in a month or two.

APPENDIX V-21(3) IMPROVEMENT OF DUST COLLECTOR

1. TSP-II Milling Section

Until now the expert has studied the mechanism of dust collectors and cyclones, and recommended as follows:

i) Modification of double seal of cyclones
ii) Cleaning of water spray pipes
iii) Cleaning of "Venturi parts" completely
iv) Perfect water supply to both dust collectors

The effect of these actions are being checked. But even these are working for short time, the effect is completely successful.

Next step, the bubbling system will be tried instead of "Venturi system".

If one could get the sufficient result in this item, he has to develop the recovery system of ore from the slurry.

On the other hand, the expert has recommended the bag-filter system, as dry-separation, and double cyclone or multicyclone system is now being checked according to T.S.P.'s suggestion.

Now the expert measured the distribution of press-drop in the exhaust line, and found some abnormal points. If this pressure drop is correct, the cyclone efficiency would improve extremely.

2. TSP-I Milling Section

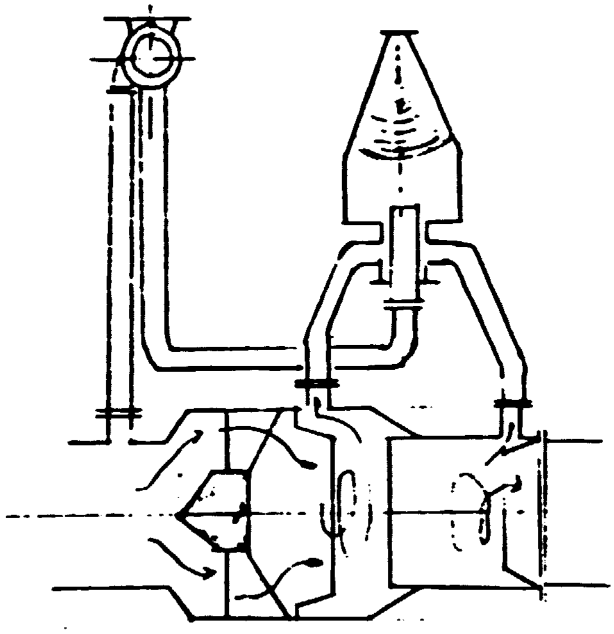
The installation of line-clone separator has already been recommended, and asked for the detail design of this separator in Japan. This separator is dry-system, and expected a very high efficiency.

But we must know exhaust air volume and particle distribution of ore in the exhaust air for design of the system.

It will take about 1.5 months to get all data about this item.

APPENDIX V-21(4) COUNTERMEASURE FOR DUST PROBLEM

1. Dust collector for a big duct (Line-clone)

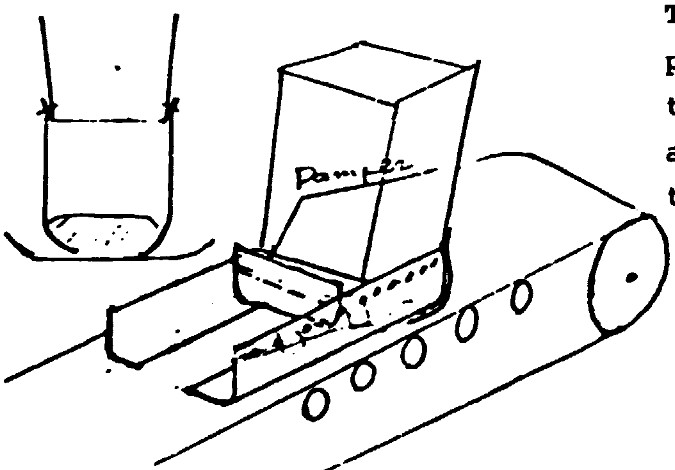


This is the new idea, and applied in some places actually. This efficiency is very good if the dust is 30 - 50 μ. Nissan installed this one for boilers duct, furnaces and other places. (See catalog, vertical installation possible.)

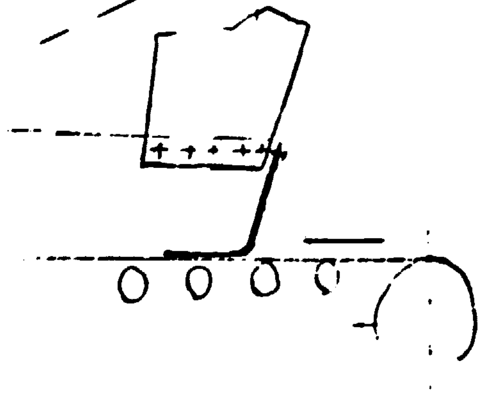
Application:

1. Duct of the dryer T.S.P.
2. T.S.P.-1 Dust in the exhaust of the milling
3. Others

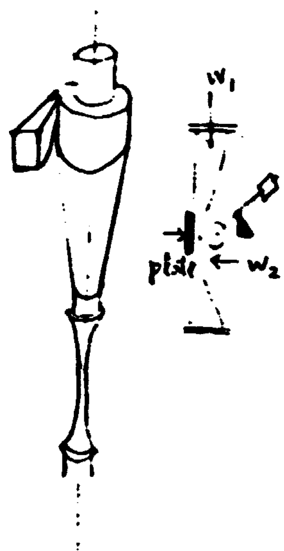
2. Modification of the feeder of "Merrick"



To protect flashing of the rock powder, the expert recommends for these modifications. This is not a basically countermeasure, but this is good for flashing.



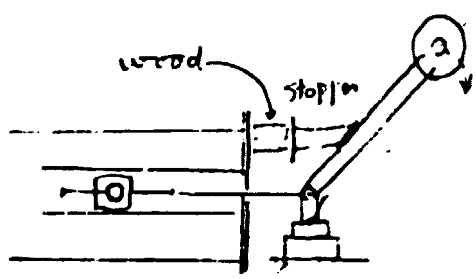
3. Seal and discharge mechanism of cyclone



If the cyclone is under vacuum, one can use this mechanism. The expert uses a rubber tube but may use a tire tube otherwise. This is a very simple method, and used actually in Nissan Chemical Ind.

Application: Try to use in the milling section

4. Take back system of flow conveyor

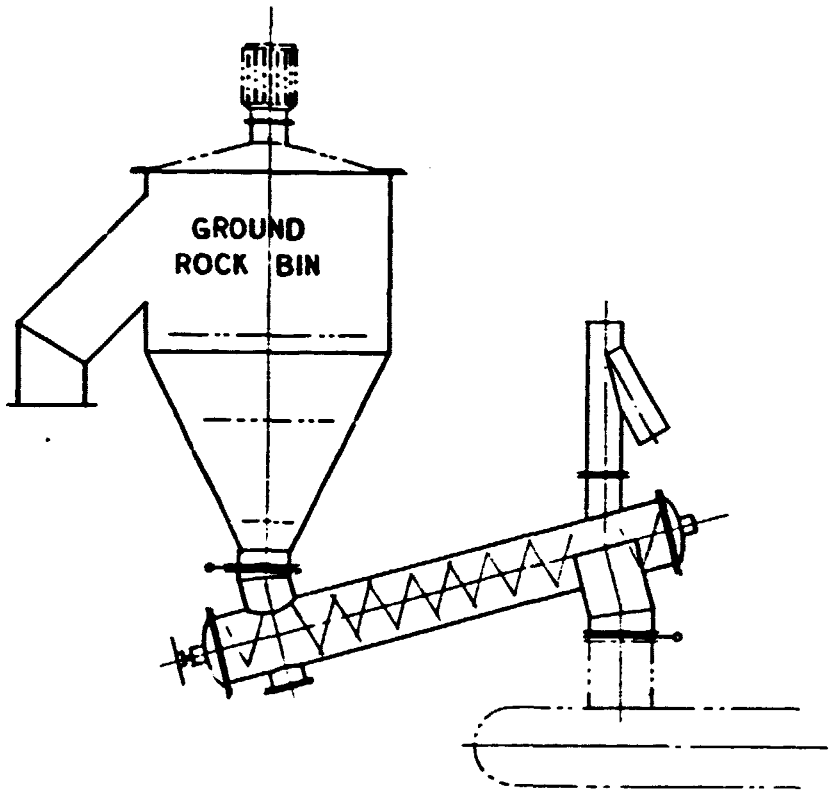


The take back of flow conveyor is loosened by friction wearing and temperature rise.

One must adjust this loose before it is big enough. Otherwise when starting, chains might run off the rail or the wheel.

Application: One should check flow-conveyors, and on recognition this phenomena one must settle for this improvement.

5. Recommendation for Charging System of Ground Rock



i) Setting of the rotary valves (PA-II, TSP-II)

Already two rotary valves are now under enquiry in Japan. These specifications are as follows :

		PA-II	TSP-II
Capacity(T/H)	Max.	21	14
	Nor	18	10
	Min	7	5

ii) Recommendation of setting an agitator

The condition of ground rock in the bin is usually homogeneous, but sometimes it may be changed by bridging, air-inclusion, un-uniformity of discharge and some other conditions of ground rock. The condition of ground rock in the bin must be homogeneous for the uniformity of discharge, so it is recommended to set a small agitator to the ground rock bin. The specification of the agitator is about 1.5 KW 25 RPM. It is better to set this agitator before the rotary volve.

APPENDIX V-21(5) QUANTITY OF VENT AIR IN TSP II ROCK GRINDING MILL

This grinding facility is under a closed circuit system adopting an air swept ball mill. On this design, in case that the rock contains moisture more than 2.5%, hot air generated in the mill furnace should be fed into rock grinding mill so as to achieve two objectives - to decrease the moisture content to less the 1% and to prevent the reduction of grinding efficiency.

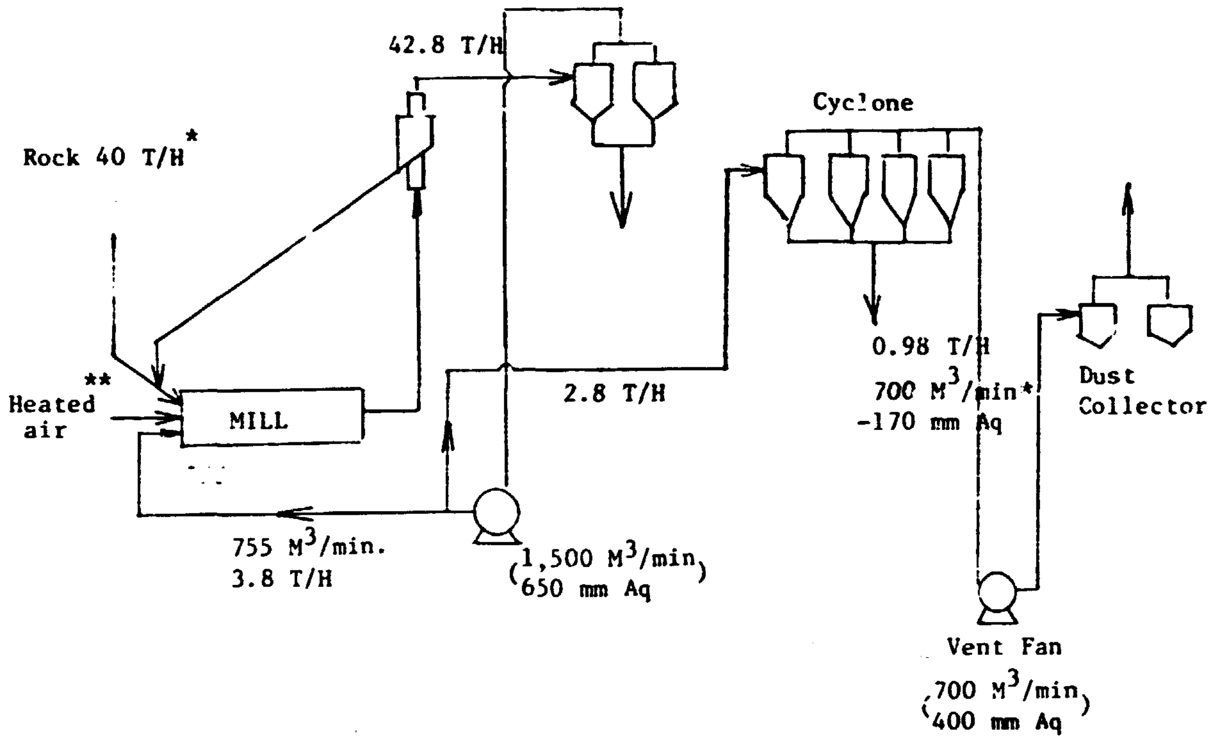
But actually, it has not been necessary to use the hot air generator.

The quantity of vent air can be decreased and result will be to load down of the dust collectors.

So the expert wants to try its test and confirm.

1. Flow

On design



Note :

Now * Rock : 30 T/H

** Heated air : don't use

*** Vent air : estimate approx. 400 M^3/min

2. Test

i) Procedure

- Check leakage of air system
- Adjust the quantity of vent fan 200 - 150 M^3/min with damper of vent fan
- Measure pressure inside mill
- Measure Δ p of cyclone (inlet, outlet)

3. Background

Some quantity of air is vented for preventing condensation of moisture in system.

Condition

Moisture in Rock

Unground rock : 1.5 %

Ground rock : 0.5 %

Volatiled moisture = (30,000)(0.01) = 300 Kg/H

Air in atmosphere

Temp. 30°C Humidity P/PS: 80 %

H = 0.0215 Kg H_2O/Kg dry air

If the quantity of vent air = 100 N^3/min.

Vent air 50°C

Humidity ?

Amount of air

(100)(60)(29/22.4) = 7,767 Kg/H

(Nearly equal dry air)

Humidity of Vent Air

[300 + (0.0215)(7.767)(1/7767)

= 0.060 Kg H_2O/Kg dry air

P/PS = 75 %

Air at 50°C

Saturated humidity 0.0862 Kg H_2O/Kg dry air

Therefore, the quantity of vent air can be reduced to 100 Nm^3/min (120 M^3/min at 50 °C)

APPENDIX V-21 (6) LONG-TERM COUNTERMEASURE FOR BAG FILTER

The expert recommends the installation of Bag Filter in order to collect the dust and recover it.

1. Operating condition

i) Material handled : Ground phosphate rock

Bulk density : 900 Kg/m^3

Temperature : *

Moisture : *

Particle size : *

ii) Treated air volume : 520 Nm^3/min

iii) Dust content at inlet : 1,000 Kg/h as dust
25 g/m^3 at 40°C

iv) Operating condition : 16 hrs/day

v) Location : Outdoor

vi) Power source : 400 V, 3 phase, 50 Hz

The values marked with should be confirmed by measuring the present dust content. The values marked with * should be decided by you, TSP's engineer, after measuring the actual running condition immediately.

2. Specification

i) Type : MS type bag filter (shaking system by reverse air and mechanical vibration)

ii) Filter area : 430 m^2 effective (This filter area will be decided by maker.)

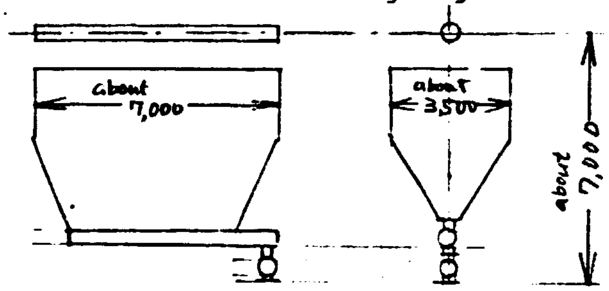
iii) Efficiency : Not less than 99 %

iv) Filter cloth : Nylon

v) Cleaning device : (1) Reverse air
(2) Motor for shaking

vi) Accessories : (1) Discharge screw conveyor
(2) Rotary valve

3. Approximative dimension for designing of installation

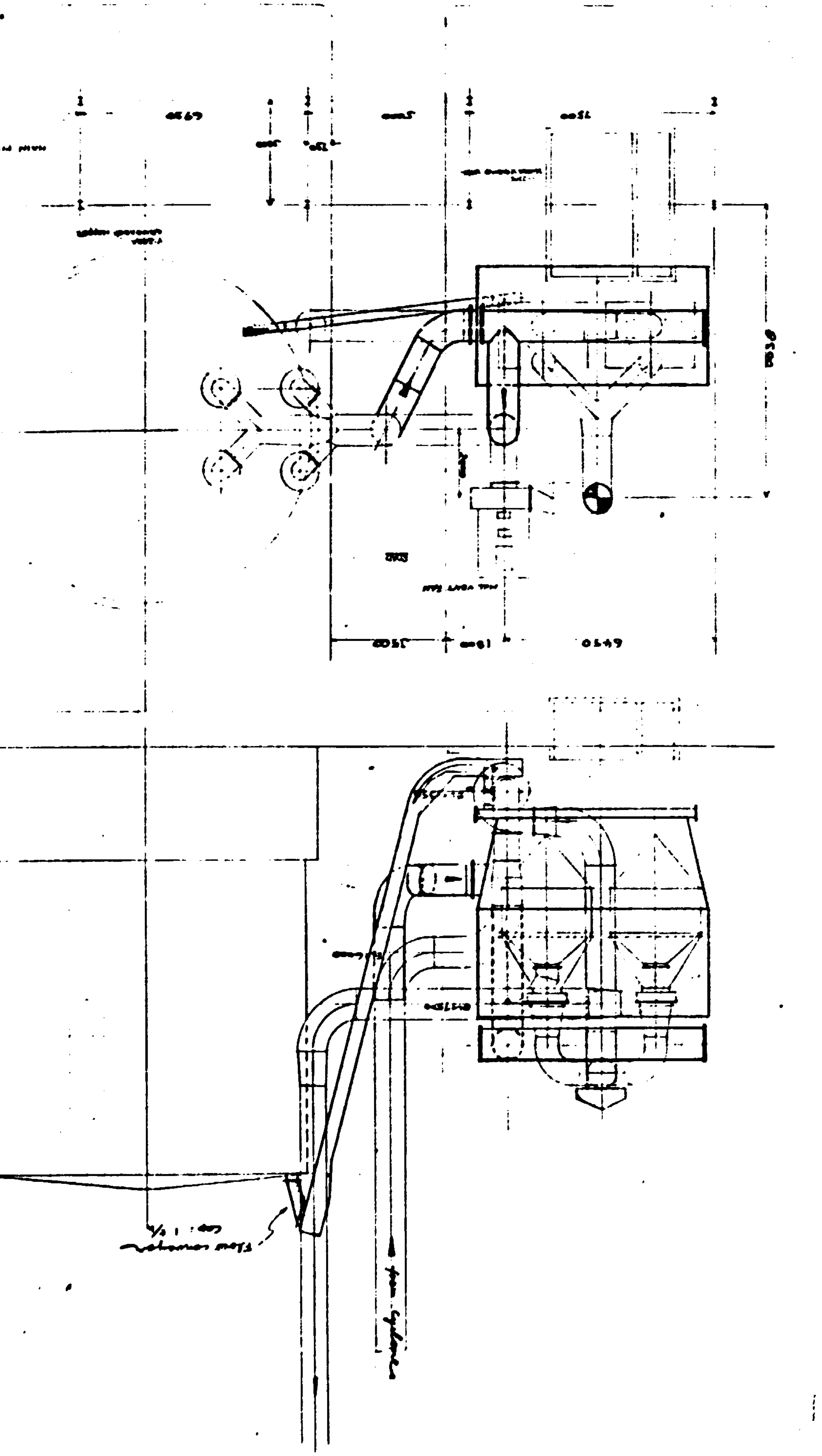


Of course, these dimensions are subject to maker.

The plan of bag filter installation is shown in next page.

Milling-2 The Plan of Bag Filter Installation

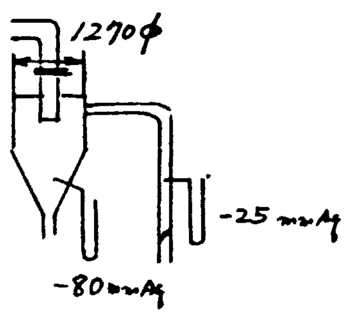
note. Exact dimensions for the installation of bag filter and conveyor should be decided after receiving the maker drawing.
In the plan, existing wet type dust collectors are removed.



APPENDIX V-21(7) SUGGESTION FOR DUST COLLECTOR IN TSP-I MILLING SECTION

1. Existing Cyclone

The exact exhaust volume cannot be measure, but the pressure distribution of this cyclone is measured.



ΔP inside the cyclone= 55 mm Aq [-80-(-25)]

$$\Delta P \propto u_1^2$$

$$\Delta P \propto \left(\frac{1}{D^2}\right)$$

u_1=Velocity of inlet gas

D=Dia of cyclone

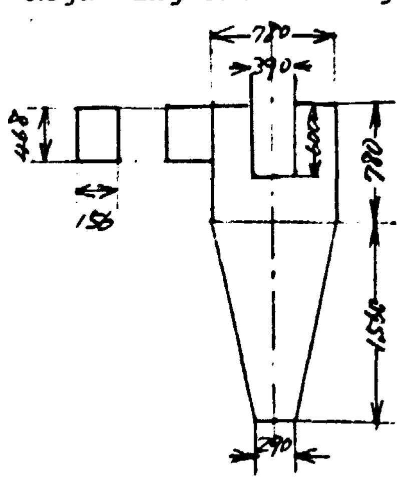
Δp of cyclone must be 120 - 170 mmAq, so if it is below these figures, cyclone cannot show its effect. Now Δp is only 55 mmAq. This cyclone should be changed.

2. Design of New cyclone

$$D = \sqrt{\frac{55}{150} \cdot (1.270)^2}$$

$$= 770\ \phi$$

Regarding extracted gas volume mentioned after, D = 780 ø



$$\Delta P = \frac{30.a\sqrt{D}}{d^2\sqrt{L+H}} \cdot \frac{\gamma a U_1^2}{2 \times 9.8}$$

$$= \frac{30 \times 0.0744\sqrt{0.78}}{(0.39)^2\sqrt{0.78+1.56}} \cdot \frac{1.29 \times (15)^2}{2 \times 9.8}$$

$$= 125.5 \text{ mmAq}$$

$$V = 15 \times (0.468 \times 0.156) \times 60$$

$$= 65.7\ m^3/\text{min.}$$

7. Minimum particle size catchable by cyclone

i) Resin's euation

$$D_p\min=3\sqrt{\frac{\mu}{\Pi\rho_p\ u}}\ \sqrt{T(1-\frac{T}{D_0})\frac{1}{V}}$$

ii) Linden's equation

$$D_p\min = 1.06\sqrt{\frac{\mu\, Dd^{1.5}}{\rho\ \ uD_0^{\ 0.5}}}$$

iii) Ikemori's euqation

$$D_p\min=\frac{18\ \mu}{\Pi(\rho_p-\ \rho_g)u}\cdot\left(\frac{1}{5.12}\ \frac{Dd}{b}\ \frac{Dd}{h}\right)^n\sqrt{\frac{bh}{H}}$$

u = inlet velocity

V = 3 - 5

ρ_p= density of particle (kg/m^3)

μ = viscosity of gas (kg/m sec)

T = $(D_0 - D_d)/2$ (m)

D_0= Dia of outer shell

D_d= Dia of gas outlet

bh = Width and height of inlet

H = from the end of outlet pipe to the end of conical shell

ρ_g=density of gas (kg/m sec.)

Results of calculation :

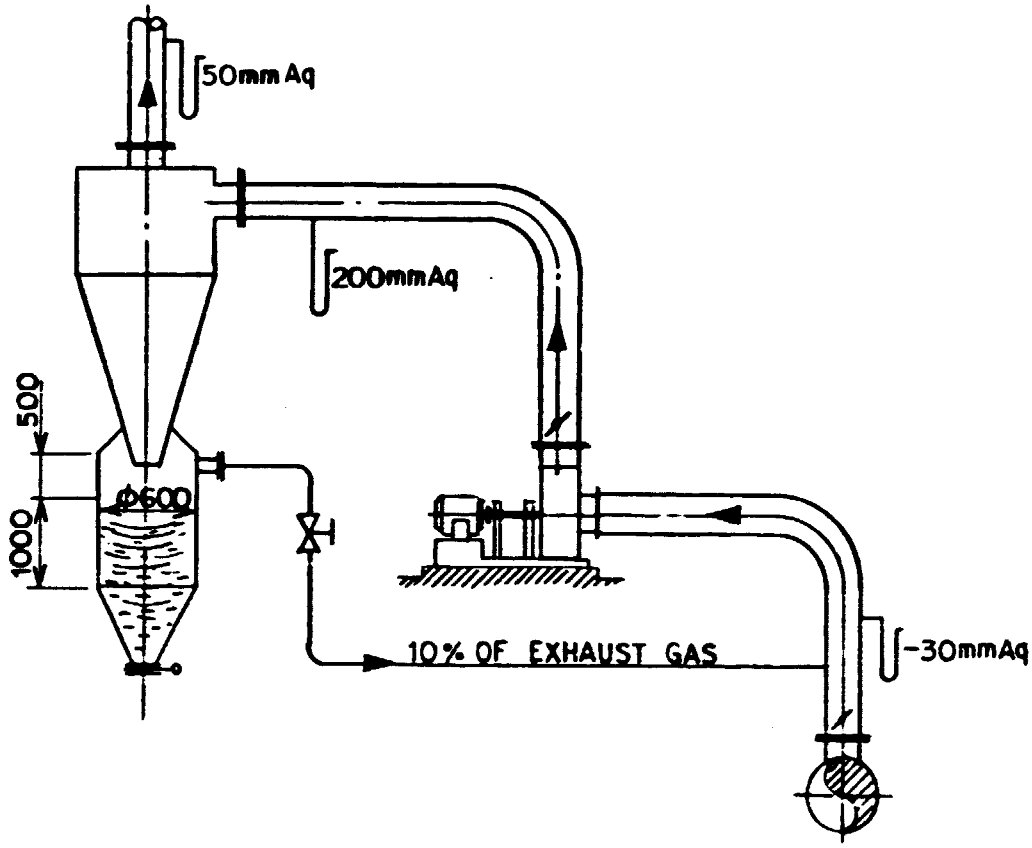
(a) $D_{pmin}= 6.5\mu$

(b) $D_{pmin}=11.2\mu$

(c) $D_{pmin}=4.9\ \mu$

Average $D_{pmin}=7.5$

3. Lay-out of New Cyclone



4. Receiver :

Assumed dust content = 10 gr/m^3

Total dust weight = 67 m^3/min x 10 g/m^3 x 60
= 40.2 kg/H
= 965 kg/D

s.g=1.29 V = 965/1.29 = 750 lit/D

Receiver capacity = 423 liter

5. Extraction of Gas

Some efficiency up will be expected by the extraction of below 10% gas volume

6. Efficiency of Cyclone

We canot get the particle size distribution.

For example

(1) Particle size distribution after dryer cyclone

Size	wt%	Size	wt%
<3μ	1.7	15μ	78.1
4μ	3.3	20	84.0
5	6.9	25	87.6
6	9.5	30	90.8
7	14.7		
8	24.6		
9	38.3		
10	52.3		

(2) Particle size distribution of ground rock

Size	wt%		Size	wt%	
>147	18.4		35	52.4	>2.4
> 74	39.4		30	54.8	>5.8
> 60			25	60.6	>14.2
> 50	46.7	>1.4	20	74.8	>19.4
> 45	48.1	>1.7	15	94.2	> 2.0
> 40	49.8	>2.6	10	96.2	> 3.0
			↓	(3.8)	

Estimated particle distribution

μ 50 - less than 10 μ

Size	wt%	Size	wt%
50-60	2.63	25-20	26.7
45-40	3.20	15-10	36.1
40-35	4.90	15-10	3.67
35-30	4.50	10	7.14
30-25	10.9		

from (1) $\Phi = 100 - 14.7 = 85.3\%$

from (2) $\Phi = 100 - 7.14 = 92\%$

We expect $\Phi e = 90\ \%$

8. Economics

Now, $\Phi = 40\%$

Loss weight = 965 kg/D x 0.6
= 965 kg/D x 200 (d) x 0.6
= 116 t/y (¥ 4,454,400.-)

@2,400 TK/t = ¥ 3,400 /t

New cyclone

$\Phi = 90\ \%$

Loss weight = 965 kg/D x 0.1
= 965 x 200 x 0.1
= 19.3 t/Y (¥ 741,120.-)

Merit = ¥ 3,713,280- (TK 232,000)

APPENDIX V-22(1) IMPROVEMENT OF O-3303

This elevator is investigated in detail on 16th July. Because this trouble of share pin break has been continued as follows:

Operation day	Frequency of break	Stop hrs.	Date
June 24 days	15	158	(2,3,4,5,6,7,8,9,11, 13,14,15,16,28,29)
July 10 days	5	51	(7,8,9,11,14)

The main cause was found out, we believe, the additional oiling will minimize problem.

Of course elevator bucket link has fatigue, so this must be replaced by new one as soon as spare is obtained.

o Proposal

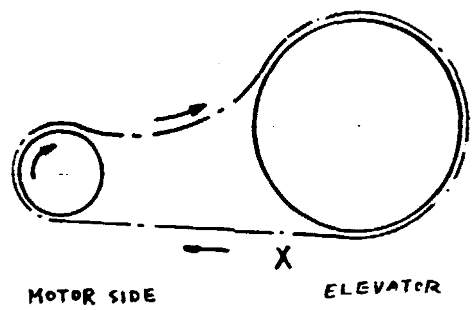
Lubricate oil should be charged 2 times per shift in order to release the chain from sprocket easily.

This share pin will be maintained two or three times more, so operator must maintain to charge oil.

Everything was checked to find out the causes.

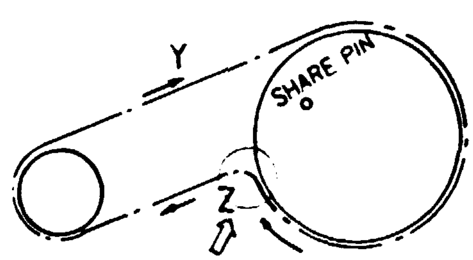
1. Chain running condition

A) Normal running



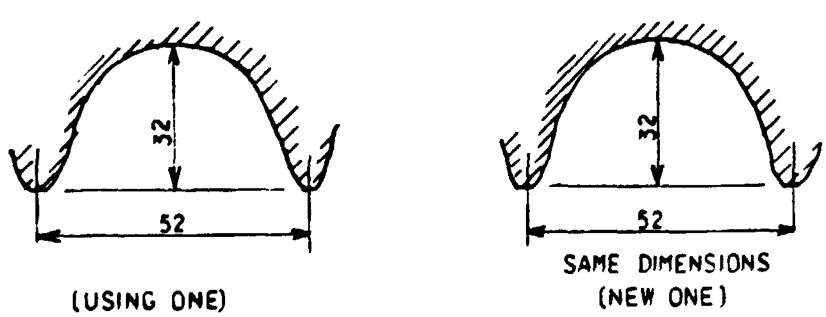
B) Abnormal running

Chain is hardly released from sprocket and the chain, that takes the shape like Z as shown below, should run like X as shown above. When this chain is released from Z, Amp. is fluctuated 12 - 24 A at this time.

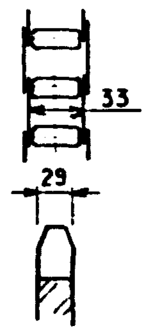


Everything was checked to find out the cause of problem.

2. Sprocket erosion no problem



3. Sprocket thickness



both side 2 mm gap
OK

4. Oiling

Condition is improved so much after attempt of additional oiling to the chain. So oil must be applied 2 times in a shift until link is renewed. Then this elevator will be running smoothly.

APPENDIX V-22(2) RECOMMENDATION TO PURCHASE "SHOCK RELAY"

1. This is regarding to the below mentioned equipments

(1)	O-3205 (7.5 kW) Bucket Elevator	Drying Section
(2)	O-3207 (5.5) Bucket Elevator	Drying Section
(3)	O-3303 (15) Bucket Elevator	Bagging Section
(4)	O-3108 (11) Pan Conveyor	Reaction Section
(5)	O-3109 (7.5) Pan Conveyor	Reaction Section
(6)	O-3107 (5.5) Continuous Den	Reaction Section
(7)	O-2202 (11) Flow Conveyor	PA-2 Section
(8)	O-2207 (11) Flow Conveyor	Reaction Section

2. On these equipments, some serious troubles occurred frequently. For example, on a bucket elevator, there are troubles, link chain broken, bucket broken, and rail broken. The expert had to spend much time to repair them, so these troubles should be prevented and to cure the origins before it could happen again.

   For this purpose, mechanical device, e.g., shear pin and friction coupling, has been used, but shear pin is not useful actually, and friction coupling is expensive.

   Conventional relay of motor trip is only a thermal relay, so it is not tripped with much excess ampere until such condition continues a few seconds. Therefore, the protection of chain and bucket is not possible.

   In this case, the shock relay is more recommendable.

   The expert has already recommended this for O-2202 and O-2207. But it is not implemented yet.

One must check this attached catalogue, purchase two shock relays at first step and try to use effectively for the above mentioned equioments.

3. Specification

TSB 152 - 100 AT - Plastic Receipt Box
TSB 152 - 120 AT - Plastic Receipt Box
Requested No. is 1 (one) each.

Maker: TSUBAKIMOTO CHAIN CO., LTD., JAPAN

APPENDIX V-23 SLIPRING REPLACEMENT OF 750KW BALL MILL MOTOR

HITACHI HITACHI WORKS	ENGINEERING SHEET	No.	MG 557
		SHEET	1 OF 2
CUSTOMER	TRIPLE SUPERPHOSPHATE FERTILIZER COMPLEX	DATE	MAY. 8, 1981
EQUIPMENT	750KW BALL MILL MOTOR		
SUBJECT	SLIPRING REPLACEMENT		

1. SPECIFICATION

750KW 3300V 152A 985 rpm 50 Hz

MFG. NO. 320574-1 , MFG. YEAR 1962

2. SLIPRING REPLACEMENT WAS CARRIED OUT AS FOLLOWS.

NO	ITEM	DETAIL OF WORK	REMARKS
1.	SLIPRING REPLACEMENT	1. REPLACEMENT OF NEW SLIPRING. 2. PERFORMED INSULATION FOR SLIPRING LEAD WIRES' CONNECTIONS. 3. MADE INSULATION TREATMENT ON LIFTING LODS TEMPORARILY. 4. MEGGARING CHECK.	(RESULT) GOOD
2.	AIR GAP ADJUSTMENT	1. ADJUSTMENT OF AIR GAP.	REQUIRED BY THE CUSTOMER
3.	BEARING CHECK	1. DISASSEMBLED BEARING PORTION AND CHECKED. (RESULT) 1.1. OBSERVED WEARING SLIGHTLY ON BEARING. 1.2. OBSERVED FRETTING CORROSION ON SURFACE OF BEARING SEAT.	
4	INSULATION RING CHECK (FOR BEARING)	1. OBSERVED THE DEFACEMENT ON BEARING INSULATION RING. 2. THE TEMPORARY COUNTERMEASURE (INSERT SHIMS) WAS DONE.	REPLACEMENT IS RECOMMENDED.
5.	ALIGNMENT	1. REALIGNMENT WAS DONE.	

REMARKS	DISTRIBUTION				
	HITACHI ZOSEN	6	PREPD.	HITACHI WORKS K. Emoto	DATE MAY. 8, 1981
			CHKD.	K. Emoto	"
			CHKD.		
			APPD.	[illegible signature]	"

ENGINEERING SHEET

ES NO.	MQ 557	SHEET	2/2

NO.	ITEM	DETAIL OF WORK	REMARKS
6.	BEARING LABYRINTH	1. OBSERVED THE DEFACEMENT ON BEARING LABYRINTHES. 2. NO COUNTERMEASURE WAS DONE.	REPLACEMENT IS RECOMENDED.
7.	AIR PIPES FOR BEARING LABYRINTH SEAL	1. REMOVED AIR PIPES, BECAUSE DUST IN THE AIR PATH ENTERED INTO BEARINGS THROUGH AIR PIPES.	
8	ROTOR CHECK	1. THE WEDGES (ABOUT 18 PORTIONS) MISSED.	IMMEDIATE OVERHAUL IS RECOMENDED.

3. RECOMMENDATION
   1. IMMEDIATE OVERHAUL.
   2. REPLACEMENT OF ALL LABYRINTHES, INSULATION RING AND INSULATION BOLTS FOR BEARING.
   3. AIR BLOWING BY OTHER METHODS (EXCEPT FOR AIR PIPES REMOVED) TO LABYRINTH IS NECESSARY.
   4. CHECK OIL LEVEL AND CHANGE OIL EVERY 6 MONTHS.

4. CONCLUSION

THE SLIPRING REPLACEMENT WAS CARRIED OUT SATISFACTORILY.
THANK YOU VERY MUCH FOR YOUR KIND COOPERATION.

HITACHI LTD. HITACHI WORKS
Tomio Yoneya.

MAY. 8, 1981.

APPENDIX V-24(1) IMPROVEMENT OF TROUBLE FREE OPERATION OF WEIGHING MACHINES AND INCORPORATION OF THE STAND-BY PACKER SCALE IN BAGGING PLANT

1. Regarding the stand-by packer scale, the expert has already submitted recommendation (Date July 3, 1980). The conclusion was as follows:

   Granulation Plant plan is now proceeding, so this recommendation should be reconsidered at the implementation time of the granulation plan.

   But with increasing production, it is getting more important to utilize stand-by machine usefully.

2. Regarding Trouble Free Operation of Weighing Machine

   i) Existing Instruction Manual of Merrick Scale is not clear and difficult to understand. The expert requested for new manual to the maker "KUBOTA" during his last leave.

   But at present, this type of scale is not fabricated. The new type scale is "Load Cell Type" (This document was submitted to T.S.P.)

   So the expert could not get clear Manual in English, but only Japanese. If necessary, he will advise TSP's maintenance section according to these manuals.

   ii) One must carry out to check and adjust the accuracy with test chain 4 times/year, and record it strictly.

   iii) Inspect and clean these scales periodically (e.g., once a week) and record it.

3. Improvement of feeding condition. This is now progressing. Phosphate rock is unloaded from four (4) points, and one must try to convey uniformly from 4 points, otherwise conveyed quantity is sometimes over 100% and sometimes becomes 0%.

   It is hoped that the result of this modification will be successful.

4. New Type of Scale

   Load-cell type scale is superior to Merrick scale in the points of accuracy, reliability and adjustment, so it is reasonable that Merrick scale will be replaced by new type.

   So it is a good idea to buy the new jetty unloading scale and divert the old one to other place effectively.

APPENDIX V-24(2) TROUBLE FREE OPERATION OF WEIGHING MACHINES

1. Specification of Bagging Machine

i) TSP-II

Maker	:	"KUBOTA"	
Capacity	:	360 Bags/H (50kg/Bag)	
		600 Bags/H (25kg/Bag)	
Accuracy	:	± 1/500	
Mechanism	:	Lever System, 2 step control	
		About 90 %	Micro switch
		Capacity 100%	Micro switch
		Weighing range	25 - 50 kg
		Weighing tank	Real 67 liter
		Weighing gate	Flapper Type gate
		Feeding equipment	Natural fall system Double cut-off gates
		Air supply	6 kg/cm^2 G.P.
		Air consumption	40 liter/min + 200 liter/min
Material	:	Density	0.75
		Temperature	30°C
		Grain	< 2 mm
		Moisture	2 - 4%

ii) TSP-I

"Richardson" scale comapny "E-50"

Capacity : 12 bags/min
Other details :non

2. Nature of troubles (from MR DEB's data)

Troubles happen especially in the limit switches and in the starting cam boxes.

- 4 - 5 times/week with the above points
- 10 - 15 minutes/one trouble
- The largest trouble : Cams and rollers (because of friction)
  6 - 7 hours
  We usually do this type of job when the machine stay idle.

Spare parts which we must prepare about these troubles.

		Drawing No.
i)	Starting cam	(M-3301-3b (6))
ii)	Inner geared lever	(" (7))
iii)	Cut-off gate opening roller arm & shaft	(" (13))
iv)	Roller arm & shaft closing hopper	(" (14))
v)	Roller arm and shaft for stabilizing scale lever	(" (17))
vi)	Cam roller	(" (18))
vii)	Scale lever stopper spring	(M-3301-4a(20))
viii)	Spring for large gate	(M-3301-5b(22))
ix)	Spring for small gate	(" (23))
x)	Hooks for large & samll gate	(" (5))
xi)	Spring of scale hopper gate	(M-3301-6c(12))
xii)	Hook of gate	(" (81))

These spare parts are not available in the stores. The expert team is trying to get these manufactured in BITAC.

Anyway running capacity is now satisfactory in spite of these troubles. Maintenance is done with B.M., and in idle time with P.M.

3. Capacity

TSP-II

Rated capacity	:	360 bags/h
Actual achievement	:	2.2 bags/min/on set

TSP-I

Actual achievement	:	12 bag/min

	Specification	Actual
TPS-I :	1000 Bags/8 hrs	3,000 bags/day
TSP-II:	2.2 bags x 2 set x 60 min x 20 hrs = 5,280 bags/day	9,000 bags/day

Target capacity : TSP-I = 32,000 t/y = 106.6t/d = 2,132 bags/day

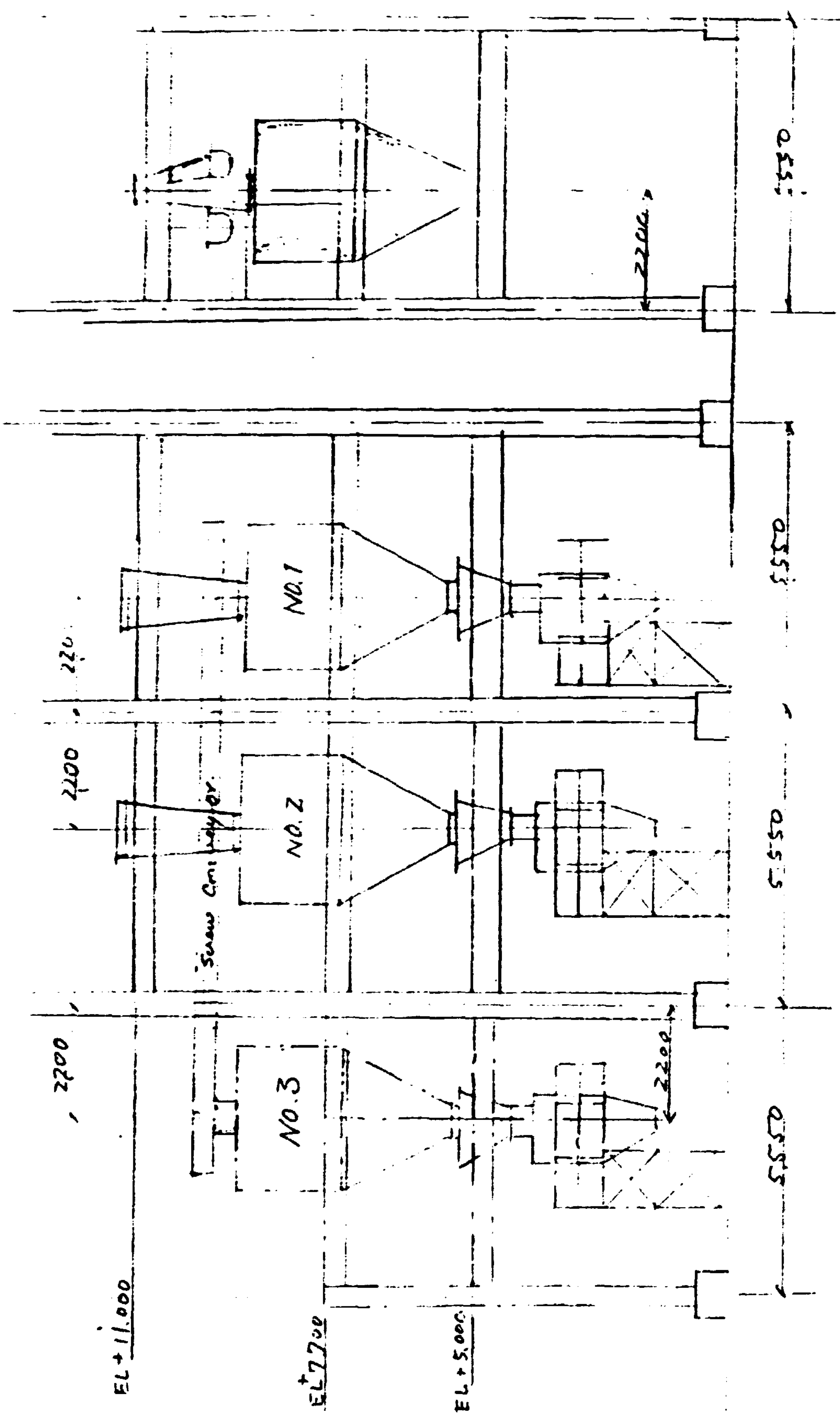
TSP-II=1,200,000t/y = 400t/d= 8,000 bags/day

4. Recommendation

One must try to use the spare machine effectively. Even now it is more useful to install this spare machine for getting time necessary for good maintenance work. Then only, one can get chance for any preventive or planned maintenance, and to prepare for the increase of production, too.

5. Investment cost

Foreign currency	:	¥ 6,000,000.-
Local currency	:	TK 15,000.-
Steel structure	:	1 set
Banker	:	1 set
Screw conveyor	:	1 set


NO.1
NO.2
NO.3
Screw Conveyor
2200
5550
EL+11,000
EL+7,700
EL+5,000

APPENDIX V-24(3) SPECIFICATION FOR BELT SCALE

Specification (Draft)

1. Name of Equipment : Belt Scale (lead-cell Type)

2. No. of Purchase : One set (1)

3. Weighing capacity : Max. 300 T/H
   Nor. 250 T/H
   Min. 60 T/H

4. Materials to be wieghed

		Rock Phosphate	Solid Sulfur
Bulk Density	:	1,480-1,650 kg/m^3	1,450 Kg/m^3
Grain Size	:	85% 16 mesh pass.	75% 9 mesh pass
		51% 60 mesh pass.	18% 48 mesh pass
		47% 100 mesh pass	11% 100 mesh pass
Max. lump size	:	12 mm	50 mm
Water content	:	1.68 %	0.38 %
Temperature	:	Ambient	Ambient

5. Setting Conditions

(1) Setting place : Indoor
(2) Max. room temp : 40°C
(3) Min. room temp : 7°C
(4) Condition : Very dusty

6. Belt conveyor specification tobe installed on

Belt width	:	750 mm
Belt trough	:	30°
Blet speed	:	85 M/Min.
Inclination of conveyor	:	8°54'

7. Specification

i) General

This belt scale shall be settled on the existing belt conveyor in item (6) and used to weigh the raw materials unloaded from the carge (DW 10,000 M.T. - 20,000 M.T.)

So this belt scale must have high precision, reliability and stability. This shall have one local indicator and one remote indicator and totalizer.
(Distance from control room is about 200 M)

ii) Specification

<u>Load-cell type belt scale</u>

Type	"KUBOTA KDB-75 (Indoor) (or Equivalent)
Unit weighing capacity	141.2 kg
Weighing length	2,400 mm
Reading totalizer	10 kg
Max. totalizer weight	99,999.99t
Operation accuracy	$\pm$ 1/100
Automatic Zero adjuster	
Electricity supply	AC 100 V 50 Hz

8. Supply

i) One complete set of load detector
ii) One local indicator
iii) One remote indicator and totalizer
iv) Automatic zero adjuster
v) Accessories

Test chain	40 kg/m x 6 m
	15 kg/m x 6 m
	8 kg/m x 6 m

vi) Spare parts

Sufficient number of spare parts necessary for 2 years operation.

vii) Documents

Maintenance Manual, Operation Manual and Drawings necessary for maintenance.

viii) Superviser

One expert shall be sent for installation, adjustment and commission.

9. Guarantee and Warranty

A guarantee test shall be carried out for the purpose of evaluation of the scale, and Manufacturer/Supplier must take full responsibility for any defects, which might arise from poor design workmanship and supplies for a period of at least 12 (twelve) months after the guarantee test run.

APPENDIX V-24(4) IMPROVEMENT OF CONVEYING SYSTEM AT JETTY

The expert recommends to keep uniform conveyance of unload phosphate rock and sulfur from the Jetty section.

For this purpose, 4 bunckers at Jetty Section should be set and to adjust these dampers by operators for uniform conveyance.

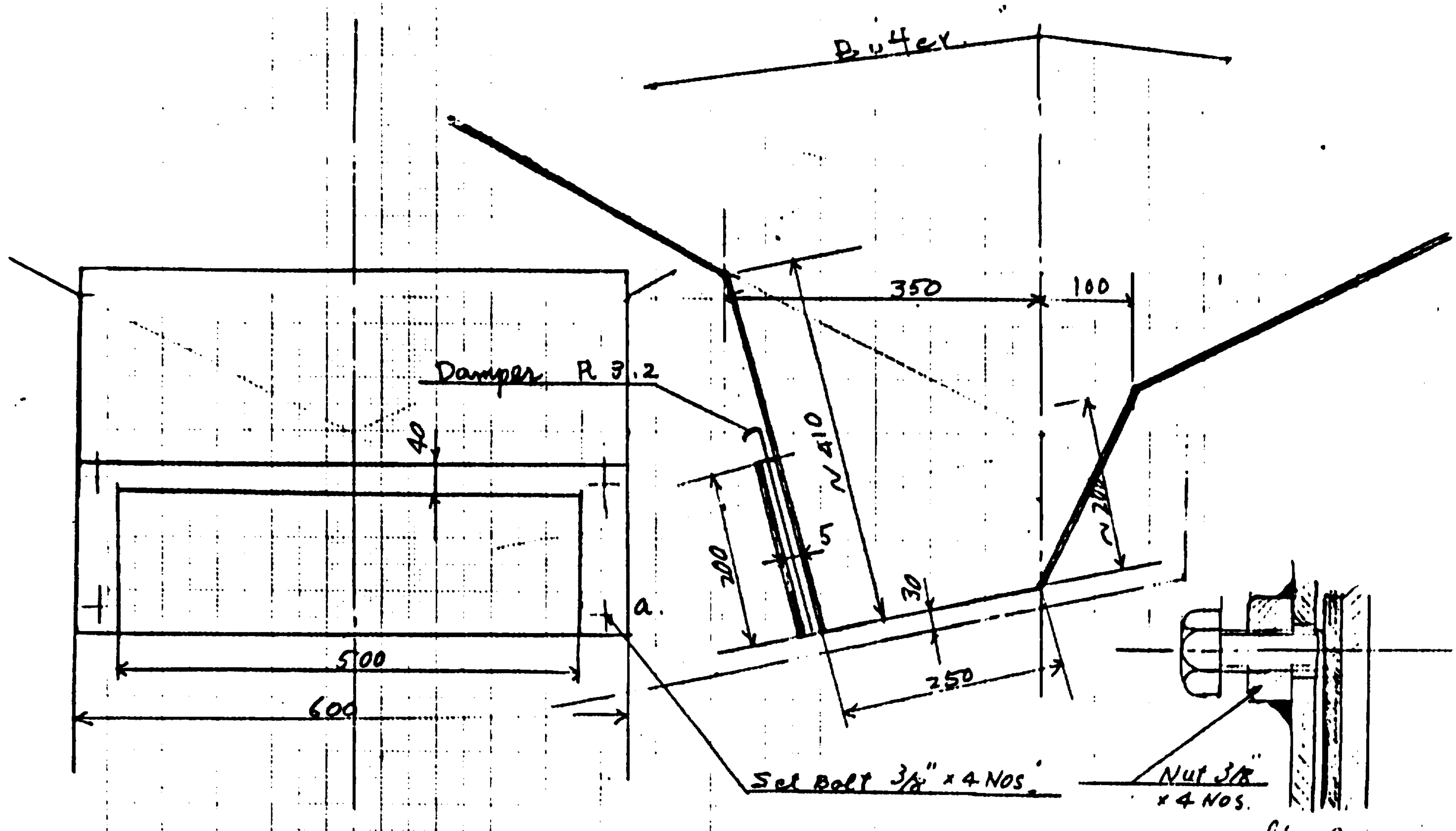
It is observed now that the reading figures of merrick scale is changing frequently from 0% to over 100% and the conveyor (O-1102A) floats up sometimes.

By this improvement, we expect the merit as follows:

1. The error of Merrick scale will decrease.

2. The life of conveyor belts, chains and rollers will extend.

3. Leakage of materials will decrease
   (See attached drawing.)



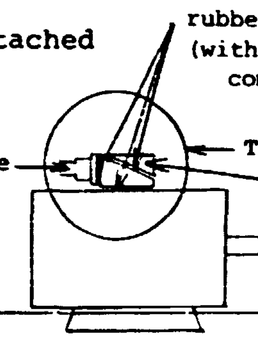
Damper of Jetty. (1/6)

Material : SS   R 4.5 t ~ 6 t

APPENDIX V-25 POINTING OUT OF ELECTRIC INADEQUATE SYSTEM

Plant	Problem	Coun
General	1. Many motors have not terminal box and fan cover	° Regular terminal box i to motor ° In view of safety and effect of cooling, fan cover is also to be attached.
	2. Flexible pipe for motor is corroded and broken	° Corroded and broken fle Therefore such pipes ar of conduit tube is to b
	3. Ground wire is not connected to motor case and push button box.	° In order to protect ele be connected to motor c
	4. Joint of cable is only covered with vinyl tape.	° Joint of cable is to b to protect it from rai
	5. Fire alarm station is almost corroded	° New station is to be co
	6. Electric welder ° No cover for distributor panel of electric welder ° Supply cable for electric welder crosses the road ° Regular cable, connector and earth clip are not used for electric welder	° Distributor panel of e with new one, and thin section of each plant. to attach earth leakag these panel. ° More flexible tube and is to be used.
	7. Most of local panels and electric control panels are very dirty.	° Especially, inside of cleaned once a year in Checking of bolt and n characteristic, cable equired at that time.

SECTION 1

	Countermeasures
›t terminal box	° Regular terminal box is to be attached to motor ° In view of safety and effect of cooling, fan cover is also to be attached. 
:›tor is corroded	° Corroded and broken flexible mines damage the cable. Therefore such pipes are to be taken off and bushing of conduit tube is to be attached.
connected to motor :n box.	° In order to protect electric shock, ground cuire is to be connected to motor case and electric equipments.
:ly covered with	° Joint of cable is to be conducted in joint box in order to protect it from rain, sunlight and mechanical stress.
is almost corroded	° New station is to be constructed if necessary.
›utor panel of ectric welder :ector and earth ›r electric welder	° Distributor panel of electric welder is to be replaced with new one, and thin panel is to be installed at each section of each plant. In veiw of safety, it is better to attach earth leakage tripping type as switch of these panel. ° More flexible tube and regular connector and earth clip is to be used.
; and electric ›ery dirty.	° Especially, inside of high voltage panel is to be cleaned once a year in scheduled shut down time. Checking of bolt and nut of connecting point, relay characteristic, cable characteristic, etc. is also equired at that time.

Plant	Problem	
General	8. Incomplete lighting and receptacle line	° Broken lighting and rec with new one. ° In mercury lighting pol completely sealed with ° Outdoor receptacle is t distribution is to be r
TSP-I	° Specification of motor is not clear, because a lot of tag number pl is missing. ° MCB panel and magnetic switch box is to be rearranged according to ° 3 lines of wires connect control room and motor, so that it is to	
SA-1	1 General ° New electric panle will be installed at early time. Cable, motor, also to be checked in order to obtain imporvement as loop. ° Protection of cable against hot air and steam is also to be requir	
	2. Pump room ° Roof of pump room is broken. ° Cable is jointed on road without joint box. ° Control box is not sealed ° No sealing in cable entrance ° The cable of 22 mm^2 is used between pump room and distributor panel without cover.	° Repairing is required. ° Cable is to be jointed ° Couplete seal is neces ° " ° Conduit tube is to be
	3. Motors of sulfur metling pit pump ° One motor has not cover of terminal box and the other is not sealed in cable entrance.	° Regular cover and seal motor.

SECTION 1

	Countermeasures
ng and receptacle	° Broken lighting and receptable line is to be replaced with new one. ° In mercury lighting pole, the hole for stabilizer is completely sealed with cover. ° Outdoor receptacle is to be water proof and it's distribution is to be reconsidered.
motor is not clear, because a lot of tag number plates and specification plates netic switch box is to be rearranged according to the tag number. connect control room and motor, so that it is to be exchanged regular cable.	
e will be installed at early time. Cable, motor, cable duct and conduit tube are d in order to obtain imporvement as loop. le against hot air and steam is also to be required.	
is broken. on road without joint t sealed le entrance m^2 is used between tributor panel	° Repairing is required. ° Cable is to be jointed with joint box. ° Couplete seal is necessary. ° " ° Conduit tube is to be supplied.
metling pit pump cover of terminal s not sealed in	° Regular cover and sealing is to be attached to each motor.

SECTION 2

Plant	Problem	Counterme
PA-1	1. General ° Terminal box of most motors is not completely sealed. ° Most of cable installed recently is not covered with conduct tube. ° Regular cable is to be used instead of 3 wires. ° Cable rack or cable duct is to be installed.	
	2. Cable for lighting is not covered with conduit pipe, and front door of lighting distributor panel is broken.	° Cable is to be jointed i conduit tube. ° Front door of panel is t
	3. Pump control room ° MCB and magnetic switch box is not completely sealed. ° Magnetic switch of running motor is vibrating. ° All cable is not covered ° Three motors are not sealed in cable entrance	° Complete sealing is requ ° Core contact is to be c ° It is to be covered wit is to be conducted.
	4. Distance of cable for agitators' motor is too long.	° It is better to shorten work.
	5. Dust is accumulated in MCB panel in control room.	° Frong door for MCB pane
TSP-1	1. MCB panel and magnetic switch box are not completely sealed.	° MCB panel and magnetic providing room in order
	2. Motor of blower (95 kw) cable entrance is not attached.	° Cable entrance is to b

SECTION 1

em	Countermeasures
nost motors is not completely sealed. stalled recently is not covered with conduct tube. to be used instead of 3 wires. ole duct is to be installed.	
ng is not covered e, and front door ributor panel is	° Cable is to be jointed in joint box and covered with conduit tube. ° Front door of panel is to be fixed.
om switch box is not d. of running motor is covered not sealed in	° Complete sealing is required. ° Core contact is to be cleaned. ° It is to be covered with conduit tube complete seal is to be conducted.
le for agitators' motor	° It is better to shorten the calbe in view of maintenance work.
ted in MCB panel in	° Frong door for MCB panel is to be installed.
gnetic switch box are aled.	° MCB panel and magnetic switch box is to be sealed by providing room in order to protect against dust.
(95 kw) cable entrance	° Cable entrance is to be attached.

SECTION 2

Plant	Problem	Countermeasu
TSP-1	3. Motor of mill ° Non sealing ° The cable is touched to the edge of terminal box	° Cable entrance is to be a
No.1 Substation	1. Cable is wired on the ground without cover	Conduit tube is to be attach
	2. Cable to PA-1 and SA-1 is wired without cable rack.	Wiring is to be rearranged b
	3. Cable between trans. house and drying tower (F 1402) is wired without support.	Cable is to be wired by cabl
	4. Bushing of 11 kv transformer is much dusty.	Bushing is to be covered by
	5. Emergency generator room Both front door and rear door for distributor panel is not completely attached.	After cleaning of inside pan attached.
SA-2	1. J 1404 (waste acid pump) ° Front cover of push button box is not completely sealed. ° Bottom of motor terminal box is open.	Especially this motor is ne cover and bottom are to be s
	2. J 1405 (waste acid pump) ° There is no cap for push button. ° Cable between rack and push button box is wired without cover. ° There is no fan cover for motor. ° There is no cable entrance seal for terminal box of motor.	Each item is to berepaired a method.

SECTION 1

	Countermeasures
ed to the edge of	• Cable entrance is to be attached.
the ground without	Conduit tube is to be attached.
SA-1 is wired .	Wiring is to be rearranged by cable rack.
s. house and J2) is wired	Cable is to be wired by cable rack.
ansformer is	Bushing is to be covered by PVC box.
r room d rear door for s not completely	After cleaning of inside panel, both doors are to be attached.
pump) n button box is not rminal box is open.	Especially this motor is near to acid cooler. Both front cover and bottom are to be sealed.
pump) push button. and push button box ver. ver for motor. ntrance seal for tor.	Each item is to berepaired according to the above mentioned method.

Plant	Problem	Count
SA-2	3. M 1204 (turbine for air blower) • The door of Blower Turbine Panel is broken. • No cover between midway terminal box of control circuit and turbine.	° Repair of door is r ° Conduit pipe is to
	4. The cable across the road in front of control room is jointed without cover.	° Cover with pit and
	5. The cable is wired along the velt conveyer without binding above sulfur storage open yard.	° The cable is to be
	6. Transformer	° It is to be painte ° Stainless bolt is ° Silicagel should b
	7. Sulfur vibrating feeder ° Joint of cable is not covered. ° Cable is too long.	° Joint box is to be ° Cutting to proper required.
	8. M 1202A (agitator) Agitator swings due to looseness of 4 sets bolts to the chnnel base.	Tighten bolts and nut
	9. M 1202B (agitator) Terminal box of motor is not sealed.	Terminal box is to be
	10. J 1201A, B (sulfur pump) ° Terminal box of motor is not covered. ° Cable touchs to the steam pipe.	° Terminal box is to ° Separate the cable conduit tube.

SECTION 1

n	Countermeasures
for air blower) wer Turbine Panel is broken. n midway terminal box of and turbine.	° Repair of door is necessary. ° Conduit pipe is to be attached.
s the road in front of control without cover.	° Cover with pit and rack is to be installed.
red along the velt conveyer above sulfur storage open	° The cable is to be bounded.
	° It is to be painted. ° Stainless bolt is to be used to seal the cover. ° Silicagel should be renewed.
feeder is not covered. ng.	° Joint box is to be attached. ° Cutting to proper length and connection are required.
or) due to looseness of 4 sets nnel base.	Tighten bolts and nuts.
or) motor is not sea_ed.	Terminal box is to be sealed.
ur pump) motor is not covered. the steam pipe.	° Terminal box is to be sealed. ° Separate the cable from steam pipe and cover with conduit tube.

SECTION 2

Plant	Problem	Counter[illegible]
SA-2	11. D 1204 (oil burning unit) ° Cable entrance of push button and heater is not sealed. ° Cable is too long.	° It is to be sealed. ° Cutting to proper le[illegible] required.
	12. M 1203 (boiler chemical feed) Nut for the lamp of push button box is not attached.	Attach the nut.
	13. J 1202B (boiler feed water pump) ° Cable is wired on the ground. ° Joint of cable is not covered. ° Grounded wire is not connect to motor case.	Each item is to be repa[illegible] mentioned method.
	14. J 1401A, B, J 1402 A, B(AT, DT pump tank) ° Flexible tube to motor and push button cable are broken and corroded. ° Terminal box of motor is not completely sealed.	° Flexible tube is to [illegible] ° Terminal box is to [illegible]
	15. Electric panel	° Oil is occasionally [illegible] door. ° Terminal box is cov[illegible] ° Cable on the pit co[illegible] properly.

SECTION 1

·em	Countermeasures
· unit) ·ush button and heater	° It is to be sealed. ° Cutting to proper length and connection are required.
·nical feed) · push button box is not	Attach the nut.
·d water pump) ·he ground. ·ot covered. ·ot connect to motor case.	Each item is to be repaired accrding to above mentioned method.
· A, B(AT, DT pump tank) ·otor and push button cable ·roded. ·tor is not completely	° Flexible tube is to be taken off. ° Terminal box is to be sealed completely.
	° Oil is occasionally charged to the screw of unit door. ° Terminal box is covered with screw. ° Cable on the pit cover and floor is to be wired properly.

SECTION 2

Plant	Existing problem	Countermeasu
PA-2	Conduit tube and motor are easily corroded by acid and so they should be painted as soon as possible.	
	1. J-2503 AB (liquor transfer pump) ° Cable is wired on the floor. ° Cable is jointed without cover. ° Grounded wire is not connected to motor case.	Each item is repair method.
	2. J-2501 B (concentrator circulation pump) ° Front cover of push button is cracked. ° Cable entrance for terminal box of motor is fallen.	Front cover is to b
	3. J-2301 B (slurry pump) ° Joint of cable is not covered. ° Grounded wire is not connected to motor case. ° Fan cover is not attached to motor.	Each item is to be mentioned method.
	4. J-2406 B (concentration feed pump) Roof of push botton box is damaged, so front cover is not open.	
	5. J-2406 A (concentrator feed pump) Terminal box ox motor is hung by motor wire.	Install properly a
	6. J-4124 (R.W. booster pump) Nut for the lamp of push botton box is not attached.	Attach the nut.

SECTION 1

	Countermeasures
r are easily corroded by d be painted as soon as	
ransfer pump) he floor. thout cover. ot connected to motor case.	Each item is repaired according to above mentioned method.
ator circulation pump) n button is cracked. terminal box of motor	Front cover is to be replaced.
ump) not covered. ot connected to motor case. ttached to motor.	Each item is to be repaired according to above mentioned method.
ation feed pump) n box is damaged, so front	
ator feed pump) tor is hung by motor wire.	Install properly at once.
er pump) f push botton box is not	Attach the nut.

SECTION 2

Plant	Existing problem	Counter
PA-2	7. J-2402 (1st filtrate pump) ° Grounded wire is not connected to motor case. ° Conduit tube of motor cable is corroded. ° Joint of cable is not covered.	 ° Connection is ° New conduit t ° Joint box is
	8. K-2301 (exhaust fan) ° Terminal box of motor is not attached	 Terminal box is
	9. M-2303 A (crystallizer agitator) ° Flexible tube is broken	 Flexible tube i
	10. M-2303 B (crystallizer agitator) ° Flexible tube is broken ° Motor is too noisy.	 ° Flexible tub ° Check and re
	11. M-2405 AB (filtrate holding tank agitato:) ° Motor is too noisy	 ° Check and re
	12. M-2301 ° Cover of terminal box is not completely closed.	 ° Close comple
	13. M-2302 A-1 ° Cable entrance for terminal box of motor is opened.	 ° Cable entran
	14. O-2301 (feed screw conveyor) ° Cable is jointed without cover. ° Cable is too long. ° Magnet coupling of VS motor is not sealed.	 ° Joint box is ° Cut to prop ° It should be purge.

SECTION 1

m	Countermeasures
te pump) ct connected to motor case. tor cable is corroded. ot covered.	° Connection is required. ° New conduit tube is to be installed. ° Joint box is to be attached.
n) tor is not attached	Terminal box is to be attached.
izer agitator) roken	Flexible tube is to be taken off.
izer agitator) roken .	° Flexible tube is to be taken off. ° Check and repair.
e holding tank agitator)	° Check and repair
box is not completely closed.	° Close completely.
terminal box of motor is opened.	° Cable entrance is to be sealed.
conveyor) ithout cover. VS motor is not sealed.	° Joint box is to be attached. ° Cut to proper length. ° It should be covered with thin plate and air purge.

SECTION 2

Plant	Existing problem	
PA-2	15. J-2201 A ° Cable entrance for terminal box of motor is not attached.	° Cable en
	16. Electric panel	° The ceil be repai ° All unit
TSP-2	General ° In this plant, most of motors have a reducer. Therefore, those mot necessary to maintain original efficiency regarding cooling fan of be cleaned and shelter is to be attached. ° Complete seal type of panel structure should be ordered, and the dc	
	1. O-3107-3 ° Terminal box of motor is not attached.	° Termina
	2. O-3015 (rock weigher) ° Magnet coupling of VS motor is not sealed.	° It is t purge.
	3. V-3014 (P.A. acid feed weigher) ° Cover of terminal box of motor is not closed completely.	° Cover i
	4. Furnace panel for ground rock mill. ° The hole for push botton is not sealed after taking it off.	° Seal th
	5. Furnace panel for druer and TSP (L-3) lighting panel board ° The door is not closed, because cable is wired between panel and front door.	° Cable r panel.

SECTION 1

oblem	Countermeasures
terminal box of motor is not	° Cable entrance is to be sealed.
	° The ceiling of room for electrical panel is to be repaired to protect against rain. ° All units door should be closed.

t of motors have a reducer. Therefore, those motors are easy to have heat, so it is ain original efficiency regarding cooling fan of motor. Dust on the motor should lter is to be attached.

of panel structure should be ordered, and the door should be always completely closed.

tor is not attached.	° Terminal box is to be attached.
er) VS motor is not sealed.	° It is to be covered with thin plate and air purge.
feed weigher) box of motor is not closed	° Cover is to be closed completely.
ground rock mill. botton is not sealed after taking	° Seal the hole and clean inside of panel.
druer and TSP (L-3) lighting panel osed, because cable is wired front door.	° Cable route is to be changed and then inside of panel.

SECTION 2

Plant	Existing problem	C
TSP-2	6. P-3302-3 ° Fan cover of motor is not attached. ° Nut for the stop botton of push bottom box is nothing.	° Attach t
No.2 Sub station	1. The bottom of panels may be dipped into water in case of heavy rai all panels when all plants are shut down. 2. Electric equipments are high quality and so maintenance of them mu ability. When plant is shut down, insulate oil, high voltage cabl and nut, interlock circuit are to be checked and panel, busduct, b to be cleaned.	
Water treat-treatment plant	Electric equipments are not so corroded that conditions of this secti The other section's electric equipments are to be maintained at the s	
	1. Cable between SA-2 and W.T.P. hangs from rack.	Cable is t
	2. Most of flexible tubes are broken and corroded.	Flexible t
	3. J-4202 ° Joint cable is not covered.	Joint box
	4. J-4015 ° Cable entrance bushing of terminal box of motor is not attached.	Bushing is
	5. J-4109 A ° Joint of cable is not covered. ° Cable entrance bushing of terminal box of motor is not attached.	° Joint b ° Bushing

SECTION 1

	Countermeasures
attached. f push bottom box is	° Attach the fan cover and the nut.
be dipped into water in case of heavy rain. So it is better to attach feet to s are shut down. igh quality and so maintenance of them must be premediated to keep their hut down, insulate oil, high voltage cable, relay character, tightness of bolt t are to be checked and panel, busduct, bushing of trsnfrormer, etc. are also	
so corroded that conditions of this section's equipments is best in TSP complex. equipments are to be maintained at the same level of this section.	
.T.P. hangs from rack.	Cable is to be bound to rack.
re broken and corroded.	Flexible tube is to be taken off.
ed.	Joint box is to be attached.
terminal box of motor is	Bushing is to be attached.
ered. terminal box of motor is	° Joint box is to be attached. ° Bushing is to be attached.

SECTION 2

Plant	Existing Problem	Cou
Water treatment plant	6. Lighting panel board in electric panel room is dirty.	When plant is s
	7. Transformer ° Bolt of bushing cover and busduct cover are very rusty. ° Color of silicagel was changed.	° Exchange to ° Exchange to

SECTION 1

...em	Countermeasures
...rd in electric panel room is dirty.	When plant is shut down, open and clean.
...ver and busduct cover are very ... was changed.	° Exchange to stainless bolt. ° Exchange to new one.

SECTION 2

APPENDIX V-26(1) IMPROVEMENT OF THE CONVEYING SYSTEM

Recommendation to use new type conveyor rollers

Two kinds of new type conveyor rollers are recommended.

- o "Mitsui-Joy Limberroller
  Maker: Mitsui Miike Manufacturing Co., Ltd., Japan
- o Plaloy Roller
  Maker: Nissan Jushi CO., Ltd., Japan
  (Subsidiary company of Nissan Chemical Ind., Ltd.)

Both conveyor rollers are now used in Japan very successfully, and sometimes used in combination with these two types.

1. Characteristic:

i) "Mitsui-Joy"

- o There are only two sealed bearings on the both outsides of belt.
- o Roller is supported by string covered with rubber.

ii) Plaloy Roller

- o There are no bearings and it belongs to plastic rollers which are strong self-lubricate material.
- o Roller is supported by some plastic rollers connected with stainless strings.

2. Experience

i) Plaloy Roller

Plaloy roller has been used in many kinds of plants of Nissan Toyama Factory.

Name of Site	Name of Machine	Description
Slurry Compound Fertilizer Plant	Conveyor to Silo 450 W x 7,000 L Handled Material Compound Fertilizer V = 50 m/min. Cap. = 20 T/H	50 ϕ x 12 Nos. x 8 sets Oct. 1972 Mar. 1975 Life. 2.5 years After replacement to 90 ϕ no trouble now.
Slurry Compound Fertilizer Plant	Return conveyor 1,200 W x 12,000 L Handled Material Compound Fertilizer V = 40 m/min. Cap. = 160 T/H	90 ϕ x 18 Nos. x 27 sets Nov. 1974 Running very well
Phosphoric Acid Plant	No.2 Conveyor 450 W x 10,000 L Handled Material Gypsum V = 26 m/min. Cap. = 20 T/H	90 ϕ x 7 Nos. x 9 sets Mar. 1975 Running very well
	No.4 Conveyor 500 W x 67,000 L Handled Material Gypsum V = 26 m/min. Cap. = 20 T/H	90 ϕ x 6 Nos. x 72 sets Jun. 1975 Running very well
	No.5 Conveyor 500 W x 10,000 L Handled Material Gypsum V = 26 m/min. Cap. = 20 T/H	90 ϕ x 6 Nos x 14 sets Apr. 1975 Running very well

Name of Site	Name of Machine	Description
Granulated Gypsum Plant	No.1 Conveyor 500 W x 33,000 L Handled Material Gypsum V = 15.6 m/min Cap. = 11.9 T/H	90 ϕ x 6 Nos. x 50 sets Jun. 1975 Running very well
	No.2 Conveyor 500 W x 27,000 L Handled Material Gypsum V = 15.6 m/min Cap. = 11.7 T/H	90 ϕ x 6 Nos. x 31 sets Jun. 1975 Running very well
	No.11 Conveyor 500 W x 28,000 L Handled Material Granulated Gypsum V = 33 m/mkn Cap. = 17 T/H	90 ϕ x 6 Nos. x 19 sets Jul. 1975 Running very well

ii) Mitsui-Joy :

No detailed results are available but by expert's experience in his factories they are also very good.

3. Price

e.g., 600 W Conveyor

Name	Plaloy Roller	Mitsui Joy (LR-200,202)	Joy (LR-350)
Carrier Rollers	¥ 7,199	¥ 13,400	¥ 30,544
Bracket	4,911	7,261	26,680
Return Roller	6,935	15,400	-
Bracket (Return)	3,381	4,384	-

Economical investigation.

(These figures are in bad condition with powder.)

	Plaloy roller	Steel carrier roller
Initial costs	100	146(roller only)
Maintenance fee	100	700
Belt fee	100	200
Total	100	330

4. Summary

"Plaloy Roller" was prepared for test run, and after recognizing these results, the expert would recommend the final economic design of various conveyor systems. But one method is to use "Mitsui-Joy" for rollers handling stickly material and "Plaloy Roller" for rollers handling powders.

APPENDIX V-26(2) TEST RESULTS OF THE PLALOY ROLLERS

6 pieces of Plaloy Roller were prepared for test.

These were tested at following three points:

- The conveyor next to the pan conveyor (TSP-II)
- The conveyor in the cured house (TSP-II)
- The conveyor next to the dryer (TSP-II)

One month after the test, these rollers were checked, and the expert could not find any fault. During this test, it was confirmed that these were running smoothly without any troubles.

The expert team is very pleased to inform that this test has been conducted very successfully in the acid corrosive and dusty conditions, and so the maintenance cost will be decreased extremely.

APPENDIX V-27   INVESTIGATION AND ESTIMATION OF CONVEYOR BELT SYSTEM

1. History and present condition of each belt conveyor

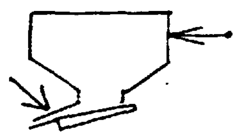
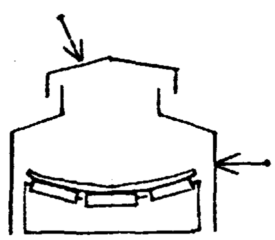
Item No.	Dimension	Date of change	Maker	Cause	Times of change from erection	Remarks
JO-1	210Mx800x10x4P	Dec.'79	Korea	Friction	4	life 1 year
O-1101A	545Mx750x10x5P	Repair	1/3 Japan 2/3 Korea	Fatigue	None	Planning to change 1/3 length of this belt
O-1101B	185Mx750x10x4P	Dec.'79	Korea	Friction	5	life = 1/2 year
O-1101C	38.5Mx750x10x4P	Dec.'79	Korea		6	life = 9 months
O-1102A	285Mx750x10x4P	Dec.'79	Korea	Friction	3	life = 1 $^{1}/_{2}$ years
O-1102B O-1103A&B O-1104B		-	-	-	None	
O-1104 C	20Mx750x10x4P	-	Bango	Friction	1	

2. Inspection reports and countermeasures

In general, i) The life of Korean belt seems to be 1/2 in comparison with the life of Japanese belt. S
conveyors.

ii) Now 15-20% of carrier rollers and return rollers are changed and repaired, but we found
condition. Especially adjusting roller must not be fixed at an angle of inclination.

iii) Some rivets has been used in the case of connection of belt. It is better to get the co

Item No.	Inspection Reports
JO-1	1. Unloader  • Bunker plates are corroded and broken (Ore leakage) • Damper and vibration feeder must be used to adjust discharge volume. When 2 or 3 units of unloaders are in operation, discharge volume at the end of J-ol conveyor must be smooth as much as possible. It is very effective for downstream conveyors.
	2. Cover plate of conveyor  • Side plates of all covers are much corroded, and all cover plates are taken off. • All parts of the conveyor are not also good, especially rollers are not good
	3. Cleaning of rollers • About 10 rollers are not working. Clean at least once a week.
	4. Max. oper tion  • 65 mm of belt from outside is not to be used, so theoretical max. capacity is 295 m^3/hr.

SECTION 1

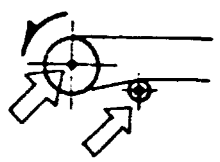
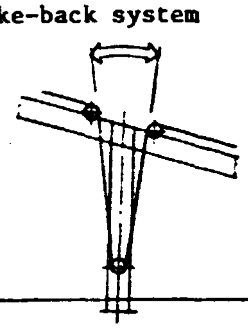
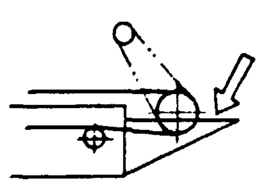
; to be 1/2 in comparison with the life of Japanese belt. So it must not be used for the important

and return rollers are changed and repaired, but we found pretty no rollers were not in good
ing roller must not be fixed at an angle of inclination.

the case of connection of belt. It is better to get the correct belr joiner machine.

s	Countermeasures
:ates are corroded and broken (Ore leakage) :d vibration feeder must be used to adjust volume. : 3 units of unloaders are in operation, discharge the end of J-ol conveyor must be smooth as much ole. It is very effective for downstream conveyors.	° Bunker must be repaired. ° Damper must be settled.
ates of all covers are much corroded, and all cover are taken off. :s of the conveyor are not also good, especially are not good	° Side plates must be renewed. ° Cover plates must be placed.
rollers are not working. Clean at least once a	° Several rollers must be repaired.
belt from outside is not to be used, so theoretical city is 295 m^3/hr.	

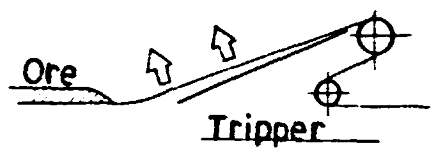
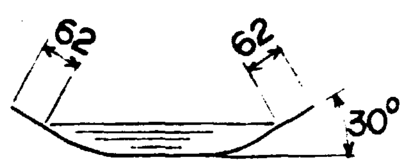
SECTION 2

Item No.	Inspection Reports
0-1101A	1. Carrier rollers • Several rollers near the gate are ready to change. 2 or 3 units of rollers could not run smoothly. This is the problem of maintenance.
0-1101B	1. Pulley  • The bearings of the driving pulley must be [illegible]nged, and this pulley is working periodically with sound. • One pulley is deformed line an ellipse.
	2. Belt • 2 or 3 layers of the belt changed in December 1979 in back side have already worn off.
	3. Take-back system • The take-back guide is always vibrating, and wide angular system causes some unbalance forces. 
	4. Chute to the next conveyor (Other points are same) • The steel plates of this part are corroded and deformed and nearly all gaskets are lost.
0-1101C	1. Driving pulley • The driving pulley moves periodically up and down, and its frame bolts are loosened. 

SECTION 1

	Countermeasures
e ready to change. t run smoothly. nce.	• Change the repair method. • Check the imported rollers and the repaired rollers.
gs of the driving pulley must be changed, and this working periodically with sound. is deformed line an ellipse.	• Change the pulley bearings and the deformed pulley.
ers of the belt changed in December 1979 in back already worn off.	• The belt must be changed in a few months.
ck guide is always vibrating, and wide angular system e unbalance forces.	• Change the take-back system to the vertical type, and strengthen the guide and some other parts. (Detail drawing)
points are same) e corroded and deformed and nearly all gaskets are	• Repair the plates and set the gaskets properly.
pulley moves periodically up and down, and its frame oosened.	• Strengthen the frame of the pulley by connecting to the structure.

SECTION 2

Item No.	Inspection Reports	
0-1101 C	2. Roller and pulley	• All rollers and pulleys must be checked and adjusted for centering of the belt.
0-1102 A	1. Belt  	• 2 or 3 layers of the belt changed in December 1979 in back side have already work off. • The belt floats up periodically, so we are afraid of some large trouble. 1) Deminish of belt weight 2) Irregularity of conveyed material 3) Raising of roller friction 4) Height of tripper is too much.
	2. Roller and pulley	• There are some noises of rollers, and several rollers are not in good condition.
	3. Max. operation  	• 62 mm from both side is not to be used, so theoretical max. capacity = 276 m^3/hr.

Approximative estimation

Local	
Personnel expenses	TK 51,960
Materials expenses	TK 298,800
Total	TK 350,760
Import	
Materials expenses	¥ 3,945,000
* -do-	¥ 9,780,000
Total	¥ 13,725,000

*Note: Th
wh
an

SECTION 1

	Countermeasures
.ers and pulleys must be checked and adjusted for ıg of the belt.	• All rollers and pulleys must be checked and checked when the belt is renewed. (This must be done for every conveyor.)
layers of the belt changed in December 1979 in ;ide have already work off. ılt floats up periodically, so we are afraid of .arge trouble. minish of belt weight regularity of conveyed material ising of roller friction ight of tripper is too much.	• 4) is very difficult • 1) - 3) must be done.
are some noises of rollers, and several rollers are good condition.	• All rollers and pulleys must be checked and repaired.
from both side is not to be used, so theoretical max. ity = 276 m^3/hr.	

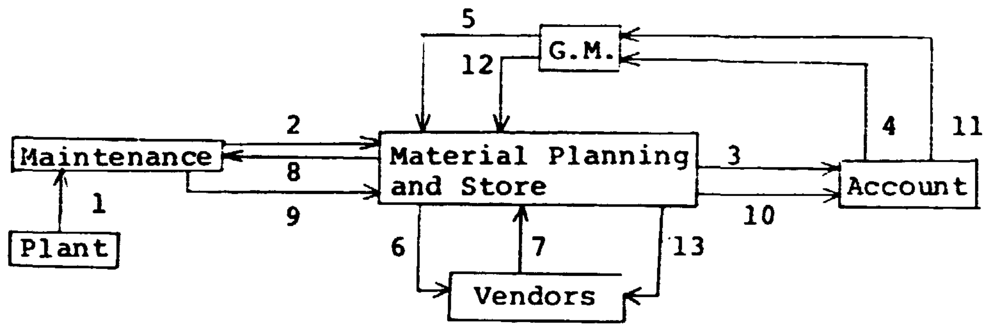
.
,1,960 3,800
0,760
.945,000 .780,000
.725,000

Note: The mark "" means that the procurement is necessary when the repairs of rollers and others are difficult and/or impossible.

SECTION 2

iii) Purchase procedure

The purchase procedures applied in this factory are shown briefly as follows :



1. Offer for required item
2. Requisition of item
3. Information for purchase and review of finance
4. Offer for approval
5. Approval if there is no problem
6. Tender inquiry
7. Collection of quotations
8. Consultation and checking of specifications
9. Information and comment for each vender
10. Selection and requisition for budgetary review and finance.
11. Offer for final approval of order
12. Approval to purchase
13. Order

It usually takes about one year to obtain the items which require foreign currency. The expert cannot comment exactly on the said procedures. However, if it takes much time to pass each department, in order to expedite the process, simplification of the procedures about specific items, such as ordinary valves, bearings would be desirable.

APPENDIX V-28 RECOMMENDATION FOR THE IMPROVEMENT OF THE EXISTING INVENTORY CONTROL SYSTEM

1. Investigation of present condition

i) Coding system of items in inventory

At present, each item has a code number which is determined arbitrarily by the store officer and based on the general commodity classification register book. This code number carried in stores has an individual stock number and if there are some changes in aspect of the material dimensions, this number may also be changed and renewed.

The code number consists of seven (7) digits and first two digits have twenty groups of inventory, each digit is determined as mentioned below.

01. Construction materials
02. Iron steel, non-ferrous material
03. Pipe tubes and fittings
04. Refractories
05. Fuel oil and lubricant
06. Raw materials and chemicals
07. Painting and paints accessories
08. Hard-ware materials
09. Loose tools
10. Domestic equipments
11. Furniture and fixture
12. Steel rope, stread, twine core
13. Packing and insulation materials
14. Laboratory apparatus
15. Medicals
16. Stationary materials
17. Mechanical spare parts
18. Electrical and instrument spare parts

19. Office equipment
20. Miscellaneous

And another digit classification is the stock number, which is used by stores to identify the item. This number is a sequence number starting from 01.000. Classification of all spare parts is determined only by the equipments' names. Even if there are same parts within the different equipments, this item has the different code number, so that if stores do not have a required parts, such as a bearing, "O" ring, it is almost difficult fcr stores to search for any suitable replacement.

However at present, new code for common stock numbers are going to be given in the three plants, which are in Chittagong, Ghorasal and Fenchuganj, based on Bresler recommendation. A particular item would have the same stock number among these fractories.

When thisnew code number system will function properly, volume of parts stored in each factory will be reduced considerably.

ii) Inventory levels

Present inventory order criteria are based on the procedure of reaching the quantity to be ordered. This ordered quantity is determined on the past several years' spare parts consumption. In our understanding, it is difficult to maintain the adequate number of spare parts due to problem of foreign currency which are beyond the control of the management in this factory and it is also one difficulty that whether the time supplied the foreign currency is adequate or not.

iv) Store keeping

As an item is received by the stores, the following works have to be done

1. Keeping the items in the warehouse or outside

2. Delivery of an item against requisition from plant and posting the transaction in the kardex sheet.

3. Inspection

   After receiving an item, it is checked against relevant shipping documents and this item's stock number is informed to the Maintenance Section by quality checking form, and mechanical item is checked by mechanical person and electrical item is checked by electrical person.

4. Preparing the forms

   Stores are preparing the following forms
   - Stock declaration form
   - Store return memo
   - Stock transfer form (to Account)
   - Material receiving report (to Account and MPC)
   - Quality checking form (to Maintenance)

2. Problem to be remedied and recommendations

i) Poor storage of stock items

It is understood that inventory control system itself is operating smoothly in TSP Complex. However, several items, such as mild steel plate and piping, portable belt conveyor, rubber lined agitation shaft, carbon heat exchanger, fuel oil, cast iron values, etc. are being kept in the field without any cover. The items mentioned above will be damaged gradually due to rain and sunlight. Therefore these items in the field should be kept in the warehouse in order to avoid the deterioration before usage.

Several used mechanical parts which are kept in the warehouse, such as the shaft of head pully, agitator, get rusty due to moisture on the fine metal finished surface. Therefore, anticorrosive agent such as grease rustless 606 R should be applied on the important parts as mentioned above in the system of fits.

ii) The low efficiency in practical utilization of the covered storage area.

Several items, such as pumps, rubber hose, belt pully, pipe-fittings, impeller, etc. are put on the floor at haphazard. Storage area of the stores should be utilized effectively by rearrangement of the items in order to reduce the dead space and the unused items, if possible, should be discarded for the same purpose. The small items, such as fine mechanical spare parts, bolts and nuts, small bearings, etc. are to be stored in the individual shelf with drawer in order to save the storage floor space, to keep them clean and to distinguish easily among the required items. Therefore, layout of internal warehouse should be reviewed by store person.

iii) Lack of the detail drawings and spare parts

After selection of vendor and order, general drawings for uer's approval is requested by maintenance person. However, at present, such drawings are not obtained.

It is necessary for the maintenance people and the M.P.C. to request for the drawings from the manufacturer and send them back after checking specifications and dimensions in order to avoid any misunderstanding. When the items are received, the final drawings are also to be obtained for every case for record and future reference.

These drawings are very useful for the store person, and more useful for the maintenance and it is essential to check by using these drawings whether received items are correct.

The requisition and arrangement of the said drawings should be done by the maintenance section. These drawings should be also revised and kept up-to-date whenever modification or change of specification is done.

APPENDIX V-29 (1) EXAMPLE OF OPERATOR's PREVENTIVE MAINTENANCE SYSTEM OF SHOVEL LOADER

In Japan, "Operator's preventive maintenance system of shovel loader has been conducted successfully as follows :

1. Operators check the condition of their shovel loaders every day by the check list.

2. Contents of check list are prepared according to the important points of shovel loaders and their experiences of troubles.

   Example

Inspection Item	Point	4/17	4/18	4/19	4/20
Air Filter	Clean or Dust				
Black					
Oil Pump					

   Signature of operator

3. Operators pay attention to shovel loader as if they are its owners.

4. Unexpected troubles and special periodical inspection are treated by professional maintenance person.

APPENDIX V-29(2) REPAIR OF HYDRAULIC GEAR PUMP

Judging from repair of hydraulic gear pump, the expert points out following important items regarding maintenance of shovel loader.

1. Preparation of small clean place with working table for assembladge.

2. Preparation of paper on the working table, new washing oil, lubricating oil, waste clothes and some clean vessels to assembly and disassemble precise machine like this.

3. Preparation of every spare part

   Some trouble was caused by attachment of unsuitable packing due to lack of formal packing. The expert repaired the trouble by temporary packing, but it is not correct. One must always prepare formal spare parts.

4. Periodical cleaning of filter

   Gear pump was very dusty. Cleaning of filter should be conducted periodically.

APPENDIX V-29 (3) IMPROVEMENT OF MAINTENANCE OF BULK HANDLING VEHICLES

1. Present Conditions

i) No. of Shovel Loaders

	Type	No.
° SD-23M	TCM max. 2,300 kg	5
° SD-22M-4	TCM max. 2,200 kg	1
° SD-22III	TCM max. 1,900 kg	2
° SD-20-5	"KOMATSU" max 2,000 kg	2
Others :	Small shovel loader 1,000 kg	5
	" 1,400 kg	2

These small loaders are not used now for operation.

ii) Running Condition

	No.
° Drying Section (TSP-II) ° Bagging Section (TSP-II)	3
° Milling Section (TSP-II)	1
° Milling Section (TSP-I)	1
° SA-I Section	1
° SA-II Section	1
° Bagging Section (TSP-i)	1
° Under Repair	2
Total	10

iii) Members

Section in charge	1
Worker	10 persons
Helper	4

2. Contents of Trouble

i) Radiator : Net of the radiator is blocked due to dust so that cooling water overboils.

ii) Alternator : Alternator/Dynamo doesn't work due to dust.

iii) Filter : There are four filters for Hydrolic clutch, Diesel and air. These are also jammed with dust.

iv) Hydraulic line (H.P.) : In long run, pressure of hydraulic oil gradually increase, and finally the pipe torn out.

v) Control valve : There are three shafts in the valve and the shaft is blocked frequently due to dust.

vi) Rear axle : Steering bearing, thrust bearing and needle bearint are frequently jammed with dust.

vii) Brake shoe : Due to dust brake shoe and lining is damaged frequently.

viii) Fuel pump assembly : Air is frequently locked due to the jam of the line.

3. Countermeasures

i) Dust

Above mentioned troubles are all caused by dust. The expert has tried to look for type of sealed shovel loader. Till now the expert received the information regarding TCM sealed type which seals driver's cabin and provide only a little better air filter.

Therefore, it is the urgent problem to establish preventive maintenance system of shovel loaders.

ii) Establishment of preventive maintenance system

a) Preparation of list regarding history and spec of shovel loader for all shovel loaders as shown in Fig.1

b) Daily checking

All maintenance are to be conducted in the corporation of operators and repairs persons. To get information of troubles early, daily checking is recommended as shown in Fig. 3 which is to be done by operators in every shift.

c) Periodical checking

For preventive maintenance, the periodic maintenance shown in Fig.3 is also requested. The most important thing is that all persons are concerned to keep this system any time.

Maintenance shall be divided into two methods.

° 2 days checking (See Fig.4)
° Periodical checking (See Fig.5)

These two actions should be done by maintenance persons, and recorded strictly.

iii) Necessary documents

Necessary documents are almost sufficient, but some ones shall be provided according to Fig.6.

iv) Spare parts

Spare parts are not sufficient. Preparation of minimum spare parts list is to be done as soon as possible.

v) Cleaning

It is better to submit some paint and waste clothes in order to keep vehicles clean.

Fig.1 HISTORY AND SPEC OF SHOVEL LOADER

(I) NAME

(II) MAKER

(III) PURCHASE DATE

(IV) PURCHASE ROUTE

(V) PURCHASE PRICE

(VI) SPECIFICATION

Machine Model Serial No.

Engine Model Serial No.

(VII) HISTORY

FIG.2 CHECKING LIST (A) (DAILY)

Date : . . 1980 | T & SL Section

No. of Vehicle : | Approved by :

Item No	Description		I-Shift	II-Shift	III-Shift	Remarks
A-1	Cooling Water	· level				
		· leakage				
		· valve				
-2	Engine Oil	· level				
		· dirty				
-3	Warning Lamp	· water temp.				
		· Torque conv. temp.				
		· Transmi. oil press				
		· battery charging				
		· Control resist.				
		· fuses				
-4	Tire	· Air press.				
-5	Brake System	· efficiency				
		· oil				
-6	Cylinder	· loading action				
-7	Body	· bolts & nuts				
		· Oil leakage				
-8	Others.	· · ·				
		Checked by.				

Item No.	Description	Remarks.
Action -1	Radiator Cleaning (with air)	Done by.

Repairing works about the checking items:

Recorded by:

FIG.3 LIST OF PERIODIC MAINTENANCE

T & SL Section

	Item.	Period	one week	one month	Two month	Three month	six month
Engine	1	Engine Oil (EO)	⊕				
	2	Cooling Water (W)		⊕			
	3	Radiator Clearing	©				
	4	Injection Pump (EO)	O			⊕	
	5	Governer (EO)	O			⊕	
	6	Engine Oil Filter	©			⊕ element	
	7	Fuel Filter	© Drain			⊕ element	
	8	Joint Bolt Strainer of Fuel Feed Pump Inlet	©				
	9	Fan Belt	O				
	10	Cylinder Compression pressure		O			
	11	Valve Clearance		O			
Electric System	1	Electric Parts (lamps, fuses, wires)					
	2	Starter and Generator		O			
Drive & Steering System	1	Transmission Torque converter (TO)	O			⊕	
	2	Differential (GO)		⊕ oil			
	3	Final reduction (GO)		⊕ oil			
	4	Transmission Screen		©			
	5	Line Filter		©			
	6	Wheel Alignment		O			
Brake	1	Brake Shoe		O		⊕	
Loading system	1	Hydraulic Oil (HO)		⊕			
	2	Suction Filter		©			
	3	Drain	O Drain				
Others	1	Retightening of Clamp Bolts	O				
	2	Fuel Tank Drain	O Drain				
	3	Fuel Tank Strainer		©			
	4	Greasing (CG)	⊕				

Keys.
O : check
⊕ : change
© : Cleaning
CG : Chasis Grease

GO : Gear Oil
BO : Brake Oil
HO : Hydraulic Oil
EO : Engine Oil
W : Water

F : Fuel
TO : Torque Conv. Oil.

FIG.4 CHECKING LIST (B-1) (PERIOD 2DAYS)

Responsible Person :

Checking Item.

Item No.	Description	Mark.
B-1-1	AIR FILTER CLEANING	O check © cleaning ⊕ change
-1-2	BATTERY LIQUID CHARGE	O check © charge ⊕ change
-1-3	" " GRAVITY	

Record.

No	Name of Shovel Loader	. .	. .	. .	. .	. .	. .	
1	SD-23M-A							
2	SD-23M-B							
3	SD-23M-C							
4	SD-23M-D							
5	SD-23M-E							
6	SD-22M-4							
7	SD-22-5-A							
8	SD-22-5-B							
9	SD-22-III-A							
10	SD-22-III-B							

SECTION 1

T & SL Section A-188

Date : . . 1980

Approved by.

...ing ⊕ change

...rge ⊕ change

SECTION 2

FIG.5

CHECKING LIST (B-2) (PERIODICAL)

Name of Shovel Loader:

Responsible Person:

Item.			Checking Date
Engine	1	Engine Oil (EO)	
	2	Cooling Water (W)	
	3	Radiator Cleaning	
	4	Injection Pump (EO)	
	5	Governer (EO)	
	6	Engine Oil Filter	
	7	Fuel Filter	
	8	JOINT BOLT Strainer of Fuel Feed Pump Inlet	
	9	Fan Belt	
	10	Cylinder Compression pressure	
	11	Valve clearance	
Electric System	1	Electric Parts (lamp, fuses, wires)	
	2	Starter and Generator	
Drive & Steering System	1	Transmission Torque Converter (TC)	
	2	Differential (GO)	
	3	Final reduction (GO)	
	4	Transmission Screen	
	5	Line Filter	
	6	Wheel Alignment	
Br[illegible]	1	Brake Shoe	
	2		
Loading System	1	Hydraulic Oil (HO)	
	2	Suction Filter	
	3	Drain	
Others	1	Retightening of Clamp Bolts	
	2	Fuel Tank Drain	
	3	Fuel Tank Strainer	
	4	Greasing (CG)	

SECTION 1

T8 SL Section
Date: . . .
Approved by:

SECTION 2

FIG.6 DOCUMENTS

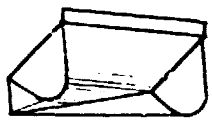
Name of Machine	Provided Documents	Remarks
TCM SD-23M No.5	1. Operation Manual 2. Parts Manual Model TCM-23M Book No. S-527B 3. TCM Parts Manual Book No. EFB-60S30C MITSUBISHI	
TCM SD-22 III No.2	1. Parts List SD-22III Torque Converter type 2. Engine parts list ISUZU D400	
KOMATSU SD 20-5 No.2	1. Operation & Maintenance Manual SD 20-5, SD20P-5 KOMATSU WHEEL LOADER 2. Parts Book KOMATSU SD20-5 SD20P-5 Serial No. SD 20-40143 SE 20P-30016 up 3. Parts Book KOMATSU SD20-5 SD 20P-5 Serial No. SD 20-40143 SD 20P-30016 up	
TCM SD-22M-4 No.1	——	Some parts of this machine are different from other TCM loaders (e.g. Hydraulic pump), so you should request the parts list of this machine.

APPENDIX V-29 (4) TCM SHOVEL LOADER

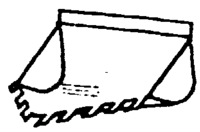
Summary of Discussion with TCM in Japan

1. Bucket Type :

TCM recommended to use Type-2 or Type-4 in TSP factory.
It may reduce the shocks of digging.



Type - 2



Type - 4

They want to know which type we are now using.

2. Dust

They are now studying, and will send the report for this purpose afterwards. But they may recommend "Donaldson Type" filter FHG 10.

3. Strength "Tire"

They recommend Aichi Tire (Unique Tire) They say the life is expected to be three times.

4. To dig the pile of TSP

To this purpose they recommend the truck shovel with Backhoe attachment. This may be useful for this purpose,

APPENDIX V-30 EXAMPLE OF HISTORY SHEET OF IMPORTANT EQUIPMENT

1. Plant — SA-II
2. Name of equipment — BOILER FEED WATER PUMP
3. Item NO. — J-1202 A & B
4. Date of manufacture — Erection time
5. Serial No. — R-710336
6. Maker — EBARA MFG. CO., LTD., JAPAN
7. Specification
   1) Model — 80 x 65 MS(B) V//M
   2) Suction & Delivery — 3" x $1\frac{1}{2}$"
   3) Capacity of discharge — $26M^3/H$ & Total head $26\ kg/cm^2$
   4) Speed — 2,950 r.p.m.
   5) Power — 37 KW, 400 V, 50 HZ
   6) Specific Gravity — 0.958
   7) Temperature — 105°V, Boiler feed water

   Six stage horizontal centrifugal pump with motor driven & turbine driven.

8. No. of Equipment — 1 x 3 (one is another type)
9. Required Documents

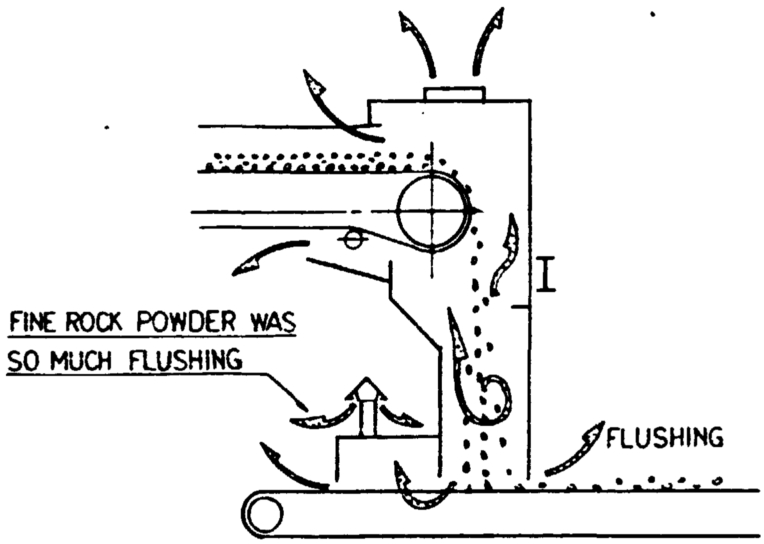
	Exist or Not	Remarks
1) Maintenance Manual	No.	-
2) Operation Manual	No.	-
3) Performance Test	Yes	CT-283 CT-300
4) Drawings		
i) General View	Yes	-
ii) Detail Drawing	No.	-

10. Required Spare Parts

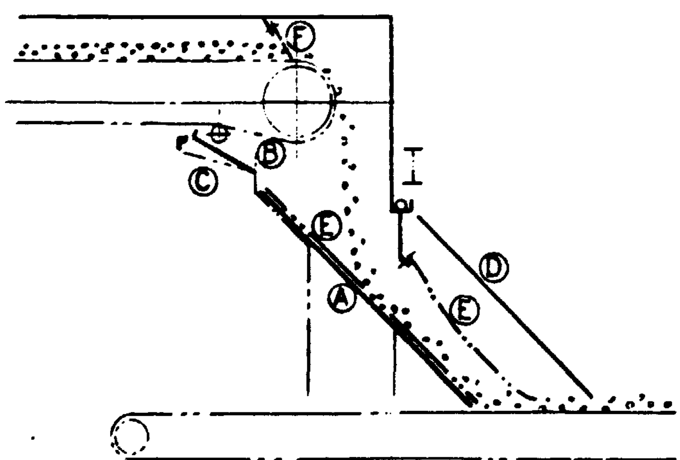
No.	Name	Mini. stock	Date 12.1.81
1	Suction casing	1	1
2	Main shaft with rey	1	2
3	Plain bearing (suction)	4	4
4	Plain bearing (delivery)	4	6
5	Shaft sleeve (suction)	4	7
6	Shaft sleeve (delivery)	4	7
7	Impeller	6	12
8.	Sleeve nut	2	6
9	Balancing seat	2	4
10	Balancing disk	2	4
11	Interstage bushing	6	12
12	Lantern ring bushing	2	4
13	Liner ring	6	13
14	Balancing bushing	2	4
15	Gland pakcing V[illegible]# 134	12 sets	36 sets
16	O-ring-A Syn rubber (casing)	24	28
17	O-ring-B Syn rubber (Balancing room cover)	16	16
18	O-ring-C Syn rubber (Sleeve)	16	24
19	Deflector synthetic rubber (suction)	2	4
20	Deflector synthetic rubber (delivery)	2	4
21	Gland	2	2
22	Pump side coupling	2	2
23	Needle valve for inspection (angle type)	2	4
24	Flexible coupling	2 sets	Nil

APPENDIX V-31(1) IMPROVEMENT OF RAW MATERIAL EFFLUENT

Prevention of dust in belt conveyor at main gate



EXISTING



MODIFICATION

1. The rock ch
good in ord

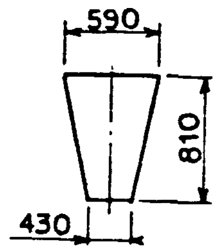
2. It is poss
made of ir
saved.

3. These coun

4. This metho
Then, one
money will

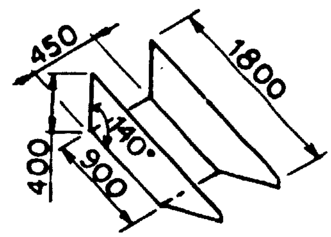
5. The life o
shock of o
plate was

SECTION 1



A

Bottom Plate



D

Outside Shell

1. The rock chute was tested with tin plate. The result is good in order to prevent the rock flashing.

2. It is possible to minimize the loss by setting this chute made of iron plate. For example, rock of 3 t/M may be saved.

3. These countermeasures are also good for human health.

4. This method should be applied for other 4 positions. Then, one can obtain more merit. (Total amount of saving money will be up to 200,000 TK/M)

5. The life of conveyor belt is also protected from the big shock of dropping. To everybody's surprise, the thick tin plate was broken in only few days.

SECTION 2

APPENDIX V-31(2) IMPROVEMENT OF RAW MATERIAL EFFLUENT

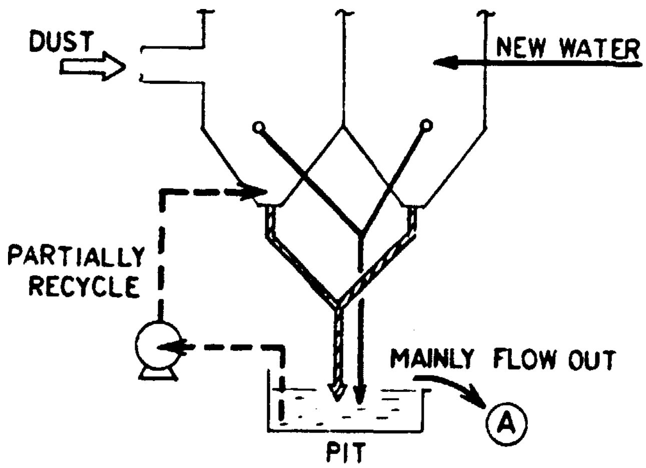
Washing water in dust collector of Milling section

1. Dust collector in Milling section is working as a wet collecting method. The expert tried to obtain better efficiency, and now its efficiency is better than that of previous time.

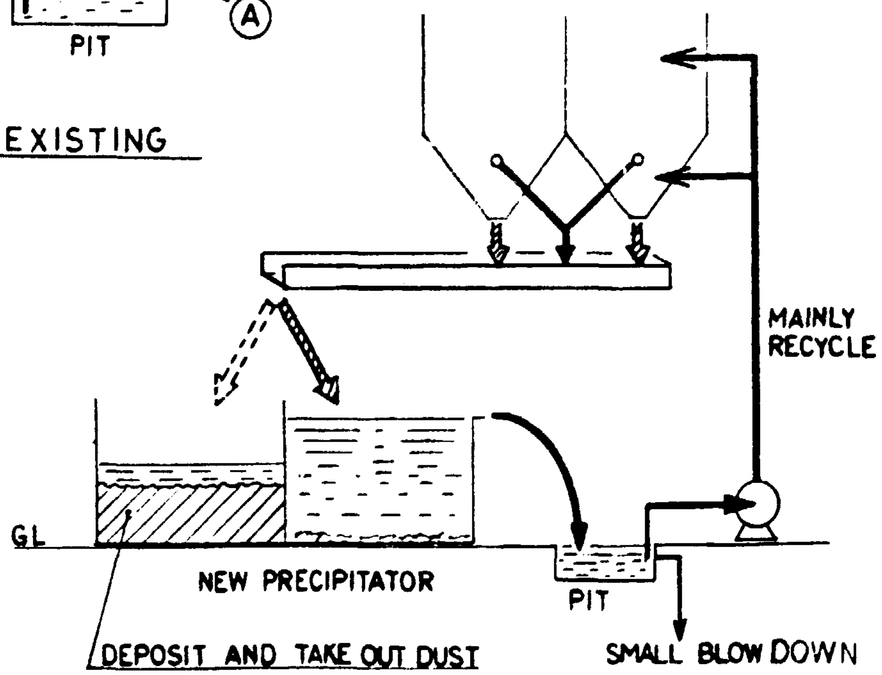
2. The information regarding bag filter and multi cyclone have already submitted as dry collection method.

3. Those dry methods are not so easy. So the expert recommends to increase the efficiency of existing dust collector as follows:

i) Proposal Idea

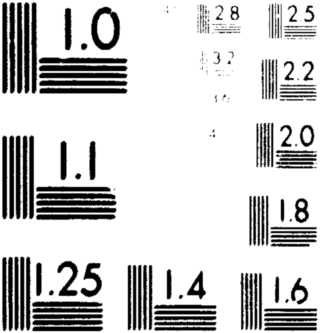


EXISTING



SECTION 1

PROPOSAL IDEA


1.0
2.8
2.5
3.2
2.2
1.1
2.0
1.8
1.25
1.4
1.6

ii) Test Result concerning A sample

300 cc slurry sample precitate	water flow rate based on following data.	
	Velocity	9.23 m/sec
3.27 g	Flow area	0.068 x 0.023 = 0.0156 m^2
10.9 g/lit.	Flow rate	0.23 x 0.0156 x 3,600 = 12.9 m^3/H

Quantity of dust caught in collector on the basis of flow rate at 10 m^3/H

10.9 x 10.0 = 109 kg/hr

Expected quantity of dust precipitated in Pit 109 x 0.5 = 55 kg/H 1,100 kg/D
(0.5: expected recovery ratio)

iii) Merit

1.1 (t/D) x 1,400 = 1,500 TK/D $\xrightarrow{\text{300 day}}$ 450,000 TK/Y

Price of Jordan rock is assumed to be 1,400 TK/t

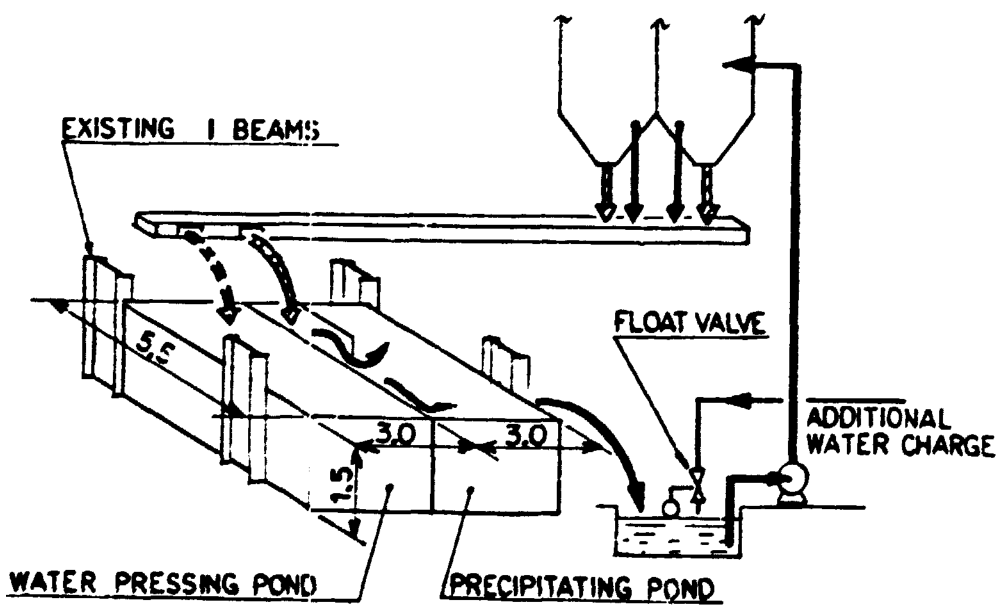
iv) Expenses

- o Blick working metioned below
- o 2 inches pump 1 set
- o Others

} 100,000 TK

v) Detail method

- o In every half month, water supplied pond is alternatively changed.



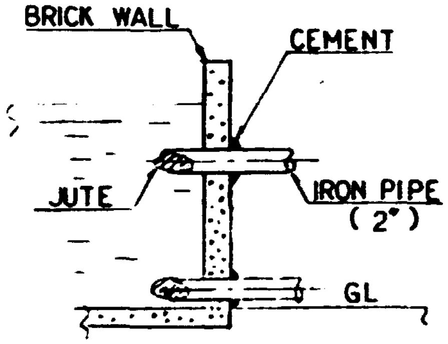
SECTION 2

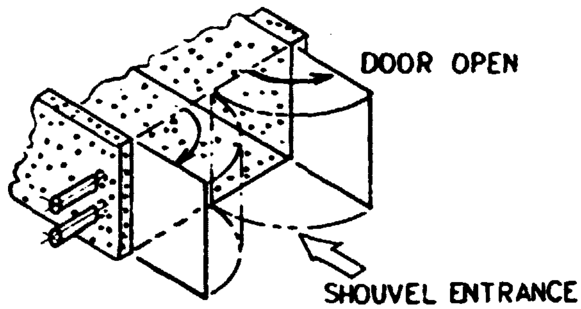
o Pond vol (V_p m^3) $V_p = 5,5 \times 3.0 \times 1.5 = 24.75\ m^3$

o water flow velocity

$$V_p(m/s) = \frac{V}{A - 3600} = \frac{10\ m^3/H}{3 \times 0.1 \times 3,600} = 0.01\ m/sec.$$

alternative operation (precipitating & pressing water and take out)



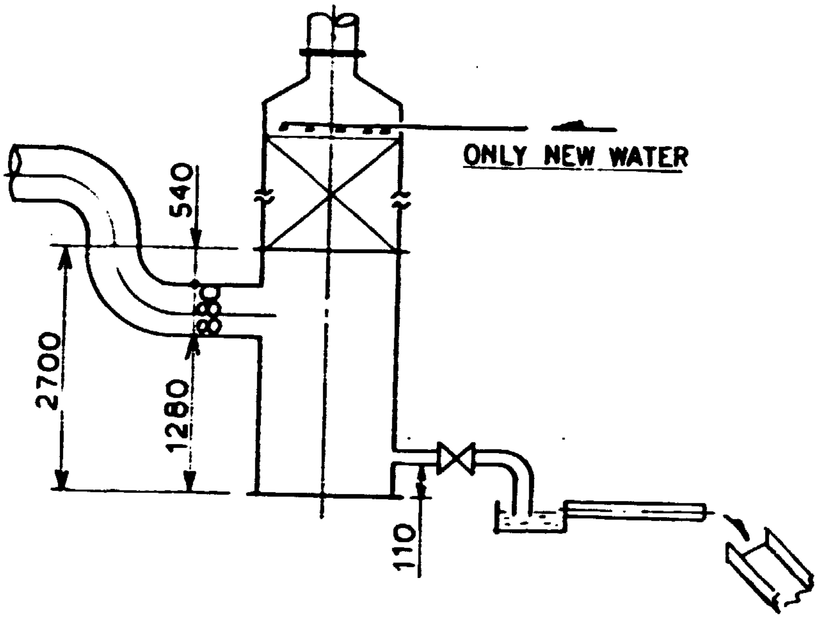


ALTENATIVE OPERATION
(PRECIPITATING &PRESSING WATER AND TAKE OUT)

APPENDIX V-31(3) IMPROVEMENT OF RAW MATERIAL EFFLUENT

Recovery of T.S.P. from waste warter of scrubber in drying section of TSP-2 Plant.

1. Existing System



i) Waste water

$A = 0.250^{W} \times 0.300^{D} = 0.075\ m^2$ $U = 3\ m/8\ sec = 0.375\ m/s$

$V = AU \times 3{,}600 = 100\ m^3/H$

ii) TSP content

300 cc waste water

precipitate is 0.929 g

TSP content in water

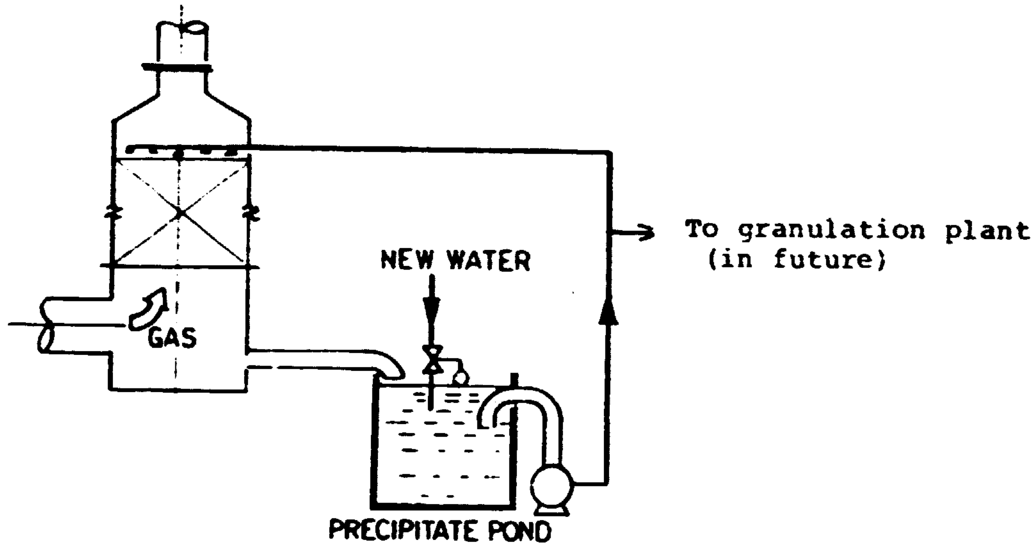
$$C\ \% = \frac{0.928\ g}{300\ g} \times 100 = 0.31\ \%\ (wt)$$

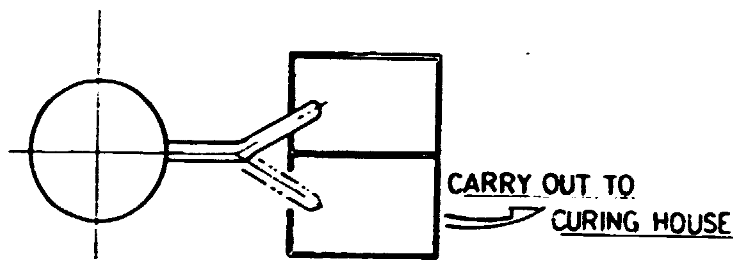
loss of TSP

$$W' = V \times \frac{C}{100} = 310\ kg/H$$

$W = 0.7 \times W' = 217\ kg/H$ 0.7 : measuring error (because it is only 1 time test)

2. Proposal Idea





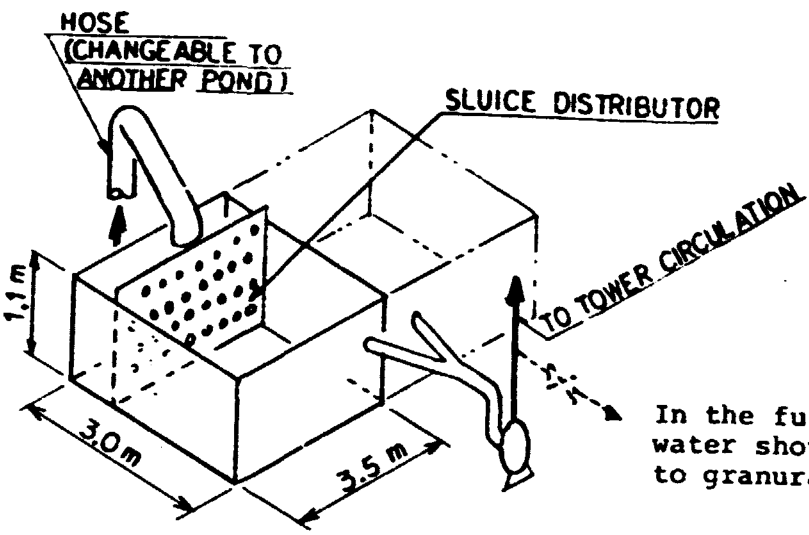
i) Washing water is recycled in stead of one-pass.

ii) TSP dust is collected in precipitated pond.

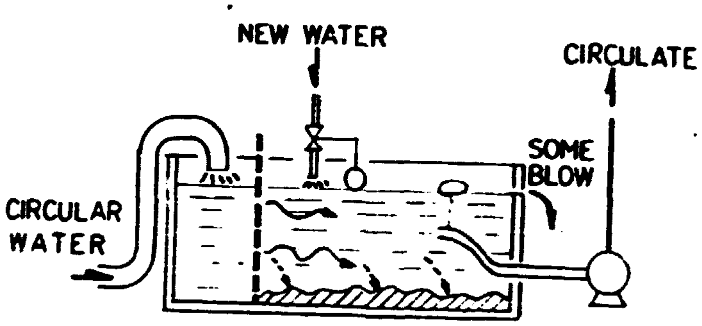
iii) This recovered TSP is dried and become products.

iv) Some part of recycled water can be consumed in granulation plant in future in order to recover P_2O_5 caught in this scrubber.

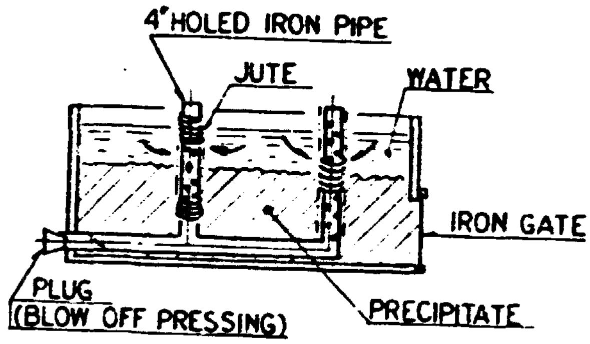
3. Detail Method



In the future, this water should be used to granurating water.



OPERATING POND



PRESSING POND

4. Expected Merit

i) Recovered TSP

217 x 0.3 = 65 kg/H

0.3 : expected ratio

ii) Merit

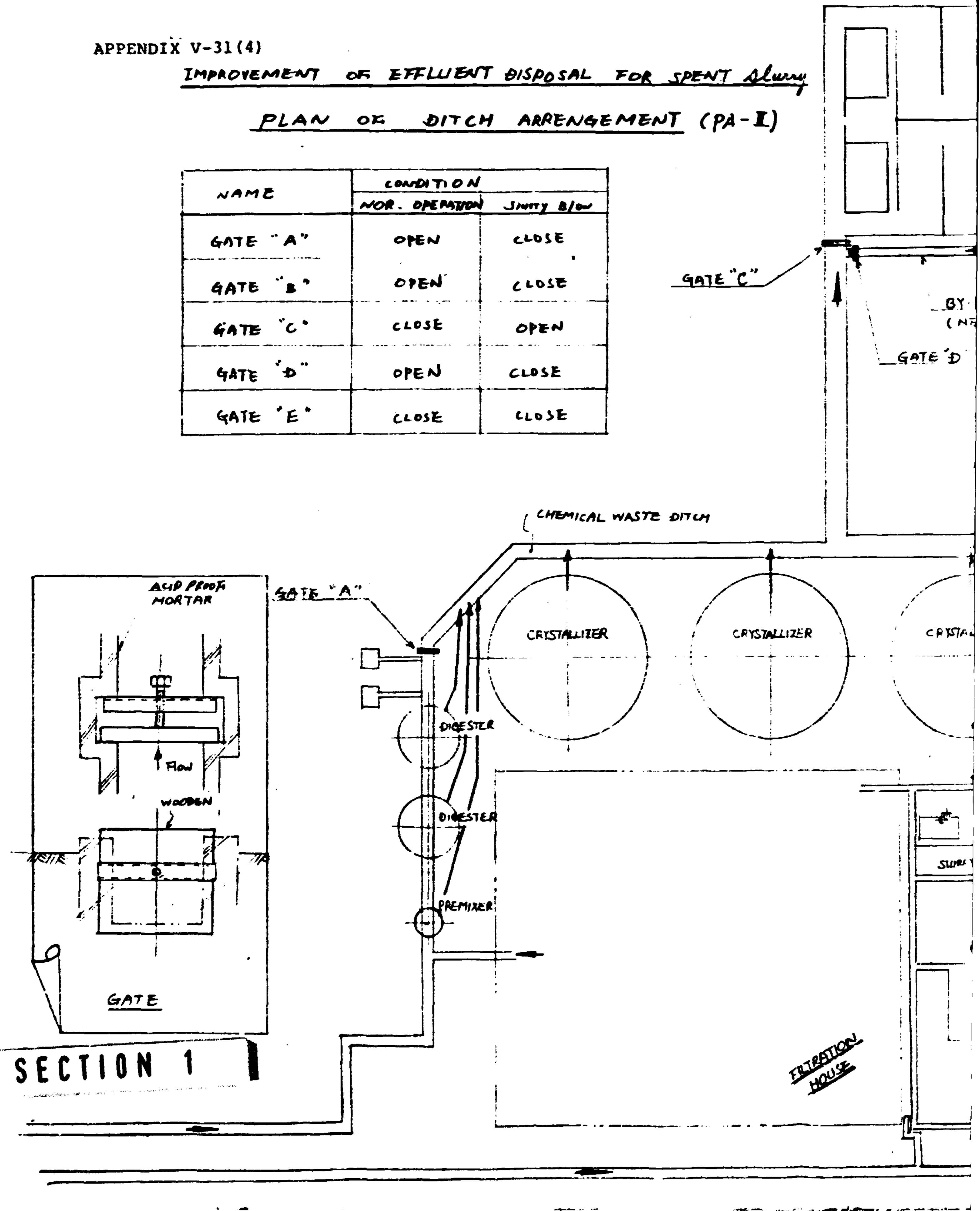
65 kg/H x 20 hr/d x 30 d/d x 3,500 TK/t = 136,500 TK/M

APPENDIX V-31(4)

IMPROVEMENT OF EFFLUENT DISPOSAL FOR SPENT Slurry

PLAN OF DITCH ARRENGEMENT (PA-II)

NAME	CONDITION	
	NOR. OPERATION	SLURRY B/OW
GATE "A"	OPEN	CLOSE
GATE "B"	OPEN	CLOSE
GATE "C"	CLOSE	OPEN
GATE "D"	OPEN	CLOSE
GATE "E"	CLOSE	CLOSE



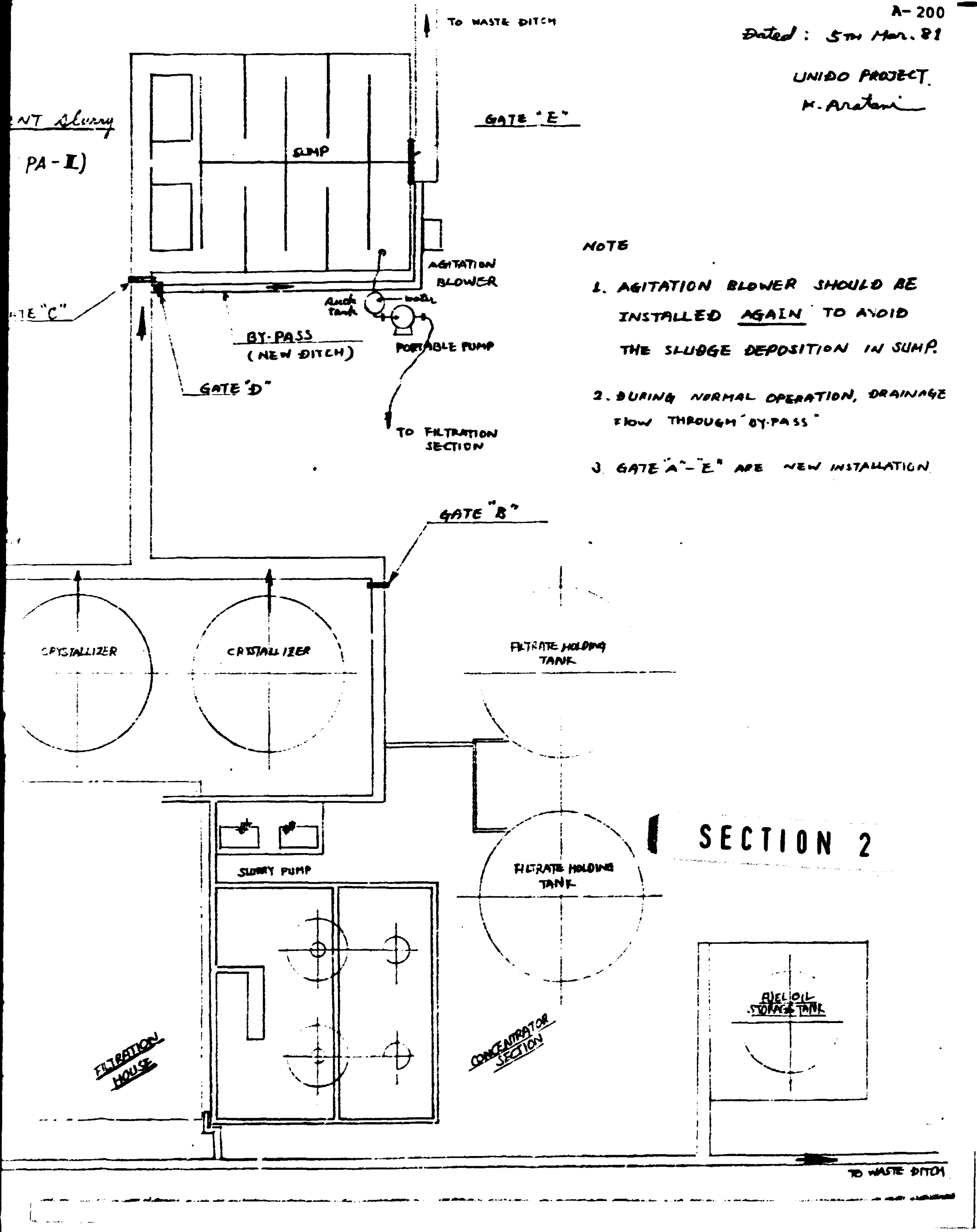
SECTION 1

A-200
Dated : 5th Mar. 81

UNIDO PROJECT
K. Aratani

NOTE

1. AGITATION BLOWER SHOULD BE INSTALLED <u>AGAIN</u> TO AVOID THE SLUDGE DEPOSITION IN SUMP.
2. DURING NORMAL OPERATION, DRAINAGE FLOW THROUGH "BY-PASS"
3. GATE "A"-"E" ARE NEW INSTALLATION

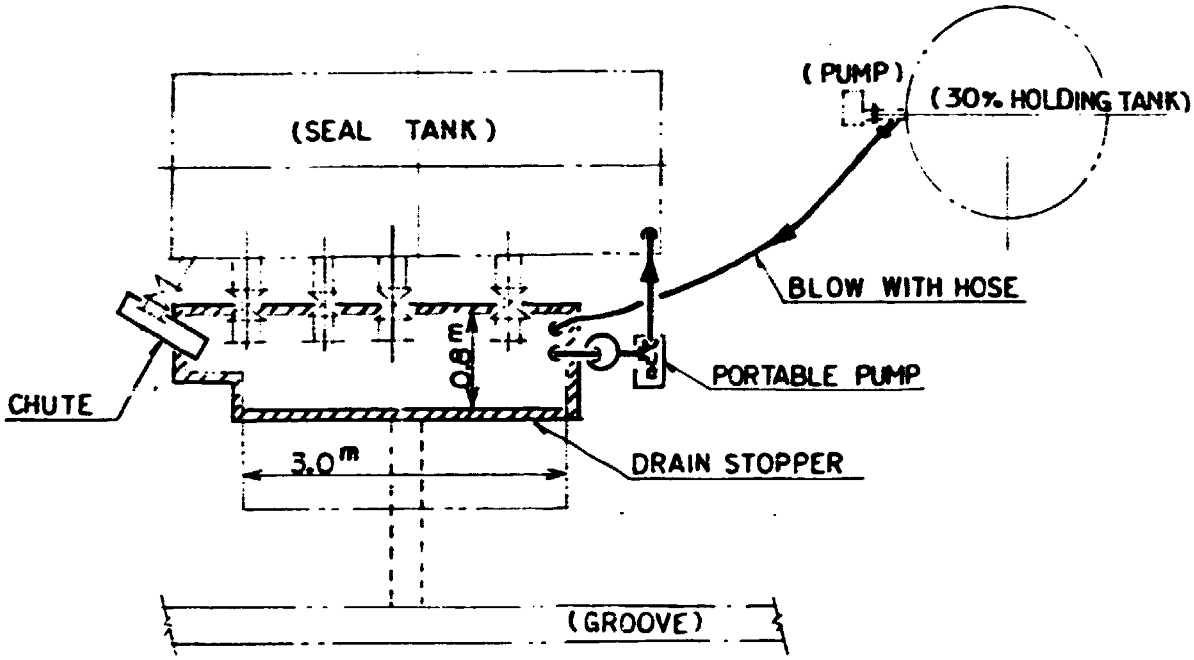


APPENDIX V-31(5) IMPROVEMENT OF PA-1 SLURRY EFFLUENT

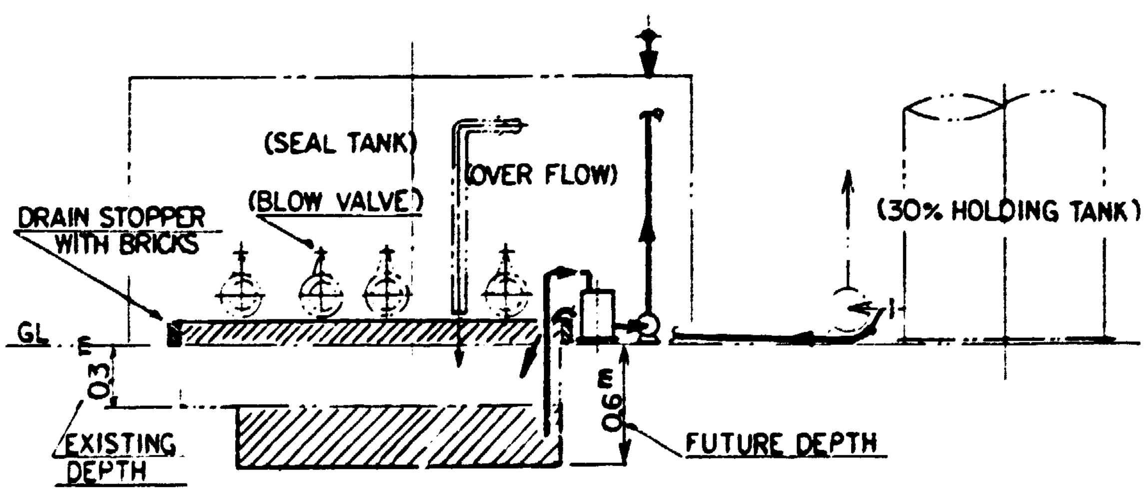
1. Present Condition

Mainly slurry is diposed from seal tank periodically, 3 times per day in order tc prevent chorking of the seal pipes.

2. Countermeasures

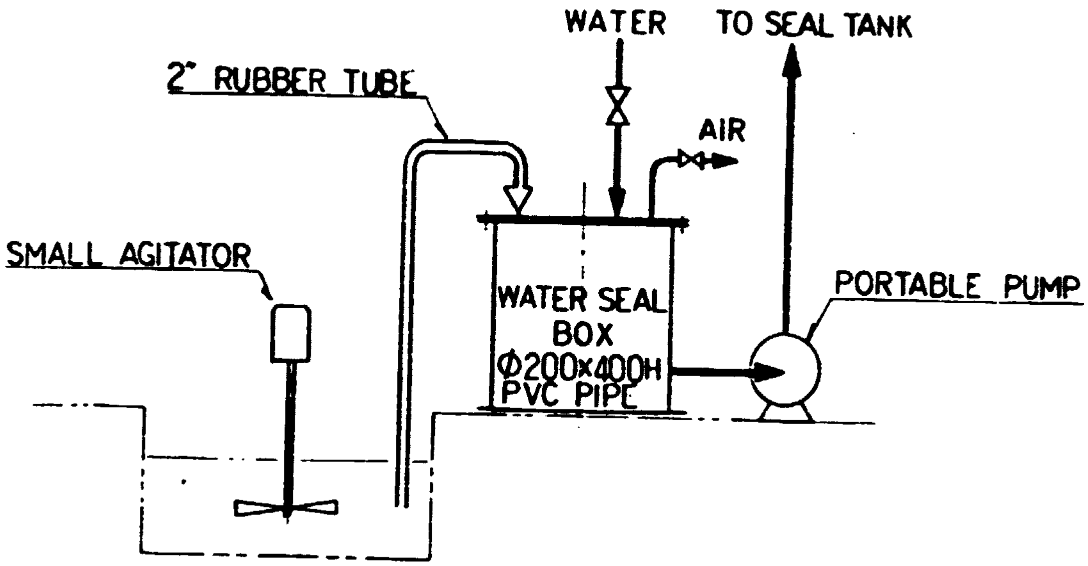


Newly installed



New pit vol, $V(m^3) = 0.8 \times 3.0 \times 0.6^{mH} = 1.4\ m^3$

3. Details of pump sucking



i) Fill up water to water seal box and then blow air and some water from blow value.

ii) Stop water supply & water blow

iii) Start agitater

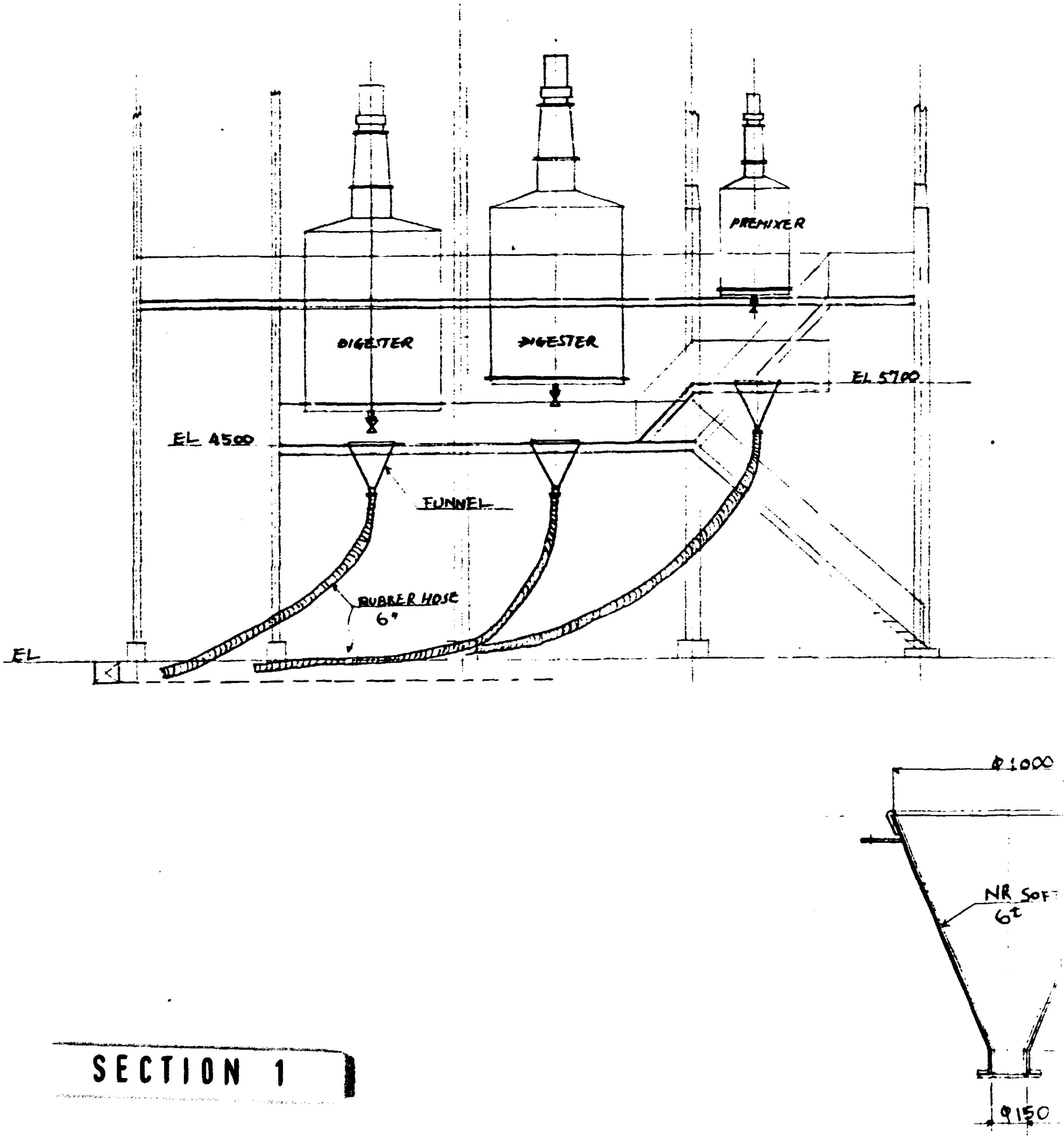
iv) Start the pump

v) After sending slurry, a little water should be sucked.

4. Others

o This method is very helpful for recovery of slurry.
o It is possible to apply this method of PA-2 plant.
o Cost of pump (waman 2" x $1\frac{1}{2}$") 2,000 US$ + tax

APPENDIX V-31(6) RECOVERY OF P^-II PLANT SLURRY

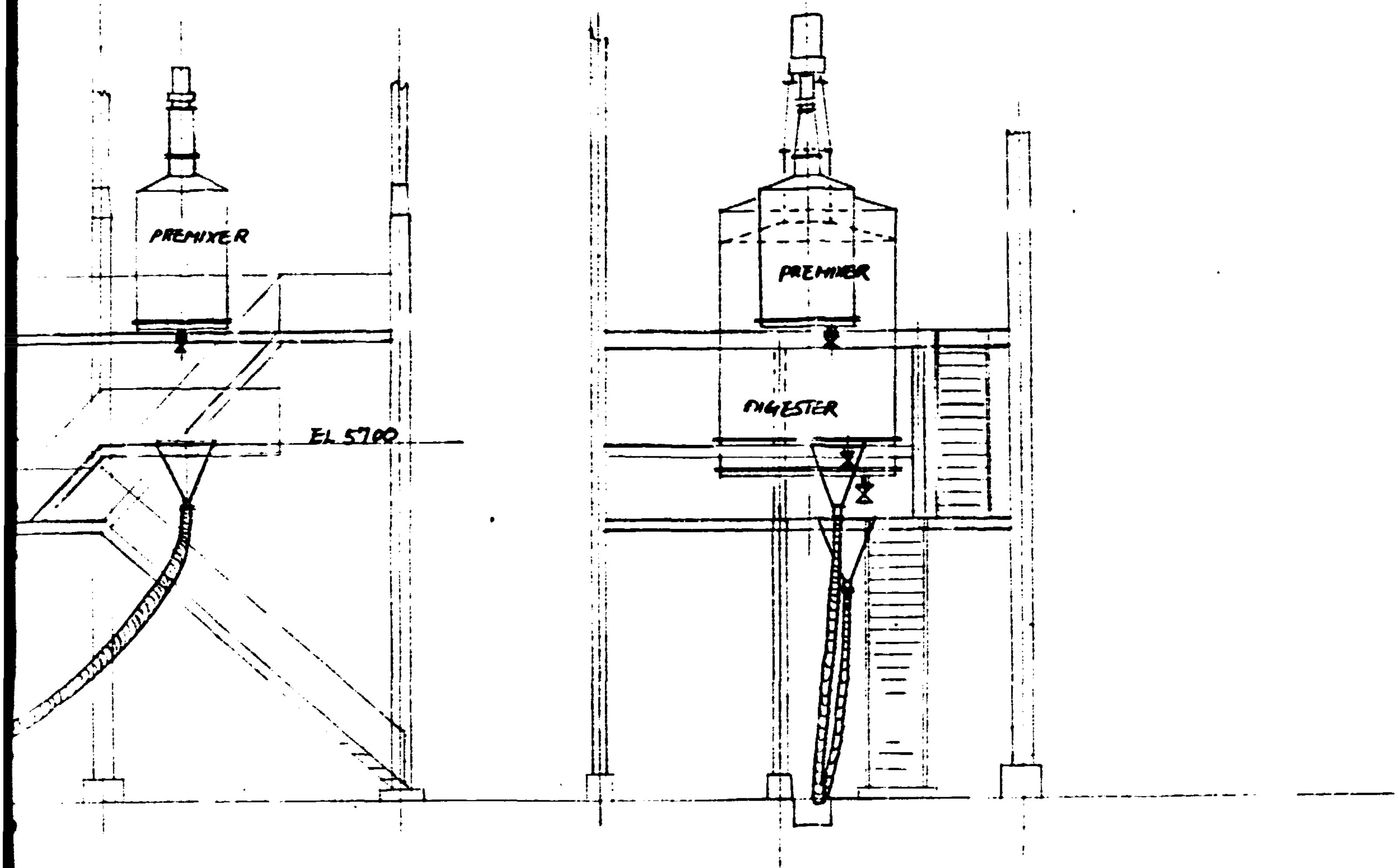


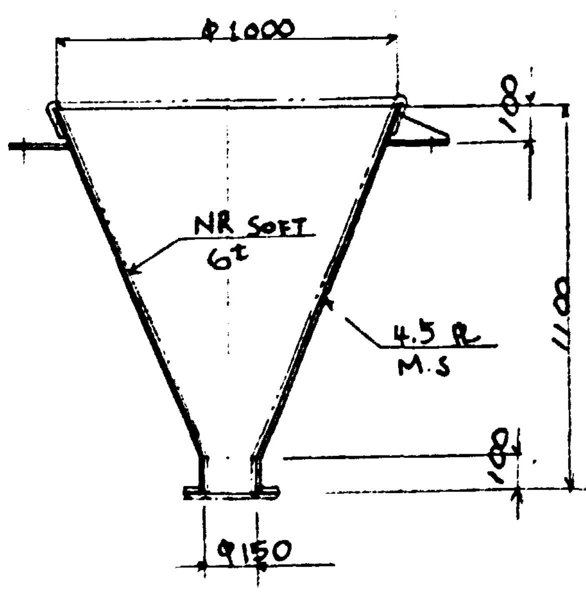
SECTION 1

A-203

Dated ; 6th Mar 81

K. Aratani

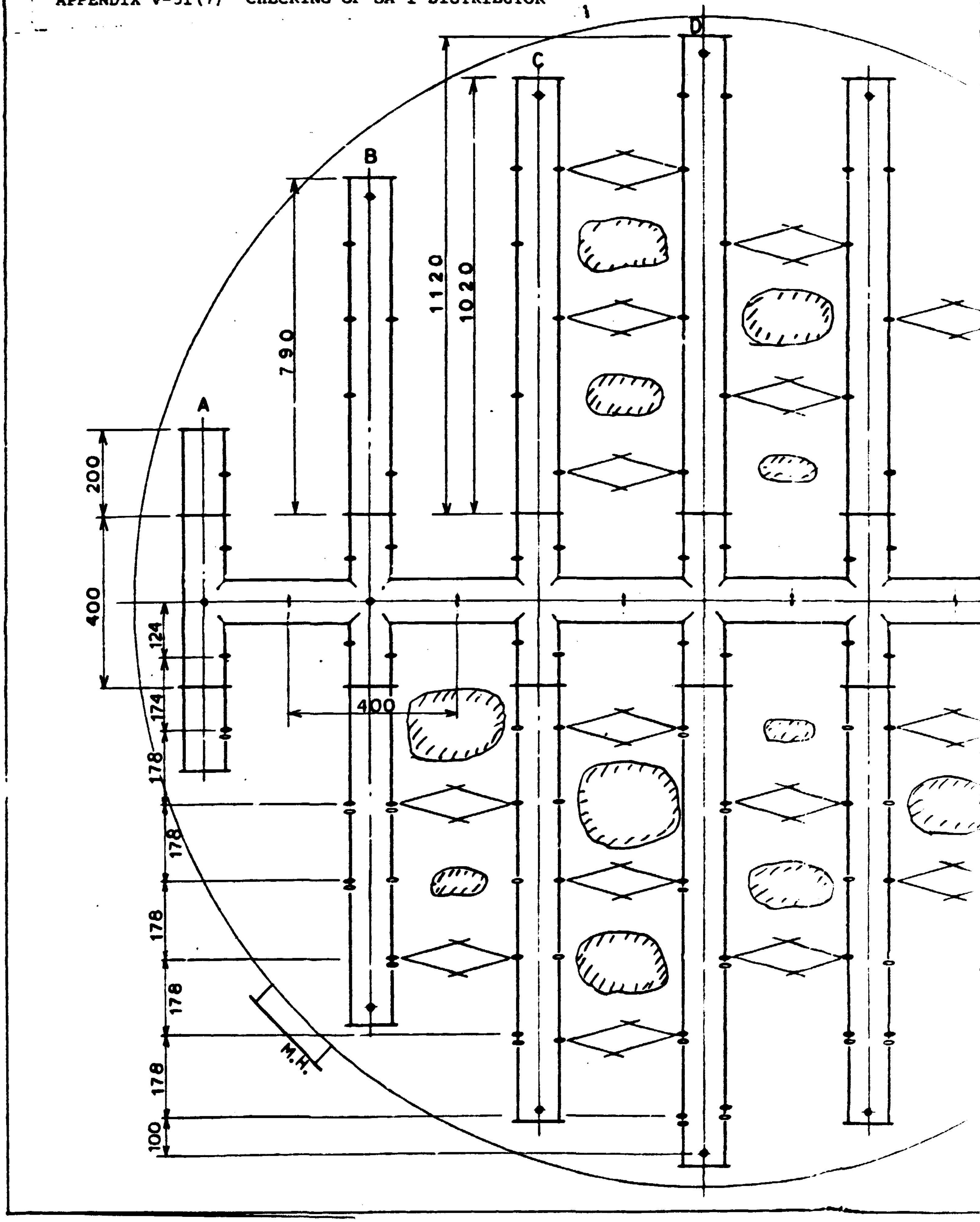




REQ'D NO : 3

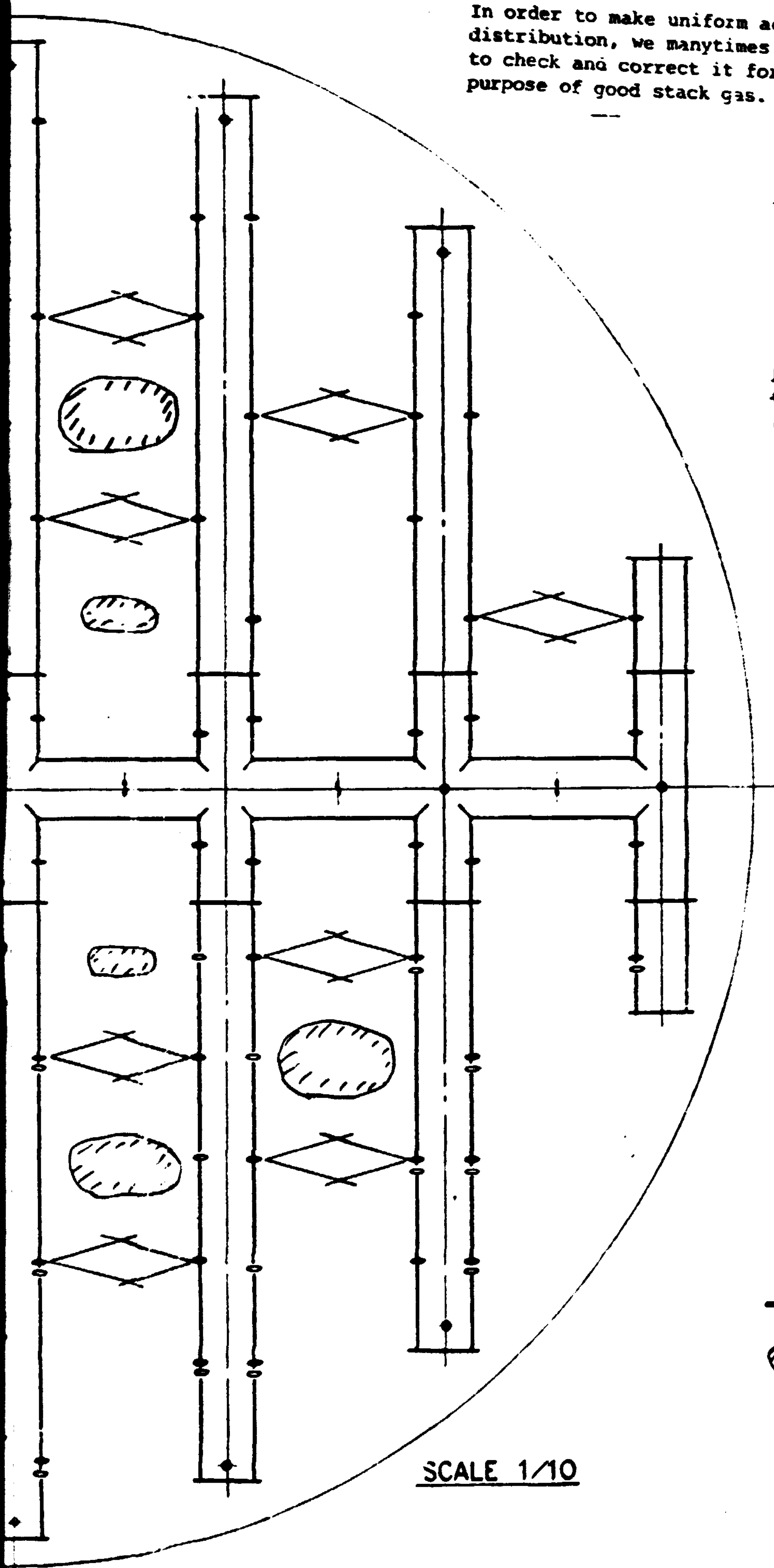
SECTION 2

APPENDIX V-31(7) CHECKING OF SA-1 DISTRIBUTOR

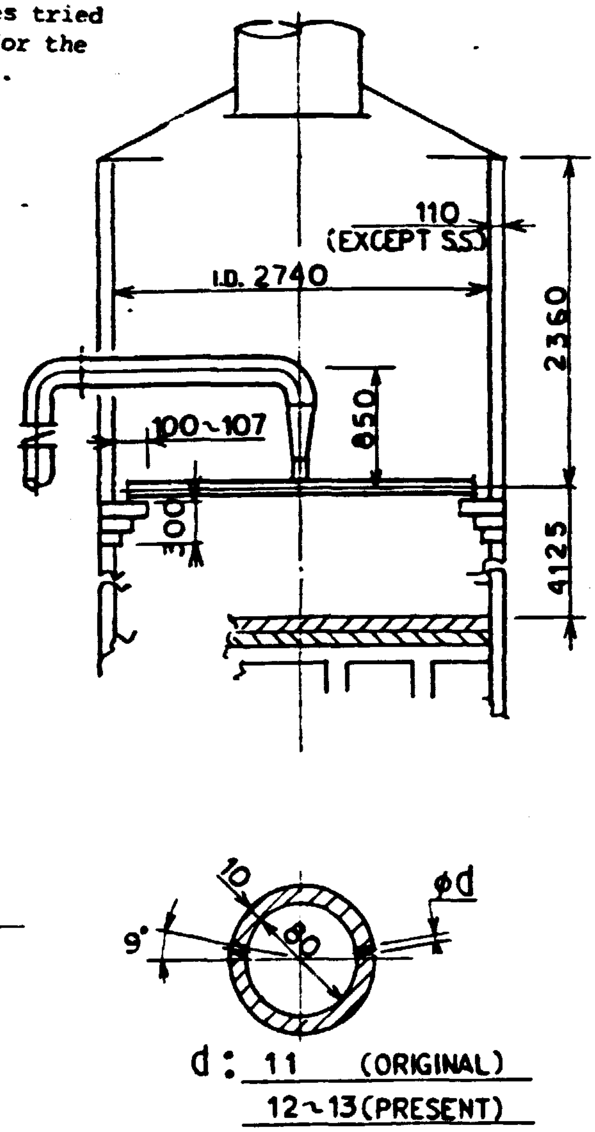


SECTION 1

In order to make uniform acid distribution, we manytimes tried to check and correct it for the purpose of good stack gas.



SCALE 1/10



SPRAY PIPE

Present hole

Original hale

too much spray
(attack each other)

due to less spray portion,
it is necessary to clean.

APPENDIX V-31(8) IMPROVEMENT OF SA-1 STACK GAS

iii)

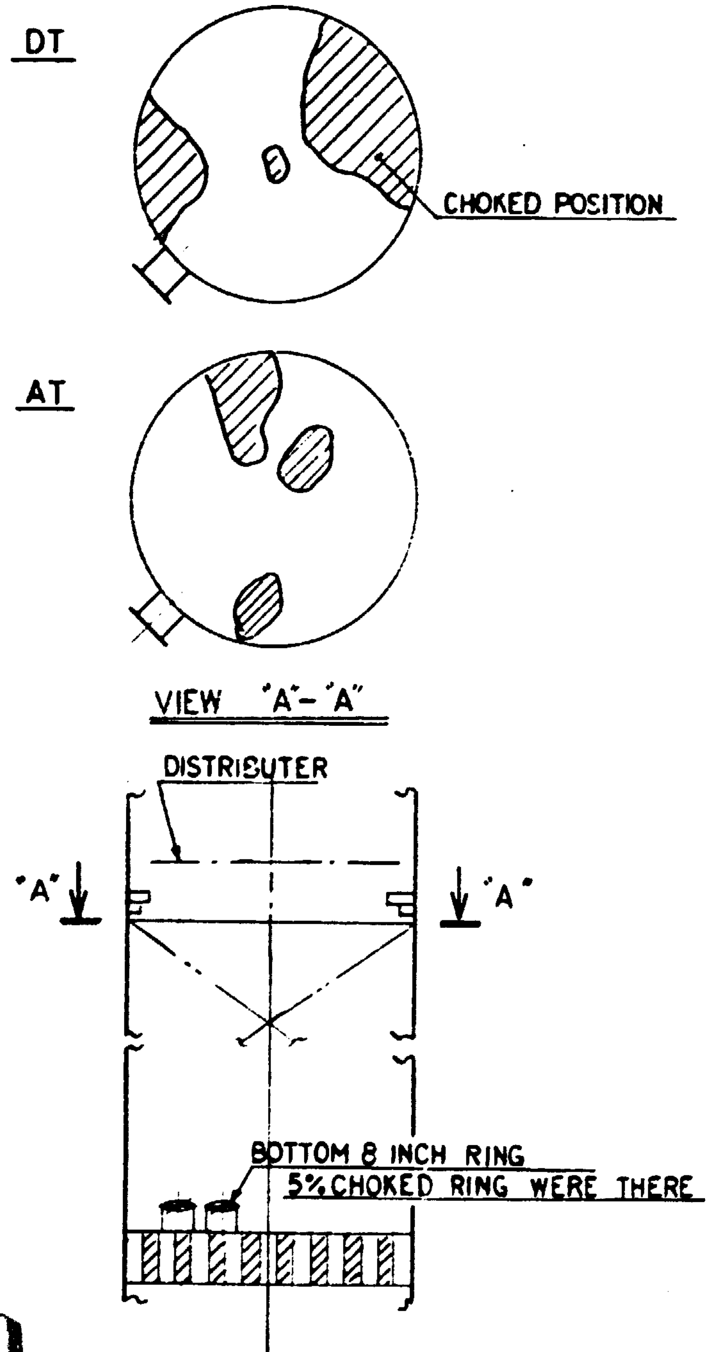
1. Duration of Implementation 18-11-1980 - 2-12-1980

2. Improved items

i) Moisture at DT outlet(mg/Nm^3)

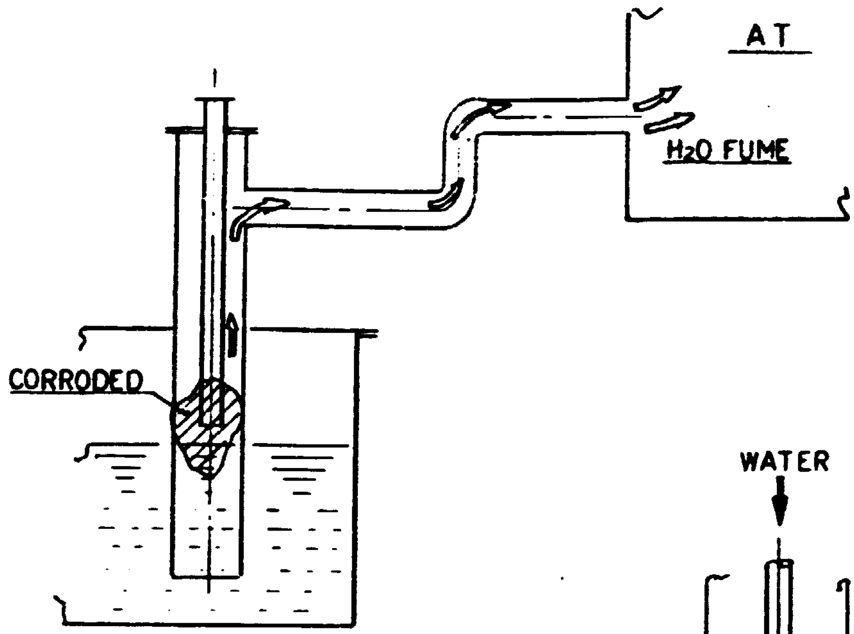
before repair	after repair
321 mg/Nm^3	130 mg/Nm^3
273 mg/Nm^3	58 mg/Nm^3
(av) 297 mg/Nm^3	(av) 94 mg/Nm^3

ii) Repacking of ring in DT & AT for prevention of channeling

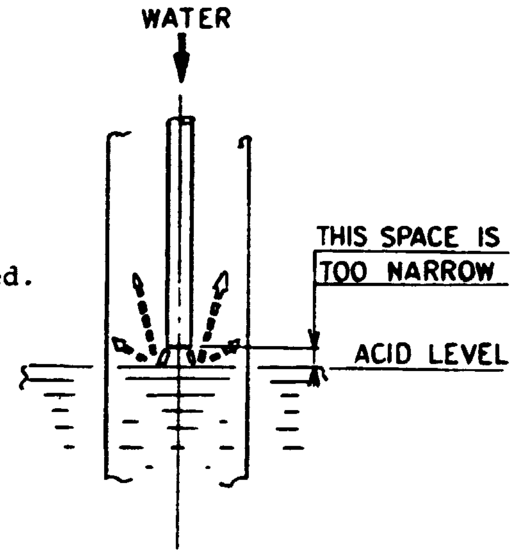


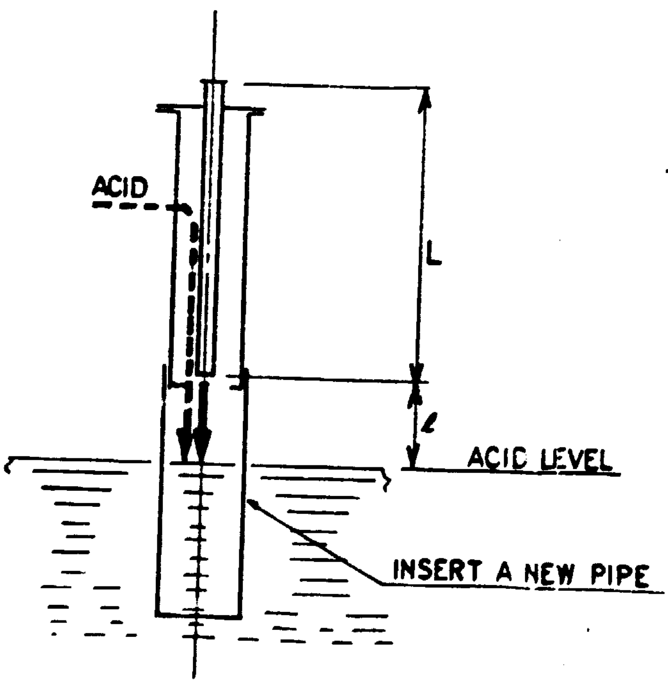
SECTION 1

iii) Change of acid and water mixing method in pump tank



added water were almost rejected.





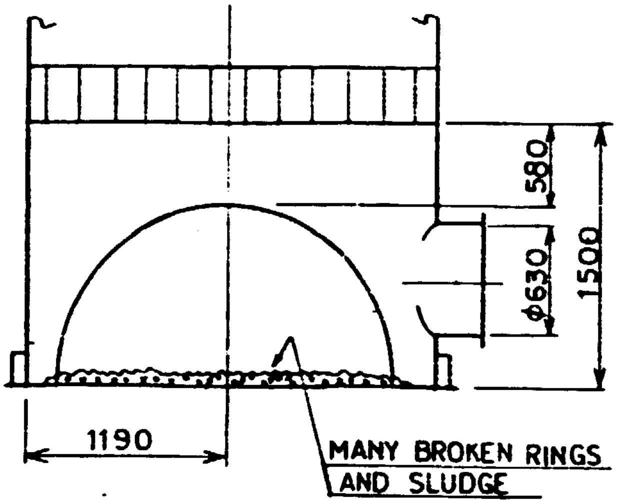
L : WATER TUBE LENGTH

Dimention (mm)

	Present	Before
L	1,260	2,200
lit.	900-1,000	0-100

Now, mixing is sufficient.

iv) Cleaning of the bottom of AT, DT and pump tank



If broken rings and sludge are remained, distributers will be again choked.

v) Acid cooling

- o Cleaning of the cooler surface by scratching
- o Change and repair of water distributer
- o Acid temp (°C)

		Before	Present
	AT	85 - 95	7·
	DT	75 - 80	

vi) Others

- o Adjustment of acid strength meter in different temp.
- o Justification of acid distributer
- o All acid is changed to all.
- o Checking of pump capacity
- o Setting of mist separator

V-32 RECOMMENDATION FOR INSTRUMENTATION

The whole documents were already submitted to TSP factory which were made by the expert team. Due to big volume, only each sample of following articles is inserted.

Appendix No.	Item	Inserted leaf	Original leaves
V-32			
(1)	Tag No. system	1	6
(2)	Instrument table of SA-2	1	13
(3)	Panel instrument	1	26
(4)	Instrument to be procured	1	6
(5)	Specification to order	1	18
(6)	Code No. to be cancelled	1	3

APPENDIX V-32(1) TAG NO. SYSTEM (1/12)

No SA Plant	Tag No		Name	
F-1	FR -	1001	Sulfur furnace Inlet air	
2	FRS-	1002	High pressure steam flow	
3	Fs -	1003	B.F.W Deerator inlet flow	
4	FS -	1004	B.F.W pump delivery flow	
5	FI -	1005	Flash tank flow meter	
6	FRC-	1006	Drying tower outlet air flow	
7	FS -	1007	Cooling water SA plant inlet	
8	FS -	1008	(D.M.W SA plant Inlet)	
L-1	LG -	1001	Sulfur pit pump section	
2	LG -	1002	" " " "	
3	LRCA	-1003	Waste heat boiler drum	
4	LG -	1004		
5	LG -	1005		
6	LICA-	1006	Dearater	
7	LG -	1007		
8	LC -	1008	Flash tank level controller	
9	LA -	1009	Boiler Chemical (Na_3PO_4) feed system level	
10	LA -	1010	Boiler Chemical (NaOH) feed system level	
11	LA -	1011	Boiler Chemical (Na_2SO_3) feed system level	
12	LG -	1012	Fuel Oil tank	
13	LI -	1013	Absorbing tower pump tank	
14	LI -	1014	Drying tower pump tank	
15	LA -	1015	Cooling water return pump pit	
16	LA -	1016 A B		
17	LG -	1017		
18	LC -	1018		
P-1	PICA-	1001	High pressure steam pressure	
2	PICA-	1002	Dearater	
3	PICA-	1003	Low pressure steam	
4	PIA -	1004	Boiler feed water pump outlet	
5				
6				
7	PG -	1007	Sulfur pump outlet	(Stop)
8	PG -	1008	Sulfur pump outlet	(Stop)
9	PG -	1009	Oil heater outlet	

(2/12)

No	Tag		No	Name
10	PG	-	1010	Molten sulfur trace steam (Jacket pipe)
11	PG	-	1011	Sulfur furnace air inlet
12	PG	-	1012	Sulfur furnace outlet gas
13	PG	-	1013	Waste heat boiler drum
14	PG	-	1014	Waste heat boiler outlet
15	PG	-	1015	Gas filter inlet
16	PG	-	1016	DM water SA Plant inlet
17	PG	-	1017	Deaerator inlet B.F.W.
18	PG	-	1018	Boiler feed water pump inlet
19	PG	-	1019	Boiler feed water pump delivery
20	PG	-	1020	Boiler feed water pump discharge
21	PG	-	1021	Gas filter outlet
22	PIA	-	1022	Boiler feed water pump outlet
23				
24	PG	-	1024	B.F.W.P. turbine outlet steam
25	PG	-	1025	B.F.W.P. turbine inlet steam
26	PG	-	1026	10^k steam
27	PG	-	1027	Molten sulfur trace steam
28	PG	-	1028	
29	PG	-	1029	Flash tank
30	PG	-	1030	Deaerator
31	PG	-	1031	Boiler chemical (Na_3PO_4) feed system outlet
32	PG	-	1032	Boiler chemical (NaOH) feed system outlet
33	PG	-	1033	Boiler chemical (Na_2SO_3) feed system outlet
34	PG	-	1034	Oil burner inlet
35	PG	-	1035	High pressure steam
36	PG	-	1036	Converter inlet
37	PG	-	1037	Converter No 2 layer inlet
38	PG	-	1038	1st heat exchanger inlet gas
39	PG	-	1039	1st heat exchanger outlet gas
40	PG	-	1040	Converter outlet
41	PG	-	1041	Economizer outlet gas
42	PG	-	1042	Air fan suction
43	PG	-	1043	Air fan delivery
44	PG	-	1044	Economizer inlet BFW
45	PG	-	1045	Economizer outlet B.F.W.
46	PG	-	1046	Absorbing tower inlet gas

APPENDIX V-32(2) INSTRUMENT TABLE SA-2

(1/15)

No	Tag No.	Location	Specification: Transmitter	Receiver	Controller	Detector		Others			Others	
1	FRS-1001	Furnace inlet air	13A-LK2/LD	PO-400	—	Orifice 10	FOP-1000A-ENV	3-Valve	DVH-310-4V			
2	FRS-1002	H.P. steam flow	13A-MK2	16A (3 pen)	—	Orifice 2000	FOP-150A-ENC	3-Valve	DVH-114-4V		Square root converter	157
3	FS-1003	BFW Deaerator inlet	—	—	—	Water meter	75-WW					
4	FS-1004	BFW pump delivery	—	—	—	Oval meter	LC323-N-F[illegible]	Strainer	SR03/203			
5	FI-1005	Plant tank flowmeter	—	—	—	Armored rotameter						
6	FRC-1006	D.T outlet air	13A-LK2/LD	2P 5030TSF-E/CSP4	2811-3[illegible]/TK(1.8)	Orifice 50	FOP-1050A-ENV	3-Valve	DVH-310-4V		Sub panel	575R-93-N
7	FE-1007	C.W. SA plant inlet	—	—	—	Orifice 3000	FOP-400A-ENV	3-Valve	DVH-114-4V			
8	FS-1008	D.W. SA plant inlet	—	—	—	Water meter	75-WW					
9	LRCA-1003	WHB drum	13A1-MK2-L	5033TSF-E/CSP4	2805(50/20)/TK(2.0)	Computer	56-5-9	Pressure switch	7100	8 pcs	Sub panel	575R-61-N
10	LRA-1006	Deaerator	13A1-MK2 L/LD	43A-A6-P/PR1	2805(50/20)			Pressure switch	7100	2 pcs		
11	LI-1013	AT Pump tank	—	DU80 150×2670	—	Bubbling tube	LBP	Air purge set	LD-11			
12	LI-1014	DT Pump tank	13A1-MK2	PO-150DF	—	Bubbling tube	LBP	Air purge set	DB-11			
13	LA-1015	C.W. return pump pit	—	—	—	Floatless switch	61F-G3	Electrode holder	BS-1N	5 pcs		
14	PICA-1001	H.P steam	45/PS1 (30 kg)	53A-SH4	2805(80)/TK(3.0) 2815(80)/T/C(3.0)			Pressure switch	7100			
15	PRA-1002	Deaerator	45/PS2/CAP (0.7 kg)	43A-A6-P/PR1	2805(10)/T/C (1.4)			Pressure switch	7100			
16	PRA-1003	L.P Steam	45/PS2/CAP (2.5 kg)	43A-A6-P/PR1	2811(80)/T/C (3.0)			Pressure switch	7100	3 pcs		
17	PIA-1004	BFW Pump outlet	45/PS1 (40 kg)	PO-150%	—			Pressure switch	7100			
18	PIA-1022	BFW Pump outlet	—	—	—			Pressure switch	CM-40 (40 kg)			
19	PIA-1058	Irrigation water inlet	45/PS2 (10 kg)	PO-150%	—			Pressure switch	7100			
20	PIA-1071	DW for SA plant	45/PS2 (4 kg)	PO-150%	—			Pressure switch	7100			
21	PIA-1072	I.A for SA plant	—	—	—	Gauge with valve	DB$\frac{1}{2}$·150×7"					
22	TRA-1001	Sulfur furnace outlet	—	TRE-30-M-23 (2P)	—	Thermocouple	21100-PR(S)-UM650	2 pcs	See another page			
23	TI-1002	Temperature for SA	—	TIH-30-23 (10P)	—	Thermocouple	21500-CA-SUS27 / 2[illegible]-CA-SUS27	3 pcs / 6 pcs			Select switch	SLH-11-10
24	TR-1003	Temperature for SA	—	TRB 12-30-23 (12P)	—	Thermocouple	[illegible]-CA-SUS27 / [illegible]-CA-SUS27 / [illegible]-CA-SUS27 / [illegible]-CA-SUS27	4 pcs / 3 / 1 pc / 1				
—			—									
25	AI-1001	Boiler water	Converter MCD-12	EIE-10	—	Conductivity detector	SAL-1F-81-1					
26	AR-1002	Converter inlet gas	[illegible]	ZP1-10	-			Power box	PD-1-1			
27	AR-1003	AT inlet acid		ECEAS-10	280[illegible](31/31)							
28	PHRA-1002	Cooling water	PH converter HPH 3-1	EHE-10K	—	Electrode	CLF-3F 11					
29	HC-1001	Storage tank inlet		—	2802 (40)						Sub panel	5706-N
30	HC-1002	Acid from AT to DT		—	2801 (50)						Sub panel	5706-N
31	HC-1003	Acid from DT to AT		—	2802 (50)						Sub panel	5706-H

V-32(3) PANEL INSTRUMENT

30. 9 1980

No	Name	Type	Q'ty	Used Tag No	Standard Spare	Stored Spare		Rack No	Remarks
1	Recording control station	S422TSF-E (3P)	3	F1006, L1003, L2305	1	3	18-53-531	14-R	
2	Recording control station	S412TSF-E	6	P2303 P2301 P2314A P2301B P2314A P2301B	1	3	18-53-533	14-R	
3	Universal controller	SSPS	2	L2306 P2301	1	4	18-52-342	14-M	JFW-5 Fixing 1
4	Universal controller	SSPA	7	F1006, L1003, F2303, F2301A, F2314B, P2301A P2314B	1	16	18-52-341	14-M	YEW 10 Fixing 6
5	Recording controller	(4643-5450)**	1	F-2304	1	1	18-53-550		
6	Recording controller	(4641-5550)**	1	A1003	1	1	18-53-546	14-M	Stock Type in 4641-4551(new)
7	Recording controller	(4641-5450)**	2	F2301, F2302	1	0	18-53-548		
8	Recording controller	(4642-3551)**	3	T2301 T2314A, T2301B	1	2	18-53-549		
9	Indicating controller	S2A-S4B	3	P1001, L2301A, L2301B	1	3	18-53-534	14-H	
10	Temp. Recorder	(4231-2550-30)**	1	T1001	1	0	18-53-507		
11	Temp. Recorder	ERB12-30-23	1	T1003 (0-800°C)	1	1	18-53-541	14-C	
12	Temp. Recorder	(4231-2050)**	1	T2301 (0-300°C)	0				
13	Temp. Recorder	ERB12-30-24	1	T2302 (0-150°C)	0				
14	Temp. Recorder	ER26-30-30	1	T3003 (0-150°C)	0				
15	Temp. Recorder	ERB6-10HLD12	1	T3003 (0-300°C, 0-600°C)	0	1	18-53-536	14-C	Relay unit Type RY-140A
16	Temp. Transmitter	TRP-121	2	T3003-1 ( ) T-3003-2 ( )	0	0			
17	Elect. recorder	(4231-5050)**	1	A1002	0				Power box PD-16-1
18	Elect. recorder	(4231-5550)**	1	PHI-1005					
19	Elect. recorder	(4231-5550)**	1	C4101	0				
20	Temp. indicator	EIH-30-23	1	T1002	0	1	18-53-440	14-C	
21	Select switch	SLH-14-10	1	for T1002	0	1	18-54-173	14-C	
22	Elect. indicator	(4231-5050)**	1	A1001	0				
23	Elect indicator	(4231-5050)**	1	PH4101	0				
24	Integrator	14A (200)	1	F-1002	0	2	18-53-557	14-H	
25	Integrator	ESG-34	1	F2301	0	0			
26	Integrator	ESQ-33/18	1	F4111					now out of order
27	Receiver gauge	PO-4DQ	3	F1001, F2301A, F2301B	1	2	18-51-142	14-P	
28	Receiver gauge	PC-4DL (100)	5	L2301 L2305 L2307 D2301 L2301A L2301B	1	5	18-51-132	14 P	
29	Receiver gauge	PC-4DL (150°C)	3	T2304 T2302A T2302B	1	1	18-51-133	14 P	
30	Receiver gauge	PC-100DF	6	P2330 P2331 P2302 P2333 P2334	1	10	18-51-133	14 P	
31	Receiver gauge	PC-150DF	8	L1010 P1003 P1038 P1071 P2312 P2313 P2316 [illegible]	1	2	18-51-315	14 P	
32	Receiver gauge	[illegible]	1	L1106 ([illegible])	[illegible]				
33	Pneumatic indicator	SCCIV	1	L3-4	[illegible]		18-53-414	14-H	

** recommended type No.

APPENDIX V-32(4) THE INSTRUMENT TO BE PROCURED

Item 1 Recording controller

Type : Electric and pneumatic controller
Model : 4641-5550 (NREA of YEW)
Index set : Local
Input signal : 1-5VDC
Output signal : 0.2-1.0 Kg/cm² G
Supply pressure : 1.4 Kg/cm² G
Electrical source : AC 100V, 50Hz
Connection of signal : Tapped NPT 1/4
Control action : Proportional plus integral plus derivative
Scale range : 92.5 — 96.5 % H_2SO_4
Tag No : ARC-1003M
No of recording : 1 (one)
Quantity : 1 (one)

Item 2 Recording controller

Type : Electrical and pneumatic controller
Model No. 4641-5450-A11 (NREA of YEW)
Index set : Local
Input signal : 1—5VDC
Output signal : 0.2-1.0 Kg/cm² G
Supply pressure : 1.4 Kg/cm² G
Electrical source : AC100V, 50Hz
Connection of signal : Tapped NPT 1/4
Control action : Proportional plus integral

Scale range : 0 - 12 m³/H
Tag No : FRC-2301M
No of recording : 1 (one)
alarm : Absolute high and low N.C.
Quantity : 1 (one)

contd. P/2

Item 3 Recording controller

Type : Electrical and pneumatic controller
Model No : 4642-3551-A11-2
Index set : Local
Input signal : Resistance bulb (Pt 100 ohm, 3W)
Output signal : 0.2-1.0 Kg/cm² G
Supply pressure : 1.4 Kg/cm² G
Connection of signal : Tapped NPT 1/4
Control action : Proportional plus integral plus derivative
Scale range : 0-150°C
No of recording : 2 (two, No 2. pneumatic)
Alarm : Absolute high and low N.O. (No 1)
Tag No : TRC-2301
Quantity : 1 (one)

Item 4 Recording controller

Type : Electric and pneumatic controller
Model No : 4643-5450 (NREA of YEW)
Index set : Local/Remote both
Input signal : 1-5VDC
Output signal : 0.2-1.0 Kg/cm² G
Electrical source : 1.4 Kg/cm² G
Connection of signal : Tapped NPT 1/4
Control action : Proportional plus integral
Scale range : 0-60 m³/H
Tag No : FRC-2304
No of recording : 1 (one)
Quantity : 1 (one)

Contd. P/3

APPENDIX V-32(5) SPECIFICATION TO ORDER

1/35

Panel instruments

No.1 Code No.18-53-531

Recording control station

Model 5422 TS, F-E

Index set	:	Local
Input signal	:	0.2-1.0 Kg/cm^{2}G
Output signal	:	0.2-1.0 Kg/cm^{2}G
Supply pressure	:	1.4 Kg/cm^{2}G
Electrical source	:	AC100V,50HZ
Connection of signal	:	Tapped NPT ½
No. of recording	:	2. (Two)
Scale range	:	(Decide when order)

No.2 Code No.18-53-533

Recording control station

model No.5412TS, F-E

Index set	:	Local
Input signal	:	0.2-1.0 Kg/cm^{2}G
Output signal	:	0.2-1.0Kg/cm^{2}G
Supply pressure	:	1.4 Kg/cm^{2}G
Electrical source	:	AC 100V,50HZ
Connection of signal	:	Tapped NPT ½
No. of recording	:	1 (one)
Scale range	:	(Decide when order)

No.3 Code No.18-52-342

Universal controller

Type	:	Universal Controller
Model No.	:	58P5
Input signal	:	0.2-1.0 kg/cm^{2}G
Output signal	:	0.2-1.0 Kg/cm^{2}G
Supply pressure	:	1.4 Kg/cm2G
Control action	:	Proportional plus integral plus delivative
Mounting	:	Each of recorder

Continued....P/2.

2/35

No. 4 Code No. 10-52-341

Universal controller

Type : Universal Controller

Model No. 58P4

Input signal	:	0.2-1.0 Kg/cm2 G
Output signal	:	0.2-1.0 Kg/cm2 G
Supply pressure	:	1.4 Kg/cm2 G
Control action	:	Proportional plus integral
Mounting	:	Back of controller

No. 5 Code No. 10-53-550

Recording controller

Type : Electric and pneumatic controller

Model : 4643-5450, (NREA of YEW)

Index set	:	Local/Remote
Input signal	:	1-5V DC
Output signal	:	0.2 - 1.0 Kg/cm2 G
Supply pressure	:	1.4 Kg/cm2
Electrical source	:	AC100V, 50Hz
Connection of signal	:	Tapped NPT ½
Control action	:	Proportional plus integral.
Scale range	:	0-60 m^3/H
Tag No.	:	FRC - 2304N
No. of recording	:	1 (One)

No.6 Code No. : 10-53-546

Recording controller

Type : Electric and pneumatic controller

Model : 4641 - 5550 (NREA of YEW)

Index set	:	Local
Input signal	:	1-5V DC
Output signal	:	0.2-1.0 Kg/cm2 G
Supply pressure	:	1.4 Kg/cm^2
Electrical source	:	AC100V 50 Hz
Connection of signal	:	Tapped NPT ½

Continued......P/3.

APPENDIX V-32(6) CODE NO. TO BE CANCELLED 1/4

18-51-003	Pressure gauge	0-2 kg/cm²
18-51-006	-do-	0-4 -do-
18-51-007	-do-	0-8 -do-
18-51-009	-do-	0-15 -do-
18-51-010	-do-	0-3 -do-
18-51-011	-do-	0-20 -do-
18-51-012	-do-	0-25 -do-
18-51-013	-do-	0-30 -do-
18-51-014	-do-	0-33 -do-
18-51-019	-do-	0-5 -do-
18-51-020	-do-	0-60 -do-
18-51-022	-do-	0-70 -do-
18-51-023	-do-	0-75 -do-
18-51-024	-do-	0-80 -do
18-51-025	-do-	0-5 -do-
18-51-026	-do-	(PG-4111)
18-51-028	-do-	0-100 kg/cm²
18-51-147	Out put gauge	0-2 kg/cm²
18-51-148	-do-	0-200 do
18-51-458	Temperature gauge	0-400 °C
18-51-599	Control valve	
18-51-631	Thermocouple	
18-51-636	-do-	
18-51-782	Thermo resistance bulb	
18-51-789	-do-	
18-51-792	Thermo element	
18-51-796	Thermo resistance bulb	
18-51-798	-do-	
18-51-801	Resistance bulb	
18-51-802	-do-	

18-52-005	Pressure switch C-437H
18-52-006	Pressure switch for air comp.
18-52-128	micro-switch
18-52-218	Pressure switch
18 52 279	Converter 6149-2250
18-52-280	-do- 6149-2250
18-52-289	Square root converter
18-52-372	Pneumatic controller
18-52-435	Synchronous motor
18-52-450	Balancing motor
18-52-478	Chart motor
18-52-559	Voltage stabilizer
18-53-025	Transmitter Y/12A
18-53-059	d/p cell transmitter
18-53-070	-do-
18-53-071	-do-
18-53-077	-do-
18-53-078	-do-
18-53-081	-do-
18-53-082	-do-
18-53-091	-do-
18-53-098	-do-
18-53-099	-do-
18-53-068	-do-
18-53-193	Transmitter
18-53-249	Purge meter
18-53-423	Indicating controller 43AP
18 53 468	-do- -do- -do
18-53-471	-do -do -do
18-53-476	pressure indicator
18-53 477	-do- do

APPENDIX V-33(1) RECOMMENDATION FOR QUANTITY AND SPECIFICATION OF ELECTRICAL SPARES FOR MAINT 503

* : Specification added or corrected by us.

HITACHI LTD. (Japan)

Sl.No.	Description	Q'ty Required	Recommendable Q'ty
1	For Jetty Moving Hopper, Item No. JV-1ABCD* Control Box Type Ho., Form AM. Volt 400, Date 1969 MFG.No.E 26891E-9 Drg.No. Narashino Works NB341968 - 341971* Date : 1969	4 Nos	4
2	For Unloading Conveyor, Item No.O-1101ABC. O-1102AB, O-1103ABC* O-1104C, O-1105 Control Box Type Ho., Form Am Volt 400, Data 1969 MFG. No.E 26891E-9 Drg. No. NB341946 NB341949 - 341957*	10 Nos	10
3	Fuses & their auxiliaries Low tension fuse element for control circuit, 250V 3 Amps.	25 Nos	0
4	-do- 5 Amps *Type F_CF_2-5 (Fuji Electric)	25 Nos.	0
7	Holder for cartidge, Item No. JO-1ABC and O-1101-O-1105 Fuse, AFC-20-3 Drg.No. Narashino Works NB 341945 Dt.1969 *Type AFC-30(Fuji Electric)	7 Nos.	7
9	Expulsion (Fuse in door type) Type FT - SR Rated Voltage 12KV Rated Current 0.5A Insulation class 10A JEC No. JEC-176 Date 1969 MFG. No.487643, Single Line diagram Drg.No. 2120686	3 Nos.	3
11	For LT. Motor Starter Panel Bus bar holder (Knife socket) Complete with ebomite base for branch bus connection Type - EG 523 Units connection diagram, Drg. No. Narashino - NB 342799 *NB 342796	50 Nos.	NB 342796 30 NB 342799 20
12	For 800 KVA Power condenser : Capacitor - 100 KVA Phase - 3, 50 Hz SOU - J Form 3 RD Insulation level 3 Rated voltage 3,300 V Rated current 17.5 A Total wt 70 kgs MFG. No. 568168-2-8 Dated Dec. 1967, Electric single line diagram Drg.No. 2120686	8 Nos (1set)	8 Nos(1set)

Sl.No.	Description	Q'ty Required	Recommendable Q'ty
13	Flexible copper strip for connection of the above capacitor MFG No. 568168-2-8 Drg.No. 2120686 Dt. Dec. 1967	50 Nos	50
14	Toggle Switch or Snap Switch Type ST-22V 250V,5A Drg.No.EPB-1056	2 Nos	2
15	Magnetic contactor AC Auxiliary contactor 600 V, 3A Type K-8 x 4 *Type K-8-6 Poles 4A 4B Operating coil 100/110 50/60 Hz, MFG No. XK13819, Sequence Drg.No. 24NB 342325	6 Nos	6
16	Auxiliary AC Contactor 600V, 5A Type Frame K-4 x 2 *Type K-4-6 Poles 2a, 2b Operating coil 10-/110V 50/60 Hz, symbol 49x MFG.No. XK05429	6 Nos	6
17	Magnetic contactor, 600 V, 3A K-30-DPD Coil voltage 100VDC MFG.No. C204529 *Type K30N-EPG	3 Set	3
18	Magnetic contactor K-10F-DPD 110V coil MFG.No. 210349 *Type K11N-EPG	3 Nos	3
19	Magnetic contactor K-75 DPD 110V Coil, Sequence drg.No. 24NB 342325 Dt. 1969 *Type K100N-EPD	2 Nos	1
20	Voltage relay Type K1V-KM 110 Volts 50 Hz set tap. 70-100 Cont. Volt DC 100V, Ser. No. V2122 Mfg. Medensha Electric Co. Ltd.	2 Nos	1
21	OFF/On Switch (Symbol BSS-E1 & BS-E1) *Type (E) B-1ED Ac 600V, 3A. Sequence drg.No. NB 342322*	4 Nos	4
22	Timer SM-15-01, Type SM For-IS 0.1-1 sec. No. K 36861, Dt 1969 Sequence Drg.No. 24NB 342322 *Type DMT (Tateishi Electronics)	2 Nos	2

Sl.No.	Description		Q'ty Required	Recommendable Q'ty
23	List of Carbon Brushes For Generator & Air Blower:			
	Size : 1.72 cm breadth 1.99 cm length 2.9 cm height (for slipring) along with holder		12 sets Mfg: Meiden Sha Electric Mfg. Co.	0 set
	Item No.5101, Serial No. 5121900 Dt. 1968, JEC-114 (1969)			
	Solderless Amp. Terminals :			
1	3.5/3.5 mm^3	3.5 ø	1 kg	1 kg
2	3.5/5.5 mm^2	4 ø	1 kg	1 kg
3	3.5/5.5 mm^2	8 ø	1 kg	1 kg
4	80.0 mm^2		24 Nos	24 Nos
5	150.0 mm^2		12 Nos	12 Nos
6	Amp. Joints 2.0 mm^2		2 kg	2 kg
7	Amp. Joints ranging from 3.5 mm^2 to 3.8 mm^2		3 kg	3 kg

APPENDIX V-33 (2) RECOMMENDATION FOR QUANTITY AND SPECIFICATION OF ELECTRICAL SPARES FOR MAINT 537

* : Specification added or corrected by us

Sl.No.	Description	Unit	Manufacturer: Hitachi Ltd. JAPAN Q'ty Required	Recommendable Q'ty
	No Fuse Braker for Incoming Panel			
1	Panel No.1FA Item No.5405-2 Item No. Incoming Panel PA Plant Working voltage : 400 V C.T. Ratio : 1,200/5 Code No. K - 1F (Hitachi Code No.) Rated Ampere 1,400 Amper Frame Tripping Ampere 1,200 A Item No.5405-3, Drg. No.NB341023 * Type F-1400/1200A	No.	1	1
2	Panel No. 1FA Item No.5304-1 Code No. K-TF (Hitachi Code No.) TSP No.1, Rated Voltage 400V C.T. Ratio 600/5 Rated Ampere 600 AF Tripping Current 600 A Item No.5304-1, Drg. No. NB341024 * Type F-600C/600A	No.	1	1
3	Panel No. 4FA Item No.5404(4) Item No.5304-2 C.T. Ratio 1000/5 Tripping Current 1000 A-F Rated Current 1000 AF Drg. No. NB 341026 * Type F-1000B/1000A	No.	1	1
	RELAY : OVER VOLTAGE RELAY FOR 5MVA TRANSFORMER 2RY PANEL			
4	Induction Disk Flush Swing out type rated voltage 110V, 50 HZ Rated Power, Comsumption 19VA setting Tap 80-120-135-165 volts Hitachi Type IV-AC-B2 Symb. 59s Item No.5108-2, Mfg.No. 135051 Sequence diagram (rev) U 3398877 Sept. '69 * Type IV-AC-B_1	No.	1	1
5	UNDER VOLTAGE RELAY FOR 5MVA 2RY PANLE:			
	Induction Disk, Flush Swing out Type Rated voltage 110V, Rated Frequency 50 HZ, 20VA setting Tap 60-65-70-75-80 volts Hitachi Type IV-UC-B2 Symbol. 27S, Item No. 5108-2 Mfg.No.135042 Sequence diagram (rev) U 3398877, Sept. 1969 * Type IV-UC-B	No.	2	1
6	Instantaneous in verse time relay for W.T. & C.T. Panel in Main Sub-Station. over current relay Induction Dist Flush swing out type, rated current 5 Amps. 50 HZ, 10VA setting tap 2.5-3.75-5-6.25 7,5-8-75-10, Amps, Type 10-CIB-B2 Symbol 50151F Item No.5108-6 Sequence diagram No. U 3398880 Mfg.No. 1350122 Dt. Sept. '69 * Type IO-CIA-5B	No.	1	2

Sl.No.	Description	Unit	Q'ty Required	Recommendation Q'ty
7	Instantaneous and Inverse : Time Over Current Ground			
	Relay for 5MVA Tranformer Primary Panel Induction Dist Flush swing out type rated current 5 Amps frequency 50 Hz power consumption 10 VA setting tap 1-1.5-2-2.5-3-3.5-4 Amps. Range of setting in Instantaneous unit 10-40 Amps Type : 10-CIB-B2 Symbol 50/51 GR Mfg. No. 162021 Dated 1969 *Type IO-CIA-$5B_1$	No.	1	1
8	Instantaneous and Inverse : (For Air Blower (K-1201)			
	Thime over current relay Induction Disk Flush swing out type, rated current 5 Amps frequency 50 Hz, Power consumption 0.44VA, setting tap 2-2.2-2.5-2.8-3.1-3.5-4 Amps. Range of setting in first Instantaneous unit 24-72 Amps. Instantaneous second unit 4-12 Amps. Operating time in the first Instantaneous unit 20-30 Amps. Type 10 MB-C3-B8 Mfg. No. 135036, Symbol 49-50-83F *Type IOM-C-B_1	No.	1	1
	THERMAL OVERLOAD RELAY :			
	Thermal Relay : Type TR-20-RTC for LT motor starter panel units (of TSP-2 Factory) *Type			
9	0-48 Amp to 0.52 Amp TR20-IE 0.5A	No	5	2
10	1.0 Amp to 2.2 Amp TR20-IE 1.4A	No.	3	3
11	4.0 Amp to 5.0 Amp TR20-IE 3.8A	No.	3	3
12	12 Amp to 18 Amp TR20-IE 15A	No.	3	0
13	22 Amp to 34 Amp TR40-IE 28A	No.	3	0
14	43 Amp to 57 Amp TR100-IE 55A	No.	2	2
15	58 Amp to 78 Amp TR100-IE 67A	No.	2	2
16	65 Amp to 96 Amp TR100-IE 80A	No.	2	2
17	80 Amp to 120 Amp TR100-IE 105A	No.	2	0
18	120 Amp to 180 Amp	No.	2	0
19	150 Amp to 220 Amp	No.	2	0
20	200 Amp to 280 Amp	No.	2	0
	MAGNETIC CONTACTOR FOR LT MOTORS STARTER UNITS OF TSP-2 FACTORY :			
	Magnetic Contactor Complete set, 600 volts Coil voltage 100 volts, 50 Hz Single Phase *Type			
21	K-15-EP_3 (12 Amp) K15BN-EP_3,TR20-IE 9A	No.	3	3
22	K-30-EP_3 (35 Amps) K30N-EP_3, TR40-IE 40A	No.	3	0
23	K-50-EP_3 (33 Amps) K25N-EP_3, TR40-IE 28A	No.	3	5
24	K-60-EP_3 (60 Amps) K60N-EP_3, TR100-IE 67A	No.	3	3
25	K-20-EP_3 K20BN-EP_3, TR20-IE 20A	No.	2	2

Sl.No.	Description	Unit	Q'ty Required	Recommendable Q'ty
26	$K-200-EP_3$	No.	1	0
27	$K-250-EP_3$	No.	1	0
28	$K-600-EP_3$	No.	1	0
	Auxiliary Magnetic Contactor For LT Motors Start Units			
29	K-8 x 4, 100v, 50 Hz(4a + 4b) *Type K-8 x 6	No.	3	0
30	K-8 x 2, 100v, 50 Hz(2a = 2B) *Type K-4 x 6	No.	3	0
	Coil for Air circuit Braker Mfg.No. 447070-5 Dated 1969			
31.a	Closing Coil Type - 3 DCB-50C	Set	2	0
b	Tripping coil Type - 3 DCB-50C	Set	2	0
c	Over current Tripping device of Air Circuit Braker Type 3 DCB - 50C	Set	2	0
d	Draw out Machanism Lever of Air Circuit Braker Type 3 DCB - 50C	No.	1	1
32	P. Transformer for IIKV Panle in Main sub-station			
	Potential Transformer			
	Rated Primary Voltage 11KV	No.	1	1
	Rated Secondary Voltage 110V 50 Hz, Single Phase, Rated Burden, 50 VA, Accuracy Class-1.0-Class Type OELV-CC Electric Single Line diagram Drg. No.2120686			
33	Current Transformer for 11KV Panel in Main sub station Rated Primary Current 400 Amps. Rated Secondary current 5Aps. Highest System Voltage 11KV 50 Hz Single Phase, Rated Burden 40VA Rated Over current strength Factor 75 times 1 sec. Type NUH-11-C, Electric Single line diagram Drg.No.2120686	No.	1	1
34	Current Transformer for L.T. Panel primary current 1000A secondary current 5A Highest system voltage 115V, 50 Hz, single phase Rated Burden 15VA Type ESI-15S Item No.5505-4, Sequence Diagram Drg.No.455387			0
35	Current transformer for L.T.Panel Primary current 1200A Secondary current 5A Highest system voltage 115V 50Hz, Single Phase Rated Burden 15VA Item No.5405-2, Sequence Diagram No.0441519	No.	1	0

Sl.No.	Description	Unit	Q'ty Required	Recommendable Q'ty
36	Saturable current Transformer (For Inverse Time Over Current Relay) current ratio 110A/0.65A to 50 MA/1.5 MA, Highest system voltage 115V 50 Hz, single Phase Rated Burden 30 Ohms, Type MU-R	No.	1	0
37	Source Transformer for Jetty, W.T. & SA Operation system Single Phase 50 Hz WOUND CORE Type 5KVA* Primary voltage 3.3KV Secondary 210 t 105V Item No.5505(3), sequence diagram No.U 3398904	No.	1	1
38	CIRCUIT BRAKER :			
	Oil circuit braker (OCB) Ball Mill Motor Item NO.M-2201-1 3 Pole single throw bulk oil removal Type rated voltage 7.2 KV Rated Current 400 Amps. Rated frequency 50 HZ, rupturing pacacity 100MVA (at 3.6 KV) Rated short circuit current 16.0 KA (2 ACC) Closing current 43.7 KA Operating and Tripping Battery Insulation Level - 5 Class D.S. Test Voltage 22KV Mfg. No.432264-8, Date 1969	No.	1	1
39	Air circuit Braker (ACB) for PA Feeder No.1 600 Volts 1,200 Amps. Rupturing capacity 40KA (at 600V) 50Hz with solencid operator magnetic type closing and tripping battery Type 3DCB - 50C-03 TMA Mfg. No.447070 - 5 Date 1969	No.	1	1
40	Air circuit Braker for PA II Plant Incoming Panel 600V 50 Hz Rupturing Capacity 70KA Magnetic Type Closing & Tripping Battery Type : 3DCB-75A-03TMA Mfg. No.447069-3 dated 1969	No.	1	1
41	Spares for A.C.B. (for sl.No.)			
a	Moving are contactor Type 3 DCB - 75A form 03 TMA	Set	2	2
b	Moving Main Contactor Type 3 DCB - 75A Form 03 TMA	Set	2	2
*c	Arc chuto Type 3DCB-75A Form 03 TMA			2
42	Meter			
	A.C. Voltmeter for metering panel(H.T.) Rated voltage 150V Frequency 50Hz Accuracy Class 1.5 Class Scale 0-15 KV Rated Power Consumption 7.5 VA Type SR-36 *Meter Scale 15KV	No.	2	1
43	Ampere Meters for metering panel (H.T.) A.C.Ampere meter rated current 5 Apms. 50 Hz accuracy class 1.5 scale 0-400 Ampr. Rated Power consumption 2.5 VA Type SR-36 No. 611011 *Meter Scale 400A	No.	2	1

Sl.No.	Description	Unit	Q'ty Required	Recommendable Q'ty
44	A.C. Ampere Meter Rated current 5 Amps Frequency 50 Hz Accuracy class 1.5 Scale 0-1200 Amps (0-1.2KA) Rated Power 2.5VA Type SR-36 No.648011 *Meter Scale 1200A	No.	2	1
45	A.C. Ampere Meter Rated current 5 Amps Frequency 50 Hz Accuracy class 1.5 Rated power 2.5VA Scale 0-300 Amps. Type SR-36 For Ball Mill Panel (M-2202-1) No. 648013 *Meter Scale 300A	No.	2	1
46	-do- But scale 0-600 Amps. for L.T. Metering Panel No. 648021	No.	2	1
47	-do- But scale 0-2000 Amps. (0-2KA) for SA Metering Panel	No.	1	1
48	Watt. Meter for 5 MVA Transformer panel Rated voltage 110V Rated current 5 Amps. Accuracy Class 1.5 Scale 0-8 MW* Rated Power consumption No.611031 a Voltage circuit 2.5VA b Current circuit 1.0VA Type SR-36	No.	1	1
49	Watt.Meter for Ball Mill Panel (M-2202) Rated voltage 110V Rated current 5 Amps. Frequency 50 Hz Accuracy class 1.5 Rated power consumption a Voltage circuit 2.5VA b Ampere circuit 1.0VA Scale 0-1.8 MW No.6480310	No.	1	1

324

CUSTOMER	QUANTITY	ORDER NO	WORK NO

APPENDIX V-33(3)

LT MOTOR STARTER PANEL

PARTS & RATING LIST

DWN [illegible]	LIST (1/11)	Hitachi, Ltd. Tokyo Japan	NARASHINO WORKS DWG NO 324 3B 005302
CHKD [illegible]			
APPD [illegible]			

A-223

CUSTOMER	QUANTITY	ORDER NO	WORK NO

NEW TYPE V. OLD TYPE'S COMPARATIVE SELECTION TABLE
(CACE OF NOFUSE BRAKER)

MOTOR			OLD TYPE		NEW TYPE	
CAPACITY	FULL-LOAD CURRENT	STARTING CURRENT	TYPE / FRAME	THERMAL TRIP / INSTANT TRIP	TYPE / FRAME	THERMAL TRIP / INSTANT TRIP (ADJUSTABLE RANGE)
0.2 kW	0.6 A	2.4 A	L1031/100A	—/10A	LA1031/100A	—/10A
0.4 kW	1.2 A	4.8 A	L1031/100A	—/12A	LA1031/100A	—/12A
0.75kW	1.9 A	9 A	L1031/100A	—/20A	LA1031/100A	—/20A
1.5 kW	3.4 A	17.5 A	L1031/100A	—/40A	LA1031/100A	—/40A
2.2 kW	4.5 A	24 A	L1031/100A	—/57A	LA1031/100A	—/57A
3.7 kW	7.2 A	39 A	L1031/100A	—/78A	LA1031/100A	—/78A
5.5 kW	11 A	58 A	L1031/100A	—/120A	LA1031/100A	—/120A
7.5 kW	14 A	74 A	L1031/100A	—/160A	LA1031/100A	—/160A
11 kW	20 A	117 A	L1031/100A	—/240A	LA1031/100A	—/240A
15 kW	27 A	122.3A	L1031/100A	—/320A	LA1031/100A	—/320A
18.5 kW	32 A	181 A	L1031/100A	—/380A	LA1031/100A	—/380A
22 kW	40 A	213.3A	L1031/100A	—/450A	LA1031/100A	—/450A
30 kW	52 A	291 A	L1031/100A	—/620A	LA1031/100A	—/620A
37 kW	65 A	361.5A	L1031/100A	—/780A	LA1031/100A	—/780A
45 kW	80 A	456 A	L1031/100A	—/920A	LA1031/100A	—/920A
55 kW	98 A	526 A	L2031/225A	—/1200A	LA2031/225A	—/1200A
75 kW	130 A	960 A	L2031/225A	—/1480A	LA2031/225A	—/[illegible]
90 kW	155 A	950 A	L2031/225A	—/1840A	LA2031/225A	—/[illegible]
95 kW	164 A	950 A	L2031/225A	—/2240A	LA2031/225A	—/[illegible]
110 kW	185 A	1280A	L2031/225A	—/2240A	LA2031/225A	—/[illegible]
150 kW	252 A	1750A	L2031/225A	—/2760A	LA2031/225A	—/[illegible]

REMARKS

(1) THIS TABLE ADAPTS FOR ELECTRICAL CIRCUITS OF AC THREE-PHASE 50HZ AND 400V

(2) NO FUSE BRAKER HOLDS AUXILIARY CONTACT WITH LEAD WIRE.

D.R.	[illegible]	[illegible]	LIST (2/1)	Hitachi, Ltd. Tokyo Japan	DRG. NO NARASHINO WORKS 3B005308
CH'K	F. NOTTA				
APPD	[illegible]				

CUSTOMER	QUANTITY	ORDER NO	WORK NO

NEW TYPE V. OLD TYPE'S COMPARATIVE SELECTION TABLE
(CACE OF MAGNETIC CONTACTOR)

MOTOR			OLD TYPE					NEW TYPE				
				THERMAL OVERLOAD RELAY					THERMAL OVERLOAD RELAY			
CAPACITY	FULL-LOAD	STARTING CURRENT	MAGNETIC SWITCH	TYPE	SET VALUE / STANDARD VALUE	ADJUSTABLE RANGE		MAGNETIC SWITCH	TYPE	SET VALUE / STANDARD VALUE	ADJUSTABLE RANGE	
0.2KW	0.6A	2.4A	K10F-DP3	TR15-RTA	0.75A / 0.8A	0.68A~0.92A	TC	K15BN-EP3	TR20-1E	0.6A / 0.8	0.6A~1.0A	RC
0.4KW	1.2A	4.8A	K10F-DP3	TR15-RTA	1.5A / 1.4A	1.2A~1.6A	TC	K15BN-EP3	TR20-1E	1.2A / 1.2A	0.8A~1.6A	RC
0.75KW	1.9A	9A	K10F-DP3	TR15-RTA	2.4A / 2.3A	1.9A~2.7A	TC	K15BN-EP3	TR20-1E	1.9A / 2.4A	1.6A~3.2A	RC
1.5KW	3.4A	17.5A	K10F-DP3	TR15-RTA	4.25A / 4.7A	4.0A~5.4A	TC	K15BN-EP3	TR20-1E	3.4A / 3.0A	2.5A~3.6A	RC
2.2KW	4.5A	24A	K10F-DP3	TR15-RTA	5.63A / 6.3A	5.4A~7.2A	TC	K15BN-EP3	TR20-1E	4.5A / 3.8A	2.5A~5.0A	RC
3.7KW	7.2A	39A	K15F-DP3	TR15-RTA	9A / 8.3A	7.2A~9.8A	TC	K15BN-EP3	TR20-1E	7.2A / 6.8A	4.5A~9.0A	RC
5.5KW	11A	58A	K15F-DP3	TR15-RTA	13.8A / 14A	12A~16A	TC	K15BN-EP3	TR20-1E	11A / 9A	6A~12A	RC
7.5KW	14A	74A	K30-DP3	TR30-RTA	17.5A / 18A	15A~21A	TC	K35N-EP3	TR40-1E	14A / 15A	12A~18A	RC
11KW	20A	117A	K30-DP3	TR30-RTA	25A / 27A	23A~31A	TC	K35N-EP3	TR60-1E	20A / 20A	16A~24A	RC
15KW	27A	122.3A	K30-DP3	TR30-RTA	33.8A / 35A	30A~40A	TC	K50N-EP3	TR60-1E	27A / 28A	22A~36A	RC
18.5KW	32A	181A	K60-DP3	TR60-RTA	40A / 42A	36A~48A	TC	K50N-EP3	TR100-1E	32A / 28A	22A~36A	RC
22KW	40A	213.3A	K60-DP3	TR60-RTA	50A / 50A	43A~57A	TC	K50N-EP3	TR100-1E	40A / 40A	32A~48A	RC
30KW	52A	291A	K60-DP3	TR60-RTA	65A / 68A	58A~78A	TC	K50N-EP3	TR100-1E	52A / 55A	45A~65A	RC
37KW	65A	361.5A	K120F-DP3	TR60-RTA	81.3A / 85A	72A~98A	TC	K120N-EP3	TR100-1E	65A / 67A	55A~80A	RC
45KW	80A	450A	K120F-DP3	TR60-RTA	100A / 100A	85A~115A	TC	K120N-EP3	TR100-1E	80A / 80A	65A~95A	RC
55KW	95A	526A	SRC3631-6	CT TR15-RTA	122A / 130A	110A~150A	TC	SC-6	CT-100A(100:1) TR20-1E	98A / 130A	80A~160A	RC
75KW	130A	960A	SRC3631-8	CT TR15-RTA	162A / 160A	135A~185A	TC	SC-8	CT-100A(100:1) TR20-1E	130A / 140A	100A~180A	RC
90KW	155A	930A	SRC3631-10	CT TR6-RTA	194A / 200A	170A~230A	TC	SC-8	CT-100A(100:1) TR20-1E	155A / 140A	100A~180A	RC
95KW	164A	950A	SRC3631-10	CT TR15-RTA	205A / 200A	170A~230A	TC	SC-10	CT-100A(100:1) TR20-1E	164A / 140A	100A~180A	RC
110KW	185A	1280A	SRC3631-12	CT TR15-RTA	232A / 240A	200A~280A	TC	SC-10	CT-100A(100:1) TR20-1E	185A / 240A	160A~320A	RC
150KW	252A	1750A	SRC3631-12	CT TR15-RTA	315A / 300A	255A~345A	TC	SC-12	CT-100A(100:1) TR20-1E	252A / 240A	160A~320A	RC

REMARKS

(1) SET VALUE OF NEW TYPE'S THERMAL OVERLOAD RELAY IS DIFFERENT FROM OLD ONE'S.
TC: OLD TYPE' SET VALUE = 1.25 x 'MOTOR FULL-LOAD CURRENT'
RC: NEW TYPE' SET VALUE = 'MOTOR FULL-LOAD CURRENT'

(2) MAGNETIC SWITCHS OF THICK LINE'S INSIDE ARE ABLE TO FIX WITHOUT WORKING UP, IF YOU EXCHANGE NEW ONE'S FROM OLD ONE'S

(3) IN THE CACE OF THERMAL OVERLOAD RELAYS OF THICK LINE'S OUTSIDE, YOU HAVE TO WORK SOME HOLES, BECAUSE HOLE POSITITIONS OF NEW TYPE ARE DIFFERENT FROM OLD ONE'S

(4) SPESIFICATION OF ELECTRICAL CIURCUITS

MAIN CIRCUIT VOLTAGE	400V
CONTROLLING CIRCUIT VOLTAGE	100V
FREQUEVCY	50HZ

DWN	CHKD	APPD			
			LIST	Hitachi, Ltd. Tokyo Japan	NARASHINO WORKS DWG NO 324 3B 00?304

CUSTOMER	QUANTITY	ORDER NO	WORK NO.

OLD TYPE'S SELECTION TABLE

MOTOR CAPACITY	MOTOR FULL-LOAD CURRENT	MOTOR STARTING CURRENT	UNIT SIZE	NO FUSE BREAKER TYPE / FRAME	NO FUSE BREAKER THERMAL TRIP / INSTANT TRIP	MAGNET SWITCH	THERMAL OVERLOAD RELAY TYPE	THERMAL OVERLOAD RELAY SET VALUE / STANDARD VALUE	THERMAL OVERLOAD RELAY ADJUSTABLE RANGE	AMMETER'S CT	MAIN CIRCUIT'S WIRE SIZE	TRANSTAIABLE TERMINAL BLOCK	MAXIMUM CONNECTING WIRE SIZE
0.2KW	0.6A	2.9A	1U	L103I / 100A	— / 10A	K10F - DP3	TR1S - RTA	0.75A / 0.8A	0.68A ~ 0.92A	1 / 1A	5.5	75A	14
0.4KW	1.2A	4.8A		L103I / 100A	— / 12A	K10F - DP3	TR1S - RTA	1.5A / 1.4A	1.2A ~ 1.6A	2 / 1A	5.5	75A	14
0.75KW	1.9A	9A		L103I / 100A	— / 20A	K10F - DP3	TR1S - RTA	2.4A / 2.3A	1.9A ~ 2.7A	3 / 1A	5.5	75A	14
1.5KW	3.4A	17.5A		L103I / 100A	— / 40A	K10F - DP3	TR1S - RTA	4.25A / 4.7A	4.0A ~ 5.4A	5 / 1A	5.5	75A	14
2.2KW	9.5A	29A		L103I / 100A	— / 57A	K10F - DP3	TR1S - RTA	5.63A / 6.3A	5.4A ~ 7.2A	7.5 / 1A	5.5	75A	14
3.7KW	7.2A	39A		L103I / 100A	— / 78A	K15F - DP3	TR1S - RTA	9A / 8.5A	7.2A ~ 9.8A	10 / 1A	5.5	75A	14
5.5KW	11A	56A		L103I / 100A	— / 120A	K15F - DP3	TR1S - RTA	13.8A / 14A	12A ~ 16A	15 / 1A	5.5	75A	14
7.5KW	14A	79A		L103I / 100A	— / 160A	K30 - DP3	TR30 - RTA	17.5A / 18A	15A ~ 21A	20 / 1A	8	75A	14
11KW	20A	117A		L103I / 100A	— / 240A	K30 - DP3	TR30 - RTA	25A / 27A	23A ~ 31A	30 / 1A	8	75A	14
15KW	27A	122.3A		L103I / 100A	— / 320A	K30 - DP3	TR30 - RTA	33.8A / 35A	30A ~ 40A	30 / 1A	8	75A	14
18.5KW	32A	181A	2U	L103I / 100A	— / 380A	K60 - DP3	TR60 - RTA	40A / 42A	36A ~ 48A	40 / 1A	14	75A	14
22KW	42A	213.3A		L103I / 100A	— / 450A	K60 - DP3	TR60 - RTA	50A / 50A	43A ~ 57A	50 / 1A	14	75A	14
30KW	5?A	291A		L103I / 100A	— / 620A	K60 - DP3	TR60 - RTA	65A / 68A	58A ~ 78A	75 / 1A	14	75A	14
37KW	65A	361.5A	3U	L103I / 100A	— / 780A	K120F - DP3	TA60 - RTA	81.3A / 85A	72A ~ 98A	75 / 1A	22	120A	60
45KW	80A	456A		L103I / 100A	— / 920A	K120F - DP3	TA60 - RTA	100A / 100A	85A ~ 115A	100 / 1A	38	120A	60
55KW	98A	526A		L203I / 225A	— / 1200A	SRC - 3631 - 8	CT TA1S - RTA	122A / 130A	110A ~ 150A	150 / 1A	50	120A	60
75KW	130A	960A		L203I / 225A	— / 1486A	SRC - 3631 - 8	CT TR1S - RTA	162A / 160A	135A ~ 185A	150 / 1A	80	225A	100
90KW	155A	930A		L203I / 225A	— / 1890A	SRC - 3631 - 10	CT TA1S - RTA	194A / 200A	170A ~ 230A	175 / 1A	80	225A	100
95KW	169A	930A		L203I / 225A	— / 2240A	SRC - 3631 - 10	CT TA1S - RTA	205A / 200A	170A ~ 230A	200 / 1A	100	225A	100
110KW	185A	1290A	4U (BREAKER TYPE)	L203I / 225A	— / 2291A	SRC - 3631 - 12	CT TA1S - RTA	232A / 240A	200A ~ 280A	200 / 1A	100	225A	100
[illegible]KW	253A	1253A	4U (BREAKER TYPE)	L203I / 225A	— / 2760A	SRC - 3631 - 12	CT TA1S - RTA	313A / 300A	255A ~ 345A	300 / 1A	200	400A	325

D R.	[illegible]	[illegible]
CH'K	[illegible]	DO
APP'D	[illegible]	DO

LIST (4/11)

Hitachi, Ltd.
Tokyo Japan

DRG NO NARASHINO WORKS
3B005305

CUSTOMER	QUANTITY	ORDER NO	WORK NO

NEW TYPE'S SELECTION TABLE

MOTOR			UNIT SIZE	NO FUSE BRAKER		MAGNETIC SWITCH	THERMAL OVERLOAD RELAY				AMMETER'S CT	MAIN CIRCUIT'S WIRE SIZE	TRANSLATIONAL TERMINAL B.O.K	MAXIMUM CONNECTING WIRE SIZE
CAPACITY	FULL-LOAD CURRENT	STARTING CURRENT		TYPE / FRAME	THERMAL TRIP / INSTANT TRIP		TYPE	SET VALUE / STANDARD MAX	ADJUSTABLE RANGE					
0.2KW	0.6A	2.9A	1U	LA103S / 100A	— / 10A	K1SBN-EP3	TR20-1E	0.6A / 0.8A	0.6A~1.0A	RC SCALE	1/1A	5.5mm²	75A	14mm²
0.4KW	1.2A	4.8A	1U	LA103S / 100A	— / 12A	K1SBN-EP3	TR20-1E	1.2A / 1.2A	0.8A~1.6A	RC SCALE	2/1A	5.5mm²	75A	14mm²
0.75KW	1.9A	9A	1U	LA103S / 100A	— / 20A	K1SBN-EP3	TR20-1E	1.9A / 2.4A	1.6A~3.5A	RC SCALE	3/1A	5.5mm²	75A	14mm²
1.5KW	3.9A	17.5A	1U	LA103S / 100A	— / 40A	K1SBN-EP3	TR20-1E	3.9A / 3.8A	2.5A~5.0A	RC SCALE	5/1A	5.5mm²	75A	14mm²
2.2KW	4.3A	28A	1U	LA103S / 100A	— / 57A	K1SBN-EP3	TR20-1E	4.5A / 3.8A	2.5A~5.0A	RC SCALE	7.5/1A	5.5mm²	75A	14mm²
3.7KW	7.2A	39A	1U	LA103S / 100A	— / 78A	K1SBN-EP3	TR20-1E	7.2A / 6.8A	4.5A~9.0A	RC SCALE	10/1A	5.5mm²	75A	14mm²
5.5KW	11A	50A	1U	LA103S / 100A	— / 120A	K1SBN-EP3	TR20-1E	11A / 9A	6A~12A	RC SCALE	15/1A	5.5mm²	75A	14mm²
7.5KW	14A	74A	1U	LA103S / 100A	— / 160A	K25N-EP3	TR40-1E	14A / 15A	12A~18A	RC SCALE	20/1A	8mm²	75A	14mm²
11KW	20A	117A	1U	LA103S / 100A	— / 240A	K25N-EP3	TR40-1E	20A / 20A	16A~24A	RC SCALE	30/1A	8mm²	75A	14mm²
15KW	27A	122.3A	1U	LA103S / 100A	— / 320A	K30N-EP3	TR40-1E	27A / 28A	22A~34A	RC SCALE	30/1A	8mm²	75A	14mm²
18.5KW	32A	181A	2U	LA103S / 100A	— / 380A	K50N-EP3	TR100-1E	32A / 28A	22A~34A	RC SCALE	40/1A	14mm²	75A	14mm²
22KW	40A	213.3A	2U	LA103S / 100A	— / 480A	K50N-EP3	TR100-1E	40A / 40A	32A~48A	RC SCALE	50/1A	14mm²	75A	14mm²
30KW	52A	281A	2U	LA103S / 100A	— / 620A	K50N-EP3	TR100-1E	52A / 55A	45A~65A	RC SCALE	75/1A	14mm²	75A	14mm²
37KW	65A	361.5A	3U	LA103S / 100A	— / 782A	K120N-EP3	TR100-1E	65A / 67A	55A~80A	RC SCALE	75/1A	22mm²	120A	60mm²
45KW	80A	450A	3U	LA103S / 100A	— / 920A	K120N-EP3	TR100-1E	80A / 80A	65A~95A	RC SCALE	100/1A	38mm²	120A	60mm²
55KW	90A	520A	3U	LA103S / 225A	— / 1200A	SC6	CT-100M (100:1) TR20-1E	90A / 120A	80A~160A	RC SCALE	150/1A	50mm²	120A	60mm²
75KW	130A	800A	3U	LA203S / 225A	— / 2400A (UBA 30KA)	SC8	CT-100M (100:1) TR20-1E	130A / 140A	100A~180A	RC SCALE	150/1A	80mm²	225A	100mm²
90KW	155A	950A	3U	LA103S / 225A	— / 3000A (UBA 30KA)	SC8	CT-100M (100:1) TR20-1E	155A / 160A	100A~180A	RC SCALE	175/1A	80mm²	225A	100mm²
95KW	169A	950A	3U	LA103S / 225A	— / 3000A (UBA 30KA)	SC10	CT-100M (100:1) TR20-1E	169A / 190A	100A~180A	RC SCALE	200/1A	100mm²	225A	100mm²
110KW	185A	1280A	4U (FIXED TYPE)	LA203S / 225A	— / 3600A (UBA 30KA)	SC10	CT-100M (100:1) TR20-1E	185A / 280A	160A~370A	RC SCALE	200/1A	100mm²	225A	100mm²
150KW	252A	1750A	4U (FIXED TYPE)	LA203S / 225A	— / 3800A (UBA 30KA)	SC12	CT-100M (100:1) TR20-1E	252A / 280A	160A~370A	RC SCALE	300/1A	200mm²	400A	325mm²

REMARKS (1) THERMAL OVERLOAD RELAY'S RATED CURRENT VALUE "SET VALUE" = MOTOR FULL-LOAD CURRENT.
(2) NO FUSE BRAKER HAVE AUXILIARY CONTACT WITH LOAD WIRE.
(3) SPECIFICATION OF ELECTRICAL CIRCUITS
MAIN CIRCUIT VOLTAGE [illegible] CONTROLLING CIRCUIT VOLTAGE 100V FREQUENCY [illegible]

DWN	[illegible]	[illegible]	LIST (5/11)	Hitachi, Ltd. Tokyo Japan	NARASHINO WORKS DWG NO 3243B005306
CHKD	[illegible]	[illegible]			
APPD	[illegible]	[illegible]			

A-226

N128

CUSTOMER	QUANTITY	ORDER NO	WORK NO

NEW V. OLD PARTS' COMPARABLE TABLE
OF CONTROLLING CIRCUIT

NO	PART NAME	OLD PARTS SPECIFICATION	OLD PARTS MAKER	NEW PARTS SPECIFICATION	NEW PARTS MAKER	REMARKS
1	PUSH BUTTON SWITCH (BLACK)	ABN211BOC-11 WITH ACRYLIC NAME PLATE 'START' OF N TYPE	IZUMI DENKI CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO CHANGE
2	PUSH BUTTON SWITCH (BLACK)	ABN211BOC-11 WITH ACRYLIC NAME PLATE 'FORWARD' OF N TYPE	IZUMI DENKI CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO CHANGE
3	PUSH BUTTON SWITCH (BLACK)	ABN211BOC-11 WITH ACRYLIC NAME PLATE 'REVERSE' OF N TYPE	IZUMIDENKI CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO CHANGE
4	PUSH BUTTON SWITCH (RED)	ABN211ROC-11 WITH ACRYLIC NAME PLATE 'STOP' OF N TYPE	IZUMIDENKI CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO. CHANGE
5	PUSH BUTTON SWITCH (RED)	(B) B-1ED	HITACHI, LTD.	(E) B-1ED	HITACHI, LTD.	COMPATIBILITY
6	PUSH BUTTON SWITCH WITH KEY (BLACK)	(B) B-1ED	HITACHI, LTD.	(E) KB-1ED	HITACHI, LTD.	COMPATIBILITY
7	PUSH BUTTON SWITCH WITH KEY (RED)	(B) B-1ED	HITACHI, LTD.	(E) KB-1ED	HITACHI, LTD.	COMPATIBILITY
8	CHANGE OVER SWITCH	ASN-311 WITH ACRYLIC NAME PLATE 'MANU-AUTO' OF N TYPE	IZUMIDENKI CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO. CHANGE
9	SIGNAL LAMP (RED)	APN118R O9P11R 100V SONE WITH ACRYLIC NAME PLATE 'RUNNING' OF N TYPE	IZUMIDENKI CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO CHANGE
10	SIGNAL LAMP (RED)	APN118R O9P11R 100V SONE WITH ACRYLIC NAME PLATE 'FORWORD' OF N TYPE	IZUMIDENKI CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO CHANGE
11	SIGNAL LAMP (RED)	APN118R O9P11R 100V SONE WITH ACRYLIC NAME PLATE 'REVERSE' OF N TYPE	IZUMIDENKI CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO CHANGE
12	SIGNAL LAMP (RED)	(C) L-TE 100V SONE	HITACHI, LTD.	(E) L-TE 100V SONE RED	HITACHI, LTD	COMPATIBILITY
13	SIGNAL LAMP (RED)	APNR9-21B DC110V	IZUMIDENKI CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	COMPATIBILITY

DRWN	CHKD	APPD	LIST			NARASHINO WORKS DWG NO
[illegible]	E. Hotta	[illegible]	LIST (4/11)	Hitachi, Ltd.	Tokyo Japan	3243B 005301

A-227

CUSTOMER	QUANTITY	ORDER NO	WORK NO

REMARKS

NO	PART NAME	OLD PARTS SPECIFICATION	OLD PARTS MAKER	NEW PARTS SPECIFICATION	NEW PARTS MAKER	REMRKS
14	SIGNAL LAMP (GREEN)	APNRG-218 DC 110V	IZUMI DENKI CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO CHANGE
15	SIGNAL LAMP (GREEN)	(C) L-TE 100V 50HZ	HI.'CHI, LTD.	(E) L-TE 100V 50HZ	THE SAME OF THE LEFT MAKER	COMPATIBILITY
16	TOGGLE SWITCH	S-732 DC110V	NIHON KAIHEIKI	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO CHANGE
17	AUXILIARY RELAY	K-4X3D DC110V 2a+2b	HITACHI, LTD.	K-4X6G DC 110V 2a+2b	THE SAME OF THE LEFT MAKER	COMPATIBILITY
18	AUXILIARY RELAY	K-8X4 400V 50HZ 4a+4b	HITACHI, LTD.	K-8X6 400V 50HZ 4a+4b	THE SAME OF THE LEFT MAKER	COMPATIBILITY
19	AUXILIARY RELAY	K-8X4 100V 50HZ 4a+4b	HITACHI, LTD.	K-8X6 100V 50HZ 4a+4b	THE SAME OF THE LEFT MAKER	COMPATIBILITY
20	AUXILIARY RELAY	K-4X3 100V 50HZ 2a+2b	HITACHI, LTD.	K-4X5 100V 50HZ 2a+2b	THE SAME OF THE LEFT MAKER	COMPATIBILITY
21	POWER RELAY	A70-2XPH 100V 50HZ	HITACHI, LTD.	MM2XP 100V 50HZ	OMRON TATEISHI ELECTRONICS CO.	COMPATIBILITY
22	POWER RELAY	A70-4XPH DC110V	HITACHI, LTD.	MM4XP DC110V	OMRON TATEISHI ELE LEFT MAKER	COMPATIBILITY
23	TIMER	SM-1S DC110V FLUSH MOUNTING TYPE '1 SEC'	HITACHI, LTD.	DMT DC 110V FLUSH MOUNTING TYPE '10 SEC'	OMRON TATESHI ELECTRONICS CO.	COMPATIBILITY
24	TIMER	MMI90-30SP 100V 50HZ '30 SEC'	HITACHI, LTD.	STPN 100V 50HZ '36 SEC'	OMRON TATEISHI ELE LEFT MAKER	COMPATIBILITY
25	TIMER	MMI90-10SP 100V 50HZ '10 SEC'	HITACHI, LTD.	STPN 100V 50HZ '12 SEC'	OMRON TATEISHI ELE LEFT MAKER	COMPATIBILITY
26	TIMER	MMI90-1M 100V 50HZ '60 SEC'	HITACHI, LTD.	STPN 100V 50HZ '72 SEC'	OMRON TATEISHI ELE LEFT MAKER	COMPATIBILITY

DWN	[illegible]	[illegible]	L/S 7(7/11)	Hitachi, Ltd. Tokyo Japan	NARASHINO WORKS DWG NO 3243 B 005308
CHKD	E Hotta				
APPD	[illegible]				

A-228

CUSTOMER	QUANTITY	ORDER NO	WORK NO

NO	PART NAME	OLD PARTS		NEW PARTS		REMARKS
		SPECIFICATION	MEKER	SPECIFICATION	MEKER	
27	TIMER	MM190-1M 100V SONE '300 SEC'	HITACHI, LTD.	STPN 100V SONE '430 SEC'	OMRON TATEISHI ELECTRONICS, CO.	COMPATIBILITY
28						
29						
30	RELAY	IV-AC-B2 100V SONE CONTACTOR'S VOLTAGE DC110V USE TAP '80V'	HITACHI, LTD.	IV-AC-B1 OVER VOLTAGE RELAY 100V SONE USE TAP '80V'	HITACHI, LTD.	COMPATIBILITY
31	RELAY	SO2-L-R2 100V SONE (ECT 13NT COMPATIBLE)	HITACHI, LTD.	SO-L-2R 100V SONE (X-SGF-K200 ECT INST)	HITACHI, LTD.	COMPATIBILITY
32	RESISTOR	80 SW TYPE SW 20Ω	NIHON KAIHEIKI CO.	THE SAME OF THE LEFT SPECIFICATION	NIHON KAIHEIKI, CO.	NO CHANGE
33	INSTRUMENT TRANSFORMER	DU-2 440/110V SONE 50VA	MINATO, LTD.	CU-2SR 440/110V SONE 50VA	MINATO, LTD.	NO CHANGE
34	CURRENT TRANSFORMER	PA-2R /5A 15VA FIRST CLASS 'ROLL UP' TYPE	MINATO, LTD.	PRIMARY CURRENT 100A UNDER E-15AR 'ROLLUP' TYPE SECONDARY CURRENT 400A UNDER B-15E 'PENETRATION' TYPE FIRST CLASS 15VA	MINATO, LTD.	NO COMPATIBILITY
35	CURRENT TRANSFORMER	PA-2R /5A 15VA FIRST CLASS 'ROLL UP' TYPE	MINATO, LTD.	PRIMARY CURRENT 100A UNDER E-15AR 'ROLLUP' TYPE SECONDARY CURRENT 400A UNDER B-150 'PENETRATION' TYPE FIRST CLASS 15VA	MINATO, LTD.	NO COMPATIBILITY
36	AMMETER	AM-20 DIRECT INPUT	IZUMI DENKI, CO.	THE SAME OF THE LEFT SPECIFICATION	MINATO, LTD	NO CHANGE
37	AMMETER	AM-20 /1A	IZUMI DENKI, CO.	THE SAME OF THE LEFT SPECIFICATION	MINATO, LTD.	NO CHANGE
38	AMMETER	SR 36 TYPE /5A	HITACHI, LTD.	THE SAME OF THE LEFT SPECIFICATION	MINATO, LTD.	NO CHANGE
39	VOLTMETER	SR 36 RANGE 0-600V WITH 440/100V PT	HITACHI, LTD.	THE SAME OF THE LEFT SPECIFICATION	MINATO, LTD.	NO CHANGE

A-229

DWN	H. Hiradama		LIST 18/11	Hitachi, Ltd. Tokyo Japan	NARASHINO WORKS DWG NO 3243B00530F
CHKD	E. Hotta				
APPD	[illegible]				

CUSTOMER	QUANTITY	ORDER NO	WORK NO

NO	PART NAME	OLD PARTS SPECIFICATION	OLD PARTS MAKER	NEW PARTS SPECIFICATION	NEW PARTS MAKER	REMARKS
40	FUSE BLOCK	7PEF-30LM	HITACHI, LTD.	FB - 30	FUJI ELECTRIC CO, LTD.	COMPATIBILITY
41	FUSE BLOCK	DPEF-60L	HITACHI, LTD.	FB - 30	FUJI ELECTRIC CO, LTD.	COMPATIBILITY
42	FUSE ELEMENT	EF 005 5A	HITACHI, LTD.	FCF 2-5 5A	FUJI ELECTRIC CO, LTD.	COMPATIBILITY
43	FUSE ELEMENT	EF 010 10A	HITACHI, LTD.	FCF 2-10 10A	FUJI ELECTRIC CO, LTD.	COMPATIBILITY
44	FUSE ELEMENT	EF 030 30A	HITACHI, LTD.	FCF 2-30 30A	FUJI ELECTRIC CO, LTD	COMPATIBILITY
45	FUSE ELEMENT	EF 060 60A	HITACHI, LTD.	FCF 2-60 60A	FUJI ELECTRIC CO, LTD	COMPATIBILITY
46	CHANGE OVER SWITCH	NB 432204 UM TYPE AMMETER'S	KITAGAWA, LTD	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO. CHANGE
47	CHANGE OVER SWITCH	NB 432205 UM TYPE AMMETER'S	KITAGAWA, LTD	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO CHANGE
48	TERMINAL BLOCK	B3T 2063 600V CLASS 20A TERMINAL BLOCK 36P	JYONAN ELECTRIC CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO CHANGE
49	TERMINAL BLOCK	B0T 4003 600V CLASS 40A TERMINAL BLOCK 3P	JYONAN ELECTRIC CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO. CHANGE
50	TERMINAL BLOCK	B0T 7503 600V CLASS 75A TERMINAL BLOCK 3P	JYONAN ELECTRIC CO.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO CHANGE
51	TERMINAL BLOCK	B0T 120F01 600V CLASS 120A TERMINAL BLOCK 1P	HITACHI. LTD.	TS - 606B	KIMUDEN LTD.	THE SAME OF THE LEFT MAKER
52	TERMINAL BLOCK	B3T 225 F01 600V CLASS 225A TERMINAL BLOCK 1P		TS - 607B	KIMUDEN LTD	NO CHANGE

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CHKD
APPD

LIST (9/11)

Hitachi, Ltd.
Tokyo Japan

NARASHINO WORKS DWG NO
3243B005310

CUSTOMER	QUANTITY	ORDER NO	WORK NO

NO	PART NAME	OLD PARTS		NEW PARTS		REMARKS
		SPECIFICATION	MAKER	SPECIFICATION	MAKER	
53	CONTOROLLING CIRCUIT'S CONNECTOR	NO 480003 RECEPTACLE HOUSING (WHITE)	NIHON AMP	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO CHANGE
54	CONTOROLLING CIRCUIT'S CONNECTOR	NO. 480004 HOUSING (WHITE)	NIHON AMP	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO. CHANGE
55	CONTOROLLING CIRCUIT'S CONNECTOR	NO 42100 RECEPTACLE CONTAKUT	NIHON AMP	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO. CHANGE
56	CONTROLLING CIRCUIT'S CONNECTOR	NO 42090 TAGE CONTAKUT	NIHON AMP	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO. CHANGE
57	SIGNAL LAMP'S INDICATIVE NAME PLATE	NB 419597-72 'RUNNING'	HITACHI, LTD.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO. CHANGE
58	SIGNAL LAMP'S INDICATIVE NAME PLATE	NB 419598-2 'STOP'	HITACHI, LTD.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO. CHANGE
59	SIGNAL LAMP'S INDICATIVE NAME PLATE	NB 419597-1 'ON'	HITACHI, LTD.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO. CHANGE
60	SIGNAL LAMP'S INDICATIVE NAME PLATE	NB 419597-2 'OFF'	HITACHI, LTD.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO. CHANGE
61	FAULT INDICATOR	CR-1 DC 110V	HITACHI, LTD.	THE SAME OF THE LEFT SPECIFICATION	THE SAME OF THE LEFT MAKER	NO. CHANGE
62	CONTROLLING CIRCUIT'S TRANSFORMER	4C0500S100 400V/100V SONE 500VA 158W(110H)x150D(95T)x170H-7φx4	FUJI ELECTRIC CO. LTD.	THE SAME OF THE LEFT SPECIFICATION	AKI SEISAKUSHO CO, LTD.	NO COMPATIBILITY
63	CONTROLLING CIRCUIT'S TRANSFORMER	4C0750S100 400V/100V SONE 750VA 200W(130H)x150D(95T)x225H-7φx4	FUJI ELECTRIC CO. LTD.	THE SAME OF THE LEFT SPECIFICATION	AKI SEISAKUSHO CO. LTD.	NO COMPATIBILITY
64	CONTROLLING CIRCUIT'S TRANSFORMER	FO-66130A 400V/100V SONE 1KVA 150W(115H)x180D(105T)x190H-7φx4	FUJI ELECTRIC CO. LTD.	THE SAME OF THE LEFT SPECIFICATION	AKI SEISAKUSHO CO. LTD.	NO COMPATIBILITY
65	CONTROLLING CIRCUIT'S TRANSFORMER	FO-63009 400V/100V SONE 1.5KVA 170W(115H)x210D(130T)x180H-7φx4	FUJI ELECTRIC CO. LTD.	THE SAME OF THE LEFT SPECIFICATION	AKI SEISAKUSHO CO, LTD.	NO COMPATIBILITY

DWN	H. Wada		LIST (10/11)	Hitachi, Ltd. Tokyo Japan
CHKD	E. Hotta			NARASHINO WORKS DWG NO 3243B005311
APPD	[illegible]			

A-231

NO	PART NAME	OLD PARTS SPCIFICATION	OLD PARTS MAKER	NEW PARTS SPCIFICATION	NEW PARTS MAKER	REMARKS
46	CONTROLLING CIRCUIT'S TRANSFORMER	FO-68060A 400V/100V SONE 2KVA 180W(130W)×210D (130T)×180H-7Φ×4	FUJI ELECTRIC CO, LTD.	THE SAME OF THE LEFT SPECIFICATION	AAI SESAKUSHO CO, LTD.	NO COMPATIBILITY
47	CONTROLLING CIRCUIT'S TRANSFORMER	FO-68060A 400V/100V SONE 3.5KVA 235W(200W)×210D (170T)×270H-7Φ×4	FUJI ELECTRIC CO, LTD.	THE SAME OF THE LEFT SPECIFICATION	AKI SESAKUSHO CO, LTD.	NO COMPATIBILITY
48	CONTROLLING CIRCUIT'S TRANSFORMER	FO-60060A 400V/100V SONE 4KVA 235W(200W)×210D (170T)×290H-7Φ×4	FUJI ELECTRIC CO. LTD.	THE SAME OF THE LEFT SPECIFICATION	AKI SESAKUSHO CO. LTD.	NO COMPATIBILITY

CUSTOMER | QUANTITY | ORDER NO | WORK NO

DWN: H. Maeda | CHKD: E. Hatto | APPD

LIST (11/11)

Hitachi, Ltd. Tokyo Japan

NARASHINO WORKS DWG NO 3243B005312

APPENDIX V-34(1) DOCUMENTS REGARDING PAINT AND PAINTING WORK

1. Typical example (Example of Maker's standard)

° Site	:	a)Sea side place b)Inside land (Desert)
° Site condition	:	Meditorranean Sea Weather
° Plant	:	a)Sea side place PA-plant, MAP, DAP, H_2SO_4-plant b)Inside land (Desert) H_2SO_4-plant, PA-plant, TSP, Fluodized aluminium, Off-site plants (water treatment, power ....)
° Purchase	:	Japan, other countries site.
° Purchase condition	:	Complete equipment, Pre-fab. material
° Equipment	:	° Vessel : Complete/semi complete site welding ° Tank : Complete/pre-fab. material, site-assemble ° Conveyor : Semi-complete, site welding ° Pump, Blower : Complete Comp. HE ° Bag filter: Complete ° Agitator : Complete

2. Examples in our Toyama Plant
(Maker Name of Paint :"Nihon-Yashi")

No.	Item	Name of plant	No.of coat	Quantity Required (gr/m^2)	Dry film Thickness (μ)
i)	Building				
	Surface	Preparation : 2nd class A grade, Power tool cleaning			
	Under coat	EPICO MARINE Red Lead Primer	1	180 - 220	40 - 45
	Under coat	"	1	"	"
	Finish coat	BLE-NINE	1	280 - 300	100 - 125
	Finish coat	"	1	"	"
ii)	Steel structure, Motor-Machine,Piping, Out-door equip. (Tank convey)				
	Surface	Preparation : 2nd class A grade, Power tool cleaning			
	Under coat	EPICO MARINE Red lead primer	1	180 - 220	40 - 45
	Finish coat	BLE-NINE	1	280 - 300	100 - 125
	Finish coat	"	1	"	"
iii)	Conveyor of Proudct				
	Surface	Preparation : 2nd class A grade, Power tool cleaning			
	Under coat	Urethene primer	1	-	-
	Middle coat	BLE-NINE	1	280 - 300	100 - 135
	Finish coat	"	1	"	"
	Finish coat	"	1	"	"
iv)	Dryer, etc. (High temp)				
	Surface	Preparation : 2nd class A grade, Power tool cleaning			
	Under coat	Thermstite #200 primer	1	120 - 140	-
	Finish coat	Thermotite #200	1	100 - 120	-
	Finish coat	"	1	"	-

3. Examples in Nihon Rinsan Co.

(Maker Name of Paint : Shinto-Toryo)

No.	Item	Name of plant	No.of coat	Quantity Required (gr/m2)	Dry film Thickness (u)
i)	Building				
	Surface	Preparation : 2nd class A grade, Power tool cleaning			
	Under coat	NEO DERUST	1	130	25
	Finish coat	NEO GOSE #300	1	135	50
	Finish coat	"	1	120	40
ii)	Steel structure, motor, piping, out-doow equioment (Tank, convey)				
	Surface	Preparation : 2nd class A grade, Power tool cleaning			
	Under coat	NEO DERUST	1	130	35
	Finish coat	NEO GOSE #300	1	135	50
	Finish coat	"	1	120	40
iii)	Conveyor of product				
	Surface	Preparation : 2nd class A grade, Power tool cleaning			
	Under coat	NEO DERUST	1	130	35
	Finish coat	NEO GOSE #300	1	135	50
	Finish coat	NEO GOSE #300	1	120	40

APPENDIX V-34(2) ROTARY DRYER (M-3207)

This is the extract of the letter from "KURIMOTO IRON WORKS" in reply to expert team's letter.

At the overhaul time in 1979, they renewed all rollers and adjusted gear and pinion, and they could not find out any bad figures in the data presented in our letter.

As usual, if vibration is over 30 (total amplitude) one can find wave pattern on the surface of a tire and rollers, and have to repair the surfaces of them.

To keep the smooth running of this equipment, wearing and damage at every point should be checked according to check list and instruction manual attached here.

1. Check list of rotary dryer

	Part	Check Item	Inspect.Measure. Data
Supporting Point	Tire 3,350ϕ x 300W	° Touch condition of tire & roller ° Friction wearing condition ° Inspection condition on the surface of tire	
	Roller 750ϕ x 350W	° Friction wearing condition on the surface of roller	
	Bearing of Roller 170ϕ # 22334	° Lubrication ° Leakage or not from oil-seal (Metal wearing)	
	Thrust Roller & Bearing 500 ϕ	° Friction wearing condition on the roller surface ° Inclination of thrust roller (Wearing of bearing bush)	
	Liner Plante of Tire	° Abnormal condition on the surface	
Driving Point	Gear M22 NT 186/21 W 265/286	° Touch condition of teeth ° Inspecting condition on the teeth surface	Top clearance (>0.25 M) Back-rash (0.04 - 0.06 M)
	Pinion and Bearing # 22236K + H 3136		
	Gear Cup	° Noise or not ° Name of lubrication oil	
	Motor and Reducer	° 75 KW 8P ° 75 KW 1/30	
Attach-ment	Rabilins seal Hammering	° Friction wearing of bush	
Others	Shell (Body) Lifter	° Wearing, corrosion, deforming -do-	

2. The Instruction Manual of Rotary Dryer

1) Confirm the rotating direction of dryer and fan.

2) Confirm the oil quantity of gear case and reducer.

3) Check the grease of rollers and pinion.

4) Check the bearing temperature with hand. Sudden rise of temperature must be cared.

5) Grease and oil must be changed each 4000 Hr (about 6 months running), and supplied periodically.

6) Motor ampere must be checked periodically.

7) Test running before normal running must be enough.

8) Enough time is necessary for the warming up of the dryer body and other machines. Necessary pre-heating hours cannot be decided generally. Charge material after the temperatures of machines become steady.

9) When the dryer is to be stopped, it must not stop suddenly and continue no load running until the temperature of the body becomes low.

10) Discharge all material in the body at the stop time.

11) Clean the material stuck to the chute periodically.

12) Wipe the surfaces of tire and roller 2-3 times/day with oil dipped cloth.

13) Take care of the noise of bearings and rotating parts.

14) After running the center of the body goes down with wearing of tire and roller and touch point of teeth becomes deep, so friction wearing on teeth surface becomes severe. Touch condition must be checked periodically.

Adjustment of Rollers

Even if maintenance technician is skillful, he must read this instruction well and adjust rollers for floating tire between thrust rollers according to the instruction.

At first check that following conditions are available or not.

1) Roller surfaces are parallel to the surface of tire and touch in good condition.
2) Roller shafts are correctly parallel with each other.
3) The body can be run by motor.
4) Final adjustment of the body is finished and rated capacity of material is capable.
5) Positions of bearings of rollers are correct.
6) The upper surface of roller beds are not deformed by adequate stuffing material or cement.

After these confirmation, one should go to the second step. Start to rotate the empty body by motor, inspect the running state of tire between two thrust rollers.

The ideal position is that the tire touches lightly to thrust rollers, leaving from them or floats between thrust rollers. In this case, one should not adjust the rollers.

If rollers are correctly parallel to the center of the dryer body, the body will go down tradually by the pulling force to discharge direction from the inclination of body even if the body is empty.

Loading time, this force is larger proportionally. One must adjust in this case. For this purpose, give some inclination to rollers, then the body will move a little up or down by the correct adjustment.

Adjustment

- At first check the numbers of adjust screws.
- Loosen & lock muts of adjust screws of bearings.
- Confirm adjust screws are tight.
- Loosen (free from tension) fix bolts of bearings.
- Place a dial gauge on the backside of bearing and set dial at zero.
- Screw in adjust screws No. (2),(3), (6), (7) 0.3 mm.
- Tighten fix bolts of bearings.
- Turn the body for 10 minutes
- If the body does not change the position of center, loosen fix bolts.
- Place a dial gauge in front of bearings
- Loosen adjust screw No. (1), (4), (5), (8) 0.3 mm.
- Set bearings at adjust screws by hammering the back side of bearings.
- Tighten fix bolts.
- Turn the body
- If the body does not change the position of center, try to adjust again.
- If you cannot get good results after several adjustments, check whether you mistake the number of adjust screws or not.
- Repeat the adjustment
- Continue adjustment until the empty body becomes to float between thrust rollers or to touch slightly on the surface of inlet side thrust roller.

- Keep times for getting balance after each adjustment.
- After the position of the body is fixed, tighten all fix bolts of bearings.
- Tighten all adjust screws.
- Tighten all lock nuts of adjust screws.
- After charging material into the body, it tends to go down.
- Inspecting its movement, if it is necessary to float the charged body between thrust rollers, adjust again.
- The method of readjustment is the same as above mentioned procedure.
- Rollers adjusted adequately make the charged body float for many weeks, don't touch thrust rollers.
- In the case of an empty body, they push up the inlet side thrust rollers.
- To adjust rollers, use dial micro-meters.
- If not available, mark on the surfaces of adjust screws.
- When the body change its center on the rollers, you can see the parallel of center, if you check the adjust screws

Important points

1. Shafts of rollers must be parallel at Fig.2. If you move No.2 adjust screw, 0.3 mm, you must move No.3 in the same amount.

   (Note) Screw adjustment depends upon diameter and pitch.

2. In the case of moving out, bearings must move at the same time.

3. Adjust rollers as upward thrusts of every roller may be same. Then lives of both side rollers are same. Don't adjust more than 4 bearings.

4. Don't move adjust screw more than 0,3 mm (1/2 rotate) at one time. Because if you move at one point you must move another 3 points at the same rate, so its effect becomes 4 times.

5. Keep the balance of the body after 10-15 minutes, finishing adjustment.

6. The body of small inclination has small adjustment rate. The body charged much weight has much adjustment rate.

7. There are no standards for adjustment according to inclination and loadint rate. You must find them through the tests.

3. Answer Letter to "Hitachi Zosen" (May 16, 1979)

A) Life and replacement of parts must be decided considering using condition and cannot be done uniformly.

(1) Tire and Roller

Because these touch each other, wearing occurs to the other side if it happens to the one side. So bette. change them all together if wearing happens.
Standard of replacement is 10-15 mm. Replacement is also necessary when carck is found.

(2) Girth gear and Pinion

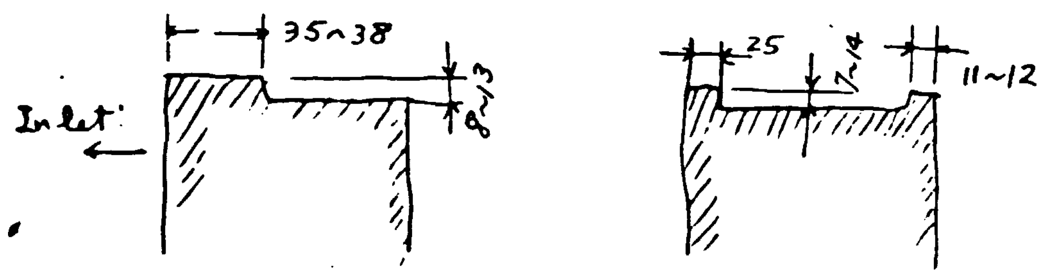
Same as (1). One must judge from the points of crack, destroy and wear of teeth.

B) About drawings and photographs

(1) Tire is worn 6-3 mm inlet side and 5 mm outlet side on the corner, but the surface is clean. So one can use this tire.

(2) Rollers

Inlet side Outlet side



If searing is small, rollers can be used after the surface is machined smooth. But existing one was worn about 13-14 mm, the rollers should be changed.

(3) Girth gear and pinion

The present surface is worr but clean. And we think sometimes the top of teeth attached the bottom of the opposite teeth. This phenomena is that the body went down because of the wearing of tire and roller.

(4) If necessary, exchange the inlet one to the outlet one.

(5) To change the tire is difficult and to renew the tire is very skillful work. The conditions are as follows.

(i) Thickness of the shell under the tire is about 20 m/m or more.

(ii) In the case of welding, the thickness of shell is over 2/3 original thickness.

(iii) No crack on the shell

(iv) Sometimes cracks happen on welding, because of heating and corrosion for the long-time running.

(v) Centering is very difficult.

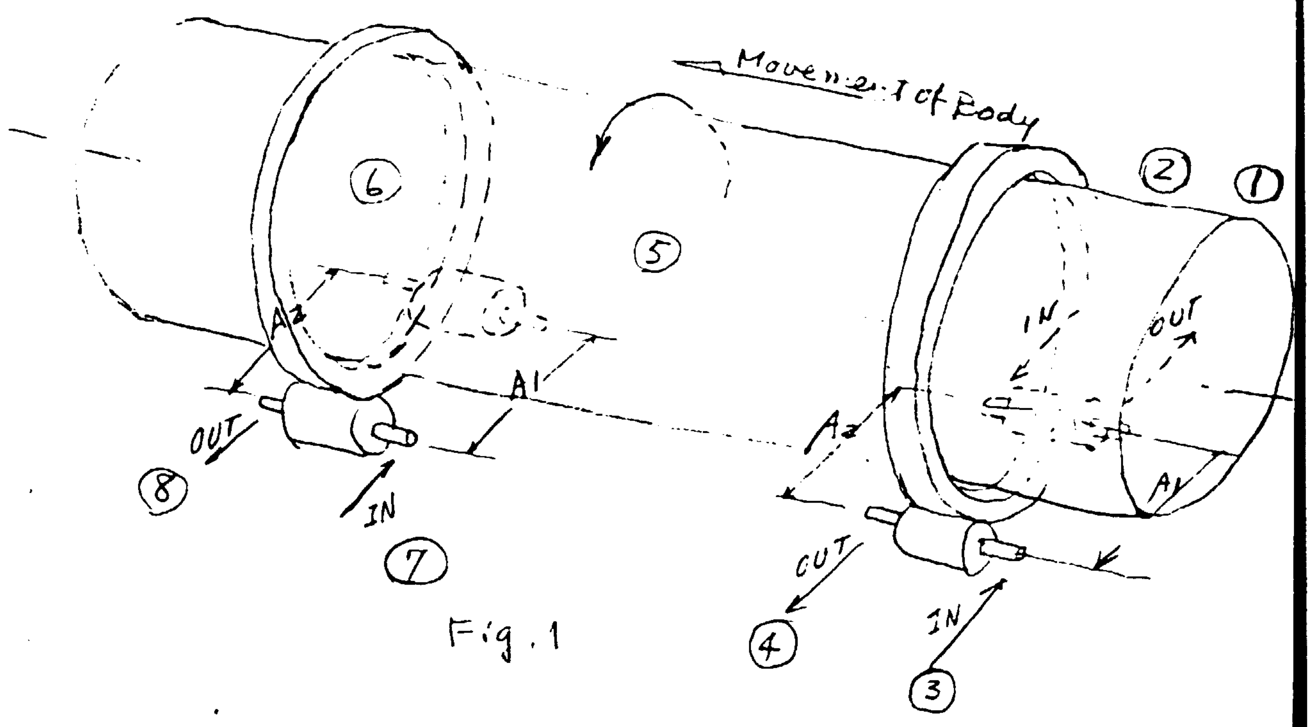

Movement of Body
1
2
3
4
5
6
7
8
IN
OUT
A1
A2

Fig. 1

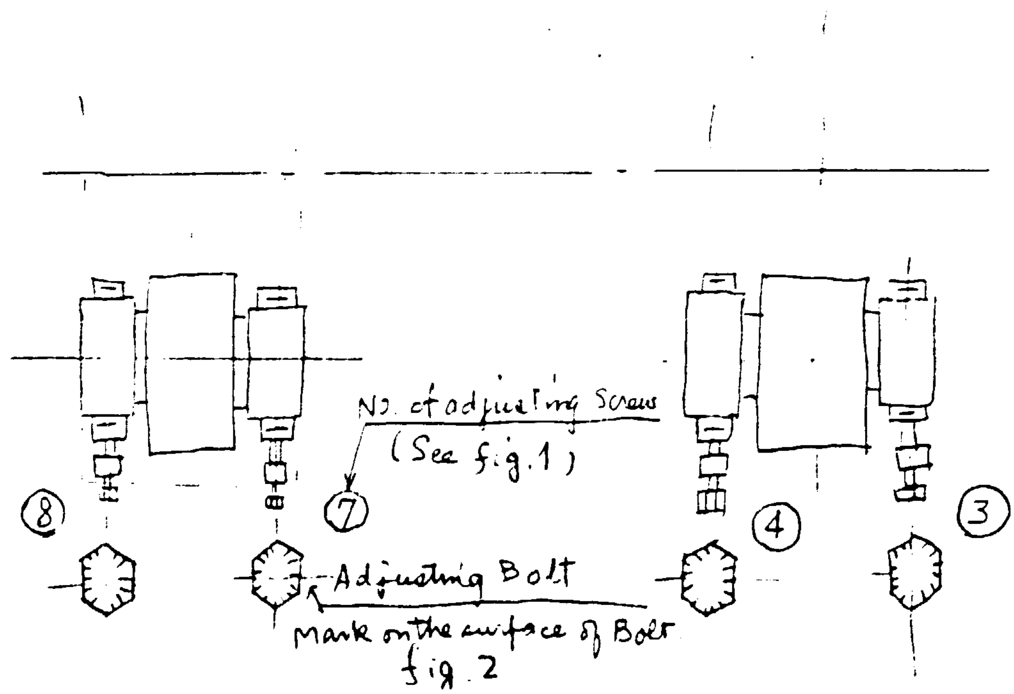
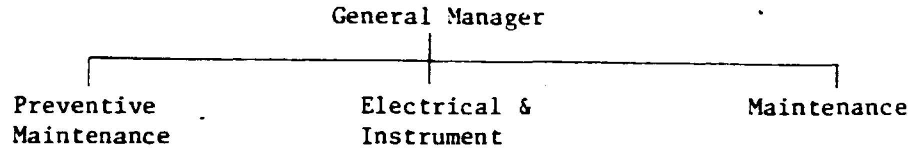

No. of adjusting Screws
(See fig. 1)
Adjusting Bolt
Mark on the surface of Bolt
8
7
4
3

fig. 2

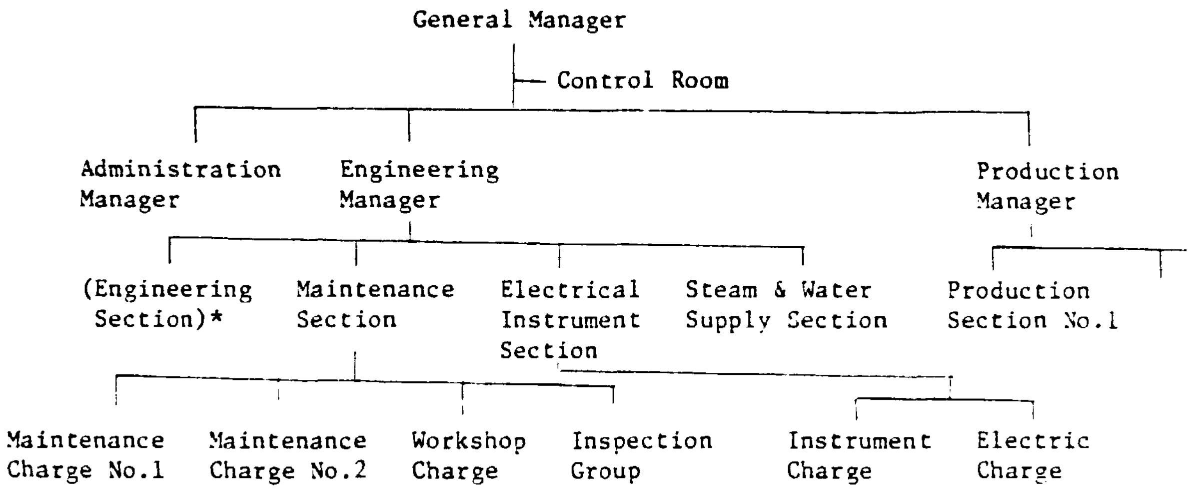
APPENDIX VI-1 (1) PREVENTIVE MAINTENANCE

1. Organization

i) Existing Organization of TSP Factory



ii) Organization of Nissan Chemical Ind., Ltd. (Large)



* This section sometimes changes to the staffs of the Engineering Manager.

iii) Organization of Nissan Chemical Ind., Ltd. (Small)

- General Manager
  - Pollution Control Room
  - Production Section
    - Production Charge No.1
    - Production Charge No.2
  - Engineering Section (1)
    - Analysis Charge (7)
    - Engineering Charge (M.2) + (EI.2) (TL.3) + (TL.2)
  - Administration Section

( ) : M : Mechanical
EI : Elec & Inst.
TL : Technical labor

° Inspection section consists of the skillful inspectors who do their jobs according to the requests of the engineers.

° In the present chemical factory, maintenance should be done by the combined knowledges of mechanical, electrical, instrument and civil engineering. If these knowledges are not utilized synthetically, one may make a large mistake in the maintenance trouble. From this point of view, the existing TSP organization seems to have a problem.

2. Existing P.P.M. Section

i) Planned Preventive Maintenance

- DCME/D.C.Ch
  - Clerk cum Typist -1
  - Peon -1
  - Planning & Scheduling — A.M.E. -1
    - Plant History Record Work Analysis, Etc. — S.A.M.E. -1
  - Inspection & Lubrication — A.M.E. -1
    - Inspection — S.A.M.E./S.A.Ch
      - Minor Adjustment (Inspection) H.S.T. -2
    - Lubrication — S.A.M.E./S.A.C-2
      - Lubrication ST/SST/HELPER 2+2+4 -8

Designation	Proposal	Present
D.C.M.E./D.C.Ch.	1	1
M.E./Chemist		2
A.M.E.	2	2
S.A.M.E./S.A.Ch.	5	1
H.S.T.	2	3
S.T.	3	
S.S.T.	2	3
Helper	4	3
Clerk	1	
Peon	1	1
Total	20	14

ii) P.M. Activities in Japan

Maintenance = P.M. =

- Planning
- Inspection No.1
  - Daily patrol = Daily inspection
  - Lubrication
  - Cleaning
  - Small adjustment
  - Replacement of small parts
- Inspection No.2
  - Detail inspection
  - Periodical inspection
- Repairing
- Recording
- Management

° In the Japanese chemical factories, inspection No.1 is ordinarily done by the operation side in every shift, and all abnormal points are informed to the P.M. section every day.

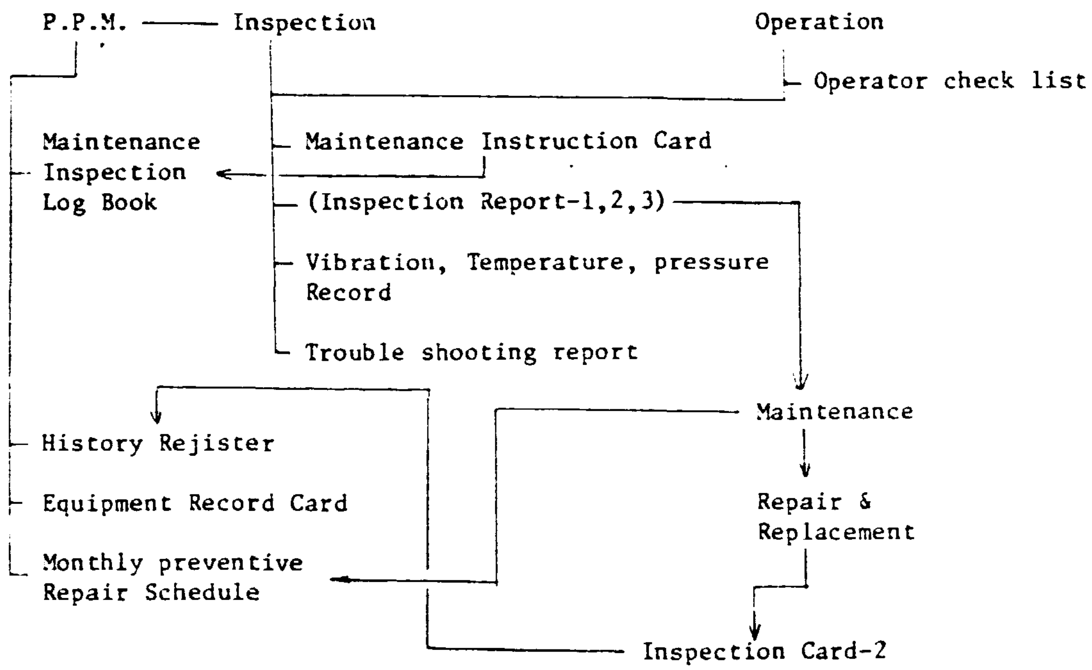
° Lubrication is also done by the operation side, because the operators take interests in the machines by doing this job. Moreover lubrication itself is not to be the main job of P.M. Section.

In TSP factory, lubrication work is done by the lubricators of PPM section, but this work does not include the following sections :

1. Water Treatment Section
2. Bagging Section
3. SA-1
4. SA-2
5. Drying Section

Then the unification of lubrication does not seem to be essential.

iii) The activities of P.P.M.



° The recording system and the arrangement of recording is rather complicate, and sometimes the data from the maintenance section to P.P.M. was not sufficient or was not supplied. In Japan, the maintenance section and the P.M. section are not divided, so the engineer who repaired the machine records the useful data for the history.

- Monthly preventive maintenance schedule should be prepared by P.P.M. section. This is now submitted by the maintenance section, so that the data recorded by P.P.M. may not fulfill the functions.

- These recording data should be used for the statistics. It is very useful to see the effects of the P.M. activities, and also excite the activities of maintenance in the TSP factory.

  (e.g.)
  - Graph of monthly accidental stop
  - Graph of monthly maintenance labors in each section
  - Maintenance fee of each section
  - Maintenance fee / Products

3. Overall functions of P.M. (Maintenance)

◎ : Major position, ○ : Sub position

Function	Description	Operating Section	P.M. Section	Engineering Section
Planning	Long term planning (e.g. (e.g. 5 years) Annual Plan Short tern planning (e.g. monthly) Fixed term maintenance plan	○	◎	○
	Equipment inspection plan Operation improvement plan	◎	○	○
	Detail inspection plan	○	◎	○
Inspection	Plant improvement analysis Technical analysis of trouble	○	○	◎
	Daily patrol, daily inspection	◎	○	○
	Detail inspection Simple technical analysis	○	◎	○
Repairing (Construction)	Detail analysis work	○	○	◎
	Small adjustment (First action)	◎	○	○
	Usual maintenance work Fixed term maintenance work	○	◎	○
Control	Maintenance budge control Maintenance materials control Recording	○	◎	○
	Measurement of maintenance effect & standard training	○	○	◎

° This table is one of the typical functions of PM. The functions of the section are influenced by the quality of the assigned persons.

° Plant maintenance should be done by the maintenance section which is composed of PM and BM functions.

APPENDIX VI-1(2) RUNNING MAINTENANCE

1. Existing System

System of running maintenance started in 1977. At present 28 persons including 4 S.A.M.E. Engineers engage in this job.

4 fixed engineers are distributed in 2nd and 3rd shift.
On the other hadn, general maintenance at present is as follows:

PA-TSP		SA	
Superdt.	1	Superdt.	1
A.M.E.	1	Asstt. Superdt.	1
		A.M.E.	1
S.A.M.E.	2	S.A.M.E.	1
Technician	26	Technician	16
Total	30	Total	20

This distribution and scattering of Maintenance energy is to be avoided.

Contents of the work of this team is minor maintenance work mentioned here.

- Opening and closing of manhole covers
- Lighten volts of flanges
- Replacement of pipes and fittings
- Others

Large part of these works must be done in the day time. If unfortunately some troubles happes at night, operator should try to solve the trouble and if necessary, it is better to call maintenance people from this home by phone. But if the trouble is serious, plant must be stopped, and operator should take preparation for easy start of maintenance in the morning.

2. Request to operator

As recommended before, operator must take charge minor mechanical works.

- ° Tightening of flange bolts
- ° Closing and opening of manhole covers
- ° Changing of pressure gange
- ° Changing of steam traps
- ° Tightening of gland bolts
- ° Changing of gland packing
- ° Others
- ° First daily checking of equipment
  (They are all near equipment on every shift.)
- ° Lubrication of equipment
- ° Cleaning of equipment every morning
  (Especially dust)

3. Requests to maintenance people

- ° All stand-by equipment must be settled and ready to run.
  Product acid transfer pump (SA-1, SA-2)
  Pump (PA-1, PA-2)
  AT, DT pump (SA-1, SA-2)
- ° They must do their best in the day time and have confidence to run all equipments until next morning.
- ° If necessary, they must come to the factory and try to repair the equipment at any time.

After repairing work, it is the duty of maintenance people to clear away used rubber, scarap and wastes. Some dumping grounds must be settled in some points of the factory yard as shown in Fig.1.

4. Summary

Maintenance people are distributed in every shift, but this system shall be canceled as soon as possible, and they must try to root out troubles in the day time in view of purpose of P.M.

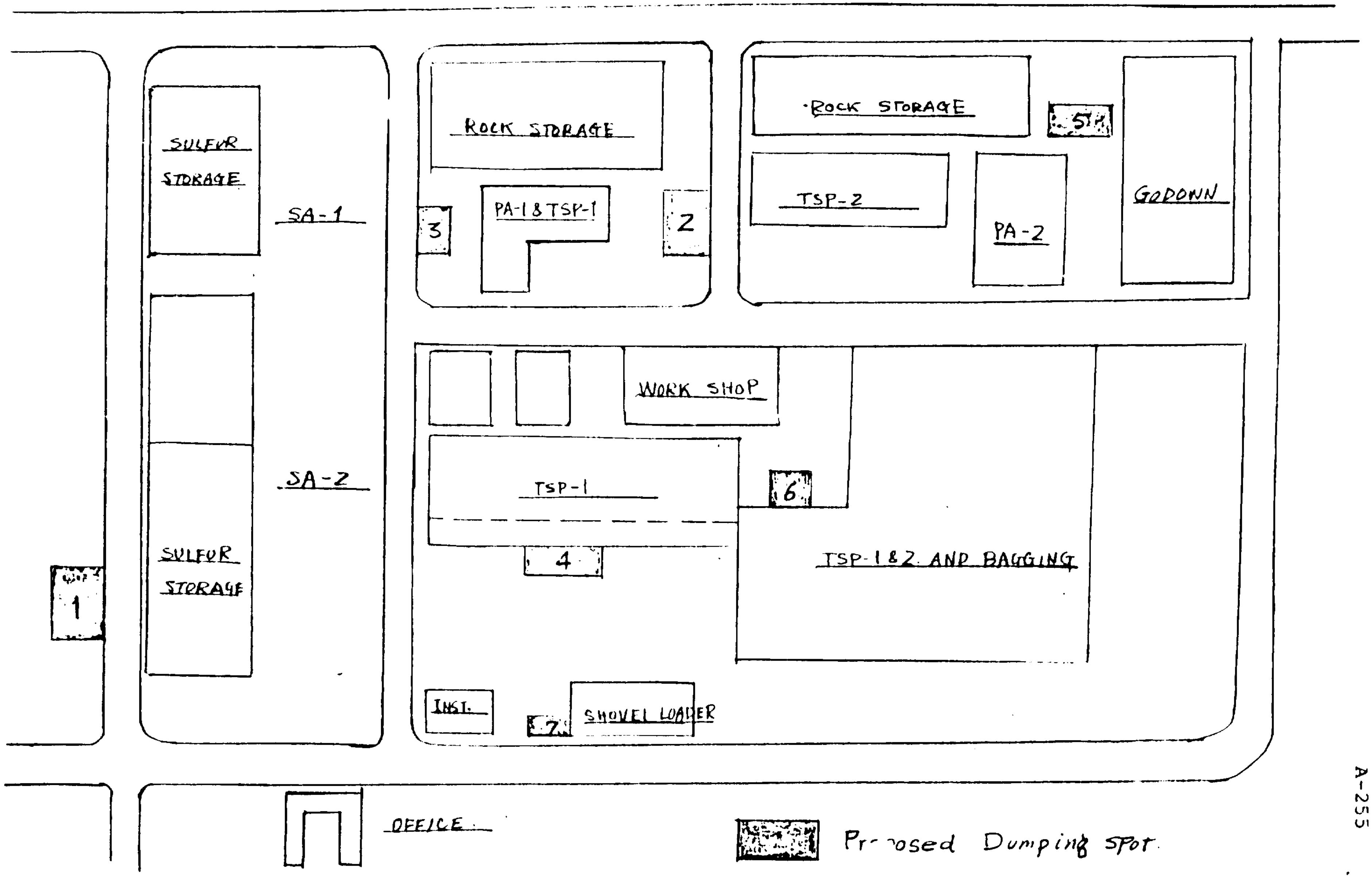
It is recommended to cancel the system of running maintenance and join it to maintenance section, because finally this action will reduce maintenance fee and rise the production of this plant.

LAYOUT OF PLANT (Free' le)

Fig. 1

March 3. 1981

UNDP EXPERT
Y FUJIKI



APPENDIX VI-1(3) INSTRUCTION OF CHECK LIST OF OPERATOR

1. Standard of judgement for operator check list (Please refer to Fig. 1 and 2 attached here.)

   o = Good condition

   Δ = Small repairing is necessary or checking by maintenance people is necessary.

   x = Repairing necessary.
   If immediately repairing is necessary, write it in (remark) space.

2. Operator of every shift must fill and write same marks every day, even if same condition of equipments continue every day. At first this check list may be filled with x or Δ mark, and at final stage it will be full of o marks.

3. This check list should be sent to maintenance department every morning at 8:30 A.M. after checked by the concerned Plant-in-charge.

Fig 1. OPERATOR CHECK LIST (FOR EQUIPMENTS)

PLANT: PA-II

Date ______________

Filled by IST SHIFT / 2ND SHIFT / 3RD SHIFT

Checked by ______________

ITEM NO	Name of Equipment	Sub-Item	Mechanical Trouble Temp.	Press	Nose	Vib Amp.	Electrical Trouble Temp.	Amp.	Noise	Vib	Remarks.
0-2202	Conveyor	.Flow Con.									
0-2301		.Screw Con.									
0-2210		.									
J-2301	Pump	.Slurry									
J-2402		.1st Filtrate									
J-2404		.2nd wash Acid									
		.Concent Feed									
J-2501		.Concent.GVC.									
J-2503		.CBA Transfer									
J-2405		.Gypsum Slurry									
J-2403		.Return Acid									
J-2408		.Recovered water									
-2506		.Hot water clean									
-2507		.Hot water									
		.Demi-W.Booster									
		.River W.Booster									
K-2403	Pan	.Vacuum									
K-2302		.Cooling Air									
K-2303		.Cry.Exhaust									
K-2402	Blower	.Dige.Exhaust									
.2401		.Filter Cake									
-2301		.Dige.Exhaust									
V-2302		.Vessel									
M-2301	Premixer	.Reducer									
V-2303		.Vessel									
M-2302	Digester	.Reducer									
V-2304		.Vessel									
M-2304	Crystallizer	.Reducer									
V-2304		.Vessel									
M-2305	Filtrate Holding	.Reducer									
.2409		.Vessel									
.2403	RA Tank	.Reducer									
V-2404		.Vessel									
M-2404	G.S. Tank	.Reducer									
V-2305	Ret.Acid Tank	.Vessel									
		.Reducer									
M-2401	Filter	.Pan Arm									
		.Bearing Roller									
		.Reducer									
		.Lubricator									
E-2301	Dilution Cooler										
E-2501	Conc.Calandria										
M-2304	Rock weigher	.Detector									
		.Indicator									
		.Screw Con.									
	Valve	.Steam									
		.Acid									
		.Water									
	Piping	.Steam									
		.Acid									
		.Water									
		.Slurry									

Fig 2. OPERATOR CHECK LIST
(For Equipments)

PLANT : REACTION-II Date ____________

Checked by ____________

Filled by IST SHIFT
2ND SHIFT
3RD SHIFT.

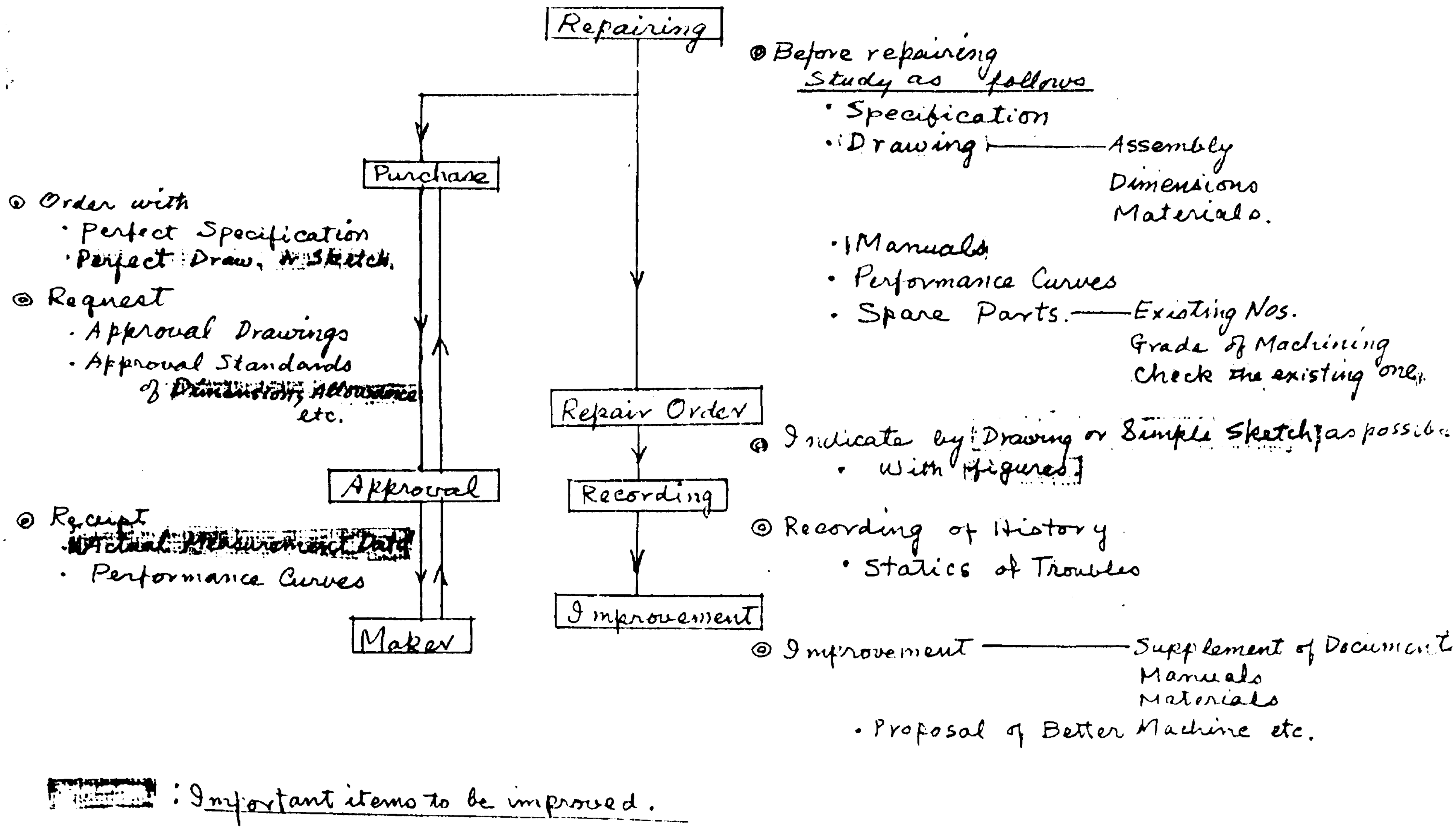
ITEM NO.	Name of Equipment	Sub-Item	Mechanical Trouble	Electrical Trouble
			Temp.Press Amp. Noise Leak Vib Lub	Temp.Amp.Noise Vib
K-3101	Fan	.Exhaust Fan		
		.Bearing		
0-3105	G.Rock weigher	.Indicator		
		.Detector		
V-3105		.Reducer		
V-3106	Premixer	.Ribbon		
		.Brg.		
0-2207	Conveyor	.Flow Con		
0-2209				
0-3112		.Screw Con.		
0-3108		.[illegible]		
0-3108		.Pan. Con.		
0-3109				
0-3110		.Belt Con.		
0-3111				
M-3107	Den	.Reducer		
		.Link & Roller		
		.Cutter		
		.Sliding Plate		
		.Bearing		
V-3104	CPA weigher	.Reducer		
		.Bearing.		
	Others			

Maintenance Section

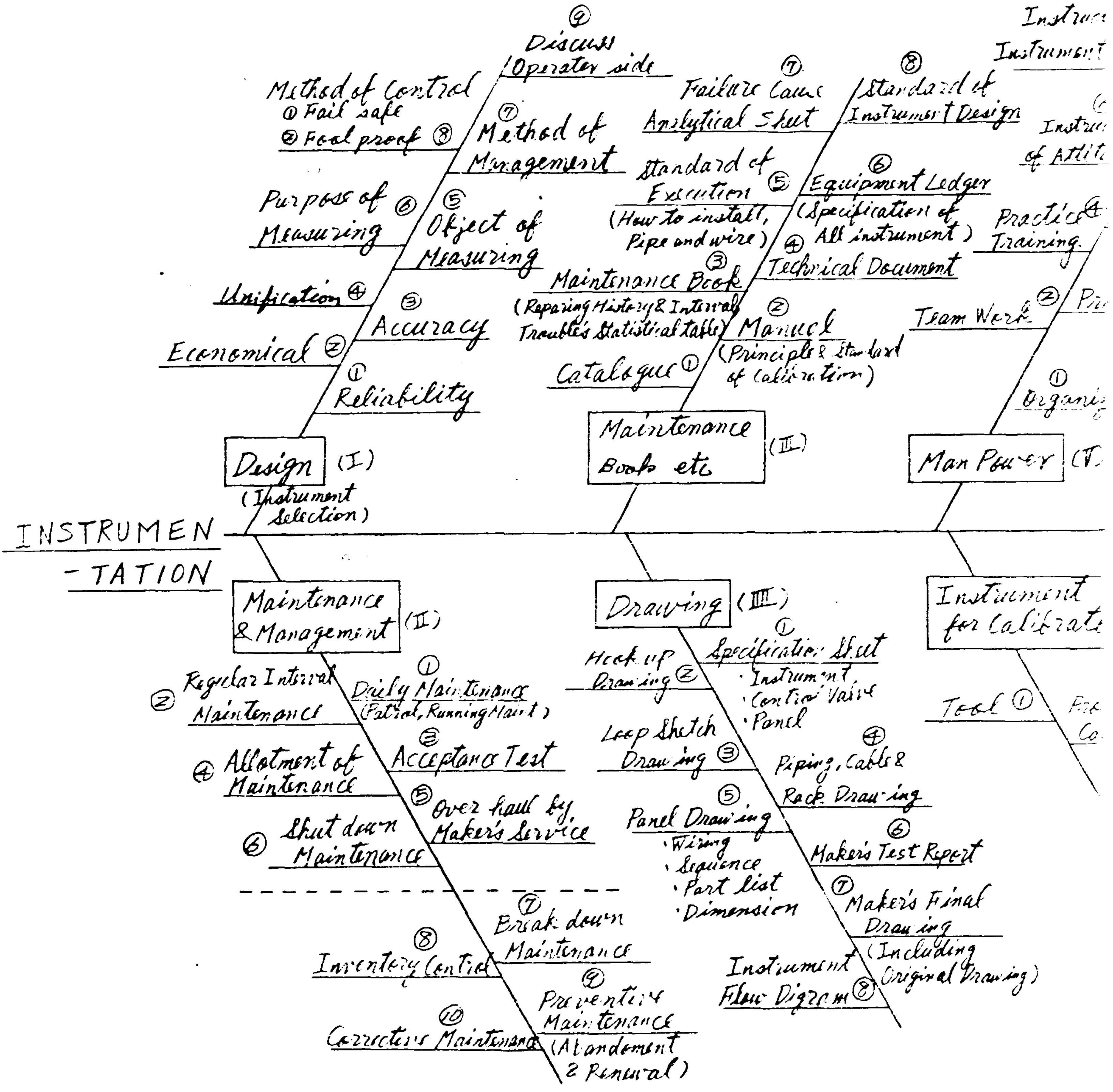
Checked by :- ________

Action by Maintenance Section :

APPENDIX 1-2 BASIC ACTION OF MECHANICAL ENGINEER

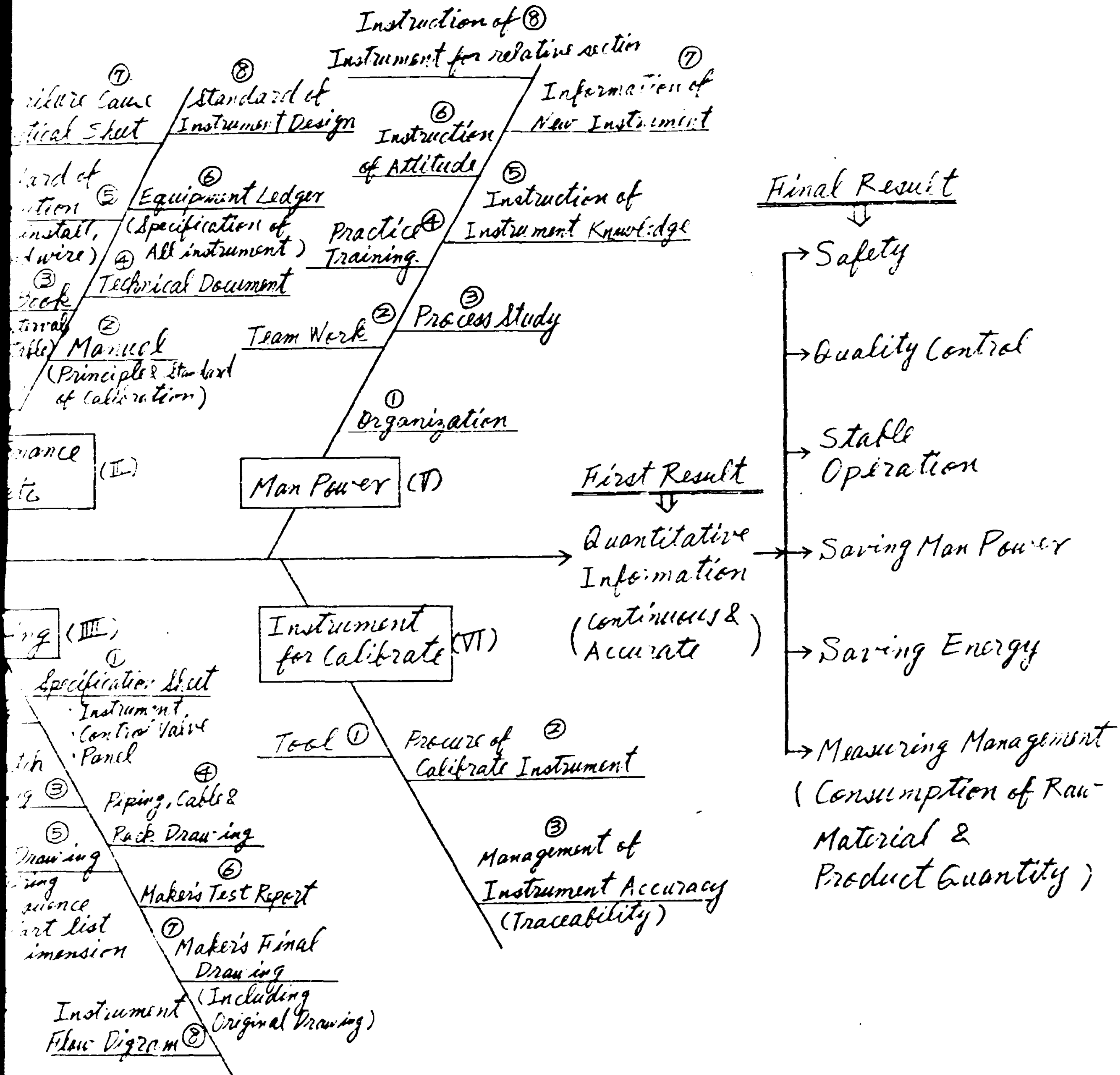


APPENDIX VI-3(1) IMPORTANT FACTORS FOR INSTRUMENTATION



SECTION 1

FACTORIAL DRAWING



SECTION 2

RIAL DRAWING

Analytical sheet of failure cause

(NO) DATE

GM	Sub GM			Concerned section	⟷	Elect & Inst Section			
						Manager	Sub manager	S.I.C	Execute person

Plant Failure parts		TAG, NO Failure phenomenon	

1. Trouble phenomenon
2. Trouble cause
3. Countermeasure (temporary, future)

Occured date	
Timing of trouble occured	1. Starting 2. Running 3. Stopping 4. Daily patrol 5. Regular maint...
Detecter	1. Maintenance person 2. Operater
Influence for production	1. Yes 2. No
Scope of stopped	

Occured	Repair start	Repair finish	Plant start	Normal	Product reduction Lost cost
					Repaired cost

History of repair

Failure cause	Primary cause		View of concerned section		Countermeasure	
	Secondary cause					
Degree of failure	1. Impossible to repair 2. Parts change 3. Repair on part 4. Whole repair					* If necessary, apend the technical report.

INSTRUMENT SPECIFICATION SHEET

ITEM. NO		TAG. NO	
PLANT		LOCATION	
NAME		NO. OF SET	

INDICATOR & RECORDER		
TYPE		
SCALE RANGE		
UNIT		
NO. OF PEN	1 PEN 2 PEN	
	POINTER 2.3.6.12	
CHART SPEED	mm/h	
CHART TYPE	ROLL, FOLDING, OTHER	
INPUT SIGNAL		
ELECTRIC SOURCE	AC100V, AC200V 50Hz	
AIR SUPPLY	Kg/cm²G	
MOUNTING		
CASE COLOR		
CONN. OF SIGNAL		
ALARM STRUCTURE		
ALARM SYSTEM		
SETTING SYSTEM & NO		
STRUCTURE & CAPACITY		
CHART	12 ROLLS	
ACCESSORIES		

ADDITIONAL	
ALARM STRUCTURE	
ALARM SYSTEM	
SETTING SYSTEM & NO.	
STRUCTURE & CAPACITY	
ACCESSORIES	

INTEGRATER	
TYPE	
INPUT SIGNAL	
NO. OF FIGURE & UNIT	
INTEGRATE RANGE	
SOURCE (SUPPLY)	
MOUNTING	
CASE COLOR	
CONN. OF SIGNAL	

DETECTOR & TRANSMITTER		
TYPE		
LOCATION		
RANGE		
INPUT SIGNAL		
OUTPUT SIGNAL		
MATERIAL		
MOUNTING		
AIR SET		
STRUCTURE		
SUPPLY		
CASE COLOR		
CONN. OF SIGNAL		
ACCESSORIES		
SERVICE CONDITION		
FLUID		
PRESSURE	MAX	NOR
FLOW RATE	MAX	NOR
TEMPERATURE	MAX	NOR
DIFFERENTIAL PRESURE		
SPECIFIC GRAVITY		
VISCOSITY		
PH		
CONDUCTIVITY		

CONTROLLER		
TYPE		
INDICATE STRUCTURE		
SCALE RANGE		
UNIT		
INPUT SIGNAL		
OUTPUT SIGNAL		
CONTROL SYSTEM		
CONTROL ACTION	PID. ON-OFF	
P ACTION	%	
I ACTION	MIN.	
D ACTION	MIN.	
SETTING SYSTEM		
SET SIGNAL		
OUTPUT GAUGE		
ELECTRIC SOURCE	50Hz	
AIR SUPPLY	Kg/cm²G	
MOUNTING		
CASE COLOR		
CONN. OF SIGNAL		
ACCESSORIES		

OTHERS	
NAME PLATE	ENTER TAG NO. SUS PLATE
PROPOSAL & FINAL DRAWING	5 COPY & 1 ORIGINAL
TEST REPORT	3 COPYS
GUARANTEE	1 YEAR

REMARKS

DELIVERY PLACE		DELIVERY DATE	
DATE		REVISIONS	

T.S.P. FERTIRIZER COMPLEX L.T.D	WRITEN BY	
	EXAMINED BY	
	CHIEF OF SECT.	

CONTROL VALVE SPECIFICATION SHEET

PLANT		TAG.NO	
NAME		LOCATION	
VALVE MODEL		NO. OF SET	
VALVE		LUBRICATOR	YES, NO
BODY/PORT SIZE		POSITIONER	YES, NO
PIPE SIZE & RATING		AIR REGULATER	YES, NO
		AIR FILTER	YES, NO
BODY TYPE	SINGLE, DOUBLE	SOLENOID VALVE	YES, NO
		PORT NO.	
BODY MATERIAL		ORIFFICE DIA.	
PORT TYPE	P, V, G	PRESSURE	
FLOW CHARACTOR	LINEAR, %, ON-OFF	CONN. SIZE	
TRIM MATERIAL		FAILURE POSITION	
SEAT MATERIAL		VOLT	AC100V, 200V 50HZ
GRAND PACKING MAT.		HAND WHEEL	YES, NO
GASKET MATERIAL		LIMIT SWITCH	YES, NO
BODY PAINT		TYPE	
		MAKER	
OPERATION			
ACTUATE SYSTEM	DIAPHRAM, CYLYNDER, OTHER	SERVICE CONDUCTION	
VALVE ACTION	AIR TO OPEN, SHUT, BOTH WAYS	FLUID NAME	
CONTROL ACTION	ON-OFF, CONTROL	COMPOSITION	
INPUT SIGNAL	Kg/cm²G	INLET PRESSURE	
		PRESSURE DROP	
AIR SUPPLY	Kg/cm²G	FLOW RATE (MAX)	m³/h, l/min, t/h
FAILURE POSITION	OPEN, SHUT	(NOR)	m³/h, l/min, t/h
CONN. OF SIGNAL		(MIN)	m³/h, l/min, t/h
FLOW DIRECTION	RIGHT—LEFT	TEMPERATURE	°C
		DENSITY	%
ACCESSORIES		VISCOSITY	cP
BONNET	YES, NO	SPECIFIC GRAVITY	
	FIN, EXTENTION, BELLOSEAL	CALCULATED Cv	
	STEAM JACKET		
OTHERS		REMARKS	
NAME PLATE	ENTER TAG. NO. SUS PLATE		
PROPOSAL & FINAL DRAWING	5 COPYS & 1 ORIGINAL		
TEST REPORT	3 COPYS		
GUARANTEE	1 YEAR		
DELIVERY PLACE		DELIVERY DATE	
DATE		REVISIONS	
T.S.P FERTILIZER COMLEX LTD		WRITEN BY	
		EXAMINED BY	
		CHIEF OF SECT.	

APPENDIX VI-3(5) INSTRUMENT PANEL DESIGN SHEET (/)

INSTRUMENT PANEL DESIGN SHEET

ITEM NO	I-2010	TAG NO	PB-2301	NO. OF SET	
NAME	INSTRUMENT PANEL FOR PA PLANT			REVISIONS	

GENERALITY	LOCATION	Control room
	TYPE	Self standing
	CONSTRUCTION	enclosed type
		with silkscreen
		semigraphic plate
SIZE	WIDTH	1100 m/m
	HEIGHT	2400 m/m
	DEPTH	1500 m/m
	NUMBER	3
MATERIAL	FRONT BOARD	3.2 mmt CRS
	GRAPHIC BOARD	2.3 mmt CRS
	BENCH BOARD	Nil
	SIDE BOARD	2.3 mmt CRS
	BACK BOARD	2.3 mmt CRS
	CEILING BOARD	2.3 mmt CRS
	CHANNEL BASE	100 m/m/50 m/m/5 mmt
COLOR	DOOR	Munsel N7.0
	GRAPHIC BOARD	Munsel N7.0
	INSIDE	Munsel N7.0
	CHANNEL BASE	Munsel N7.0
INSTALLATION	NAME PLATE	See another paper
	INSTRUMENTS	See instrument design sheet
INSTALLATION – ANNUNCIATOR	LAMP	Yes 26 point
	AUDIBLE UNIT	Yes 2 set
	FLICKER RELAY	Yes 2 set
	PUSH BUTTON	Yes 2 set
	TEST BUTTON	Yes 2 set
	SNAP SWITCH	

PIPING – AIR SUPPLY	INLET PRESSURE	5 kg/cm²
	INLET POSITION	
	CONNECTION	3/4 JIS10K flange
	FILTER	Yes, 2 set
	REDUCING UNIT	Yes 2 set
	PRESSURE GAUGE	Yes 2 set
	AIR HEADER	3/4B brass
	STOP VALVE	1/4 3 pc
	TUBING MATERIAL	Copper 1/4 B
PIPING – SIGNAL	TUBING MATERIAL	Copper
	BACK HEADER	1/4 B
	LEADING POSITION	
WIRING – SOURCE	POWER	230 ± 15% 50 Hz
	INLET POSITION	
	SWITCH	Yes 1 PB
	TRANSFORMER	230/100 V
	WIRING MATERIAL	Vinyl chloride insulated
	COLOR	
	TERMINAL	
	Voltage regulator	Yes
WIRING – SIGNAL	WIRING MATERIAL	Vinyl chloride insulated
	COLOR	
	TERMINAL	
	LEADING POSITION	
	RELAY	

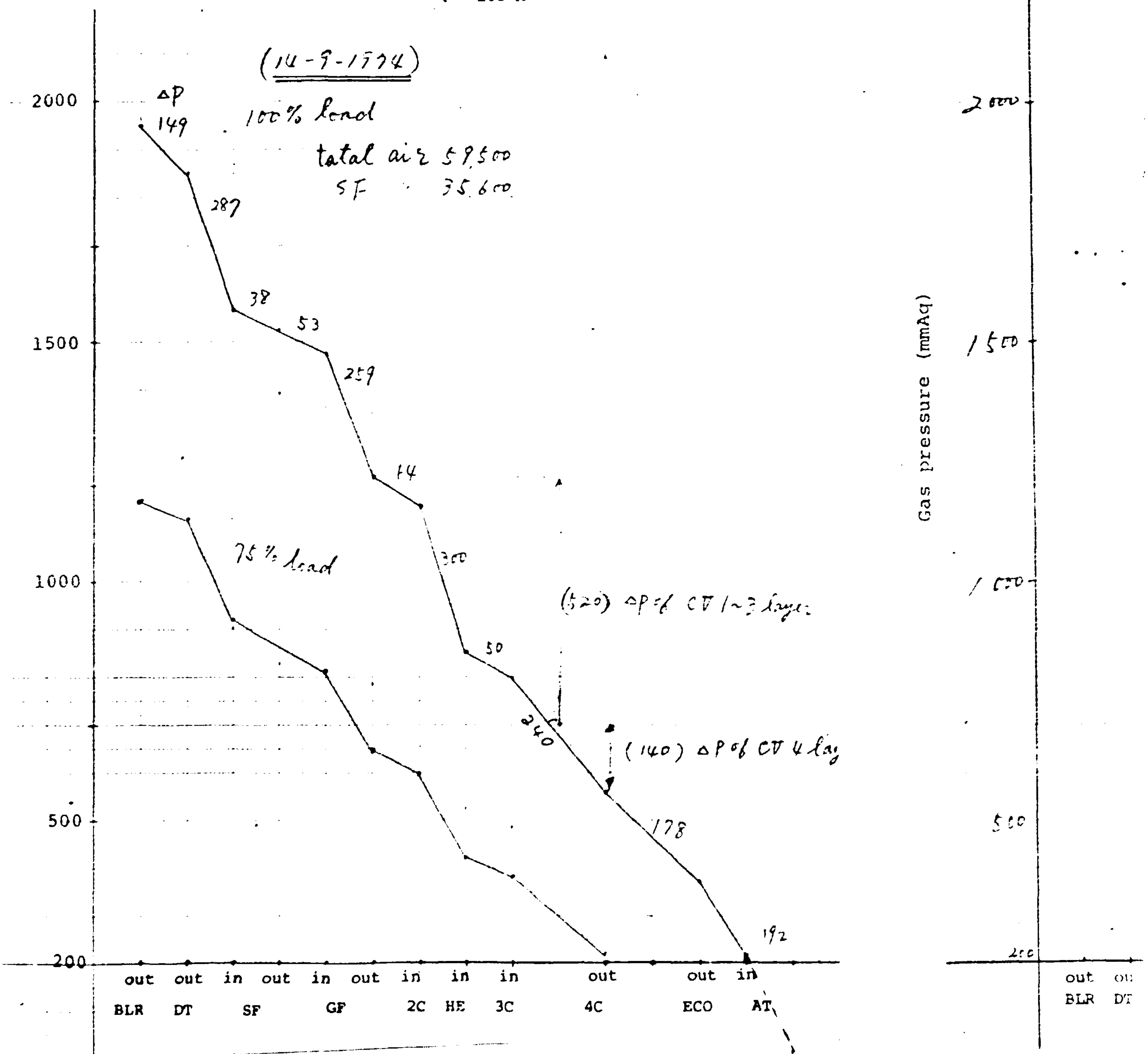
Selector switch	12
Running lamp	32
Ax. relay	15
Push button switch	8
Ammeter	20

APPENDIX VII-1 GAS FLOW RESISTANCE (ΔP) of SA-2 PLANT

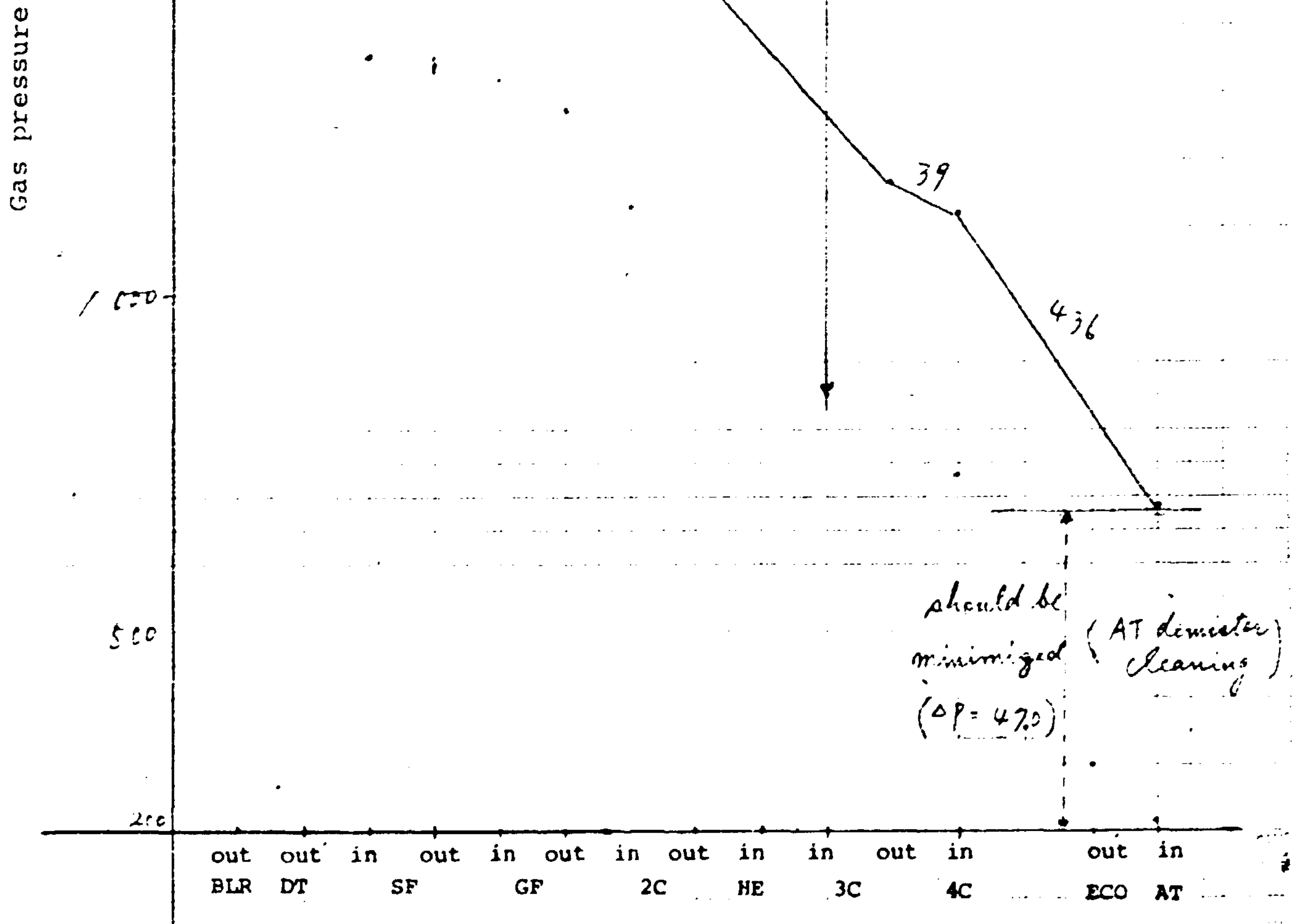
Comparison of resistance between the commissioning data and recent one.

Specification of blower: 61,800 Nm^3/H
Suc: -60 mmAq
del: 2,300 mmAq

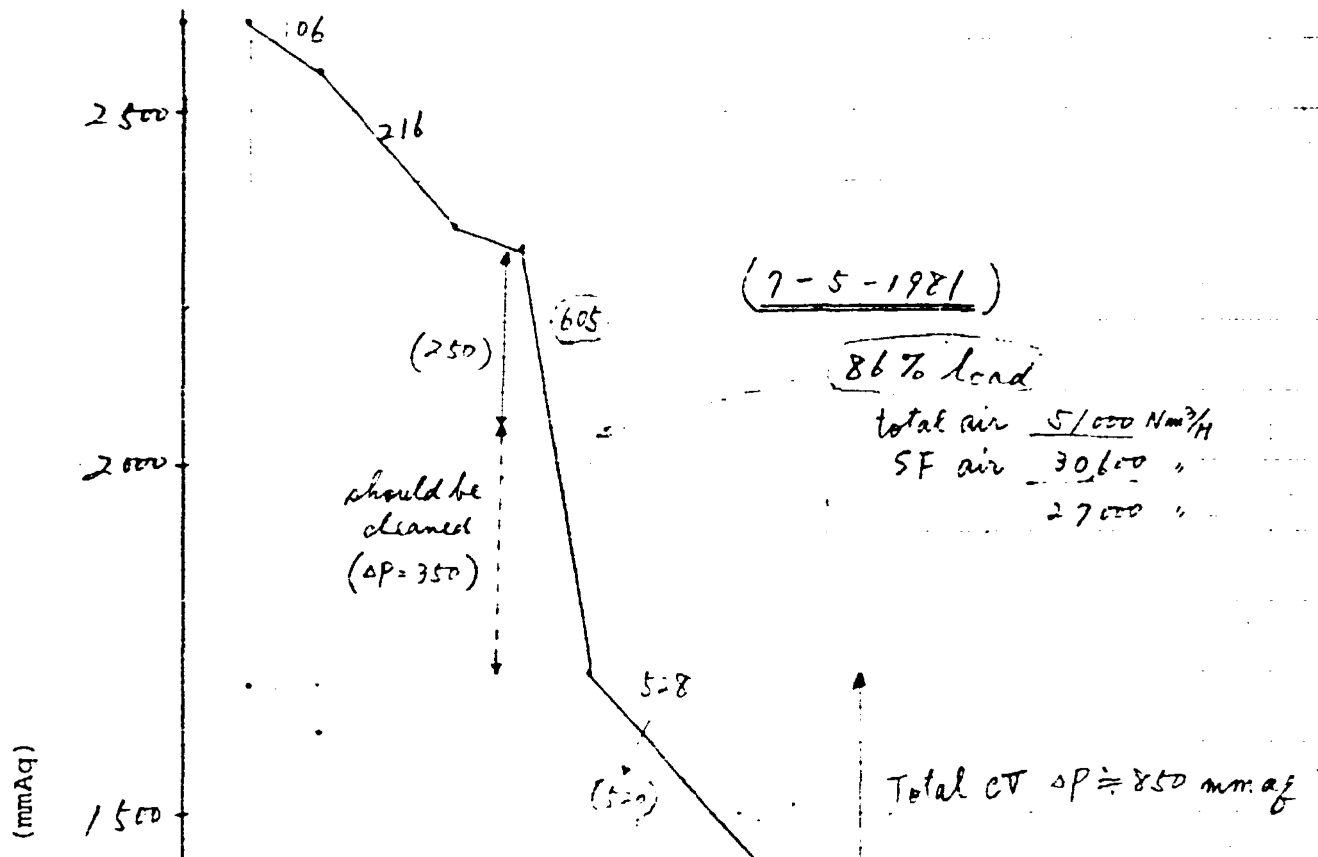
Motor { 500 KW, 3,300 V, 103 A }



SECTION 1


Gas pressure
1000
500
200
39
436
should be minimized (ΔP = 470)
(AT demister cleaning)
out BLR
out DT
in SF
out
in GF
out
in 2C
out
in HE
in 3C
out
in 4C
out ECO
in AT

SECTION 2



(mmAq)
2500
2000
1500
106
216
605
528
(520)
(250)
should be cleaned
(ΔP = 350)
(7-5-1981)
86% load
total air 51,000 Nm³/H
SF air 30,600 "
27,000 "
Total CT ΔP ≑ 850 mmAq

APPENDIX VII-2 CALCULAT
MAKE-UP

1. Basis

i) Total air

$$V = \frac{100,000 \times 22.4}{24 \times 98 \times 0.97}$$

ii) Moisture H_1 Kg/hr

$H_1 = V \times H_0 = 18,1$

Basis 25°C, 60%

iii) Total water H_2 Kg/

$$H_2 = \frac{100,000}{24} \quad \frac{18}{98}$$

iv) Make up water H_3

$H_3 = H_2 = H_1 = 623$

v) Common formula

y = load percentag

$H_3 = y \times (0.140$ -

vi) Rota meter

10.4 lit/min is eq

$$(\frac{H_3}{0.362} = \frac{10.4}{0.362} = 2$$

vii) Control of acid perce

Volume of additional
of acid content durin

) kg/20 minutes

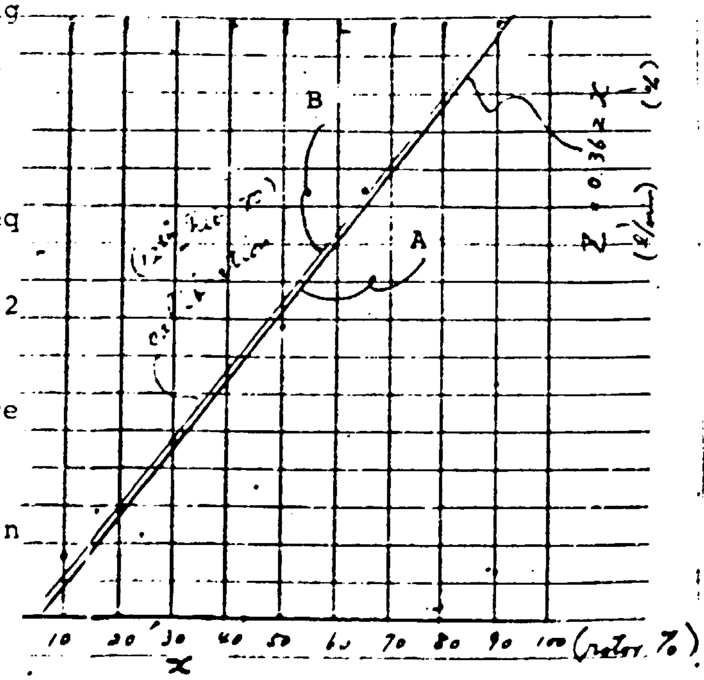
$$\text{eter} = \frac{260}{20} \times \frac{1}{0.362} = 36\ \%$$

rota meter = 36 + 29 = 65 %

n condition

25	30	35	40
6.36 5.646 4.956	5.61 4.08 3.75	4.734 3.444 2.202	3.54
8.48 7.528 6.608	7.48 5.44 5.00	6.312 4.592 2.436	4.72
9.54 7.528 7.434	8.415 5.44 5.625	7.101 4.592 3.303	5.31
10.6 9.41 8.26	9.35 6.9 6.25	7.89 5.94 3.78	5.9

rameter



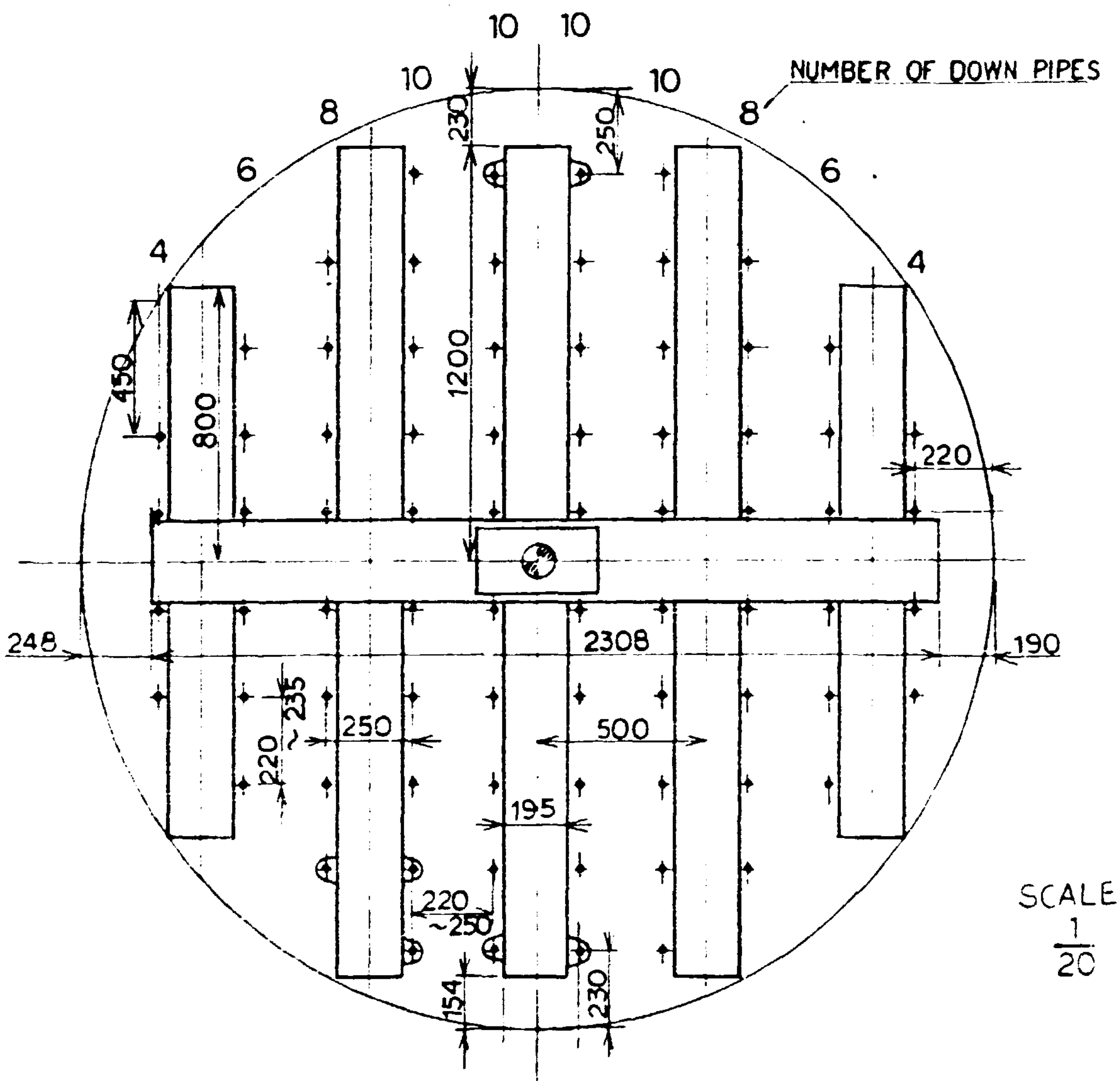
VII-3 OBSERVATION OF SA-1 AT,DT NEW TYPE DISTRIBUTOR

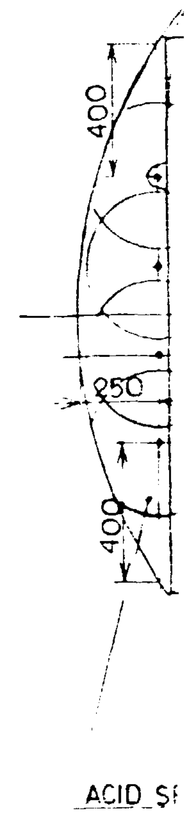
1. DT

D (inside diameter) = 2,735 mm N(No. of downpipe) = 76

A (total area) = 5.87 m^2 N/A = 12.9 pcs/m^2

[cf N/A in SA-2 plant = 9.6]





2. AT

Result is shown in the right page.

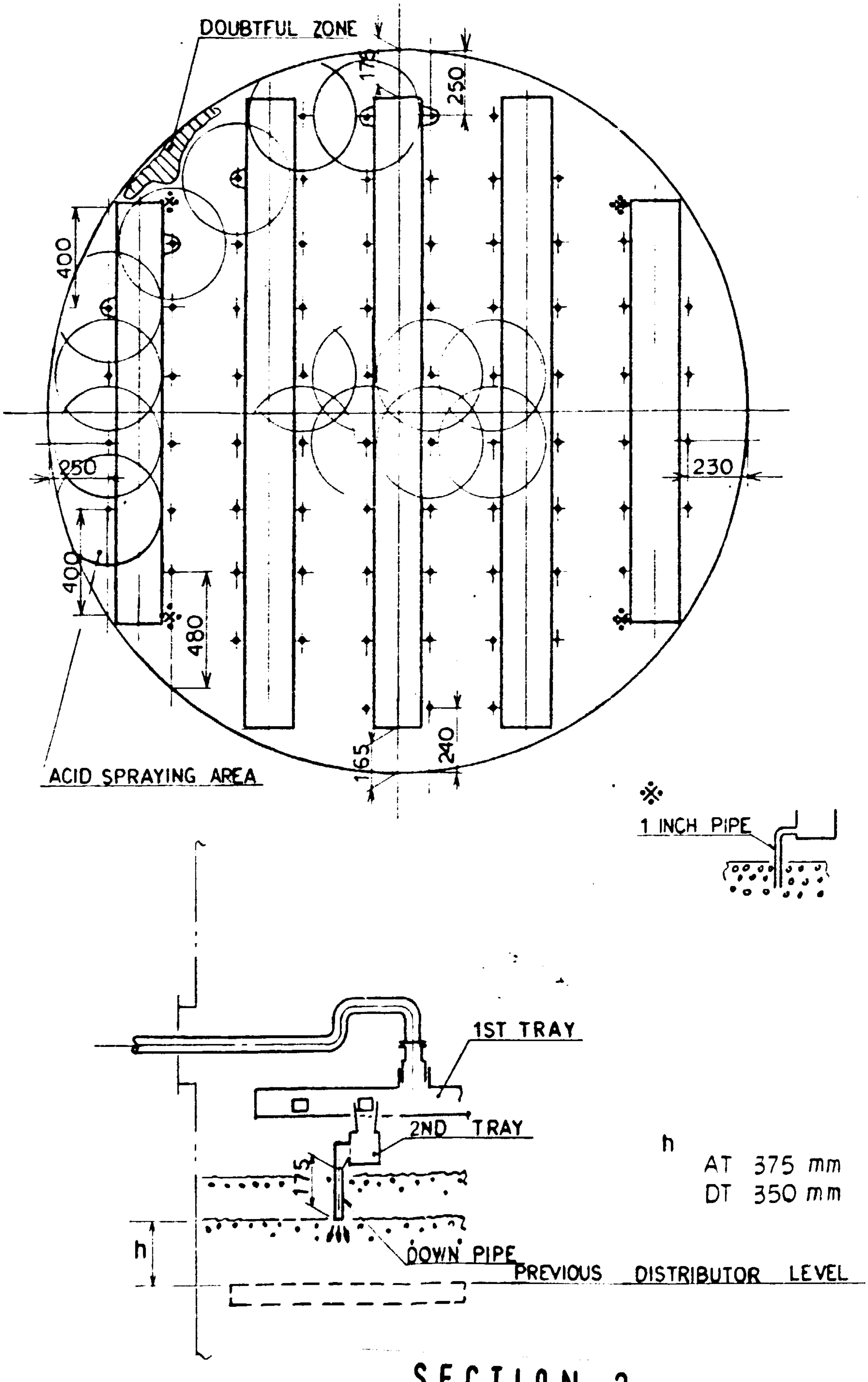
3. Comment

i) Number of nozzle is sufficient in comparison with that of SA-2 plant.

ii) There is doubtful zone as to distribution. If condition of stack gas is not desirable, addition of 1 inch pipe will be necessary. [Note] Stack gas was no problem.

iii) It is better to plug pin holes of down comer.
[Note] This item was conducted with welding method.

SECTION 1


DOUBTFUL ZONE
175
250
400
250
230
400
480
165
240
ACID SPRAYING AREA
※
1 INCH PIPE
1ST TRAY
2ND TRAY
175
h
DOWN PIPE
PREVIOUS DISTRIBUTOR LEVEL
h
AT 375 mm
DT 350 mm

SECTION 2

APPENDIX VII-4 EXAMPLE OF CALCULATION FOR SA-1 150 T/D PLANT

1. S Vol.(SU) = $\frac{150000}{24}$ × $\frac{32}{98}$ × $\frac{1}{0.975}$ = 2093 Kg/H (= 65.4 Kg mol/H)

Kg/H Kmol. efficiency.

2. SO_2 vol.(S) = $\frac{2093}{32}$ Kg.mol/H x 22.4 = 1465 Nm^3/H

3. SF air vol. (AS)= $\frac{S}{SO_2 \text{ content}}$

Case 1. SO_2 7.5% production 100 T/D (existing)

$AS_1 = \frac{S \times 100 \, T/150 \, T}{0.0\,75}$ = 13,040 Nm^3/H

Case 2 SO_2 11. 0 % product 150 150 T/D (150% load time)

$AS_2 = \frac{1465}{0.11}$ = 13,320 Nm^3/H

$AS_1 = AS_2$

This means, if SO_2 % is increased upto 11%, capacity can be increased without air increasing.

existing condition SF in air temp. (t_1) = 260°C out (t_2) = 1050°C

SO_2 % increase method (t_1 *should be down*) t_1 = 50°C *, then SO_2 % increases to 11%*

4. SF heat load FQ $Mcal/m^3$ hr

$S + O_2 = SO_2$ + 70900.Kcal/Kgmol

$Q = 70900 \times SU/32 + AS_2 \cdot 0.31\, T_1$ = 4637 + 207

2093 13320 50

= 4844 Mcal/H

SF chamber vol. (FV m^3) = $0.785 \times 2.74^2 \times 6.78 \times 0.9$ (effi) = 36.0 m^3

FQ = Q/FV = 136 180 230 $Mcal/m^3$ hr (normal value)

<u>OK safety.</u>

5. CV
$SO_2 + \frac{1}{2} O_2 = SO_3$ + 22600 Kcal/kg mol ... 1478 Mcal/H.

necessary catalyst volume & its distribution for each bed and each conversion ratio should be calculated exactly by a contractor or vender with using computer.

But existing catalyst vol. is 15,3 m^3 = 153 L/SA.t/D which is almost minimum ratio (Mini = 160)
and also it depends on catalyst activity which should be tested by vender.

By these reason I must now only assumpt that 50% vol. = 7.7 m^3 will be needed.
and also assumpt its distribution as follows

method A : if possible to be put in this to existing each bed.

B : if impossible to be done it due to space shortage.

		1C	2C	3C	4C	5C	Total
	A:	1.6 m^3	1.8	1.9	2.4	-	7.7 m^3
	B:	0.5 m^3	0.5	0.5	0.5	5.7	7.7
Conv.ratio for B (X)		55%	26	12	3	1.5	97.5%
generated heat (q)		813	384 Mcal/H	($q = 22600 \times 65.4 \times X$)			

As 5th bed existing HGF which will be spared after S-filter & air filter is established can be used.

6. WHB

1) Existing boiler specification:

	NO1 Boiler = 1B	NO2 Boiler = 2B
Shell dia	= 1346 mm	1168 mm
Tube length	4570	1870
dia	50.8	50.8
Thick	3.5	3.5
NO.S	204 Pcs	144 Pcs.
Heat area	149 M^2	42 M^2

2) Gas specific heat (Apprex) Kcal/Nm^3 °C

1B inlet CP.1 = 0.339 X 0.89 + 0.544 X 0.11 + 0 = 0.362
(air) (SO_2) (SO_3)

out CP.2 = 0.320 X 0.89 + 0.486 X 0.11 + 0 =0.338

2B in. CP.3 = 0.326 X 0.89 + 0.508 X 0.05 + 0.723X0.06 = 0.359

out CP.4 = 0.321 X 0.89 + 0.490 X 0.05 + 0.69 X0.06 = 0.352

3) Heat calculation

Each Boiler enthalpy to be taken in

Qo Kcal/H = W Nm^3 / H. x (Cp. T in - Cpt out)

For NO 1B effective heat Q_1 = Q_o X 0.97 should be cooled by 1B

1B W_1 = AS_2 = 13320 (t_2) 1070 in (t_3) 430°C out

2B W_2 = AS_2- ½ S. X = 12920 (t_4) 600 (t_5) 465

(X = CV ratio = 0.55 in Ist bed)

For 1B Q_1 = 13320 (0.362 X 1070 - 0.338 X 430)X0.97 = 3127 Mcal/H

For 2B Q_2 = 12920 (0.359 X 600 - 0.352 X 465) X0.97= 648

On the other hand, actual X should be confirmed for 1st bed.

Q_3 = generated heat in 1st bed, calculated from increasing of gas enthalpy.

Q_3 = (2B inlet enthalpy - 1B outlet anthalpy) X 0.97 = q

= (12920 x 0.359 x 600 - 13320 x 0.338 x 430) .0.97

q = Generated heat in Ist bed (= 823 Mcal/H.) calculated from SO_2 reaction.

If nearby Q_3 q, X must be adjusted a little by increasing or decreasing to be equal Q_3 = q

Q_3 = (12920.0.359 .600 - 13320.0.338.430)0.97 = 822 Mcal/H.

Q_3 = q, So in this case assumption of X = 0.55 is almost suitable.

4) **Steam generation.**

This is also affected by feed water (HFW) temperature, t_{14}

I show here to set economizer to CV 5th bed outlet.

Then t_{4} will come to 200°C

(existing design temp. t_{4} - 100°C, actual operating 90°C)

ST_1 = steam generation in 1B (Kg/H)

Q_4 -: Boiler absorbing heat (Kcal/H), Q_4 = WT. (i A - i B)

WT_1 = HFW vol. (kg/H) for 1B. WT_1 = ST_1

i A.B = enthalpy kcal/kg, A = steam side B = HFW side

t_{14}	=	70	100	215	(press = 20 kg/cm²)
i B	=	70	100	220	(iA = 668)

$Q_4 = Q_1$

∴ $ST_1 = Q_1/(iA-iB)$	=	5306	5597	7083	in 1B
$ST_2 = Q_2/(iA - iB)$	=	1084	1141	1446	
Total ST.	=	6390	6398	8529	
actual useful ST	=	6071	6401	8103	(~~x~~ blow off etc.)

5) **Possibility by existing heat area**

Limit of steam generation is generally 65 Kg/m² hr.

1B : ST_1/ tube heat area = 7083/149 = 47.5 kg/m² hr

2B : ST_2/ : = 1446/42 = 34.4

∴ tube heat area will be enough used.

7. HE (among 4C to 5C)

Gas is slightly cooled by existing HE from 465°C to 440°C

gas vol, $W_5 = AS_2$ - 765 X 0.96 + W_3 + W_4 = 13320 - 703 + 2500 + 1100
= 16200

CP can be roughly used with C0.3

$Q_5 = W_5$ Cp (465 - 440) = 16200 0.359 25 = 145 mcal/H)

Q_5 is a little comparing big HE, so it will be removed by natural air draft.

If it is some difficult a simple ventilating ~~a~~ fan will be enough for forcing air.

8. 5th bed CV.

HGF can be transfer to 5C after HE

HGF specification

dia	3.5 m
height (straight)	710 mm
from grid)	
vol.	6.8 m^3

This is possible to set 5.7 m^3 catalyst.

Catalyst net should be set on the existing net

9. ECO after 5C

1) heat capacity

gas vol. $W_6 = W_5 - \% S \times 0.015 \doteqdot 16200$

water vol ST_3 = Total ST − WT_4 (by pass vol.) kg/H

water temp. t_{12} (inlet) = 90°C i_{12} = 90 Kcal/kg.

t_{13} (outlet) =215°C i_{13} = 220 "

" absorbed heat QW kcal/H. = WT_3 (220 − 90) x 0.95

gas temp. t_5 (in) = 450°C

t_6 (out) = 250°C

CP CP_5(in) = 0.32 x 0.92 + 0.687 x 0.08 = 0.2944+0.0550
= 0.349

air SO_3

CP_6 (out) = 0.313 x 0.92 + 0.08 = 0.2870+ 0.0505
= 0.338

Cooled neat QG Mcal/H

$QG = W_6 (CP_5\ t_5 - CP_6 t_6 \times 0.98$ = 16200 (1571−84.5) 0.98 = 1153

QG = QW

$WT_3 = W_6 (CP_5\ t_5 - CP_6\ t_6)\ 0.98/123.5$
= 9330 Kg/H

total Boiler Feed = 8530 Kg/H 80 800 kg/H is by-passed-

.˙. Boiler inlet water temp. = (8530.215+ 800.90).9330= 204°C

2) Heat area

each flow	gas top to bottom	450°C	250°C
	water bottom to top	215	90
	t temp. difference	235	160
	dtm.(av.temp. def.)	= (235+160)/2 = 197°C	

over all heat trans. coeff. $U \doteq 45$ kcal/m^2 hr. °C

heat area A m^2 A = QW/U. dtm = 115 3000/45x197

(approx) = 130 m^2

A. depends on various type of ECO by each vender.

10. AT

1) Tower

Existing AT capacity seems to be full with 100% load.
So in this planning we don't increase ~~mm~~ air so much in order fully to use the existing equipment.

But anyway additional AT should be established (or height of existing AT should be added about 1.2 m packing zone) after attempt of about 120% load with existing AT.

- Additional AT dia inside 1,940 mm ∅
  length 4,100 mmH (Packing zone)
  Packing interrock saddle.

2) Pump for this Ad. AT existing spec. OAT pump can be used and existing spare one will be used as common spare.

3) Acid cooler

For AT side more 4 stages of existing sets should be set.

(As another method 35 m^2 of tefron tube cooler is very useful in this case DM water can be used to cool them this DM water can be sent to BFW tank to save heat.

If so 500 kg/H of steam is also saved.)

4) Remarks

If purified SA Plant will be considered here AT and acid cooler should be established with glass linings or tefron so that import is stopped and also export is possible.

11. Air Blower

- specification

rpm	= 600	4000	4400
W m^3/H	7220	14400	15300
HP	30	160	232
head inch aq. in	410	410	410
out	440	480	510
(original load	50	100	120%)

- Required air vol. wo Nm^3/H

$W_o = AS_2 + W_3 + W_4$

$= 13320 + 2500 + 1100 = 16900$

W = 15300 W_o 16900 so it will be shortage, but if its characteristic curve is available or actual flow volume is tested, capacity will be enough anyway test is necessary.

12. Test method of max. air volume at running time
(this test is necessary because pressure head is doubtful)
Products (G Kg/D), SO_3 % and total gas vol. (W Nm^3/H)
have a relation. It is shown by the following formula

$G/24 = \overline{W} \times (SO_3\% / 100) \times 98/22.4$

$\therefore G = 1.05\ \overline{W}\ SO_3\%$ (SO_3 is measured by analysis)

At minimum gas flow resistance time (after CV catalyst shieving) you can measure the W with minimum SO_3 % operation, then W comes to max. volume by max. rpm.
ex. $G = 100 \times 10^3$ Kg/D. SO_3 = 5.6% then W = 1700 Nm^3/H

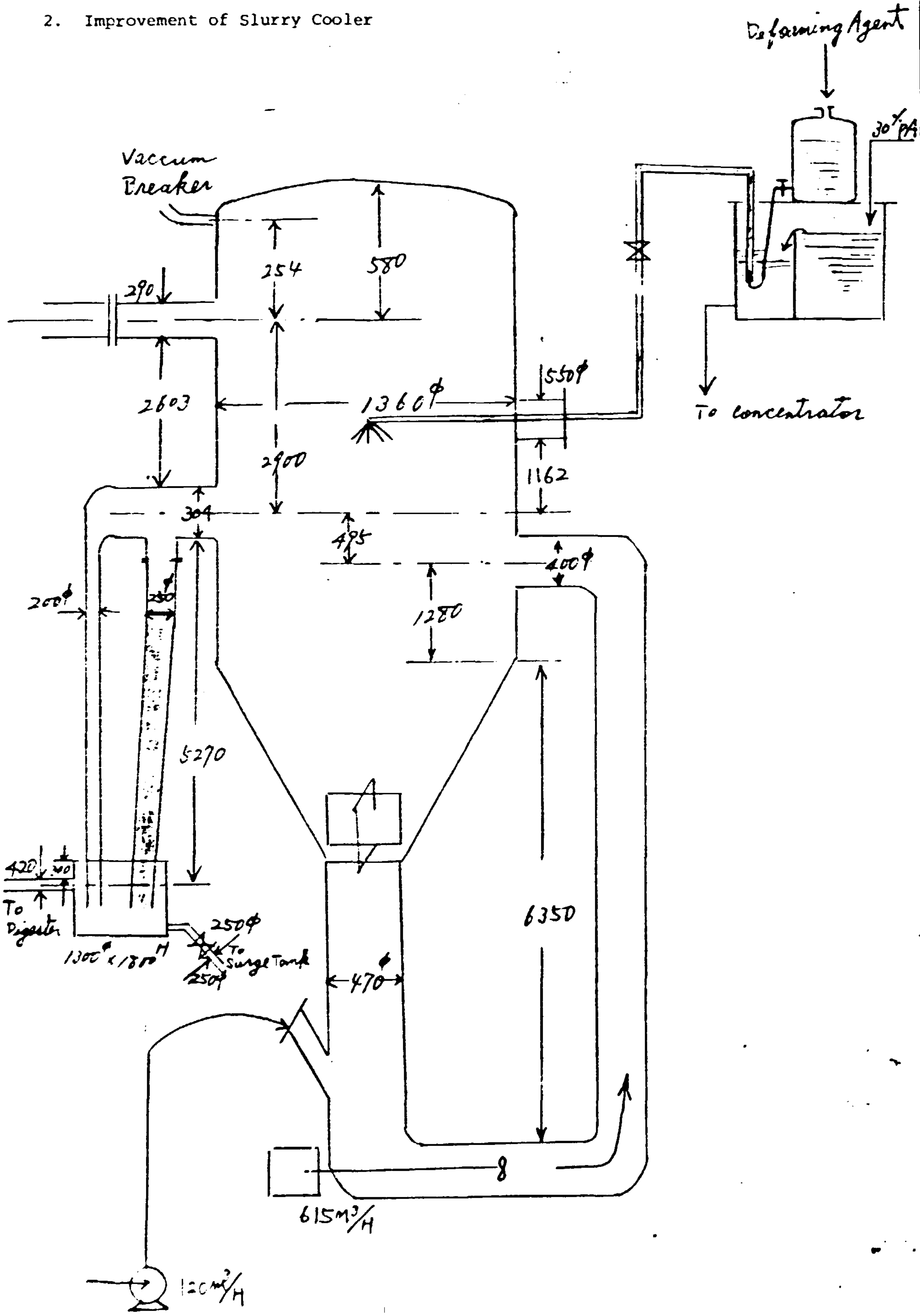
This test is very useful for confirmation of AT absorption capacity also. If complete absorption is possible in this condition 150% will be possible with existing AT only.

APPENDIX VII-5(1) OPERATION OF PA-I FOR 100% LOAD

1. The result of operation for 100% load is given below :

	December 1980 -	Reference
Phosphate rock Feed (T/H)	4.38	According to calculation for material balance of Morocco Rock.
Phosphate rock Fineness	-100M 90% -200M 70% Morocco Rock	Ref : Ship-Cape Kasmari Date of sample - 3.9.1900 T/H H P_2O_5 in rock 4.38 x 24 x 0.317 x 0.96(recover) = 32 T/D as 100% P_2O_5
Product Acid		
P_2O_5 (%)	27 - 28	
H_2SO_4 (%)	1.5 - 2.5	
Temp.(°C)		
Digester	78 - 80	
Slurry surge tank	72 - 75	
Cooled slurry drum	71 - 74	
Pressure (mmHg)		
Slurry cooler (PIC)	-330 - 380	
Slurry cooler		
Slurry cooler feed pump	120 m^3/H	
1st condenser inlet water	-1.3 m^3/min	
2nd "	-30 lit/min	
Steam pressure	9.5-10.5kg/cm^2G	
Antifoaming agent	150 ml/30min (=0.2 kg/T P_2O_5)	DEHYDRANE (west G)
Filter		
Vacuum	-280-350mmHg	
Vacuum pump.Amp	70A	
Filter speed	4- 6	Reducer motor's mark
Cake thickness	40 mm	

2. Improvement of Slurry Cooler



3. Feed rates (32 T/D = 1,333 T/H)

	kg/T P_2O_5	kg/H	ρ	flow rate
Rock (wet)	3,287	4,382	-	4.38 T/H
Rock (dry)	3,231	4,307	-	-
98.3% H_2SO_4	2,838	3,782	1,825	2.1 m^3/H
Return Acid	8,850	11,797	1.17	10.1
Slurry (at feeding)	14,975	19,962	1.57	12.7
Slurry (at filtration)	13,797	18,391	1.57	11.7
Wash Acid-1 (3rd Filtrate)	6,289	8,382	1.05	8.0
Wash Acid-2 (4th Filtrate)	5,728	7,635	1.02	7.5
Wash Water	5,742	6,988	1.00	7.0
Product Acid	3,571	4,760	1.30	3.7
1st Filtrate	5,478	7,302	1.30	5.6
1st Filtrate splitted to be Return acid	1,907	2,542	1.30	2.0

Assumption

1 Raw material

1) Rock (dry) Morocco

P_2O_5	32.24 %
CaO	50.91
SO_3	1.88
CO_2	5.41
F	3.85
Moist	1.69

2) Sulfuric Acid

2. Solid conc.
at filtration 37 %

3. Decomp. ratio 97 %

4. P_2O_5 recovery 96 %

5. Product acid

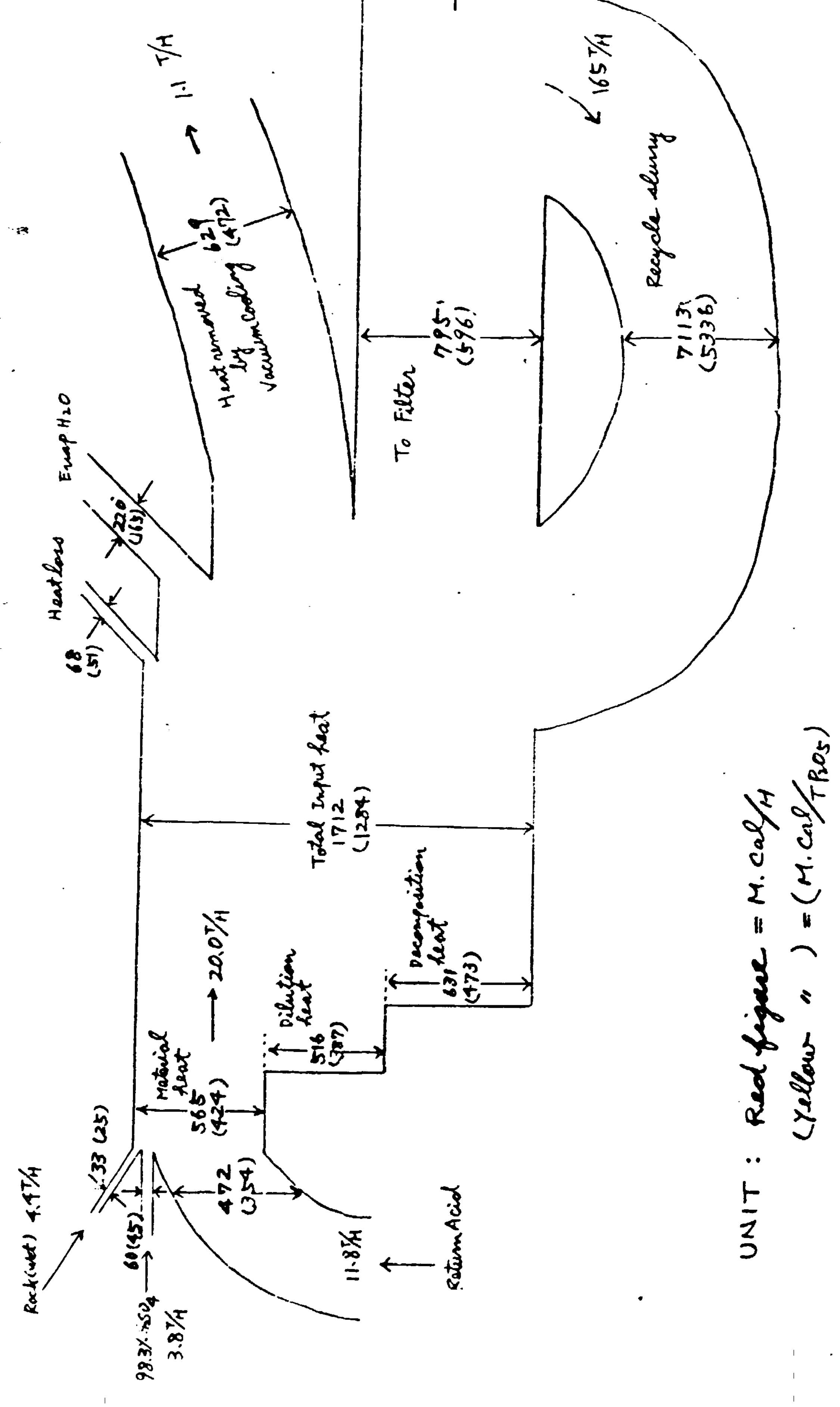
P_2O_5 28 %

H_2SO_4 2 %

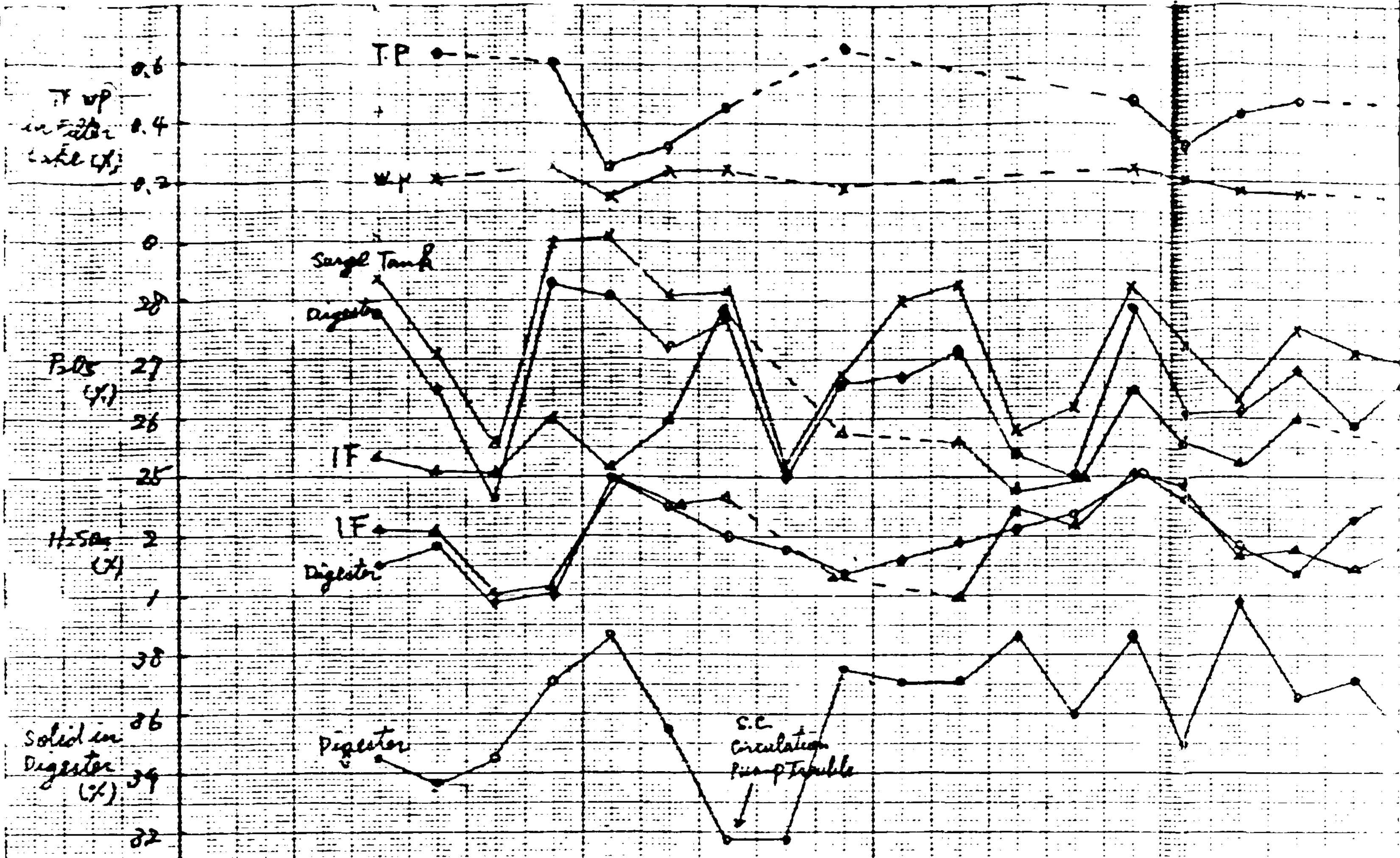
6. Liq. in wet cake

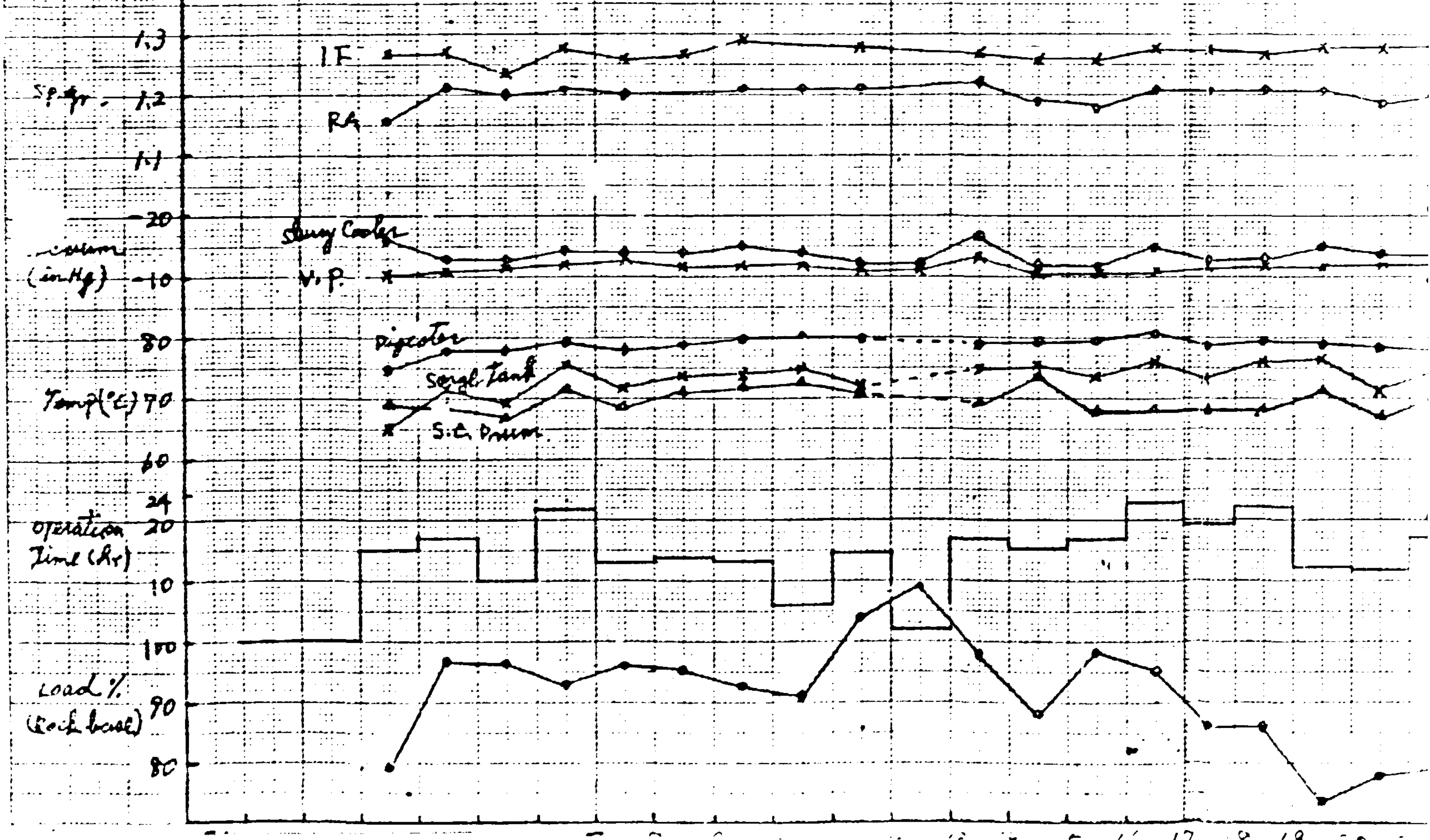
40-35-30-25

4. Heat Balance (32 t/D Base)

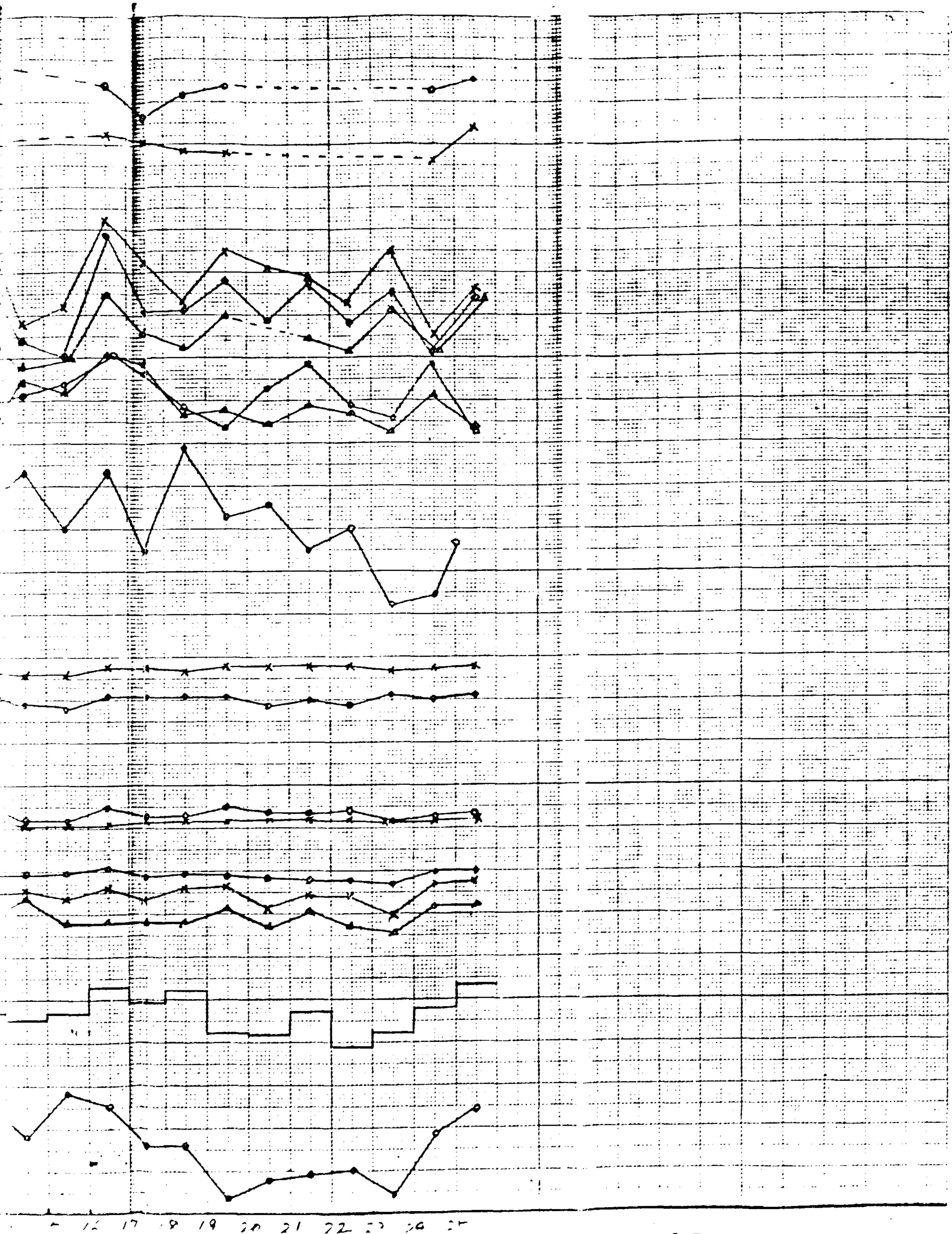


5. Operation Record




1.3
Sp.Gr. 1.2
1.1
IF
RA
20
Slurry Cooler
(in Hg) 10
V.P.
80
Digester
Seal Tank
Temp(°C) 70
S.C. Drum
60
24
Operation Time (hr) 20
10
100
Load % (rock base) 90
80

SECTION 1



SECTION 2

(AM 5:00 — AM 5:00)

DEC. 1980 — PA PLANT — I OPERATION DATA (

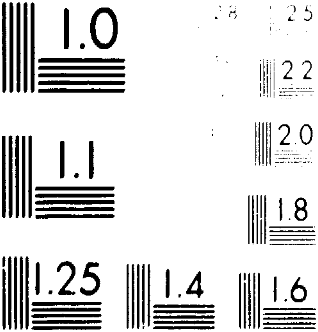
		DATE	1	2	3	4	5	6	7	8	9	10	11	12
		Operation Time (hr)			15.4	17.4	10.2	22.3	13.0	14.0	13.5	6.0	14.5	2.0
		Average Load (%)			79.2	96.6	96.1	92.8	95.8	95.0	92.5	90.4	103.7	109.4
FEED		Rock (T/H)			3.47	4.23	4.21	4.07	4.20	4.16	4.05	3.96	4.54	4.79
FEED		H_2SO_4 (T/H)			3.12	3.87	3.90	3.84	3.83	3.91	3.80	3.86	4.40	4.51
FEED		H_2SO_4 Sp.gr / Temp	/	/	1.829 / 30	/	/	/	/	/	/	1.830 / 29	/	/
FEED		R.A Sp.gr / Temp	/	/	1.16 / 44	1.21 / 46	1.21 / 46	1.20 / 45	1.21 / 45	1.20 / 46	1.20 / 46	1.20 / 45	1.20 / 45	1.20 / —
TEMP		Premixing (°C)												
TEMP		Digester (°C)			73-77	77-79	77-78	79-80	77-78	79-80	79-82	80-82	79-80	—
TEMP		C.S. Drum (°C)			64-72	68-69	66-67	71-74	68-69	72-73	72-74	72-74	71-74	—
TEMP		S. Tank (°C)			63-66	71-73	68-69	76-77	71-73	72-76	72-76	74-76	71-76	—
COOLER	TEMP	Circulation Pump outlet												
COOLER	TEMP	Vapour Head												
COOLER	PRESSURE	Vapour Head			-16" (-406)	-13" (-330)	→	-14 (-360)	→	→	-15 (-380)	-14 (-360)	-12 (-305)	→
COOLER	FLOW	outlet, Total			80% open 119 m³/H	→	→	→	→	→	→	→	→	→
COOLER	FLOW	To Digester												
COOLER	FLOW	DeFoaming Agent add. Digester			0	260 ml/H	0	280	60	340	0	430	380	0
1ST CONDENSER	TEMP	1st Condenser												
1ST CONDENSER	TEMP	Water, Inlet									26	→	→	→
1ST CONDENSER	TEMP	Water, Outlet									29	→	—	—
1ST CONDENSER	FLOW	Valve, Open			½ open 150 m³/min	→	→	→	→	→	→	→	→	→
1ST CONDENSER	P	Pressure			-410	-380	→	→	→	-340	-400	-380	-320	→
2ND CONDENSER	TEMP	2nd Condenser												
2ND CONDENSER	TEMP	water, Outlet									26	→	→	—
2ND CONDENSER	FLOW	Valve, Open			100% open 30 m³/min	→	→	→	→	→	→	→	→	→
2ND CONDENSER	P	Pressure			-380	-320	-300	→	→	→	-340	-300	→	—
EJECTOR	FLOW	Steam, 1st Ejector												
EJECTOR	FLOW	Steam, 2nd Ejector												
EJECTOR	P	Pressure			9.0 kg/cm²	9.5	10.0	9.5	→	→	→	→	→	→
			SA-1 stop				-100mm 89% / -200mm 70	91 / 70	90 / 71			93 / 69		

SECTION 1

OPERATION DATA (1/2)

8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0	13.5	6.0	14.5	2.0	16.5	15.3	16.8	23.3	19.5	22.2	12.5	12.0	17.4	8.8	12.5
-0	92.5	90.4	103.7	109.4	97.7	88.2	98.0	95.0	86.3	86.0	73.5	77.9	79.5	80.4	74.2
16	4.05	3.96	4.54	4.79	4.28	3.86	4.29	4.15	3.78	3.77	3.22	3.41	3.48	3.52	3.25
?1	3.70	3.86	4.40	4.51	3.59	3.66	4.02	3.97	3.70	3.64	3.13	3.16	3.55	3.49	3.22
/	/	1.830 29	/	/		/	/	/	/	/	/	/	/	/	/
46	1.20 / 46	1.20 / 45	1.20 / 45	1.20 / —	1.20 / 45	1.20 / 45	1.20 / 44	1.20 / 46	1.20 / 45	1.20 / 45	1.21 / 45	1.20 / —	1.20 / —	1.20 / 46	1.21 / 46
80	79-82	80-82	79-80	—	78-79	79-80	79-80	80-81	77-80	78-80	77-79	77-78	76-80	77-80	77-78
73	72-74	72-74	71-74	—	67-70	67-70	67-70	68-69	67-69	66-71	71-73	66-68	71-75	66-67	64-66
-76	72-76	74-76	71-76	—	74-76	76-77	72-75	75-78	72-74	76-77	76-77	70-72	73-76	74-76	68-7[illegible]
→	-15 (380)	-14 (360)	-12 (300)	→	-13 (330)	-12 (300)	→	-15 (380)	-13 (330)	→	-15 (380)	— (360)	— (360)	-14 (360)	-13 (330)
→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
0	0	430	380	0	320	320	220	130	260	80	300	400	190	360	300
	26	→	→	→	→	26	→	→	→	→	→	→	→	→	→
	29	→	—	—	—	—	—	—	—	—	—	—	—	—	—
>	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
340	-400	-380	-320	→	-360	-300	→	360	320	→	360	320	330	→	→
	26	→	→	—	→	→	→	→	→	→	→	→	→	→	→
→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
>	-340	-300	→	—	→	-280	→	-300	300	→	→	→	→	→	→
→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
		93 69				95 70	94 69	91 73			90 70	90 70	90 70		

SECTION 2


1.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

DEC 1980 PA PLANT – I OPERATION DATA (3/2

	DATE	1	2	3	4	5	6	7	8	9	10	11	12	[illegible]
FILTRATION	Vacuum			−10 (−254)	−11 (280)	−12 (305)	−12 (305)	−14 (355)	−12 (305)	→	→	−11 (280)	→	[illegible]
	Cake mm / Filter Speed (Reducer Mark)			20 / 6	20 / 6	20 / 6	40 / 5	40 / 5	45 / 5	45 / 5	45 / 5	45 / 5	45 / 5	40
	Hot water													
	1F SpGr / Temp			1.270 / 46	1.262 / 49	1.290 / 47	1.280 / 47	1.272 / 45	1.290 / 61	1.290 / 63	1.280 / 61	1.270 / 60	1.270 / —	1.27
	2F "													
	3F "													
	4F "													
PRODUCT	Filtrate Storage Tank													
	50% C. PA (T)			17.0	22.5	28.2	39.5	48.1	23.7	26.2	23.4	42.8	28.7	1[illegible]
DIGESTER	Solid / ρ			34.5 / 1.54	33.7 / 1.53	34.5 / 1.52	37.1 / 1.57	38.7 / 1.58	35.5 / 1.55	30.7 / 1.50	30.2 / 1.50	37.6 / 1.57	37.1 / 1.57	37
	P_2O_5 / H_2SO_4			27.8 / 2.57	26.5 / 1.80	24.6 / 0.87	28.3 / 1.03	28.1 / 3.12	27.2 / 2.51	27.7 / 2.02	25.0 / 1.78	26.7 / 1.36	26.7 / 1.63	27.
	TP_2O_5 / $W.P_2O_5$													
	CaO / Decomp.													
SURGE TANK	Solid / ρ			33.3 / 1.53	33.4 / 1.53	33.3 / 1.52	35.9 / 1.56	35.9 / 1.56	34.8 / 1.55	33.2 / 1.51	29.6 / 1.50	34.8 / 1.55	37.4 / 1.57	33.
	P_2O_5 / H_2SO_4			28.4 / 2.40	27.1 / 1.70	25.6 / 0.87	29.0 / 1.26	29.1 / 3.30	28.1 / 2.52	28.2 / 1.80	25.2 / 1.69	26.8 / 1.15	28.0 / 1.11	28.
	TP_2O_5 / $W.P_2O_5$													
	CaO / Decomp.													
1F	P_2O_5 / H_2SO_4 / Sp.g. (temp)			25.4 2.15 1.27 (29)	25.09 2.05 1.27 (29)	25.1 1.53 1.24 (30)	26.0 1.12 1.28 (29)	25.2 3.0 1.26 (29)	26.0 2.6 1.27 (29)	27.9 2.71 1.29 (28)		25.8 1.37 1.28 (28)		25.6
RA	P_2O_5 / H_2SO_4 / Sp.g. (temp)			17.9 2.0 1.16 (26)	19.4 1.6 1.21 (29)	18.5 0.9 1.20 (29)	26.0 1.0 1.21 (29)	19.6 2.4 1.20 (29)		20.7 1.8 1.21 (28)	[illegible] 1.4 1.21 (28)	20.2 1.20 1.21 (28)		20.6
wet cake	T.P / W.P / CaO				0.64 0.21 31.56		0.61 0.26 31.53	0.35 0.15 31.45	0.32 0.24 30.38	0.46 0.24 31.60		0.66 0.19 30.26		
	Decomp. Ratio				97.8		98.2	99.5	99.6	98.9		97.5		
	P_2O_5 Recovery				96.8		96.9	98.7	98.3	97.7		96.6		
AMP.	Agitator of Digester			11.5-15-8 7.5-7-8	11.5-15-8 7.5-7-8	11.5-15-9 8.5-7.5-8.5	11.5-15-9.5 9-7.5-9	→	11.5-15-9.5 9.5-8.5-9.5	→	→	12.0-15-9.5 8.5-8-8	→	—
	Cooler Feed Pump			10	→	→	9.5	→	→	→	→	10.5	→	—
	Cooler Circ. Pump													
	Fume Exhaust Fan													
	Vacuum Pump													?

SECTION 1

I OPERATION DATA (2/2)

8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
-12 (305) 5/5	→ 45/5	→ 45/5	-11 (280) 45/5	→ 45/5	-14 (355) 40/5	-11 (280) 40/5	→ 40/—	→ 40/—	-14 (355) 40/—	-13 (330) 40/—	-12 (305) 40/5	→ 40/5	→ 40/5	→ 40/6	→ /
.290/61	1.290/63	1.280/61	1.270/60	1.270/—	1.270/—	1.270/—	1.270/—	1.280/—	1.280/—	1.280/—	1.270/76	1.270/—	1.280/—	1.280/44	1.270/61
23.7	26.2	23.4	42.8	28.7	19.9	40.3	52.5	31.4	56.5	53.0	30.0	27.0	27.0	31.0	6.0
[illegible] 1.55 72 2.51	30.7 1.50 27.7 2.02	30.2 1.50 25.0 1.78	37.6 1.57 26.7 1.36	37.1 1.57 26.7 1.63	37.1 1.56 27.1 1.92	38.5 1.60 25.4 2.14	36.0 1.51 25.0 2.44	38.7 1.57 27.9 3.09	35.0 1.54 26.1 2.69	39.8 1.59 26.1 1.78	36.6 1.56 26.8 1.39	37.1 1.57 25.9 2.39	35.0 1.55 26.8 2.95	36.0 1.56 25.8 1.91	32.3 1.53 26.51 3.02
28 1.55 28.1 2.52	33.2 1.51 28.2 1.80	29.6 1.50 25.2 1.69	34.9 1.55 26.8 1.15	37.4 1.57 28.0 1.11	33.8 1.53 28.3 1.09	39.0 1.59 25.8 3.29	33.8 1.50 26.2 2.19	37.4 1.56 28.2 2.97	33.3 1.54 27.3 2.72	36.9 1.57 26.2 2.04	36.9 1.56 27.5 1.24	35.9 1.56 27.1 2.30	35.7 1.55 26.7 3.46	33.8 1.54 26.3 1.81	34.3 1.54 27.5 3.00
[illegible] 2.6 1.27(29)	27.9 2.71 1.29(28)		25.8 1.37 1.28(28)		25.6 1.04 1.27(28)	23.7 2.53 1.26(36)	25.4 2.31 1.26(28)	26.5 3.13 1.28(28)	25.6 2.16 1.27(32)	25.3 1.71 1.27(28)	26.0 1.80 1.28(28)	— 1.49 1.29(28)	25.5 1.99 1.28(28)	25.1 1.93 1.28(28)	26.1 1.26 1.26(28)
	20.7 1.8 1.31(28)	[illegible] 1.4 1.21(28)	20.2 1.20 1.31(28)		20.6 0.92 1.22(28)	18.6 1.73 1.19(28)	19.8 1.83 1.21(28)	19.6 2.63 1.21(28)	18.1 2.93 1.21(30)	20.5 1.45 1.31(28)	19.2 1.19 1.21(28)	18.9 1.96 1.19(28)	18.0 1.84 1.20(28)	18.5 1.45 1.19(28)	19.2 1.26 1.20(28)
0.32 0.24 30.38	1.46 0.24 31.60		0.46 0.9 30.26					0.49 0.25 30.65	0.37 1.21 31.25	0.43 0.19 31.25	0.48 1.16 31.06				
99.6	98.9		97.5					98.8	99.4	98.7	98.4				
98.3	97.7		96.6					97.5	98.3	97.8	97.6				
5-15-9.5 8.5-9.5	→	→	12.0-15-9.5 8.5-8-8	→	→	→	10-15-10 8.5-7.5-7	8.5-15-9 8-7-7.5	9.5-11-15 9-9-8	8.5-10.5-8.5 9-8-9	8-15-7.5 9-8-9	13-15-9.5 9.5-8-9.5	13.5-15-9 7.5-7.5-8	10.5-15-9 7.5-8-7.5	11-15-9 8.5-8-8.5
→	→	→	10.5	→	→	→	→	→	→	→	→	15	10	→	→
					70	→	→	→	→	→	→	→	→	→	→

SECTION 2

6. Recommendations for stable operation of existing plant are as follows :

   i) Check and cleaning for the Rock weigher periodically, and the preparation of spare parts.

   ii) Filter feed slurry pump and slurry cooler feed pump should be set as standby.

   Suitable pump specification :

Filter feed slurry pump	0.42 m^3/min.	20 m
Slurry cooler feed pump	2 m^3/min.	15 m

   iii) Maintaintenance of the filter (center valve, roller, separators, cake blower, cell drying fan, etc.)

   iv) Maintenance for the cooler circulation pump.

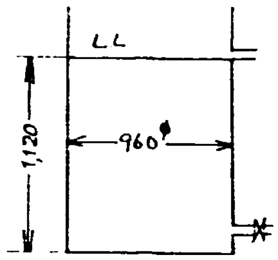
   v) The filtrate storage tank is necessary to provided with new one.

   vi) Check of leakage for the steam pipe line.

   vii) Please check and set motor cover for safety first.

7. Filtration

i) Test of filter feed slurry pump's capacity



Filtrate Feed Box

Eff. Vol = 0.80 m^3

Slurry over flow time

Test No.	Time
1	3' - 7"
2	3' - 4"
Av.	3' - 5.5" = 3.1'

Test result of pump capacity = 0.80/3.1'=0.258=0.26m^3/min.

According to the specification	0.265/0.318m^3/min	
Pump capacity deficient for 50 T/D	33 T/D	50 T/D
Flow rate of slurry (normal)	0.2	0.31 m^3/min.

ii) Filter speed

Indicating figure of variable motor	Filter speed	min/r min.
0	2'-54"	2.9
1	3 - 21	3.35
2	3 - 57	3.95
3	4 - 34	4.57
4	5 - 18	5.3
5	6 - 19	6.32
6	7 - 39	7.65

iii) 2nd test of feed slurry pumps capacity

Test was conducted after cleaning of surge tank and filter feed box.

Slurry over flow time

Test No.	
1	2' - 48"
2	2 - 44
3	2 - 45
Av	2' - 46' = 2.77'

Test result of pump capacity

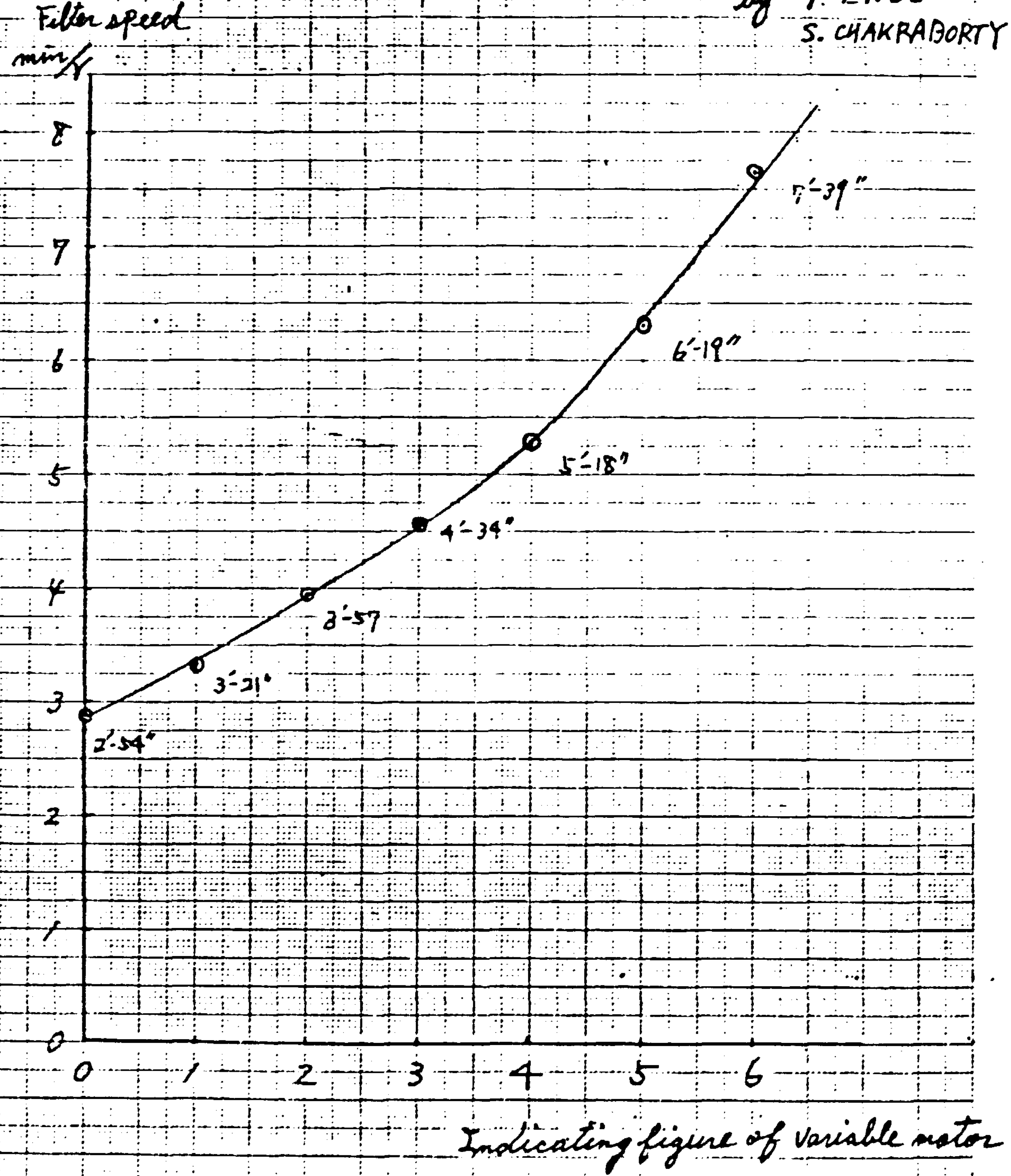
$$= 0.80/2.77 = 0.289 = 0.29\ m^3/min$$

$$= 17.4\ m^3/H$$

Filter revolution speed

20 DEC, 1980

by T. ENDO
S. CHAKRABORTY



8. Heat Balance of PA-1 concentrator

For check of consumption of steam to PA-1 concentrator, we calculated required heat for concentration.

i) Mass balance

(a) Basis : Feed acid P_2O_5 1,000 kg

Feed acid	P_2O_5	28 %	50°C
Product acid	P_2O_5	50 %	85°C
			(in evaporator)

(b) Input

Feed acid (1,000/0.28)=3,571 kg

(c) Output

Product acid (1,000/0.50) = 2,000 kg

Evaporated water

3,571 - 2,000 = 1,571 kg

ii) Heat balance

Basis : Feed Acid P_2O_5 1,000 kg, 0°C

(a) Apparent heat of feed acid

(3,571)(0.70)(50) = 125,000 Kcal

(b) In evaporator

Heat up from 50°C to 85°C

(3,571)(0.70)(85 - 50) = 87,500 Kcal

Latent heat of evaporated water at 85°C

(1,571)(548) = 861,000 Kcal

Heat of concentration

P_2O_5 28% = H_3PO_4 38.6 % ...... 1,080 Kcal/kg-mol

P_2O_5 50% = H_3PO_4 69 % ...... 2,500 Kcal/kg-mol

1,000/71 = 14 kg mol H_3PO_4

(14)(2,500 - 1,080) = 19,900 Kcal

Therefore

Required heat for concentration (P_2O_5 28% to 50%)

87,500 + 861,000 + 19,900 = <u>968,400 Kcal</u>

(c) Apparent heat of product acid

(2,000)(0.52)(85) = 88,400 Kcal

APPENDIX VII-5 (2) EFFECT OF PRECUT IN PA-I PLANT

These figures show P_2O_5 content (%)

Date	December, 1980			January, 1981			May, 1981		
	Surge tank	1st fil-trate	P_2O_5 decre-ase	Surge tank	1st fil-trate	P_2O_5 decre-ase	Surge tank	1st fil-trate	P_2O_5 decrease
1	-	-	-	28.45	24.39	4.06	-	-	-
2	-	-	-	-	-	-	-	-	-
3	28.40	25.40	3.00	20.25	18.13	2.12	-	-	-
4	27.10	25.09	2.01	26.61	22.13	4.48	28.40	27.93	0.47
5	25.63	25.13	0.50	25.41	22.95	2.46	26.56	26.21	0.35
6	28.98	25.99	2.99	26.60	24.54	2.06	25.62	24.22	1.40
7	29.08	26.17	3.41	26.04	24.79	1.25	27.78	25.96	1.82
8	28.07	25.96	2.11	27.78	24.42	3.36	29.47	27.40	2.07
9	28.17	27.90	0.27	26.17	25.12	1.05	28.15	26.80	1.35
10	25.20	20.[illegible]	4.57	25.88	24.91	0.97	28.94	27.49	1.45
11	25.13	25.78	-0.65	28.37	26.29	2.08	31.62	29.45	2.17
12	-	-	-	25.88	23.77	2.11	27.68	24.28	3.40
13	-	25.64	-	29.28	25.82	3.46	30.37	27.21	3.16
14	25.51	23.72	1.79	28.24	-	-	31.36	29.82	1.54
15	24.16	25.37	-1.21	-	-	-	-	-	-
16	28.21	26.53	2.84	28.41	-	-	30.74	29.93	0.81
17	-	25.63	-	-	-	-	29.28	27.42	1.86
13	26.15	25.53	0.82	27.60	26.51	1.09	31.08	29.88	1.10
19	27.52	25.96	1.56	28.07	26.20	1.87	28.58	27.80	0.78
20	27.10	-	-	26.64	23.46	3.18	29.51	26.02	3.52
21	28.12	25.52	2.60	25.03	23.32	1.71	31.18	29.88	1.3
22	26.33	25.10	1.23	26.11	24.97	1.14	30.93	29.01	1.32
23	27.46	26.08	1.38	25.86	24.63	1.23	30.68	27.71	2.97
24	25.25	25.10	0.15	25.20	23.22	1.98	32.52	30.00	2.52
25	28.53	26.66	1.87	27.62	25.61	2.01	32.47	30.62	1.85
26	27.96	25.89	2.07	26.20	24.52	1.68	30.27	29.85	0.42
27	26.49	25.35	1.14	27.32	25.77	1.55	28.25	25.98	2.27
28	28.27	23.29	2.92	27.29	24.32	2.97	27.52	26.92	0.60
29	30.53	22.45	8.08	28.44	23.74	4.70	27.86	26.01	1.85
30	27.63	-	-	28.07	26.87	1.20	27.35	-	-
31	26.09	20.54	5.55	25.65	24.79	0.86	25.86	24.99	0.87
Average	27.21	25.22	1.99	26.73	24.43	2.30	29.26	27.69	1.66

APPENDIX VII-5 (3) INCREASE OF PA-I CAPACITY UP TO 50 T/D

(32 T/D $\longrightarrow$ 50 G/D as 100% P_2O_5)

1. Flow rates

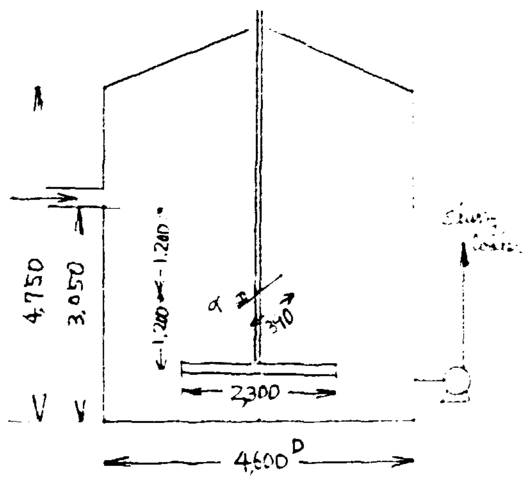
	kg/T P_2O_5		Flow Rates	
			32 T/D	50 T/D
Rock (wet)	3,287	-	4.38 T/H	6.85 T/H
Rock (dry)	3,231	-	-	-
98.3 % H_2SO_4	2,838	1.825	2.1 m^3/H	3.2 m^3/H
Return Acid	8,850	1.17	10.1 "	15.8 "
Slurry (at feeding)	14,975	1.57	12.7 "	19.9 "
Slurry (at filtration)	13,797	1.57	11.7 "	18.3 "
Wash Acid-1 (3rd filtrate)	6,289	1.05	8.0 "	12.5 "
Wash Acid-2 (4th filtrate)	5,728	1.02	7.5 "	11.7 "
Wash Water	5,242	1.00	7.0 "	10.9 "
Product Acid	3,571	1.30	3.7 "	5.7 "
1st Filtrate	5,478	1.30	5.6 "	8.8 "
1st Filtrate split to be return acid	1,907	1.30	2.0 "	3.1 "

2. Heat Balance (Please refer to APPENDIX VII-5 (1), 4)

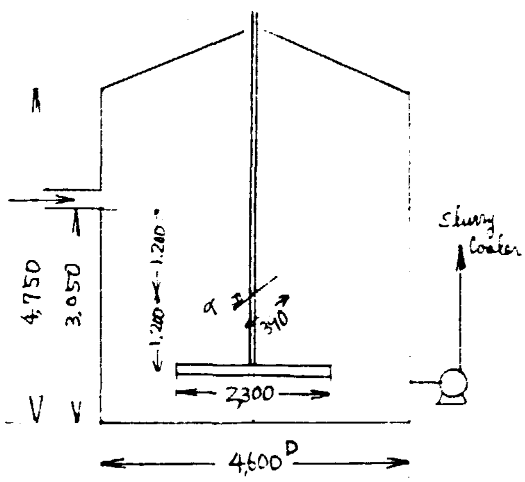
Unit : Mcal/H

	32 T/D	50 T/D
Input heat	1,712	1,712 x 50/32 = 2,675
Output heat		
Evaporation heat	220	220
Heat loss	68	68
Slurry to Filter	795	795 x 50/32 = 1,242
Removal heat		
by slurry cooler	620	629
by air bubbling	-	2,675 - (220+68+1,242+ 629) = 516

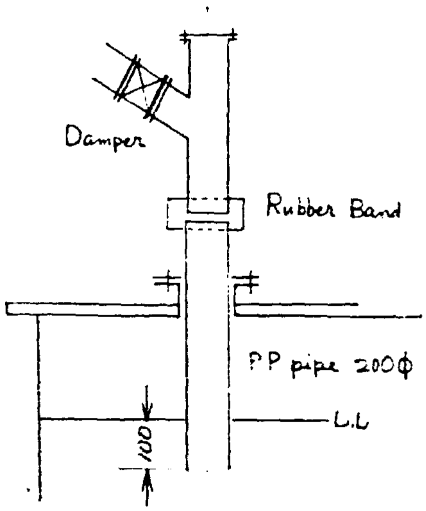
3. Recommendation

Equipment	Existing plant	…0 T/…	
		Actual	
1. Rock Weigher	° Rock feeder Screw sprocket wheel Motor: 19, Screw side: 21 Capacity max 6.5 T/H (Measured on Oct.10,1980)	Screw sprocket wheel change Motor: 21, Screw side: 19 Capacity $6.5 \times \frac{21}{19} \times \frac{21}{19} = 7.9$ T/H Normal feed rates approx. 7.5 T/H	
2. Digester	Veff = 100 m^3 $\theta = 100/12.7 = 8$ hrs	$\theta = 8 \times 32/50 = 5$ hrs  	

SECTION 1

	50 T/D	
	Actual	Ideal
neel de Capacity max 6.5 T/H (Measured on Oct.10,1980)	Screw sprocket wheel change Motor Screw side  21 19 Capacity $6.5 \times \frac{21}{19} \times \frac{21}{19} = 7.9$ T/H Normal feed rates approx. 7.5 T/H	
	$\theta = 8 \times 32/50 = 5$ hrs  	It is necessary to set an additional new digester. θ = 3 hrs $\longrightarrow$ 2.5 hrs (due to shortage of space) Veff = $19.9 \times 3 = 60$ m^3 $19.9 \times 2.5 = 50$ m^3 **Vessel** No. of unit : 1 Type : Vertical, cylindrical Capacity : 50 m^3 effective Diameter : 4,600 mm Shell height : 4,750 mm Effective height : 3,050 mm Material : Mild steel lined with natural rubber **Agitator** Type : Pitched paddles Flow pattern : Axial flow, upward No. of stage : 2 Blade length : 2,300 mm Blade width : 390 mm Blade α : 45 ° Revolution speed : 38 rpm Motor capacity : 30 KW

SECTION 2

	Existing plant	Actual
3. Cooling air blower		A) Air cooling using SA-I starting blower Type : Turbo blower Capacity : 142 m^3/min. 1,000 mm Aq Main air pipe : 250 ϕ Air bubbling nozzle: 200 ϕ x 4 B) Air cooling using TSP-II Dryer fan after granulation plant establishment Type : Turbo fan Capacity : 440 m^3/min. 259 mmAq
4. Exhaust fan	Type : Plate fan Capacity : 226 m^3/min Head 250 mm Aq Material : Mild steel lined with natural rubber	Increase of capacity by pulley changing 350 m^3/min. same same

SECTION 1

	50 T/D	
	Actual	Ideal
		Material Shaft : Forged steel lined with butyl rubber Blade : Mild steel lined with butyl rubber
Rubber Band PP pipe 200ϕ L.L	A) Air cooling using SA-I starting blower Type : Turbo blower Capacity : 142 m^3/min. 1,000 mm Aq Main air pipe : 250 ϕ Air bubbling nozzle: 200 ϕ x 4 B) Air cooling using TSP-II Dryer fan after granulation plant establishment Type : Turbo fan Capacity : 440 m^3/min. 259 mmAq	It is necessary to set new one. No. of unit : 1 Type : Turbo fan Capacity : 100 m^3/min. Head 350 mm Aq at 33°C, 70 % Material : Mild steel Main air pipe : 320 ϕ Air bubbling nozzle : 150 ϕ x 4
m^3/min : 250 mm Aq steel lined with ral rubber	Increase of capacity by pulley changing 350 m^3/min. same same	It is necessary to set additional new one. No. of unit : 1 Type : Plate fan Capacity : 120 m^3/min. Head 300 mm Aq Material : Mild steel lined with natural rubber

SECTION 2

	Existing plant	Actual
5. Slurry cooler	Improvement of overflow	
6. Filter	Type PRAYON 12B Effective area 12.6 m^2 32/12.6 = 2.54 T/D m^2 Filter revolution speed max. 2' - 54"/r	same same 50/12.6 = 4 T/D m^2 Morocco, Jordan rock... According to our experience, enough (Necessary to conduct the test run of 150% load)
7. Pump ° Slurry cooler feed pump	Type : Centrifugal (Warman) Capacity 2 m^3/min = 120 m^3/H (Recycle ratio = 120/12.7 = 19)	Same Same. (Recycle ratio = 120/19.9 = 6) It is necessary to check
° Slurry cooler circulation pump	Type : Axial flow Capacity : 615 m^3/H	Same Same It is necessary to check and repair.
° Filter feed pump	Type : Centrifugal (Warman) Capacity : 0.29 m^3/min = 17.4 m /h Head 20 m	It is necessary to set on new one. Type : Centrifugal Capacity : 0.42 m^3/min = 25 m^3/H Head 20 m Reducer : Variable speed reducer
° Recycle acid pump	Type : Vertical Type : Vertical Capacity : 242 lit/min Head 13.7 m	It is necessary to set new one. Same 320 lit/min Same

SECTION 1

..nt	50 T/D	
	Actual	Ideal
..rflow		
.6 m^2 .. m^2 .. speed	same same $50/12.6 = 4$ T/D m^2 Morocco, Jordan rock... According to our experience, enough (Necessary to conduct the test run of 150% load)	
.. (Warman) . = 120 m^3/H .20/12.7 = 19)	Same Same. (Recycle ratio = 120/19.9 = 6) It is necessary to check	It is necessary to set as stand by.
.. ../H	Same Same It is necessary to check and repair.	
. (Warman) .../min = 17.4 m^3/H .. m	It is necessary to set on new one. Type : Centrifugal Capacity : 0.42 m^3/min = 25 m^3/H Head 20 m Reducer : Variable speed reducer	It is necessary to set as stand by.
..t/min .3.7 m	It is necessary to set new one. Same 320 lit/min Same	

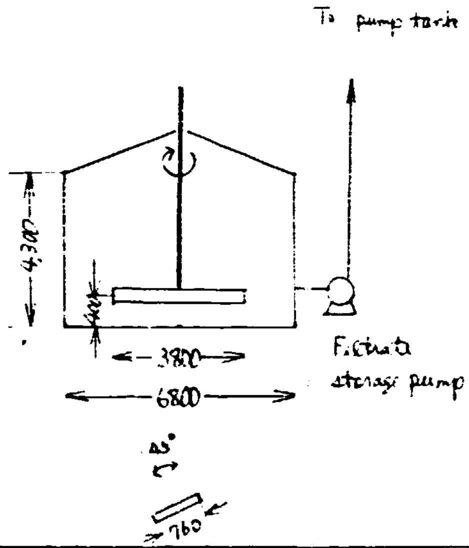
SECTION 2

	Existing Plant	Actual
° 1st wash acid pump	type : Vertical Capacity : 170 lit/min Head 19.8 m	It is necessary to set new one. Same 250 lit/min 20 m
° 2nd wash acid pump	Type : Vertical Capacity : 182 lit/min Head 19.8 m	It is necessary to set new one. Same 250 lit/min 20 m
° Concentrator feed pump	Type : Centrifugal Capacity : 83 lit/min Head 19.8 m	It is necessary to set new one. Same 130 lit/min 20 m
8. Anti-foaming agent		It is necessary to set new one. Tank : 50 lit Pump : 5 - 10 ml/min.

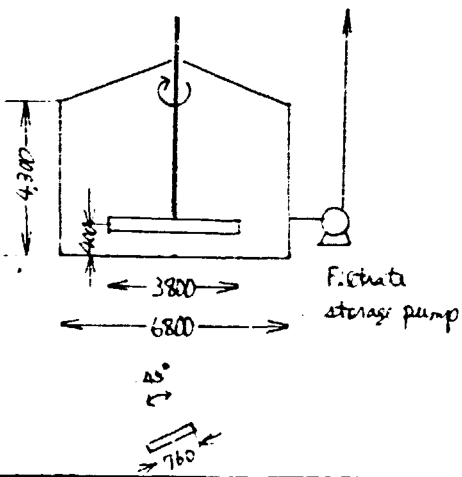
SECTION 1

	50 T/D	
	Actual	Ideal
	It is necessary to set new one. Same 250 lit/min 20 m	
	It is necessary to set new one. Same 250 lit/min 20 m	
	It is necessary to set new one. Same 130 lit/min 20 m	
	It is necessary to set new one. Tank : 5C lit Pump : 5 - 10 ml/min.	

SECTION 2

	Existing plant	50 T	
		Actual	
9. Filtrate storage tank	Veff = 120 m^3 θ = 120/3.7 = 32 hrs	θ = 120/5.7 = 21 hrs  	It is nec θ = 2 day Veff = (5. Vessel No. of un Type Capacity Diamet Shell Material Agitator Type Flow patt No. of st Blade len Blade wid Blade Revolutio Motor cap Material Shaft : Blade :
10. Filtrate storage pump			It is nec Type : C Capacity

SECTION 1

	50 T/D	
	Actual	Ideal
hrs	θ = 120/5.7 = 21 hrs  	It is necessary to set additional new one. θ = 2 days = 48 hrs Veff = (5.7 x 48) - 120 = 155 m^3 Vessel No. of unit : 1 Type : Vertical, cylindrical Capacity : 155 m^3 effective Diameter : 6,800 mm Shell height : 4,300 mm Material : Mild steel lined with natural rubber Agitator Type : Pitched paddles Flow pattern : Axial flow, upward No. of stage : 1 Blade length : 3,800 mm Blade width : 760 mm Blade α : 45° Revolution speed : 9 rpm Motor capacity : 3.7 KW Material Shaft : Forged steel lined with natural rubber Blade : Mild steel lined with natural rubber
		It is necessary to set new one Type : Centrifugal Capacity : 130 lit/min Head 10 m

SECTION 2

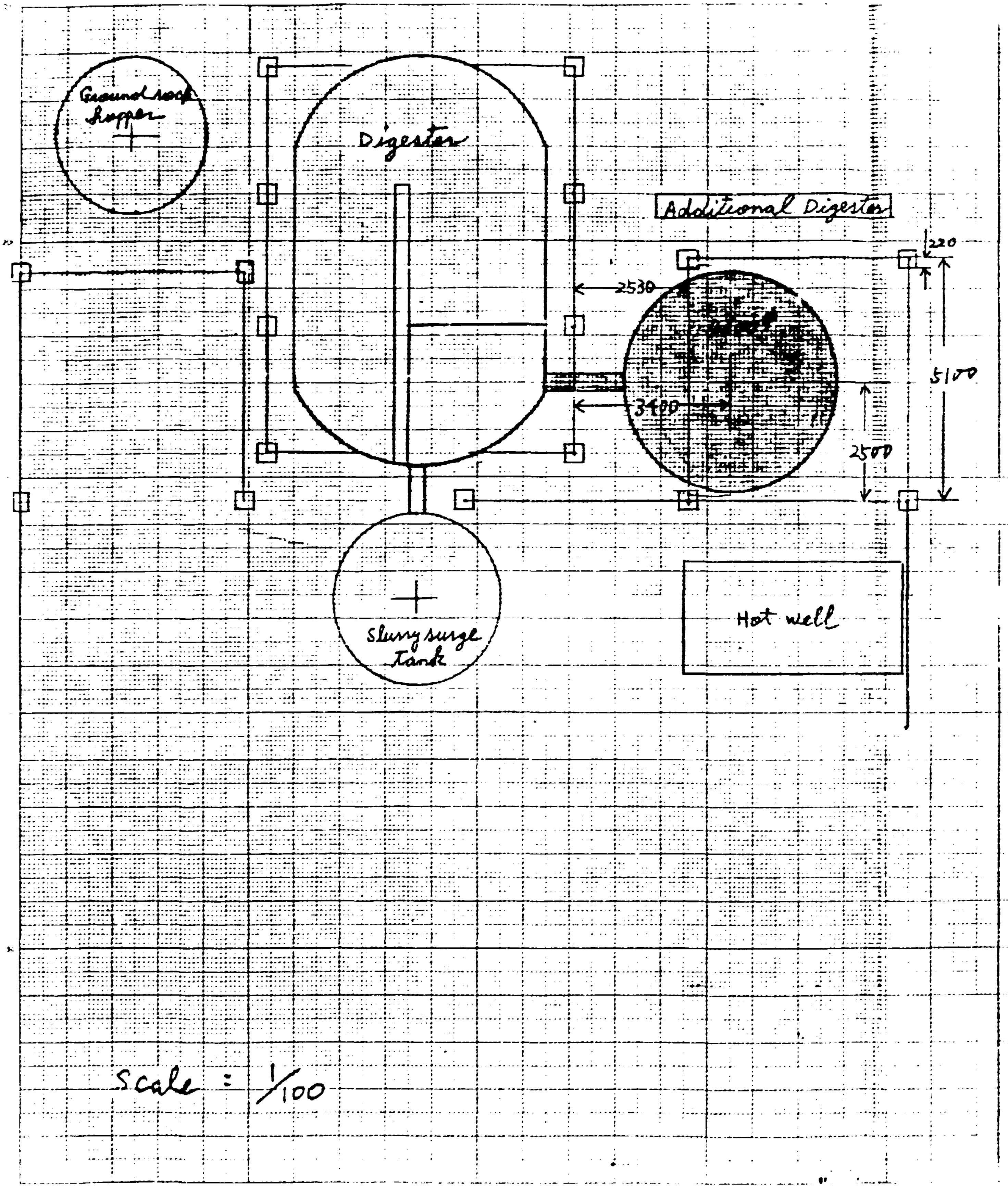
	Existing plant	Actual
11. Instrument		
° Flow meter		It is necessary to set new one
98% H_2SO_4	FRC-101 max 11.6 gal/min = 2.6 m^3/H	FRC max 20 gal/min = 4.5 m^3/H
Return acid	FRC-102 max 60 gal/min = 13.6 m^3/H	FRC max 90 gal/min = 20 m^3/H
Slurry (slurry cooler feed)		FI max 150 m^3/H
Water (1st condenser inlet)		FI max 40 m^3/H
Water (Inter condenser inlet)		FI max 4 m^3/H
Water (Filter, Hot water)		FI max 15 m^3/H
° Thermometer		
1st condenser outlet water		TG 0 - 100°C
2nd condenser outlet water		TG 0 - 100°C

SECTION 1

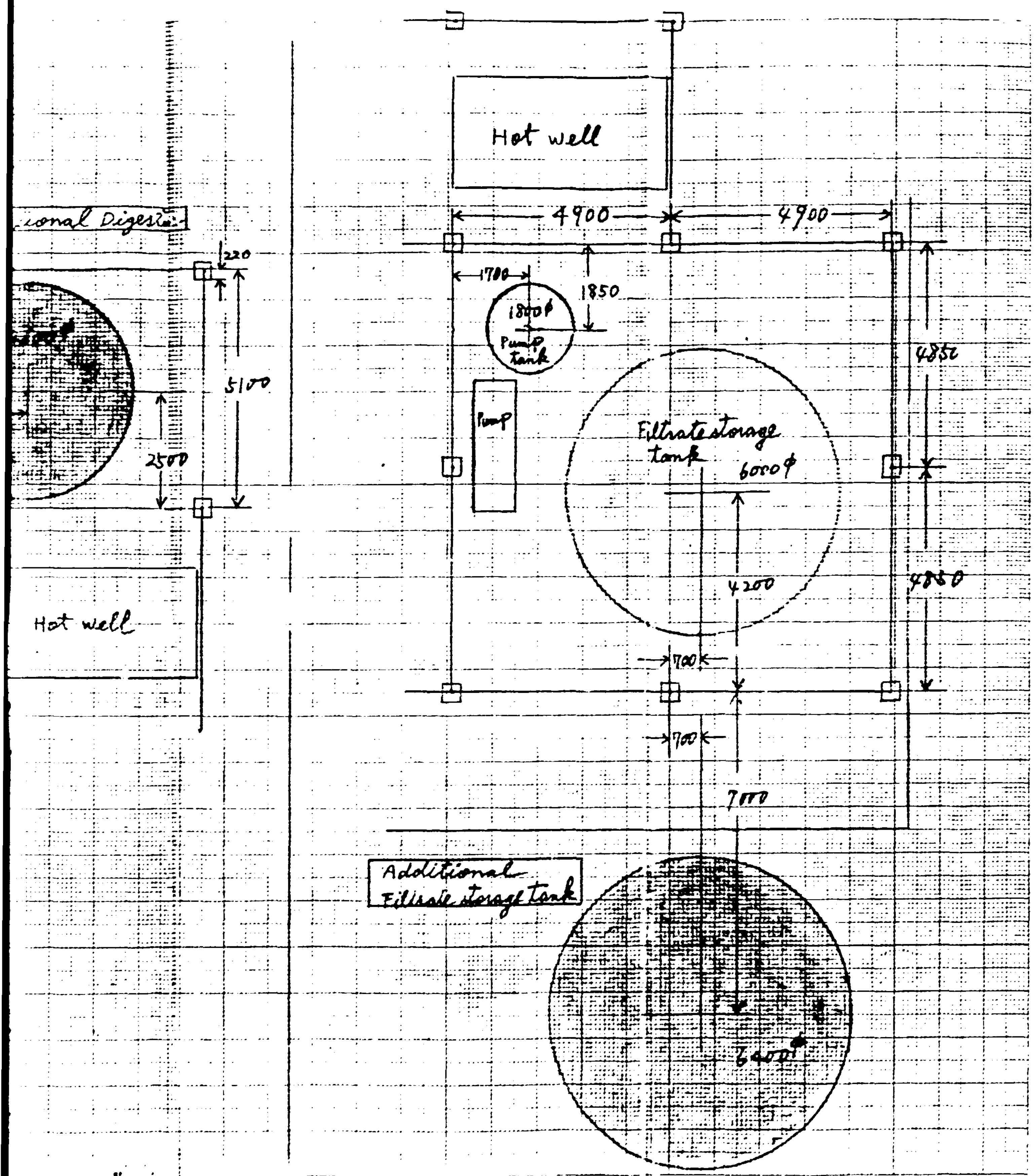
	50 T/D	
	Actual	Ideal
	It is necessary to set new one	
/min = $2.6m^3/H$	FRC max 20 gal/min = 4.5 m^3/H	
min = 13.6 m^3/H	FRC max 90 gal/min = 20 m^3/H	
	FI max 150 m^3/H	
	FI max 40 m^3/H	
	FI max 4 m^3/H	
	FI max 15 m^3/H	
	TG 0 - 100°C	
	TG 0 - 100°C	

SECTION 2

4. PLOT PLAN



Ground rock hopper
Digester
Additional Digester
220
2530
5100
3400
2500
Slurry surge tank
Hot well
Scale : 1/100


Hot well
4900
4900
...ional Digest...
220
1700
1850
1800φ
Pump tank
5100
4850
Pump
Filtrate storage tank
6000φ
2500
4200
4850
Hot well
700
700
7000
Additional Filtrate storage tank
6400φ

APPENDIX VII-6(1) OPERATION DATA OF PA-2 PLANT

MAY. 1981 PA- PLANT- 2 OPERATION DATA (1/1)

Date	Consumption of Rock	Production (Wet basis)		Production(as P_2O_5)		Running time of 30% acid	Capacity uti of 30% acid
		30% Acid	50% Acid	30% acid	50% Acid		per running day
1	144 t/d	155 t/d	73 t/d	40 t/d	36 t/d	12 h/d	59.2 %
2	0	0	40	0	20	0	-
3	0	0	0	0	0	0	-
4	327	375	75	96	35	22.5	75.5
5	273	315	176	79	88	18.3	76.3
6	331	390	191	98	92	19.0	91.8
7	344	470	211	111	100	20.3	97.0
8	405	491	190	122	89	24.0	90.3
9	191	270	203	66	102	10.8	108.1
10	395	439	207	112	101	21.5	92.5
11	0	0	120	0	56	0	-
12	189	203	130	50	57	11.0	80.7
13	356	406	155	103	76	20.5	89.6
14	186	210	224	57	114	11.3	89.6
15	316	380	190	102	96	19.0	95.5
16	312	365	240	100	115	18.0	98.5
17	300	325	246	86	125	17.8	85.9
18	244	300	215	80	108	15.0	100.7
19	235	259	118	70	59	13.0	95.5
20	372	425	218	115	111	21.2	96.4
21	168	215	214	56	110	9.3	106.6
22	396	440	236	117	113	22.0	94.0
23	422	455	183	127	88	24.0	94.0
24	381	430	247	117	125	20.2	102.9
25	257	295	220	81	109	15.5	92.5
26	432	450	278	125	137	24.0	92.6
27	424	447	254	128	125	24.0	94.8
28	98	120	240	34	121	5.5	109.6
29	176	215	190	58	95	11.5	89.6
30	78	85	25	23	12	6.4	62.7
31	293	325	152	85	78	18.3	82.2

$\bar{x}$ 90.4

SECTION 1

.. (%)

n(as P_2O_5) 50% Acid	Running time of 30% acid	Capacity utilization of 30% acid per running day	Capacity utilization of 30% acid per average day	Temperature (° C) (at 9 A.M.) Premixer	Digester	Cry.A	Cry.B	Cry.C	75% SA
36 t/d	12 h/d	59.2 %	30.0 %						
20	0	-	0						
0	0	-	0						
35	22.5	75.5	71.1						
88	18.3	76.3	58.5	90	93	70	64	59	71
92	19.0	91.8	72.5	91	92	71	62	60	79
100	20.3	97.0	82.2	90	92	69	64	59	80
89	24.0	90.3	90.3	90	94	72	63	60	80
102	10.8	108.1	48.9	90	94	70	64	57	80
101	21.5	92.5	83.0	90	93	72	67	60	80
56	0	-	0						
57	11.0	80.7	37.0	90	92	70	62	58	80
76	20.5	89.6	76.3	90	94	73	67	63	82
114	11.3	89.6	42.2	90	92	71	65	62	78
96	19.0	95.5	75.5	90	92	73	67	60	82
115	18.0	98.5	74.0	90	94	74	70	63	
125	17.8	85.9	63.7			71	66	61	
108	15.0	100.7	59.2	90	93	72	66	61	80
59	13.0	95.5	51.8	90	92	70	65	60	83
111	21.2	96.4	85.2	90	93	72	66	61	83
110	9.3	106.6	41.4	90		72	65	59	83
113	22.0	94.0	86.6	91	93	73	67	62	82
88	24.0	94.0	94.0	90	92	72	67	61	83
125	20.2	102.9	86.6	90	92	72	67	62	84
109	15.5	92.5	60.0	90	92	70	66	62	84
137	24.0	92.6	92.6	91	92	71	67	63	84
125	24.0	94.8	94.8	90	92	69	64	62	83
121	5.5	109.6	25.2	90	92	71	66	61	83
95	11.5	89.6	43.0	90	93	69	63	58	82
12	6.4	63.7	17.0	89	91	66	60	56	72
78	18.3	82.2	62.9	90	93	68	62	58	82
		$\bar{x}$ 90.4	$\bar{x}$ 58.2						

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SECTION 2

MAY 1981 PA-PLANT-2 OPERATION DATA (2/4)

Date	Digester				Crystallizer "C"		Filter			
	$T\text{-}P_2O_5$	H_2SO_4	Decompo-sition	Crystalline water	$T\text{-}P_2O_5$	H_2SO_4	$T\text{-}P_2O_5$	$W\text{-}P_2O_5$	CaO	Decompo-sition
1	21.74	2.30			26.54	2.97				
2	-	-	-	-	-	-				
3	-	-	-	-	-	-				
4	21.94	3.09			26.48	0.59	0.42	0.24	30.90	99.07
5	21.88	0.79		9.84	27.21	1.15	0.57	0.10	-	
6	19.98	10.34			26.22	3.02				
7	20.50	6.05		6.00	24.81	4.07	0.76 0.41	0.32 0.20	29.92 31.52	97.63 98.95
8	19.41	7.86		5.32	26.31	1.97	0.38	0.12	31.08	93.68
9	18.54	10.71			25.05	3.95	0.35	0.16	30.80	99.03
10	18.81	9.58			26.22	3.89	0.31	0.16	29.93	99.2
11	-	-	-	-	-	-				
12	21.76	6.02			25.27	3.20				
13	18.21	14.24	82.97	6.34	27.16	1.39	0.50	0.25	31.05	98.73
14	20.26	13.16	81.56	6.20	28.11	2.09	0.42	0.14	31.31	98.59
15	20.05	6.87	82.28	6.89	27.18	2.20	0.35	0.09	30.27	98.65
16	23.05	4.62			28.03	1.66	0.56	0.24	32.49	99.45
17	23.66	8.47			27.88	2.45	0.43	0.19	31.30	99.29
18	22.65	4.39	91.47	11.81	27.61	3.17	0.37	0.3	30.78	98.77
19	21.21	5.86			27.99	2.37				
20	21.52	6.97	80.60	7.18	27.09	2.63	0.52	0.33	30.31	99.00
21	21.65	5.52			27.67	2.78				
22	20.33	6.81	79.87	7.58	27.23	2.14	0.33	0.15	30.90	99.08
23	25.13	6.72	81.34	7.52	29.42	1.88	0.39	0.19	30.25	98.95
24	22.43	5.33			27.62	2.56	0.50	0.16	29.68	98.18
25	21.72	7.52	78.81	8.09	28.54	2.27	0.42	0.25	30.22	99.11
26	22.60	5.19	82.59	5.96	29.14	3.27				
27	22.48	3.99	87.74	5.58	29.45	2.89	0.38	0.20	30.72	99.07
28	21.86	8.37		6.18	30.21	3.99	0.37	0.15	31.94	98.91
29	26.14	3.78			29.14	4.00				
30										
31	22.90	7.31			27.51	3.75				
$\bar{x}$	21.52	6.82	82.92	6.58	27.44	2.67				98.75

SECTION 1

(Unit : %)

Crystallizer "C"		Filter						30% PA (1st filtrate)
T-P_2O_5	H_2SO_4	T-P_2O_5	W-P_2O_5	CaO	Decomposition	P_2O_5 recovery	Crystalline water	T-P_2O_5
26.54	2.97							25.53
-	-							
-	-							
26.48	0.59	0.42	0.24	30.90	99.07	97.85		25.53
27.21	1.15	0.57	0.10	-			19.01	25.17
26.22	3.02							25.30
24.81	4.07	0.76 0.41	0.32 0.20	29.92 31.52	97.63 98.95	95.9 97.9	18.88	23.71
26.31	1.97	0.38	0.12	31.08	93.68	98.0	19.88	24.93
25.05	3.95	0.35	0.16	30.80	99.03	98.2	19.25	24.53
26.22	3.89	0.31	0.16	29.93	99.2	98.3	18.29	25.61
-	-							
25.27	3.20							24.53
27.16	1.39	0.50	0.25	31.05	98.73	97.45	19.26	25.31
28.11	2.09	0.42	0.14	31.31	98.59	97.88	18.29	27.14
27.18	2.20	0.35	0.09	30.27	98.65	98.17	18.57	26.82
28.03	1.66	0.56	0.24	32.49	98.45	97.27	18.96	27.24
27.88	2.45	0.43	0.19	31.30	98.29	97.82	18.60	26.57
27.61	3.17	0.37	0.3	30.78	98.77	98.09	20.0	26.81
7.99	2.37							26.86
7.09	2.63	0.52	0.33	30.31	99.00	97.28		27.10
7.67	2.78							26.24
7.23	2.14	0.33	0.15	30.90	99.08	98.31		26.58
9.42	1.88	0.39	0.19	30.25	98.95	97.96		27.82
7.62	2.56	0.50	0.16	29.68	98.18	97.33		27.24
8.54	2.27	0.42	0.25	30.22	99.11	97.80		27.63
.14	3.27							27.69
.45	2.89	0.38	0.20	30.72	99.07	98.04		28.78
.21	3.99	0.37	0.15	31.94	98.91	98.16		28.36
.14	4.00							27.29
7.51	3.75							26.42
7.44	2.67				98.75	97.79	19.08	26.39

SECTION 2

MAY 1981 PA-PLANT-2 OPERATION DATA (3/4)

Date	Amperage at 9 Am								
	Premixer	Dig 'A'	Dig 'B'	Cry "A"	Cry "B"	Cry "C"	Slurry pump	Cooling air fan	Cry exhau fan
1									
2									
3									
4									
5	6 - 6.5	32 - 42	-	42 - 45	37 - 40	30 - 32	40 - 42	195	170
6	6.5 - 7.0	32 - 42	-	41 - 43	37 - 40	30 - 32	40 - 41	195	175
7	6 - 7	32 - 42	-	40 - 42	36 - 39	27	44	205	185
8	6.5 - 7.0	32 - 40	-	40 - 42	36 - 38	27	43	205	180
9	6.5 - 7.0	36 - 38	-	40 - 42	38 - 40	26	41	205	180
10	6.5 - 7.0	35 - 42	-	40 - 43	36 - 39	28	45	200	180
11	-	35 - 42	-	40 - 43	34 - 36	30	-	-	-
12	6.5 - 7.0	-	28 - 35	39 - 42	37 - 39	29	44	200	175
13	6 - 7	-	30 - 36	40 - 42	38 - 40	29	43	180	170
14	6 - 7	-	30 - 36	41 - 43	37 - 39	30	41	200	170
15	6 - 7	-	29 - 35	42 - 45	37 - 40	28	44	180	180
16	6 - 7	-	28 - 34	42 - 45	37 - 40	28	43	190	175
17	6 - 7	-	28 - 34	41 - 44	38 - 40	29	42	195	175
18	6 - 7	-	28 - 35	42 - 45	38 - 40	29	43	195	180
19	6 - 7	-	28 - 34	40 - 43	38 - 41	28	42	195	170
20	6 - 7	-	28 - 35	42 - 45	38 - 41	28	42	195	170
21	6 - 7	-	28 - 34	42 - 44	38 - 42	30	43	190	175
22	6 - 7	-	28 - 32	42 - 45	38 - 42	29	43	200	175
23	6 - 7	32 - 37	-	42 - 45	38 - 42	28	45	195	175
24	6 - 7	32 - 38	-	42 - 45	38 - 42	27	42	190	175
25	6 - 7	30 - 37	-	42 - 45	38 - 42	27	42	200	175
26	6.5 - 7.0	32 - 36	-	42 - 45	38 - 42	29	44	200	180
27	7 - 8	32 - 38	-	42 - 46	38 - 42	28	44 - 48	200	180
28	6.5 - 7.0	32 - 38	-	42 - 46	38 - 42	28	42 - 46	205	180
29	6.5 - 7.0	32 - 38	-	42 - 46	38 - 42	28	45	200	175
30	6 - 6.5	34 - 41	-	41 - 44	38 - 41	28	45	-	-
31	6.0 - 6.5	34 - 41	-	42 - 44	38 - 40	29	45	200	180

SECTION 1

PA-PLANT-2 OPERATION DATA (3/4)

Amperage			at 9 Am				Filtration		
"A"	Cry "B"	Cry "C"	Slurry pump	Cooling air fan	Cry exahust fan	Vacuum pump	Vacuum	Cake	Filter speed
							(-mmHg)	(mm)	
							-	-	-
							-	-	-
45	37 - 40	30 - 32	40 - 42	195	170	145	490	60	0.48
- 43	37 - 40	30 - 32	40 - 41	195	175	135	500	60	0.50
- 42	36 - 39	27	44	205	185	135	450	60	0.48
- 42	36 - 38	27	43	205	180	145	480	65	0.48
- 42	38 - 40	26	41	205	180	150	460	65	0.48
- 43	36 - 39	28	45	200	180	140		60	0.48
- 43	34 - 36	30	-	-	-	-	-	-	-
- 42	37 - 39	29	44	200	175			65	0.48
- 42	38 - 40	29	43	180	170		480	60	0.48
- 43	37 - 39	30	41	200	170		520	55	0.50
- 45	37 - 40	28	44	180	180		530	55	0.50
- 45	37 - 40	28	43	190	175		490	55	0.50
- 44	38 - 40	23	42	195	175		500	55	0.48
- 45	38 - 40	29	43	195	180		480	60	0.50
- 43	38 - 41	28	42	195	170		480	60	0.50
- 45	38 - 41	28	42	195	170		470	60	0.50
- 44	38 - 42	30	43	190	175		560	60	0.50
- 45	38 - 42	29	43	200	175		560	60	0.50
- 45	38 - 42	28	45	195	175		540	65	0.50
- 45	38 - 42	27	42	190	175		560	60	0.50
45	38 - 42	27	42	200	175		580	60	0.50
- 45	38 - 42	29	44	200	180		600	65	0.50
46	38 - 42	28	44 - 48	200	180		580	60-65	0.50
- 46	38 - 42	28	42 - 46	205	180		480	60	0.50
- 46	38 - 42	28	45	200	175		400	60	0.45
- 44	38 - 41	28	45	-	-		-	-	-
- 44	38 - 40	29	45	200	180		500	60	0.50

SECTION 2

May 1981 PA-PLANT-2 OPERATION DATA (4/4)

Date	30% Acid Flow Rate (at 9:00) Rock t/h	98%SA m^3/h	DM water m^3/h	RA m^3/h	Wash acid m^3/h	Concentration Un[illegible] Analysis Sp Gr (at 30°C)	P_2O_5	Low Pr[illegible] (FF[illegible]
1						1.59	48.82	
2								
3								
4						1.53	47.04	
5		7.4	4.5	39.0		1.60	50.23	
6	14.6	11.2	6.7	52	26	1.57	48.08	
7	18.6	10.4	6.7	50	25	1.57	47.70	
8	17.6	10.8	6.9	50	24	1.56	46.97	
9	17.4	11.2	6.9	49	24	1.62	50.51	
10	18.7	11.2	7.0	49	25	1.61	48.90	
11								
12	18.8		7.0		25	1.52	44.08	
13	18.0	10.8	6.7	49	25	1.60	48.88	
14	14.0	9.8	6.0	45	22	1.62	50.96	
15	16.2	11.0	6.8	49		1.61	50.36	
16	12.1	11.0	6.9	50	25	1.58	48.13	
17	17.0	10.8	7.0	52	27	1.62	50.97	
18	15.8	10.6	7.0	50	23	1.61	50.42	
19	18.0	11.0	7.0	49	27	1.58	48.62	
20	19	11.2	7.0	50	26	1.62	51.53	
21	17.8	11.2	6.5	48	26	1.65	51.67	
22	17.4	10.8	6.5	48		1.57	47.87	
23	19.0	11.0	6.7	45	30	1.59	48.31	
24	16.6	11.4	7.0	42	26	1.61	50.90	
25	15.0	11.2	7.0	44		1.60	49.83	
26	14.2	11.2	7.0	47	30	1.60	49.60	
27	15.5	11.0	6.8	43	20	1.60	49.50	
28	15.8	11.0	6.8	50	25	1.61	50.57	
29	15.0	10.6	6.8	44	23	1.60	50.44	
30	12.0	6.5	4.4	30	25			
31	16.3	11.0	6.7	44	26	1.62	51.58	

SECTION 1

OPERATION DATA (4/4)

		Concentration Unit			
:t 9:00)		Analysis		Low Pressure Steam	TRCA-2501
RA m^3/h	Wash acid m^3/h	Sp Gr (at 30°C)	P_2O_5	(FRC-2501) T/hr	A
		1.59	48.82		
		1.53	47.04		
39.0		1.60	50.23		
52	26	1.57	48.08		
50	25	1.57	47.70		
50	24	1.56	46.97		
49	24	1.62	50.51		
49	25	1.61	48.90		
				7.5	78
	25	1.52	44.08	7.0	79
49	25	1.60	48.88	8.0	84
45	22	1.62	50.96	8.0	83
49		1.61	50.36	8.0	84
50	25	1.58	48.13	8.0	88
52	27	1.62	50.97	8.0	86
50	23	1.61	50.42	8.0	88
49	27	1.58	48.62	8.0	84
50	26	1.62	51.53	8.0	88
48	26	1.65	51.67	8.0	85
48		1.57	47.87	8.0	84
45	30	1.59	48.31	7.5	82
42	26	1.61	50.90	8.0	82
44		1.60	49.83	8.0	86
47	30	1.60	49.60	8.0	88
43	20	1.60	49.50	8.0	85
50	25	1.61	50.57	5.0	
44	23	1.60	50.44	7.5	84
30	25			5.5	82
44	26	1.62	51.58	8.0	82

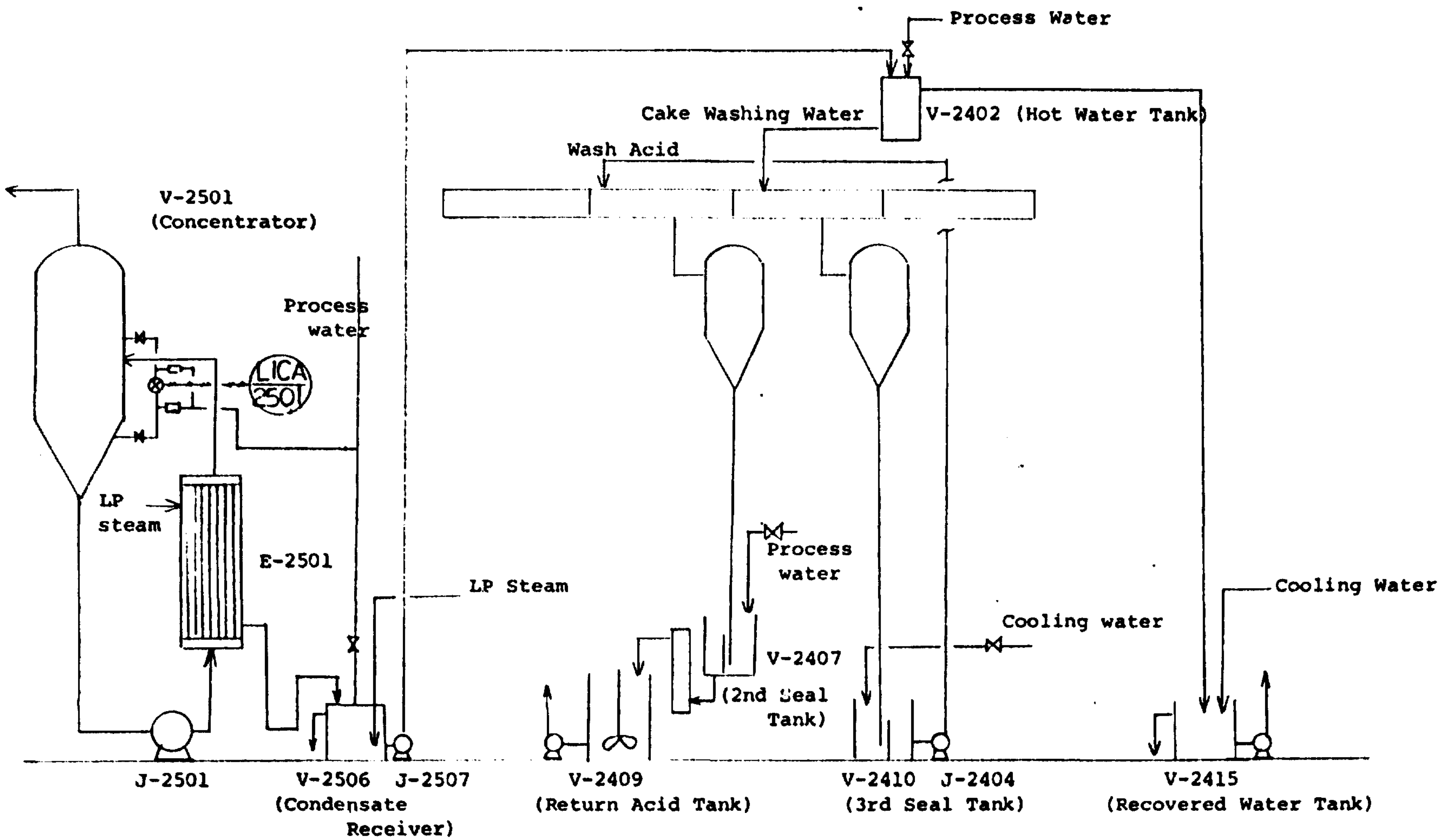
SECTION 2

Shut Down of PA-2 (30% Acid Production) Plant

(May 1981)

Date	Shut down hour	Reason
1	12	Breakage of vacuum pump's bearing
2	24	-do-
3	24	-do-
4	1.5	-do-
5	1.75 4.0	Exchange of cover plate liner of slurry pump Shortage of river water
6	5.25	Exchange of cover plate line of slurry pump
7	2.25 1.5	Breakage of pully key of K-2401 Shortage of ground rock
8	0	
9	13.3	Burning of motor of vacuum pump
10	2.5	Fullness of 30% acid storage tank
11	24.0	-do-
12	13	Maintenance work of premixer
13	3.5	Shortage of river water
14	12.75	Exchange of slurry pump's motor
15	5.0	Trouble of bearing of slurry pump
16	6.0	-do-
17	4.5 1.75	Leakage in S.A. line Power failure
18	910	Tear of chain of ground rock elevator
19	11.0	Shut down of SA-2 plant
20	2.7	Exchange of impeller of gypsum slurry pump
21	14.7	Brust of hoose between splitting box and filtrate holding tank
22	2.0	Leakage of slurry from slurry pump
23	0	
24	2.7	Cleaning of cooling air pipe
25	8.5	Exchange of slurry pipe line
26	0	
27	0	
28	18.5	Breakage of bearing of premiser agitator
29	3.0 9.5	Exchange of motor for slurry pump Trouble of rock weigher
30	5.0 3.5 9.1	Repair of V.S. coupling Shut down of SA-2 plant Power failure
31	4.2 1.5	Exchange of bearing of rock feed screw conveyor Power failure
Total	267.95	

Filter Cake Washing System



APPENDIX VII-6(3) P_2O_5 DECREASE IN FILTRATION OF PA-II PLANT

DATE	January, 1981			April 1981			May, 1981		
	Crys-tall izer	1st - fil trate	P_2O_5 decre-ase	Crys-tall-izer	1st - fil-trate	P_2O_5 decre -ase	Crys-tall -izer	1st fil- - trate	P_2O_5 decre -ase
1	27.96	25.58	2.38	23.36	-	-	26.54	25.53	1.01
2	25.66	25.52	0.14	-	-	-	-	-	-
3	25.41	25.32	0.09	21.72	20.69	1.03	-	-	-
4	25.32	24.66	0.66	20.67	18.94	1.73	26.48	25.53	0.95
5	25.87	25.24	0.63	25.75	21.48	4.27	27.21	25.17	2.04
6	26.53	25.02	1.51	25.63	24.98	0.65	26.22	25.30	0.92
7	26.89	24.30	2.59	27.96	26.63	1.33	24.81	23.71	1.10
8	26.67	25.32	1.35	27.72	27.73	-0.01	26.31	24.93	1.38
9	24.84	28.18	-0.34	25.77	-		25.03	24.53	0.52
10	26.31	25.52	0.70	29.00	28.19	0.81	26.22	25.61	0.61
11	25.52	25.13	0.39	27.19	26.60	0.59	-	-	-
12	25.33	24.84	0.49	27.48	26.17	1.31	25.27	24.53	0.74
13	27.32	25.74	1.58	27.49	26.46	1.03	27.16	25.31	1.85
14	26.98	24.85	2.13	29.16	27.61	1.55	28.11	27.14	0.97
15	26.18	25.72	0.46	27.10	25.37	1.73	27.18	26.82	0.36
16	24.54	23.86	0.68	26.73	26.25	0.48	28.03	27.28	0.79
17	-	-	-	27.02	24.99	2.03	27.88	26.57	1.31
18	-	-	-	26.07	25.11	0.96	27.61	26.81	0.80
19	-	-	-	26.47	25.52	0.95	27.99	26.86	1.13
20	-	-	-	26.44	25.36	1.08	27.09	27.10	0.01
21	25.11	-	-	27.48	24.88	2.60	27.67	26.24	1.43
22	24.49	-	-	26.12	25.23	0.89	27.23	26.58	0.65
23	26.14	24.09	2.05	28.28	25.94	2.34	29.42	27.82	1.60
24	28.19	28.14	0.05	26.38	25.73	0.65	27.62	27.24	0.38
25	24.21	22.84	1.37	26.61	24.38	1.63	28.54	27.63	0.91
26	-	-	-	25.93	25.10	0.83	29.14	27.69	1.45
27	-	-	-	26.23	25.73	0.50	29.45	28.78	0.67
28	-	-	-	26.07	25.11	0.96	30.21	28.36	1.85
29	-	-	-	-	-	-	29.14	27.29	1.85
30	-	-	-	25.58	24.66	0.92	-	-	-
31	-	-	-	-	-	-	27.51	26.42	1.09
average	25.97	25.09	0.88	26.31	25.19	1.12	27.44	26.39	1.02

APPENDIX VII-6(4) RECOMMENDATION FOR MISCELLANEOUS ITEM OF PA-2 PLANT

1. Preparation of Instruction Sheet

   To improve the quality of operator, it is better to prepare the detailed instruction for operator as required. Such instruction sheet should include main important factors for operation, so that operator easily understand and may take suitable action when required. In the followings several such instructions are described.

2. Exchange of Filter Cloth

   Exchange of filter cloth has been conducted frequently due to breakage of cloth. This may be caused by breakdown of drainage screen of filter.

   Basically, drainage screen should be checked periodically and repaired. But, as temporary action, small piece of rubber plate is to be attached to the portion of breakdown to protect the filter cloth.

   Filter cloth which was broken recently has not been used for a long time, and so it is not choked up with gypsum. Therefore, such filter cloth is to be used again after sewing.

   Filter cloth is so expensive that a hole of breakdown is easily closed by special bond and small piece of cloth in a short time to save the shutdown time of plant and cost of filter cloth.

3. Cleaning of Digester Exhaust Gas Line

   Digester exhaust gas line at outlet of digester is so easily choked that operators are requested to open the man hole in every shit and clean if necessary.

   To minimize the leakage gas in case of using one digester, damper of digester is to be repaired perfectly. Exhaust gas line is always sprayed with minimum river water for prevention of choking and is to be checked and cleaned in long shutdown time.

Example of Instruction sheet

Items of recommendation for 100% load run
(20th May - 3rd June)

1. Feed rates of ground rock 19.0 T/hr

   Control the setter in control room by calculating the difference per one hour in local integrator.

2. H_2SO_4 content in crystallizer "C"

   3.0 ± 0.5 (%)

3. Density of return acid (with hydrometer)

   1.20 - 1.22

4. Amperage of motor

Cooling air blower	200 - 205 Amp.
Crystallizer exhaust fan	180 - 185 Amp.

5. Pressure of crystallizer

Crystallizer A and B	:	minus
Crystallizer C	:	0

6. Remarks

   (1) Process water is to be supplied to condensate receiver in stead of 2nd seal tank to increase P_2O_5 recovery of F.C.

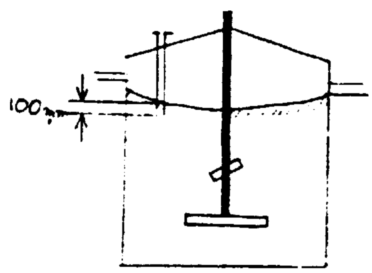
   (2) Process water is to be supplied to condensate receiver in stead of river water to 3rd seal tank.

   (3) In every shift, check the exhaust gas line at outlet of digester to maintain the pressure of digester to be minus.

4. Cleaning Cooling Air Pipe

In order ot maintain cooling capacity in crystallizer, operators are requested to check condition of cooling air pipes periodically or in shutdown time, and to clean the choked pipes.

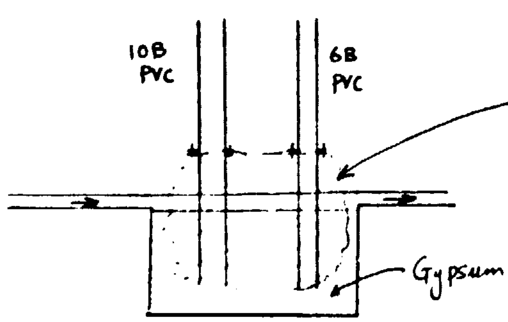
For effective cooling, dip length of cooling air pipe is approx. 100 mm in running condition as shown below.



Please check the dip length at 100% load and adjust it if necessary.

5. Seal in Crystallizer Exhaust Gas Line

In crystallizer exhaust gas line, two kinds of drainage pipe (10-PVC & 6-PVC) are attached. But they are not sealed at the position of leg, so that one can not ignore the volume of leakage gas in view of cooling capacity. It is recommended to change seal leg to other portion of ditch or to prepare seal pot.



This portion was taken out due to choking with gypsum.

Due to imcomplete guide of each crystallizer's damper, it is not so easy to control the inside pressure of crystallizer. It is recommended to attach the guide to crystallizer 'C' damper.

6. Complete Cover of Trough

To prevent dusting of rock and shortage of cooling capacity, it is necessary to attach complete cover to trough between vessels.

Especially the cover between crystallize "A" and "B" is extremely damaged and so the expert is very anxious about damage of rubber lining of crystallizer if the cover is broken and taken into crystallizer.

In case of using Digester 'A', the trough between digester 'A' and Crystallizer 'A' is so long that complete cover is to be repaired in order to prevent suction of air and rainfall. Material of such cover is carbon steel lined with rubber and its size is to be small for easy cleaning of trough.

7. Sedimentation of Gypsum to Drip Pan in Filter

Small quantity of gypsum attaches to backside of tilting pan at cake disposal section in filter and dropes to almost all drip pans.

Cleaning of such sedimentated gypsum has been conducted in shutdown time. Continuous washing system of backside of tilting pan is easily possible by using trough washing pipe.

8. HZPO Blade of Agitator

In Nissan Toyama Plant, special alloy HZPO has been used as blade of premixer and digester agitator since July 1977 and HZPO has strong resistance to phosphoric acid at high temperature.

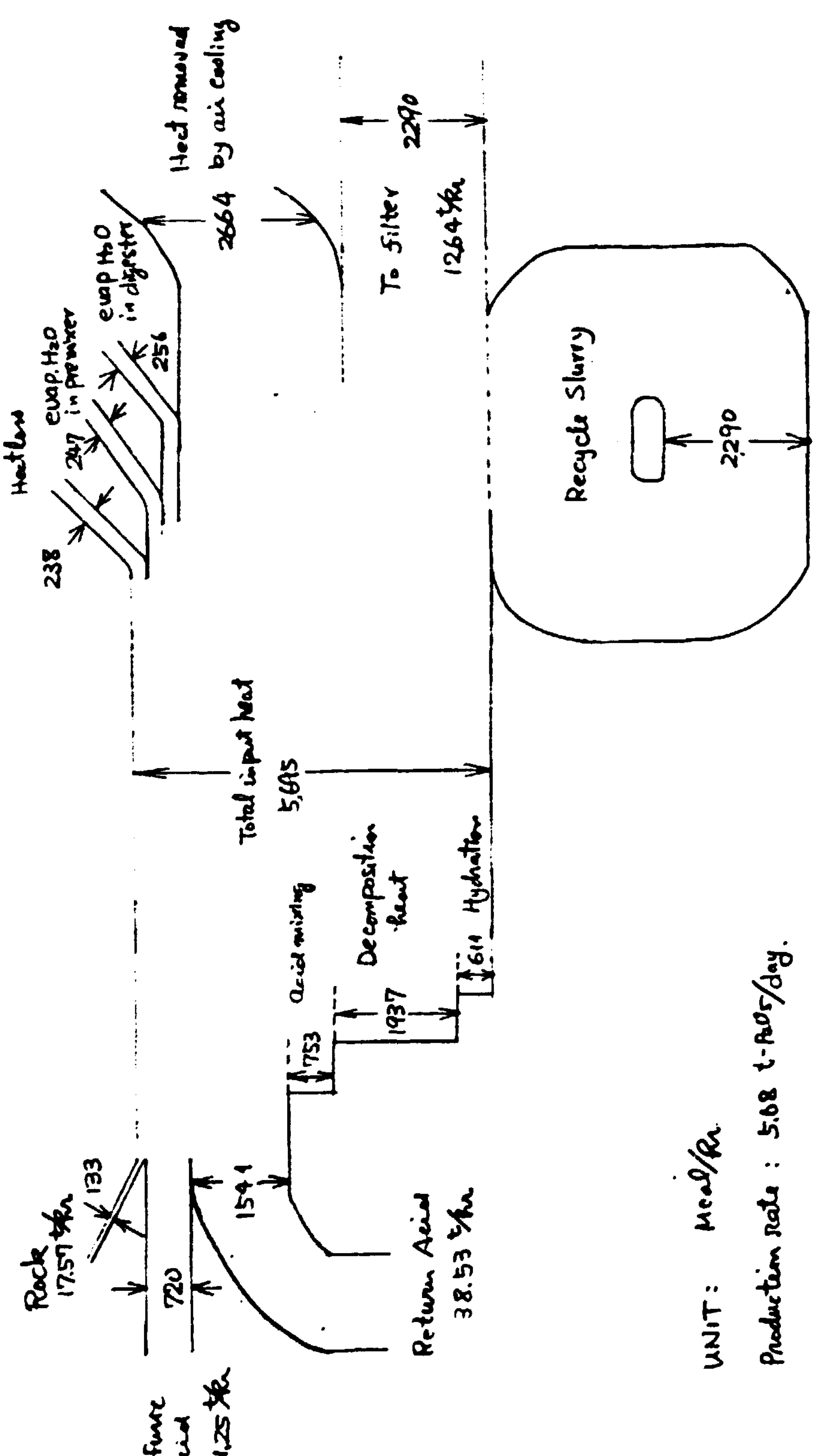
In spite of expensive cost in construction, life is long and maintenance of blade is easy. As it is experienced in impeller of slurry pump, it is recommended HZPO blade for premixer and digester's agitator.

In TSP plant, cooling water which has approx. 500 PPM chlorine is sometimes supplied to 3rd seal tank and so three pieces of HZPO test piece have already been supplied, for corrosion test on May 19, 1981.

Component of HZPO is as follows:

Ni	38 - 40 %
Cr	20 - 23
Mo	7.5 - 8.5
Fe	Balance

9. Heat Balance of PA-2 Plant



APPENDIX VII-7(1)

DETERMINATION OF TOTAL CHLORIDE IN PHOSPHATE ROCK

(Turbidimetric Method - Silver Chloride)

Add milk of lime into a sample, mix well, dry, and ignite until organic matter is carbonized completely. Thereafter dissolve this residue with nitric acid, filter it, make this solution turbid white by adding silver nitrate, and measure the concentration of chloride from turbidity with eye.

Reagent and chemicals

(1) Calcium exide

(2) Milk of lime

Weigh approximately 30 g of calcium oxide, suspend it in 1000 ml of water, and shake well prior to use.

(3) Nitric acid (Conc.) (1:1)(1:3)

(4) Silver nitrate (2%)

(5) Sodium chloride (standard)

(6) Standard Cl solution

a) Dissolve accurately 1.65 g of sodium chloride in some water and dilute it with water into exactly 1000 ml in a measuring flask.

b) Put 10 ml therefrom and dilute it with water into exactly 1000 ml in a measuring flask.

c) This solution contains 0.01 mg of Cl in 1 ml.

Procedure

(1) Preparation of sample solution

a) Weigh 1.000 g of sample into a platinum dish.

b) Add 20 ml of lime milk solution, shake well, and dry up in an electric thermostatic even at 100 - 110°C.

c) After drying, ignite it for about 4 hours in an electric furnace at 600 - 650°C.

d) Put the residue into a 100 ml beaker, and 5 ml of HNO_3 (1:3), and dissolve by heating for about 5 minutes at 50 - 60°C.

e) Filter through a filter paper (whatman No. 44 110 mm) into a 250 ml measuring flask, and wash the filter cake with water.

f) After washing, fill up with water, and shake well.

g) Measure out appropriate quantity of the sample solution (0.02 - 0.1 mg as Cl) with a pipette into a color comparison tube (100 ml).

(2) Comparison of turbidity

a) Add 1 ml of HNO_3 (conc.) and 2 ml of 2% $AgNO_3$, make the quantity of the solution 40 ml with water, shake well, and leave it for 5 minutes.

b) Compare turbidity of the sample solution with that of the standard Cl solution, and determine Cl content.

(3) Preparation of standard solution

a) Put 1, 2, 3, ..., 9, and 10 ml of standard Cl solution into the respective color comparison tubes.

b) Make turbid in the same way as with the sample solution.

c) Carry out a blank test without using sample.

(4) Calculation

$$\mathrm{Cl}\ \% = \frac{0.00001\ (\mathrm{g/ml}) \times \text{standard Cl solution } (A-B)\mathrm{ml}}{1 \times a/250} \times 100$$

where,

a: Pipetted volume of sample (ml).

A: Standard Cl solution ml for the sample solution.

B: Standard Cl solution ml for blank test.

APPENDIX VII-7(2) CALCULATION FOR TSP-I PRODUCT

1. Design Condition

1.1 Chemical Composition of Jordan Rock

Moisture:	0.5%
P_2O_5:	33.1
CaO:	51.4
SO_3:	1.7
SiO_2:	4.8
CO_2:	4.9
F:	4.2
Al_2O_3:	0.35
Fe_2O_3:	0.46

*All figures except for moisture, are on dry matter basis.

1.2 Chemical Composition of the Concentrated Phosphoric Acid.

P_2O_5:	50.0%	
H_2SO_4:	3.6	(2.9 as SO_3)
Impurity:	3.7	

2. Calculation

2.1 Amount of Phosphoric Acid Required.

Basic for calculation

phosphate rock (Dry basis) ——→ 100 kg

CaO ——→ $(Ca(H_2PO_4)_2\ H_2O$

P_2O_5 forming $Ca(H_2PO_4)_2 2H_2O$

(5/4) (2.536) ——→ 130.4

where 2.536: P_2O_5/CaO

$Fe_2O_3 \longrightarrow Fe\ (H_2PO_4)_3$

P_2O_5 forming Fe $(H_2PO_4)_3$

(0.46) (2.667) $\longrightarrow$ 1.2

where 2.667: 3 P_2O_5/Fe_2O_3

$Al_2O_3 \longrightarrow Al\ (H_2PO_4)_3$

P_2O_5 forming Al $(H_2PO_4)_3$

(0.35) (4.176) $\longrightarrow$ 1.5

where 4.176: 3 P_2O_5/Al_2O_3

P_2O_5 in phosphate rock $\longrightarrow$ -33.1

SO_3 in phosphate rock

$SO_3 \longrightarrow Ca\ SO_4\ 1/2\ H_2O \longrightarrow P_2O_5$

$P_2O_5 \longrightarrow$ (1.7) (1.775) $\longrightarrow$ -3.0

where 1.775: P_2O_5/SO_3

F in phosphate rock

$F \rightarrow Ca\ F_2$

$P_2O_5 \longrightarrow$ (4.2) (3.737) $\longrightarrow$ -15.7

where 3.737: $P_2O_5/2F$

Total 81.3 kg as P_2O_5

Amount of phosphoric acid required is 81.3 kg as P_2O_5 per 100 kg rock.

But phosphoric acid contains sulfuric acid.

Therefore, we consider it.

Concentrated phosphoric acid.

P_2O_5: 50.0%

H_2SO_4: 3.6% (2.9% as SO_3)

Acid 100 base (kg)

$SO_3 \longrightarrow P_2O_5$

(2.9) (1.775) = 5.148

50.0 + 5.148 = 55.148

55.148/50.0 = 1.10

So, acid ratio

81.3/1.10 = 73.9 kg as P_2O_5/Rock 100 kg

2.2 Amount of Product

Basis for the calculation: phosphate rock 100 kg

Volatile matter

CO_2 in the rock: 90% volatilized

(4.9) (0.9) = 4.4 kg

Fluorine in the rock: 10% volatilized in the form of SiF_4

(4.2)(0.1)(SiF4/4F) = 0.6

where SiF4/4F: 1.370

(1) Amount of dry product derived from the rock will be (by subtracting the vilatile components from the rock):

$$100 - 4.4 - 06 = 95 \text{ kg.}$$

(2) Amount of dry product derived from the concentrated phosphoric acid will be:

$$(73.9)(1.380) + (73.9)(3.6/50.0) + (73.9)(3.7/50.0) = 112.7 \text{ kg}$$

where 1.380: $2H_3PO_4/P_2O_5$

(3) Therefore, amount of dry product (1)+(2) = 207.7 kg.

(4) If moisture 6.4% in the product,

Amount of product will be:

$$207.7/(1-0.064) = 221.9 \text{ kg}$$

2.3 Consumption of Rock and CpA. per product 1 ton

Rock: (100/221/9)(1) = 0.45 ton

CPA: 0.45 x 0.739 = 0.33 ton as P_2O_5

0.33/0.50 = 0.66 ton as 50% P_2O_5

2.4 Estimated Quality of TSP

moisture: 6.4%

T-P_2O_5: [(0.45) (0.331) + 0.33)] (100) = 47.9%

A-P_2O_5: (47.9)(0.97) = 46.5%

where 0.97: A-P_2O_5/T-P_2O_5.

APPENDIX VII-8 CHEMICAL KINETICS

After some lecture, we conducted following exercises.

No.1

How much quantity of 20% SA is added to 1.5 ton of 98 % SA to produce 65 % SA?

Soln : X ton of 20% SA is required for the purpose.

$$0.98 \times 1.5 + 0.2 \times X = 0.65\ (1.5 + X)$$

$$X = \frac{1.5 \times 0.33}{0.45} = 1.1 \text{ ton}$$

1.5 ton of 98% SA = 1.5 x 0.98 as 100% SA
X " 20% SA = X x 0.20 as 100% SA
(1.5 + X)" 65% SA = (1.5 + X) 0.65 as 100% SA

No.2

a) Find out the quantity of evaporated water (Ve, ton) to produce 50% PA from 15 t of 30% PA. (% PA means % of P_2O_5.)

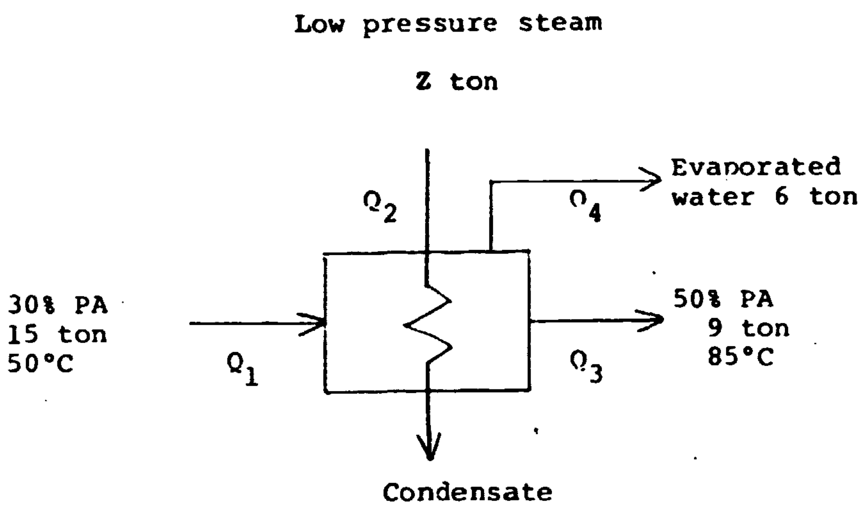
b) How much low pressure steam is required for this evaporation? Pressure of low pressure steam is 0.6 kg/cm^2 and temperature of 30% PA is 50°C and that of 50% PA is 85°C.

Soln:

a) Quantity of 30% acid = V_1 = 15 t
Strength of 30% acid = S_1 = 0.3 t P_2O_5/t acid
Quantity of 50% P_2O_5 = V_2 t
Strength of 50% P_2O_5 S_2 = 0.5 (t P_2O_5/t acid)

$V_2S_2 = V_1S_1$ (because quantity of P_2O_5 will remain always same).
$V_2 \times 0.5 = 15 \times 0.3$
$V_2 = 4.5/0.5 = 9$ t

Hence amount of evaporated water = $V_1 - V_2 = 15 - 9 = 6$ t b)



For evaporation, Z (5) of steam is required.

Q_1 = 15 x 0.69 z 50 (Mcal)

Q_2 = Z x 530.7 (Mcal)

(latent heat of 0.6 kg/cm^2 steam is 530.7 Kcal/kg)

Q_3 = 9 x 0.51 x 0.85 (Mcal)

Q_4 = 6 x 1 x (85 - 50) + 6 x 548

= 6 x (35 + 548)

= 6 x 583 (Mcal)

$Q_1 + Q_2 = Q_3 + Q_4$

15 x 0.69 x 50 = Z = Z x 530.7 = 9 x 0.51 x 85 + 6 x 583

517.5 + 530.7 Z = 390 + 3,498

Z = 6.35 MT

Latent heat of water

Temperature	Latent heat
75°C	554 Mcal/ton
80°C	551 "
85°C	548 "
90°C	545 "
95°C	542 "

Specific heat of phosphoric acid

P_2O_5 %	C_p M cal/ton/°C	
	Pure	Crude
10%	0.94	0.89
20%	0.79	0.77
30%	0.69	0.65
40%	0.60	0.54
50%	0.51	0.43

Steam enthalpy

Temp. °C	Press (kg/cm^2)	Enthalpy (Mcal/ton)		
		Water i_1	Steam i_2	Latent heat $i_1 - i_2$
70	-0.7	69.93	627.0	557.1
100	0.0	100.04	638.8	538.8
105	(0.2)	105.07	640.7	535.6
120	(1.0)	120.25	646.1	525.9
150	3.8	150.92	655.8	504.9
170	7.1	171.68	661.1	489.5
185	10.4	187.46	664.4	477.0
215	20.5	219.46	668.7	449.1

No.3

10 ton of 20% oleum is diluted with water to produce 93.2 % SA.

Soln : 20% oleum means that 100g of the sample consists of 20 g of SO_3 and 80g of 100% SA.

(method-1) $SO_3 + H_2O = H_2SO_4$

20 (g) of SO_3 is equivalent to 24.5 (g) of H_2SO_4.

$$20 \times \frac{\text{Mol wt of } H_2SO_4}{\text{Mol wt of } SO_3} = 20 \times \frac{98}{80} = 24.5 \text{ (g)}$$

Therefore, 100 (g) of 20% oleum is converted to 104.5 (g) of 100% S.A.

Calculation method of No.2 is applied here.

$$V_2S_2 = V_1S_1$$

Quantity of 98.3% SA

$$V_2 = \frac{V_1S_1}{S_2} = \frac{10 \times 1.045}{0.932} = 11.21 \text{ ton}$$

Amount of total dilution water

$X = V_2 - V_1 = 11.21 = 10.00 = 1.21$ (t)

(method-2) 10t oleum includes 2t-SO_3 and 8t-H_2SO_4 (as 100%)

1st stage : 2t-SO_3 is converted to H_2SO_4 (100%) by adding water X

$$SO_3 + H_2O = H_2SO_4$$

$$X_1 = 2 \times \frac{18}{80} = 0.45 \text{ (t)}$$

Total 100% SA; 2 + 8 + 0.45 = 10.45 (t)

2nd stage : Calculation method of No.2 is applied here.

$$V_2S_2 = V_1S_1$$

Quantity of 98.3% SA

$$V_2 = \frac{10.45 \times 100}{93.2} = 11.21 \text{ (t)}$$

Amount of total dilution water

$$X = (V_2 - V_1) = X_1 = 0.76 + 0.45$$
$$= 1.21 \text{ (t)}$$

No.4

What will be the volume of 4kg air at 50°C and 1.6 kg/cm^2 abs pressure ?

Density of air at N.T.P. is 1.293 (kg/m^3)

Soln:

Volume of air at N.T.P. is $V_1 = \frac{4}{1.293}$ (m^3)

T_1 = 273°K·

P_1 = 76 cm of Hg = 1 kg/cm^2

T_2 = (273 + 50)°K = 323 °K

P_2 = 1.6 kg/cm^2

V_2 = reqiested volume

$$P_2V_2 = \frac{1 \times 4 \times 323}{1.6 \times 1.293 \times 273} = 2.287 \ (m^3)$$

No.5

1.5 ton of 98% SA is added with 20% SA to produce 65% SA. What is temperature of mixed acid if each acid is 40°C?

Soln:

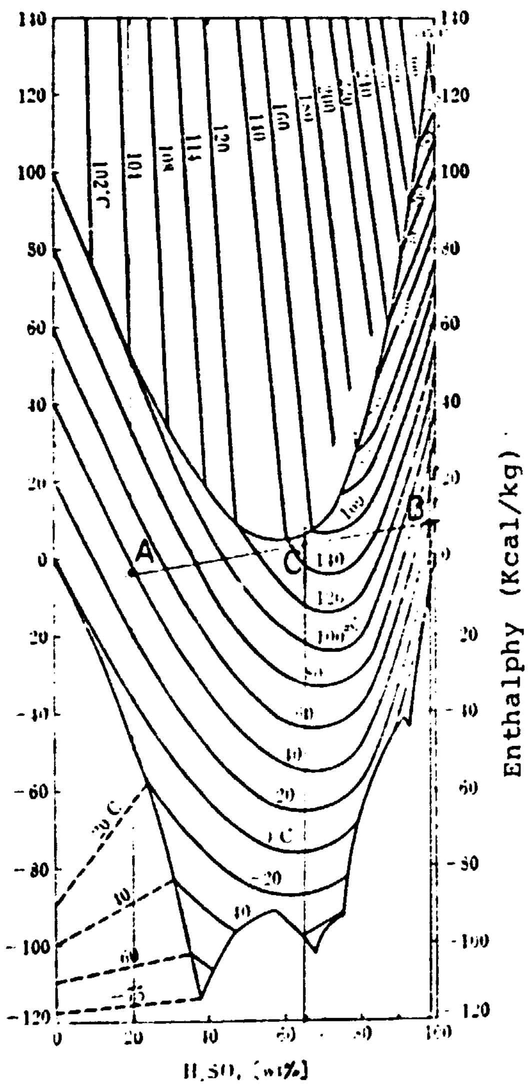
The enthalpy of the respective solution is marked on the Fig.1*. Respective concentration points A and B are connected by a straight line. Another line is drawn vertically through the final concentration of 65 %. The point C intersected by these two lines will give the temperature of mixed acid.

Fig.1 shows that the temperature of 65% SA is approx. 153°C**.

* According to the concentration and temperature of sulfuric acid.

** This Fig.1 is very convenient for brief calculation.

Fig. 1 SA Mixing Enthalphy



No.6

How much water is necessary to cool 3 (t) of 98% SA per hour from 80°C to 60°C with 30°C cooling water? Temperature of cooling water is 45°C at outlet.

Soln :

Heat to be removed

$$Q_1 = 3 \times (0.367 \times 80 - 0.358 \times 60) \text{ Mcal}$$
$$= 3 \times 7.88 = 23.64 \text{ (Mcal)}$$

X (t) of cooling water is required for cooling. Increase of sensible heat cooling water

$$Q_2 = X \times 1 \times (45 - 30) = 15 \times X \text{ (Mcal)}$$

$$Q_1 = Q_2$$

$$15 \times X = 2364 \qquad X = 1.58 \text{ (t/Hr)}$$

Specific heat of SA (Kcal/kg/°C)

% of SA		40°C	60°C	80°C
85	-	-	0.446	0.452
92	0.375	0.385	0.395	0.405
98	0.340	0.351	0.358	0.367
100	0.332	0.343	0.351	0.359

No. 7

Calculate the required air volume (Nm^3/hr) to cool the mixed gas (SO_2 2%, SO_3 9%, air 89%) at the flow rate 20,000 Nm^3/hr by heat exchanger at the following conditions.

	Mixed gas	Air
Temp. of inlet	600 °C	30 °C
Temp. of outlet	450 °C	200 °C

Soln

Specific heat of mixed gases at 600°C ($Kcal/Nm^3°C$)

(Air) (SO_3) (SO_2)

$$C_{P1} = 0.326 \times 0.89 + 0.723 \times 0.09 + 0.508 \times 0.02$$
$$= (0.290 \times 0.065 \times 0.010) = 0.365 \ (Kcal/Nm^3°C)$$

Specific heat of mixed gases at 450°C

$$C_{P2} = 0.3205 \times 0.89 + 0.6865 \times 0.09 + 0.493 \times 0.02$$
$$= 0.285 \times 0.062 \times 0.010 = 0.357 \ (Kcal/Nm^3°C)$$

Specific heat of air at 200°C

$$C_{P3} = 0.32 \ (Kcal/Nm^3°C)$$

Specific heat of air at 30°C

$$C_{P4} = 0.310 \ (Kcal/Nm^3°C)$$

Mixed gas : W 20,000 Nm^3/H
Air : Y Nm^3/H

Heat to be removed by mixed gases

$$= W\ (CP_1 t_1 - CP_2 t_2) = 20{,}000\ (0.365 \times 600 - 0.356 \times 450)$$
$$= 20{,}000\ (219 - 160.2) = 1{,}176{,}000\ (Kcal/H)$$

Heat to be gained by air

$$= Y\ (CP_3 t_3 - CP_4 t_4) = Y\ (0.312 \times 200 - 0.310 \times 30)$$
$$= Y\ (62.4 - 9.3) = 53.1 \times Y\ (Kcal/H)$$

$53.1 \times Y = 1,176,000$

$Y = 22,150\ (Nm^3/H)$.

Specific heat of each gases ($Kcal/Nm^3 \cdot °C$)

Temp	50	100	200	300	400	500	600	1000	1200
Air	0.310	0.310	0.312	0.314	0.320	0.321	0.326	0.339	0.343
SO_2	0.428	0.437	0.455	0.473	0.486	0.500	0.509	0.544	0.553
SO_3	0.553	0.571	0.615	0.647	0.673	0.700	0.723	-	-
O_2	0.314	0.319	0.321	0.326	0.330	0.336	0.339	0.354	0.361
CO_2	0.401	0.410	0.433	0.450	0.466	0.482	0.493	0.531	0.549

No. 8

10,000 Nm^3/H air passes through following duct made by mild steel, which includes 6 bends and 2 stop valves.

Dimension of duct — diameter (D) 500 mm
length (L) 150 m

Temp of air 30°C

Calculate pressure drop (mm Aq)

Density of air at N.T.P. (R) 1,293 Kg/Nm^3

Co-efficient of viscosity of air at 30°C 1.8×10^{-5} kg/m.sec

Soln:

Diameter of duct, D = 500 (mm) = 0.5 (m)

Duct area, $A = 0.785 \times (0.5)^2 = 0.196$ (m2)

Velocity of air at N.T.P. (U)

$$U_1 = \frac{10,000}{3600A} = \frac{10,000}{3600 \times 0.196} = 14.17\ (m/sec)$$

Velocity of air at 30°C and 1 atm pressure (U)

$$U = U_1 \times \frac{303}{273} = 14.17 \times \frac{303}{273} = 15.73\ (m/sec)$$

Rayaold's number

$$N_{Re} = \frac{D \times U \times R}{\times M} = \frac{0.5 \times 15.73 \times 1.165}{1.8 \times 10^{-5}} = 509{,}000$$

$$R : \frac{1.293 \times 273}{303} = 1.165 \text{ kg/m}^3$$

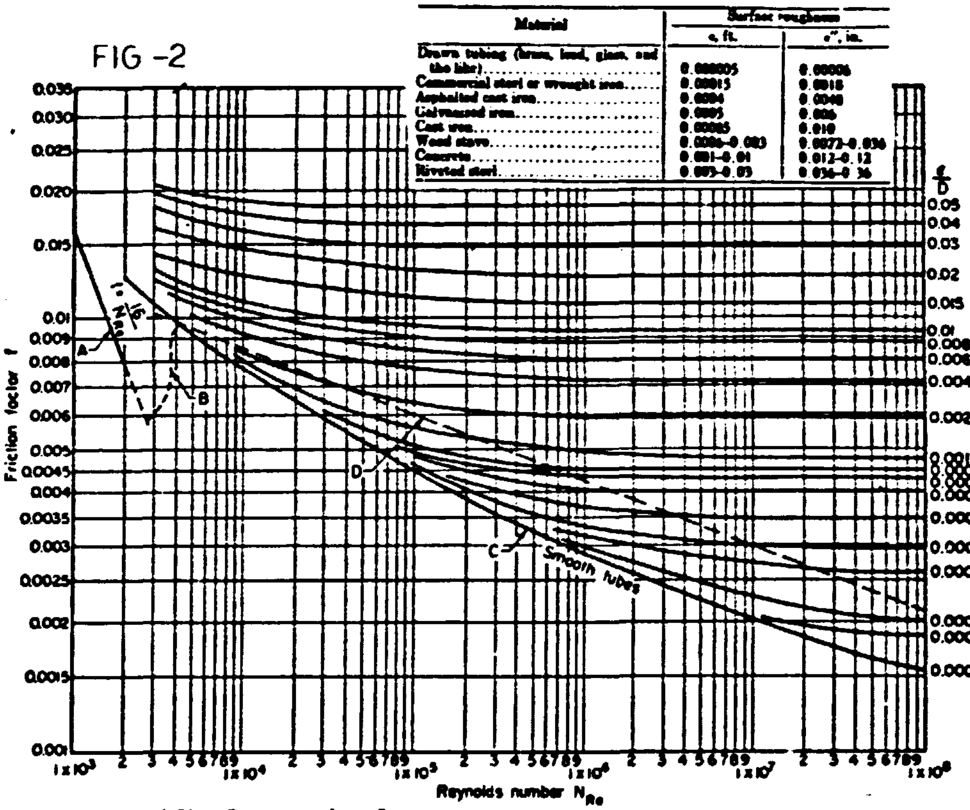
$$M : 1.8 \times 10^{-5} \text{ kg/m.sec}$$

Relative roughness

$$= \frac{\ }{D} = \frac{0.000046}{0.5} = 0.0001$$

is surface roughness, for mild steel it is 0.000046.

FIG -2



Friction factor (f) from Fig.1

$f = 0.0035$

Total length traversed by the air (Lo)

= Length of duct (Lo) + Equivalent length (Le) due to bend and valve

$Le = N \times n \times D$

N : Number of bend and valve

n : Factor for bend and valve

90° elbow	30
90° bend	10-20
Stop valve	300
Sluice valve	7
Angle valve	1.7

$$L = Lo + Le = 150 \times (6 \times 15 + 2 \times 300) \times 0.5 = 495 \text{ (m)}$$

Friction loss $F = \dfrac{2fU^2L}{gD}$ m

Pressure drop (Δp)

$$\Delta P = R \text{ X } F = \frac{2fU^2LR}{gD}$$

$$= \frac{2 \times 0.0035 \times 15.73 \times 495 \times 1.165}{9.8 \times 0.5}$$

$$= 203.84 \text{ Kg/m}^2 = 203.84 \text{ mm Aq}$$

No.9

Water passes through a pipe of mild steel at the rate of 15 m^3/hr.

Diameter of pipe	3 inch
Length of pipe	150 m

The length of pipe is 150 (m), in which 15 (m) vertical line is included. 6 bends and 3 stop valves are attached in this line.

Calculate pressure drop

Density of water at 30°C (R) 1,000 kg/m^3

Co-efficient of viscosity of water at 30°C (M)
1.01×10^{-3} kg/m.sec

Soln I

$V = 15 \text{ m}^3/H$

Pipe dia D = 3" = 3 x 2.54 (cm) = 0.0762 (m)

Area of pipe

$$A = 0.785 \times (0.0762)^2 = 45.58 \times 10^{-4} \text{ (m}^2\text{)}$$

Velocity $U = \frac{15}{3600A} = \frac{15 \times 10^4}{3600 \times 45.58} = 0.914$ (m/sec)

Reynolds number $\underline{DUR}$ $\underline{0.0762 \times 0.914 \times 1,000}$

$$NRe = \frac{DUR}{M} \quad \frac{0.0762 \times 0.914 \times 1,000}{1.01 \times 10^3} = 69,000$$

Relative roughness = $\frac{\ }{D} = \frac{0.000046}{0.0762} = 0.0006$

Friction factor $f = 0.0046$

Total length of pipe which water has to pass.

$$L = Lo + Le = 150 + (6 \times 15 + 3 \times 300) \times 0.0762$$
$$= 22.5 \text{ (m)}$$

Pressure drop due to friction

$$\text{Pressure drop} = P_1 = \frac{2fu^2LR}{gD} = \frac{2 \times 0.0046 \times (0.914)^2 \times 225 \times 1000}{9.8 \times 0.0762}$$
$$= 2,630 \text{ (kg/m}^2\text{)} = 0.26 \text{ (kg/cm}^2\text{)}$$

Pressure drop due to height

$$\text{Pressure drop} = P_2 = hp = 15 \times 1,000 \text{ kg/m}^3$$
$$= 15,000 \text{ kg/m}^2 = 1.5 \text{ kg/cm}^2$$

$$\text{Total pressure drop} = P_1 + P_2$$
$$= 0.26 + 1.50 = 1.76 \text{ kg/cm}^2$$

No.10

In case of oil firing, the flow rate of air is 13,000 Nm^3/H at 30°C and gas temperature at outlet of furnace is 1,000°C. How much oil is necessary per hour for the purpose? Oil is preheated from 25°C to 85°C by high pressure steam (3.8 kg/cm^2). How much steam is necessary for preheating?

Soln

(a) The quantity of oil ; X (lit/H)

Sensible heat of air (Q_1)

$$Q_1 = 13,000 \times 0.310 \times 30 = 120.900 \text{ (Kcal/hr)}$$

Sensible heat of oil (Q_2)

$$Q_2 = X \times 0.90 \times 85 = 76.5\,x \text{ (Kcal/hr)}$$

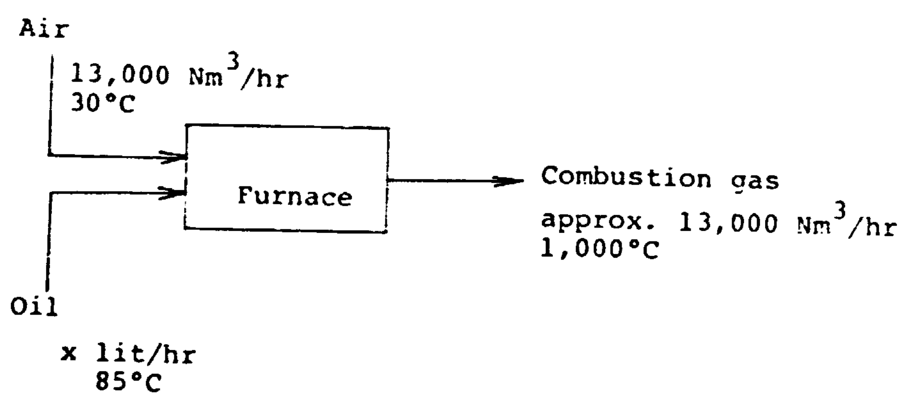
Heat of combustion of heavy oil = 10-11 x 10^3 Kcal/kg

Sensible content of gas

$$= 13,000 \times 0.339 \times 1,000 = 4,407,000 \text{ (Kcal/H)}$$

0.339 = specific heat of air at 1,000°C

$$Q_1 + Q_2 + Q_3 + Q_4 = 120,900 + 76.5X + 9,200X = 4,407,000$$



(b) Heat supplied to oil $462 \times 0.9 \times (85 - 25)$ (cal/hr)

Heat supplied by steam $505 \times Y$ (Kcal/hr)

Y : flow rate of steam (kg/hr)
505 : latent heat of 3.8 kg/cm^2 steam

$$462 \times 0.9 \times (85 - 25) = 505 \times Y$$

Heat of combustion (gross value in Kcal)

	Kcal/Kg.mol)	(Kcal/kg)	$Kcal/Nm^3$
CH_4			9,530
C_2H_5			16,610
C_3H_8			22,450
C_2H_2			13,900
H_2 H_2O	57,600		
C CO_2	94,400	7,860	
CO CO_2		2,420	3,020
S SO_2	70,900		
SO_2 SO_3	22,600		
Normall Cokes		7-8,000	
Natural gas dry			7,300-9,600
Natural gas wet			9,710-10,800
Heavy oil	$10\text{-}11 \times 10^3$		

APPENDIX VII-9 ARRANGEMENT OF THE LABORATORY

(1) All rooms, chambers, desks and drawers should be cleaned once. These are very dirty at present.

(2) Improvement and replacement of the whole room like the following drawing.

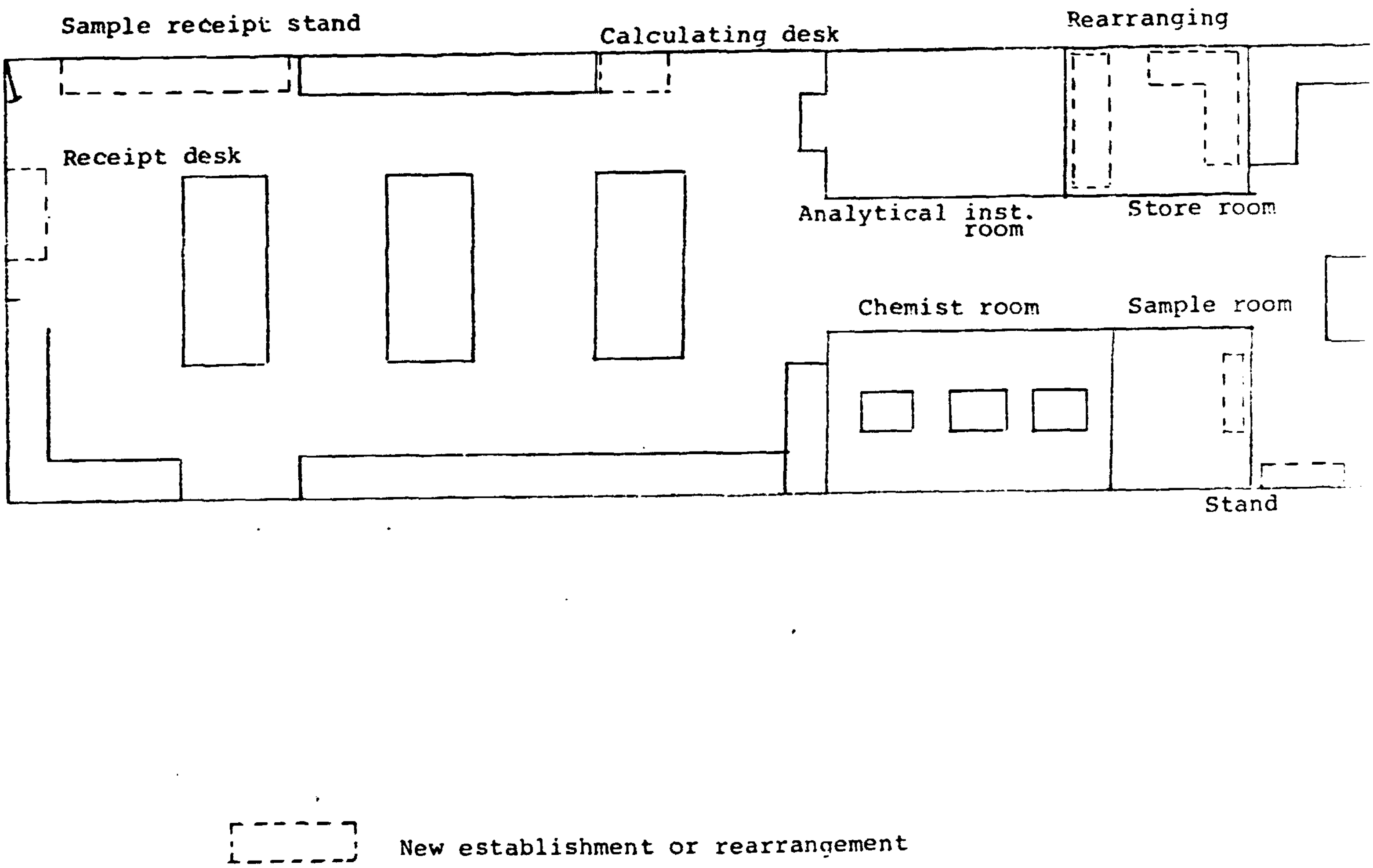
(3) No chatterers are required in the room.

(4) Repairing the broken apparatus and equipments (oven, furnace, etc.)

(5) Advanced researches should be done here for promoting this factory and the country.

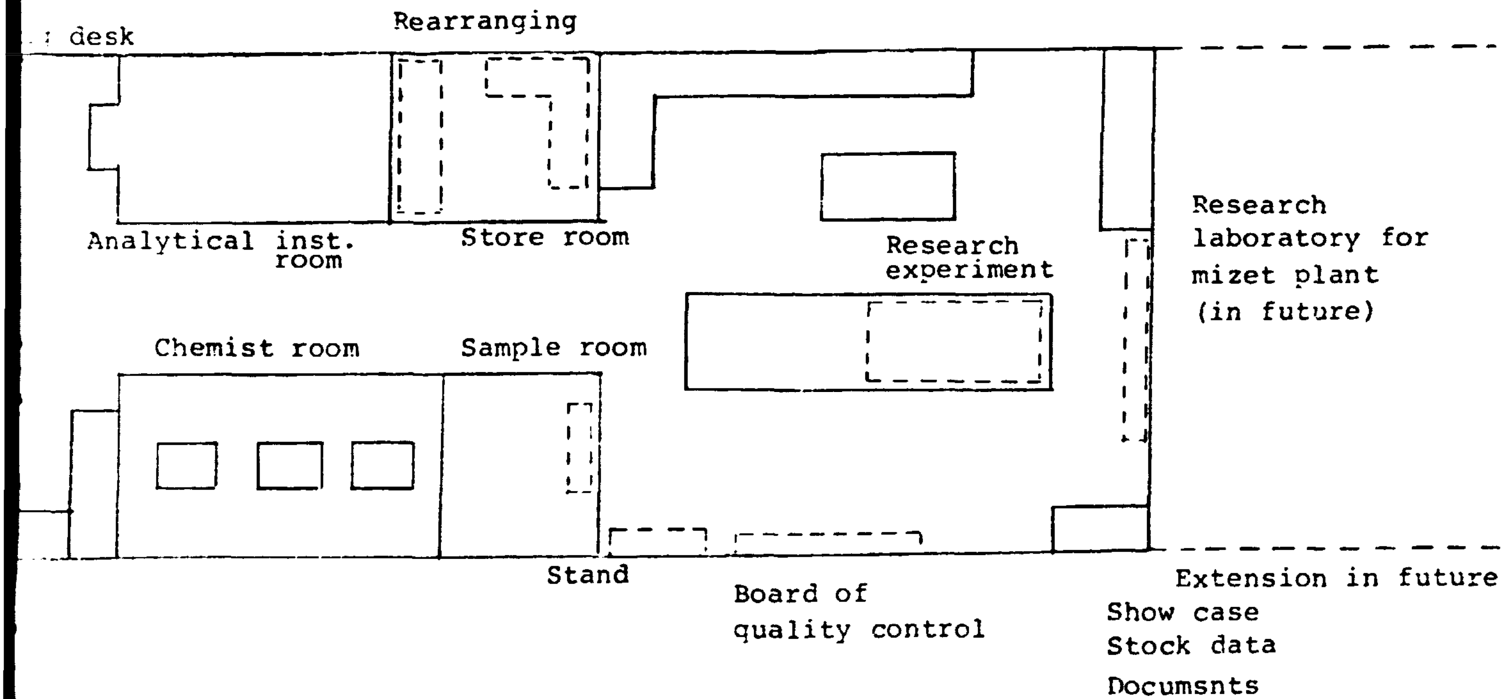
(6) It is better to provide one engineer of electronic machine treatment & repairing and one of quality controller regarding raw materials and products.

PLAN OF LABORATORY



SECTION 1

PLAN OF LABORATORY



rrangement

SECTION 2

APPENDIX VII-10 HAND-MADE HYDROMETER

1. Materials

A : PCV (2 inch pipe, height 200 mm)

B : Dry sand and lead

C : PCV rod (1/2 inch pipek length 160 mm)

D : Liquid to be measured

E : Top welding (after adjustment of weight)

F : PCV (3 inch pipe, height 480 mm)

G : Multi holes plate (6 mm dia. hole)

H : Measuring scale (score after calibration)

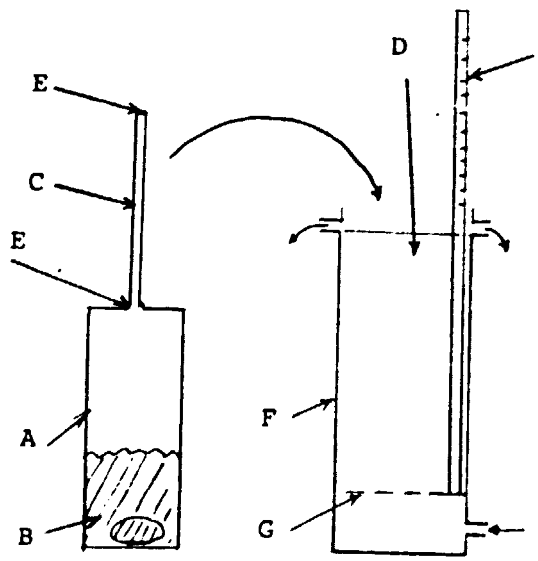
2 Making procedure

1) Make the heaviest liquid

2) Dip A to this liquid after B is entered.

3) Adjust the weight of V. (sand is taken out or in)

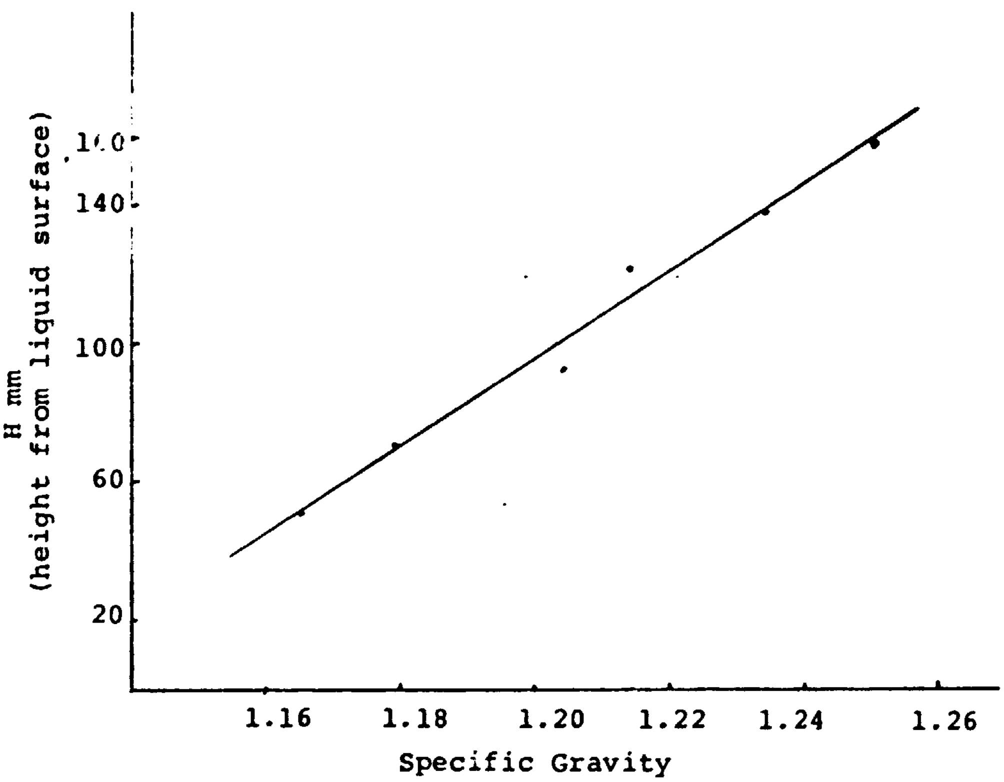
4) Calibrate it with liquid of various density and measure height C from liquid surface and make H.



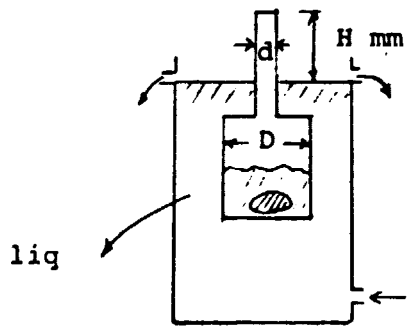
Calibration of Hand Made Hydrometer

If one requires more sharp line, d/D should be less than 0.255.

If one requires more dull line (wide range), d/D should be more than 0.255.



$$\frac{d}{D} = \frac{13^{\text{mm}}}{51} = 0.255$$



APPENDIX VII-11 PRODUCTION OF PURIFIED SULFURIC ACID

1. Purpose

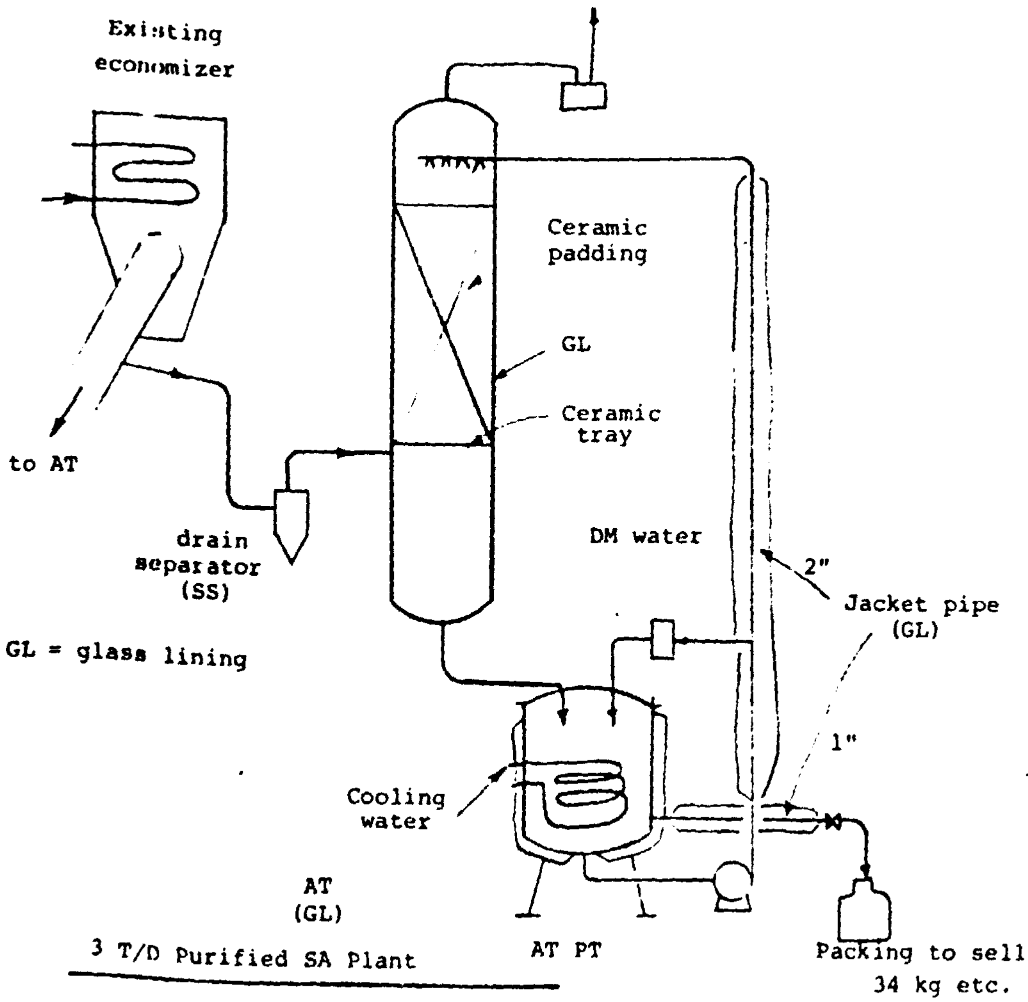
   i) Cost — Industrial SA 2 TK/kg; Purified SA 100 TK/kg

   ii) Export may be possible

   iii) It will be a-plied to battery acid.

2. Flow

   Plant capacity if assumed to be 3 t/d as one example.



3 T/D Purified SA Plant

3. Required SO_3 gas volume at 3 (t/day) Plant

i) SO_3 Gas

$$\frac{3{,}000\ \text{kg}}{24} \cdot \frac{22.4}{98} \cdot \frac{1}{0.99} = 28.86\ \text{Nm}^3/\text{hr}$$

ii) ECO outlet actual gas (SO_3 content 6.8%)

$$28.86/0.068 = 425\ (\text{Nm}^3/\text{hr})$$

$$425 \times \frac{353°\text{K}}{273°\text{K}}\ \frac{1}{3{,}600} = 0.153\ (\text{m}^3/\text{sec})$$

4. Specification of A.T.

retention time $\theta = 10$ sec.

AT vol $= 0.153 \times 10 = 1.53\ \text{m}^3$

$$\left.\begin{array}{l} D = \text{dia (m)} \\ L = \text{length (m)} \end{array}\right\} D \times L = 1.53$$

D → 0.2 0.3 0.4 0.5

L → 7.65 5.10 3.83 3.06

D = 400 mmø

L = 4500 mmø (including allowance)

5. Quality

	U.S.A. (Federal Spec.)		JAPAN (JIS)
H_2SO_4	93 %	37 %	98 %
SO_2	0.004%	1.6 ppm	0.004%
NO_3	0.0005	0.2	0.01
Cl	0.001	0.4	0.0005
NH_4	0.001	0.4	0.0001
Fe	0.005	2.0	0.0001
Cu	0.005	2.0	-
Mn	0.00002	0.008	-
Sb	0.0001	0.04	-
As	0.0001	0.04	-
Ni	0.0001	0.8	-
Zn	0.004	0.08	-
ig loss	0.03	0.012	0.002
Pb			0.0005

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APPENDIX VII-12

PRELIMINARY INFORMATION

ON

NISSAN DIAMMONIUM PHOSPHATE PLANT

FOR BCIC PROJECT

JULY, 1981

NISSAN CHEMICAL INDUSTRIES, LTD.

ENGINEERING DIVISION

NISSAN CHEMICAL INDUSTRIES, LTD.

TABLE OF CONTENTS

I. PREFACE

Nissan Chemical Industries has started production of single superphosphate fertilizer in 1887 and since then has kept the position as leading chemical fertilizer manufacturer in Japan sharing 15 - 20% of Japanese chemical fertilizer production today.

During these periods, Nissan has developed not only Nissan wet phosphoric acid process, but also manufacturing process of ammonium phosphate (DAP, MAP) from wet phosphoric acid and NPK compound fertilizer based on ammonium phosphate by its own technology. These processes are not only used in its own factory but also licensed to many factories both in Japan and abroad and technical assistance for plant construction and operation was furnished to them.

Nissan Chemical has developed two kinds of NP/NPK compound fertilizer manufacturing processes. The one is the spray tower process in wnich dry product is directly obtained from reactor by utilizing reaction heat between ammonia and phosphoric acid for the removal of moisture accompanied by phosphoric acid. The other is the slurry process in which ammonium phosphate slurry obtained by the neutralization of phosphoric acid with ammonia, is granulated and dried up over big amount of seed.

If these two processes are compared, the spray tower process is very efficient and will probably give the most economical consumption figure in case when adoption of this process is appropriate. On the other hand the slurry process has wide range of applicability for production of various kinds of NPK fertilizer.

The slurry process is classified into two types following the type of the equipment where major portion of the reaction between phosphoric acid and ammonia takes place. They are neutralizer type and pipe reactor type and both have special features respectively. Neutralizer type is suitable for the production of NPK fertilizer with wide range of N/P/K ratio including ammonium sulphate rich NPK fertilizer which needs more sulphuric acid in production. In the case of pipe reactor type, the water content in ammonium phosphate slurry can be lowered, the amount of recycle seed granules can be made less and less heat for drying is needed resulting in remarkable energy saving.

Here the outline of Nissan compound fertilizer process taking the case of manufacturing diammonium phosphate with energy saving pipe reactor type slurry process is briefly discussed.

II. PROCESS DESCRIPTION

(Please refer to the Flow Sheet attached in Annex II.)

(1) Raw Material

54% phosphoric acid and 98% sulphuric acid are measured by electro-magnetic flowmeters and mixed in acid tank. Liquid ammonia is charged to pipe reactor at constant pressure.

(2) Reaction

. Primary reaction takes place for the purpose of recovering ammonia gas in waste gas from pipe reactor and granulator. Ammonia gas is recovered by washing the waste gas with weak phosphoric acid in scrubber. This weak acid Absorving the waste gas is introduced together with 54% acid to pipe reactor.

Main reaction takes place in pipe reactor, where neutralization reaction proceeds under pressure. Hot reaction slurry is discharged into granulator.

(3) Granulation

In the granulator, reaction slurry from the pipe reactor is mixed with seed granules which are mixture of fine granul and ground coarse granul sieved and certain portion of product recycled to granulator.

Mixture is granulated by rotation movement of the granulator. Supplemental gaseous ammonia is supplied at the bottom of the rotating granule bed.

(4) Cooling

Product granules are charged into dryer-cooler and cooled down by counter current air. At the exit of the dryer-cooler, lump crusher is equipped and lumps are crushed when formed. Cooled product from the dryer-cooler is sieved by screen.

(5) Sieving .

Sieving takes place in two steps. Coarse granules are separated first and then fine granules are separated from final product.

Coarse granules are crushed in crusher and charged to granulator together with fine granules as recycle. This recycle acts as seeds for granulation in the granulator.

Product granules after sieving are sent to product storage by conveyor.

(6) Dust Recovery

Air from the coarse granul crusher contain dust and this dust is recovered by bag-filter and recycled to the granulator.

(7) Waste Gas Washing

Waste gas from the dryer-cooler is washed by water in the scrubber and discharged into the air. This washed water is used as dilution water of phosphoric acid for primary reaction.

Waste gas from the pipe reactor and granulator is first washed by weak phosphoric acid in the scrubber and then further washed by water.

III. SALIENT FEATURES

Followings are salient features of the Nissan slurry process with pipe reactor to produce ammonium phosphate from concentrated 54% P_2O_5 phosphoric acid and liquid or gaseous ammonia.

(1) With pipe reactor, plant is simple, operation is easy and drying energy can be saved.

(2) Component analysis of product DAP does not fluctuate. Granules are uniform in size and easy to handle. Product is also suitable for bulk blending.

(3) Mono ammonium phosphate can be produced in the same plant if necessary. NPK compound fertilizer can also be produced by equipping supplying equipment (conveyor, weigher, etc.) of potassium source such as muriate of potash.

(4) The process is established based on research and development work and experience of long period. Plant operation is flexible, easy and stable.

(5) Waste gas is discharged after treatment with bag filter and scrubber resulting in very little loss.

(6) Recycle ratio is less than half of that in the conventional slurry process.

(7) Low plant construction cost, because recycle ratio is very small and therefore granulator, dryer-cooler, screen, crusher, recycle conveyor, exhaust gas treatment and other equipments can be made compact.

(8) Less utility consumption, because recycle ratio is small and moisture content at the outlet of granulator is low, so that fuel oil for drying is not necessary under normal operation.

IV. DESIGN BASIS

1. Process

The plant is designed in accordance with the know-how at Nissan pipe reactor process for the production of Diammonium Phosphate.

2. Capacity

1) DAP	:	600 MT/D x one train
2) On stream day	:	330 days per year

3. Product Specification

A-N (Ammoniacal Nitrogen)	:	18.0 wt%
A-P_2O_5 (Available P_2O_5)	:	46.0 wt%
Moisture	:	max. 2.0 wt%
Particle size 1-4 m/m	:	min. 90%

4. Raw Material Specification

1) Ammonia

(1)	State	:	Liquid
(2)	NH_3	:	99.9 wt% min.
(3)	Supply pressure	:	15 kg/cm^2G
(4)	Supply temperature	:	Ambient

2) Phosphoric Acid

Typical chemical analysis in weight % :

P_2O_5	:	54 %
H_2SO_4	:	4.5 %
$Al_2C_3 + Fe_2O_3$	:	3.0 %

MgO	:	0.6 %
F	:	1.0 %
CaO	:	0.5 %
Moisture	:	Balance

3) Sulfuric Acid

(1) H_2SO_4 : 98 wt% min.

(2) Supply to the Battery Limits through the pipe line.

5. Utility Specification

1) Process Water

(1) Demineralized water

(2) Supply pressure : 4 kg/cm^2G

(3) Supply temperature : 30°C max.

2) Fuel Oil

(1)	Gross calorific value	:	10,000 Kcal/kg
(2)	Flash point	:	max. 100°C
(3)	Viscosity	:	max. 100 centistokes
(4)	Moisture	:	max. 0.1 %
(5)	Ash	:	max. 0.1 %
(6)	S	:	max. 3 %

3) Electric Power

(1) For motors

150 kw and above 150 kw	:	6,000 V 3 phase 50 HZ
Below 150 kw	:	400 V 3 phase 50 HZ

(2) For lighting : 200 V 1 phase 50 HZ

(3) For instrumentation: 100 V 1 phase 50 HZ

4) Instrument Air

(1) Pressure : 7 kg/cm^2G

(2) Dew Point : -20°C

(3) Temperature : Ambient

5) Steam

(1) Pressure : min. 2 kg/cm^2G

(2) Temperature : Saturated

6) Climatic Condition

(1) Temperature : 35°C max.

(2) Relative humidity : 70 % at 30°C

(3) Atomospheric pressure : 750 mmHg

(4) Wind velocity : 60 m/sec.

(5) Seismic factor (k) : 0.3

7) Code and Standard

For this information, Japanese codes and standards are considered.

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V. CONSUMPTION FIGURES, etc.

1. Raw Materials (per metric ton of product)

1) Phosphoric acid as 100% P_2O_5	:	463 kg
2) Sulfuric acid as 100% H_2SO_4	:	52 kg
3) Ammonia as 100% NH_3	:	220 kg

2. Utilities (per metric ton of product)

1) Electricity	:	45 KWH
2) Process water	:	300 kg
3) Steam	:	50 kg
4) Fuel oil	:	- A little amount of fuel oil is required only at the time of start-up
5) Instrument air	:	1.0 Nm^3

3. Emission and Effluents

At the exit of Final Scrubber

F : 15 mg/Nm^3

Dust : 100 mg/Nm^3

Total amount of Effluent gas from Final Scrubber is approximately 120,000 Nm^3/hr. at the production rate of 600 MT/D DAP.

4. Man power Requirement (only for operation)

		Total	
Manager	1	1	
Foreman	1 x 4 shifts	4	
Operator	3 x 4 shifts	12	
Total		17	men

VI. BATTERY LIMITS

1. Battery Limits

Please refer to the flow sheet attached in Annex II.

1) Input

(1) Phosphoric acid	:	From Phosphoric Acid Service Tank
(2) Sulfuric acid	:	From Sulfuric Acid Service Tank
(3) Ammonia	:	One point in the plant area
(4) Fuel oil	:	From Oil Service Tank
(5) Electricity	:	From switch gear for high tension motors and control center for low tension motors in the plant area
(6) Other utilities	:	One point in the plant area

2) Output

(1) Product DAP	:	Up to including Product Conveyor
(2) Waste gas	:	Up to and including Scrubber

3) Exclusion

The following items are not included in the Battery Limits and are not considered in the cost estimation.

(1) Phosphoric acid storage tank

(2) Sulfuric acid storage tank

(3) Liquid ammonia tank

(4) Product DAP storage house

(5) Product bagging unit

2. Plant Area

1) Plant area : 2,160 m^2 (60 m x 36 m)

2) Building area : Total 575 m^2

For Granulator Control room and others

: 15 m x 15 m x 10 mH

For Screen Crusher and others

: 20 m x 15 m x 15 mH

For Dryer-cooler and others

: 5 m x 10 m x 12 mH

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ANNEX I

ACHIEVEMENT LIST

	Company & Plant Location	Current Licensed Capacity	Start up Year
1.	Hokkaido Nissan Chemicals, Ltd. Hakodate, Japan	S.S.P.& T.S.P. 300 MTPD	1927
2.	Kansai Nissan Chemicals, Ltd. Osaka, Japan	S.S.P.& Y.S.P. 240 MTPD	1930
3.	Nissan Chemical Ind., Ltd. Onoda, Japan	S.S.P.& T.S.P. 300 MTPD	1932
4.	Kansai Nissan Chemicals, Ltd. Osaka, Japan	Granulated Complex Fertilizer 120 MTPD	1952
5.	Hokkaido Nissan Chemicals, Ltd. Hakodate, Japan	Granulated Complex Fertilizer 80 MTPD	1955
6.	Nissan Chemical Ind., Ltd. Toyama, Japan	Granulated Complex Fertilizer 160 MTPD	1959
7.	ACF & Shirleys Fertilizers, Ltd. Brisbane, Queensland, Australia	D.A.P. 240 MTPD	1966
8.	Hokkaido Nissan Chemicals, Ltd. Hakodate, Japan	Granulated S.S.P. & T.S.P. 100 MTPD	1967
9.	Hokkaido Nissan Chemicals, Ltd. Hakodate, Japan	Granulted Complex Fertilizer 200 MTPD	1967
10.	Chosun Fertilizer Ind. Co., Ltd. Ulsan, Korea	Granulated Complex Fertilizer 230 MTPD	1968
11.	Tokyo Nissan Chemicals, Ltd. Saitama, Japan	Granulated Complex Fertilizer 200 MTPD	1969
12.	Nippon Rinsan K.K. (Nippon Phosphoric Acid Co., Ltd.) Chiba, Japan.	D.A.P. 250 MTPD x 2 sets	1969

NISSAN CHEMICAL INDUSTRIES, LTD

Company & Plant Location	Current Licensed Capacity	Start up Year
13. Nissan Chemical Ind., Ltd. Toyama, Japan	Granulated Compound Fertilizer 300 MTPD	1969
14. Bangladesh Fertilizer Chemical and Pharmaceutical Corp. Chittagong, Bangladesh	T.S.P. 430 MTPD	1974
15. Southern Petrochemical Industries Corp, Ltd. 2 Tuticorin, India	D.A.P. 500 MTPD	1974
16. Federal Ministry of Industries, Nigeria	S.S.P. 334 MTPD	1976

<u>Still others currently under negotiation</u>

Note : S.S.P. Single Superphosphate

T.S.P. Triple Superphosphate

D.A.P. Diammonium Phosphate

SOME FIGURES
OF THIS DOCUMENT
ARE TOO LARGE
FOR MICROFICHING
AND WILL NOT
BE PHOTOGRAPHED.

ANNEX III EQUIPMENT LIST

Item No.	Description	No. Req'd	Specification	
E-101	Evaporator	1	Shell and Tube	Carbon Steel
E-102	Pipe Reactor	1	Pipe Reactor	Stainless Steel
E-103	Acid Heater	1	Shell and Tube	Graphite
M-101	Oil Combustion Unit	1	Pump Heater Burner	Carbon Steel
P-101A/B	Phosphoric Acid Pump	1+1	Centrifugal	Cast iron + Rubber Lining
P-102	Sulfuric Acid Pump	1	Centrifugal	Low Cr. Cast Iron
P-103	Hot Water Pump	1	Centrifugal	Cast Iron
V-101	Phosphoric Acid Service Tank	1	Vertical cylindrical with Agitator	Carbon steel + Rubber Lining
V-102	Sulfuric Acid Service Tank	1	Vertical Cylindrical	Carbon Steel
V-103	Phosphoric Acid Head Tank	1	Vertical Cylindrical with Agitator	Carbon Steel + Rubber Lining
V-104	Sulfuric Acid Head Tank	1	Vertical Cylindrical	Carbon Steel
V-105	Hot Water Tank	1	Vertical Cylindrical	Carbon Steel
V-106	Acid Tank	1	Vertical Cylindrical with Agitator	Carbon Steel
V-107	Fuel Oil Tank	1	Vertical Cylindrical	Carbon Steel
C-201	Screen Feed Conveyor	1	Belt Conveyor	Carbon Steel and Rubber
C-202	Screen Feed Elevator	1	Bucket Elevator	Carbon Steel
C-203	Recycle Conveyor	1	Belt Conveyor	Carbon Steel and Rubber
C-204	Recycle Elevator	1	Bucket Elevator	Carbon Steel
C-205	No.1 Product Conveyor	1	Belt Conveyor	Carbon steel and Rubber
C-206	Product Elevator	1	Bucket Elevator	Carbon Steel
C-207	No.2 Product Conveyor	1	Belt Conveyor	Carbon Steel Rubber

Item No.	Description	No. Req'd	Specification	
C-208	Oversize Mill Conveyor	1	Screw Conveyor	Carbon Steel
C-209A/B	Dust Conveyor	1	Flow Conveyor	Carbon Steel
C-210	Dust Conveyor	1	Flcw Conveyor	Carbon Steel
C-211	Granulator Conveyor	1	Epron Conveyor	Carbon Steel
E-201	Furnace	1	Horizontal Cylindrical	Fire Brick
M-201	Granulator	1	Rotary Drum	Carbon Steel
M-202	Dryer Cooler	1	Rotary Drum	Carbon Steel
M-203	Lump Crusher	1	Cage Mill	Carbon Steel
M-204	No.1 Screen	1	Vibrating Screen	Carbon Steel
M-205A/B	No.2 Screen	2	Vibrating Screen	Carbon Steel
M-206A/B	Oversize Mill	2	Chain Mill	Cast Iron
M-207	ecycle Weigher	1	Merric Scale	Carbon Steel
M-208	Product Weigher	1	Merric Scale	Carbon Steel
V-201	Product Feed Hopper	1	Cylindrical Vertical	Carbon Steel
V-202A/B	Cyclone	4	Cyclone	Carbon Steel
G-301	Scrubber Fan	1	Turbo Blower	Carbon Steel Rubber Lining
G-302	Cooler Fan	1	Turbo Blower	Carbon Steel
G-303	Dust Fan	1	Turbo Blower	Carbon Steel
M-301	Bag Filter	1	Bag Filter	Carbon Steel
P-301A/B	Scrubber Pump	1+1	Centrifugal	Cast Iron + Rubber Lining
P-302A/B	Scrubber Pump	1+1	Centrifugal	Cast Iron + Rubber Lining
P-303A/B	Pipe Reactor Feed Pump	1+1	Centrifugal	Cast Iron + Rubber Lining
T-301	Scrubber	1	Spray Tower	Carbon Steel Rubber Lining
T-302	Scrubber	1	Turbulent Contact Absorber	Carbon Steel Rubber Lining

NISSAN CHEMICAL INDUSTRIES, LTD.

APPENDIX VII-13

PRELIMINARY INFORMATION

FOR

NITROPHOSPHATE GRANULATED FERTILIZER PROCESS

June, 1981

NISSAN CHEMICAL INDUSTRIES, LTD.

ENGINEERING DIVISION

1. Preface

This information is concerned with the process to produce granulated NPK fertilizer based on ammonium nitrate phosphate using Nissan Slurry Process.

The principal theoretical relationships can be expressed as follows :

$$3Ca_3(PO_4)_2 \cdot CaF_2 + 20HNO_3 \longrightarrow 6H_3PO_4 + 10Ca(NO_3)_2 + 2HF$$

$$6H_3PO_4 + 4H_3PO_4 + 10Ca(NO_3)_2 + 2HF + 20NH_3$$
$$\longrightarrow 10\ CaHPO_4 + 20NH_4NO_3 + 2HF$$

2. Features of the Process

(1) This process needs neither separation section of calcium compounds such as gypsum or calcium nitrate nor concentration section. By-product is not produced at all.

This is a very big advantage of this process.

(2) Product Grades

1) Suitable for produce medium nutrient content NPK fertilizer.

2) Water-soluble P_2O_5/Total P_2O_5 in the product is optional depending on the quantity of phosphoric acid used.

3) Ammoniacal nitrogen/nitrate nitrogen in the product can be made larger than 1.

4) Example of products Nissan is producing :

(AN-NN)-P	:	20-20-0, 16-20-0, 15-26-0
(AN-NN)-P-K	:	14-10-12, 12-6-18
		20-10-10, 13-13-13
		10-10-15, 12-10-14
		17-9-10, 25-5-8
		16-6-18, 20-5-5
		14-8-13, 15-15-12
		16-10-14, 8-18-14
		15-10-15

5) Other kinds of fertilizers such as urea containing NPK, Ammonium phosphate basis NPK, Ammonium phosphate-sulphate can be also produced in the same plant.

Example of products Nissan is producing :

AN-P	:	12-49-0, 12-30-0, 16-34-0
		17-26-0
AN-P-K	:	14-10-13, 12-20-14
(AN+UN)-P-K	:	15-5-20, 20-3-15, 15-15-15
		15-15-15, 15-30-15, 15-3-15

(3) Because of the uniformity of particle size, the products are suitable for the raw material of bulk blending as well as for the direct application on the fields by machine.

(4) Exhaust gas does not substantially contain fume or dust because of thorough scrubbing of ammonia, NO_x and fluorine gas from the Preneutralizer, the Granulator and the Dryer with phosphoric acid and water, and of dust collection by Cyclone, Bag Filter and Scrubber.

3. Process Description

3-1. Raw Material Feeding

Magnetic flow meters are used to control the flows of nitric, phosphoric and sulfurinc acids.

Gaseous ammonia is metered by orifice plate meter. Phosphate rock, potassium chloride and filler are weighed on constant feed weigher.

Vaporization of liquid ammonia and superheating of gaseous ammonia are accomplished in a heat exchanger.

Ammonia must be supplied as gas at constant temperature and pressure in order to effect accurate metering.

3-2. Extraction and Neutralization

Phosphate rock is acidulated with nitric acid in two Extractors. The resultant mixture flows, via overflow troughs, to the Preneutralizer, where phosphoric acid and sulfuric acid are added.

Gaseous ammonia is also introduced into the Preneutralizer and reacts with the acids. Vapors and fumes evolved in the reaction are scrubbed in the Fume Scrubber.

3-3. Granulation

Slurry from the Preneutralizer is introduced to the Granulator of rotating drum type. Recycle fines, potash and filler are added to the Granulator along with additional ammonia.

The rolling action promotes the formation of granules, while the heat of reaction drives off a considerable amount of water vapor.

As a result, uniform size and hard granules of the required nutrient composition are produced.

3-4. Drying

Material from the Granulator flows by gravity to a co-current dryer where it contacts with the air heated in an oil fired furnace. Careful temperature control is effected to avoid cigar burning of the dried materials.

The dried product is separated from lumps by a grizzly screen.

Lumps are crushed by the Lump Crusher. Crushed lumps and product are carried via the Precooler Feed Conveyor and enter to the Precooler before being fed to the Screen.

3-5. Precooling, Screening and Crushing

All of the material leaving the Dryer are cooled in the Precooler for maintaining the desired reaction temperature in the Granulator.

Precooled granules are separated into oversize, product size and fines by the No. 1 and No. 2 Screens. Oversize is crushed in the Oversize Crushers. Crushed oversize, fines and a portion of product are recycled via the Recycle Conveyor to the Granulator.

3-6. Cooling of Product

The rest portion of the product size granules are cooled in the Product Cooler before conveyed to product storage.

Total amount of the product is continuously weighed.

3-7. Anti-caking Treatment

Before packing of product, product is coated with anti-caking agent in the Coater.

3-8. Dust Recovery

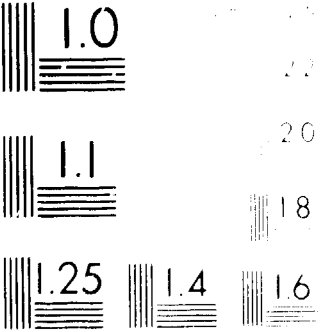
Dust from dusting points such as Elevators, Screens, Crushers and Precooler is collected in the Bag Filter.

Recovered dust is conveyed via the Recycle Conveyor to the Granulator.

3-9. Scrubbing of Exhaust Gas

Ammonia, fluorine and No_x evolved in the Extractors, the Pre-neutralizer and the Granulator are washed by scrubbing with water or phosphoric acid and the washed liquid is recycled to the Pre-neutralizer.

Ammonia fume and fine dust in the Dryer exhaust gas are recovered by the Bag Filter and Scrubber with water.


1.0
2.2
2.0
1.1
1.8
1.25
1.4
1.6

4. Plant Performance

Case of producing 15-15-15 as an example.

4-1. Product Quality

(a) Chemical analysis

Total nitrogen	:	15	%
Ammoniacal nitrogen	:	9.3	%
Nitrate nitrogen	:	5.7	%
Citrate acid soluble P_2O_5	:	15	%
Water soluble P_2O_5	:	8.5	%
Water soluble K_2O	:	15	%
Moisture	:	1.5	%

(b) Particle size

1 – 4 m/m : approx. 90 %

4-2. Raw Materials

(a) Phosphate Rock

- Source Jordan rock
- Chemical Analysis (Dry basis %)

P_2O_5	:	33.7	%
CaO	:	51.7	%
SO_3	:	1.5	%
F	:	3.4	%

o Fineness

+ 20 Tyler mesh	:	16 %
- 65 Tyler mesh	:	53 %
- 80 Tyler mesh	:	41 %

(b) Phosphoric Acid

P_2O_5	:	54 %
H_2SO_4	:	5.4 %

(c) Sulfuric Acid

H_2SO_4	:	98 %

(d) Nitric Acid

HNO_3	:	56 %

(e) Ammonia

State	:	Liquid
Temperature	:	Ambient

(f) Potassium Chloride

K_2O	:	60 %
Fineness	:	60 Tyler mesh pass 60 %

(g) Anti-caking Agent

Material	:	Diatomaceous earth or Silica powder
Fineness	:	250 Tyler mesh pass 98 %

4-3. Expected Raw Material and Utility Consumption

(per 1,000 kg product)

Phosphate rock (as dry basis)	:	136	
Phosphoric acid (as 100 % P_2O_5)	:	105	
Nitric acid (as 56 % HNO_3)	:	462	
Liquid ammonia (as 100 % NH_3)	:	115	
Sulfuric acid (as 98 % H_2SO_4)	:	57	
Potassium chloride (as 60 % K_2O)	:	251	
Anti-caking agent	:	10	
Electricity	:	60	KWH
Process water	:	0.5	ton
Steam	:	200	kg
Heavy oil	:	25	kg

4-4. Annual Operating Days

330 days / year

4-5. Operator

Operator	:	**3 persons/shift**
Foremen	:	**1 person/shift**

G-945

2.11.13