SURVEY REPORT
ON
GLASS CONTAINER PRODUCTION EXPANSION PROJECT
IN THAILAND

FEBRUARY 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request by the Government of Thailand, the Government of Japan decided to take up a study on the Glass Container Production expansion Project and the Japan International Cooperation Agency carried out the study. The JICA dispatched a 4-man study team headed by Mr. Seiki Takayasu, Technical Manager, International Department, Toyo Glass Co., Ltd. from August 25 to October 9, 1978.

The study team held discussions on the project with the Thai authorities concerned and collected information and data and conducted surveys for the planning of the management of Banga Glass. Based on these surveys, the team conducted related studies after returning to Japan and has compiled this resport.

I sincerely hope that this report will contribute to the development of the project and to the enhancement of the friendly relations between our two countries.

I would like to take this opportunity to express my heartfelt appreciation to the authorities and people concerned of Thailand for their cooperation extended to the study team.

February, 1979

Shinsaku Hogen
President
Japan International Cooperation Agency

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1. Introduction

This report presents the findings of a survey conducted at the request of the Government of Thailand in accordance with the following objectives and schedule.

1-1 Organization Surveyed:

Glass Organization, Ministry of Defense, Bangna Prakonong, Bangkok, Thailand.

1-2 Objectives of the Survey:

To observe and define precisely the problems currently facing the organization and then provide effective consultations to its executive officers and key technical personnel regarding improvements and even an expansion program that may be possible to alleviate their difficulties.

1-3 Period of Survey:

From August 25, 1978 to October 9, 1978.

2. Outline of Bangna Glass Works

This glass works was originally planned around 1940 by Thai Royal Navy with intention to manufacture and supply vacuum glass lamp tubes used for a radio at that time. A break out of the World War II forced the plan to halt during the War. In 1947, the plan to build the glass plant revived and conducted various studies for the establishment of the glass plant which continued up until 1953.

A unit of furnace having capacity of 20 tons per day commenced its operation with L-B and L-10 machines in 1955 with cooperation and assistance provided by Maurice Lambert of Belgium and Rockware Glass of United Kingdom.

Thus, initial machinery and equipment installed are of UK origin.

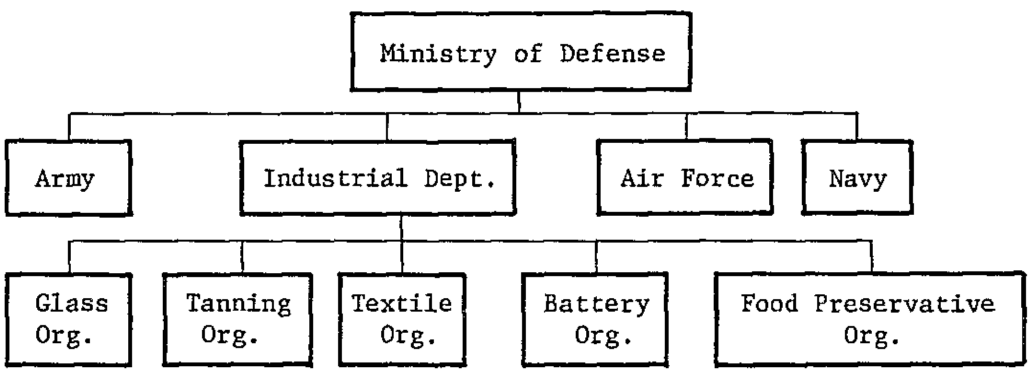
In 1958, the second 20 ton/day furnace designed by the Maurice Lambert started operation to manufacture table-ware by PB16.

1961 - 1962	Introduced a Unit-Melter type 40 ton/day furnace through Yashima Trading of Japan.
1964 - 1966	Introduced a Unit-Melter type 70 ton/day furnace through Yashima Trading of Japan.
1969	3rd plant including a Regenerative type 100 ton/day furnace was determined to be procured from Nippon Glass of Japan.
1972 to date	The 100 ton/day furnace has been in operation.

2-1 Organization of Bangna Glass

The organization, as implied by the name is a state owned glass corporation controlled by Ministry of Defense, Thailand. It is officially named as GLASS ORGANIZATION, MINISTRY OF DEFENSE and generally called BANGNA GLASS after the plant location at Bangna.

The following represents the organizational structure of the Ministry of Defense:



Accordingly, organization of the Board of Directors comprises in majority military personnel representing respective interests as shown below.

Historically most of the Managing directors are also appointed from among the military forces.

2-2 Organization of the Board of Directors

Chairman	Gen. Porn Phanabhumi	Ministry of Defense
Vice Chairman	Gen. Komchorn Promyote	Ministry of Ind.
Managing Director	Mr. Naphadej Pussayanawin	Air Force
Director	Dr. Phisit Pakkasem	National Economic & Social Development Board Office of the Prime Minister
"	Dr. Esara Nitetangprapart	Budget Bureau, Ministry of Finance
"	Mr. Sumie Tailandka	Ministry of Justice
"	Mr. Sanit Kesasiri	Ministry of Finance
"	Mr. Chanin Rintokun	Navy
"	Mr. Pone Ninsiri	Army
"	Mr. Praparn Tootemi	Air Force
"	Mr. Sanan Tojinda	Police

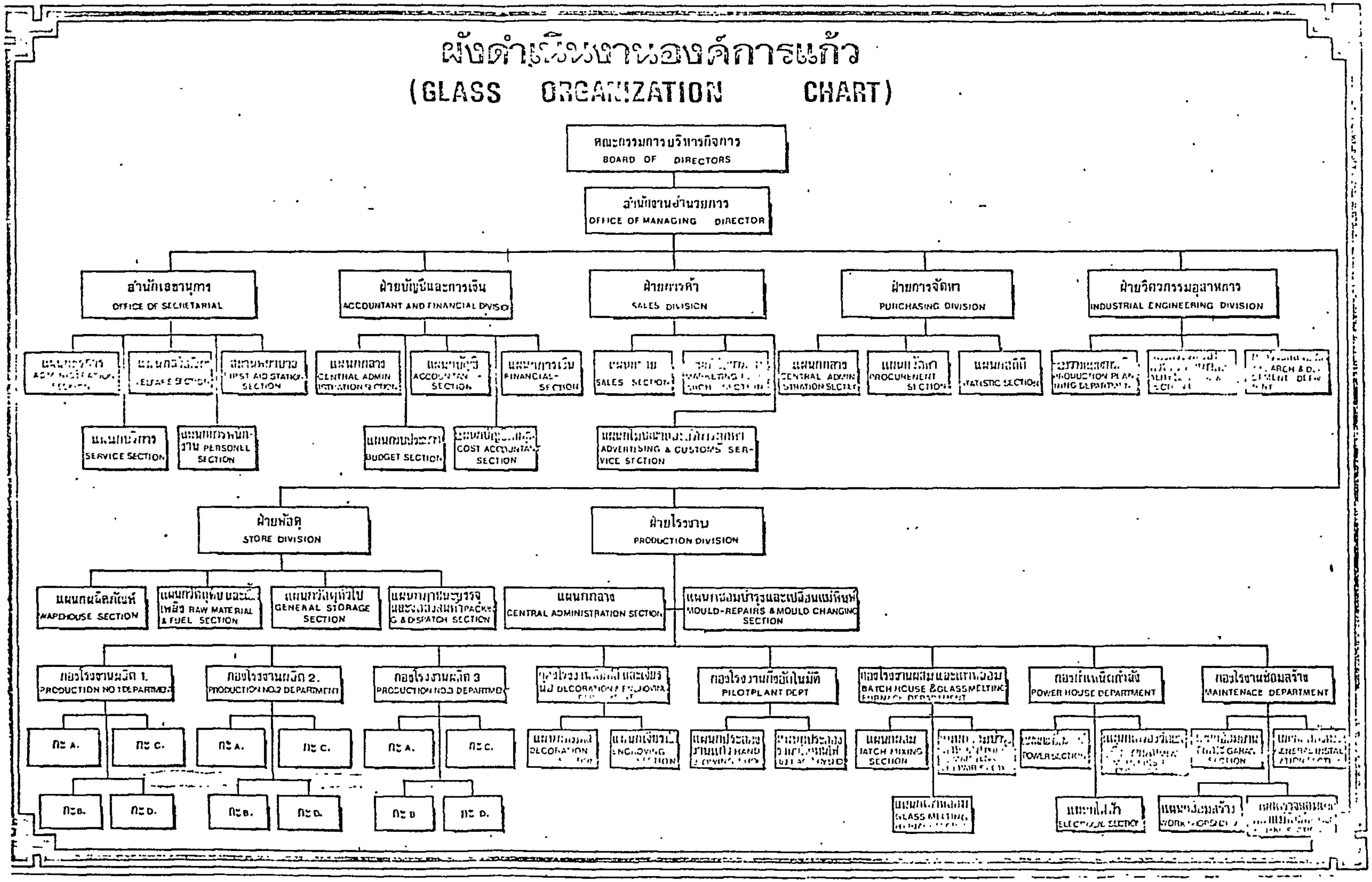
The Board of Directors holds its meeting on every 28th day of the month. Mr. Naphadej, Managing Director is only the officer of the director members who serves directly and full time for the operation of the BANGNA GLASS. So, other directors are all dispatched from other functions. The managing director is subject to the 60 year old retirement age system generally applied and reportedly serving a short tenure of the office at the average of only 2 to 3 year term.

2-3 Organization of the Company

As referred to the Attached Chart (1) staffs assigned to the organization is governed by administrative ordinance to a fixed number, however, actually exceed always by 880 employees being engaged in operation in a nominal status of temporary hire. Number of employees totals 1,920 consisting of 1,040 regular and 880 temporary employees.

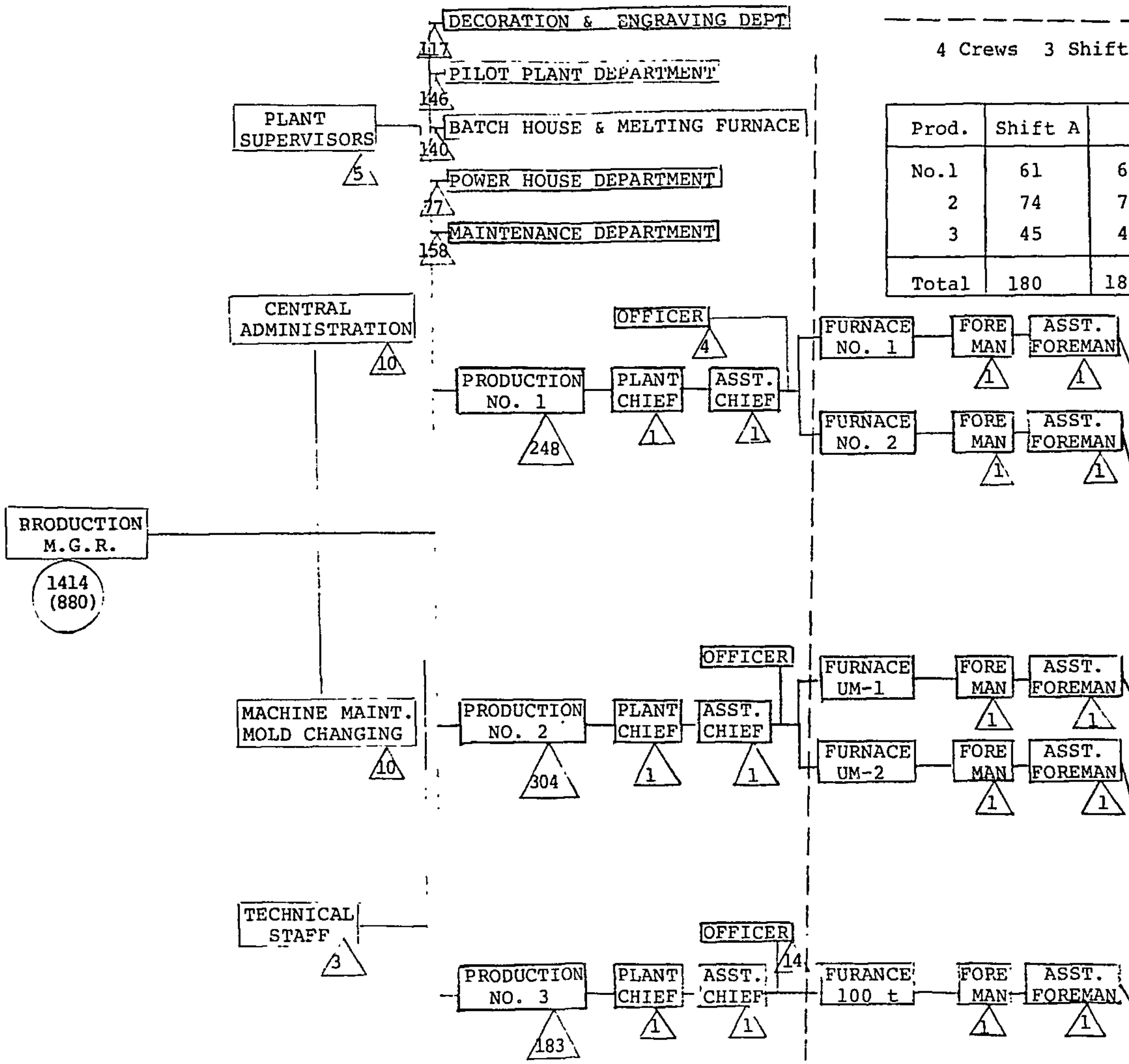
According to the organization chart, the organization is divided into the major functions of Administration and Production which may give an impression of orderly setup formation. However, in fact, this affects horizontal coordination between functions to be hindered with requirement that every contact between the departments, not to mention of the Division level, must be made through Division managers. Since mutual cooperation between departments remains nil as a result, operating efficiency stays poor, but rather, flows of the physical operation and administrative work are found often stalemated.

Table (1)


ผังดำเนินงานองค์การแก้ว
(GLASS ORGANIZATION CHART)
BOARD OF DIRECTORS
OFFICE OF MANAGING DIRECTOR
OFFICE OF SECRETARIAL
ACCOUNTANT AND FINANCIAL DIVISION
SALES DIVISION
PURCHASING DIVISION
INDUSTRIAL ENGINEERING DIVISION
SERVICE SECTION
PERSONEL SECTION
CENTRAL ADMINISTRATION SECTION
ACCOUNTANT SECTION
FINANCIAL SECTION
BUDGET SECTION
COST ACCOUNTANT SECTION
SALES SECTION
ADVERTISING & CUSTOMS SERVICE SECTION
PROCUREMENT SECTION
STATISTIC SECTION
STORE DIVISION
PRODUCTION DIVISION
WAREHOUSE SECTION
RAW MATERIAL & FUEL SECTION
GENERAL STORAGE SECTION
CENTRAL ADMINISTRATION SECTION
MOULD-REPAIRS & MOULD CHANGING SECTION
PRODUCTION NO.2 DEPARTMENT
PILOTPLANT DEPT
POWER HOUSE DEPARTMENT
MAINTENACE DEPARTMENT
BATCH MIXING SECTION
POWER SECTION
ELECTRICAL SECTION

MANPOWER DELEGATION SCHEDULE

Table (2)



4 Crews 3 Shift Operation

Prod.	Shift A	B	C	D	Total
No.1	61	63	60	60	244 (248)
2	74	76	76	71	297 (304)
3	45	43	45	44	177 (183)
Total	180	182	131	175	718 (735)

Machine Type	No.	Mach. Opr.	Anneal-ing	Inspec-tor	Pack-ing	
L-10		2			2	day shift 3 persons
LBJ	2	4	1	1	2	
LBJ	11	4			2	
GT		19			4	
PB6	3	4			3	
LBJ	10	4		1	2	
PB6	2	4			3	
Sub Total		41	1	2	18	
IS.S/G	1	4			3	
IS D/G	6	5		1	8	
L-10	1	2			2	
LBJ	9	4	1	+1		
IS-D/G	2	5			5	
L-10	4	2			2	
L-10	3	2		1	2	
LBJ	7	4			2	
LBJ	8	4			2	
Sub Total		32	1	3	28	
IS-F D/G	5	5		3	3	
IS-F D/G	4	5	1	3	3	
IS-D/G	3	5			8	
Sub Total		15	1	6	14	
Total		88	3	11	60	

162 persons x 4 crews = 648 persons + 40 persons = 688 persons

2-4 Sales Records

Fiscal year commences in October and ends in September of the following year. The net sales achieved in the previous fiscal year from October 1975 to September 1976 followed the shifting as shown in attached Table (3). The following figures are quoted from the data presented before the Board of Director's meeting:

	Net Sales	Net Profit
1976 (2519)	228,596,511 Bahts	8,930,392 Bahts
1977 (2520)	252,424,422 "	31,639,788 "
1978 (2521)	237,390,393 "	39,711,074 "

The figures for 1978 represents the totals up to the August for 11 months.

A Baht of the Thailand currency is equivalent to approximately ¥10 of Japanese Yen.

Table (3)

Trend of 3 Year Sales

△—△ 2,519 - 1976
o—o 2,520 - 1977
x—x 2,521 - 1978

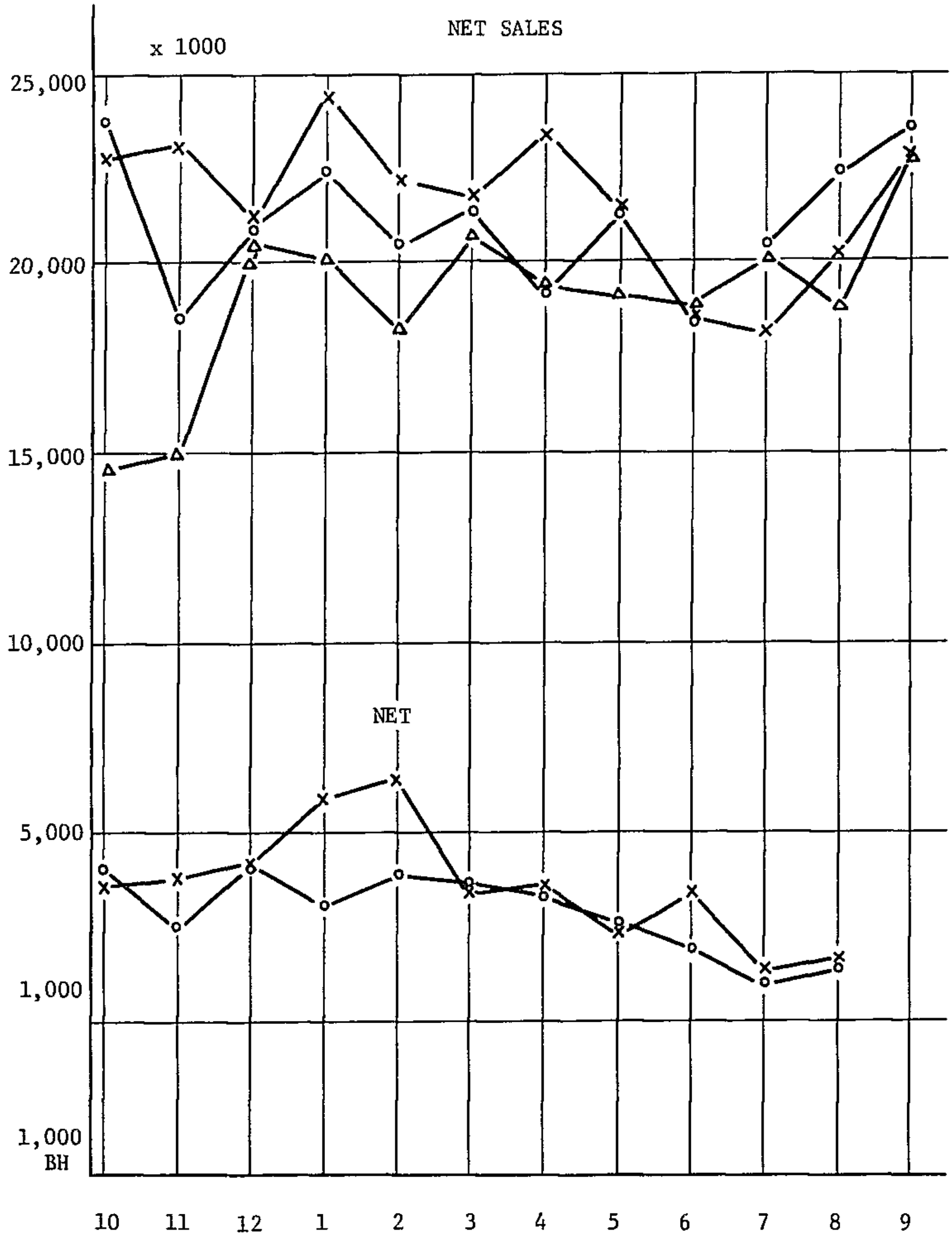


Table (4)

Sales by Product Item

2521 (1978)

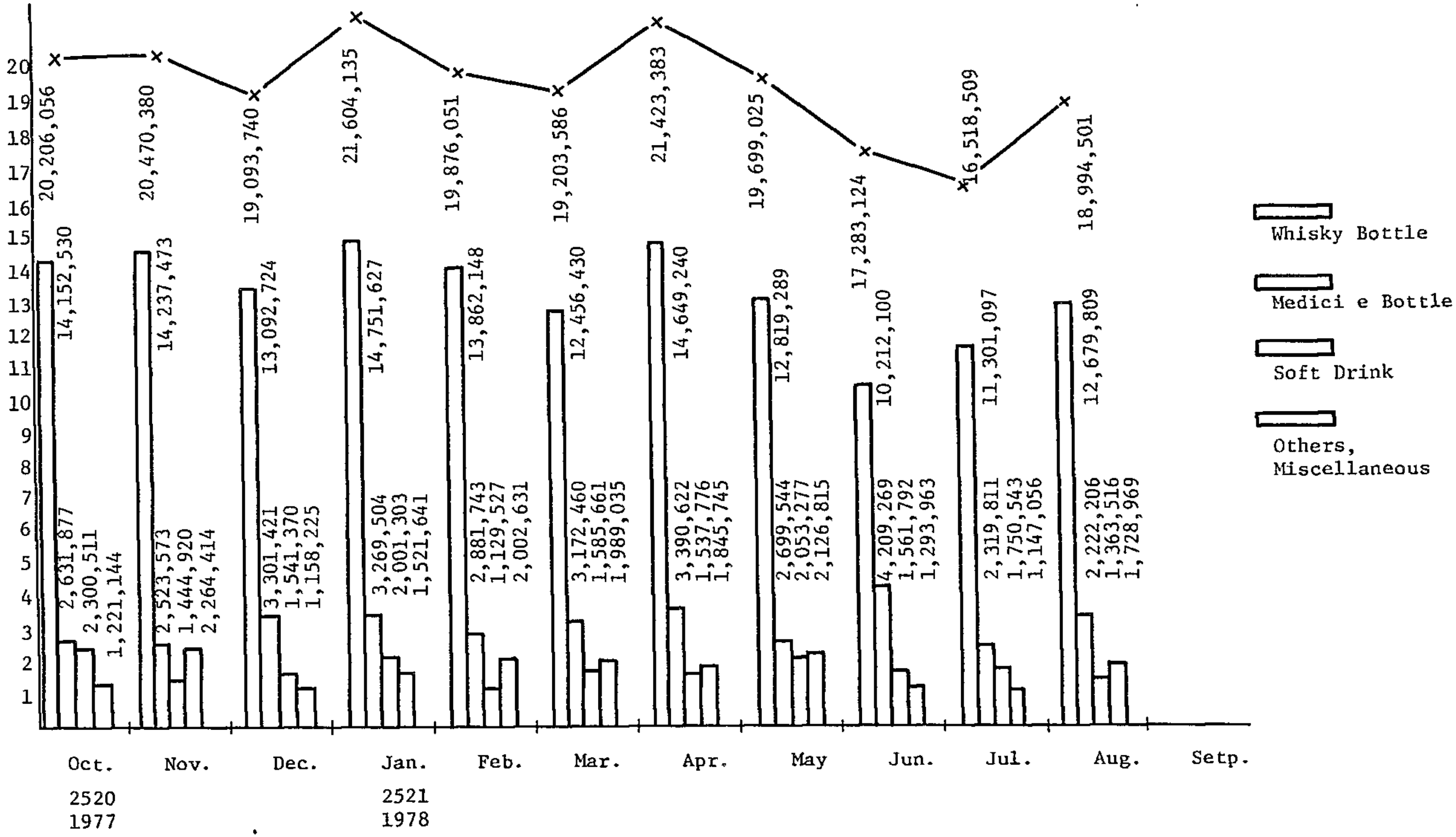
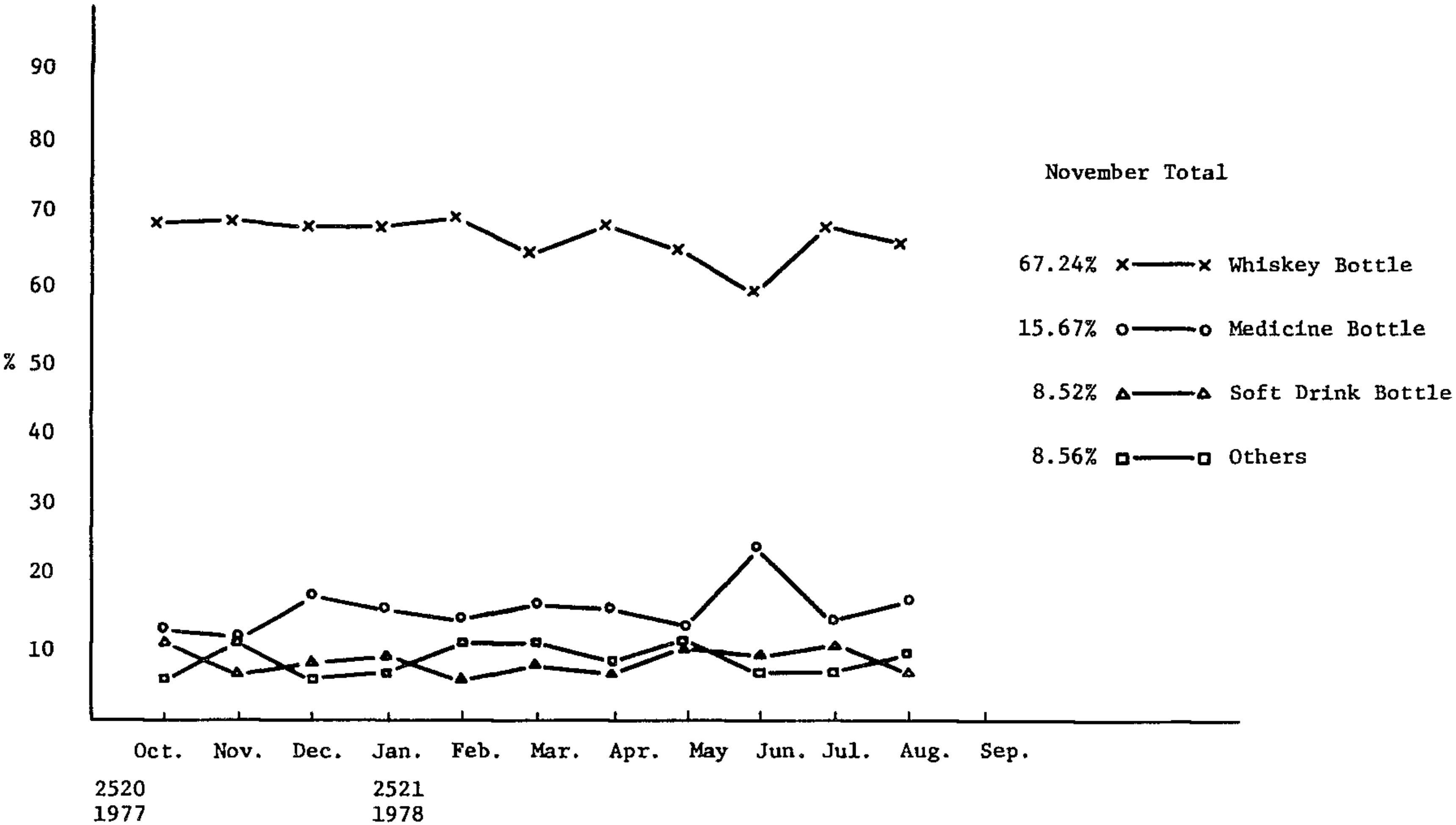


Table (5)

Percentage Share by Product of Monthly Sales



2-5 Sales by product Item and Production by tonnage

Year / Item	1976		1976		
	Baht	t	Baht	t	BH/t
Soft Drink	19,693,912.20	3,691	21,908,458.05	4,070	5,382
Medicine Bottle	57,930,527.06	8,216	57,212,252.62	10,033	5,702
Whisky	133,646,721.12	31,182	151,242,280.99	36,208	4,177
Tableware	17,947,350	3,299	16,334,443.04	3,086	5,293
Tube	89,698		3,083,138.59	363	8,493
Hand made	754,322.60	10	2,064,797.62	12	172,066
Total	230,062,531.24	46,398	251,845,370.32	53,772	4,683

Sales by product and by month is as shown in the attached Table (4)

The followings show percentage share by each product item, while the annual sales trend is shown in Attached Table (5):

	Whisky Bottle	Medicine Bottle	Soft Drink	Others
Sales (%)	67.24%	15.67%	8.52%	8.56%
Production (ton)	67.3%	18.60%	7.5%	6.5%

Whisky sharing 67% of the total sales are being sold at a less price than an average of the general selling prices.

3. Outline of the Machinery & Equipment of the Plant

3-1 Plant Layout and Equipment

The Plant is located in Bangna which is about 20 km from Bangkok city area, facing the West Bank of the Menam River. The layouts are shown in the attached Drawing (6) for the Plant Nos. 1, 2 and 3.

The Plant No.1; equipped with 2 units of 20 ton/day Recuperative type Furnace.

The Plant No.2; with a unit of 40 ton/day unit melter type Furnace and a unit of 70 ton/day unit-melter type Furnace (with Booster).

The Plant No.3; with a unit of 100 ton/day Horse Shoe Regenerative Type Furnace.

These plants have a total of 250 ton/day melting capacity.

Layout of each plant and specification of the melting furnace can be referenced as follow:

Attached Drawing (7) for the Plan No.1 Layout

Attached Drawing (8) for the Plan No.2 Layout

Attached Drawing (9) for the Plan No.2 Layout

Attached Table (10) for Specification Schedule of the Glass Melting Furnace

Attached Table (11) and (12) for Incidental Equipment Schedule of the Furnace.

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LAYOUT OF THE PLANT — Table (6)

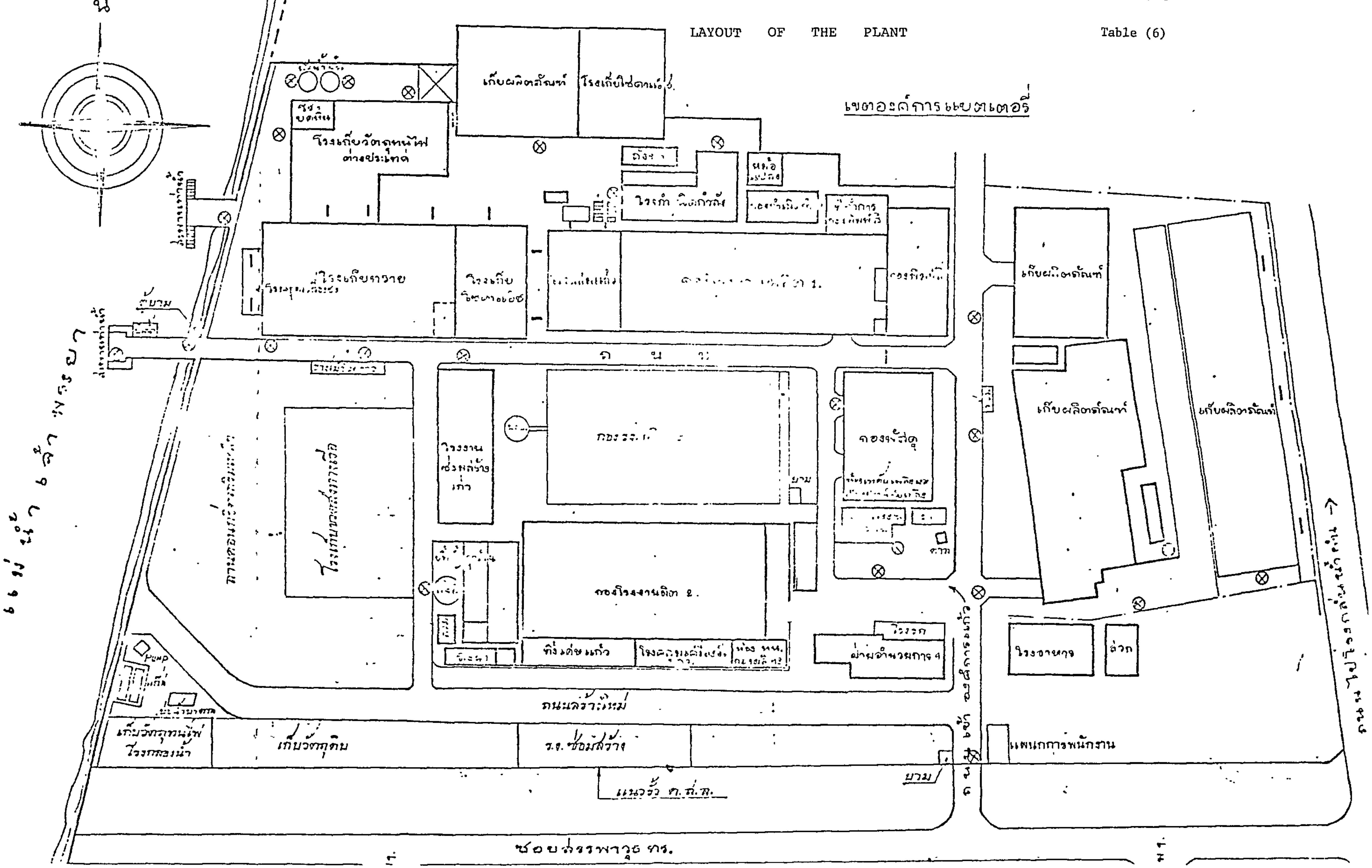


Table (7)

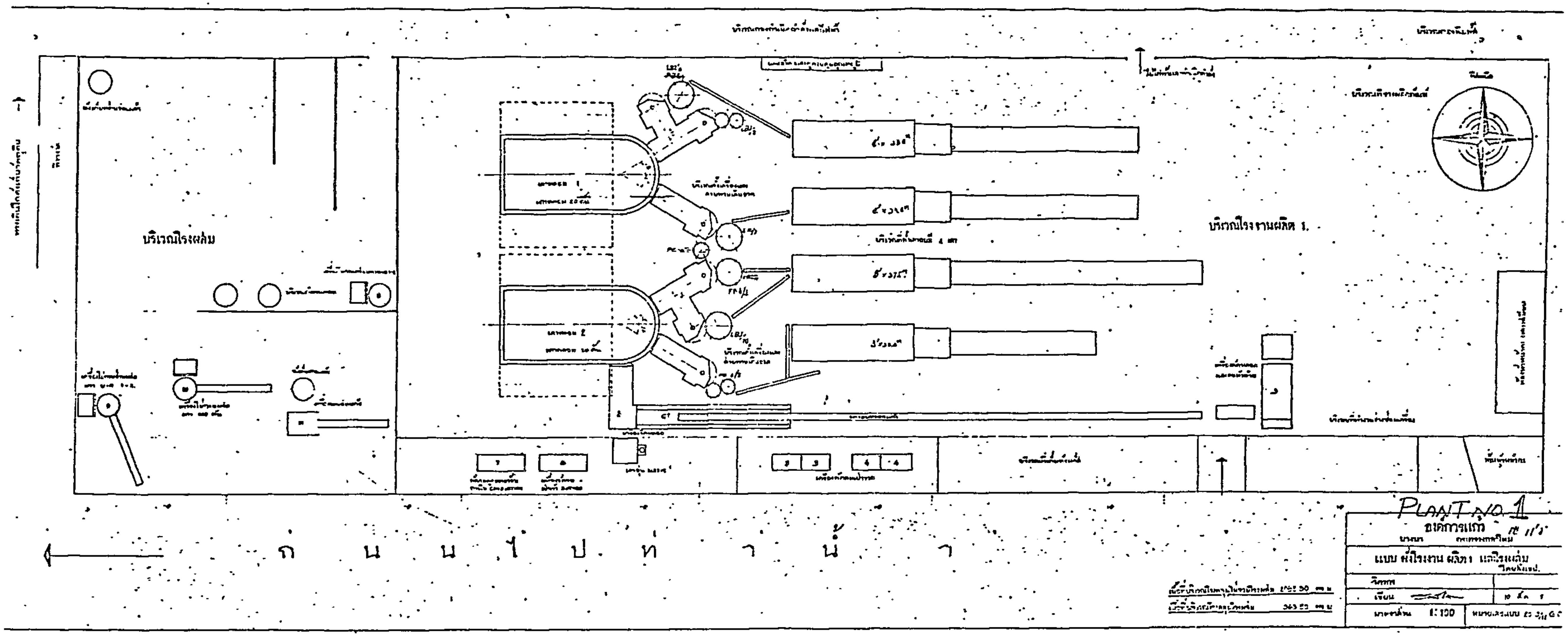


Table (8)

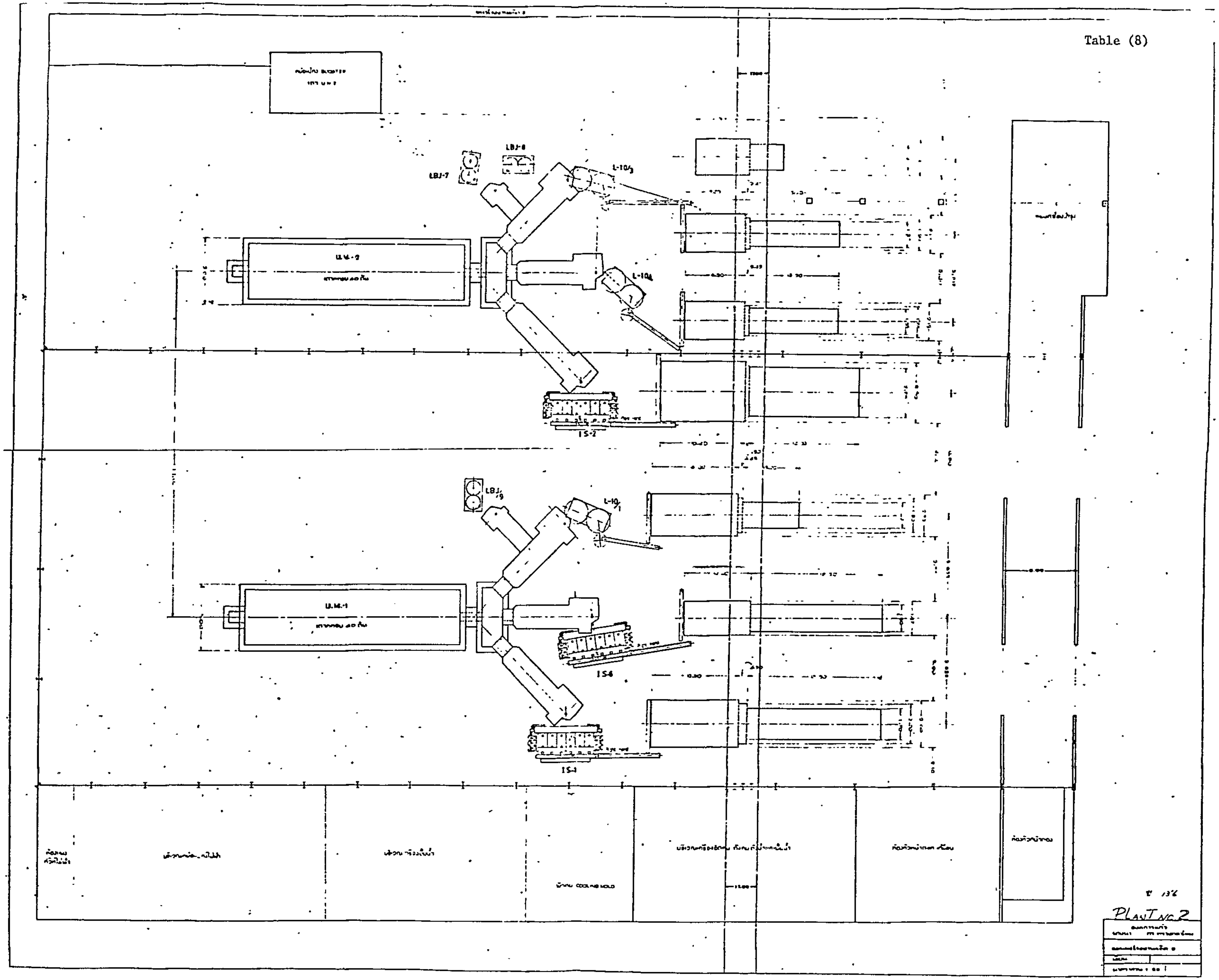


Table (9)

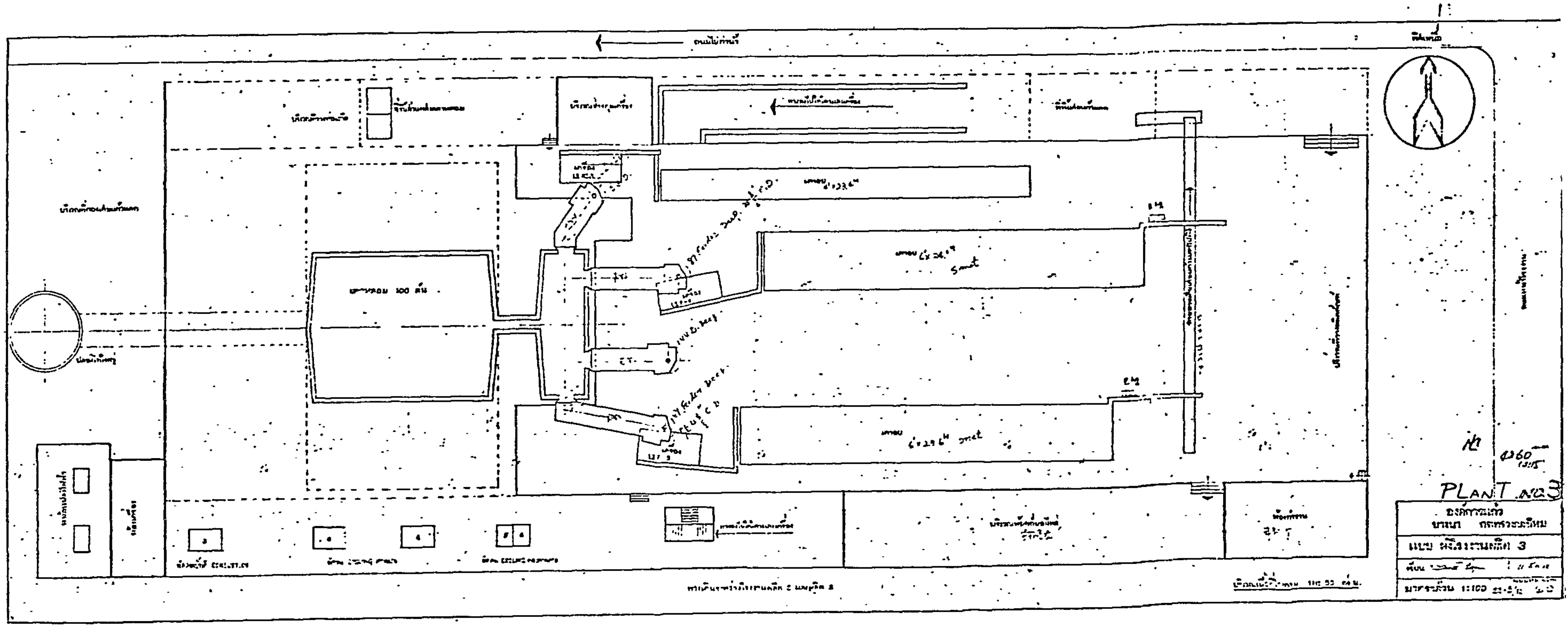


Table (10)

Glass Melting Furnace

The following table shows the specifications of the Glass Melting Furnace in operation at Bagna Glass Works

Furnace No.	Type	Initial start up	Campaign began	Melting Area (ft^2)	Melter Depth
PLANT NO.1 Tank-1	Recuperative End Firing	12-1956	10-7-'78	200	36"
PLANT NO.1 Tank-2	"	2-1958	10-6-'78	"	"
PLANT NO.2 UM-1	Unit Melter	1-1963	20-11-'76	400	36"
PLANT NO.2 UM-2	"	1-1966	22-3-'75	"	"
PLANT NO.3 100 T/D	Regenerative End Port Firing	1973	28-10-'75	491	42"

Furnace No.	Refiner Area (ft^2)	$\frac{\text{Refiner Area}}{\text{Melter Area}}$	$\frac{\text{Melter Length}}{\text{Melter Width}}$	Metal Line	Kind of Glass	No. of Entrance
PLANT NO.1 Tank-1	40.6	0.20	1.71	11'-3"	Flint	2
PLANT NO.1 Tank-2	"	"	"	"	Tableware & Tube	3
PLANT NO.2 UM-1	68	0.17	4.00	13'-6"	Flint	3
PLANT NO.2 UM-2	"	"	"	"	"	3
PLANT NO.3 100 T/D	108	0.22	1.25	13'-6"	"	4

Table (11)

Equipment Incidental to Furnace

Equipment	Tank No.1	Tank No.2	UM-1	UM-2	100 T/D
1 BURNER	Low Pressure Atomizing Type Burner (Maurice Lambert)	"	HAUCK Low Pressure Atomizing Type Burner No. 782	"	High Pressure Atomizing Type Burner Chugairo 64-MB-80(S)
2 Batch Charger	Screw Type $200\phi \times 1,000^{L}$ 2.5r.p.m./ min Manual Control	"	Enholding Vibratory Type Trough $80^{D} \times 200^{W} \times$ $1,000^{L}$ Push Bar $200^{M} \times 500^{W}$ Auto Control	"	Blanket Type Trough $150^{D} \cdot 400^{W}$ $(1000/1200)^{L}$ Stroke 300mm 2HP On-Off Control
3 Fan	(1) 2nd Air 3HP, 83A 50HZ, 220V (2) 2nd Air 3HP, 83A 50HZ, 220V (3) Waste Gas 5.5HP 50HZ, 220V (4) Waste Gas 5.5HP	(1) 2nd Air 3HP 50HZ, 220V (2) Waste Gas 4KW (3) Waste Gas 4KW (4) Bottom Cooling 22KW	(1) Combustion 40HP,2,900 r.p.m. 3,400 CFM ($96m^3$/min) 20 OZ (2) Combustion 40HP,2,900 r.p.m. 3,400 CFM ($96m^3$/min) 20 OZ	(1) Combustion 40HP,2,900 r.p.m. 3,400 CFM ($96m^3$/min) 20 OZ (2) Combustion 40HP,2,900 r.p.m. 3,400 CFM ($96m^3$/min) 20 OZ	(1) 2nd Air $330m^3$/min. 150mmAq at 20°C 22KW 1,800r.p.m. (2) Sidewall & Crown Cooling Type OT $1,000m^3$/min. 220mmAq 60KW

Table (12)

Equipment Incidental to Furnace

Equipment	Tank No.1	Tank No.2	UM-1	UM-2	100 T/D
3 Fan	(5) Bottom Cooling 22KW (6) Sidewall Cooling 22KW	(5) Sidewall Cooling 22KW	(3) Sidewall Cooling 22KW 1,450 r.p.m. (4) Sidewall Cooling 22KW 1,450 r.p.m. (5) Throat Cooling 30KW (6) Throat Bottom Cooling 5HP 2,935 r.p.m.	(3) Sidewall Cooling 22KW 1,450 r.p.m. (4) Sidewall Cooling 22KW 1,450 r.p.m. (5) Throat Cooling 30KW (6) Throat Bottom Cooling 5HP 2,935 r.p.m.	(3) Sidewall & Crown Cooling Type POT 1,000m^3/min 220mmAq 60KW (4) Throat Cooling 30HP 1,470 r.p.m. (5) Throat Bottom Cooling 30HP 1,470 r.p.m.
4 Reversal Damper	-	-	-	-	Blow Knox

Equipment Schedule

		NO.1 PLANT							NO.2 PLANT								NO.3 PLANT		
		NO.1 FURNACE			NO.2 FURNACE				UM-1				UM-2				100 t/D		
Tank Fur-nace	Type Kind of Glass Max. Melting Capacity	Recuperative Flint 20 t/Day 11'-3"			Recuperative Flint 20 t/Day 11'-3"				Unit Melter Flint 40 t/Day 13'-6"				Unit Melter Flint 70 t/Day With Booster 13'-6"				Regenerative end port Fling 100 t/Day 13'-6"		
Fore-Hearth & Feeder	No. of Fore-hearth	1	2	3	1	2	3	4	1	2	3	4	1	2	3	4	3	2	1
	Type	ZU	ZU	ZU B	ZU	ZU	ZU B	ZU	ZW	ZW	ZW	ZU B	KZW	ZW	ZW	ZU B	KW	KW	ZW
	length (feet)	14'	14'	8'-7-1/2"	14'	14'	8'	14'	16'	14'	14'	8'	16-8-1/2"	14'	14'	8'	18'-8-1/2"	16-8-1/2"	10'
	width (inch)	16"	16	16"		16	16"	16"	26"	26"	26"	16"	26"	26"	26"	16"	26"	26"	26"
	spout	5"STD	5"STD	5"STD		5"STD	5"STD	5"STD	5"STD	6"/5" Deep	5" STD	5" STD	7" Deep	5" STD	5" STD	5" STD	7" Deep	7" Deep	6"/5" Deep
	Tube Dia.(inch)	5"	5"	5"		5"	5"	5"	5"	6"	5"	5"	7"	5"	5"	5"	7"	7"	6"
	Feeder mechanism	144C	144C	144C		144C	144C	144C	144D	144D	144D	144D	81	144D	144D	144D	81	81	144D
For-ming Mach-ine	Machine Type	L-10	LBJ	LBJ	TUBE GT	PB6	LBJ	PB6	ISE-6	ISE-6	L-10	LBJ	ISE-6	L-10	L-10	LBJ×2	ISF-6	ISF-6	ISE-6
									S/G	D/G			D/G			Two Through	D/G	D/G	D/G
	stacker	Bangna	-	-		-	-	-	Pneu-matic Push	Pneu-matic Push	Bangna		Pneu-matic Push	Bangna			Nippon Glass	Nippon Glass	Bangna
Lehr	Net width (feet)	4'-0"	4'-0"			3'-0"	5'-0"		5'-0"	4'-0"		4'-0"	7'-0"	4'-0"	4'-0"	4'-0"	7'-0" (2200)	7'-0" (2200)	4'-0"
	length (m)	24	24			24	26		28	28		26	26	26	26	26	24	24	28
	Fuel	oil	oil			oil	oil		oil	oil		oil	Ele-ctric	oil	oil	oil	Ele-ctric (SMIT)	Ele-ctric (SMIT)	oil
Remarks													ISE-4 D/G 4-1/4						Booster 81 Feeder ISEF-8

Attached Table (13) for Equipment Schedule.

3-2 Incidental Facilities

3-2-1 Fuel Oil and Storage Facilities

Bunker C Oil or diesel oil are used as fuel i.e., Fuel oil for the furnace, and diesel oil for the forehearth and the diesel engine generator. Storage tanks have been installed for 568 Kl capacity for Bunker C oil and 87.5 Kl capacity for diesel oil respectively.

Oil delivery is done by means of oil tanker berthed at unloading pier where oil is pumped up by the pump equipped with the boat and measured with oil flow meter for receiving. Normal oil stock level is said to be of 15 day consumption.

3-2-2 LPG

With 2 units of 5 ton storage tank installed, vaporized gas by means of natural vaporization is reduced to a lower pressure with reduction valve and directly piped to the plant. There is no liquid pump and vaporizor installed. Delivery is received in 4 ton tank lorry and pumped-up L.P.G. is measured with flow meter for receiving. The storage tanks are not of the company's property and leased from the Gas Company. Presumably, because of the ownership, no checking nor maintenance care seems to have been taken as rust is noted of tank, valve and piping with high pressure portion posing seemingly dangerous condition at many spots. ≑ 2800 kg/day.

3-2-3 Oxygen Gas

Used in combination with butane gas for fire poli shing of tableware and bottle, and for cutting of tube. A manifold header connecting oxygen cylinders distributes oxygen gas directly to the locations of use.

Daily usage: 40 Cylinders

Stock Level: 100 Cylinders

3-2-4 Compressed Air Equipment

According to the explanation received air compressors have been installed at 4 separate locations with piping connecting to all compressors. However, no flow sheet, nor piping deiagram is available to prove as such.

All air compressors are of Broom-Wade (England), 250 KW × 4 units and 90 KW × 17 units.

A total generating volume is 12,550 Cubic Feet/Min. (355.3 m^3/Min).

Due to priority on increase in manufacturing equipment which preceded the requirement of air compressor, all air compressors are almost in full operation.

With lack of control by unloader valve, loading is said to have been adjusted by looking at the main recorder. Main pressure is 45 Lbs/square inch. See attached Drawing (14) for the equipment locations.

3-2-5 Diesel Engine Generators

Blackstone (England)	234 KVA × 4 units
	390 KVA × 3 units
Total	2,106 KVA

Power is constantly supplied to the furnaces, the forehearth, the lehr net drive and the automatic equipment control.

Constant Power Demand ≑ 1,520 KVA

3-2-6 Power Transformer Facilities

Power supply of 12,000 V 50 HZ 3ϕ is received from Metropolitan Electricity Authority (MEA).

Incoming supply received exclusively at a substation is distributed to the plant. Instead of so-called power receiving system, extra high tension supply of 12,000 V is directly received at groups of power transformer dispersed at 4 locations with fuse breaker (manual) mounted on the entry point of each transformer.

Metering of supply received is made with KWH meter connecting to each P.T and C.T for commercial transaction requirement. However, no measurement on a daily or hourly basis is taken for electricity usage.

Power transformer equipment installed are:

Plant No.1,	1500 KVA	× 1 unit
	800 KVA	× 1 unit
Plant No.2,	1000 KVA	× 2 units
	800 KVA	× 2 units
Plant No.2	1500 KVA	× 2 units
For electric booster		× 1 unit

Electricity Usage is:	MEA	65,600 KWH/day
	Generator	17,760 KWH/day
		83,360 KWH/day
		≑ 3,473 KW/hr.

See attached Drawing (15) for a location of the transformer installed.

For in-plant use of low voltage power, transformers with the primary at 12,000 V and secondary at 220 V 3ϕ 50 Hz is utilized to lower the incoming voltage for distribution to load through 3 distribution rooms located at the transformers installed.

Table (14)

Compressor

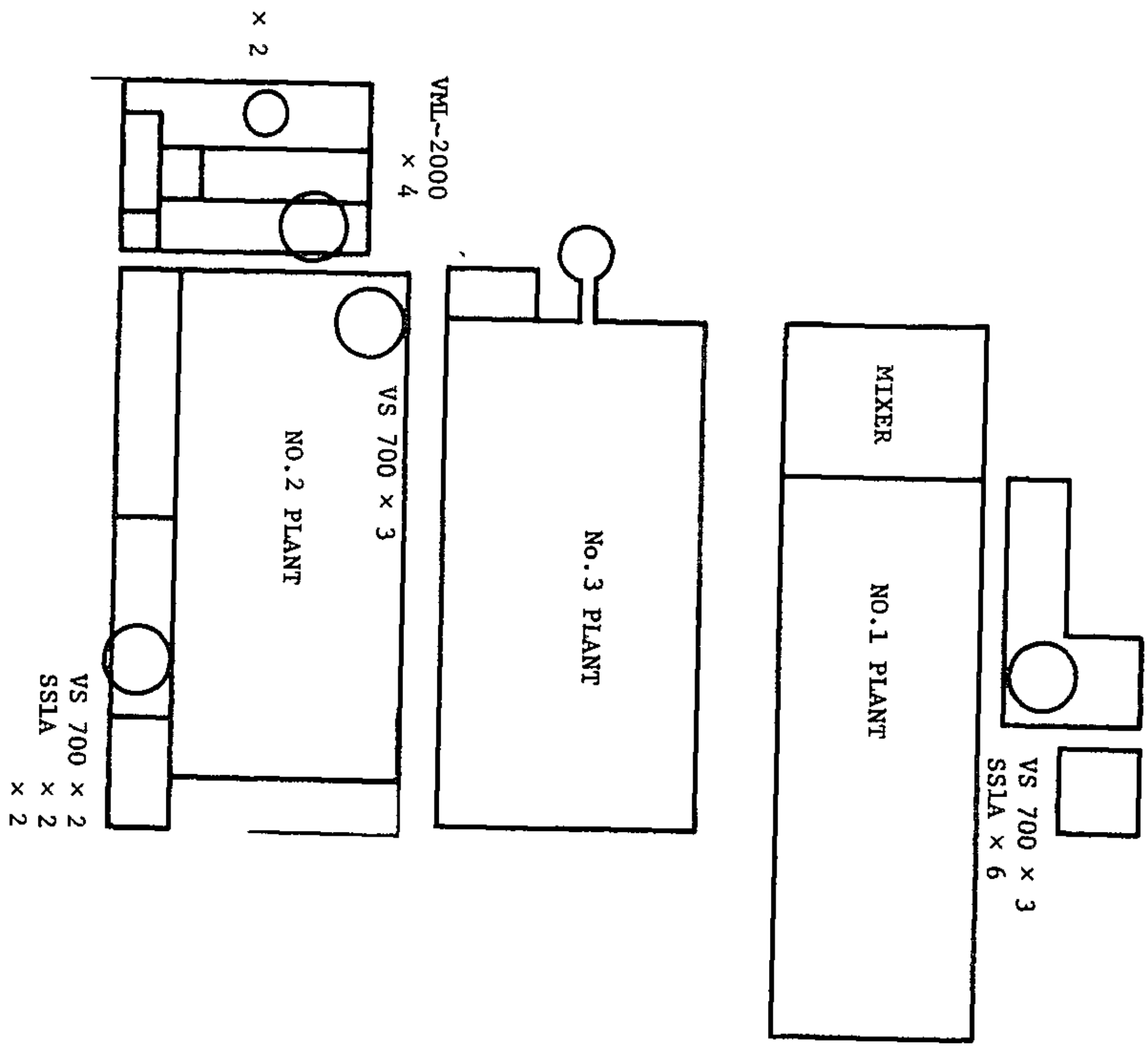
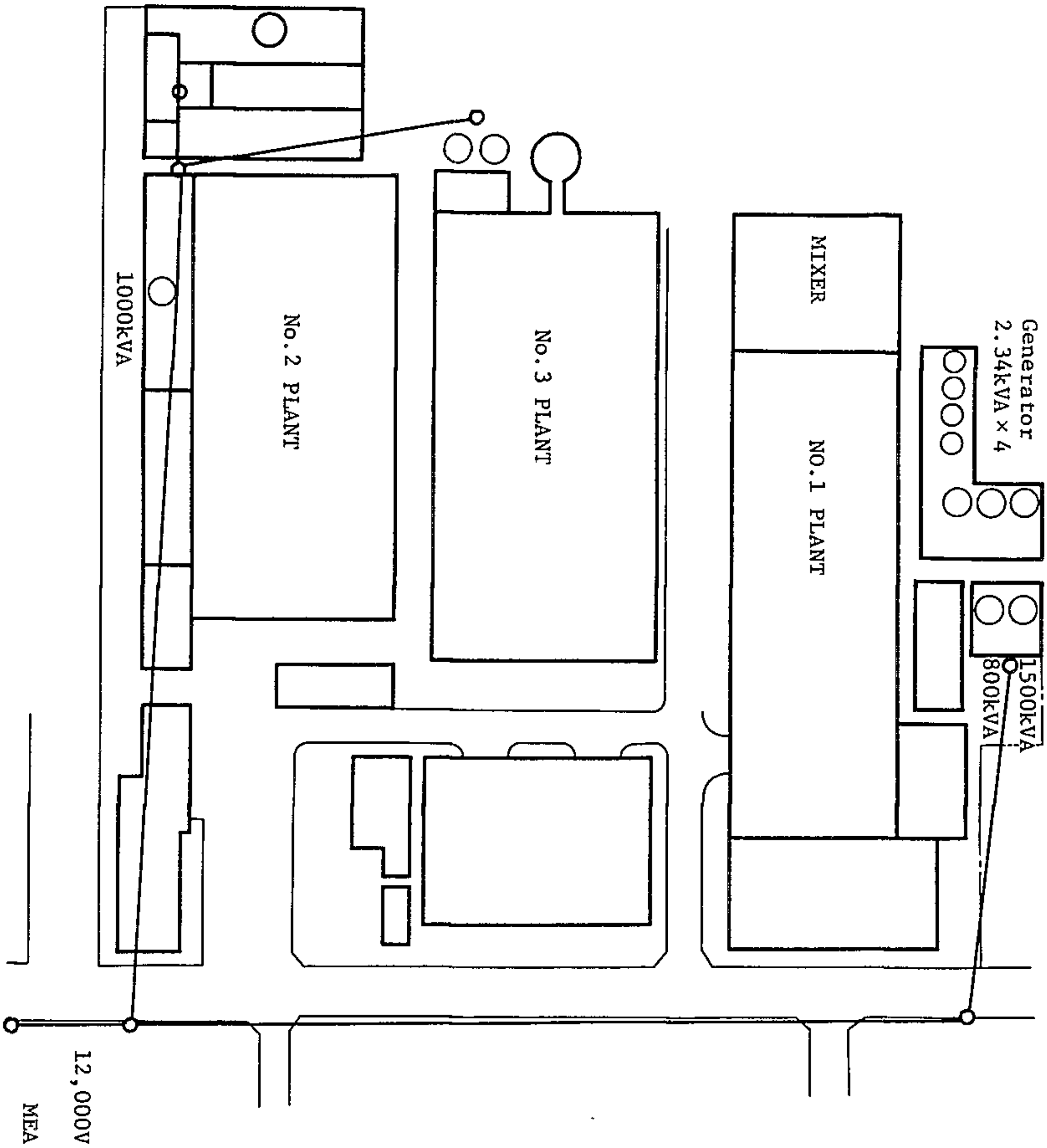


Table (15)

Power Transformer and Generating Equipment



3-2-7 Cooling Water

Taking advantage over the location of the plant along with the big river, water supply poses no problem in volume-wise, regardless of its quality. Then water pump room at the bank operates to pump up the river water. While, 2 units of the engine pumps are installed ready for an electricity suspension. Besides these, a deep well pump is installed as a back-up system.

Elevated water tank and home-built cooling tower at two locations in the plant are being used for the recycled water.

4. Comment on the present Situation of productions and Suggestion for Improvement

This section is intended to cover present situation of operation processes from fuel and raw material storage to product packing, and also to advise possible measures to improve problems spotted of the processes.

The suggestions for the improvement are categorized mainly in three areas with symbols of A, B and C as follow:

(A) Long range improvement

(B) Improvement on current operation including new equipment installation

(C) Minor improvement on current operation

4-1 Mixing

4-1-1 Raw Material Specfication

Acceptable raw material standards currently applied by Bangna Glass are as follow:

Rayong Sand

SiO_2	99.40%
R_2O	0.50
Fe_2O_3	0.06
Sieve, 120 mesh (0.12 mm)	50.0%

Crushed Limestone

$CaCO_3$	98.50%
insoluble matter in Hcl	1.0
Fe_2O_3	0.06
Sieve	3/16" (4.8 mm)

Washed Sand
(For Pilot Plant)

SiO_2	99.40%
R_2O_3	0.50
Fe_2O_3	0.02
Sieve	120 mesh 50%

Feldspar

SiO_2	70%
R_2O_3	18
Fe_2O_3	0.15
CaO	3.0
K_2O+Na_2O	10
Sieve	20 mesh 100% (0.84 mm)

Soda ash

Not available

Limestone

$CaCO_3$	99.00%
Insoluble matter in Hcl	1.00
Fe_2O_3	0.06
Sieve	9"ϕ (229 mm)

Dolomite

$CaCO_3$	50%
$MgCO_3$	40
Fe_2O_3	0.06
Insoluble matter in Hcl	1

Sodium Nitrate

$NaNO_3$ 98%

Fe_2O_3 0.03%

Insoluble matter in H O 0.5%

Moisture 1%

Arsenic

AS_2O_3 96%

Fe_2O_3 0.06

(A) Iron content of 0.06% that is allowed in silica sand used for tableware is excessive as tolerance. It should be limited to 0.015% or below to obtain a better glass color. It is suggested that a receiving standard separately established for silica sand used for table ware.

Size of crushed limestone is 3/16" (48 mm) according to the receiving standard. This is too great and should be limited to approximately 20 mm. All raw material should be in a same grain size. The finer the size is, the shorter it takes to melt.

(A) It is suggested that the receiving standard for grain size be revised to a level of 0.1 ∿ 2.0 mm.

Allowable iron content of 0.04% in limestone used for tableware is too great.

To improve glass color, limestone containing 0.02% or less of iron should be used.

(A) It should be recognized that it is important to reduce iron content of the natural meterial such as silica sand, limestone, soda ash, feldspar and fluorspar for the improvement of glass color, and an action is necessary in an attempt for reduction of the iron content.

(A) It is better to use flourspar in powder form of 100 mesh (0.15 mm) or less in size.

(A) It is recommended that a receiving standard be worked out for flourspar.

4-1-2 Chemical Analysis Values of Raw Material

See attached Table (16) for the chemical analysis value of the raw material.

(C) Fluctuation of Na_2CO_3 content in soda ash is too great. The difference among lots is found as much as 2.34% at the maximum. This denotes the same effects that change in soda ash by approximately 1 kg can result in Tank Nos. 1 and 2 and that by approximately 2 kg in 100T furnace.

Sample 10	0.585 × 0.9986 × 100 kg = 58.418
Sample 11	0.585 × 0.9752 × 100 kg = 57.049

$$\left(\frac{Na_2O}{Na_2CO_3} \right) \times (\text{Purity}) \times (\text{Batch Composition}) = (\text{volume of } Na_2O)$$

$$\frac{58.418 - 57.049}{0.585} = 2.34 \text{ Kg} \ldots \text{Fluctuation}$$

(C) If results of analysis are available prior to use, batch composition must be changed by calculation so as to keep a homogeneous glass composition.

From the cost conscious point of view, low purity raw material requires more usage of the material, which in turn, higher the cost. In this view, use of a high purity material is recommendable.

Table 16

CHEMICAL ANALYSIS DATA OF RAW MATERIALS

1. Silica Sand

	SiO_2	R_2O_3	Fe_2O_3	Al_2O_3	Ig. Loss
1	99.42	0.30	0.06	0.24	-
2	99.42	0.33	0.05	0.28	0.16
3	99.45	0.20	0.05	0.15	
4	99.43	0.25	0.05	0.20	0.21
5	99.48	0.20	0.05	0.15	-
6	99.50	0.21	0.05	0.16	-
7	99.52	0.20	0.04	0.16	-
8	99.45	0.25	0.05	0.20	-
9	99.48	0.20	0.05	0.15	-
10	98.93	0.46	0.05	0.41	-
11	99.41	0.35	0.06	0.29	0.21
12	99.10	0.24	0.04	0.20	0.17
13	99.41	0.25	0.06	0.19	-
14	98.79	0.15	0.05	0.10	0.30
15	99.03	0.51	0.04	0.47	0.17
16	99.50	0.27	0.05	0.22	0.18
17	99.45	0.20	0.05	0.15	0.18
18	99.07	0.11	0.05	0.06	0.39
19	99.41	0.27	0.06	0.11	0.18
20	99.46	0.25	0.05	0.20	-
Σn	1986.71	5.2	1.01	4.09	2.15
$\bar{X}$	99.33	0.26	0.05	0.20	0.21
R	0.73	0.40	0.02	0.35	0.23

2. Soda Ash

	Na_2CO_3	Fe_2O_3	In-soluble
1	99.04	0.004	0.09
2	99.01	0.006	0.09
3	98.87	0.009	0.12
4	98.55	0.010	0.10
5	99.57	Tr	0.08
6	98.04	0.03	0.39
7	98.80	0.01	0.17
8	99.15	Tr	0.22
9	97.70	0.02	0.15
10	99.86	Tr	0.10
11	97.52	0.01	0.70
12	99.80	Tr	0.10
Σn	1185.84	0.0264	2.28
$\bar{X}$	98.82	0.0022	0.19
R	2.34	0.009	0.30

3. Limestone

	$CaCO_3$	Fe_2O_3	In-soluble
1	99.02	0.05	0.4
2	99.05	0.05	0.4
3	99.03	0.03	0.45
4	98.80	0.05	0.50
5	98.50	0.03	0.30
6	98.85	0.03	0.30
7	98.88	0.03	0.32
8	99.04	0.05	0.28
9	98.95	0.05	0.40
10	99.07	0.04	0.30
Σn	989.19	0.41	3.65
$\bar{X}$	98.92	0.04	0.365
R	0.57	0.02	0.22

4. Dolomite

	$CaCO_3$	$MgCO_3$	Fe_2O_3	Insoluble
1	58.34	41.57	0.04	0.09
2	59.13	40.68	0.04	-
3	56.21	41.50	0.04	0.25
Σn	173.69	123.75	0.12	0.34
$\bar{X}$	57.89	41.25	0.04	0.17
R	2.92	0.89	0	0.16

5. Feldspar

	SiO_2	Fe_2O_3	Al_2O_3	$Na_2O + K_2O$	CaO
1	68.80	0.143	18.51	12.40	Tr
2	68.98	0.150	18.60	12.41	"
3	69.01	0.150	19.35	11.40	"
4	68.90	0.150	18.90	11.60	"
5	68.88	0.150	19.80	10.67	"
Σn	344.57	0.743	95.16	58.48	
$\bar{X}$	68.91	0.148	19.03	11.70	
R	0.21	0.007	1.29	1.74	

6. Fluorspar

	CaF_2	SiO_2	Fe_2O_3	Al_2O_3
1	97.10	0.30	0.04	0.16
2	97.02	0.30	0.04	0.26
3	97.90	0.50	0.05	0.20
4	97.50	0.62	0.03	0.25
5				
Σn	389.52	1.72	0.16	0.87
$\bar{X}$	97.38	0.43	0.04	0.22
R	0.88	0.32	0.02	0.10

7. Sodium Sulfate

	Na_2SO_4	Insoluble	Fe_2O_3
1	99.70	0.10	Tr

8. Mixed Oxide

	AS_2O_3	Sb_2O_3	Fe_2O_3	CuO
1	84.27	14.07	0.15	0.1
2	83.05	14.87	0.15	Tr
3	84.26	14.10	0.12	"
Σn	251.58	43.04	0.42	
$\bar{X}$	83.86	14.35	0.14	
R	1.22	0.77	0.03	

9. Selenium

	Se	Fe
1	99.51	0.01
2	99.51	0.01
3	99.56	Tr
4	99.60	-
5	99.66	-
Σn	497.84	
$\bar{X}$	99.57	
R	0.09	

(C) Percentage fluctuation of $CaCo_3$ in dolomite is too great. Similar to the approach for the soda ash above, the batch composition is required to be corrected by batch calculation.

4-1-3 Batch Composition

Representing data as of August 31, 1978, batch composition by furnace is shown in the attached Table (17) and Glass Analysis Value as well as calculated data in the attached Table (8).

Attached Table (19) shows the Glass Analysis Values covering a period from August 1977 to August 1978.

As obvious from Tables (17) and (18), there are much differences in glass composition among Tank Nos.1 and 2, UM-1 and UM-2, and 100 T/D furnace. It is, however, noted that Tank Nos.1 and 2 employ cullet of 100 T/D furnace. This practice is not recommendable for keeping constant glass quality. So, cullet of a same glass composition should be used.

(C) Measured values came out greater than those calculated of Fe_2O_3 percent for all furnaces.

Table (17)

Batch Composition

Date: 31-8-'78

	Material	PLANT No.1 Tank-1	PLANT No.1 Tank-2	PLANT No.2 UM-1 & 2	PLANT No.3 100 T/D
	Color	Flint	Flint	Flint	Flint
	Product	Bottle	Table & Tube	Bottle	Bottle
	Silica Sand	100	100	100	100
	Soda Ash	40.65	40.65	33.3	33.3
	Limestone			25.0	25.0
	Dolomite	25.20	22.76		
	Feldspar	9.76	9.76	13.0	13.0
	Fluorspar		1.463	1.2	1.2
	S. Nitrate	0.488	0.569	0.367	0.367
	S. Sulfate	0.650	0.650	0.783	0.783
*1	Selemium-Soda	0.106	0.040	0.080	0.080
*2	Cobalt-Soda	0.065	0.069	0.040	0.035
	Mixed-Oxide	0.065	0.065	0.053	0.053
	Raw Batch Wt(Kg)	176.984	176.026	173.823	173.818
*3	Cullet (Kg)	163	163	66.7	66.7
	Total Batch Wt(Kg)	339.984	339.026	240.523	240.518
	Cullet %	50%	50%	31%	31%
	Selenium	2.585 g	0.976 g	1.951 g	1.951 g
	Cobalt	0.162 g	0.172 g	0.100 g	0.087 g

*1 Selenium-Soda ..... Se: Na_2CO_3 = 1:40

*2 Cobalt -Soda ..... CO: Na_2CO_3 1.6:400

*3 Cullet are not of scaled value, but shows that of mixing table.

Table (18)

Glass Analysis Values and Calculated Data

	PLANT NO.1				PLANT NO.2				PLANT 3	
	Tank-1		Tank-2		UM-1		UM-2		100 T/D	
	°	*	°	*	°	*	°	*	°	*
SiO_2	73.34	72.259	72.23	72.024	72.869	73.415	72.962	73.415	72.88	73.415
Fe_2O_3	0.068	0.050	0.064	0.050	0.069	0.054	0.074	0.054	0.07	0.054
Al_2O_3	1.912	1.401	1.976	1.400	2.156	1.813	2.126	1.813	2.07	1.813
CaO	8.71	5.568	6.83	5.708	10.16	9.962	10.12	9.962	10.09	9.962
MgO	0.55	3.378	2.45	3.041	0.279	-	0.33	-	0.33	-
Na_2O+K_2O	14.75	17.095	15.77	17.058	13.70	14.409	13.60	14.409	13.83	14.409
SO_3	0.33	0.248	0.351	0.246	0.300	0.297	0.31	0.297	0.31	0.297
F_2	0.21	-	0.37	0.470	0.48	0.051	0.46	0.051	0.33	0.051
Total	99.870	99.999	100.041	99.997	100.013	100.001	99.982	100.001	99.910	100.001
Glass & Product	Flint Bottle		Flint Tableware & Tube		Flint Bottle		Flint Bottle		Flint Bottle	

°: Average values of analytical results from Aug. 1977 to Aug. 1978.

*: Batch Composition calcuated as of Aug. 31, 1978 based on the average analysis values of raw material.

Table 19-1/5

GLASS COMPOSITION (FLINT)

PLANT NO. 1
Tank No. 1

	SiO_2	Fe_2O_3+ Al_2O_3	CaO	MgO	K_2O+Na_2O	SO_3	F_2	Fe_2O_3	SG
1977 Aug.	74.58	1.82	8.82	0.28	14.12	0.17	0.21	0.025	2.4637
Sept.	74.54	1.97	8.00	1.04	14.02	0.18	0.21	0.08	2.4628
Oct.	72.83	2.11	7.96	0.20	16.53	0.26	0.21	-	2.4817
Nov.	73.20	2.01	9.38	0.32	14.56	0.32	0.21	-	2.4831
Dec.	72.98	1.89	9.02	0.32	15.24	0.34	0.21	-	2.4853
1978 Jan.	73.46	2.61	9.39	0.05	13.91	0.38	0.21	0.065	2.4829
Feb.	73.16	2.65	9.75	0.44	13.31	0.48	0.21	0.063	2.4860
Mar.	73.56	2.62	8.56	0.59	13.91	0.55	0.21	0.057	2.4809
Apr.	73.98	2.09	8.38	0.51	14.56	0.48	0.21	0.067	2.4793
May.	73.20	1.96	8.45	0.64	15.33	0.21	0.21	0.078	2.4849
Jun-	72.61	1.90	9.19	0.55	15.26	0.28	0.21	0.071	2.4902
Aug.	71.94	1.97	7.62	1.60	16.26	0.34	0.21	0.057	2.4920
Σn	880.04	23.78	104.52	6.54	177.01	3.99	2.52	0.613	29.7728
$\bar{X}$	73.34	1.98	8.71	0.55	14.75	0.33	0.21	0.068	2.4811
R	2.64	0.83	1.43	1.55	3.22	0.38	0	0.023	0.0283

NOTE: S.G = Specific Gravity.

Table 19-2/5

GLASS COMPOSITION (TUBE)

PLANT NO. 1
Tank No. 2

	SiO_2	Fe_2O_3 + Al_2O_3	CaO	MgO	K_2O+Na_2O	SO_3	F_2	Fe_2O_3	SG
1977 Aug.	71.85	1.79	6.56	2.46	16.86	0.13	0.37	0.065	2.4739
Sept.	73.01	2.53	6.47	2.73	14.98	0.28	0.37	0.06	2.4686
Oct.	72.15	1.81	6.62	2.74	16.02	0.29	0.37	-	2.4848
Nov.	71.82	1.84	6.79	2.08	16.75	0.35	0.37	-	2.4841
Dec.	72.34	1.83	6.20	2.77	16.62	0.36	0.37	-	2.4809
1978 Jan.	72.76	2.29	7.25	1.96	15.00	0.37	0.37	0.073	2.4792
Feb.	72.36	2.34	6.69	2.70	15.05	0.49	0.37	0.060	2.4842
Mar.	73.37	2.32	6.37	2.48	14.56	0.59	0.37	0.055	2.4744
Apr.	72.92	1.92	6.70	2.87	14.73	0.45	0.37	0.058	2.4761
May.	71.86	2.10	6.26	2.86	16.24	0.28	0.37	0.073	2.4803
June	71.68	1.93	7.01	3.00	15.74	0.27	0.37	0.065	2.4885
July	71.48	1.83	8.31	1.65	15.88	0.41	0.37	0.067	2.4891
Aug.	71.43	2.03	7.59	1.61	16.59	0.30	0.37	0.066	2.4916
Σn	939.03	26.56	88.82	31.89	205.02	4.57	4.81	0.642	32.2557
$\bar{X}$	72.23	2.04	6.83	2.45	15.77	0.351	0.37	0.064	2.4812
R	1.94	0.72	2.11	1.39	2.30	0.46	0	0.018	0.0230

GLASS COMPOSITION (FLINT)

PLANT NO. 2
Tank UM-1

	SiO_2	Fe_2O_3 + Al_2O_3	CaO	MgO	K_2O+Na_2O	SO_3	F_2	Fe_2O_3	S.G
1977 Aug.	73.28	2.10	10.34	0.10	13.40	0.30	0.48	0.081	2.4896
Sept.	73.29	2.05	10.14	0.14	13.63	0.23	0.48	0.068	2.4891
Oct.	72.96	2.09	10.02	0.19	13.99	0.27	0.48	-	2.4922
Nov.	72.65	2.05	9.75	0.44	14.33	0.30	0.48	-	2.4853
Dec.	72.63	2.07	10.00	0.40	14.07	0.35	0.48	-	2.4946
1978 Jan.	72.81	2.55	10.42	0.16	13.21	0.34	0.48	0.085	2.4939
Feb.	72.44	2.72	10.53	0.18	13.25	0.40	0.48	0.074	2.4943
Mar.	73.66	2.66	10.10	0.30	12.52	0.28	0.48	0.064	2.4913
Apr.	73.01	2.10	9.85	0.36	13.88	0.32	0.48	0.041	2.4899
May	72.73	2.16	9.89	0.26	14.45	0.23	0.48	0.083	2.4947
Jun.	72.86	1.93	10.68	0.16	13.51	0.26	0.48	0.071	2.4938
Jul.	72.37	2.06	10.56	0.36	13.69	0.41	0.48	0.063	2.4954
Aug.	72.61	2.07	9.8	0.58	14.14	0.26	0.48	0.058	2.4951
Σn	947.300	28.61	132.08	3.63	178.07	3.95	6.24	0.688	32.3992
$\bar{X}$	728.69	2.200	10.16	0.279	13.70	0.30	0.48	0.069	2.4922
R	1.03	0.79	0.93	0.48	1.93	0.17	0	0.044	0.0063

GLASS COMPOSITION (FLINT)

PLANT NO. 2
Tank UM-2

	SiO_2	Fe_2O_3+ Al_2O_3	CaO	MgO	K_2O+Na_2O	SO_3	F_2	Fe_2O_3	S.G
1977 Aug.	73.34	2.09	10.19	0.10	13.55	0.26	0.48	0.09	2.4897
Sept.	74.15	2.14	10.06	0.17	12.71	0.29	0.48	0.07	2.4893
Oct.	73.28	2.04	10.15	0.32	13.47	0.26	0.48	-	2.4882
Nov.	72.65	2.05	9.75	0.44	14.33	0.30	0.48	-	2.4853
Dec.	72.86	2.17	9.98	0.43	13.72	0.36	0.48	-	-
1978 Jan.	72.68	2.42	10.17	0.14	13.75	0.36	0.48	0.081	2.4920
Feb.	72.56	2.63	10.34	0.30	13.22	0.40	0.48	0.072	4.4943
Mar.	73.51	2.55	9.99	0.64	12.42	0.41	0.48	0.061	2.4915
Apr.	72.87	2.65	10.16	0.32	13.77	0.25	0.48	0.071	2.4898
May	72.89	2.24	9.94	0.18	14.25	0.20	0.18	0.083	2.4945
Jun.	72.68	2.08	10.59	0.40	13.48	0.29	0.48	0.081	2.4960
Jul.	72.72	1.99	10.15	0.56	13.69	0.34	0.48	0.071	2.4964
Aug.	72.32	2.08	10.09	0.32	14.38	0.27	0.48	0.057	2.4956
Σn	948.51	28.63	131.56	4.32	176.74	3.99	5.94	0.737	29.903
$\bar{X}$	72.962	2.20	10.12	0.33	13.60	0.31	0.46	0.074	2.4919
R	1.83	0.64	0.84	0.54	1.96	0.21	0.30	0.03	0.0111

Table 19-5/5

GLASS COMPOSITION (FLINT)

PLANT NO. 3
100 T/D

Month	SiO_2	Fe_2O_3+ Al_2O_3	CaO	MgO	K_2O+Na_2O	SO_3	F_2	Fe_2O_3	S.G
1977 Aug.	74.07	2.29	10.02	0.28	12.85	0.19	0.30	0.084	2.4922
Sept.	73.40	1.96	9.52	0.42	14.12	0.28	0.30	0.06	2.4877
Oct.	72.91	2.12	9.86	0.48	14.00	0.33	0.30	-	2.4925
Nov.	73.52	1.91	10.05	0.27	13.64	0.31	0.30	-	2.4879
Dec.	72.42	1.99	10.47	0.20	14.26	0.36	0.30	-	2.4947
1978 Jan.	72.98	2.52	10.55	0.14	13.27	0.24	0.48	0.078	2.4925
Feb.	72.43	2.58	10.28	0.27	13.50	0.46	0.48	0.07	2.4949
Mar.	73.47	2.58	10.03	0.42	12.67	0.53	0.30	0.062	2.4915
Apr.	73.05	1.96	10.16	0.32	13.93	0.25	0.30	0.068	2.4897
May	72.82	1.94	9.65	0.32	14.79	0.18	0.32	0.080	2.4913
Jun.	72.64	1.98	10.35	0.40	14.07	0.26	0.30	0.071	2.4948
Jul.	72.53	2.05	10.56	0.49	13.63	0.38	0.30	0.062	2.4963
Aug.	72.25	2.01	9.71	0.34	15.07	0.25	0.30	0.068	2.4969
Σn	947.49	27.89	131.21	4.35	179.800	4.02	4.28	0.703	32.4029
$\bar{X}$	72.88	2.14	10.09	0.33	13.83	0.31	0.33	0.07	2.4925
R	1.82	0.67	1.04	0.35	2.22	0.35	0.18	0.024	0.092

Fe_2O_3 %

	TANK-NO.1	TANK-NO.2	UM-1	UM-2	100 T/D
Measured Value	0.068	0.064	0.069	0.074	0.070
Calculated Value	0.050	0.050	0.054	0.054	0.054
Difference	+0.018	+0.014	+0.015	+0.020	+0.016

As described earlier, to improve the glass color, Fe_2O_3 % should be regulated as follows:

Bottles, flint glass 0.05% or less

Tableware, flint glass 0.02% or less

0.014 ∿ 0.020 % increases in measured value can be attributed to the causes as follows:

1. Influence from a foreign substance (metal) contained in the cullet.

2. Substancial amount of Fe_2O_3 content in the foreign cullet.

3. A greater amount of an actual Fe_2O_3 content than the analyzed value is found in the silica sand, the limestone, the soda ash, the feldspar and the fluorspar.

(C) Great differences are observed in CaO and MgO contents between Tanks No. 1 and No. 2.

CaO %	Tank No.1	Tank No.2
Measured Value	8.71	6.83
Calculated Value	5.568	5.708
Difference	+3.142	+1.122

MgO %	Tank No.1	Tank No.2
Measured Value	0.55	2.45
Calculated Value	3.378	3.041
Difference	-2.828	-0.591

This seems to be attributable to mixed use of the cullet turned out of 100 T/D furnace in Tanks No.1 and No.2.

(C) A higher unit price of the purchased cullet than raw batch cost tends to raise batch cost, if the purchased cullet is used. It is advised to calculate the batch cost every month in an effort to reduce its cost. (See Attached Annex 1)

(C) As an apparent in Table (19), a wide dispersion is noted of values from chemical analysis. It is recommended that standard glass compositions be established with upper and lower limits for better control.

4-1-4 Specific Gravity

Specific gravity of the glass produced during a month of August 1978 is shown in the attached Table (20).

(C) Control on the specific gravity offers an effective approach and instrument to obtain constant glass quality. Generally speaking, if the raw material control, the batch mixing and the melting condition are maintained satisfactorily, fluctuation of the specific gravity over a period of three days would remain 0.0012 g/cc or below.

The followings are excerpts from the attached Table (20) of the data taken on both 28th and 29th of August:

Data	Tank NO.1	Tank NO.2	UM-1	UM-2	100 t
Aug. 28	2.4918	2.4904	2.4982	2.4987	2.4969
Aug. 29	2.4893	2.4891	2.5008	2.5010	2.5008
Difference	-0.0025	-0.0013	+0.0026	+0.0023	+0.0039

As noted apparently, specific gravity is less in both Tanks No.1 and No.2, while more of other furnaces. With an each actual value at higher levels, there were some unusual conditions that are considered to have caused the high values. However, it is hard to determine the real causes only with the specific gravity factor alone.

(C) Difference in 3 day fluctuation is desired to be controlled not more than 0.0030 g/cc.
When specific gravity is specifically high, the causes must be found and remedial action should be taken accordingly.

Example: Investigation on raw material
Checking on weighing scale
Confirmation of mixing condition

(C) A due care should be exercised of changing of batch composition for soda ash, limestone, dolomite and feldspar.
(Refer to the change of the batch composition section)

(C) Specific gravity values taken from August 1977 to August 1978 as excerpted from the attached Table (19) shows extremely great fluctuation as follows:

	Tank NO.1	Tank No.2	UM-1	UM-2	100 t
Maximum	2.4920	2.4916	2.4954	2.4964	2.4969
Minimum	2.4637	2.4686	2.4891	2.4853	2.4877
Difference	0.0283	0.0230	0.0063	0.0111	0.0092

Specific gravity of the glass is important as well for the mold design. So, it is advised that $\bar{X}$-R control chart be utilized for control with standard specific gravity established.

Table (20)

Specific Gravity

Date	Tank-1	Tank-2	UM-1	UM-2	100 T/D
8/1	2.4914	2.4905	2.4978	2.4967	2.4978
2	2.4909	2.4897	2.4979	2.4961	2.4976
3	2.4913	2.4907	2.4983	2.4974	2.4981
4	2.4889	2.4902	2.4971	2.4967	2.4971
5	2.4909	-	2.4957	2.4948	2.4968
6	-	-	-	-	-
7	2.4920	2.4916	2.4951	2.4956	2.4969
8	2.4931	2.4928	2.4941	2.4949	2.4970
9	2.4925	2.4908	2.4950	2.4947	2.4954
10	2.4923	2.4911	2.4954	2.4965	2.4972
11	2.4920	2.4905	2.4950	2.4948	2.4957
12	-	-	-	-	-
13	-	-	-	-	-
14	2.4907	2.4901	2.4967	2.4966	2.4961
15	2.4897	2.4893	2.4959	2.4949	2.4963
16	2.4905	2.4900	2.4958	2.4967	2.4977
17	2.4902	2.4898	2.4969	2.4956	2.4970
18	2.4902	2.4897	2.4976	2.4956	2.4971
19	2.4922	2.4891	2.4971	2.4959	2.4970
20	-	-	-	-	-
21	2.4929	2.4899	2.4965	2.4965	2.4974
22	2.4927	2.4903	2.4954	2.4959	2.4970
23	2.4929	2.4916	2.4968	2.4964	2.4971
24	2.4916	2.4919	2.4974	2.4974	2.4982
25	2.4922	2.4922	2.4976	2.4976	2.4973
26	2.4929	2.4928	2.4970	2.4970	2.4963
27	-	-	-	-	-
28	2.4918	2.4904	2.4982	2.4987	2.4969
29	2.4893	2.4891	2.5008	2.5010	2.5008
30	2.4902	2.4876	2.4989	2.4980	2.4981
31	2.4901	2.4897	2.4960	2.4960	2.4956
Σn	64.7754	62.2634	64.9160	64.9073	64.9255
$\bar{X}$	2.4914	2.4904	2.4968	2.4965	2.4971
R	0.0042	0.0037	0.0067	0.0063	0.0054

4-1-5 Change of Batch Composition

In Tank No.1, soda ash was changed from 50 kg to 48 kg. The followings show the constituents of glass composition before and after the change of the batch composition (Not including cullet):

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O+ K_2O	SO_3	Total
Pre-change	72.259	1.401	0.050	5.568	3 378	17.095	0.248	99.999
Post-change	72.725	1.410	0.051	5.605	3.399	16.560	0.249	99.999
Difference	+0.466	+0.009	+0.001	+0.037	+0.021	-0.535	+0.001	-

The followings show fluctuation of the specific gravity and softening point as obtained by calculation: (regarded Na_2O + K_2O as only Na_2O)

	Softening Point	Specific Gravity
Pre-change	607°C	2.4050
Post-change	702°C	2.4009
Difference	+ 5°C	-0.0041

The calculation reveals SiO_2 increase by 0.466 % and 0.535 % decrease in Na_2O + K_2O, which shows a great shifting of characteristics value of glass. Yet, with the substantial use in amount of cullet as much as 50 %, as actual fluctuation could be less than the calculated. Under such state of practice, it is difficult to exercise control on the specific gravity fluctuation.

(C) It is suggested that a change of the input of the soda ash is to be restrained 1 kg or less per 1 ton of glassification.

(C) Similarly, change of limestone and dolomite input should be limited to 1 kg or less per 1 ton of glassification.

(C) Further, feldspar input change also should be kept to 1 kg or less per 1 ton of glassification.

4-1-6 Quality Test on Raw Material and Glass

At present, items currently subjected to the test performed by testing personnel are as follows:

Control Items	Frequency
1. Measurement of moisture content in silica sand	once/day
2. Analytical measurement of glass	once/day
3. Analytical measurement of raw material	once/week
4. Measurement of specific gravity	once/week

(A) & (B) Other than the above, the following items are recommendable to be implemented for the improvement of the glass quality, strengthening daily control and better services to the customers:

Control Items	Frequency
1. Measurement of softening point	once/week
2. Measurement of brightness; dominant wave length and excitation purity	Twice/month
3. Chemical durability test	once/month
4. Measurement of seeds	once/day
5. Measurement of cords	once/day

4-1-7 Storage of Raw Material

Status of raw material delivery and storage is shown in the attached Table (21).

4-1-7-1 Storage and Crushing of Cullet

Actual usage of cullet during the month of August (assumed consumption as cullet is not weighed).

	Tank No.1	Tank No.2	UM-1	UM-2	100 t	Total
Domestic cullet	173.4	158.4	391.9	425.4	761.8	1,910.9
Foreign cullet	97.2	95.4	81.2	95.9	57.9	427.6
Total	270.6	253.8	473.1	521.3	819.7	2,338.5

(Excerpt from Furnace Material Usage Daily Report)

Table (21)

Storage of Raw Material

Material	Trans- ported By	Packed Style	Std. Q,ty of Stock	Unloading Method	Stock Style
Silica Sand	Truck	Bulk	15 days	Labour	Bulk
Soda Ash	"	Bag 50Kg	4 Month	"	Bag 50kg
Limestone	"	Rock	50 t	"	" 75kg
Crushed Limestone	"	Bulk	3 Month	"	" "
Dolomite	"	"	3 "	"	- -
Feldspar	"	"	6 "	"	Bag 50kg
Fluorspar	"	Rock	6 "	"	- -
S.Nitrate	"	Bag 50kg	8 "	"	Bag 50kg
S.Sulfate	"	" "	8 "	"	" "
Selenium	"	Can 25kg	8 "	"	Can 25kg
Cobalt	"	" 100kg	8 "	"	" 100kg
Mixed Oxide	"	" 200kg	8 "	"	" 200kg
Cullet	"	Bulk		"	

(A) Isolation of Cullet Storage

Segregation of the cullet by each plant and foreign sources is necessary. In addition, domestic cullet must further be classified by kind of glass for storage.

- Domestic cullet (Flint)
  - Cold end cullet
  - Hot end cullet
  - Printed cullet
- Tableware & Tube
  - Cold end cullet
  - Hot end cullet
- Foreign Cullet
  - Flint cullet
  - Mixed cullet
  - Sheet glass cullet
  - Tableware flint cullet

(C) Cullet overflowed into the passage way poses safety hazard. Concrete or wooden partition wall must be provided to prevent the storage from spreading into the walk way.

(A) Oil stained cullet must not be mixed with the clean one.

(C) Much foreign substances are found mixed in the cullet. Foreign substances can cause deterioration of glass quality, especially metals damage the bottom of furnace and shorten the furnace service life (Metal Attack). It is desired to make all concerned aware of bad practice that foreign matter is mixed in the cullet and at the same time, make constant effort to avoid the mixing. Foreign substances found in the cullet (in domestic cullet) were bolt, nut, swabbing stick, paper, oil stained materials, ceramics, wood chips, iron chips, copper tube, pipe, wire, spring. (in foreign cullet) Aluminum cap, pebbles, printed cullet.

(B) Crushing of the cullet is not done well. Replacement to an impeller type cullet crusher is recommended.

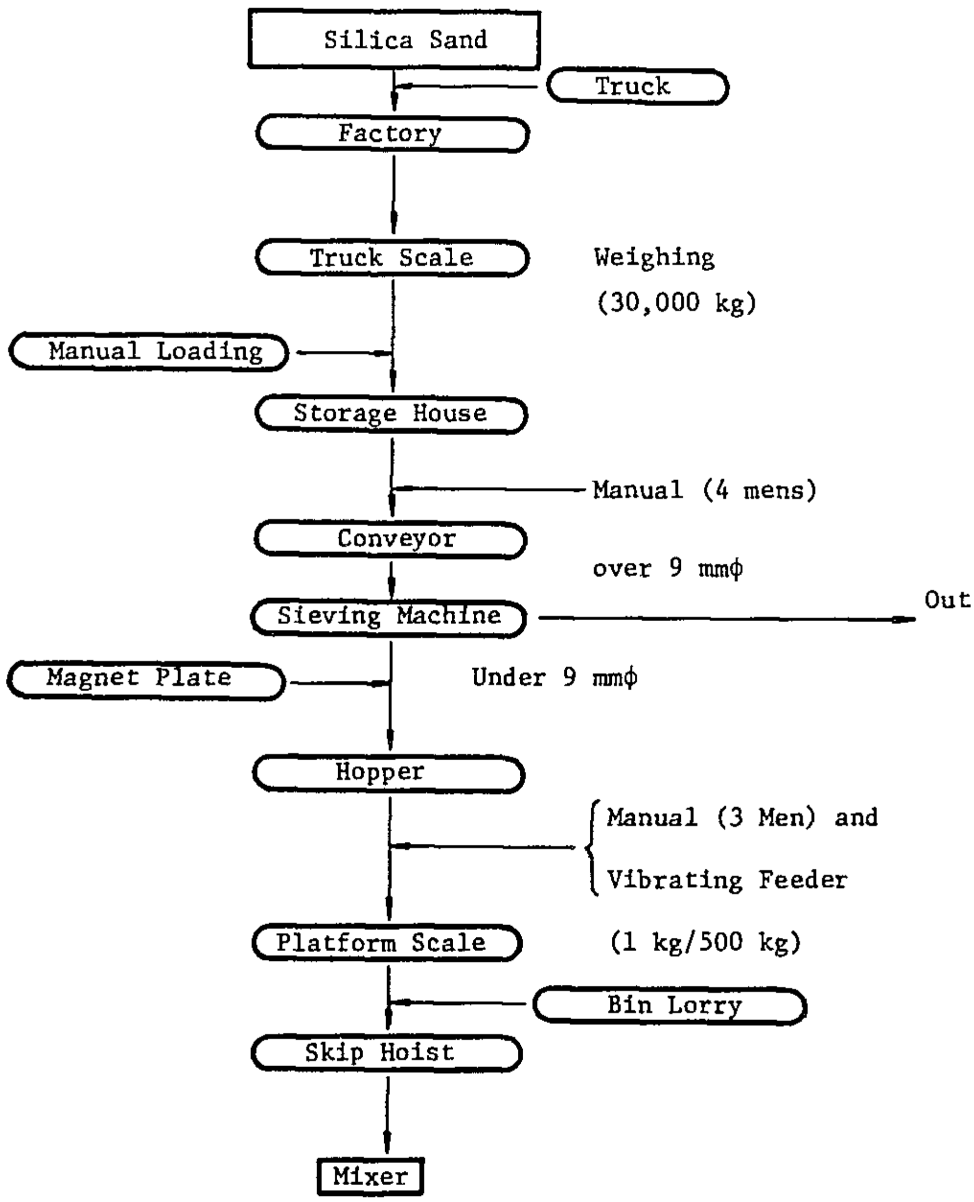
(C) Oil stained cullet should be cleaned by maximum utilization of the existing cleaning device before use in process.

4-1-7-2 Receiving and Storage of Silica Sand

Flow of the silica sand processing from receiving to the mixing is as follows:

- See next page -

Silica Sand Receiving & Mixing Flow Sheet



(A) Recommended silica storage space be partitioned so that silica sand can be stored classified according to the type of glass.

(B) If processed silica sand through cleaning and sieving is not commercially available, it would be necessary to provede cleaning and sieving facilities of own in the factory.

(B) For saving unloading operation from truck and effective use of silica sand storage space, a new receiving system employing backet elevator and distribution conveyor is recommended.

(C) It is desired that discharging operation from silica sand storage be converted from manual to shovel loader for saving manpower.

(C) 9 mmϕ sieving machine now in use to eliminate foreign material of 9 mmϕ or larger in size has a larger hole which is left unattended in operation. Daily checking must be enforced with immediate repair to be made as a hole is discovered.

4-1-7-3 Crushing Process of Limestone and Fluorspar

Receiving and crushing process flows are shown in the attached Table (22-1) & (22-2)

(A) There is no partition wall segregating limestone and fluorspar storage yard. Segregated storage is desired.

(A) Particle size of crushed limestone is as large as 20 mm × 5 mm × 5 mm of the largest, which apparently fails to meet the receiving standard. It is necessary to check the grain size & distribution on a daily basis.

(B) It would be necessary to install on additional sieving process after crushing as occasions demand.

(B) It is desired to provide a dust collector in future for preventing dust generated from crushing and to protect possible silicosis.

(C) Bagging is done after weighing at the hopper's outlet. Weighing scale must be checked for "0" point correction and kept clean.

(C) For cleaning process of the fluorspar prior to the crushing, use of cleaning equipment is recommended.

(B) A new crusher is recommendable to be employed as the existing equipment is too large in the mesh size, whereas fluorspar is generally processed with 100 mesh (approx. 0.15 mm).

Table (22)

Flow Sheet for Limestone Receiving & Crushing Process

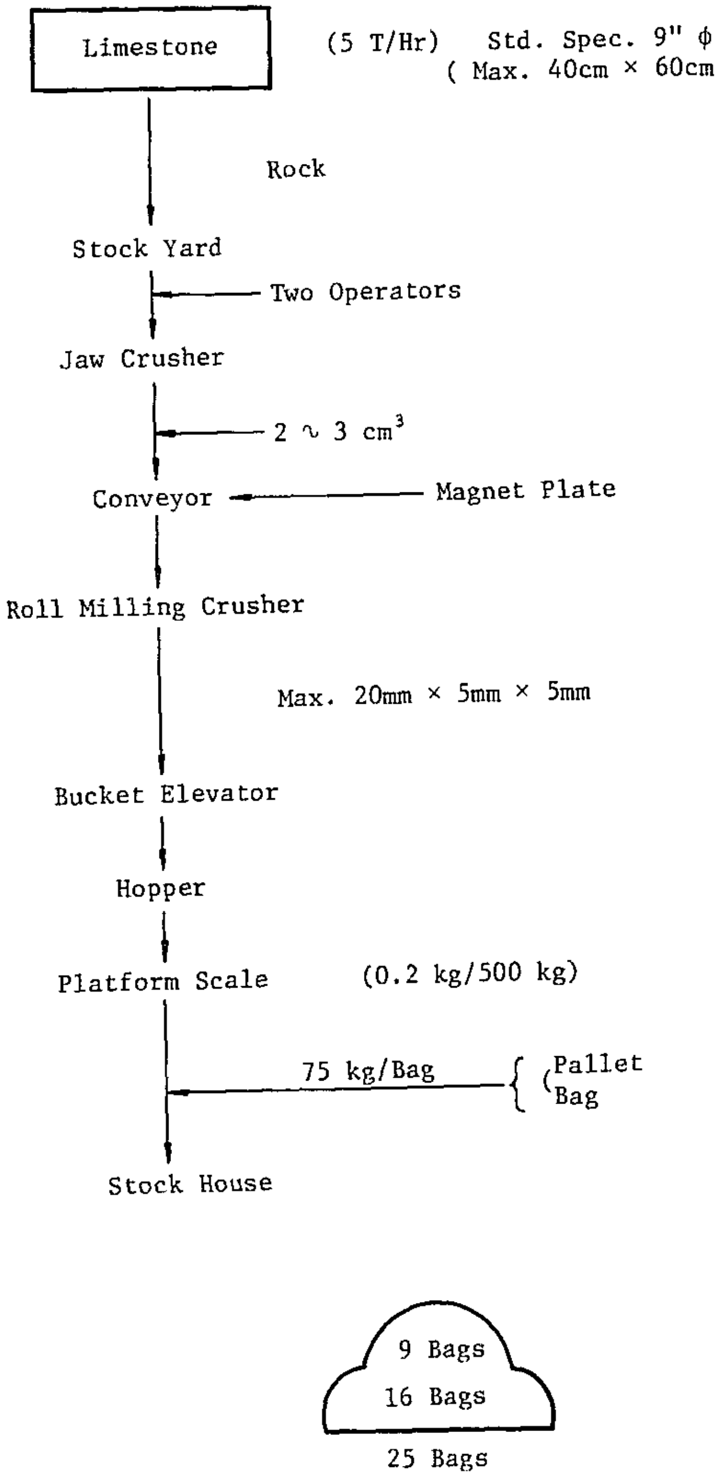
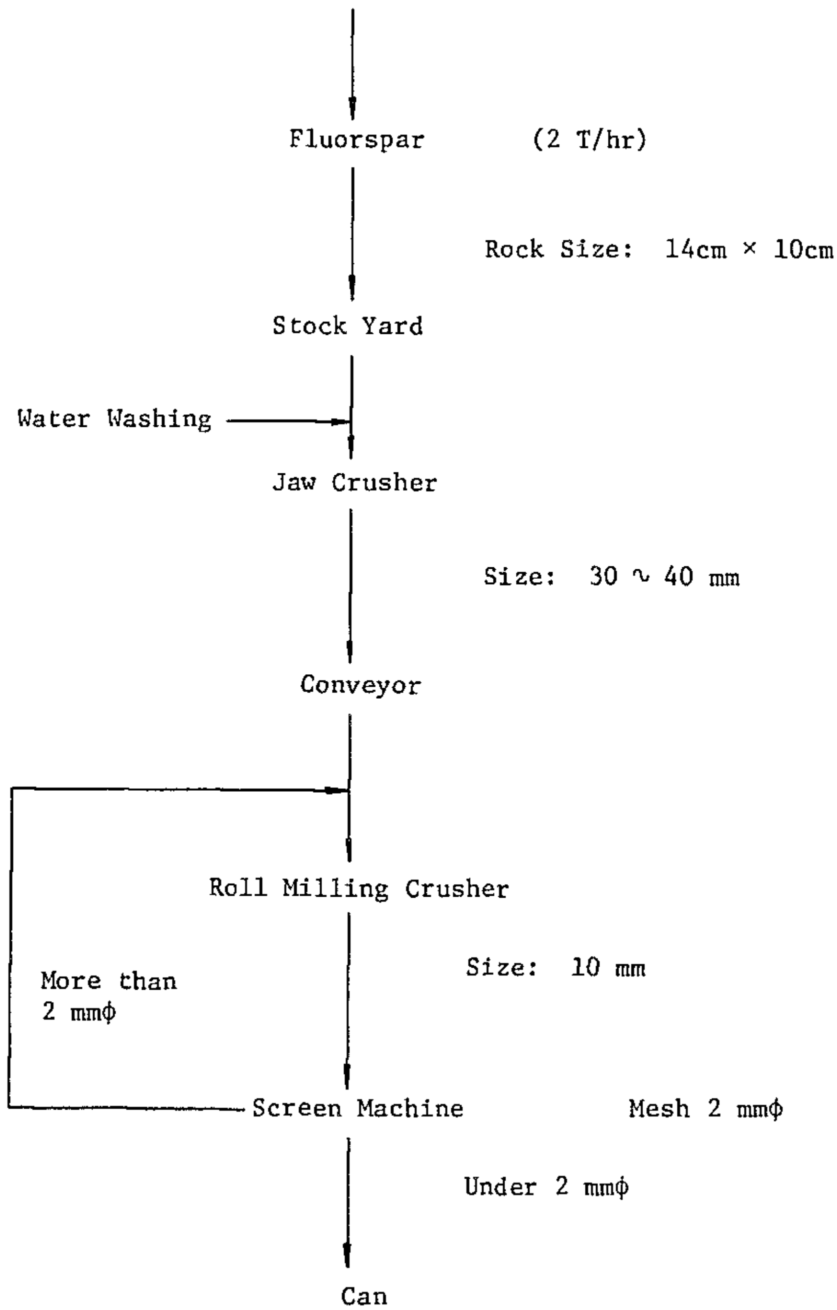


Table (22)-2

Flow Sheet for Fluorspar Receiving & Crushing Process



4-1-8 Batch Mixing

Method currently applied for batch mixing is shown in the attached Table (23).

(A) Batch mixing performed by 77 operators now is desired to be replaced with an automatic mixing plant for saving manpower (this plan is already under way).

(A) Advised that batch mixing operation now attended by the day shift workers alone be changed to 3 shift systems as well for steady supply of batch, stabilizing quality in batch mixing and also strengthening control of the glass quality.

(A) & (C) Weight flucturation of soda ash has a great influences on glass quality. So, soda ash must be weighed. At present, the nominal weight is used as indicated on the Bag.

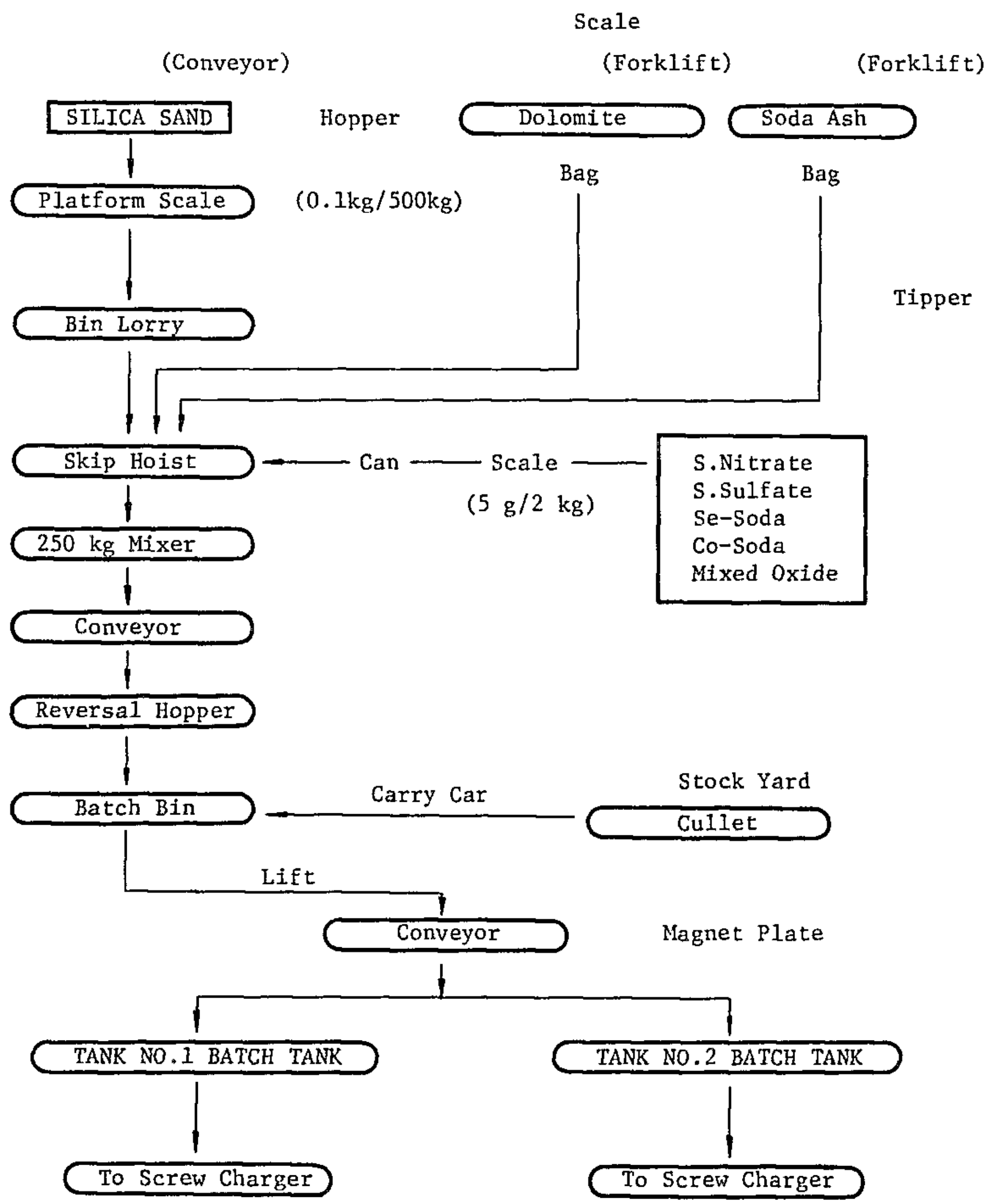
(C) It is desired to be recognized that the cullet also constitutes an important raw material, although it is not weighed at present.

(C) It is important for supervisors and all operators to be aware that steady supply of homogeneous batch is th most significant factor to produce glass of homogeneous quality.

Flow Sheet 1

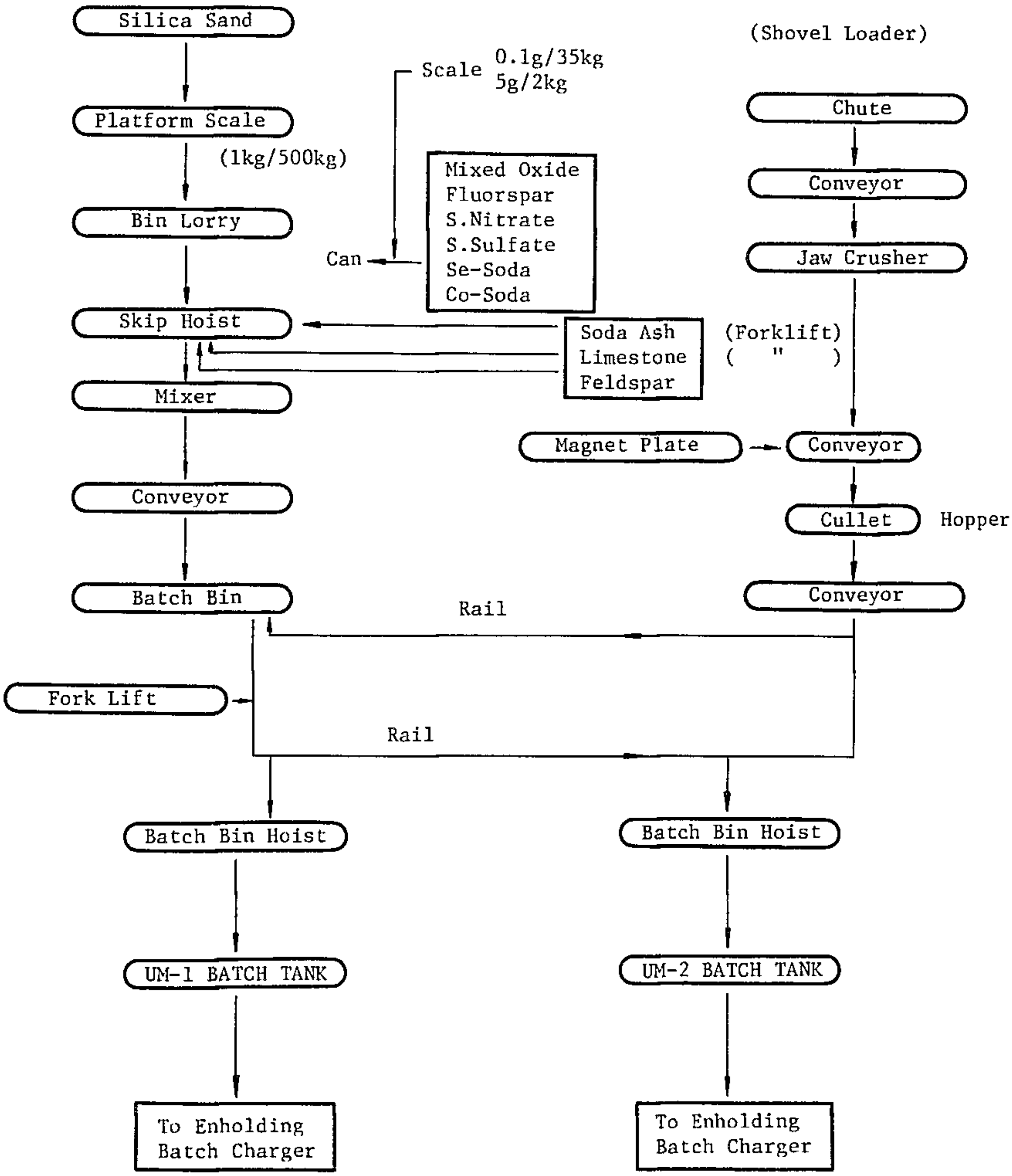
Table (23)

Plant No.1 Batch Mixing Flow Sheet

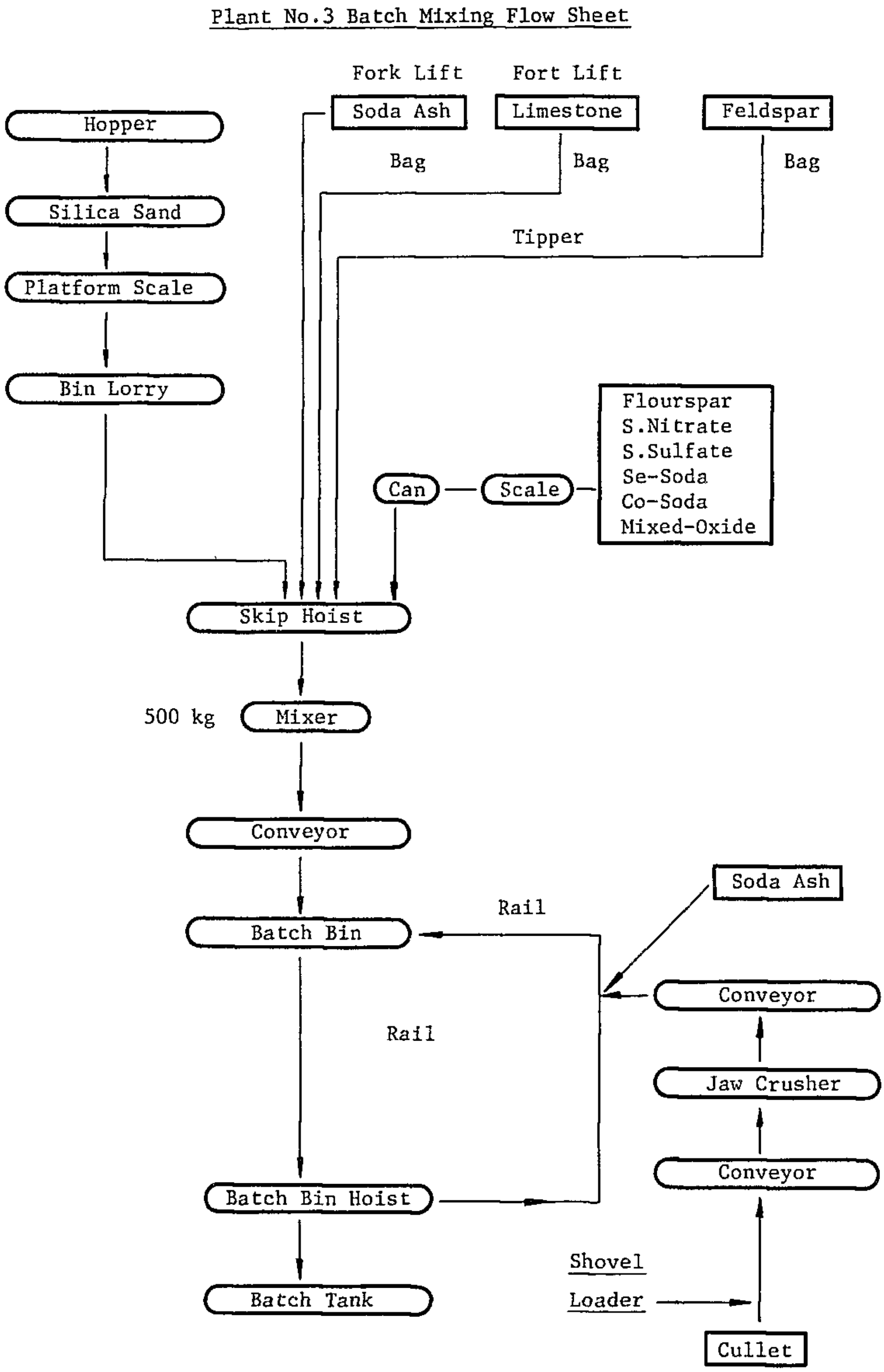


Flow Sheet 2

Plant No.2 Batch Mixing Flow Sheet



Flow sheet 3



Plant No.3 Batch Mixing Flow Sheet
Fork Lift
Fort Lift
Soda Ash
Limestone
Feldspar
Hopper
Bag
Bag
Bag
Silica Sand
Tipper
Platform Scale
Bin Lorry
Flourspar
S.Nitrate
S.Sulfate
Se-Soda
Co-Soda
Mixed-Oxide
Can
Scale
Skip Hoist
500 kg
Mixer
Conveyor
Soda Ash
Rail
Batch Bin
Conveyor
Rail
Jaw Crusher
Conveyor
Batch Bin Hoist
Shovel
Loader
Batch Tank
Cullet

Table (24)

BATCH MIXING TIME

Date: 5-9-'78

Measured values of mixing time are as follows:

	PLANT NO.1	PLANT NO.2	PLANT NO.3
1	45S	69S	115S
2	42S	47S	122S
3	36S	71S	101S
4	30S	58S	83S
5	43S	65S	145S
6	47S	41S	92S
Σn	243S	351S	658S
$\bar{X}$	40.5S	58.5S	109S
R	17S	30S	53S

Unit: Second

Mixing Time: Material feeding into the mixer from skip hoist to openning of the mixer gate.

Measuring Instrument: Stop watch, 1/10 seconds

4-1-8-1 Batch Mixing Time

Measurement made of mixing time is shown in the attached Table (24).

Apparent from the measurement, mixing time is extremely short. Although the Table does not refer to an improper operation, raw material was found being fed even when mixer gate is left open. This practice indicates that there is no mixing done at all. The optimum mixing time can not be clarified unless the batch operation is investigated. It is, however, assumed necessary to give at least 3 minutes.

(C) Standard mixing time is desired to be established.

(C) It is also desired to provide a timer which would give operators mixing time reading and enable gate to open upon a given time elapsed.

4-1-8-2 Transportation of Batch

The transportation is done by means of forklift to push batch bin along rail, posing short comings that water penetration into the batch bin makes batch segregation during the rainy season. Protection against rain water is necessary.

(C) For example, batch bin cover should be provided.

4-1-9 <u>Weighing</u>

Weighing scales used for batch mixing are listed as follows:

Silica sand	Platfom scale	1 kg/500 kg	Manual
"	"	0.1 kg/500 kg	"
Limestone	"	0.2 kg/500 kg	"
Crushed limestone	"	0.1 kg/500 kg	"
Fedlspar	"	0.1 kg/200 kg	"
Fluorspar	Spring balance	0.1 kg/ 35 kg	"
S. Nitrate	"	5 g/ 2 kg	"
S. Sulfate	"	5 g/ 2 kg	"
Se-Soda	"	5 g/ 2 kg	"
Co-Soda	"	5 g/ 2 kg	"
Mixed oxide	"	5 g/ 2 kg	"

Note: Weighing is being made neither of soda ash nor cullet. Soda ash weight is taken as 50 kg per bag.

(C) It should be made a practice to make periodical calibration of weighing scale, not to mention of making the "0" point check every time before the operation starts.

(C) In weighing silica sand with the bin lorry, it is necessary to assure all bin lorry weight, are equal. In order to apply the constant value, periodical weighing of the bin lorry is required to correct weight, if necessary.

(C) It is important to keep batch composition constant at all time. So, it is an essential for Supervisors and all operators to be aware of the importance of accurate weighing of the all raw materials.

Measurement of water content in the silica sand must be conducted by the personnel in charge of the mixing as well as the water content adjustment be made accurately.

Measurement on the water content should be made at a rate of once every 8 hours and it is recommendable to make it more often, if conditions allow.

4-2 Glass Melting Furnace

Specifications for theglass melting furnace are shown in the attached Table 10 for Section 3-1, Factory Equipment.

Table (25)

Actual Performance of Furnace Operation in August

	Kind of Glass	Melting Area(ft^2)	Total Pull(t)	Average Pull(t)	Fuel Consump. l/t	Melting Ratio(ft^2/t)
PLANT NO.1 Tank-1	Flint	200	532.031	17.162	411	11.6
PLANT NO.1 Tank-2	Table-ware & Tube	"	497.265	16.040	434	12.5
PLANT NO.2 UM-1	Flint	400	1,321.919	42.643	390	9.4
PLANT NO.2 UM-2	"	"	1,449.265	46.750	420	8.6
PLANT NO.3 100 T/D	"	491	2,520.252	81.298	263	6.0

	Packed Wt (t)	$\frac{\text{Packed Wt}}{\text{Total Pull}} \times 10^2$	Melter Temp. (°C)	Refiner Temp. (°C)
PLANT NO.1 Tank-1	307.290	57.75	R.P 1,295	R.P 1,218
PLANT NO.1 Tank-2	199.520	40.12	R.P 1,295	-
PLANT NO.2 UM-1	821.326	62.13	O.P 1,509	O.P 1,280
PLANT NO.2 UM-2	940.338	64.88	-	-
PLANT NO.3 100 T/D	2,268.987	90.03	T.C 1,378	T.C 1,267

NOTE: R.P = Radiation Pyrometer
O.P = Optical Pyrometer
T.C = Thermo Couple

The following figures represent the production achieved in August (quoted from Daily Production Report):

Plant	Furnace	Pull(t)	Yield(t)	Pack to Melt Ratio (%)
No.1	No.1	534.465	307.290	57.50
	No.2	483.175	199.520	41.29
No.2	UM-1	1,376.743	821.326	59.65
	UM-2	1,585.150	940.338	59.32
No.3	100t/D	2,918.297	2,268.987	77.75
TOTAL		6,897.837	4,537.461	65.78

As indicated in the Table above, pack to melt ratio is extremely low. If there ware 80% or 90% of pack to melt achieved increase in the production can be estimated by the following calculation:

When pack to melt increased to 80%;

$$6,897.830 \text{ t} \times 0.80 = 5,518.264 \text{ t}$$

$$\text{Increase} = 5,518.264 - 4,537.461 = 980.803 \text{ t}$$

When pack to melt increased to 90%;

$$6,897.830 \text{ t} \times 0.90 = 6,208.047 \text{ t}$$

$$\text{Increase} = 6,208.047 - 4,537.461 = 1,670.580 \text{ t}$$

Substantial increases can be expected with the rates shown respectively for 80% and 90% as follows:

80% 980.803 t/month or 39.5 t/day
90% 1,670.580 t/month or 59.8 t/day

This means that the increases commensurate with production by additional glass melting furnace of such capacity.

Actual performance of the furnace operation during the month of August is shown in the attached Table (25).

4-2-1 Life Time of Glass Melting Furnace

In spite of the adversely high melting ratio as apparently noted of the actual performance of the furnace operation in August, life time of the melting furnace remains as short as 3 to 3-1/2 years. During this survey, we had an opportunity to enter inside of the UM-2 (Unit Melter Furnace) of the plant No. 2 on the occasion of the furnace repair and inspected damages done to the blocks. We found little damage except on throat and paving and could therefore estimate the furnace serviceable for another half year or so.

(B) To extend the life of the glass melting furnace, it is recommended to convert the throat cooling method from the present air cooling to water cooling (Water Jacket).

(B) 3" thick Zircon blocks used for paving despite shallow depth of the glass melting furnace compared with the general type, poses a great deal of potential danger. Change of the paving material from Zircon to AZS as well as increase of the thickness are recommended.

(A) Study must be made to determine which portion should be reinforced or improved of furnace in the next repair by checking damaged spots thoroughly and assuring major factors affecting the furnace life to shorten whenever conducting cold repair on the furnace.

(C) Cleaning of area around doghouse was found being done by blowing batch dust with high pressure air. Use of the compressed air to blow batch dust into the furnace not only accelerate damage to the melter's blocks, but also cause clogging in the checker of the regenerating room. This practice should be discontinued entirely.

4-2-2 Fuel Efficiency

Fuel efficiency in August was extremely poor as shown below.

Plant No.1		Plant No.2		Plant No.3
Tank No.1	Tank No.2	UM - 1	UM - 2	100 t/D
411	434	390	420	263

Unit l/t

(A) To improve the fuel efficiency to a great extent for recuperative type furnace Tanks. No. 1 and No. 2, and also of unit melters for UM-1 and UM-2, regenerative and port firing type is recommended for the future conversion.

(A) Fuel efficiency remains unsatisfactory with low melting capacity of thefurnace. A unit of 60 - 70 ton furnace is recommended for use in future scrapping No. 1 and No. 2 Tanks.

(A) Recommend Each UM-1 and UM-2 be replaced respectively with a unit of 120 ton furnace of regenerative end port type.

(C) Performance records of August reveals low loading made generally of melting ratio as shown in the Table below. As long as glass quality allows (especially number of seeds), effort should be directed to work out production plan which assures higher pull for improvement not only of production amount, but also of fuel efficiency. Melting Ratio (square feet/t)

Plant No.1		Plant No.2		Plant No.3
Tank No.1	Tank No.2	UM - 1	UM - 2	100 t
11.6	12.5	9.4	8.6	6.0

(B) Use of air cooling for bottoms of the melting furnaces No. 1 and No. 2 should be discontinued, while in stead, lessening potential risk of leakage from the furnace by improving paving block material and increasing its thickness.

100 ton/Dfurnace would cause no problem, even if air cooling applied to the crown skew section is discontinued or reduced.

(C) Side wall of each furnace has not been insulated. Recommend insulation be provided to the side wall with exception to the area covering 300 mm below the top of the block and 50 mm each of the jointing part of both side.

(C) Recommend insulation be provided to crown of each furnace except for UM-1 and UM-2. However, method of insulation must be carefully studied as insulation works during the furnace operation involves danger. Further, some of the existing silica refractories blocks may not be applicable to insulation depending on the material quality. In such case, the manufacturer of the silica refractories blocks should be consulted.

(C) It is recommended that the breast wall of each furnace be insulated.

(B) Fuel oil flow and consumption can not be clarified of each fuel oil burner because of no oil flow meter mounted at all on any burner of furnaces, except for 100 ton furnace.

It is desired to provide each burner with a oil flow meter for a thorough flow regulation.

These is a total of 26 burners installed in both melting end and working end of the unit melter for UM-1 and UM-2. So, it is recommendable that the flow meter mounting be made in 3 separate zones, each of both right and left side.

(C) Flow meter mounted on the burner of 100 ton furnace is hard to fine adjustment, due to its graduation unit being 1/hour. Change in the unit to 1/min is recommended.

(C) It seems necessary to study for discontinuing fuel oil combustion on the working end of UM-1 and UM-2.

(B) Suggest metal recuperater be installed to improve efficiency of the furnace operation by raising temperature of secondary air with heat recovered from the exhaust gas from UM-1 and UM-2.

(C) Recommend excess air be minimized by analyzing exhaust gas and thoroughly adjusting secondary air flow.

(C) It is desired that all furnace operators always keeping in mind to improve the fuel efficiency for which target should be set.

4-2-3 Operating Temperature of Furnace

Actual record of the melter temperature during the month of August.

Furnace No.	Average Temp.	Max Temp.	Min Temp.	R	Thermometer
Tank No.1	1,294°C	1,340°C	1,230°C	110°C	Radiation pyrometer
UM - 1	1,509°C	1,520°C	1,490°C	30°C	Optical pyrometer
100 t	1,378°C	1,387°C	1,365°C	22°C	Thermo Couple

(C) It is desired that operating temperature of the furnace be adjusted according to the melting ratio, batch pile position in the furnace and glass quality, especially of number of seeds.

Melting condition must be checked and determined for the propriety by measuring number of seeds on finished products as well as sampling glass from working end to measure number of seeds existing in the molten glass.

Operating temperature of the furnace should be adjusted by number of seeds measured for which the company's standard must be established.

(C) Operating temperature of the furnace not only is recorded with instrument, but serves to determine the location of optical pyrometer in the furnace. The operating temperature should be checked with optical pyrometer at least once per shift and recorded the measured readings.

(C) Temperature in the working end must be stabilized at a constant level to minimize fluctuation of glass weight and also to stabilize gob forming.

Measured Temperature in the Working End During the month August.

Furnace No.	Average Temp.	Max Temp.	Min Temp.	R	Thermometer
Tank No.1	1,218°C	1,245°C	1,180°C	65°C	Radiation Pyrometer
UM - 1	1,280°C	1,290°C	1,260°C	30°C	Optical Pyrometer
100 t	1,267°C	1,280°C	1,256°C	24°C	Thermo Couple

4-2-4 Batch Feeding and Control on the Glass Level

(C) Keeping glass level at a constant level in melting operation constitutes a very important factor to batch melting and also to the forming machine. Efforts should be made to minimize fluctuation of the metal line by reducing failure of batch charger and maintaining sufficient volume of batch in the batch tank.

(B) Level guage should be provided to the Tank No. 1 on which no level gauge is installed at present.

(C) It is better to make an automatic control available for the Tank No. 2 by connecting level gauge with the existing screw type batch charger operated manually to control glass level.

(B) Screw type batch chargers of the Tanks No. 1 and the Tank No. 2 are approximately 200 mm in diameter and those of the UM-1 and the UM-2 are Enholding Vibrating Type with 200 mm trough width. Both batch chargers are of type that tends to incline batch piles toward throat and their narrow width cause batch piles to be unevenly spread. To attain an even distribution of batch piles, recommend study be made of employing a suitable type of batch charger.

(C) Screw type batch charger of the Tanks No. 1 and the Tank No. 2 are likely to wear out soon with large size or amount of cullet fed and seem required frequent replacement. Moreover, it takes long time to change the batch chargers affected by the column just behind them. This affects glass level to go down and in some case, machine must be stopped, suspending production operation for a while. Study should be made in every respect to reduce the changing time (replacement time).

(C) Front end of the water cooling blanket type batch charger for 100 t furnace is operating dipped in molten glass. This causes damage to the trough and frequent water leak trouble. Adjustment of trough height is necessary.

4-2-5 Measurement and Control of Furnace Pressure

(B) Recommend Furnace pressure on the UM-1 and the UM-2 be measured to keep constant condition of combustion.

(C) 100 t furnace pressure is extremely high at approx. 1.5 - 3.00 mm H_2O.

This makes refractories wear out faster and prevent operators from checking inside of the furnace. It is advised to keep the furnace pressure at 1 mm H_2O or below.

(C) 100 t furnace pressure is different by left firing and right firing. Carry over or clogging at the top of the checker in regenerator chamber on the dog house side can be the cause. Prevention of carry over and cleaning of checker are required.

	Furnace Pressure
Right side firing	1.5 mm H_2O
Left side firing	3.0 mm H_2O

4-2-6 Warning System

(B) It is impossible to recover losses caused by even 5 minutes suspension of production in a glass works operating 24 hour around the clock. Especially, failure of the furnace has a heavy impact on the production. Therefore, it is vitally important to prevent accident and even in case of a trouble occured, quick trouble shooting and repair must be made to recover normal operation.

As an effective measure, installation of some forms of alarming system is recommended.

Type of Alarming

1. Maximum temperature
2. Upper and lower limits of the glass level
3. High or low fuel oil pressure
4. High or low primary air pressure
5. High or low air pressure for instrument
6. Decrease in batch charger cooling water pressure
7. Stop of throat cooling fan
8. Stop of primary air fan (for UM-1 and UM-2)
9. Stop of furnace cooling fan
10. Stop of automatic reverser (for 100 t furnace)
11. Stop of batch charger
12. Falure of batch flow from the batch tank to the batch charger
13. Electric booster conditions

4-2-7 Management and Other Control

(C) It is necessary to make operators more interested in glass quality and fully aware of importance of batch mixing for melting and that fluctuation of the glass level and temperature variation in the working end have a great impact on the glass container forming operation.

(C) Data and records are well maintained of operation from day to day, but not utilized for improvement at all. They must be made use of setting operation target in future.

(C) Furnace operators should sample glass from working end by himself for checking number of seeds, color and etc. Also, they are required to check position of the batch piles in the furnace and record the findings in the daily report.

(A) Tanks No. 1 and No. 2 as well as 100 t furnace are hard to check the conditions inside.

Recommend peep hole be provided and furnace pressure be rectified to the normal level.

(C) Furnace operation process control chart should be prepared in order to strengthen control, improve guality as well as make furnace life longer. (See Attached Annex 2, 3, 4.)

(C) Disorder is noted around the furnace and the charging floor. Unused equipment must be removed and charging floor should be fixed by welding for safety.

A complete installation of inspection deck and safety passage would certainly help increase frequency of checking as a matter of course.

4-3 Production Operation

4-3-1 Gob Forming

For forehearth temperature control, daily control on instrument section has been well kept, and the maintenance and operation being well performed beyond reproach. First of all, therefore, attempt should be made to attain best gob as close in a form as Parison. Most significant factor in the gob forming is to feed the gobs in the correct shape at a constant temperature to the forming machine.

To achieve the purpose, the followings should be taken into the consideration:

(B) Change feeder combustion fuel from oil to gas.

(C) Selection of a suitable clay plunger.

(C) Selection of plunger cam and making familiarize with combination with feeder differential of the feeder machanism.

(C) Reduce shear mark by increasing shear cutting speed.

4-3-2 Forming

The points descrived below depicts problems which are common of all products by IS machine.

Once feeding of the gob in constant and correct shape at stable temperature is maintained, other points requiring important attention are rested with precision of the forming machine and the mold.

4-3-2-1 Settle Mark

Glass thickness of the body is uneven, which are causing high rate of breakage of the bottle at user's plant or during the transport.

(C) Shorten the settle time to as short as neck forming and apply settling at the same time as gob in. (Too much time allowance given over the entire processing)

(C) Keep reheat timing well on both blank mold and finish mold side to obtain even glass distribution. Timing drum setting charts were for a comperative study in the attached Table (26), (27) and (28). Weight, volume and speed by product and machine are shown in the attached Table (29).

4-3-2-2 Bent Bottle

750 ml round whisky bottles with 8 mm bent are packed.

(C) Reduce the take-out timing speed.

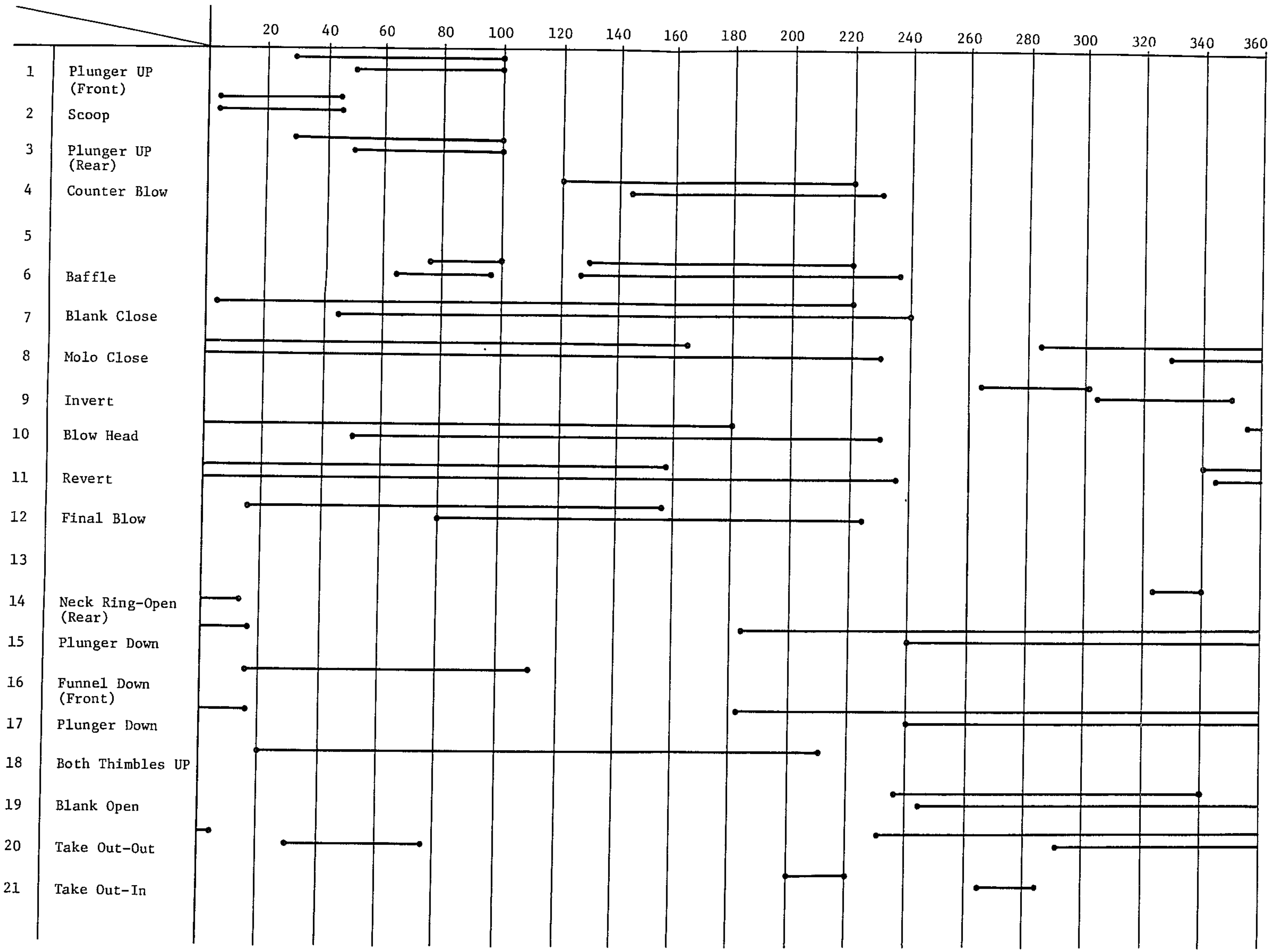
(B) Improve bottle coolin on the dead plate. Lack of air supply is noted in general on the dead plate.

4-3-2-3 Checks on the Finish

Check defects are being caused by inadequate maintenance of holders, arms and mechanisms.

(A) 2 sets (section × 2) each of holder and arm in the best quality must be provided for respective IS machine.

Table (26)



750 mℓ Bangna Plant #3

Table (27)

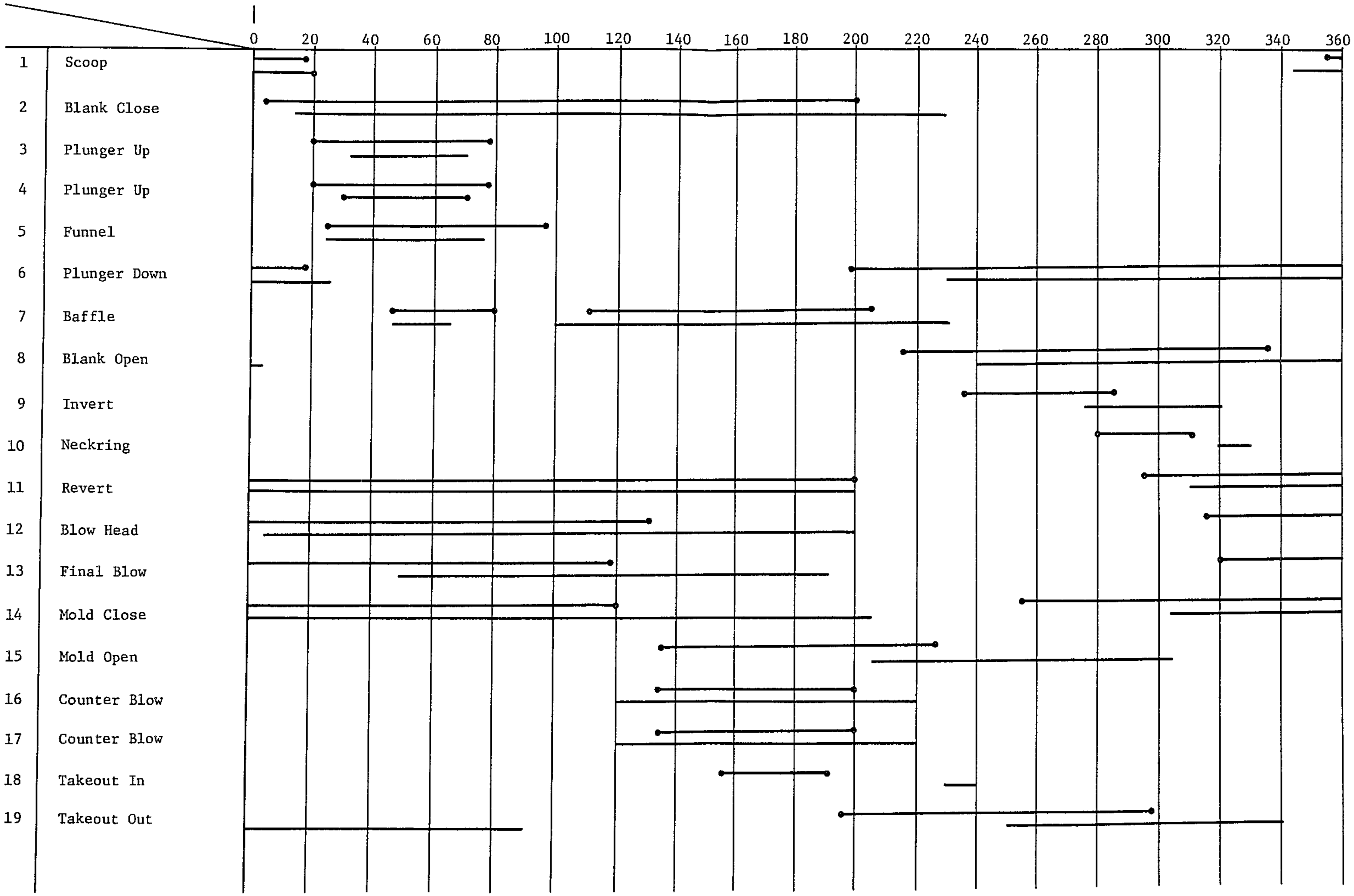

0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
1 Scoop
2 Blank Close
3 Plunger Up
4 Plunger Up
5 Funnel
6 Plunger Down
7 Baffle
8 Blank Open
9 Invert
10 Neckring
11 Revert
12 Blow Head
13 Final Blow
14 Mold Close
15 Mold Open
16 Counter Blow
17 Counter Blow
18 Takeout In
19 Takeout Out

Table (28)

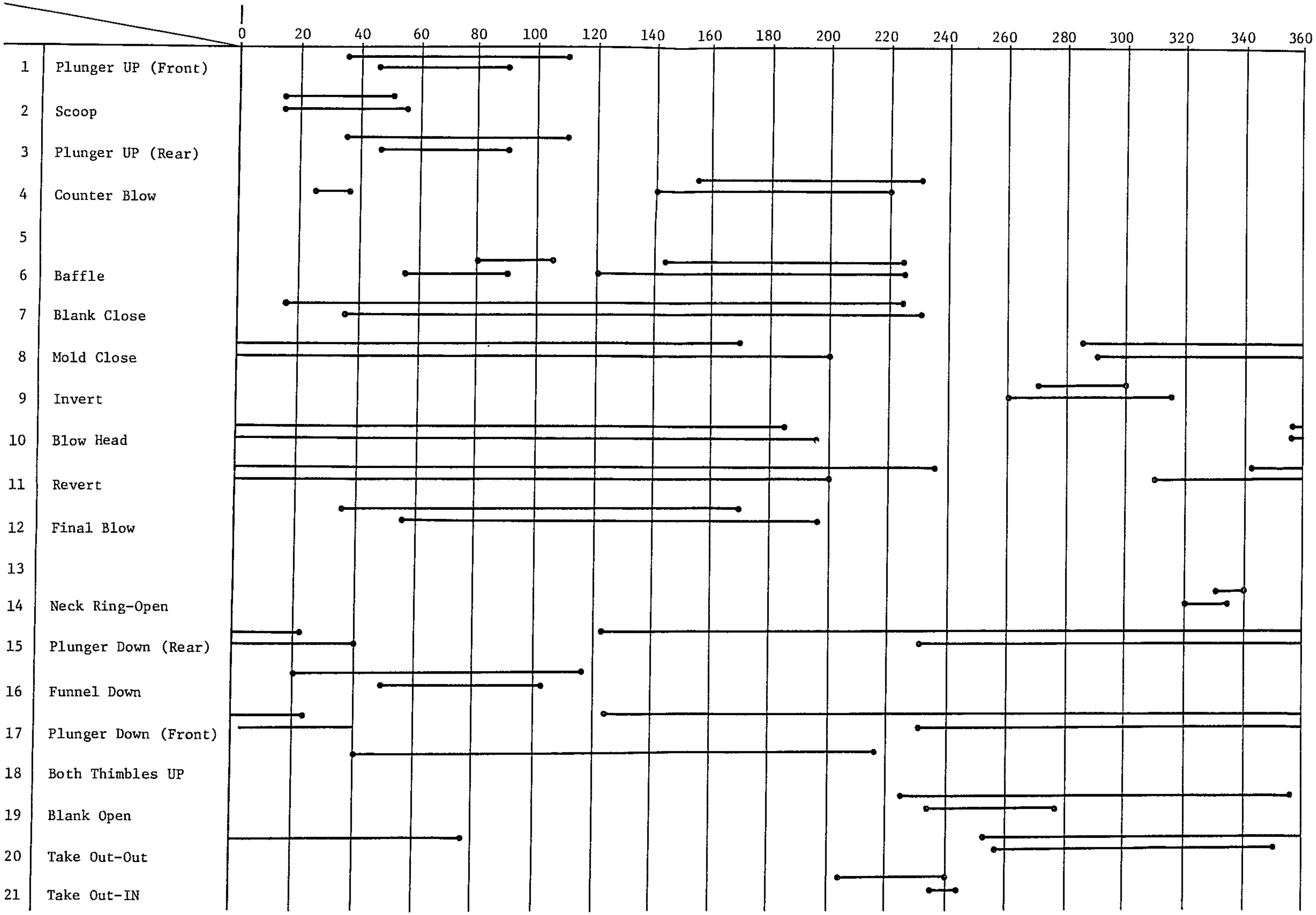

0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
1 Plunger UP (Front)
2 Scoop
3 Plunger UP (Rear)
4 Counter Blow
5
6 Baffle
7 Blank Close
8 Mold Close
9 Invert
10 Blow Head
11 Revert
12 Final Blow
13
14 Neck Ring-Open
15 Plunger Down (Rear)
16 Funnel Down
17 Plunger Down (Front)
18 Both Thimbles UP
19 Blank Open
20 Take Out-Out
21 Take Out-IN

Table (29)

Plant	Machine	Del. Dist.	C.D.	Machine No.	r.p.m.	Weight	Volume
						g	cc
1	L-10			No.2	20	300	225
	LBJ			No.2	22	125	80
	LBJ			No.11	25	70	10
	G.T				14	340	
	LBJ			No.10	30	30	
	PB-6			No.2	22	160	6-1/2 oz
	PB-6			No.2	14	220	
2	IS-6.S/G			No.1	40	340	375
	IS-6.D/G	3"	4-1/4"	No.6	110	55	102
	L-10			No.6	20	390	6-3/4 oz
	LBJ			No.6	27	45	10 oz
	IS-6.D/G	4-3/8"	4-1/4"	No.2	50	545	570
	L-10			No.4	22	300	8 oz
	LBJ			No.7	27	25	15 cc Fed into the 2 machines by D/G Cutting
	LBJ			No.8	27	25	15 cc
3	IS-6.D/G		4-1/4"	No.3	130	35	15
	IS-F-6.D/G	4-3/8"	5-1/2"	No.4	70	340	375
	IS-F-6.D/G	4-3/8"	5-1/2"	No.5	64	545	750

LBJ: Lynch Baby Machine made in Japan.

PB12 No.1)
L-10 No.3) Spare Machine available.

(C) Check the mechanism with jig for troubles involved in forming, if any, especially clossing of plunger mechanism and blank mold, squaring invert mechanism.

(C) Guide checks are also noted caused by 90° pusher, ware transfer, push stacker and etc.

Metal wire mesh is recommended for use to reduce contacting area between glass and metal.

4-3-3 <u>Process Record</u>

(C) This is an essential to control the production processes.

Various type of troubles occured, correction method used, mold replaced are to be recorded in the record for each machine controlled on an individual unit basis. The records should be utilized by feeding back the information during the continuous operation.

4-3-4 <u>Product Control at the Hot End</u>

(C) Make early dicovery of defect and correct immediately by checking unannealed bottles (bottle weight, bottle length, body diameter, bent, mouth diameter, thread pitch, etc.) with various gauges.

(C) Make early discovery of check defects and correct immediately by visual inspection on the conveyer.

4-3-5 <u>Weighing Instrument (Scale)</u>

For weighing small bottles, 100 - 200 g scale should be used instead that of 1 kg.

(C) The present practice of using large capacity scale for small bottle provides only rough reading, resulting in poor accuracy of measurement.

4-3-6 Working Environment

(A) Lack of lighting leaves working place darkish. Coupled with this, uneven floor surface poses safety hazard. If working environment is improved with "Safety First" policy intensified, operation efficiency would no doubt go up as a result.

4-3-7 Job Change Operation

Glass production operation requires a continuous processing and thus, lost time can never be recovered if occured. Shortening job changing time must be considered for this reason.

(C) Make all operators familiar with operation by means of job change instruction sheet.

(A) Make every effort to reduce time consuming operation in job changing by analyzing the operation processes.

(A) Standardize each parts used.

4-3-8 Training of Operators

It is considered essential for operators to acquire knowledge about process control techniques in order to make them fully indoctorinated of quality control concepts.

(D) Develop and maintain training materials.

(C) On-the-job training.

(A) Installation of test machines for training.

4-3-9 Lehr End

4-3-9-1 Implementation of thorough visual inspection.

(B) Improve inspection capability by employing visual inspection station (Defects are seen at least 10% - 20% of packed products).

4-3-9-2 Feed-back of Defective Data

(C) Feed back information on defects occured on bottles to prevent recurrence of the same defect.

4-3-9-3 Introduction of Cold End Coating

(B) For improvement of durability of bottle during the transport.

4-3-9-4 Installation of Cullet Conveyer

4-3-9-5 Introduction of more Sophisticated Inspection Equipment

(B) Improve inspection accuracy by converting to automatic inspection equipment in future.

4-4 Quality Control Operation

(C) The followings are recommended for improvement of operations:

Prepare ware (Product) drawings, mandatorily required.
Prepared ware (product) quality standard.
Prepare ware (product) specifications.
Establish standard criteria for ware (product) checking.
Apply sampling process and sampling inspection.
Implement control on glass weight and volume.
Secure sufficient scope of measuring instrument.
Prepare characteristic value measurement table.

4-5 Maintenance

Lack of drawings for every one of production equipment. (Majority of them are not available)

(C) Maintain and use tools and jigs effectively based on the maintenance standard.

(B) Secure adequate number, and types of spares for both machine parts and operation parts and keep them controlled daily.

(C) Air leakage is seen between piping to machines, caused by loose joint.

(A) Compressors should be relocated in concentrated area at one place or two, if ever feasible.
Compressors take approximately 50% of the total power demand.

(A) In power supply, recommend centralized receiving system facility be employed for monitoring interior of extra-high tension side and also from safe operation point of view.

Power usage is very high, showing 497.5 kwh/ton of glass as compared with 246 kwh/ton of glass for Toyo Glass. (Nearly a double)

Instruments are under daily control of measurement and Instrument Control Section and all automatic instruments are found functioning accurately on an automatic basis for which instrument maintenance and performance are observed beyond reproach. This excellent control may suggest that other operations should have been potentially able to improve as well.

4-6 Mold

Some of molds were purchased from OMCO of Belgium and Johnson Radley of UK, and others were of in-house manufacture. However, there is neither function for the mold designing nor mold drawing at all. It is necessary to make all company personnel aware that mold constitutes one of the most important factors in manufacturing quality glass bottles.

(A) Mold drawings as well as the parts drawing must be prepared.

(C) Encourage prevalent use of check-gauge in machining and discontine practice to rely on feeling or experience.

(B) Fabricate interchangeable mold by purchasing a copy lathe.

(C) Machine the plunger with profile bit.

(C) Provide a gap in the center of blank mold to prevent disalignment of neck and bottom part which is caused by warping of mold in high temperature.

(C) Repair of mold in Use - Abolish gas welding and use COLMONOY for machining.
- Use finer polishing wheel to finish surface clean.
- Use jigs for repair and check jigs with gauge.

(C) Determine acceptance or rejection of all mold by means of volume chek and gauge inspection.

4-7 Safety

As described earlier, there are some points for which measures are required to be taken for improvement of working condition and safety.

(C) Orderliness must be maintained with safety consciousness in mind, especially of such places requiring frequent access for monitoring or inspection as charging floor, feeder deck and walk way around the furnace.

Checking on hazardous spots and walk way and passage with obstacle laid in the way is likely to be avoided and the checking frequency becomes less.

Slipping stopper of stair steps

Factory lighting

Eveness of floor surface level

Scattered cullet around the cullet storage

Electricity wiring rack running overhead interrupts operators to work on shovel leader operation for carrying cullet to UM-2 conveyer hopper. They must bend to avoid the rack. Rust developing of L.P.G. Tank.

(C) There is a function responsible for safety, according to the report received. Safety committee meeting must be held periodically with strengthening safety patrol.

4-8 Management and General Comments

Work Hours	Regular day work		08:30 - 16:30
	Shift work	4 crew 3 shifts	
			07:00 - 15:00
			15:00 - 23:00
			23:00 - 07:00

Extreme laxity was noted of work hours control on regular day work functions. Stricter control is required.

It is necessary to make closer contact, coodination and cooperation between divisions of the company. Some manager insists on sectionistic view stating that Productin Division's mission is only in producing, being indifferent to increase in stack of material delayed in processing.

4-9 Sales

Sales Division is manned with:

Division office	- 6	persons
Sales	- 5	"
Marketing	- 5	"
Ads & Customer Service	- 5	"
Total	19	persons

PBS products and manual and semi-manual products manufactured by the pilot plant are all sold through Siam Glass through its agents. The glass tube is directly sold to Chong Den Eha.

On account of this sales route, communication remains unsatisfactory with difficulties in getting information on user's trend, problem and bottle demand and etc.

Bottle sales shares 67% of the total, mainly consising of round, flat and small flat bottles for Mekon Whisky. Others are of medicine bottles and those for soft drink and miscellaneous uses.

Selling prices of bottles and tableware are determined by pricing meeting comprising 7 members including plant manager, sales manager, deputy sales manager and accounting manager.

Appendix 1

Analytical Result of Silica Sand

(Analyzed in Japan)

	Silica Sand	Washed Sand
Ign. loss %	0.34 %	0.24 %
SiO_2 "	99.3	99.4
Al_2O_3 "	0.27	0.34
Fe_2O_3 "	0.043	0.040
CaO "		
MgO "		
Na_2O "	(0.01 - 0.03)	
K_2O "	0.02	0.02
SO_3 "		
TiO_2 "		
Cr_2O_3 "		
MnO "		
Total:	99.97 %	100.04 %
H O "		
More than 1.0 mm	0.1 %	0.1 %
1.0 - 0.84 mm	0.2	0.1
0.84 - 0.59 mm	0.3	0.2
0.59 - 0.42 mm	0.8	0.9
0.42 - 0.25 mm	8.2	9.4
0.25 - 0.105 mm	86.8	87.8
Less than 0.105 mm	3.6	1.2

Analytical Result of Finished Products

(Analyzed in Japan)

	Tableware	Container
S_1O_2	70.3 %	71.1 %
Al_2O_3	1.57	1.62
Fe_2O_3	0.086	0.116
Cao	7.64	9.67
MgO	2.27	0.71
Na_2O	16.90	15.60
K_2O	0.00	0.00
SO_3	0.25	0.22
Total:	99.016 %	99.036 %

S.P.	695°	712°
S.G.	2.4974	2.5015

S.P. ..... Softening Point

S.G. ..... Specific Gravity

Brightness	81.0%	84.4%
	(Toyo Glass Standard 85.0% or over)	
Wave Length	571.9 mm	569.0 mm
	(567 - 577)	
Purity	3.1%	2.3%
	(2.0% or below)	

Appendix 3

FURNACE No. & COLOUR			A PLANT-1 TANK-I ฿			B PLANT-1 TANK-II ฿			C PLANT II & III ฿		
Material	Factor %	Cost ฿/kg	Composition Wt.	Ratio to Sand 100	Cost	Composition Wt.	Ratio to Sand 100	Cost	Composition Wt.	Radio to Sand 100	Cost
Sand	99.58	0.110	123	100	13.530	123	100	13.530	300	100	33.000
Soda Ash	57.78	2.396	50	40.65	119.800	50	28.9	119.800	100	33.3	239.600
Lime Stone	55.42	1.89							75	25.0	141.750
Dolomite	99.54	0.414	31	25.2	12.834	28	16.2	11.592			
Sodium Sulfate	99.30	2.58	0.8	0.650	2.064	0.8	0.462	2.064	2.35	0.783	6.063
Sodium Nitrate	36.5	4.67	0.6	0.488	2 802	0.7	0.405	3.269	1.1	0.367	5.137
Calumite											
Fluorspar		1.175				1.8	1.04	2.115	3.6	1.2	4.230
Feldspar	88.09	1.029	12	9.76	12.348	12	6.9	12.348	39	13.0	40.131
Selonium		825	3.17g	. 2.577	2.615	1.219g	0.705g	1.006	5.253g	1.951g	4.334
Cobalt Oxide		630	0.199g	0.162	0.125	0.211g	0.122	0.133	0.298g	0.100g	0.188
Mixed Oxide		11.50	80	0.650	0.920	80	46	0.920	160g	53g	1.84
Total wt(kg)			215,690			216,515			521.570		
Glass Wt./Total Cost			180.524/167.038			181.123/166.777			442.525/476.273		
Cullet		0.94	200	163	188	200	163	188	200	66.7	188.000
Total Glass Wt./Total Cost			380.524/355.038			381.123/354.777			642.525/664.273		
Glass Wt./Batch Wt. x 100 (%)			92			92			89		
Cullet % (%)			50			51			31		
Glass Cost	Raw Batch Cost		฿ 925/t			฿ 921/t			฿ 1076/t		
Glass Cost	Batch Cost		฿ 933/t			฿ 931/t			฿ 1034/t		

DATE: 31-8-'78 COMPOSITION & COST REPORT

MELTER TEMPERATURE (°C, a.m 9:00): 1,300 / 1,250

REFINER R. P (°C, a.m 9:00): 1,200 / 1,150

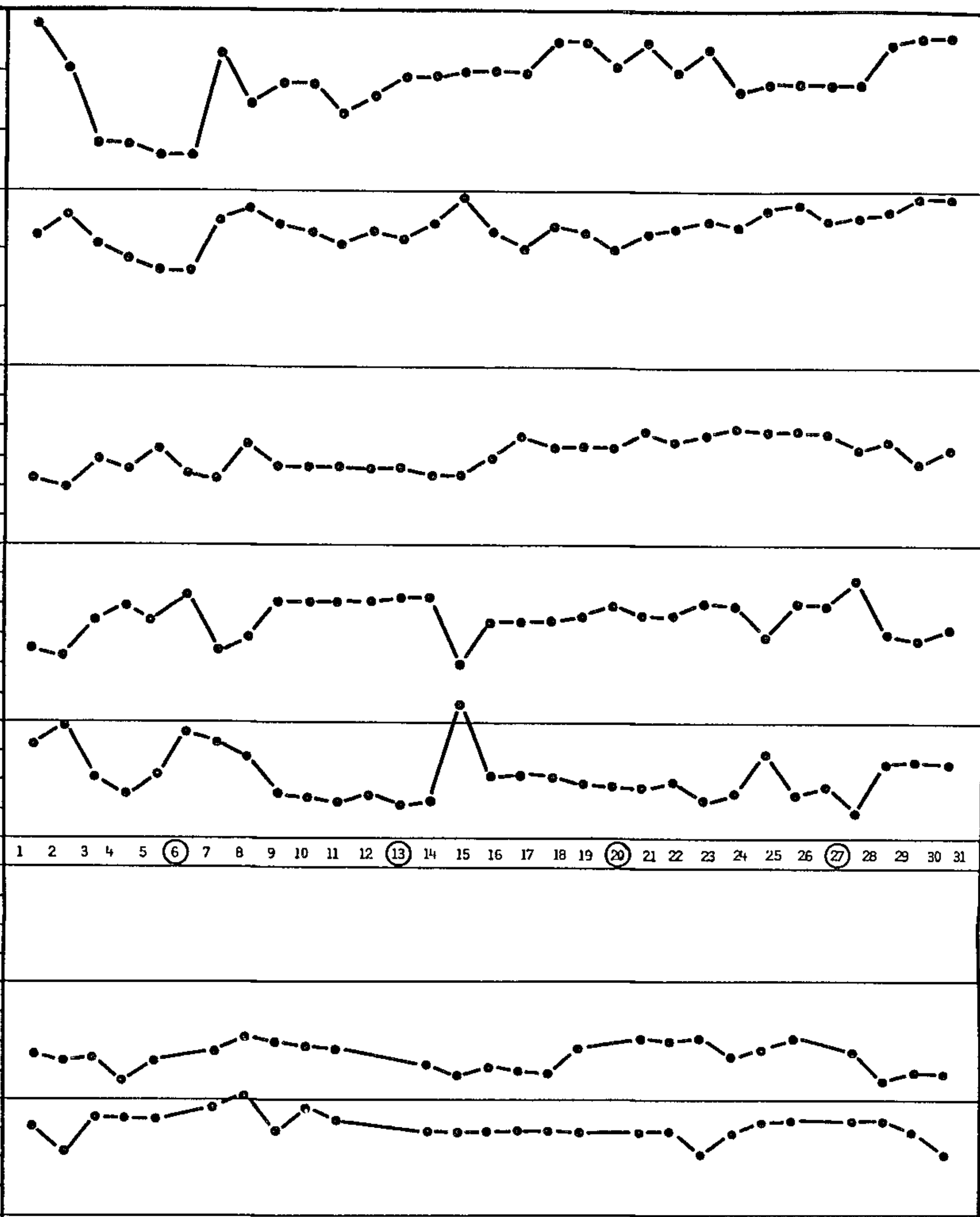
FUEL CONSUMP. kℓ/day: Oil 8 / 7 / 6; Booster kWH

PULL. ton/day: 20 / 10

Fuel Consump./ton: 500 / 300 ℓ/ton; kWH/ton

D A T E

QUALITY: Seed Count Pieces/cm³; S. G 2.4950 / 2.4900; Moisture % OF Silica Sand % 10 / 5; Ring Section Cord kg/cm²



Melter R. P
$\overline{X}$ = 1,294°C

Refiner R. P
$\overline{X}$ = 1,218°C

Oil
Total 218,880kℓ/M

Booster
Total - kW/M

Pull
Total 532,031ton/M

$\overline{P}$ = 17,162 ton/day

$\overline{X}$ = 400 ℓ/ton

$\overline{X}$ = - kWH/ton

Seed
$\overline{C}$ =

UCL 2.4931
$\overline{X}$ = 2.4914
LCL 2.4889

$\overline{X}$ = 10.3 %

$\overline{X}$ = kg/cm²

N O T E

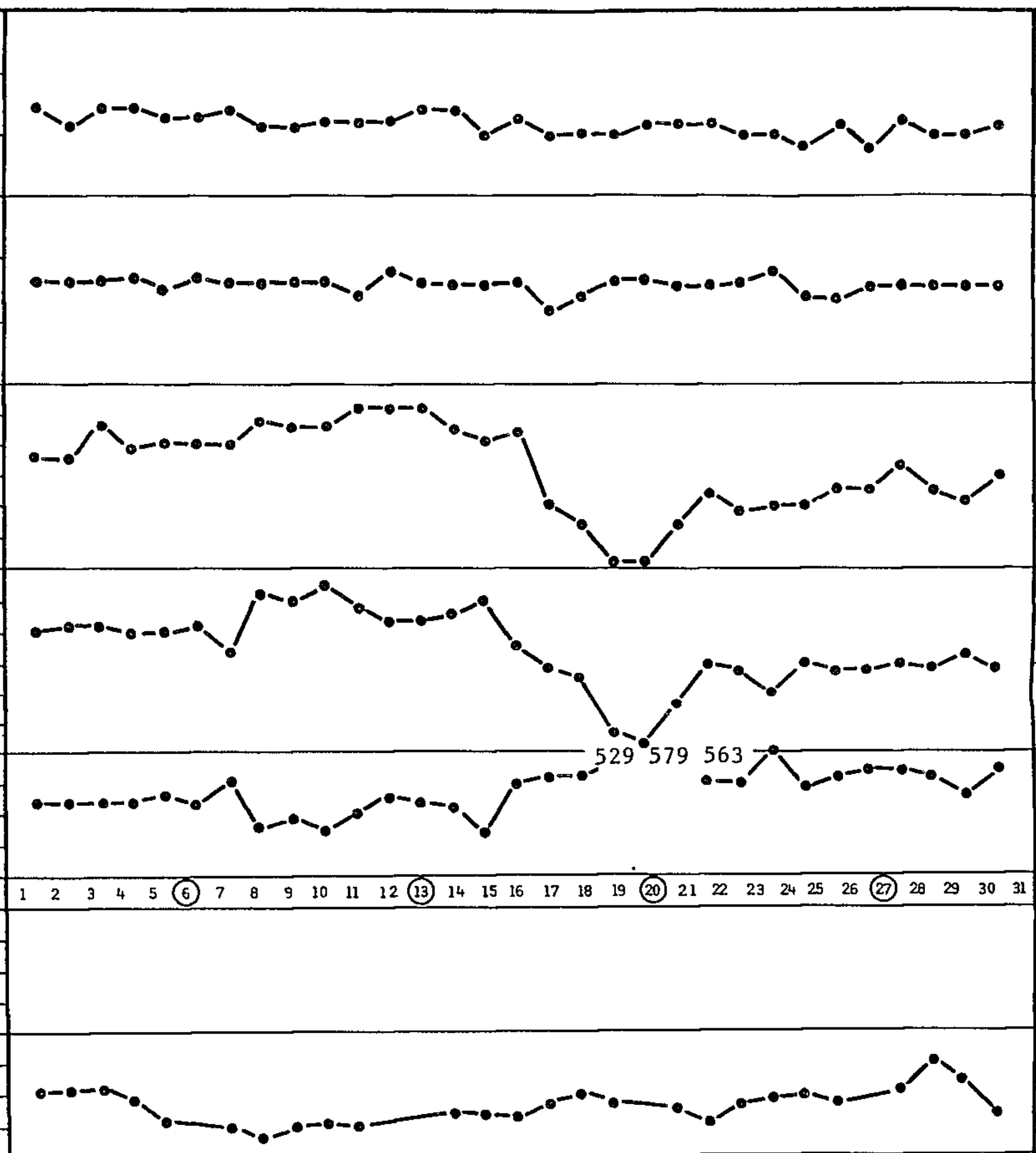
COMPOSITION	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Silica Sand (E)	Kg	123																														
Fluorspar	"																															
Soda Ash	"	50																														
Sodium Nitrate	"	0.5		0.6																												
Sodium Sulphate	"	0.8																														
Selenium-Soda	g	80																		90						110					190	
Cobalt-Soda	"	50		115						105								90														
Feldspor	Kg	12																														
Dolomite	"	30.5																								31						
Mix Oxide	g	80																														
Domestic Cullet		200																														

	Anal.	Calucu.
SiO_2	71.94	72.259
Al_2O_3	1.913	1.401
Fe_2O_3	0.057	0.050
CaO	7.62	5.568
MgO	1.60	3.378
Na_2O	16.26	17.095
K_2O		
SO_3	0.34	0.248
Alkali		ml
Y		%
λd		mμ
Pe		%

Start	10-July-'78	AGE	82 dats	Glass Wt.(A)	532,031 ton	Product Wt.(C)	307,290 ton	Oil Consump. (A)	10^4kal/t
Melting Area	200 ft²	No Product Days	days	Σ (A)	TON	Σ (C)	ton	KWH Consump. (A)	10^4kal/t
Booster	- kW	Colour Change Days, etc.	days	M. Area/$\overline{P}$	11.6 ft²/ton	Product Yield (C/A)	57.8 %	Fuel Consump. (A)	10^4kal/t
Colour	Flint	Bottom Temp.	°C	Σ M. Area/$\overline{P}$	ft²/ton	Σ(C)/Σ(A)	%		

Date: August-'78 No. TANK-1 FURNACE CONTROL CHART

MELTER TEMPERATURE (°C)	1,550 / 1,500	Melter P.P $\overline{X}$ = 1,509°C
REFINER (°C)	1,300 / 1,250	Refiner O.P $\overline{X}$ = 1,280°C
O. P (°C)		
FUEL CONSUMP: Oil (kℓ/day) / Booster (kWH)	17 / 16	Oil Total 515,510kℓ/M; Booster Total - kW/M
PULL. (ton/day)	50 / 40 / 30	Pull Total 1,312,998 ton/M; $\overline{P}$ = 42,354 ton/day
Fuel Consump/ton (ℓ/ton / kWH/ton)	400 / 300	$\overline{X}$ = 393 ℓ/ton; $\overline{X}$ = - kWH/ton
QUALITY: Seed Count (Pieces/cm^{-3})		Seed $\overline{C}$ =
QUALITY: S.G	2.5000 / 2.4950	UCL 2.5008; $\overline{X}$ = 2.4968; LCL 2.4941
QUALITY: S. P (°C)		$\overline{X}$ = °C
QUALITY: Ring Section Cord (kg/cm^2)		$\overline{X}$ = kg/cm^2



D A T E: 1 2 3 4 5 (6) 7 8 9 10 11 12 (13) 14 15 16 17 18 19 (20) 21 22 23 24 25 26 (27) 28 29 30 31

N O T E

COMPOSITION	Unit	1	23	29
Silica Sand	Kg	300		
Limestone	"	75		
Fluorspar	"	3.6		
Soda Ash	"	100		
Sodium Nitrate	"	1.1		
Sodium Sulfata	"	2.35		
Selemium-Soda	g	220	240	
Cobalt-Soda	"	105		120
Mix Oxide	"	160		
Feldspor	Kg	39		
Cullet	Kg	200		
Total wt	Kg	721,535	721.555	721.570

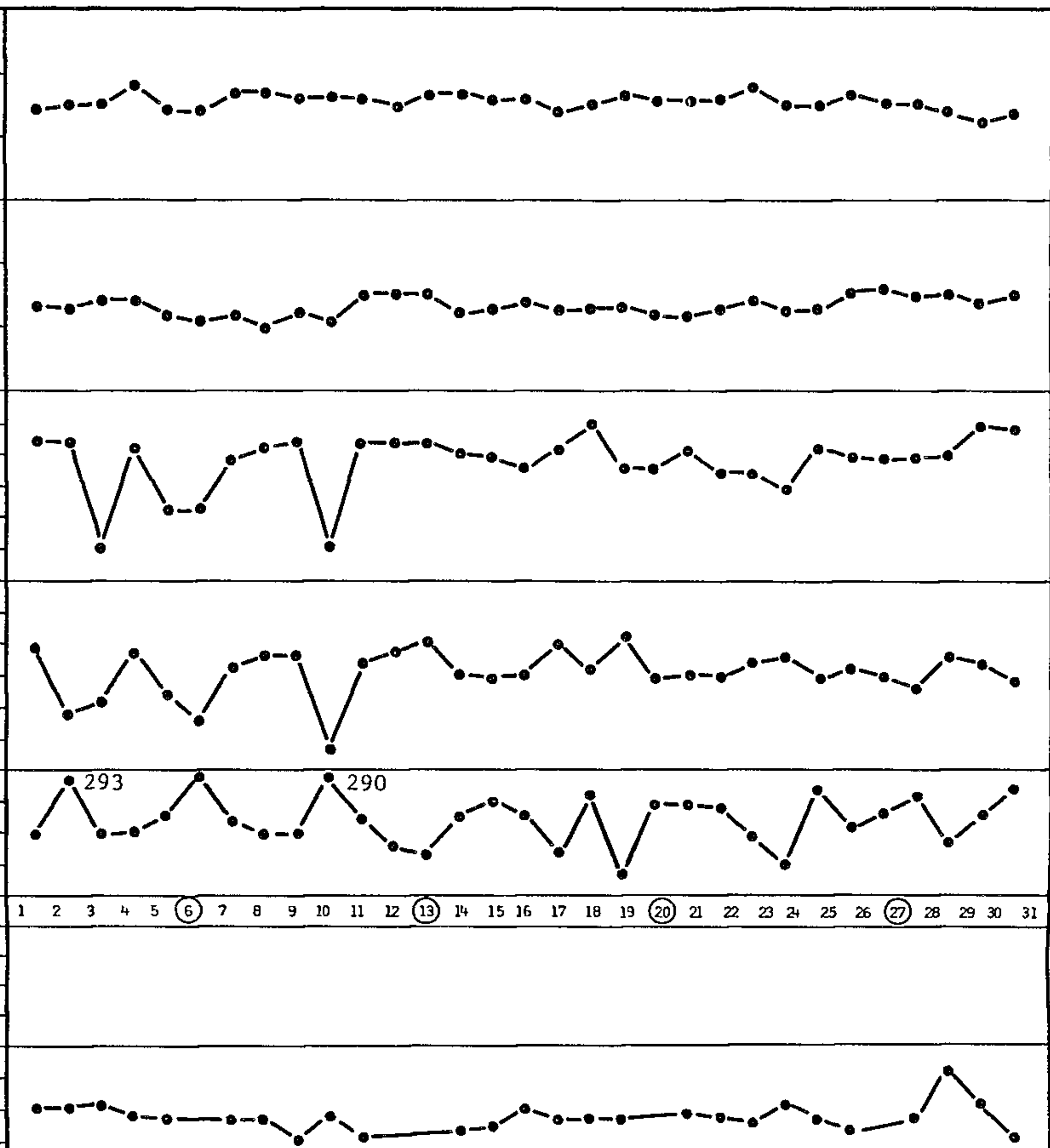
	Anal.	Calucu.
SiO_2	72.869	73.415
Al_2O_3	2.156	1.813
Fe_2O_3	0.044	0.054
CaO	10.16	9.962
MgO	0.279	-
Na_2O	13.70	14.409
K_2O		
SO_3	0.300	0.297
F_2	0.48	0.051
Alkali		ml
Y		%
λd		mμ
Pe		%

Start	20-Nov.-'76	AGE	619 days	Class Wt.(A)	1,312,998 ton	Product Wt.(C)	821,326 ton	Oil Consump. (A)	10^4kal/t
Melting Area	400 ft^2	No Product Days	days	Σ (A)	ton	Σ (C)	ton	KWH Consump. (A)	10^4kal/t
Booster	- kW	Colour Change Days, etc.	days	M. Area/$\overline{P}$	9.4 ft^2/ton	Product Yield (C/A)	62.6 %	Fuel Consump. (A)	10^4kal/t
Colour	Flint	Bottom Temp.	°C	Σ M.Area/$\overline{P}$	ft^2/ton	Σ(C)/Σ(A)	%		

Date: August-'78

No. UM-1 FURNACE CONTROL CHART

		Melter / Refiner T.C. summary
MELTER TEMPERATURE	°C: 1,400 / 1,350	Melter T.C — $\overline{X}$ = 1,378°C
REFINER T.C	°C: 1,300 / 1,250	Refiner T.C — $\overline{X}$ = 1,267°C
FUEL CONSUMP.	Oil kℓ/day: 22 / 21 / 20; Booster kWH	Oil Total 663,260kℓ/M; Booster Total - kW/M
PULL.	ton/day: 90 / 80 / 70	Pull Total 2,503,257 ton/M; $\overline{P}$ = 80,750 ton/day
Fuel Consump./ton	ℓ/ton: 270 / 260 / 250; kWH/ton	$\overline{X}$ = 265 ℓ/ton; $\overline{X}$ = - kWH/ton
DATE	1 2 3 4 5 (6) 7 8 9 10 11 12 (13) 14 15 16 17 18 19 (20) 21 22 23 24 25 26 (27) 28 29 30 31	
QUALITY — Seed Count	Pieces/cm³	Seed $\overline{C}$ =
QUALITY — S. G	2.5000 / 2.4950	UCL 2.5008; $\overline{X}$ = 2.4971; LCL 2.4954
QUALITY — S. P	°C	$\overline{X}$ =
QUALITY — Ring Section Cord	kg/cm²	$\overline{X}$ = kg/cm²
NOTE		



COMPOSITION	Unit	1 2 3 4 5 (6) 7 8 9 10 11 12 (13) 14 15 16 17 18 19 (20) 21 22 23 24 25 26 (27) 28 29 30 31			Anal.	Calucu
Silica Sand	Kg	300		SiO_2	72.88	73.415
Limestone	"	75		Al_2O_3	2.156	1.813
Fluorspar	"	36		Fe_2O_3	0.044	0.054
Soda Ash	"	100		CaO	10.16	9.962
Sodium Nitrate	"	1.1		MgO	0.279	-
Sodium Sulfate	"	2.35		Na_2O	13.70	14.409
Selenium-Sada	g	220	240	K_2O		
Cobalt-Soda	"	105		SO_3	0.300	0.297
Mix Oxide	"	110		F_2	0.48	0.051
Feldspor	Kg	39				
				Alkali		ml
Oullet	Kg	200		Y		%
				λd		mμ
Total Wt.	Kg	721.535		Pe		%

Start	28-Oct. '75	AGE	1,038 days	Glass Wt.(A)	2,503,257 ton	Product Wt.(C)	2,268,987 ton	Oil Consump. / (A)	10^4kal/t
Melting Area	491 ft²	No Product Days	days	Σ (A)	ton	Σ (C)	ton	KWH Consump. / (A)	10^4kal/t
Booster	- kW	Colour Change Days, etc	days	M. Area/$\overline{P}$	6.0 ft²/ton	Product Yield (C/A)	90.6 %	Fuel Consump. / (A)	10^4kal/t
Colour	Flint	Bottom Temp.	°C	Σ M.Area/$\overline{P}$	ft²/ton	Σ(C)/Σ(A)	%		

Date: August '78 — No. 100 T/D FURNACE CONTROL CHART

5. Conclusions

In a glass works, producing and supplying homogeneous quality glass in a series of the processes starting with raw material, furnace operation, forming and annealing, equipment are the prerequisits for improving substantial quality of glass products. And, it is essential to keep these production equipment and the incidentals in a balanced situation throughout the processes.

In addition, products assured of quality can be available for sales only when advanced technology of manufacturing, maintenance and controlling concerted in a integrated discipline.

The findings of this survey are covered in the earlier description. For improvement measures of quality, three items are recommended in the division of: (1) improvement on long range plan. (2) improvement of present situation as required at least to keep a certain quality level, although economical constraints may exist in produring new equipment, (3) minor improvement possible with less cost and adjustment or change of present operating practice alone.

Summary of survey results:

1. Some of the equipment installed are of modern type. However, imbalance between modern and conventional or rather obsolate equipment is conspicuously noted in many cases.

2. Manufacturing efficiency (yield ratio) remains low. Moreover, if the low efficiency had been of high quality standard, it would leave some bright aspect, but on the contrary, that of low quality standard as seen in the operation is just out of question. First of all, yielding ratio should be improved to 85 %.

3. With pack to melt ratio improved to 80 to 90 %, on estimated increase as salable glass containers would commensurate with production of a 50 - 60 ton/day furnace.

4. It is necessary to go through fundamental principles of production technique of the glass container once again.

5. To concrete an intensive efficiency-up drive on such high sales share item as Mekon Whisky bottle that can be blown throught the year can be an effective idea. This could contribute to cost down and manpower saving.

6. Also, it is essential to make the company competitive with private enterprises, although these may be constraints from government policies or regulations in many respects.

Finally, we would like to take this opportunity to express our heart felt appreciation for assistance and cooperation given by officilas in Bangkok office of Japan International Cooperation Agency and Bangna Glass Works.

JICA