

**Project Planning for Small and
Medium Scale Industries No. 21**

POWDER MILK
Manufacturing Plant

February 1988



JAPAN CONSULTING INSTITUTE

This technical brochure was compiled to help in the drafting of a suitable plan for the construction of a Powder Milk Manufacturing Plant.

The production scale and manufacturing process have been described in this brochure on the basis of a typical instance.

The profitability was estimated by fixing certain required conditions, which may differ from country to country.

We hope that the data contained in the brochure will help you to draw up the most suitable plan for the industrialization of your project.

In case a government or public organization requests the Japan Consulting Institute to conduct a feasibility study of the above industry for the purpose of establishing the most suitable plan, it is possible for us to carry this out free of charge.

Reproduction of any part of this brochure without permission is prohibited.

CONTENTS

	Page
1. Introduction	1
2. Powder Milk	1
2.1 Kind of Powder Milk	1
2.2 Ingredients of Powder Milk	3
2.3 Use of Powder Milk	4
3. Manufacturing Process of Powder Milk	4
4. Outline of Model Plant	12
4.1 Production Scale	12
4.2 Raw Materials Required	12
4.3 Utilities Required	12
4.4 Required Machinery and Equipment	12
4.5 Machinery and Equipment Cost	13
4.6 Layout of Plant and Building	13
4.7 Number of Workers and Placement	13
5. Production Cost and Profitability	16
5.1 Basic Conditions for the Calculation of Fixed Capital, Working Capital and Production Cost	16
5.2 Capital Required	17
5.3 Annual Sales Revenue	18
5.4 Production Cost	18
5.5 Profitability	18
6. Conclusion	19

1. Introduction

Milk contains water, protein, fat, carbohydrate, ash, vitamins, pigments, enzymes and other components, accordingly milk is one of the most important well-balanced nutritious liquid foods.

However, weak-points of milk are watery and perishable nature and as a result milk can not be preserved long and is inconvenient for transportation. Consequently it has to be consumed in a short period and within a small limited area.

Even though milking is carried out under clean condition in a dairy farm, some microbes survive in milk and decay of milk is caused by these and also by watery nature of milk.

There are several methods for processing useful components of milk into preservable dairy products as follows;

- (a) Removing majority of water and drying up milk into powder
- (b) Filling up into package after pasteurization under liquid condition
- (c) Condensing into paste product
- (d) Processing into preservable dairy product after separating specific component (i.e. butter, cheese)

Among these products, liquid product (except long life milk) and processed products, such as butter and cheese, are necessary to be stored in a cold atmosphere.

Liquid and condensed products are still watery so they are inconvenient for transportation.

On the other hand, dried powder milk shows outstanding feature of preservation and also it is easy to handle and to transport with its lighter weight.

Powder milk is a typical preservative dairy product.

Record for the powder milk dates back to the 13 century when the soldier of Genghis-khan carried powder milk as one of portable foods for expedition.

Modern powder milk manufacturing process was originated in 1855 by a technique called as thin film drum drying method and was applied for patent of UK.

Thereafter in USA, spray drying method was practically applied in 1911. In Japan, far behind western countries, Buflo-vak vacuum drum method was introduced as powder milk manufacturing process for the first time in 1920 and then in 1930's spray drying method was introduced.

Consumption of powder milk has grown remarkably as infant nursing milk was shifted from condensed milk to powder milk.

Nowadays it has occupied an important position among the dairy products.

Powder milk production and trade in the world are shown in Table 1, and international trading prices of milk and powder milk are shown in Table 2.

Under world wide scale, supply of milk and powder milk show a tendency of surplus as a whole. However, in Asian countries and other developing countries, demand for powder milk is increasing and import from USA, EC and other advanced countries is also increasing.

Generally in developing countries supply of powder milk as preserved food is apt to be short chronically because of the lack of diffusion of appropriate processing technology of milk and powder milk.

It seems to be useful for developing countries to introduce appropriate processing technology of powder milk and, as a result, to improve nutrition of people.

In this paper, description will be made on the outline of powder milk and powder milk manufacturing plant.

2. Powder Milk

2.1 Kind of Powder Milk

Powder milks are dehydrated and dried products of whole milk, skim milk, cream, butter milk, whey and others.

There are many kinds of powder milk products. Sugar and other additives are added to some of the products in the course of their production.

Typical products among them are whole powder milk, skim powder milk and whey powder.

Table 1. Whole Powder Milk and Skim Powder Milk (Production & Trade)

(Unit: 1,000 Ton)

Countries	Kind of Powder Milk		Whole Powder Milk					Skim Powder Milk				
	Year	Year	1982-83 Mean	1983	1984	1985	1982-83 Mean	1983	1984	1985	1984	1985
Production												
World total			1,782	1,763	1,937	1,925	4,331	4,996	4,482	1,250		
USA, Canada			45	61	62	65	749	832	693	780		
EC (10 countries)			706	627	742	730	2,117	2,473	2,074	1,920		
Australia, New Zealand			167	170	172	180	275	286	371	350		
USSR			205	235	270	280	363	472	480	490		
Export												
World total *1, *2			867	750	846	830	1,816	1,839	2,068	2,150		
USA, Canada			34	37	19	20	209	342	358	400		
EC (10, including regional)			622	502	610	600	1,029	1,137	1,291	1,305		
EC (10, excluding regional)			506	394	495	480	478	192	312	350		
Australia, New Zealand			158	154	171	175	173	181	219	220		
Japan			-	-	-	-	1	-	-	-		
Developing Countries			-	-	-	-	14	17	11	10		
Developing Countries (OPEC)			-	-	-	-	1	1	1	-		
Import												
World total *1, *2			583	520	623	610	1,520	2,184	2,350	2,450		
USA, Canada			-	-	-	-	5	6	7	-		
EC (10, including regional)			-	-	-	-	549	967	1,019	1,030		
EC (10, excluding regional)			-	-	-	-	3	5	4	5		
Australia, New Zealand			-	-	-	-	-	1	-	-		
Japan			-	-	-	-	93	92	90	100		
Developing Countries			350	312	409	390	1,100	1,065	1,175	1,200		
Developing Countries (OPEC)			104	86	118	105	323	305	333	325		

Source: FAO 1985-86

Remarks: *1 Including EC regional trade

*2 Deviation between export and import of world total for whole powder milk and skim powder milk is caused by difficulties of collection of statistic figures and classification of them.

Table 2. International Trading Price of Milk and Dairy Products

Year	1982-83 Mean	1983	1984	1985
(Milk Producer's Price/kg)				
USA(US\$) *1	0.27	0.27	0.26	0.25
West Germany (DM) *2	0.65	0.71	0.71	0.72
New Zealand (NZ\$)*3	0.13	0.17	0.19	0.20
Japan (Yen)	100	100	100	99
(Wholesale Price/kg)				
Butter (US\$)	3.20	3.25	3.28	3.12
Cheese (US\$)	3.02	3.05	3.04	2.89
Skim Powder Milk (US\$)	2.03	2.05	2.00	1.92

Source: FAO 1985-86

Remarks: *1 Excluding reduction of price for controlling oversupply.

*2 Including added value tax, but not subtracting common responsible surcharge.

*3 Value of dairy farm year which ends in May of the year.

(1) Whole powder milk

Whole powder milk is produced by drying whole milk after standardizing its main ingredients, pasteurizing and concentrating.

By dissolving it into water of 8-times of the weight, whole powder milk becomes almost same as whole milk.

Whole powder milk can be preserved longer compared with whole milk. However, preservability of it is lower compared with other powder milk and its preservable storage period is about 2-months under the condition of room temperature (15°C), because it contains fatty ingredient which is apt to be oxydized.

(2) Skim powder milk

Skim powder milk is a dried product of skim milk, which is made from whole milk by separating cream, pasteurizing and concentrating.

By dissolving it into water of 11-times of the

weight, the skim powder milk becomes almost same as skim milk.

The preservable period of the skim powder milk is more than one-year under the condition of room temperature (15°C), because fat content of the skim powder milk is lower than 1% and so it is not perishable unless otherwise absorbing moisture from atmosphere during storage.

(3) Prepared powder milk

Prepared powder milk is a dried product of prepared whole milk which is made from the whole milk by adding some additives necessary for artificial nurishment such as some kind of sugar, whey powder, minerals, vitamins, nicotinic acid and others.

Processing method of it is almost same as that of other powder milk products.

Prepared powder milk is mainly applied to one to five-month-old infant after dissolving it into hot water of 6-times of the weight.

(4) Whey powder

Whey powder is produced by drying cheese whey after pasteurizing and concentrating.

The whey powder is mainly utilized as a sub-raw-material in confectionery and baking bread.

In addition, there are many kind of powder milks such as sugar added powder milk, powder milk for coffee, butter-milk powder, icecream-mix powder and others.

2.2 Ingredients of Powder Milk

Contents of ingredients of the powder milk is affected by kinds of feed and other conditions of each country. They are adjusted so as to meet their use.

In each country the standard composition of the powder milk is established respectively as guidance of nutritive value.

For example, some standard composition of powder milk in Japan are shown in Table 3.

Table 3. Composition of Powder Milk

(Content in 100 g)

Kind	Ingredient	Calorific value Kcal	Water g	Protein g	Fat g	Carbo- hydrate g	Ash g	Calcium mg	Sodium mg	Phosphorus mg	Iron mg
Whole powder milk		491	3.0	25.5	26.2	39.3	6.0	890	430	730	0.4
Skim powder milk		360	3.8	34.0	1.0	53.3	7.9	1,100	550	1,000	0.5
Prepared powder milk		504	2.2	13.4	26.2	55.7	2.5	390	190	310	6.3
Icecream-mix powder milk		486	2.0	4.1	22.7	69.4	1.8	100	330	220	0.3

Source: Standard Composition of Food, Rev-3 (The Science and Technology Agency, Japan)

2.3 Use of Powder Milk

Powder milk has a superiority in preservation over other milk products and is convenient for transportation and handling with its lighter weight.

Skim powder milk is a typical product among many industrial milk products and is produced without exception in large scale milk processing plant of many countries of the world.

Skim powder milk is widely utilized as raw material for confectionery, baking bread, ice cream, cooking, infant food and home use.

With these characteristics of the skim powder milk, in every country, surplus raw milk over domestic demand is processed into skim powder milk and then it is stocked as preservative-food for domestic use or exported to other countries.

The preservability of the whole powder milk is lower compared with other kinds of powder milk because it contains about 25% of fatty ingredient which is apt to be oxydized.

In spite of above disadvantages, the whole powder milk is produced widely in all over the world, because pre-treatment of cream separation is not necessary in the manufacturing process and the process is simple.

The whole powder milk is widely utilized as raw material for reconstituted milk, confectionery and for whole milk yoghurt.

The prepared powder milk contains various

necessary nourishment for baby food and is usually used as artificial mother milk in case of insufficient mother's milk and as nutritious food for sick person.

3. Manufacturing Process of Powder Milk

There are many kinds of powder milk products as mentioned above, however manufacturing processes of them are almost same. Manufacturing process consists of clarifying of raw milk, standardizing of composition, pasteurizing and concentrating of milk, drying of concentrated milk and cooling and packing of dried powder milk.

Raw milk contains a large quantity of water, that is about 88% for whole milk, about 92% for skim milk and about 94% for whey and butter milk.

Accordingly in the course of milk processing, concentrating of raw milk and drying of concentrated milk are most important.

Manufacturing process block diagrams for the whole powder milk, for the skim powder milk and for the prepared powder milk, which are typical products of powder milk, are shown in Fig. 1, Fig. 2 and Fig. 3 respectively.

And process flow diagram for the skim powder milk is shown in Fig. 4. Their processes and equipment are outlined as follows.

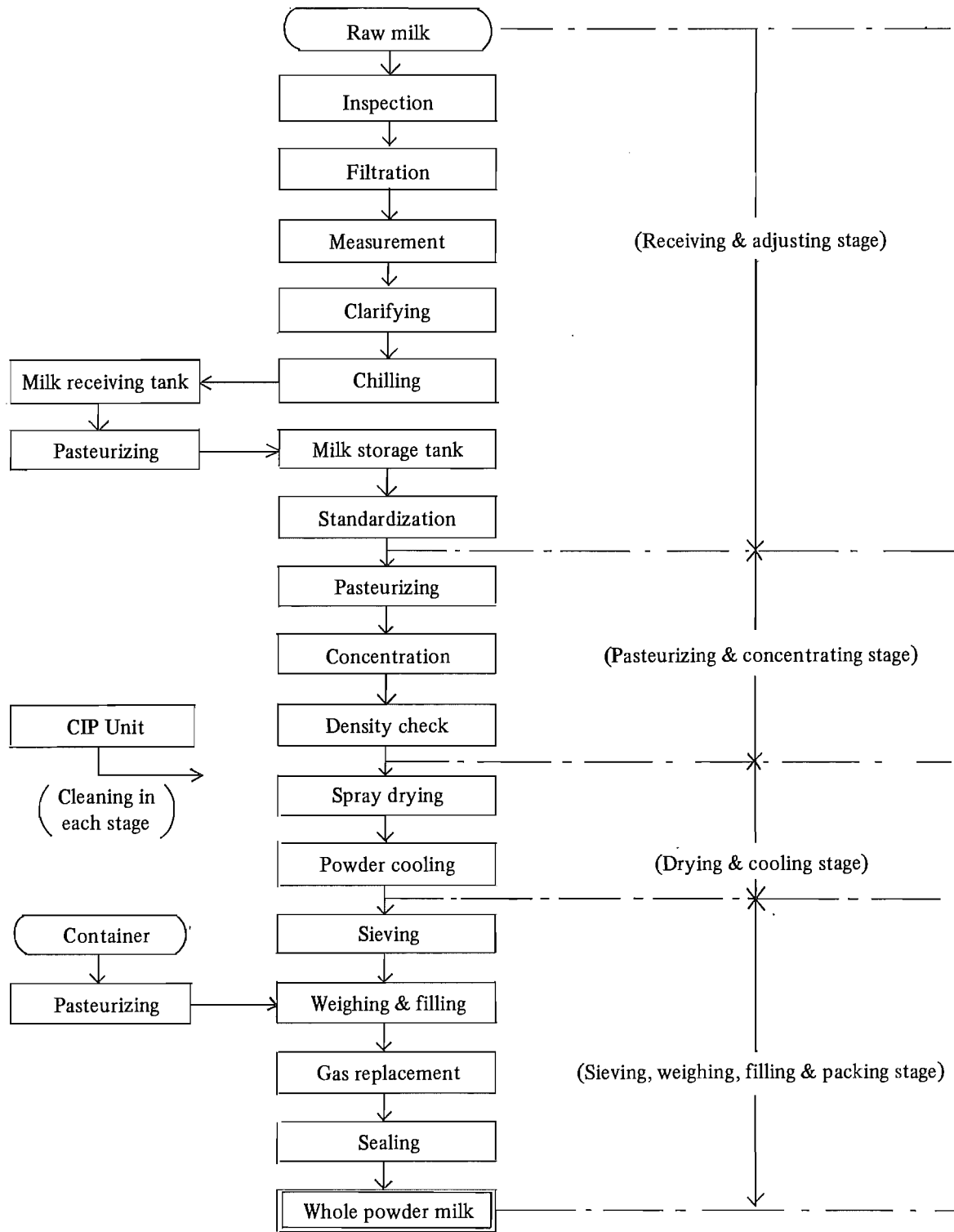


Fig. 1 Manufacturing Process for Whole Powder Milk

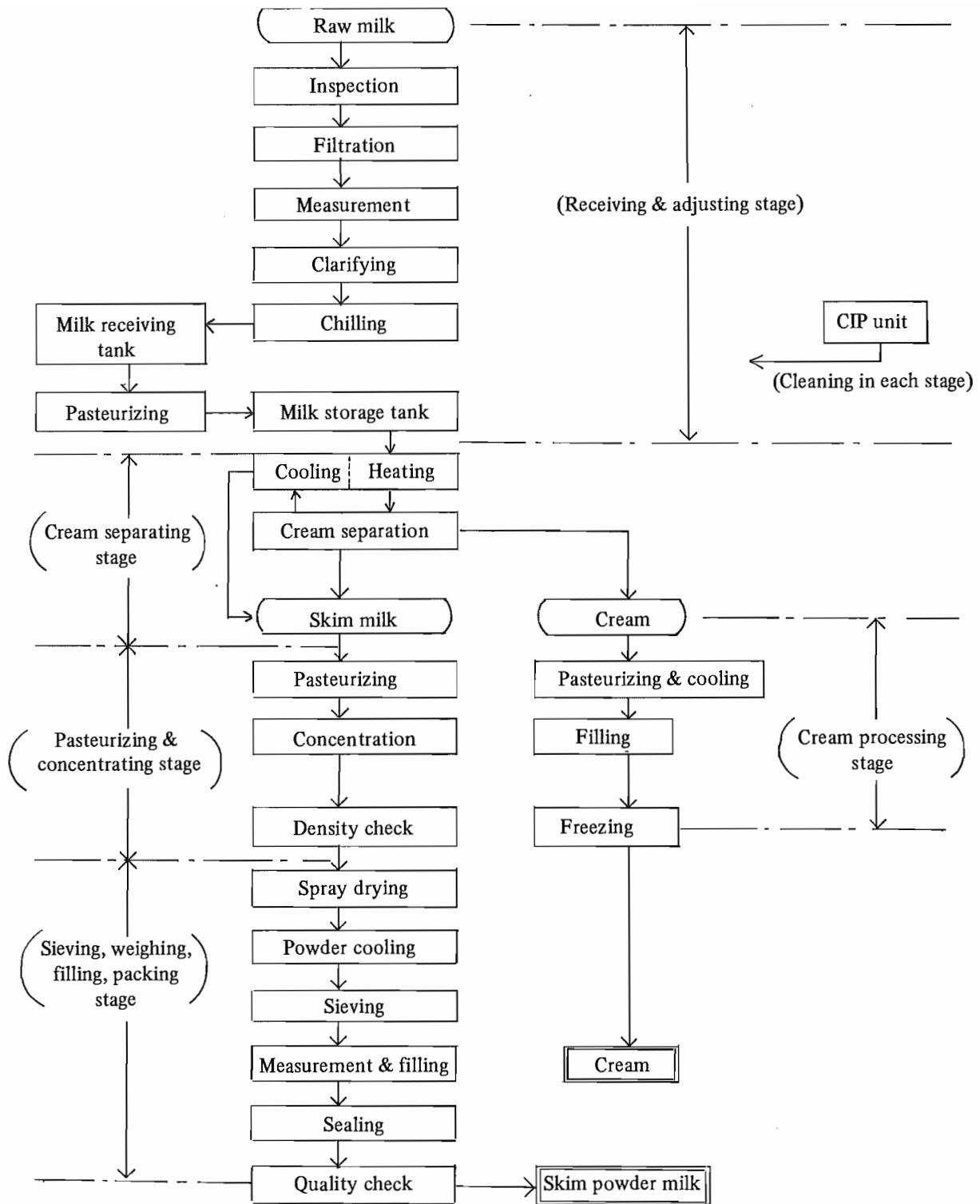


Fig. 2 Manufacturing Process for Skim Powder Milk and Cream

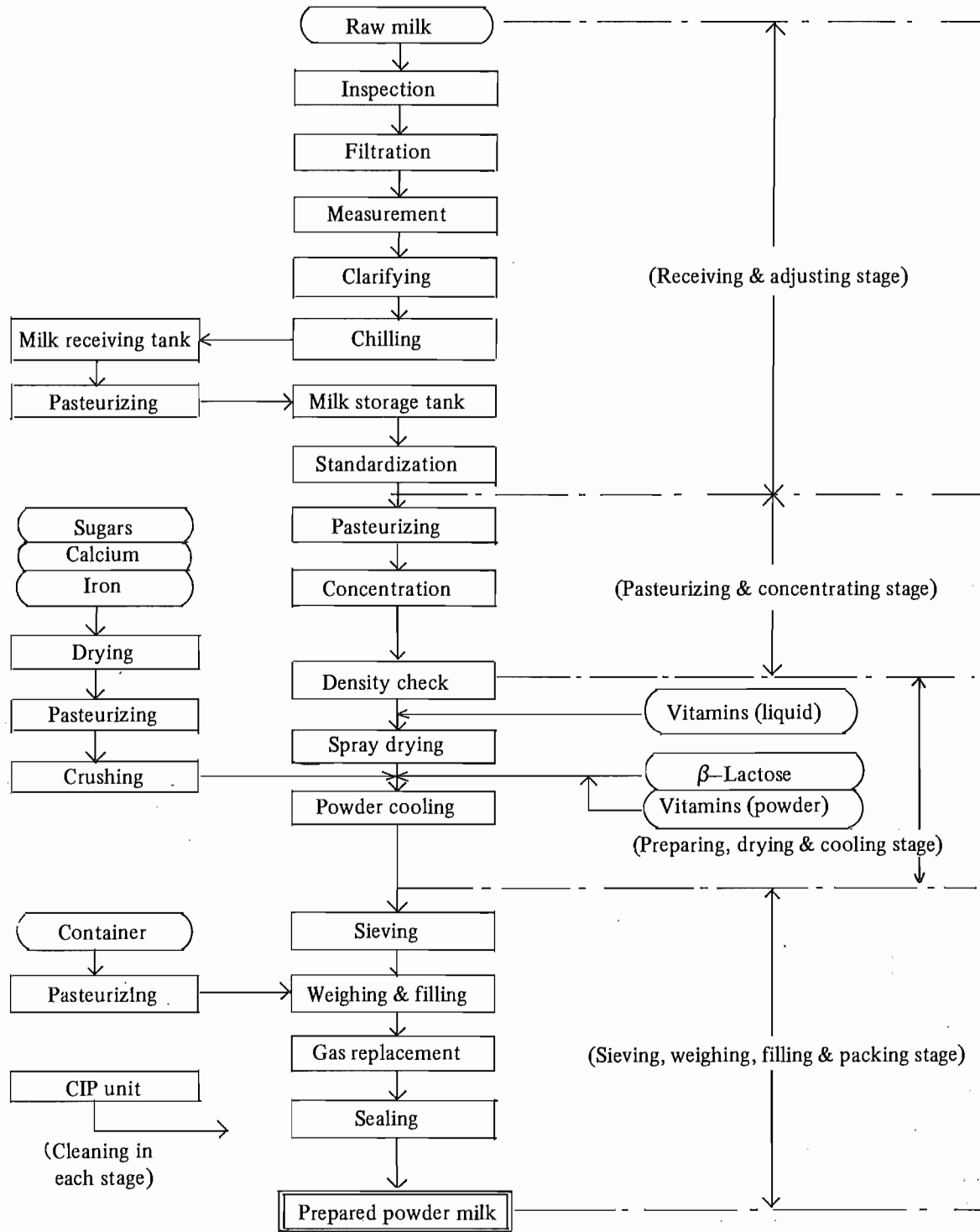


Fig. 3 Manufacturing Process for Prepared Powder Milk

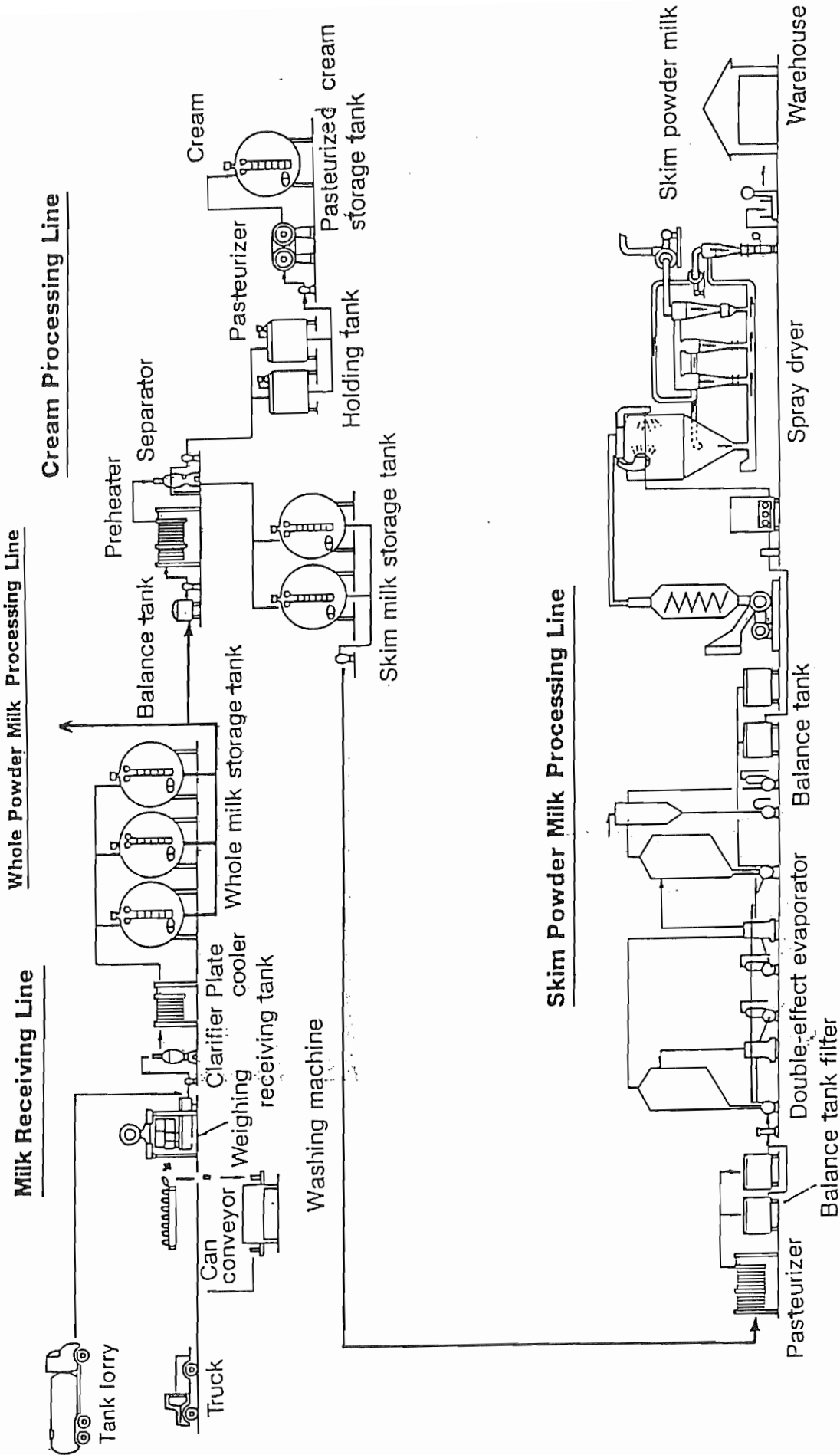


Fig. 4 Powder Milk Processing Lines

(a) Receiving, clarifying and adjusting stage

For manufacturing powder milk, fresh milk of good quality should be used as raw material.

It is not recommendable to use raw milk of higher acid value because bad taste, lower solubility and inferior preservability of powder milk will be caused.

Raw milk will be received twice a day in the morning and in the evening by tank lorry or milk can.

Freshness of received raw milk will be checked by alcohol test.

In case result of the test has shown abnormal, it should not be used as raw material of powder milk.

After checking the freshness of raw milk, weight of milk is measured. And then after filtered by nylon cloth, it is sent to a clarifier where impurities are removed from raw milk.

Clarified raw milk is cooled to below 5°C through a plate cooler and then sent to a buffer tank.

To prevent propagation of germs, the clarified raw milk stored in the buffer tank is sent to a pasteurizer where the raw milk is heated up to 85°C by high temperature short time (HTST) method.

After pasteurizing, the raw milk is cooled down again to below 5°C and then sent to a milk storage tank.

Prior to the pasteurizing stage, in case of the whole powder milk and the prepared powder milk, standardizations of ingredients are carried out so that fatty component and non-fatty solid component may meet the ingredient standard of the final product.

(b) Cream separation stage

In case of skim powder milk, pasteurized raw milk stored in the milk storage tank is separated into skim milk and cream by a cream separator after heated up to 40°C.

Usually a disc type centrifuge is used as cream separator.

Separated skim milk and cream are stored in a skim milk storage tank and a cream storage

tank respectively.

The cream stored in the cream storage tank is utilized as a raw material for icecream, butter and various kinds of cream after pasteurizing.

(c) Pasteurizing stage

During the pasteurizing stage, harmful germs in the raw milk are pasteurized and enzymes in the raw milk are also sterilized so that safety and preservation of the powder milk may be secured.

There are two typical methods for pasteurization, HTST method and UHT method. (UHT; ultra high temperature)

In the HTST method, a pasteurizing effect is realized by heating up milk to 70~85°C and keeping temperature for 15~30 seconds and in the UHT method by heating up to 120 ~ 150°C and keeping for 1~2 seconds.

The pasteurized milk is sent to concentrating stage after cooled down to about 50°C.

(d) Concentrating stage

It is desirable to concentrate the milk in a short time and in a lower temperature range as possible because protein of the milk is apt to deteriorate by heating. A vacuum type evaporator of double-effect or triple-effect is usually employed for this purpose.

The milk is concentrated effectively by the multiple-effect evaporator in a lower temperature range of 51 ~ 56°C.

Finally the volume of the concentrated milk is reduced to one third or one fourth, the density is increased to Baumé 12~16° and the solid matter content is increased to 40~50%.

When drying after concentrating the raw milk, the particle size of powder milk becomes moderate size and as a result higher solubility and longer preservability are attained.

It is not recommendable to dry up the raw milk directly without concentrating it, because this processing brings on fine, lighter particle of powder milk which causes inferior solubility and low preservability.

From the standpoint of heat efficiency, it is

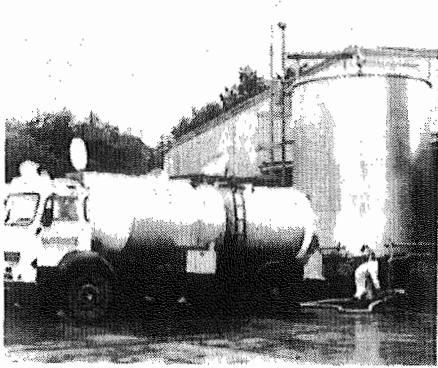


Photo 1. Raw Milk Receiving Tank

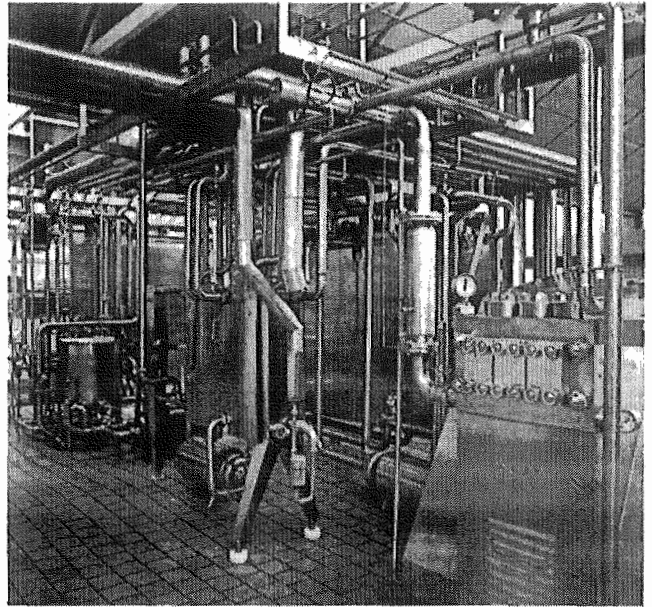


Photo 2. UHT Pasteurizer

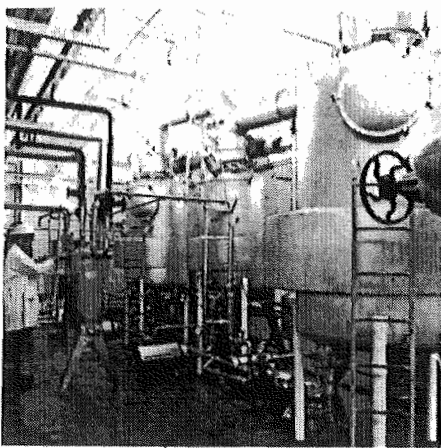


Photo 3. Multiple-effect Evaporator

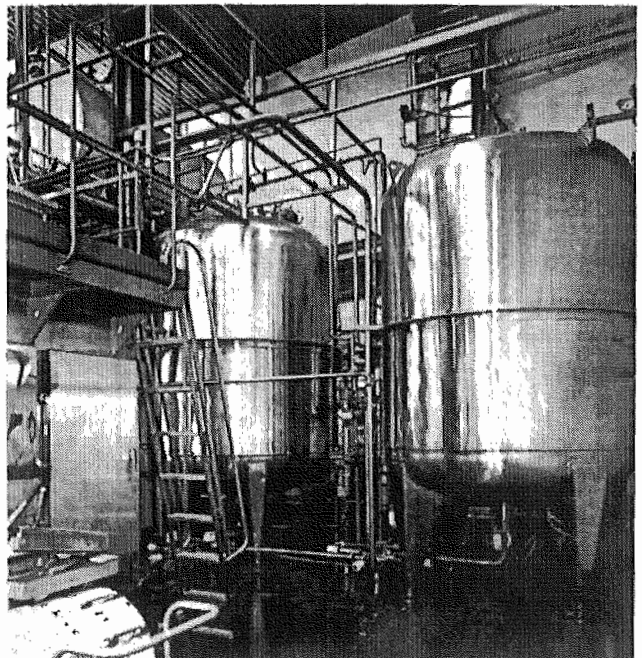


Photo 4. Pasteurized Milk Storage Tank

indispensable to concentrate the raw milk before drying.

(e) Drying stage

Historically there have been many drying methods for the powder milk making such as thin film drum drying method, vacuum type drum drying method, freeze drying method and spray drying method.

Currently spray drying method is popular from technical and economical viewpoints.

The concentrated milk with described in (d) is sent to a spray dryer.

By the high speed rotating action of centrifugal disc atomizer, the concentrated milk is sprayed into a drying chamber through which hot air is blown.

The sprayed fine mist is contacted with co-current hot air flow and the water content of milk is instantaneously evaporated in a temperature range of 85~90°C and thus the greater part of water is removed from the milk.

(f) Cooling stage

Temperature of powder milk discharged from the drying chamber is usually 70~80°C.

If the powder milk is exposed in a high temperature atmosphere for a long time, it would be in danger of deterioration by heat and congealation by moisture.

Therefore the powder milk discharged from the drying chamber should be cooled quickly to a temperature range of 23~28°C by dehumidified cooling air.

For this purpose a fluidized bed type cooler is applied.

(g) Sieving, weighing, filling and packing stage

After drying and cooling down, the powder milk is transferred to a silo by a pneumatic conveyor.

The powder milk stored in the silo is sent to a vibrating sieve where large particle, charred powder and foreign matters are removed and then the sieved powder milk is sent to an auto-

matic weighing and filling machine.

The powder milk is filled into 25 kg paper bags of 3~6 plies (the most inner side ply is laminated with polyethylene), and then polyethylene laminated ply is sealed by heat. And finally all plies of the paper bag are sealed by a sewing machine.

A clean booth is attached to the filling machine for keeping away dust.

In case of need for long preservation, the powder milk is filled up by an automatic weighing and filling machine into metal can which is sterilized previously. Then the metal can is filled up with nitrogen gas to replace air in it, and lid of the can is winded up and sealed.

(h) Cream processing stage

The cream separated by cream separator is stored in cream tank.

The cream stored in the cream tank is sent to a plate type pasteurizer where the cream is pasteurized by HTST method.

After cooling, the cream is filled up into cream can and stored in refrigerator of minus 20°C.

(i) CIP unit (Cleaning in place)

The food manufacturing plant should supply hygienic and safe products. Cleaning work is indispensable for preventing the multiplication of germs.

In case of manual cleaning, its degree varies according to technical level of each labourer employed. In addition to this, dismantling of equipment and cleaning works inside the equipment may inflict damage on the equipments.

Therefore, it is necessary to make automatic cleaning without dismantling the equipment. By adopting the CIP unit automatic cleaning without dismantling equipment is realized, and always equal and constant effects of cleaning are expected.

With the CIP unit which consists of alkali-tank, acid-tank, water tank and pumps, all equipments, tanks and piping of the powder milk manufacturing plant can be cleaned automatically without manual operation.

4. Outline of Model Plant

Outlines of various products of the powder milk are described in Chapter 2 and their manufacturing processes are described in Chapter 3.

When planning the powder milk manufacturing plant, it is very important to select the most suitable products and manufacturing process, in accordance with the circumstances and conditions of the country or district contemplated.

In this paper, a model plant of manufacturing skim powder milk as main product and cream as by-product is described.

4.1 Production Scale

(1) Products

- | | |
|----------------------|----------------------|
| (a) Skim powder milk | 1,000 t/y (3.0 t/d) |
| (b) 30% cream | 1,500 t/y (4.55 t/d) |

(2) Plant operation

- | | |
|---------------------|---------|
| (a) Operating hours | 8 hr/d |
| (b) Operating days | 330 d/y |

(3) Capacity of plant

- | | |
|----------------------------------|--------|
| (a) Raw milk processing capacity | 5 t/hr |
|----------------------------------|--------|

4.2 Raw Materials Required

- | | |
|---------------------------------|-----------|
| (a) Raw material (whole milk) | 40 t/d |
| (b) Bag for powder milk (25 kg) | 125 bag/d |
| (c) Can for cream (20 l) | 230 pc/d |

4.3 Utilities Required

- | | |
|----------------------|---|
| (a) Electricity | 1,108,800 kWh/y
420 kW x 8 hr/d x 330 d/y |
| (b) Fuel oil | 1,608 kl/y
203 l/hr x 3 x 8 hr/d x 330 d/y |
| (c) Industrial water | 10,560 m ³ /y
4 m ³ /hr x 8 hr/d x 330 d/y |

4.4 Required Machinery and Equipment

(Receiving and adjusting stage)

Milk can receiving conveyor	1 set
Milk can overturn device	1 set
Weigher (300 l)	1 set
Milk receiving vat (600 l)	1 set
Can cleaner (100 pc/hr)	1 set
Clarifier (6,000 l/hr)	1 set
Milk cooler, plate type (6,000 l/hr)	1 set
Surge tank (6 m ³)	1 set
HTST pasteurizer, plate type (7,000 l/hr)	1 set
Silo (30 m ³)	2 sets
Separator (10,000 l/hr)	1 set
Standardizing tank (10 m ³)	2 sets

(Pasteurizing and concentrating stage)

UHT pasteurizer, plate type (5,000 l/hr)	2 sets
Milk storage tank (5 m ³)	1 set
Double-effect evaporator, plate type (5,000 l/hr)	1 set
Concentrated milk tank (2 m ³)	2 sets

(Drying and cooling stage)

Air filter	1 set
Inlet fan (580 m ³ /min)	1 set
Air heater	1 set
Distribution system (atomizer)	1 set
Milk feed pump	1 set
Hot air divider	1 set
Dryer	1 set
Fluidizer (cooler)	1 set
Recirculation fan	1 set
Cooling fan for fluidizer	1 set
Dehumidifier	1 set
Cyclone separator	1 set
Exhaust fan	1 set

(Sieving, weighing, filling and packing stage)

Silo	1 set
Cyclone	1 set
Bag filter	1 set
Vibrating sieve	1 set
Automatic filling machine (25 bag/hr)	1 set
Heat sealer	1 set

Sewing machine	1 set
Clean air booth	1 set
(Cream processing stage)	
Cream tank (2 m ³)	2 sets
Cream pasteurizer (1,000 ℓ/hr)	1 set
Can cleaner (60 pc/hr)	1 set
Can filler (60 pc/hr)	1 set
(CIP unit)	
Tank for alkaline solution (2 m ³)	1 set
Tank for acid solution (2 m ³)	1 set
Tank for water (2 m ³)	1 set
Heater, plate type	1 set
Other equipments (pump, etc.)	1 set
(For control)	
Control panel	1 set
(Utilities)	
Steam boiler (2.5 t/hr)	3 sets
Chilling unit (205,000 Kcal/hr)	2 sets
Air compressor	2 sets
(Laboratory equipments)	
Water tester	1 set
Alcohol tester	2 sets
Acid checker	2 sets
pH tester	1 set
Milk fat tester (Milk analyzer)	1 set
Cultivator	1 set
Thermostat	1 set
Pure water system	1 set
(Fittings for piping)	
Easy cleaning fitting	1 set

Remark: In this model plant, description of waste water treatment equipment is omitted, because that it is necessary to design in accordance with regional restriction or regulation of plant site. For reference, the designing data for the waste water treatment system of this model plant size is shown as follows;

(a) Volume of waste water	200 m ³ /d
(b) BOD concentration of waste water (BOD)	800 mg/ℓ

4.5 Machinery and Equipment Cost

	US\$
Milk receiving & adjusting stage	786,000
Pasteurizing & concentrating stage	587,000
Drying & cooling stage	1,452,000
Sieving, weighing & filling stage	328,000
Cream processing stage	185,000
Utilities	709,000
CIP unit & fittings	541,000
Laboratory equipment	50,000
<hr/>	
Total	US\$4,638,000

Note: 1. Price of FOB Japanese port as of 1987.
2. The exchange rate of the US dollar to the Japanese Yen is assumed to be US\$ 1 = ¥150

4.6 Layout of Plant and Building

(1) Area of plant	20,400 m ²
(2) Buildings	2,702 m ²
Factory building	1,470 m ²
Warehouse for product	588 m ²
Office (2 stories)	644 m ²
(3) Plant layout	

Layouts of the skim powder milk and cream manufacturing plant are shown in Fig. 5, Fig. 6 and Fig. 7.

4.7 Number of Workers and Placement

Number of workers required and placement are shown in Table 4.

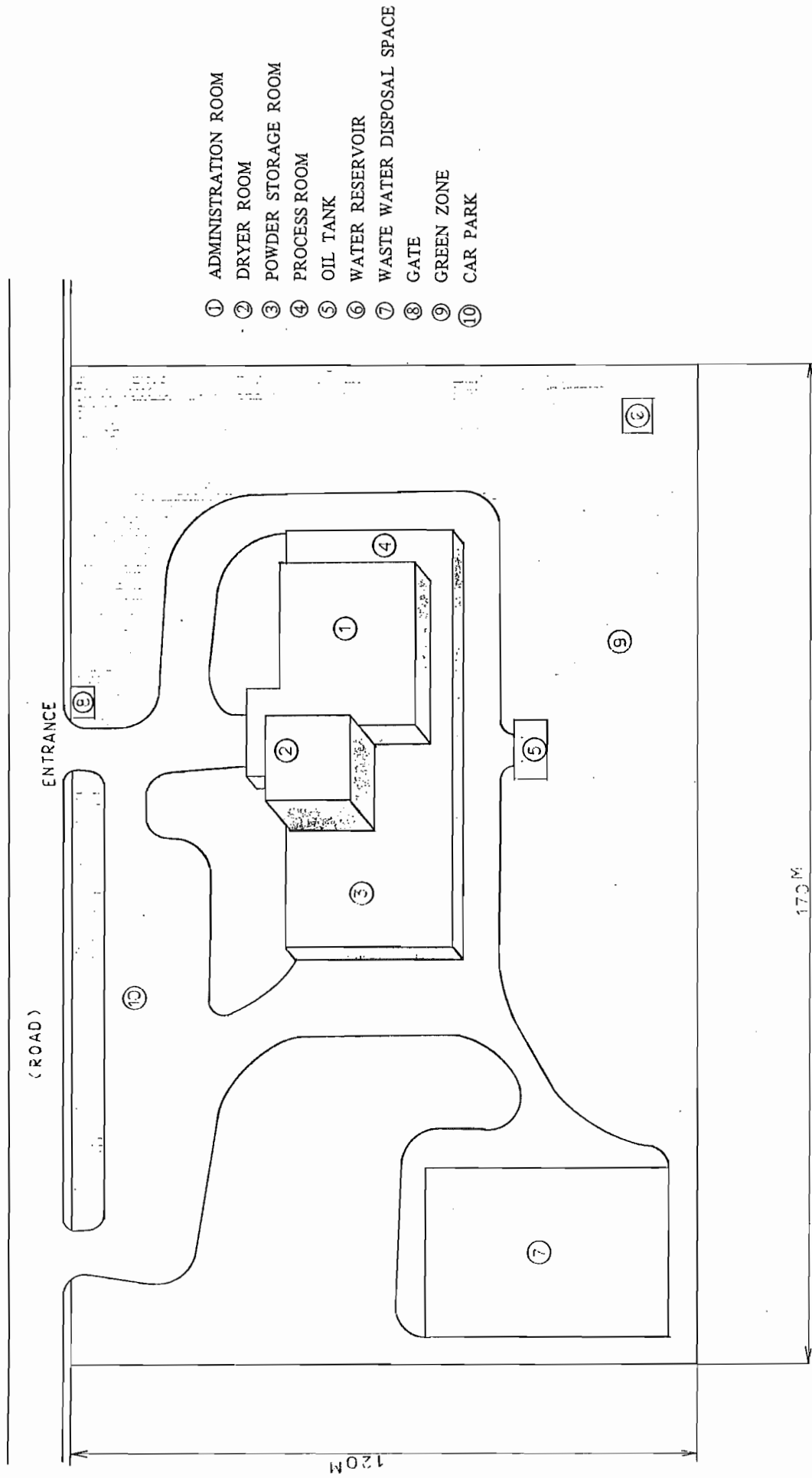


Fig. 5 Layout of Plant

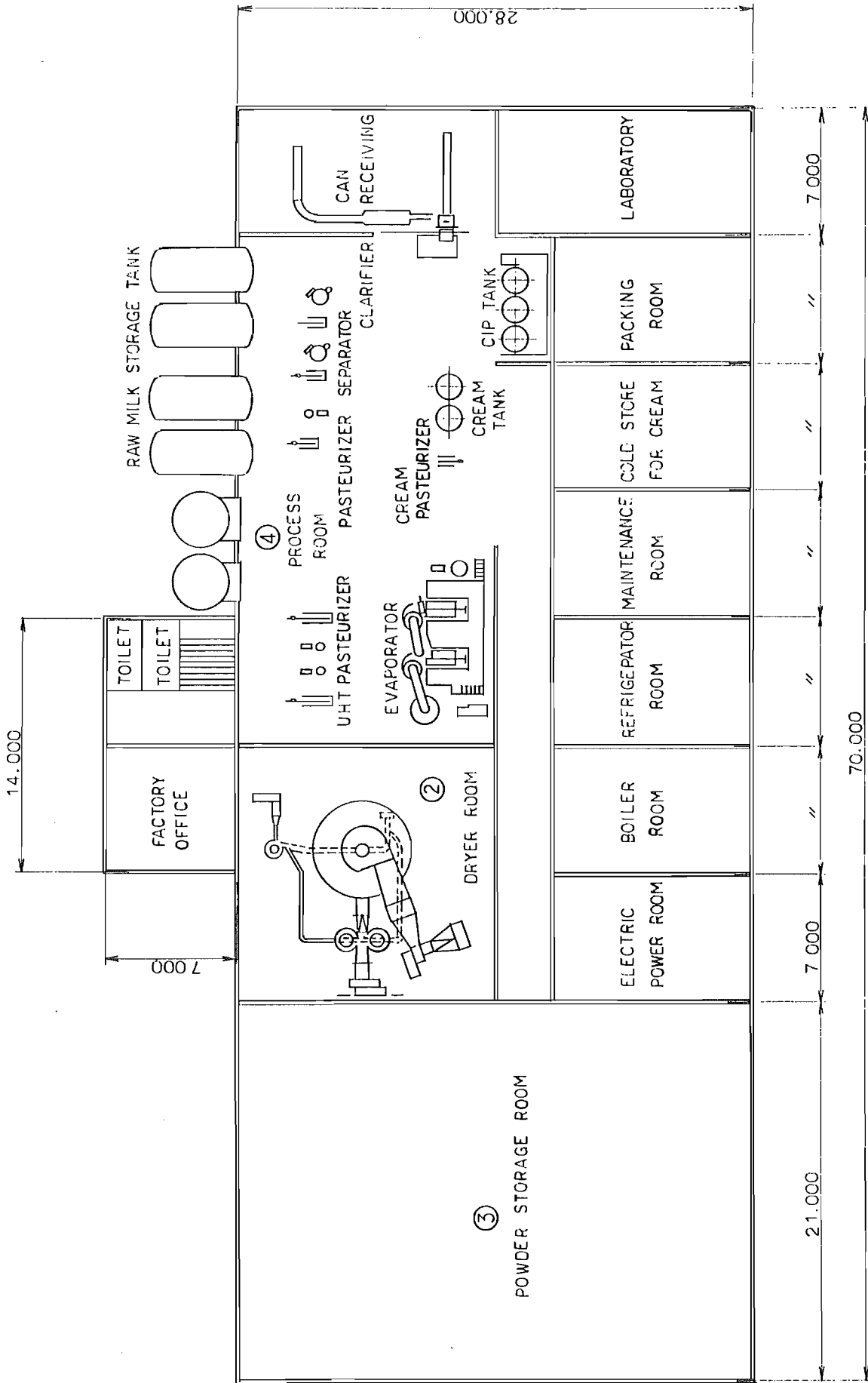


Fig. 6 Layout of Machinery and Equipment (1F)

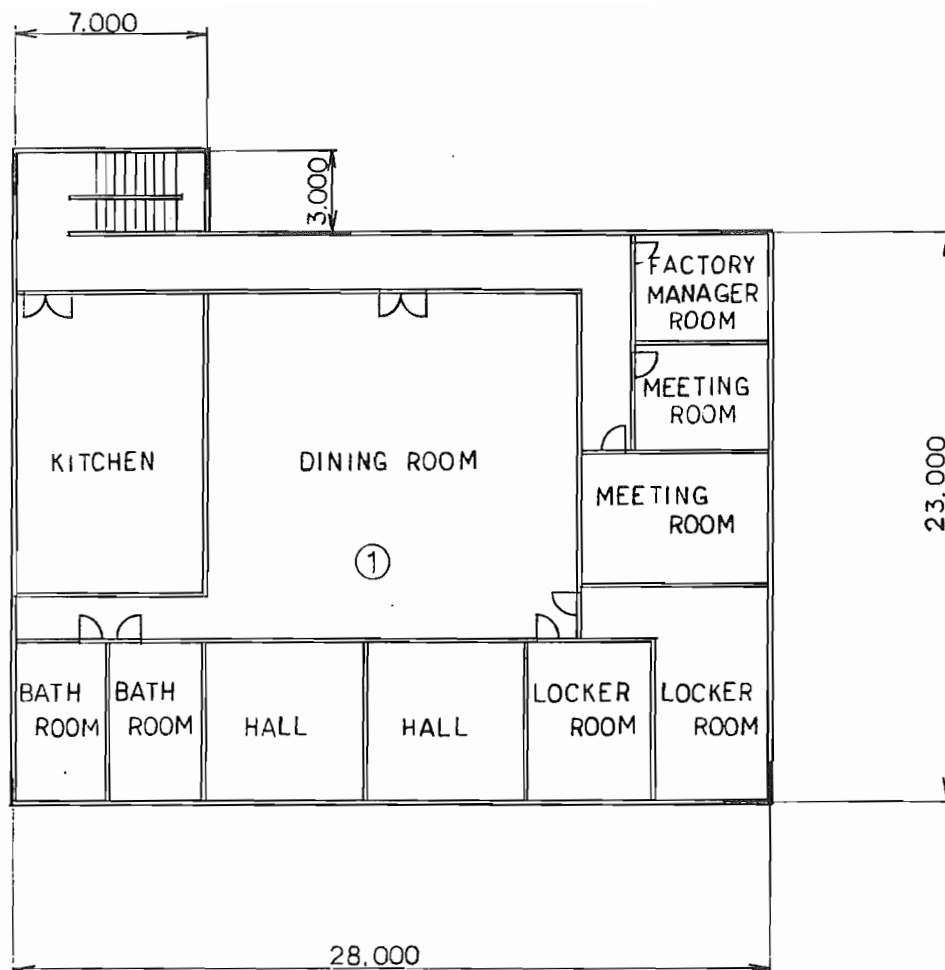


Fig. 7 Layout of Administration Room (2F)

Table 4. Number of Workers and Placement

	Male	Female	Total
Factory manager	1	—	1
Assistant manager	1	—	1
Office worker (clerk)	3	5	8
Inspector	2	2	4
Group leader	3	—	3
Milk receiving, adjusting	3	—	3
Pasteurizing, concentrating	2	—	2
Drying, cooling	2	—	2
Sieving, filling	4	2	6
Cream processing	4	2	6
Boiler man	2	—	2
Electrician	2	—	2
Maintenance	3	—	3
Shipping	3	1	4
Total	35	12	47

5. Production Cost and Profitability

In order to estimate the profitability of a powder milk manufacturing plant, it is necessary to calculate the production cost.

Usually the basis of calculation varies in each country and district. In this paper, the profitability will be calculated on the basis of the following assumptions.

5.1 Basic Conditions for the Calculation of Fixed Capital, Working Capital and Production Cost

(1) Fixed capital

(a) Land cost Not included

(b) Building cost US\$400/m²

- (c) Machinery and equipment cost
FOB Japanese port as of 1987
- (d) Spare parts cost
10% of the FOB price of machinery and equipment
- (e) Freight and insurance
10% of the FOB price of machinery and equipment
- (f) Civil engineering cost for foundation
10% of the FOB price of machinery and equipment
- (g) Erection cost
10% of the FOB price of machinery and equipment
- (h) Guidance and supervision fee
10% of the FOB price of machinery and equipment
- (i) Commissioning cost
2% of the FOB price of machinery and equipment
- (j) Education and training cost
3% of the FOB price of machinery and equipment
- (k) Contingency
10% of the FOB price of machinery and equipment

(2) Working capital

- (a) Raw material cost for one day
- (b) Sub raw material cost for half-month
- (c) Products inventory for half-month

(3) Production cost

- (a) Raw material cost
The raw material cost has been assumed referring to the international trading price.
Whole milk US\$0.2/kg
- (b) Sub raw materials cost
Bag for powder milk (25 kg) US\$0.5/bag
Can for cream (20ℓ) US\$2.0/pc
- (c) Utilities cost
Electricity US\$0.06/kWh
Fuel oil US\$200/kℓ
Industrial water US\$0.2/m³

- (d) Labor cost

Factory manager	US\$15,000/y
Managerial person	US\$10,000/y
Engineer	US\$ 8,000/y
Clerk	US\$ 3,000/y
Skilled worker	US\$ 4,000/y
Unskilled worker	US\$ 3,000/y
Odd job man	US\$ 500/y
- (e) Maintenance cost
3% of the FOB price of machinery and equipment
- (f) Depreciation
Straight-line method will be adopted.
Machinery and equipment:
(Fixed capital – building cost) x 7%
Building:
3% of the building cost
- (g) Insurance cost
0.5% of the fixed capital
- (h) Selling and administration expense
3% of the annual sales revenue
- (i) Interest
One-second of the fixed capital will be covered by a long-term loan and its annual rate of interest is 10%.

Note: The exchange rate of the US dollar to the Japanese Yen is assumed to be US\$1 = ¥150.

5.2 Capital Required

(1) Fixed capital

	US\$
Land	Not included
Factory building	1,080,800
Machinery and equipment	4,638,000
Spare parts	463,800
Freight and insurance	463,800
Civil engineering for foundation	463,800
Erection	463,800
Guidance and supervision	463,800
Commissioning	92,760
Education and training	139,140
Contingency	463,800
Sub total	US\$8,733,500

(2) Working capital	
Raw material	US\$ 8,000
Sub raw materials	US\$ 7,840
Products inventory	US\$167,120
<hr/>	
Sub total	US\$182,960

(3) Capital required
 Capital required is the sum of the fixed capital and the working capital
 Capital required US\$8,916,460

5.3 Annual Sales Revenue

The following unit selling prices of products are applied correspondingly to the international trading price.

Skim powder milk	US\$2.0/kg
30% cream	US\$2.5/kg

Total annual sales revenue of this plant is US\$5,750,000 in accordance with following calculation.

(a) Skim powder milk	US\$2,000,000
(US\$2.0/kg x 1,000,000 kg/y)	
(b) Cream	US\$3,750,000
(US\$2.5/kg x 1,500,000 kg/y)	
<hr/>	
Total	US\$5,750,000

5.4 Production Cost

(a) Raw material cost	US\$2,640,000
(US\$0.2/kg x 13,200,000 kg/y)	
(b) Sub raw materials cost	US\$172,425
Bag	US\$20,625
(US\$0.5/bag x 125 bag x 330 d)	
Can	US\$151,800
(US\$2.0/pc x 230 pc x 330 d)	
(c) Utilities cost	US\$390,240
Electricity	US\$66,528
(US\$0.06/kWh x 1,108,800 kWh)	
Fuel oil	US\$321,600
(US\$200/kℓ x 1,608 kℓ)	
Industrial water	US\$2,112
(US\$0.2/m ³ x 10,560 m ³)	

(d) Labor cost	US\$192,000
Factory manager	US\$15,000
(US\$15,000 x 1)	
Managerial person	US\$10,000
(US\$10,000 x 1)	
Engineer	US\$56,000
(US\$8,000 x 7)	
Clerk	US\$24,000
(US\$3,000 x 8)	
Skilled worker	US\$28,000
(US\$4,000 x 7)	
Unskilled worker	US\$57,000
(US\$3,000 x 19)	
Odd job man (US\$500 x 4)	US\$2,000
(e) Maintenance cost	US\$139,140
(US\$4,638,000 x 0.03)	
(f) Depreciation	US\$568,113
Machinery and equipment	US\$535,689
[US\$8,733,500 – US\$1,080,800) x 0.07]	
Building	US\$32,424
(US\$1,080,800 x 0.03)	
(g) Insurance cost	US\$43,668
(US\$8,733,500 x 0.05)	
(h) Selling and administration expense	US\$172,500
(US\$5,750,000 x 0.03)	
(i) Interest	US\$436,675
(US\$8,733,500 x 0.5 x 0.1)	
<hr/>	
Total	US\$4,754,761

5.5 Profitability

The expected profitability of the model plant, calculated on the basis of the above assumptions, will become as follows:

Annual sales revenue	US\$5,750,000
Annual production cost	US\$4,754,761
<hr/>	
Profit	US\$ 995,239
Ratio of profit to sales revenue	17.3%
(US\$995,239/US\$5,750,000 x 100)	
Ratio of profit to capital required	11.2%
(US\$995,239/US\$8,916,460 x 100)	

The above financial indications show that the profitability of the present project can be considered fairly good.

6. Conclusion

By promoting the powder milk manufacturing in the developing countries, the milk, weakpoints of which are watery and perishable, can be utilized widely to baby and sick person as well-balanced food after processing into preservable powder milk.

And also the cream, which is by-produced in the course of processing the skim powder milk, can be utilized as raw cream material for various process foods.

The present project will be useful to those countries where milk is produced.

Project Planning for Small and Medium Scale Industries

- No. 1 Rice Milling Plant and Rice Bran Oil Manufacturing Plant
- No. 2 Plastic Woven Bag Manufacturing Plant
- No. 3 Container Board Manufacturing Plant
- No. 4 Plastic Blow Bottle Manufacturing Plant
- No. 5 Concrete Block Manufacturing Plant
- No. 6 Glassware Manufacturing Plant
- No. 7 Galvanized Iron Sheet Manufacturing Plant
- No. 8 Fishing Net Manufacturing Plant
- No. 9 Ice Making, Refrigeration and Cold Storage Plant
- No.10 Starch and Syrup Manufacturing Plant
- No.11 Instant Noodle Manufacturing Plant
- No.12 Surimi and Surimi-Based Food Manufacturing Plant
- No.13 Polyethylene Shopping Bag Manufacturing Plant
- No.14 Retreading Tire Manufacturing Plant
- No.15 Husk Fired Thermal Power Plant
- No.16 Fishmeal Manufacturing Plant
- No.17 Assorted Animal Feed Manufacturing Plant
- No.18 Sanitary Napkin Manufacturing Plant
- No.19 Sanitary Ware Manufacturing Plant
- No.20 Toilet Tissue Manufacturing Plant
- No. 21 Powder Milk Manufacturing Plant

Project Planning for Small and Medium Scale Industries No. 21

Japan Consulting Institute (JCI)

Sumitomo Fudosan Kudanshita Bldg. 3 F
Kanda-Jinbocho 3-5, Chiyoda-ku Tokyo
101-0051 Japan

TEL +81-3-3222-8100
FAX +81-3-3222-8101
URL : <http://jei-plant.or.jp>

Reproduction Without Permission Prohibited

Edited date: February 1988