PLANT REQUIREMENTS TO SET UP AND OPERATE A FERTILIZER MIXING PLANT

TECHNICAL AIDS BRANCH

INTERNATIONAL COOPERATION ADMINISTRATION

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FOREWORD

This manual is a revision of an earlier report of the same type issued in 1955. This revised version includes current costs of labor, machinery, equipment and supplies, as well as additional information relative to engineering, training, safety, markets, sales, financial and economic factors.

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This manual is designed to provide a general picture of the factors which must be considered in establishing and operating a small-scale factory of this type. It should prove useful in creating interest in the subject, and serve to give enough understanding of the related considerations to help government officials, other leaders and businessmen to determine whether the potential deserves more-detailed attention.

However, it is important to note that in most cases plans for the actual development and installation of a plant will require expert engineering and financial advice in order to meet specific local situations. For further information and assistance, readers should contact their local Productivity Center, Industrial Institute, Servicio, or United States Operations Mission.

Mention of the name of any firm, product, or process in this manual is not to be considered a recommendation or endorsement by the International Cooperation Administration, but merely a citation that is typical in its field.

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PLANT REQUIREMENTS

TO SET UP AND OPERATE

A FERTILIZER MIXING PLANT

INTRODUCTION

Fertilizer, as used in this manual, means a mixture of materials that will increase the growth or yield of crops when introduced into the soil.

The grade of a fertilizer is referred to as 5-10-10; 6-12-6; or 0-10-10. These numbers tell the per cent of three materials in the mixture. The first figure tells the per cent nigrogen; the second, the per cent phosphorus; and the third, the per cent potash or potassium. The remaining part of the mixture consists of a conditioner such as:

1. Chopped up tobacco stems or gain hulls,
2. Limestone filler, and
3. Trace elements such as manganese, zinc, copper, and iron if and as needed in the locality.

The common practice in the United States is to place a small quantity of fertilizer in the planted row close to the seeds or plants. This mixed fertilizer is used every year to increase the yield of the crops. It is also common practice to use the same or similar materials in an unmixed form to improve the soil. These materials and limestone are added to the soil in comparatively large quantities. This over-all soil improvement is then supplemented with mixed fertilizers. Fertilizers are commonly sold in 80, 100, and 200 pound valve-type paper bags.

A program to increase the yield of a farm can be as follows:

1. Plow under vegetation to increase the amount of humus in the soil. This in itself conserves needed elements; increases the soil's capacity to hold moisture; and improves its tilth, or cultivation properties.

2. Spread limestone, rock, phosphate, potash, and possibly anhydrous ammonia over the field. These things are usually done prior to the planting of the crop. However, it usually is poor practice to add limestone and rock phosphate to the soil at the same time because they form a compound which the plants have difficulty assimilating.

3. Drill or sow mixed fertilizer or commercial fertilizer into the plant rows. This is done when the crop is planted.

Farmers in the United States do a great deal of soil improvement work. There has been a steady growth in the use of the unmixed materials. The use of mixed materials is limited by their somewhat higher cost per unit of nitrogen, phosphorus, and potassium.

Mixed fertilizers are sold in several ways in the United States. Some companies deal directly with the farmer or with cooperative groups. The salesmen for these companies act as advisors to the customer. They frequently make recommendations based on soil analysis. Many companies sell through local dealers. Some companies that mix fertilizers are cooperatives and deal directly with the user.

PRODUCTION CAPACITY

This manual describes a plant with a capacity of 150 tons per eight hour day. The business is seasonal and the plant would normally mix around 22,500 tons of fertilizer per year.

GENERAL ASSUMPTIONS

In order to make realistic estimates in this manual, certain assumptions are made. These are:

1. The costs of the building and general facilities are based on United States prices.

2. Material costs are based on sizes and specifications of materials used in the United States.

3. Labor costs are based on the average for the industry as recently published by the United States Bureau of Labor.

4. Adequate power and water are available at the plant site.

5. Adequate transportation facilities are available at the plant site.

6. The plant operates eight hours a day, five days a week, and thirty weeks per year.

7. No special provision is made for the training of new personnel. It is assumed that learner's rates are paid in such cases.

8. The following items cannot be estimated realistically:

   a. Land value;
   b. Distribution and selling costs;
   c. In-freight and out-freight;
   d. Taxes.

   While general estimates will be made of each of these items except taxes, for the purpose of completing cost estimates, adjustment should be made in accordance with actual local costs.

   In fact, all cost estimates contained in this manual should be adjusted to conform to local conditions.

9. Columns are provided in the tables included in this manual to facilitate the conversion of cost figures to conform with local costs.

PRODUCT SPECIFICATIONS

The elements used in mixing fertilizer come in different compounds. Some compounds contain more essential elements per pound than other compounds. Generally, the essential element costs more per pound in the compounds with the higher concentration. The usual practice is to refer to the cost per unit of 20 pounds of the essential element. For example, superphosphate has a concentration of 20 pounds of phosphorus per 100 pounds. As of August 1958, phosphorus in this form cost $.91 per unit of 20 pounds in Baltimore, Maryland. Triple superphosphate contains 46 pounds of phosphorus per 100 pounds of compound. In August 1958, phosphorus in triple superphosphate cost $.98 per unit of 20 pounds at Tampa, Florida.

The problem of building up a fertilizer formula therefore resolves itself into the following phases:

1. Using materials of sufficient concentration to meet the specifications.

2. Using materials with the lowest possible unit cost at the mixing plant.

This can be done as follows:

Find the unit cost of each element at the point or points of origin. In the United States, potash mostly comes from Carlsbad, New Mexico; phosphate from rock deposits in Florida. Nitrogen comes from many sources -- it is taken out of the air and also from some natural deposits.

Add transportation to the unit of element cost. The transportation cost per unit of element is found by dividing the transportation cost of the compound by the per cent of the element in the compound. This quotient is multiplied by 20. An example of this follows:

	Compounds			
	A	B	C	D
Per cent element	20	30	40	60
Transportation per 100 pounds of compound	$ 1.20	$ 1.20	$ 1.20	$ 1.20
Transportation per unit of element	1.20	.80	.60	.40
Cost per unit of element	1.00	1.20	1.30	1.45
Total unit element cost at mixing plant	2.20	2.00	1.90	1.85

In the above cases, compound "D" would be the more economical to use. It would still be necessary to make sure that compound "D" was easy to process.

MANUFACTURING OPERATIONS

The mixing of fertilizer involves the following work. The raw materials are received, unloaded, and moved into storage bins or tanks, or sent directly to the hoppers that feed the mixers.

The raw materials, excepting nitrogen compounds, come in box cars with bulk heads either across the doors or built up across the car so as to leave an open space between the doors. The material is removed from the cars and placed in storage bins or directly in hoppers above the mixing scales. The unloading of cars can be done in several different ways. It is possible to have an elevated track that runs over the storage bins. Then the material is dumped directly into the bins. It is also possible to pick up the material with a suction system. In some areas it may be practical to run the railroad tracks directly over the raw materials storage bins. The materials are then shipped in hopper-type dump cars with covers to protect the materials. The materials are then dumped directly into the bins.

The recommended system for the small plant under discussion in this manual is to have a hopper sunk in the ground beside the track. Or, if there are two tracks, the hopper can be between

the tracks. The tracks at this point should be covered with a shed. It may pay to have a canvas chute or apron from the car door to the hopper to prevent loss of material during unloading.

A conveyor runs from the bottom of the hopper to an elevator conveyor. The elevator conveyor lifts the material up and empties it into a swivel nozzle. This nozzle is arranged so that it can dump the material into any of the scale mixing hoppers or onto a belt conveyor leading to the raw materials stroage bins.

When the compounds are being unloaded from the box cars, an effort should be made to minimize the picking up of splinters from the car floor. The material can be moved out of the car by hand or with a tractor equipped with a bucket shovel.

It is a good idea to blow off or clean such a tractor at the end of each day. It must be equipped with effective air filters at the carburetor and breather cap to prevent injurious dusts from entering the cylinders or crankcase. The conveyor from the car hopper to the elevator conveyor must be accessible for repairs. It would be well to have it in a tunnel. In face, all the equipment used in the plant must be designed for operation in dusty locations. It must be accessible for maintenance work, and it must have provision for ample lubrication. Equipment for this type of work generally is designed to strict specifications.

One other piece of equipment is needed for unloading cars -- a car puller. During the busy season, a mixing plant will use several cars of raw materials per day, and they may ship several cars of mixed fertilizer per day.

The raw materials storage bins must be sheltered from the weather and have solid floors of concrete or hard-packed earth.

In handling the raw materials from the storage bins to the mixing hoppers a tractor and bucket shovel, such as in unloading the cars, is used. The material is scooped up and carried to a floor hopper covered with a grid onto which it is dumped. The hopper feeds the material into an elevator conveyor. It lifts the material to a swivel nozzle. The swivel nozzle dumps the material into one of several mixing hoppers. These hoppers have nozzles leading into a hopper that is attached to a 5,000-pound capacity scale. Each nozzle has a hand operated closing device. The predetermined weight of each material required for a given fertilizer specification is allowed to flow into the scale hopper. The scale hopper has an outlet into a conveyor hopper. The material is dumped from the conveyor hopper outlet into a conveyor that takes it to an elevator conveyor.

The elevator leaving the belt conveyor from the scale hopper leads to a screen. The material that falls through the screen goes into an accumulation hopper. The material that passes over the screen falls on a belt conveyor that leads to a small pulverizer. The belt conveyor has a magnetic pulley for removing

iron. The pulverizer feeds the material back into the elevator that goes up to the screen. The hopper below the screen feeds into a batch hopper. The batch hopper empties into a rotary or barrel-type mixer.

The batch hopper can be set up so that it trips a mechanism when the desired weight of materials is in the hopper. This mechanism can do either of two things. It can stop the screen and elevating mechanism, or it can shift the flow of materials to another batch hopper. The necessity for this control on the batch hopper can be avoided by making sure all of each ingredient of the batch is in the batch hopper before dumping into the mixer.

The capacity of this mixer is balanced against the capacity of the rest of the plant. A separate section of this manual discusses the economies of capacity.

Fertilizer materials come in two forms -- dry and wet. All of the materials come in tank cars. They are stored in the tank car or in bulk tanks until mixing. Since the nitrogen compounds tend to corrode low carbon steel, the tanks, valves, pumps, and piping handling them are made of stainless steel or other material that resists their corroding action.

The nigrogen compounds are pumped or moved with compressed air from the tank car into a storage tank or the batch tank. The batch tank has a sight glass that makes it possible to determine how much material is in it. These tanks should have an adjustable float-controlled valve that stops the flow of material into the tank when the proper level or quantity of material has entered.

The batch hopper and the batch tank are dumped into the mixer, and the mixer is run from five to eight minutes. It is then emptied. During the mixing, a chemical reaction occurs. This reaction heats the mix. In some cases, the heating from the chemical reaction is increased by the addition of sulphuric acid. The fertilizer may be produced in either pulverized or pellet form. Generally, the sulphuric acid is only used when producing the pellet form.

The next step in the process is determined by the form in which the fertilizer is being produced. In either case, the fertilizer eventually goes through a rotary drier. If the pellet form is being produced, it goes across a screen table that rolls the material up into small balls. Then these balls are passed through a heated rotary drier. The air in the drier may be heated by burning gas, oil, coal, or wood, and passing the gases from combustion through the heater. Care must be used to avoid smoke or carbon in the products of combustion, however. Fly ash is very undesirable as it tends to increase the abrasion of the fertilizer on the equipment used in subsequent processing and in spreading the fertilizer on the ground.

A cold drying process is used when producing pulverized fertilizer. The material is dumped directly from the mixer into the dryer. The heat in the fertilizer and the movement of air being pulled through the drier tend to evaporate the moisture in the fertilizer. The air or gases from the dryer are cleaned by passing them through a cyclone type air cleaner.

The next step after drying the fertilizer is to cure it. The purpose of this process is to keep the fertilizer from hardening in the bag. At present there is some question as to the necessity for curing the fertilizer when it is in pellet form. The curing consists of letting the fertilizer set in a bin for approximately 30 days.

A chemical reaction takes place during the curing. The material tends to form into a cake and to expand. This tendency to expand makes it necessary to have special slotted walls at the sides of the bins. These walls are made from wooden boards. They are laid with the width parallel to the floor and are spaced approximately 3 inches apart. The boards can be 2" X 6" or 2" X 8". The bins should have a cement or hard earthen floor.

A number of bins are arranged side by side. Each bin has a small crane over it. There is a reversible belt conveyor on the elevator that removes the dried fertilizer from the drier. One large belt conveyor runs crossways over all of the bins. The elevator from the drier carries the fertilizer onto the belt conveyor that runs across all of the bins. This conveyor is arranged so that it can move the fertilizer to the conveyor over any bin. The conveyor over the bin is moved on the crane. This makes it possible to place the material anywhere in the bin. The material should not be stacked in the bin over 20 feet deep.

PACKAGING OF FERTILIZER

After curing, the fertilizer is broken loose in the bin with a power shovel or a clam shell bucket. An electric shovel stands up well under the dusty conditions encountered. After it is broken loose, the fertilizer is moved to a floor-type hopper by a tractor with a bucket-type shovel. There is a pulverizer at the bottom of this hopper. The material is then elevated to a screen, passing over a magnetic pulley on the way. The fine fertilizer passes through the screen, while lumps and other materials pass over it, through a pulverizer and back to the elevator. An alternate way of doing this is to pass the material from the pulverizer over a second screen and drop the material that passes through it into the elevator. Dump the material that passes over this screen into a special bin. This will help improve the quality of the fertilizer, since pieces of wood or metal may prevent the fertilizer from passing through the device that spreads it in the field.

After screening, the fertilizer is bagged in a paper bag. There are three ways of closing the bag. It is common practice to use a valve-type bag in the United States. This is a self-sealing type of bag. A special machine is used to fill these bags. Such a machine with two nozzles will fill from 14 to 17 80-pound bags per minute.

It is also possible and practical to use open-mouth or end-type bags. These bags are filled from a hopper with a shut-off valve in the discharge nozzle. They can be closed by sewing or with a twist wire. It is generally thought that the valve-type bag is more economical, however, and it is also easier to pack on a pallet for shipping.

The bagged fertilizer is moved from the bagging machine by dropping it onto an inclined roller conveyor. At the end of the conveyor it is placed on a pallet and moved to storage with a fork lift truck. From storage it is moved to the loading dock for trucks or into a box car by fork lift truck. The fertilizer may or may not be shipped on the pallets.

* * * * * * * *

MANUFACTURING UNIT

Fertilizer production and sales are ordinarily expressed in 2,000-pound tons. Twenty-five 80-pound bags make one ton.

MACHINERY AND EQUIPMENT

Description	Estimated Cost	Actual Cost
A. Heavy Moving Equipment		
2 - Tractors with shovel capacity of 20 cubic feet		
1 - Sweeping attachment		
1 - Vacuum cleaner		
1 - Electric shovel		
1 - Lift truck		
Cost of Heavy Moving Equipment	$ 36,000	_____
B. Unloading and Elevating Dry Materials		
1 - Tractor with a bucket-type shovel		
1 - Car spotter		
1 - Floor type hopper		
1 - Conveyor to elevator		
1 - Elevator with swivel nozzle		
1 - Belt conveyor to bin		
Unload Tank Cars		
1 - Stainless Steel pump and hose connection or compressed air		
Cost of Unloading and Elevating Dry Materials Equipment	$ 10,000	_____
C. Proportioning and Weighing		
1 - Tractor with bucket-type shovel		
1 - Floor hopper with grid		
1 Elevator with swivel discharge nozzle		
6 - Mixing hoppers with manually operated valve-type discharge nozzles		
1 - 5,000 lb. capacity floor scale with a weighing hopper and manually operated discharge nozzle		

Machinery and Equipment - Continued

Description	Estimated Cost	Actual Cost
C. Proportioning and Weighing - Continued		
1 - Floor hopper		
1 - Conveyor to elevator		
1 - Aqueous ammonia tank with sight gauge - batch tank		
Cost of Proportioning and Weighing Equipment	$ 21,000	_____
D. Screening and Mixing		
1 - Elevator with a fixed nozzle		
1 - Screen		
1 - Chute to a pulverizer		
1 - Pulverizer		
1 - Chute back to the elevator		
2 - Hoppers below the screen and above the mixer		
1 - Barrel-type mixer 4,000 lb. capacity		
Cost of Screening and Mixing Equipment	$ 20,000	_____
E. Drying		
1 - Chute to a rotary dryer		
1 - 6' X 30' Rotary cold air dryer		
1 - Cyclone-type dust separator		
1 - Chute from dust separator to elevator leading to curing bins		
1 - Chute from dryer to elevator		
1 - Screen for rolling the material into small pellets or balls		
1 - Air heater		
1 - Cyclone-type dust separator		
1 - Chute from dust separator to elevator leading to curing bins		
1 - Blower to pass air through the dryer		
1 - Cooling conveyor		
Cost of Drying Equipment	$ 14,000	_____
F. Conveying to Curing Bins		
1 - Hopper		
1 - Elevator		

Description	Estimated Cost	Actual Cost
F. Conveying to Curing Bins - Continued		
1 - Conveyor to belt conveyor across bins 1 - Belt conveyor across the bins 1 - Crane over each bin 1 - Conveyor over each bin		
Cost of Conveying to Curing Bins Equipment	$ 15,000	_____
G. Curing Bins		
12 - Curing bins 15' X 36' X 21' required for storing up to 45 days production		
Cost of Curing Bins	$ 8,000	_____
H. Pulverizing and Packaging		
1 - Tractor equipped with a bucket-type shovel 1 - Floor hopper 1 - Pulverizer in the bottom of the hopper 1 - Screen 1 - Small pulverizer 1 - Screen 1 - Shute to the elevator 1 - Chute to a rejects bin 1 - Hopper above or a part of the bag filling machine 1 - Valve-type bag filler with automatic scales 1 - Bag sewing device or hand tool for placing wire twist bag closers 1 - Roller conveyor from the bagging machine to the pallet loading station A supply of pallets 1 - Electric lift truck 1 - Bag printer to print the mix numbers on the bag		
Cost of Pulverizing and Packaging Equipment	$ 27,000	_____

OTHER TOOLS AND EQUIPMENT

Description	Estimated Cost	Actual Cost
1 - Testing laboratory		
Maintenance materials		
Spare parts		
1 - Drill press		
1 - Lathe		
1 - Bench grinder		
Welding equipment		
1 - Air compressor		
Cost of Other Tools and Equipment	$ 8,000	_____

FURNITURE AND FIXTURES

3 - Desks and chairs
2 - Filing cabinets
1 - Typewriter
1 - Adding machine

Cost of Furniture and Fixtures	$ 1,000	_____

SUMMARY OF EQUIPMENT COST

Description	Estimated Cost		Actual Cost
Heavy moving equipment	$ 36,000		_____
Unloading and elevating dry materials	10,000		_____
Proportioning and weighing	21,000		_____
Screening and mixing	20,000		_____
Drying	14,000		_____
Conveying to curing bins	15,000		_____
Curing bins	8,000		_____
Pulverizing and packaging	27,000		_____
Total Machinery and Equipment		$ 151,000	_____
Other Tools and Equipment		8,000	_____
Furniture and Fixtures		1,000	_____
Total Cost of Equipment		$ 160,000	_____

SUPPLIES

Item	Estimated Cost	Actual Cost
Lubricants	$ 50	_____
Maintenance Materials	2,000	_____
Spare Parts	3,000	_____
Laboratory Materials and Supplies	500	_____
Welding Materials	250	_____
Office Supplies	200	_____
Total	$ 6,000	_____

DIRECT LABOR

Due to the fact that fertilizer is a seasonal product the plant will operate only 30 weeks per year. Therefore, all direct labor is figured on this basis.

Only five men are required on direct labor. The cost of direct labor will be as follows:

> Working 40 hours per week one man would work 30 X 40 hours or 1,200 hours per year. Five men would work a total of 8 x 1,200 hours or 9,600 hours per year.

Based on an hourly rate of $1.50 the total cost of direct labor would be 9,600 X $1.50 or $14,400 per year.

INDIRECT LABOR

All indirect employees will work the full 50 weeks per year. Small shipments may be required at any time. Raw materials will be received and all maintenance work necessary to put the plant in adequate condition for the next years' production will be accomplished by the indirect full time employees.

Occupation	Personnel Required	Hourly Rate	Estimated Cost	Actual Cost
Manager - Chemist	1		$ 10,000	_____
Foreman	1		7,000	_____
Bookkeeper	1		5,000	_____
Maintenance	1	$ 2.00	4,000	_____
Receiving and Shipping	1	1.50	3,000	_____
Total			$ 29,000	_____

DIRECT MATERIALS

Material Costs Per Ton for Two Mixes

Material	Unit Cost Per Ton	Mix: 5-10-10 Quantity Per Ton In Pounds	Mix: 5-10-10 Cost Per Ton	Mix: 10-10-10 Quantity Per Ton In Pounds	Mix: 10-10-10 Cost Per Ton
Nitrogen Solution*	$ 53.50	220	$ 5.89	230	$ 6.15
Sulphate of Ammonia	42.00	58	1.22	548	11.51
Superphosphate	18.20	1,030	9.38	418	3.81
Triple Superphosphate	45.57	---	---	266	6.06
Muriate of Potash	21.96	330	3.63	394	4.33
Magnesium Linestone	1.60	258	.21	100	.08
Borate	42.25	4	.09	4	.09
Conditioner	12	100	.60	100	.60
Total			$ 21.02		$ 32.63

* Nitrogen Solution is: 22.2% Free Ammonia

65.0% Ammonium Nitrate

12.8% Water

Assuming that the annual production will include 10,000 tons of superphosphate and 12,500 tons of triple superphosphate the cost of direct materials is shown below:

10,000 tons Mix: 5-10-10 at a cost of $21.02 per ton would amount to	$ 210,200
12,500 tons Mix: 10-10-10 at a cost of $32.63 per ton would amount to	407,875
The cost of bags is $100 per 1,000 bags or $2.50 per ton 22,500 X $2.50 =	56,250
Total	$ 674,325

PLANT LAYOUT

A plant layout is shown on the last page of this manual.

PLANT SITE

To provide for eventual expansion about 50,000 square feet of level, well drained land is required. The site should be as advantageously located as possible with respect to transportation facilities, power, water, fuel, sources of labor and markets. The cost of the plant site is estimated at $1,800.

BUILDING

A one-story building 85 feet by 280 feet or 23,800 square feet will be required. The building can be constructed with any suitable local material. However, it should have substantial framework and concrete floors. The cost of the building including a boiler, adequate plumbing and wiring is estimated at $4.00 per square foot or about $95,200. The working conditions are dusty. The material may contain an appreciable percentage of fluorine, and this element in this form can be injurious to health. It is recommended that the building be well ventilated and that adequate dust masks be provided to avoid inhaling the injurious dust. The building includes enough space for the eventual expansion of production up to 250 tons per eight-hour day.

POWER

The annual consumption of power is estimated at $4,000.

WATER

The water consumption for all purposes is estimated at $400.

FUEL

The fuel consumption is estimated at $1,000.

DEPRECIATION

Item	Estimated Cost	Years Life	Estimated Per Year	Actual Per Year
Building	$ 95,200	20	$ 4,760	_____
Machinery and Equipment	151,000	10	15,100	_____
Other Tools and Equipment	8,000	10	800	_____
Furniture and Fixtures	1,000	10	100	_____
Total			$ 20,760	_____

MANUFACTURING OVERHEAD

Item	Estimated Cost	Actual Cost
Depreciation	$ 20,760	_____
Indirect Labor	29,000	_____
Supplies	6,000	_____
Power	4,000	_____
Water	400	_____
Fuel	1,000	_____
Total	$ 61,160	_____

MANUFACTURING COST

Item	Estimated Cost	Actual Cost
Direct Materials	$ 674,325	_____
Direct Labor	14,400	_____
Manufacturing Overhead	61,160	_____
Total	$ 749,885	_____

FIXED ASSETS

Item	Estimated Cost	Actual Cost
Land	$ 1,800	_____
Building	95,200	_____
Machinery and Equipment	151,000	_____
Other Tools and Equipment	8,000	_____
Furniture and Fixtures	1,000	_____
Total	$ 257,000	_____

WORKING CAPITAL

Item		Estimated Cost	Actual Cost
Direct Materials	- 30 days	$ 56,200	_____
Direct Labor	- 30 days	1,200	_____
Manufacturing Overhead	- 30 days	5,100	_____
Reserve for Sales Collections	- 30 days	80,000	_____
Total		$ 142,500	_____

CAPITAL REQUIREMENTS

Item	Estimated Cost	Actual Cost
Fixed Assets	$ 257,000	_____
Working Capital	142,500	_____
Total	$ 399,500	_____

SALES REVENUE

Based on a price of $30 per ton for the 5-10-10 mix and $53 for the 10-10-10 mix, the annual gross sales revenue would be as follows:

10,000	X	$30	=	$ 300,000
12,500	X	53	=	662,500
Total				$ 962,500

RECAPITULATION OF COSTS, SALES AND PROFITS

Item	Estimated Cost		Actual Cost
Direct Materials	$ 674,325		_____
Direct Labor	14,400		_____
Manufacturing Overhead	61,160		_____
Total Manufacturing Cost		$ 749,885	_____
Interest on Loans	$ 10,000		_____
Insurance	1,000		_____
Legal	2,400		_____
Auditing	3,600		_____
Unforeseen Expense	17,615		_____
Total Administrative Cost		34,615	_____
Sales Commissions, Travel, Freight Out, Bad Debts, Discounts and Allowances		40,000	_____
Profit before Taxes		138,000	_____
Total Annual Gross Sales		$ 962,500	_____

A requisition form designed to provide accurate records of procurement and indicate the purpose of procurement with the least amount of time and effort is shown on the following page.

This form has an account number for each type of the various expenditures which the manager will review in detail, monthly or oftener, in order to control his expenses. Some items, such as power and water, are usually under contract and are easily checked by reference to monthly bills. For simplification, items (marked with an asterisk below) are omitted from the purchase requisition. Variations in the labor costs are easily reviewed by examination of the payroll vouchers. The simplified type of control thus provided makes certain that the manager can control expenditures promptly.

Following the requisition form, a sample voucher check is shown. Voucher checks should be used for the payment of all expenditures and the appropriate book account number placed on each voucher.

At the end of each month the manager will receive a statement of all expenditures broken down by budget accounts. If the expenditures exceed the budgeted monthly allowances of any of the accounts, the bookkeeper will furnish the manager with a break-down of all expenditures relative to the budgeted accounts exceeded. All these supporting data can be secured by reference to the purchase requisitions and the check vouchers. This reference will enable the manager to determine what caused the over-expenditure and take corrective action.

If at any time during each month it becomes apparent that expenditures will exceed any of the budget accounts, the bookkeeper will bring this to the attention of the manager for his information and action.

BUDGET CONTROL ACCOUNTS

Account Number		Monthly Expense	Monthly Budget	Annual Budget	Actual
10	Administrative	$_____	$ 1,416	$ 17,000	$_____
20	Sales	_____	3,333	40,000	_____
30	Direct Materials	_____	56,177	674,325	_____
40	Supplies	_____	500	6,000	_____
51	Power*	_____	333	4,000	_____
52	Water*	_____	33	400	_____
53	Fuel	_____	83	1,000	_____
60	Unforeseen Expense	_____			_____
	(Reserve Account)		1,468	17,615	
71	Direct Labor*	_____	1,200	14,400	_____
72	Indirect Labor*	_____	2,416	29,000	_____
80	Depreciation (Reserve Account)	_____	---	20,760	_____

Note: Administrative includes interest on loans, insurance, legal and auditing.

PURCHASE REQUISITION	COMPANY NAME	DATE

☐ 10 ADMINISTRATION ☐ 40 SUPPLIES

☐ 20 SALES ☐ 50 UTILITIES

☐ 30 MATERIALS ☐ 60 UNFORESEEN EXPENSE

INDICATE BELOW THE USE OF MATERIALS

☐ DIRECT MATERIALS ☐ MAINTENANCE SERVICES

☐ MAINTENANCE MATERIALS ☐ OPERATING SUPPLIES

	PLEASE ORDER THESE MATERIALS OR SERVICES	DELIVERY WANTED	
QUANTITY	DESCRIPTION	UNIT	TOTAL

QUOTES FROM		REQUISITIONED BY	
QUOTES FROM		APPROVED BY	
QUOTES FROM		ORDER NO.	ORDER DATE

R. W. MITCHELL MANUFACTURING COMPANY

1422 BOSWORTH STREET, S. E

65-22
514

ANYWHERE, U. S. A._____19____ No. 10000

PAY _____ DOLLARS $ _____

TO THE ORDER OF

R. W. MITCHELL MANUFACTURING COMPANY

TO FIRST NATIONAL BANK
ANYWHERE, U. S. A.

BY SAMPLE CHECK

VICE PRESIDENT

ACCOUNT NUMBER

Sample voucher check to be used for the payment of all expenditures in connection with Budget Control.

R. W. MITCHELL MANUFACTURING COMPANY

ENGINEERS

The services of professional engineers are desirable in the design of this plant, even though the proposed plant is small.

A correct design is one which provides the greatest economy in the investment of funds and establishes the basis of operation that will be most profitable in the beginning and will also be capable of expansion without expensive alteration.

The addresses of professional engineers who specialize in industrial design, some of whom may be willing to undertake such work on low cost projects overseas, can be secured by reference to the published cards in various engineering magazines. They may also be reached through their national organizations, one of which is the

National Society of Professional Engineers
2029 K Street, Northwest,
Washington 6, D. C.

Manufacturers of industrial equipment employ engineers familiar with the design and installation of their specialized products. These manufacturers are usually willing to give prospective customers the benefit of technical advice by those engineers in determining the suitability of their equipment in any proposed project.

The equipment manufacturers also know, and can recommend, professional engineers in private practice, who are willing and able to provide appropriate consulting services.

TRAINING

Manufacturing an inferior quality of product during the training period could create sales resistance that might be difficult to cope with later. To avoid such possibilities, the quality of the product should be maintained at all times, including the training period.

In some areas skilled operators may be available locally. In other areas all the operators may have to be trained.

If skilled operators are not available, adequate training would be assured by using one or more of the following methods:

A. If the plant is designed and installed by a competent engineering firm, the contract should be negotiated, if possible, on a turn-key basis. On this basis the contractor agrees to operate the plant and produce the quality and quantity of the product stated in the contract for an agreed period of time. Such a contract would assure adequate personnel training, since full quantity and quality could not be produced with an untrained organization.

B. The engineering firm that designs and installs the plant can usually make training arrangements to have key personnel placed, for training purposes, in a foreign industry that produces the same type of product. This would provide training for the key personnel while the plant is being installed.

C. If neither of the above methods is possible, then qualified and experienced individuals should be employed for the key positions, either permanently or temporarily, to perform the key operations and assist in training the organization, even if they must be secured outside the country.

D. The manager should have years of successful experience in this type of business and be fully qualified in all phases of management, including the training of employees.

SAFETY

There is always danger of accident and injury in any industrial plant. Because of this, the manager should take specific action to bring to the attention of each employee the importance of safety precautions and intelligent first aid.

Practically all machines have safety appliances, and the manager should see that these are in good working condition and that the operators are making full use of them.

In addition to constant watchfulness to make sure that all practicable safety precautions are taken, first aid supplies should be readily available. One complete first aid kit should be maintained near the manager's office, and others at appropriate places throughout the plant. Some of the employees should be trained to provide first aid service.

The use of accident posters in the plant has proved to be of value in reducing accidents. It is recommended that such posters be used, and that some direct special action be taken by the manager, at least once each month, to bring to the attention of all personnel the importance of safety precautions.

A fire brigade should be established and each member trained as to his responsibility in case of fire. Fire drills should be conducted periodically.

It is recommended that the employees be encouraged to offer suggestions or recommendations relative to prevention of accidents, removal of fire hazards and maintaining general interest in all safety factors.

SUMMARY

A small plant, built and operated according to the assumptions made in this manual would be a profitable undertaking.

There are some determinations, however, that should be made before a decision is reached to build and operate such a plant. Among the necessary determinations to be made are those with respect to the following items:

MATERIALS AND SUPPLIES

1. Are all materials and supplies available locally?
2. Is the local material market competitive?
3. Are satisfactory delivery of local materials assured at reasonable prices?
4. What materials and supplies must be imported?
5. Are they available in world markets at competitive prices?
6. Would prompt delivery of imported materials and supplies be assured so that large inventories would not be required?

MARKET FACTORS

1. Is there already a demand for the product?
   - A. Who are the principal consumers?
   - B. Who are possible new consumers?

2. How is demand for the product now satisfied?
   - A. By local production? If so, what is the volume of annual production?
   - B. What percentage of consumption is filled by local production?
   - C. By imports? If so, what is the volume of annual imports?
   - D. What percentage of consumption is met by imports?
   - E. From what areas are imports derived?

3. What is the estimated annual increase in local consumption over the next five years?
   - A. How were such estimates made?
   - B. By reference to official figures on population growth, family budgets, imports, etc.?
   - C. By consultation with trade or industry, ministries, associations, bankers, commercial houses, wholesalers, retailers, industrial consumers, etc.?

4. If the product is already being manufactured, can the existing and estimated future local market absorb production of the new plant without price-cutting or other dislocations?

5. Would the estimated sales price and quality of the new product make it competitive with an imported equivalent?
   A. After adjusting cost to local conditions, is the estimated sales price of the product so high that tariff protection is necessary to protect it from imports?

EXPORT MARKETS

1. Could the product compete in export markets on the basis of price, quality and dependability of supply?
2. Can export markets for the product be developed?
3. If so, in what areas and in what annual volume?
4. What procedures would be necessary to develop export markets?
5. What would it cost?

MARKETING PROBLEMS

1. In calculating costs of the product, has adequate allowance been made for the expense of a sales department, advertising and promotion that might be required?

2. Do consumer prejudices against locally manufactured products exist?
   A. If so, why?
   B. Would they apply to the new product?
   C. If so, how could they be overcome and what would it cost to do so?

3. Do marketing and distribution facilities for the product exist?
   A. If not, can they be set up?
   B. What would it cost to do so?

4. Will the product be sold to:
   A. Wholesalers?
   B. Retailers?
   C. Direct to consumer?
   D. Other industries?
   E. Government?

ECONOMIC FACTORS

1. How much foreign exchange (and in what currency) is required to import machinery, equipment and supplies:
   - A. How much foreign exchange (and in what currency) is required for annual interest payments and amortization of any loans contracted to import machinery and equipment, or for payment of royalties and technical services?
   - B. How much foreign exchange (and in what currency) is required for annual import of raw materials and supplies?
   - C. What are estimated annual foreign exchange earnings and in what currencies?
   - D. Has careful consideration been given to the possibility of depreciation in the foreign exchange value of the local currency?
   - E. Has careful consideration been given to the possibility of import controls, or restrictions on availabilities of foreign exchange necessary to operate the business?
   - F. What benefits would the new business bring to the economy in the use of local raw materials: in employment and in technology?
   - G. Do dependable facilities exist for transportation, power, fuel, water and sewage?
     - (1) If not, can existing deficiencies be eliminated satisfactorily?
     - (2) What would be the cost to do so?

PERSONNEL

1. Is there an adequate labor supply near the plant location?
   - A. If not, how can the problem be solved?

2. Can the problem of training competent management and supervisory personnel be solved?
   - A. Also, the training of skilled labor?
   - B. Is technical advice available in the locality?
   - C. If not, where can it be obtained and what will it cost?

LAWS AND REGULATIONS

1. Do existing labor laws, government regulations, laws and taxes favor establishment of new business?
   - A. If not, can existing obstacles be removed?
   - B. If so, how and when?

FINANCIAL FACTORS

1. Technical advice on selection of machinery and equipment.
   A. In selecting the machinery and equipment for the new plant, have reputable and competent engineers and technicians been consulted?
   B. Have they been asked for advice on the most suitable types of machinery and equipment for the process and locality?
   C. Have they carefully compared costs of various suppliers?
   D. Credit terms offered purchasers?

FINANCIAL REQUIREMENTS OF THE PROJECT

1. In estimating the cost of the project, has careful consideration been given to:
   A. The effect on costs of delays in construction schedules?
   B. In delivery and installation of machinery and equipment?
   C. In import of essential raw materials and supplies?

2. In calculating cash flow and working capital requirements, has careful consideration been given to:
   A. Maintaining adequate inventories of raw materials?
   B. Supplies and spare parts?
   C. Seasonal fluctuations in the business?
   D. The time required to liquidate credit sales to customers and bad debts?
   E. The period necessary to get the plant into production?
   F. Cash required to amortize its principle loans?

3. If the economy is in a period of inflation, has full allowance been made for the influence of rising prices and wages on the cost of the project and on working capital requirements?

SHORT TERM BANK CREDITS

1. Has it been possible to make arrangements with local banks to finance short-time working capital requirements of the business?

FINANCIAL PLAN:

1. Has a definite plan to finance the project been worked out?
   A. Is sufficient capital available locally?
   B. If not, what is the plan to obtain the required capital?

BIBLIOGRAPHY

Textbooks

Rogers Manual of Industrial Chemicals	D. Van Nostrand Company, Inc. 250 Fourth Avenue New York, New York
Commercial Fertilizers	McGraw-Hill Book Company, Inc. 330 West 42nd Street New York 36, New York

Periodicals

Commercial Fertilizers	W. W. Brown Publishing Company 75 Third Street, N. W. Atlanta, Georgia
Farm Chemicals	Ware Brothers Company 317 North Broad Street Philadelphia 7, Pennsylvania

ABBREVIATIONS

'	Foot or feet
"	Inch or inches
No.	Number
%	Per cent
lb.	Pound

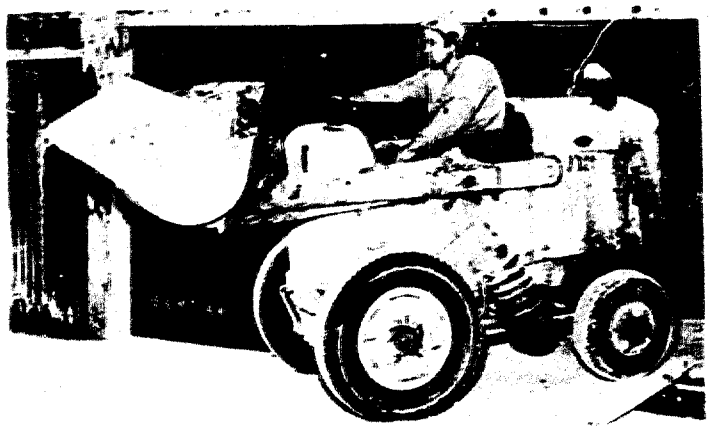


Figure 1 - Tractor with bucket-type shovel

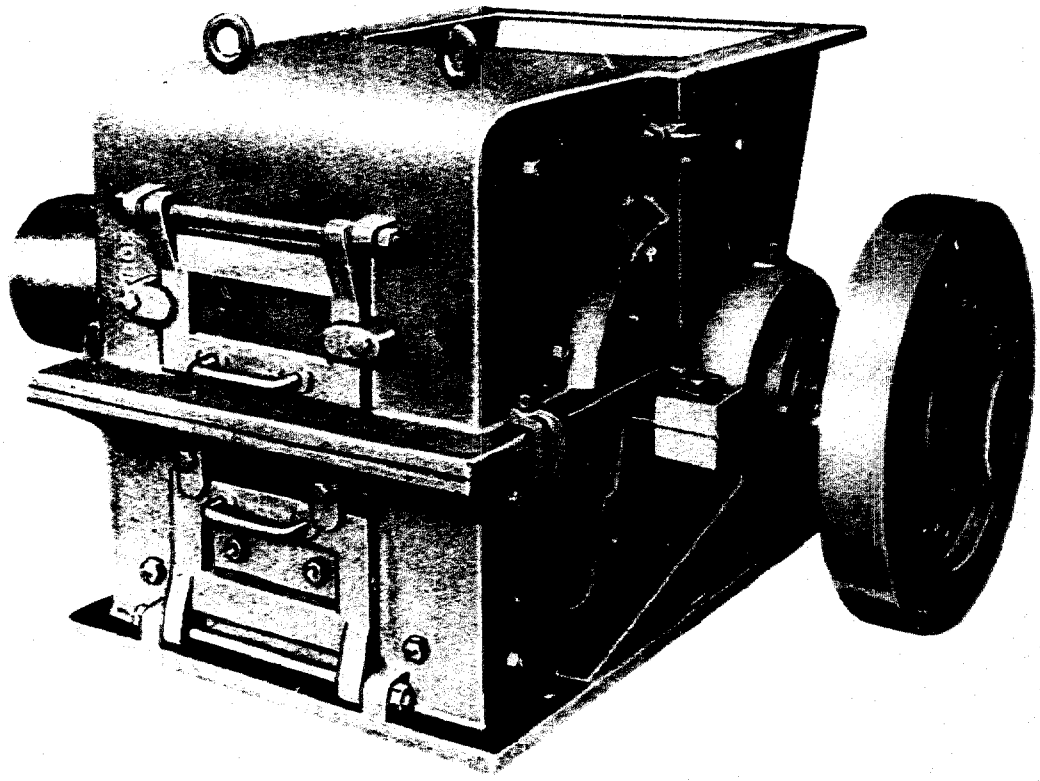


Figure 2 - A pulverizer

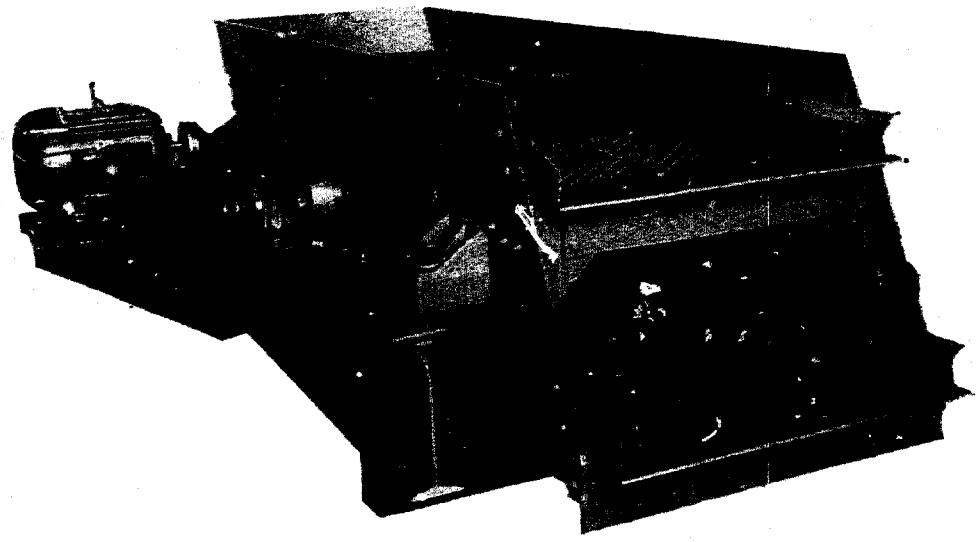


Figure 3 - A vibrating screen

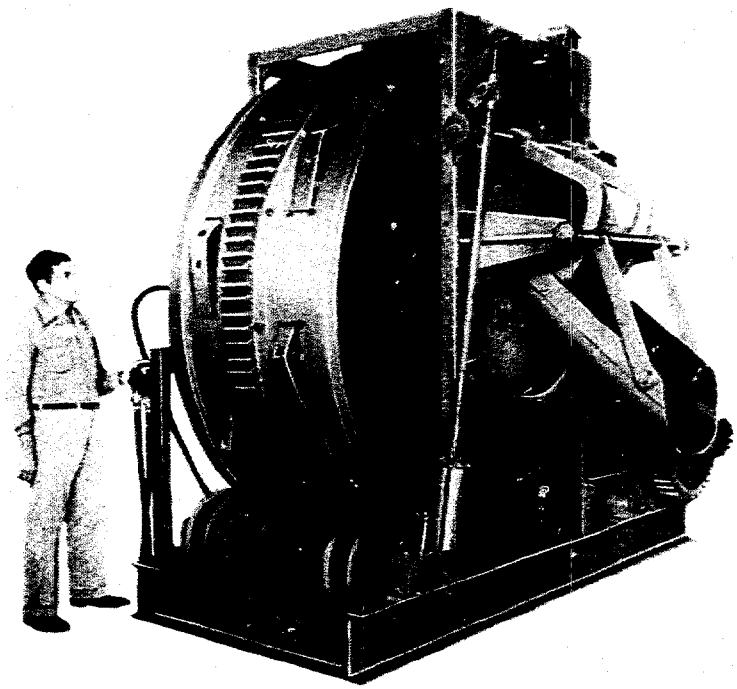


Figure 4 - A mixer

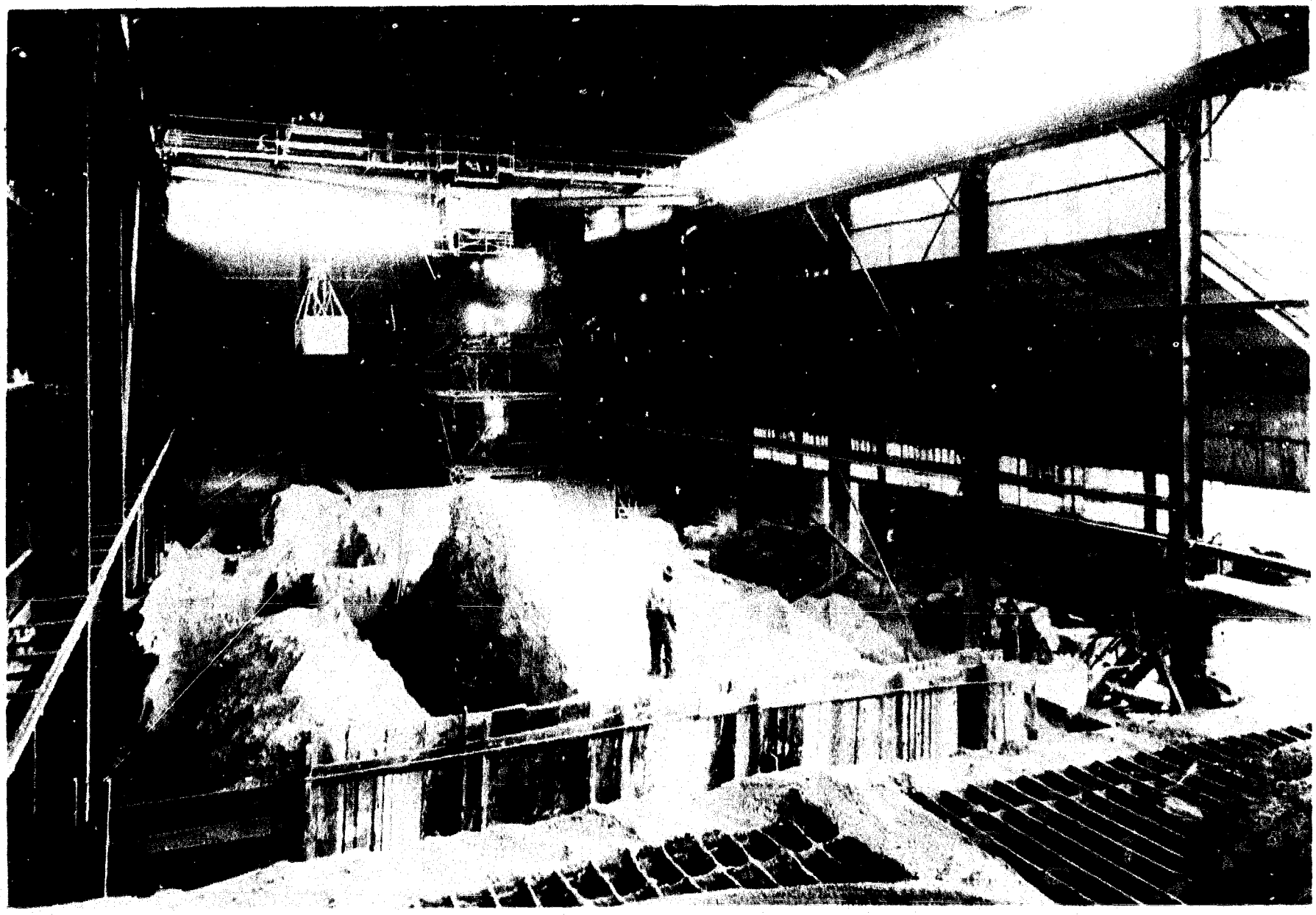
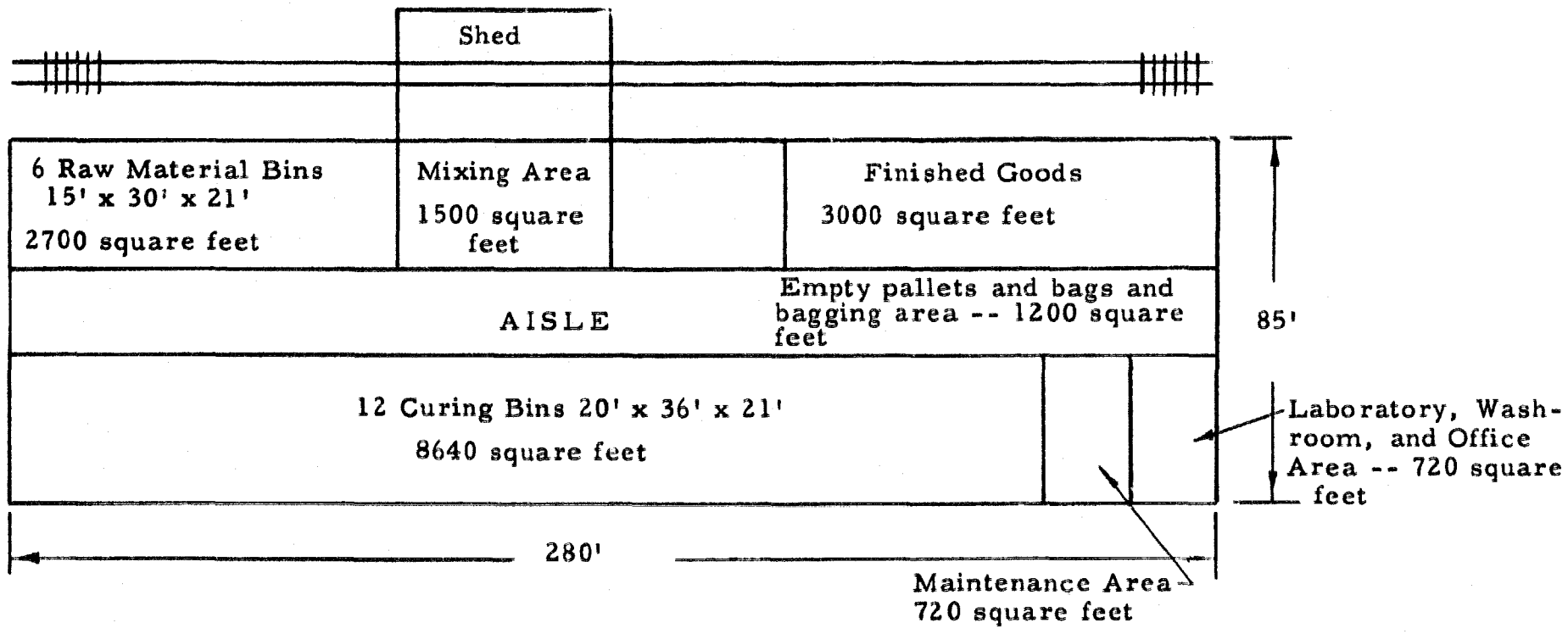


Figure 5 - Interior of a typical fertilizer plant with overhead crane equipment



Total plant area = 23,800 square feet
Plant capacity = 250 tons per day

Scale: 1" = 40'

Figure 6 - Preliminary plant layout

INTERNATIONAL COOPERATION ADMINISTRATION

SERVICES OF THE INDUSTRIAL TECHNICAL COOPERATION PROGRAM

TYPE III - TECHNICAL AIDS FOR OVERSEAS

- **INDUSTRIAL REPORTS SERVICE**

Provides basic information regarding:

1. Data and reference materials relating to private capital mobilization and its application in economic development.
2. Requirements for establishing and operating small factories in basic industries.
3. Man-hour requirements, operational characteristics, and equipment utilization in representative U. S. factories in selected industries.
4. Man-hour and materials savings through standardization, simplification, and specialization studies.
5. Supervisory and other specialized training procedures and techniques.
6. U. S. experience in specialized fields.

- **TECHNICAL DIGEST SERVICE**

Provides digests and abstracts, full length articles, and bibliographical references on U. S. developments in products, processes, and work techniques derived from U. S. technical, scientific, and trade periodicals, and other pertinent sources.

- **TECHNICAL INQUIRY SERVICE**

Provides answers to individual questions relating to products, processes, machinery and equipment, production operations, work techniques, management practices and concepts, factory engineering, and basic requirements for industrial production.

- **TRAINING MATERIALS SERVICE**

Provides basic materials for use by specialized technicians in the conduct of management, supervisory and specialized training courses in host countries.

- **TECHNICAL LITERATURE SERVICE**

Provides recommendations and guidance regarding current useful world-wide publications relating to industry and productivity improvement; distributes carefully selected and representative new publications of particular value for program use; and facilitates mission literature procurement.

- **U. S. BOOK EXCHANGE SERVICE**

Provides, on Mission approval, technical and scientific books and periodicals on exchange basis to overseas libraries.

- **VISUALS AND NEW MEDIA**

Provides technical advice and guidance to missions on new industrial visuals. Provides for cooperative program adaptation and use a variety of visual materials, including loan exhibits, silk-screen display panels, graphic brochures, slide and sound kits, and related materials.

- **TECHNICAL FILM SERVICE**

Provides guidance for and facilitates procurement of U. S. technical and training films for program use; provides representative U. S. technical industrial films and filmstrips on loan basis for short-term program requirements; and facilitates adaptation of films into foreign language versions for program use overseas.