4799
R-5

PLANT REQUIREMENTS FOR MANUFACTURE OF ASBESTOS - CEMENT SIDING

TECHNICAL AIDS BRANCH

INTERNATIONAL COOPERATION ADMINISTRATION

Washington, D. C.

REVISED MAY 1959

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.

* * * * * * * * *

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.

* * * * * * * * *

The original report was prepared by the Wolf Management Engineering Company, Chicago, Illinois.

Technical information, as well as review, was provided by R. Poliakoff, Industrial Consultant, 126 Eleventh Avenue, New York 11, New York.

* * * * * * * * *

This manual has been revised and rewritten by
George H. Andrews Engineering Associates, Inc.
411 Southern Building, Washington 5, D. C.

April, 1959

TABLE OF CONTENTS

	Page
Introduction	1
General Assumptions	1
Materials and Their Sources	2
Location of Deposits	4
Portland Cement	5
Coloring Matter	5
The Milling of Asbestos	5
Product Specifications	11
Groups of Crude and Milled Asbestos	12
Subdivision of Groups of Milled Asbestos	13
Manufacturing Unit	14
Production Capacity	14
Cost of Materials	14
The Manufacturing Process	15
Flow Chart for Shingles	17
Hatscheck Forming Machine	21
Plant Layout	22
Plant Site	22
Building	22
Power	22
Water	22
Fuel	22
Asbestos-Cement Sidewalls	23
Trimming and Nail Punching	23
Asbestos-Cement Sheets	23
Schematic Layout	24
Direct Labor	25
Indirect Labor	26
Production Tools and Equipment	27
Other Tools and Equipment	28
Furniture and Fixtures	28

	Page
Supplies	28
Depreciation	29
Manufacturing Overhead	29
Manufacturing Cost	29
Fixed Assets	30
Working Capital	30
Capital Requirements	30
Sales Revenue	31
Recapitulation of Costs, Sales and Profits	31
Budget Control	32
Budget Control Account	32
Purchase Requisition Form	33
Voucher Check	34
Engineering	35
Training	36
Safety	37
Summary	38
Materials and Supplies	38
Market Factors	38
Export Factors	39
Marketing Problems	39
Economic Factors	40
Personnel	40
Laws and Regulations	40
Financial Factors	41
Financial Requirements of the Project	41
Short Term Bank Credits	41
Financial Plan	41
Bibliography	42
Abbreviations	42

PLANT REQUIREMENTS FOR MANUFACTURE OF ASBESTOS-CEMENT SIDING

INTRODUCTION

As indicated by the name, asbestos-cement products are made by combining asbestos fiber and Portland cement. In some cases, other materials such as silica and coloring matter may be added.

In the United States the market for asbestos-cement products is very large and is still growing rapidly. This favorable situation has grown from the fact that these products meet many of the needs for a construction material that is useful in form and appearance, with excellent physical characteristics, is comparatively inexpensive and with excellent resistance to damage.

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 three 8-hour shifts a day, five days a week, fifty 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, 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 report should be adjusted to conform to local conditions.

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

MATERIALS AND THEIR SOURCES

ASBESTOS

Asbestos is the name applied to a group of fibrous materials found in natural form in rock formations in many places throughout the world. It is unique in that it has some of the characteristics of silk and wool and yet will not burn.

Asbestos is mined both from underground mines and from huge open pits. The fibers are separated from the rock and sorted into groups by length in large mills. The longer fibers are the most valuable and are used in textile manufacture to make unburnable cloth. The fibers too short for cloth are used for asbestos-cement pipe and the relatively short fibers go into the other asbestos-cement products and into heat insulating materials, such as steam packing, brake linings, clutch facings and fireproof electrical insulation.

There are many varieties of asbestos. These differ considerably in composition and also in physical characteristics. Chrysotile constitutes 95% of the world production. Its fibers are strong and flexible.

Species other than chrysotile that are available for significant use are of the Amphibole mineral group. The important varieties in this group are Anthophyllite, Tremolite, Amosite and Crocidolite. Anthophyllite and Tremolite fibers are usually brittle and weak. Very little of these two varieties are used internationally. Amosite and Crocidolite occur usually in Africa and are used in large quantities.

Chrysotile Asbestos

Chrysotile asbestos is a hydrous magnesium silicate, the chemical formula for which is $3\ MgO.\ 2\ SiO_2,\ 2\ H_2O$. It is a fibrous form of serpentine. Both (OH) the water of constitution and (H_2O) the water of crystallization are found in chrysotile asbestos. The proportion of the components vary in the fibers that come from different locations. Thus in Canadian chrysotile there is a greater proportion of the water of crystallization (H_2O) while in the Rhodesian chrysotile the hydration is due mainly to

the water of constitution (OH). This difference may explain the tremendously greater electrical resistance of the chrysotile asbestos from Rhodesia than that of the Canadian chrysotile asbestos. In general, chrysotile asbestos is more constant in quality than are other asbestos varieties.

Amphibole Asbestos

The present recognized formula for the above group is now $2\ CaO.\ 5\ MgO.\ 8\ SiO_2\ H_2O$ although previous to 1916 the formula as published was $CaO.\ 3\ MgO.\ 4\ SiO_2$.

All amphiboles contain water of crystallization. The water content of amphiboles is low (only 1 or 2%) whereas there is 14% water in chrysotile asbestos.

Amosite Asbestos

Amosite asbestos contains up to 40% iron oxide. It has rather strong fibers. It comes from Africa, fibers attain lengths of 12 to 15 inches.

Anthophyllite Asbestos

In anthophyllite asbestos, ferrous iron may replace magnesium to a maximum of 26.5%. However, in this case the MgO would be as high as 11.5%. The MgO content varies from 5 to 50% while the CaO content averages .5% and rarely exceeds 2%. Aluminum often replaces the MgO and the SiO_2 and often attains 5% and sometimes as much as 10%. Its fibers are weak, not flexible and often crumble when touched.

Tremolite Asbestos

In tremolite asbestos sodium sometimes replaces the calcium. Iron and aluminum sometimes replaces the magnesium. Aluminum may replace a small portion of the silicon. The tremolite asbestos fibers are usually weak and brittle but sometimes the converse is true. The fibers are very silky and grey to white in color.

Both tremolite and anthophyllite asbestos are superior to chrysotile asbestos in resistance to chemical reaction.

Crocidolite Asbestos

Crocidolite asbestos, meaning "wooly stone" (called blue asbestos), has the formula $3\ Na_2\ 0.6\ Fe\ O_3.\ 16\ SiO_2.\ H_2O$. Potash may replace the sodium, manganese or magnesium may replace the ferric and ferrous iron and aluminum may replace ferrous iron.

The replacement of the standard elements by other elements in the Amphibole fibers changes the properties and physical characteristics. This is also true of the effect of impurities in the fibers.

LOCATION OF DEPOSITS

Chrysotile Asbestos

Chrysotile asbestos can be found in:

1. United States - only two states, Vermont and Arizona, are consistent producers, the largest amount coming from Vermont. In Arizona the deposits are 40 to 60 miles from the railroads, which means high trucking costs for long hauls. With high mining costs, only highest grades of asbestos are produced.

2. Canada - in British Columbia and New Foundland there are deposits which need development. Deposits near Quebec and about 325 miles northwest of Ottawa are mined by open pit methods.

3. Russia

4. Rhodesia - similar to that found in Russia and Canada; 25 to 30% is of spinning grade as compared to less than 8% in Canada.

5. Italy - over 22,000 tons of tremolite and chrysotile asbestos produced annually.

6. India - small production of good quality.

7. Japan - a moderate supply is mined and used chiefly in the asbestos-cement products industry.

8. Cyprus - comprises only 1 to 2% of the rock content -- 90% is available for shingle production. It is unimportant internationally.

9. China - has produced over 20,000 tons per year, but at present this source of supply for world trade is uncertain.

10. Natal - small operation.

11. Venezuela - small amount.

12. Australia and New Zealand - produce a few hundred tons annually.

13. Switzerland

Amphibole Asbestos

Finland

Amosite Asbestos

Transvaal - annual production 30,000 tons.

Crocidolite Asbestos

1. Bolivia - a small amount is produced, but due to the six month rainy season operations are not continuous.

2. Cape of Good Hope - largest deposits found, in which 10 to 20% of the material is suitable for spinning.

Asbestos is received in 100 pound burlap bags which are marked with the grade number and letters. The asbestos used in the United States for the manufacture of asbestos-cement products is of the chrysotile variety which comes primarily from Canada, and a little from Vermont.

Detailed specifications and prices for asbestos are presented at the end of the section, "Milling Asbestos."

PORTLAND CEMENT

In the United States, Portland cement for large plants is shipped in special railroad cars. For small plants it is usually shipped in heavy paper bags containing one cubic foot and weighing 94 pounds. Export prices are usually quoted in barrel lots, each barrel weighing 380 pounds. Current New York and Philadelphia prices are $4.00 per barrel or $1.00 per bag.

Since the presence of even a small amount of moisture can cause the cement to "set", it is imperative to keep the cement perfectly dry.

COLORING MATTER

For the green color, chromium oxide is usually used, the price ranging from 30 cents to 40 cents per pound.

For the brown color, ferric oxide, costing from 6 cents to 16 cents per pound, is usually used.

THE MILLING OF ASBESTOS

Because some asbestos mines are not equipped to mill their product before shipping to their customers, a description of the milling process is included at this point.

Generally, the chrysotile asbestos that is used in the products proposed is found associated with gangue material of serpentine or serpentine and limestone. As chrysotile also is serpentine, neither chemical composition nor specific gravity can be utilized as a basis for separation. The property that makes mechanical separation of chrysotile possible is the fibrous structure. This permits it to be opened or divided by impact into separate filaments, thus making it amenable to separation from the gangue by screening and by air suction.

Although in wool, cotton and silk the fibers will divide down to only their minimum size (which is well known), the minimum size of the asbestos fibers is limited only by the delicacy of the machinery employed in the separation or splitting of the fibers. Fibers from different locations will split differently.

The value of chrysotile asbestos depends largely upon the length of the fiber. If fiber 3/8" long is worth $100 per ton, fiber 3/4" long is worth $400 per ton. This means that breaking a fiber in half destroys three-fourths of its value. The most important factor underlying the milling of asbestos, therefore, is the separation of the fiber from the rock with the minimum breakage of the fiber. The greatest care must be taken in this work for the longer the fiber the greater is the fiber value. The best machines break the rock effectively, thus releasing the fiber therefrom, yet spare the fiber unnecessarily rough treatment. Modern machines are designed to remove the separated fiber after each crushing operation to separate the sand from the fiber as soon as it is formed and to keep hard barren rock out of the mills. If the fiber already freed from the rock enters the next crushing unit along with the sand and rock fragments, it will be broken into shorter lengths, thus losing value.

Asbestos milling consists of coarse crushing, drying and recrushing in successive stages, each step being followed by screening and air separation of the fibers from the rock.

A peculiarity of asbestos milling is the absence of any known method of testing the quality of the mill feed. A rock that appears to contain little fiber may yield a fair return; conversely, one that appears promising may produce a low recovery. Although the percentage of recoverable fiber in a rock cannot be predetermined, the actual yield can be calculated from the mill output. A fair estimate of the value of the fiber bearing rock can be obtained only by making a test run in a commercial mill.

Preparation of Crudes

The rock is broken free of the larger fiber veins by sledging and the masses of fiber are sorted by hand. The fiber with some adhering rock is dried on steam coils and taken to the cobbing sheds where the fiber veins are flattened with a hand hammer, freeing them from the adhering rock. This is then sorted by hand, the process being called "hand cobbing". The separated dust rock and short fibers are dripped under the bench, the remaining high grade fibers are classed as crude

No. 1 of material is 3/4" and over, and as crude No. 2 if material is 3/8" to 3/4" in length. To separate further the short fiber and rock dust, crude No. 1 is screened on a flat shaking screen with 3/8" holes and crude No. 2 on one with 3/16" holes. The fibers are then bagged in jute bags of one hundred pound capacity. From 5 to 20% of rock fragments, the dust and the short fibers still remain in the crudes as sold and these impurities are separated at the factory where asbestos products are manufactured or where the asbestos is milled.

Preliminary Crushing

Rock from the quarry or mine is dumped into a "sluice" that holds several carloads. The bottom of the sluice has a railroad rail grizzly that provides a by-pass for "fines". The primary crusher feed from the sluice is controlled by grates of the finger grate type that may be moved up and down. A jaw crusher with a 36" web by 24" opening set for a 4 to 6" discharge is usually the primary breaker. Other size units are employed as needed. Crushers discharge to picking belts where liberated crudes are removed by hand.

Drying

The rock as it is delivered to the mill contains considerable moisture -- in winter even ice and snow -- and it must be dried for proper milling. Standard rotary driers are usually used. The shells 40 to 60 feet long, 4 to 6 feet in diameter are inclined at a 7 degree angle. The material is lifted by a series of blades and allowed to fall through the current of hot air that is blown through the shell. Production ranges from 30 to 60 tons per hour and the cost of operation is from 4 to 18 cents per ton.

Stack driers replace the rotary driers and are more economical. These are 50 feet tall by 7 feet in diameter. Rock is elevated to the top and passes to the bottom, falling over a series of grids. A current of heated air is circulated up through the falling material.

Storage

A large supply of rock insures regular mill feed. Bins have a capacity of from 25,000 to 150,000 tons. By drawing rock from several gates at one time, material of the same relative size and fiber content is obtained.

Fiberizing

Milling methods vary greatly because of differences in the material being milled. A method suitable for hard rock is too severe for the fiber found in soft rock. Secondary crushing is done with jaw crusher or gyratory crusher, rolls, Symons cones, or hammer mills. A straight impact that frees and fluffs the fiber is better than a grinding or shearing action which may shorten the fiber. Hence rolls are less desirable than impact mills.

The best modern practice is shown by the following flow chart:

1. Grizzly in rock sluice
2. Jaw crusher
3. Drier
4. Grizzly, fines to screens fitted with suction
5. Gyratory crusher
6. Screens with suction
7. Rolls
8. Screens with suction
9. Jumbo
10. Screens with suction
11. Jumbo
12. Screens with suction
13. Jumbo
14. Screens with suction
15. Jumbo
16. Screens with suction
17. Rotary graders and flat cleaning screens
18. Floats bin
19. Sand to dump

The freed fiber must be removed after each crushing.

A Jumbo is a horizontal drum 6 to 8 feet long and 24 to 30 inches in diameter. Beaters attached to the horizontal shaft consist of arms that support manganese-steel hammers. These hammers are set at intervals of 6 to 8 inches along the shaft and clear the inside of the shell by about 1/2 to 1 inch. They are turned at a slight angle to direct the broken rock toward the discharge end. The shaft rotates at 400 to 800 r.p.m., depending upon the nature of the rock being treated.

Instead of using a Jumbo, the rock may be beaten to powder by one of several types of cyclone machines. The Laurie cyclone consists of a cast iron chamber in which two beaters shaped like ship propellers are driven in opposite directions at 1700 to 2000 r.p.m. In the Pharo cyclone the beaters revolve in the same direction and the rate of discharge is controlled by gates. The Torrey cyclone is like the Jumbo, but the axis of the beater arms is vertical.

Screening

Eccentrically-operated shaking screens are generally used but sometimes vibrating screens are employed. Sizes are usually 3 to 5 feet wide and 8 to 12 feet long. Screens with holes up to 3/8" and even larger do the separating known as "scalping". Smaller holes down to 1/32" are used for the finest material. Wire screens with 3 to 24 mesh per inch are used for cleaning fiber.

The coarse rock and the longer fibers remain on the screen while the fines pass through the openings. The shaking action brings the fiber to the surface of the bedded rock fragments and it is removed by the air-suction equipment that will be described later. Thus each screen supplies three products: (1) fines that pass through as waste; (2) coarse rock fragments discharged at the end; and (3) the good fiber which is collected by suction. Oversize rock fragments pass to the next fiberizing unit.

Air Suction

Fiber that has come to the top surface of the layer of rock fragments on the screen is removed by air-suction hoods that operate on the principle of a vacuum cleaner. The opening of the suction hood is 3 to 4 inches wide and extends across the screen. The area of this slot is usually the same as that of the pipe into which it converges, which ranges from 12 to 20 inches in diameter. Large fans produce the necessary vacuum, a 10 to 15 horsepower motor being required to drive a fan giving the necessary lifting power for a pipe of 15 inch diameter. The air current sweeps the fiber from the screens and carries it through pipes to the collecting chambers, where the suddenly-diminished rate of flow permits the fiber to fall to the bottom of the chamber. The dust-laden air from the fans is blown into dust chambers, and the fine materials that settle there are returned to the mill, where the longer fibers are separated and the extremely short grades are bagged and sold as "floats".

Grading

The asbestos fiber is graded according to length in trommels about 8 feet long and 28 inches in diameter, fitted with wire cloth.

Paddles clamped to a central shaft agitate the fiber and force the shorter fiber through the screen. One type of machine consists of a stationary trommel in which the paddles rotate at 400 to 900 r.p.m. The paddle tips are twisted at a small angle to their plane of motion, which causes the fiber to travel through the machine. In

other machines, the trommel rotates at about 5 r.p.m. and the paddles rotate in the opposite direction at 180 to 250 r.p.m. Sand and dust are removed from the graded fiber on flat cleaning screens. Finished fiber is lifted from the cleaning screen by air suction and conveyed to the storeroom where it is bagged.

Classification

In order for the asbestos cement manufacturer to be able to test the quality (grade) of the milled asbestos purchased, a sampling unit described below is usually used. It consists of four wooden trays 24-1/2" x 14-3/4" x 3-1/2" deep, and a means for vibrating them. These boxes, superposed, are numbered from the top down -- 1, 2, 3, and 4. The bottom of box No. 1 has a 1/2" opening, diameter of wire .105"; No. 2 - 4-mesh wire of diameter .047; No.3 - 10-mesh wire of diameter .047; No. 4 - solid-bottom receptacle for the fines which fall through the other three boxes. The nest of four boxes is placed on a table to which a power-driven eccentric is connected.

One pound of asbestos fiber is placed on the top box, which is covered. The eccentric is run at 300 r.p.m. for two minutes, giving a horizontal shaking movement to all the boxes. The weight of material in each box is weighed. Box No. 1 contains the longest fiber, the shorter fibers according to length remain on boxes No. 2 and No. 3, and the very shortest drop into box No. 4. Of course, the more fiber on No. 1 screen and the less in box No. 4, the higher the grade and, therefore, the greater the value.

The specifications for the purchase of fiber are determined by the above test. Thus, if the fiber purchased is specified as 3-6-5-2, it means that in a sample of 16 ounces for an average of the lot, 3 ounces remained on screen No. 1, 6 ounces on screen No. 2, 5 ounces on screen No. 3, and 2 ounces in box No. 4. This would cost more than 0-0-12-4, of which none will be on screen No. 1 nor on screen No. 2, 12 ounces on screen No. 3, and 4 ounces in box No. 4. This numbered designation is the number of ounces of the different lengths of asbestos in a pound purchased.

The standard classification of Canadian and American asbestos is divided into nine groups and each group is divided into grades.

Crude asbestos is defined as "hand-selected, cross-vein material essentially in its native form".

Milled asbestos is defined as "all grades produced by mechanical treatment of asbestos ore". Except for the very lowest grades, which are based on the weight per cubic foot, all milled grades in the United States and Canada are passed on the results of tests in the standard testing machine described above.

A complete description of standard grades of Canadian asbestos are shown on pages 12 and 13.

PRODUCT SPECIFICATIONS

The finished asbestos shingle is 12" x 24" and has 5 holes punched for nailing. The material specifications are shown below:

	Base	Veneer
S K Asbestos	14 %	14 %
Portland Cement	76 %	83-1/2 %
Inert Matter (crushed scrap)	10 %	--
Coloring Matter	--	2-1/2 %

The material cost is based upon producing one half colored shingles.

GROUPS OF CRUDE AND MILLED ASBESTOS

Group No.	Standard Designation of Grade	Description
		Crude Asbestos
1	Crude No. 1	Consists of crude 3/4" staple and longer
2	Crude No. 2	Consists of crude 3/8" staple up to 3/4"
	Crude Run of Mine	Consists of unsorted crudes
	Sundry Crudes	Consists of crudes other than above specified
		Milled Asbestos
3	Spinning or textile fiber	Consists of fiber testing 0-8-6-2 and over
4	Shingle fiber	Consists of fiber testing below 0-8-6-2 and including 0-1½-9½-5
5	Paper fiber	Consists of fiber testing below 0-1½-9½-5 and including 0-0-8-8
6	Waste, stucco, or plaster	Consists of material testing below 0-0-8-8 and including 0-0-6½-9½
7	Refuse or shorts	Consists of material testing 0-0-5-11 and below and including material testing below 0-0-1-15 and specified as weighing 35 lbs. or less/cu.ft. loose measure
8	Sand	Consists of such asbestos mill products as sand weighing over 35 lbs./cu.ft., loose measure, and under 75 lbs./cu.ft., loose measure, and containing a preponderance of rock
9	Gravel and stone	Consists of such asbestos mill products weighing over 75 lbs./cu.ft., loose measure

SUBDIVISION OF GROUPS OF MILLED ASBESTOS

Group No.	Standard Designation of Grades	Guaranteed Minimum Shipping Test
3	3 D	8 - 6 - 1 - 1
	3 F	7 - 7 - 1½ - ½
	3 K	4 - 7 - 4 - 1
	3 M	2 - 9 - 4 - 1
	3 R	2 - 8 - 4 - 2
	3 T	1 - 9 - 4 - 2
	3 Z	0 - 8 - 6 - 2
4	4 D	0 - 5 - 10 - 1
	4 F	0 - 3 - 12 - 1
	4 K	0 - 4 - 9 - 3
	4 M	0 - 4 - 8 - 4
	4 R	0 - 3 - 9 - 4
	4 T	0 - 2 - 10 - 4
	4 Z	0 - 1½ - 9½ - 5
5	5 D	0 - ½ - 10½ - 5
	5 F	0 - ½ - 9½ - 6
	5 K	0 - 0 - 12 - 4
	5 M	0 - 0 - 11 - 5
	5 R	0 - 0 - 10 - 6
	5 T	0 - 0 - 9 - 7
	5 Z	0 - 0 - 8 - 8
6	6 D	0 - 0 - 7 - 9
	6 F	0 - 0 - 6½ - 9½
7	7 D	0 - 0 - 5 - 11
	7 F	0 - 0 - 4 - 12
	7 H	0 - 0 - 3 - 13
	7 K	0 - 0 - 2 - 14
	7 M	0 - 0 - 1 - 15
	7 20	20#/cu.ft. - loose measure
	7 25	25#/cu.ft. - loose measure
	7 30	30#/cu.ft. - loose measure
	7 35	35#/cu.ft. - loose measure
8	8 40	40#/cu.ft. - loose measure
	8 45	45#/cu.ft. - loose measure
	8 55	55#/cu.ft. - loose measure
	8 75	75#/cu.ft. - loose measure
9	9	Over 75#/cu.ft. - loose measure

Fiber is packed in bags of 100 to 125 pound capacity which are marked with grade letter and number.

MANUFACTURING UNIT

One square, containing 57 shingles, is the unit used in an asbestos cement siding plant.

PRODUCTION CAPACITY

The equipment described in this manual will produce about 11,124 squares of shingles per month, each square containing 57 shingles. Since about 7½ per cent of the total production is usually imperfect, the monthly production of salable product would be about 10,300 squares.

COST OF MATERIAL

One square contains 57 shingles, with an average weight of each shingle of 3 pounds. Allowing for 10 per cent moisture, the average weight per shingle would be 2.7 pounds.

Therefore, the weight of materials per square would average 57 x 2.7 pounds, or 153.9 pounds. The monthly weight of materials would amount to 11,124 x 153.9 pounds, or 1,711,984 pounds. This equals 856 tons of material per month.

The percentage distribution of materials required, based on one half colored shingles, is as follows:

	Percentage	Tons Required	Cost per Ton	Estimated Monthly Cost	Actual Monthly Cost
S K Asbestos	14.00	119.84	$140	$16,778	_____
Portland Cement	79.75	682.66	24	16,384	_____
Coloring Matter	1.25	10.70	460	4,922	_____
Crushed Scrap	5.00	42.80	-o-	-o-	_____
Totals	100.00	856.00		$38,084	_____

The annual cost of materials would be 12 x $38,084, or about $457,000.

THE MANUFACTURING PROCESS

In presenting the process of manufacturing asbestos-cement siding, it has been assumed that the asbestos as received has already been milled.

Asbestos-cement products are manufactured by either the dry-process or the wet-process.

In the dry-process, the asbestos, cement, inert filler, and coloring agent are mixed in a cylindrical mixer which is provided with paddles. The mixture is spread on an 18-inch conveyer belt and sprayed with water at 180° F. Rollers compress it to the required thickness and a rotary cutter separates it into individual shingles. The shingles are piled in stacks, separated by steel pallets, and squeezed in a hydraulic press at a pressure of 20,000 pounds per square inch. They are then cured, trimmed, and punched for nailing.

In the wet-process, asbestos fiber and Portland cement and wet filler are mixed dry and then dumped into a wet mixer which contains a large quantity of water; or the "furnish", as the ingredients are called, is, without previous dry mixing, dumped into the water in the wet mixer. The contents are thoroughly agitated and the resulting mixture is called a slurry. Portland cement thus mixed with a large quantity of water does not lose its capability of setting at a later stage when most of the water is removed. The slurry flows by gravity or is pumped to the Hatscheck machine where the solids in the form of a thin film are deposited on a forming drum which keeps turning until succeeding layers or laps of the film build the deposited solids up to the required thickness. For siding shingles, a few laps will suffice to make the required thin sheets. For asbestos-cement pressure pipe, several laps or layers of this laminating process are required, and tremendous pressure must be applied during the lamination. The wet method has been selected as the most suitable in this instance.

The siding is usually made in the form of shingles, each of which is 12 inches by 24 inches.

The raw materials are carried up from the storeroom by bag conveyor to the mixing floor.

Four batches of furnish are made per hour. A batch will contain slightly more material than is necessary to keep the forming machine operating for 15 minutes. The bags of material as

required by the formula are grouped together. As the asbestos is in bags of 100-pound capacity and the cement is in bags of 94-pound capacity, there is little or no weighing to be done. The batch of furnish is dumped into the wet mixer after the water required has been put in. The amount of water will be varied as experience shows necessary to make the slurry of the desired consistency. The wet mixer is a horizontal tank 42 inches in diameter and 6 feet long. Paddles attached to a horizontal shaft revolving at 20 to 30 r.p.m. agitate the contents which fill the mixer to a height of 24 inches. This mixing continues for five minutes, at the end of which time the contents or slurry, containing 8 to 10 per cent solids by weight, is dumped into the "stock chest". The stock, or slurry, flows from the stock chest by gravity into the vat of the Hatscheck machine. The level of the slurry in the vat controls the flow of additional slurry into this vat from its stock chest.

In vat "A" is a perforated bronze cylinder "B", 2000 perforations per square inch, with solid ends. The cylinder, which is 36 inches in diameter and 57 inches long, revolves by the pull of a woolen felt belt "C" which is 52 to 54 inches wide. The felt belt is pressed against the perforated cylinder "B" by a rubber couch roll "D" above it. The couch roll weighs 300 to 500 pounds.

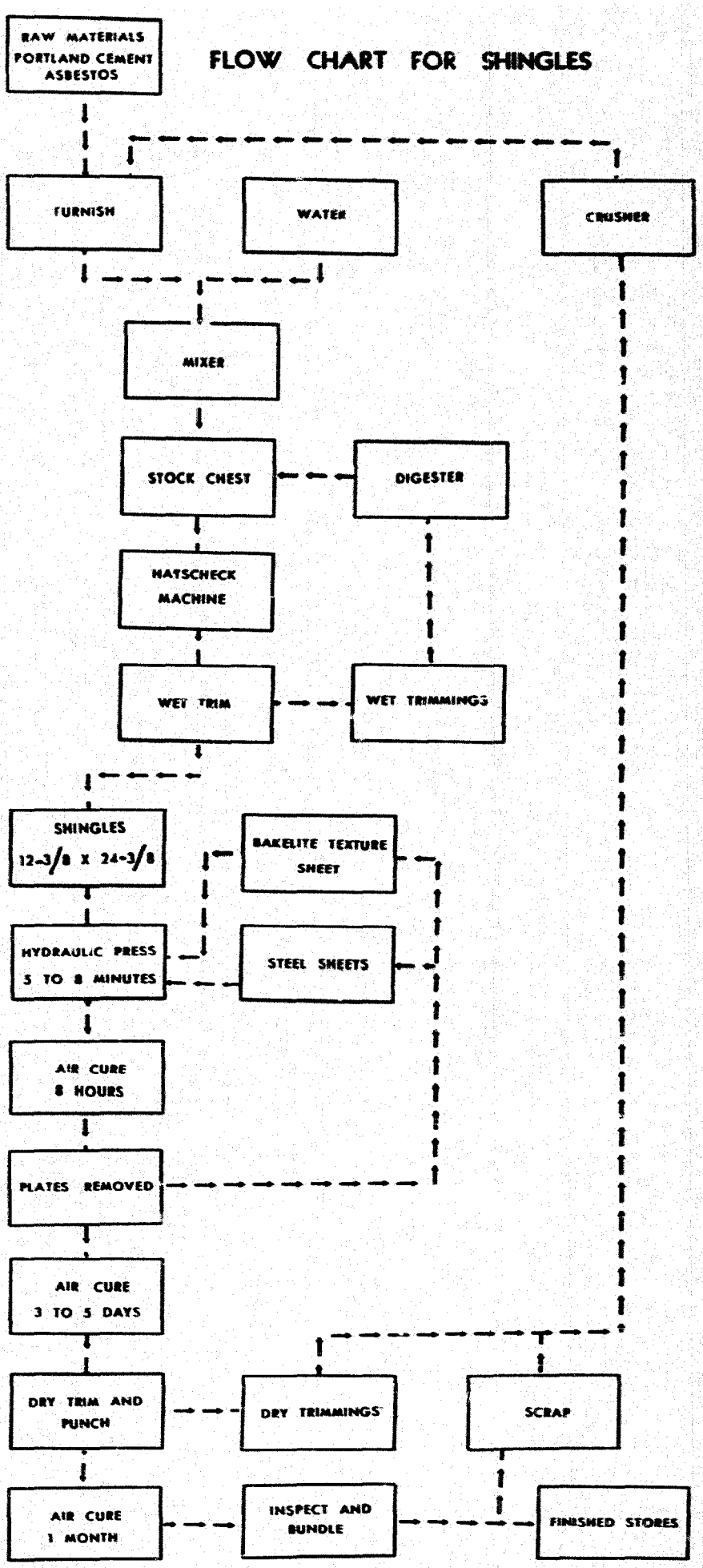
If the shingles are to be colored, a separate mixer, vat, and clarifier are used, as well as a separate stock chest.

The mixing crew keeps the stock chests supplied with the furnish. The quantity mixed at a time must be small enough so that it all will be used up during the short interval. There must not be too much stock ahead as it will become stale and overhydrate, or lose its ability to set properly. The initial set of Portland cement takes place in about $2\frac{1}{2}$ hours. This length of time is controlled by the cement manufacturer by regulating the quantity of gypsum that he puts into the cement.

The stock chest is a cylindrical tank 7 feet in diameter and 7 feet long. A central shaft revolving at approximately 8 r.p.m. has attached to it a series of buckets which drag against the shell picking up the slurry and letting it run into troughs located three-fourths of the way up from the bottom. One end of each of these troughs is connected by hoses with the vat of the Hatscheck machine. The slurry runs by gravity from this trough to the vat.

The following sketch illustrates the flow of furnish.

FLOW CHART FOR SHINGLES



The perforations of cylinder "B" revolving in vat "A" pick up the slurry. Much of the water drains off as the cylinder revolves. As the outer periphery of the cylinder "B" touches the woolen felt belt "C", the mixture from cylinder "B" is deposited on the felt belt in the form of a film. The film is carried along on the underside of the felt belt. As the felt belt moves around the couch roller "G", which can be moved up and down, the film moves from the underside of the felt belt to the upper side of this belt. The couch roll "G" has squeezed out considerable water from the film and the belt by its contact with cylinder "B". The felt belt, with its film of asbestos-cement on its upper side, passes through the suction box "N" where additional moisture is extracted from the belt and the firm. The felt belt "C" next passes between the drive cylinder "R" and the cast iron accumulator roll "P". As the accumulator roll continues to revolve, the belt gives up its film and the film is deposited in laps on the accumulator roll.

When the consistency of the slurry is correct, eight laps will bring the film on the accumulator roll to the correct thickness for the addition of the color layer. If the siding is not to be colored, then nine layers of the base furnish will be used. This colored layer is called veneer and is placed on the belt at the correct place by the use of the veneer vat "E" and the perforated veneer cylinder "F". This is accomplished by dropping the couch roll "H" into the position of "G", so that the colored veneer film is picked up by the base film already on the belt "C" at its contact with cylinder "F" and couch roll "G". When the proper length of veneer film has deposited on the felt belt, the couch roll "G" returns to its former position "H" until it is again needed to function in depositing a veneer film on the belt.

The idler wheels "J" support the felt belt. The belt adjuster is the means of keeping the belt at its proper tightness and properly aligned with the rolls and cylinders. The cylinder shower "T" is placed so as to clean the cylinder after the film has passed from the cylinder to the belt. The belt is cleaned by the belt shower "M" and the whipper wheel "L".

The water that is squeezed out by "D" and "R", the shower water at "M" and "T", and the suction box, drain to a central point from which it is pumped into the base clarifier. The clarifier is a round tank eight feet in diameter and 20 feet high. The solids settle to the cone-shaped bottom of the clarifier, from which they are drained off into the stock chest. The clarifier supplies the mixer with the necessary amount of water. Thus the water is used over and over again, so as not to lose either solids or water. Make-up water, to replace the

water which becomes part of the finished product (the finished product contains 10 to 15 per cent water) is added automatically to the clarifier so that the water level in the clarifier is kept constant.

The veneer water system, which is also a closed system, operates in the same manner as the system just described. Thus the veneer system must have its own clarifier, wet mixer, and stock chest, all of which are relatively inexpensive.

The drive cylinder "R" is attached to the prime mover and thus pulls the woolen felt belt around through the Hatscheck machine.

The thickness of the film on the forming drum or accumulator may vary, according to the ingredients used, from .015 inches to .025 inches. A siding shingle is made .160 inch thick, when one cylinder with eight base film revolutions and one cylinder with one veneer film revolution are used, and averages .018 inches in thickness.

When the proper number of laps has been laid on the accumulator, the Hatscheck machine operator runs a pointed stick across the accumulator in the cutting groove and cuts off the accumulated sheet as the cylinder turns. As the roll continues to turn, the first layer of the next sheet is formed.

The accumulator roll is usually 32½ inches in diameter and 57 inches long. The circumference of this roll is therefore 102 inches, and the asbestos-cement sheet produced is 102 inches long and 52 to 54 inches wide. If it is desired to produce a sheet 151 inches long, an accumulator roll of 48 inches in diameter is sometimes used.

To obtain a base shingle of the same weight as a colored shingle, both vats "B" and "F" can be used, cylinder "G" being held in its lowered position, and the consistency of the slurry being one-ninth greater than was used in the colored shingles previously described. In this case, only four revolutions of the accumulator roll are necessary. The production, however, will be 100 per cent greater than that of the colored shingle, the manufacture of which we have been describing. Some additional man-power may be necessary to keep the production at this higher rate.

Since the asbestos-cement sheets that come from the accumulator roll are pliable and will withstand some handling, they are rolled up and transferred to a steel table, where they are spread out flat. Manually-operated knives (guillotine cutters) cut the sheet into four pieces 24 3/8 inches wide. These are then cut into four pieces each, 12 3/8 inches long, resulting in sixteen pieces 12 3/8 x 24 3/8 inches. The pieces trimmed off are called "wet trimmings".

The cut sheets are placed in two piles on a press truck, with steel plates $25\frac{1}{4}$ x $25\frac{1}{4}$ inches, of 15-gauge steel, and bakelite texture plates of the same size alternating between them.

The stacks of plates and asbestos-cement sheets, 100 to 120 sheets high, are placed in the hydraulic press which has a platen 28 x 28 inches, and a pressure of from 500 to 1000 pounds per square inch is slowly applied. The pile is left in the press from five to eight minutes. The texture plates give the texture form to the shingle. The sheets are removed and air-cured for eight hours. The material is now hydrated or hardened sufficiently for the steel plates and bakelite plates to be removed. The asbestos-cement shingles are piled up again for further air-curing for three to five days according to the room temperature.

The sheets are then trimmed on four sides, by a power trimmer, to 12 inches x 24 inches. Five nail holes are also punched at the same operation. The shingles are again piled, and cured for one month. They are inspected and bundled 19 shingles to a bundle.

The shingles reach 85 per cent of their maximum strength in eight days and 100 per cent in four weeks.

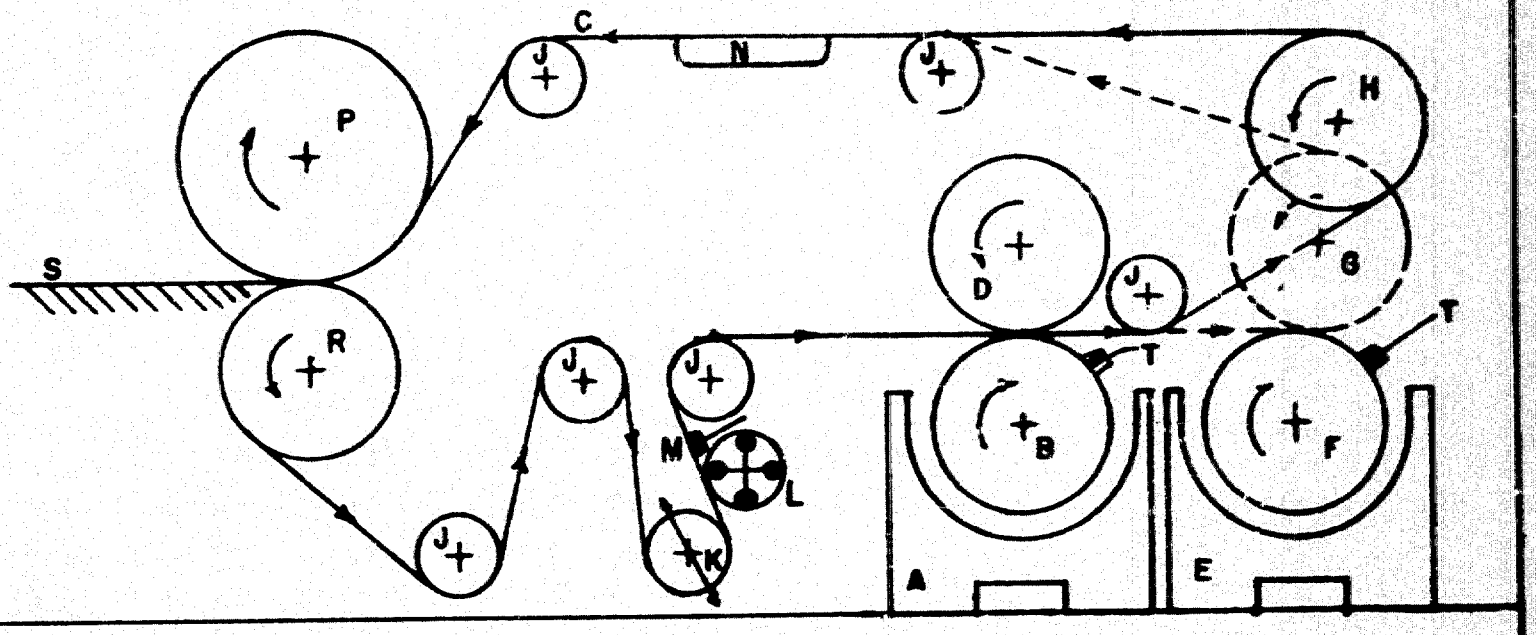
The steel plates are cleaned, and a light coating of oil is applied after each use to prevent sticking.

If texture shingles are not required, plain shingles may be made by using all plain steel sheets in the hydraulic press instead of alternating with the bakelite corrugated plates. Texture shingles at present are in great demand in the United States.

The wet trimmings are taken at short intervals to the digester, where water is added so as to form a slurry. This slurry is added to the stock chest and used as base material. The only material loss is the coloring matter contained in the veneer portion which cannot be separated from the grey base trimmings.

The scrap from the dry trimmings at the power trimmer, and the defective pieces, are crushed and pulverized in the power crusher and are used as inert filler.

Assuming a belt speed of 110 feet per minute, the Hatscheck machine produces 97.1 sheets per hour. Each sheet makes 16 shingles, and the monthly production of shingles is 97.1 x 16 x 24 x 20 = 745,728.



VAT A - FOR BASE SLURRY
B - BRONZE PERFORATED CYLINDER
C - WOOLEN FELT BELT
D - RUBBER COUCH ROLL
VAT E - VENEER (COLORED) SLURRY
F - BRONZE PERFORATED CYLINDER FOR VENEER
G - RUBBER COUCH ROLL (IN LOWER POSITION)
H - RUBBER COUCH G IN HIGHEST POSITION
J - IDLER WHEELS
K - BELT ADJUSTER
L - WHIPPER WHEEL
M - BELT SHOWER
N - SUCTION BOX
P - ACCUMULATOR ROLL-BRONZE
R - DRIVE CYLINDER
S - TABLE
T - CYLINDER SHOWER

HATSCHECK FORMING MACHINE FOR SHINGLES

PLANT LAYOUT

A plant layout is shown on page 24 and a flow chart is shown on page 17.

PLANT SITE

Adequate transportation facilities, either by rail or by truck, or preferably both, must be very good because of the large amount of heavy material to be handled. The site should include about 50,000 square feet and be located as favorably as possible with reference to sources of power, water, materials, labor, and markets. The cost of the land is estimated at $1,500.

BUILDING

A building 70 feet by 300 feet is required for the manufacture of asbestos-cement siding.

The space for raw material is 70 feet by 60 feet; and for the Hatscheck machine, 70 feet by 30 feet with a 14-foot ceiling, and a mixing floor of like size with ten feet of head room. The floors, both upper and lower, should be of concrete.

The press and curing room should be 70 feet by 80 feet. Final cure and finished storage will require 70 feet by 130 feet. In a warm climate, this could be a shed-type building which would keep the shingles dry. It should, of course, have a substantial floor to facilitate handling the siding by hand trucks.

Including the 30 foot by 70 foot mixing floor, the total floor area is 23,100 square feet, which at $4.00 per square foot including boiler, plumbing, and wiring, would cost $92,400.

POWER

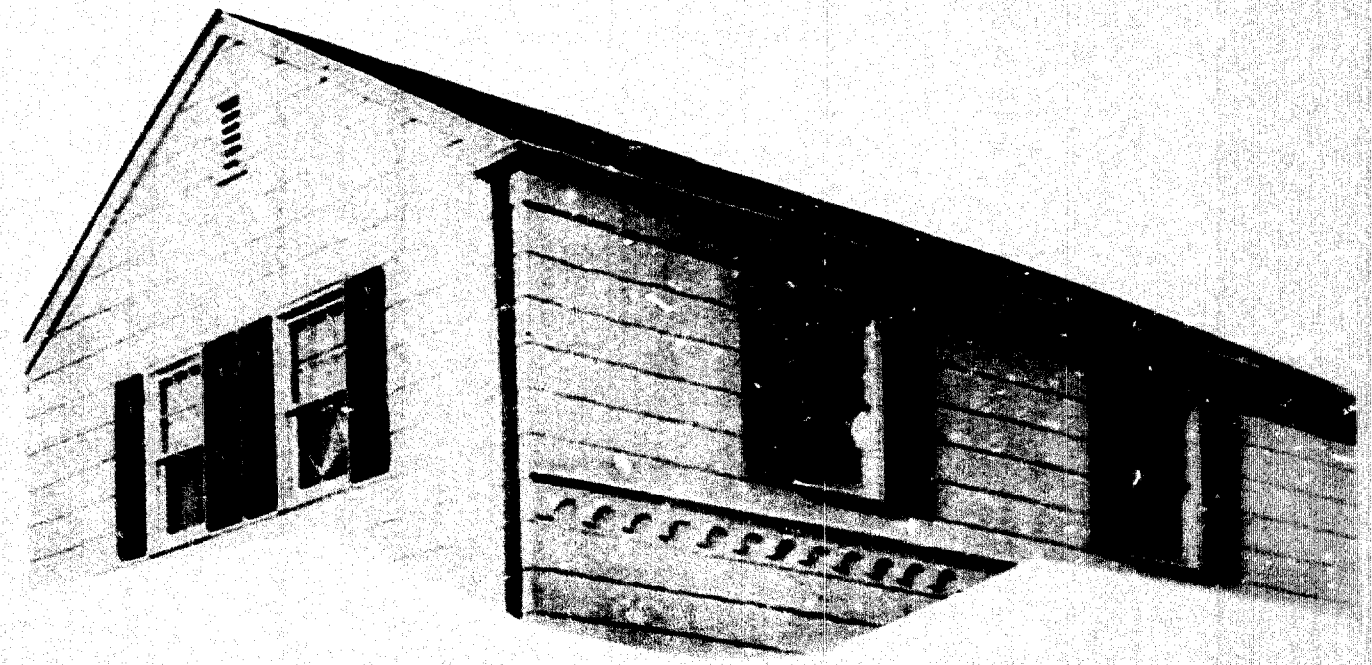
The connected load amounts to 112 horsepower. Based on an 80 per cent factor, the cost of power is estimated at $11,000.

WATER

Assuming that the plant will be located where adequate water is available, the cost of water is estimated at $1,200.

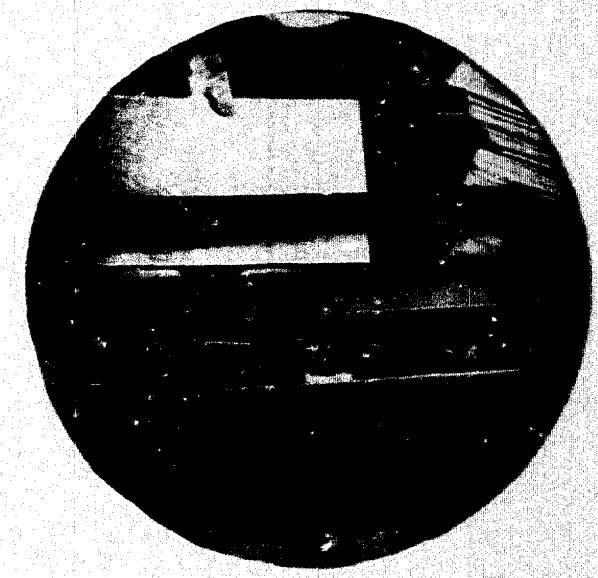
FUEL

The cost of fuel to operate the boiler is estimated at about $2,000. The boiler should be designed for the use of local fuel.



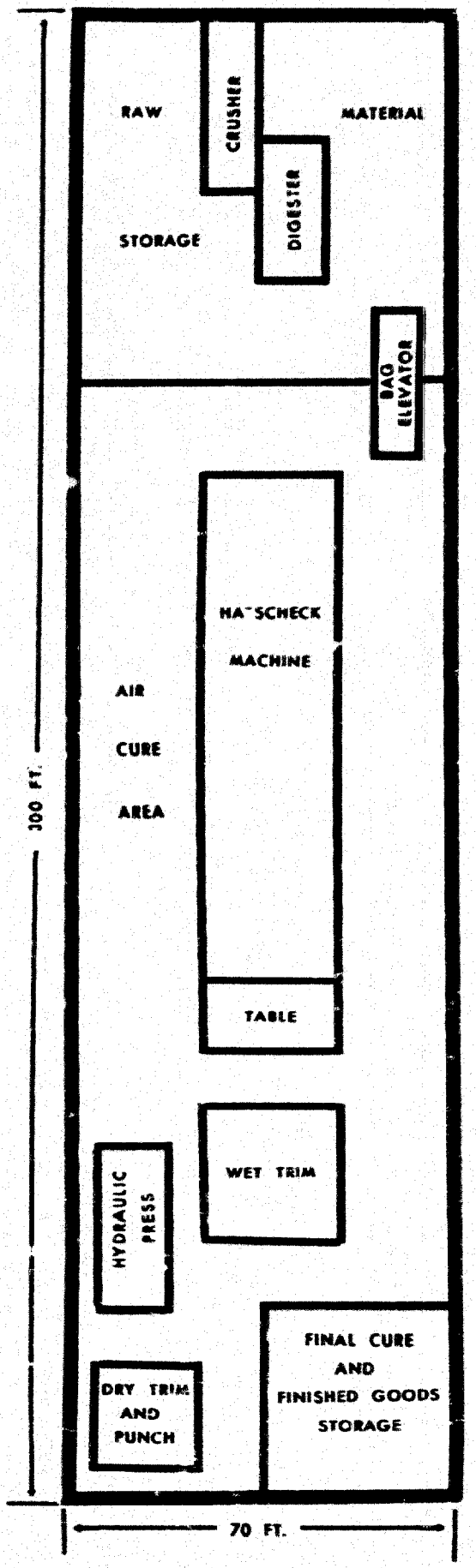
Asbestos-cement sidewalls combine beauty with durability and fire protection.

Asbestos-cement sheets coming off the forming machine.



Trimming and nail-punching asbestos-cement shingles.

SCHEMATIC LAYOUT FOR ASBESTOS CEMENT SIDING PLANT



DIRECT LABOR

Most of the labor required for the production of siding is unskilled, with only a few of the workers in semi-skilled classifications. Labor required per shift:

Classification	Number Needed	Hourly Rate	Estimated Cost	Actual Cost
Laborer	1	$1.50	$3,000	
Stores Helper	1	1.50	3,000	
Mixer	1	2.00	4,000	
Mixer Helper	1	1.50	3,000	
Machine Tender	1	2.00	4,000	
Spear Man	1	2.00	4,000	
Sheet Carrier	2	1.80	7,200	
Cutter	2	2.00	8,000	
Stacker	2	1.80	7,200	
Press Man	1	2.00	4,000	
Press Helper	1	1.60	3,200	
Separator	2	1.80	7,200	
Utility & Wet Waste Man	1	1.60	3,200	
Dry Trimmer	2	2.00	8,000	
Dry Trimmer Helper	1	1.60	3,200	
Scrap & Crusher Man	1	1.60	3,200	
Relief Man	1	2.00	4,000	
Total (1 shift)	22		$ 79,400	
Total (3 shifts)	66		$238,200	

INDIRECT LABOR

Occupation	Number Required	Hourly Rate	Estimated Cost	Actual Cost
Manager	1		$10,000	_____
Foremen	3		18,000	_____
Assistant Foremen	3		12,000	_____
Warehouse Supervisor	1		4,000	_____
Bookkeeper	1		5,000	_____
Office Clerk	1		3,600	_____
Laboratory Technician	1		6,000	_____
Secretary	1		3,600	_____
Receiving & Shipping	1		3,800	_____
Watchman	1	$1.60	3,200	_____
Inspector	1	2.00	4,000	_____
Maintenance Man	1	2.00	4,000	_____
Machine Shop Man	1	2.00	4,000	_____
Warehouse Helper	1	1.70	3,400	_____
Total	18		$84,600	_____

PRODUCTION TOOLS AND EQUIPMENT

Description	Number Needed	Estimated Unit Cost	Estimated Total Cost	Actual Cost
Two wheel trucks	4	$ 50	$ 200	_____
Bag elevator			1,500	_____
Platform scale			300	_____
Fiber buckets (square boxes)	4	100	400	_____
Mixers, 42"x6" with 1 hp. motor, back geared, runs mixer	2	2,800	5,600	_____
Stock chest with 2 hp. motor, back geared, runs chest shaft	2	5,000	10,000	_____
Hatscheck machine with 1 base cylinder and 1 veneer cylinder with 2 space interchangeable cylinders complete with vacuum pump 10 hp., with 1 base pump for white water 7½ hp. and 1 veneer pump 7½ hp., including wet machine drive 10 hp.			65,000	_____
Clarifier 8' in diameter, 20' high, with 6" discharge , 1 for base mix, 1 for veneer mix	2	3,000	6,000	_____
Manually-operated cutters with steel table			3,000	_____
Hydraulic oil press with 28"x28" press platen, including 6 press trucks, capacity total 1,000 tons with 20 hp. motor			28,000	_____
Steel press plates, cold-rolled 15 ga., 25¼"x25¼"	2250	1	2,250	_____
Bakelite texture plates	2250	7	15,750	_____
Steel press plates	50	20	1,000	_____
Wooden pallets	2000	10	20,000	_____
Hand lift trucks	6	400	2,400	_____
Oilers including rollers for plates, 1 hp.			1,200	_____
Power dry-trimmer, 3 hp., trims 4 sides			11,000	_____
Warehouse trucks, 3 wheels	12	50	600	_____
Wheel barrows and scrap buggies			3,000	_____
Crusher for dry scrap, fans 50 hp. motor including foundation			28,000	_____
Roller conveyor			3,000	_____
Electrical installation, light, and power			20,000	_____
Process piping			18.000	_____
Spare parts, including cylinder screens			5,000	_____
Total			$251,200	_____

OTHER TOOLS AND EQUIPMENT

Description	Estimated Cost	Actual Cost
Engine Lathe	$ 2,000	_____
Milling Machine	8,000	_____
Bench Grinder	300	_____
Drill Press	700	_____
Welding Equipment	500	_____
Hand Tools	500	_____
Total	$12,000	_____

FURNITURE AND FIXTURES

Description	Number Required	Estimated Unit	Estimated Total	Actual Cost
Desks and Chairs	4	$ 150	$ 600	_____
Typewriter	1	150	150	_____
Adding Machine	1	150	150	_____
File Cabinets	2	50	100	_____
Total			$1,000	_____

SUPPLIES

Description	Number Required	Estimated Cost	Actual Cost
Cylinder Screens	6	$ 180	_____
Felt Belts	6	1,200	_____
Steel Strapping		120	_____
Strapping tools (Rent)	5	350	_____
Cardboard @ 3¢ per bundle		930	_____
Office Supplies		200	_____
Lubricants		200	_____
Spare Parts		1,820	_____
Maintenance Material		1,000	_____
Total		$ 6,000	_____

DEPRECIATION

Item	Estimated Cost	Years Life	Estimated Per Year	Actual Per Year
Building	$ 92,400	20	$ 4,620	_____
Production Tools and Equipment	251,200	15	16,747	_____
Other Tools and Equipment	12,000	10	1,200	_____
Furniture and Fixtures	1,000	10	100	_____
Total		Say	$22,600	_____

MANUFACTURING OVERHEAD

Item	Estimated Cost	Actual Cost
Depreciation	$ 22,600	_____
Indirect Labor	84,600	_____
Power	11,000	_____
Water	1,200	_____
Fuel	2,000	_____
Supplies	6,000	_____
Total	$ 127,400	_____

MANUFACTURING COST

Item	Estimated Cost	Actual Cost
Direct Labor	$ 238,200	_____
Direct Materials	457,000	_____
Manufacturing Overhead	127,400	_____
Total	$ 822,600	_____

FIXED ASSETS

Item	Estimated Cost	Actual Cost
Land	$ 1,500	_____
Building	92,400	_____
Production Tools and Equipment	245,200	_____
Other Tools and Equipment	12,000	_____
Furniture and Fixtures	1,000	_____
Total	$ 352,100	_____

WORKING CAPITAL

Item		Estimated Cost	Actual Cost
Direct Materials	- 60 days	$ 76,000	_____
Direct Labor	- 30 days	19,800	_____
Manufacturing Overhead	- 30 days	10,600	_____
Reserve for Sales Collections	- 30 days	103,000	_____
Total		$ 209,400	_____

CAPITAL REQUIREMENTS

Item	Estimated Cost	Actual Cost
Fixed Assets	$ 352,100	_____
Working Capital	209,400	_____
Total	$ 561,500	_____

SALES REVENUE

The total annual saleable production will amount to about 123,600 squares.

Based on a sales price of $10.00 per square the total annual sales revenue would amount to $1,236,000.

RECAPITULATION OF COSTS, SALES AND PROFITS

Item	Estimated Cost		Actual Cost
Direct Materials	$ 457,000		_____
Direct Labor	238,200		_____
Manufacturing Overhead	127,400		_____
Total Manufacturing Cost		$ 822,600	_____
Interest on Loans	$ 10,000		_____
Insurance	2,000		_____
Legal	2,400		_____
Auditing	3,600		_____
Unforeseen Expense	20,400		_____
Total Administrative Cost		38,400	_____
Sales Commissions, Travel Freight Out, Bad Debts, Discounts and Allowances		95,000	_____
Profit before Taxes		280,000	_____
Total Annual Gross Sales		$ 1,236,000	_____

BUDGET CONTROL

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	$_____	$ 1,500	$ 18,000	$_____
20	Sales	_____	7,916	95,000	_____
30	Direct Materials	_____	38,083	457,000	_____
40	Supplies	_____	500	6,000	_____
51	Power*	_____	916	11,000	_____
52	Water*	_____	100	1,200	_____
53	Fuel	_____	166	2,000	_____
60	Unforeseen Expense (Reserve Account)	_____	1,700	20,400	_____
71	Direct Labor*	_____	19,850	238,200	_____
72	Indirect Labor*	_____	7,050	84,600	_____
80	Depreciation (Reserve Account)	_____	---	22,600	_____

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

PURCHASE REQUISITION	COMPANY NAME	DATE

- ☐ 10 ADMINISTRATION
- ☐ 20 SALES
- ☐ 30 MATERIALS
- ☐ 40 SUPPLIES
- ☐ 50 UTILITIES
- ☐ 60 UNFORESEEN EXPENSE

INDICATE BELOW THE USE OF MATERIALS

- ☐ DIRECT MATERIALS
- ☐ MAINTENANCE MATERIALS
- ☐ MAINTENANCE SERVICES
- ☐ 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 have 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

Textbook

Materials of Construction	Bruce Publishing Company 400 North Broadway Milwaukee, Wisconsin

Periodicals

Asbestos and Its Trade	U. S. Department of Commerce Washington 25, D. C.
Material Survey - Asbestos	U. S. Department of Interior Department of Mines Washington 25, D. C.

ABBREVIATIONS

'	Foot or feet
"	Inch or inches
ft.	Feet
hp.	Horsepower
#	Number
cu. ft.	Cubic feet
^{o}F.	Degree Fahrenheit
%	Per cent

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.