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**PLANT REQUIREMENTS
FOR MANUFACTURE OF
ADHESIVE TAPE**



TECHNICAL AIDS BRANCH

**INTERNATIONAL COOPERATION
ADMINISTRATION
Washington, D. C.**



FOREWORD

This brochure is one of a series of reports resulting from overseas technical inquiries on factory or commercial establishments, operation, management, and engineering. The report is designed to provide only a general picture of the factors that must be considered in establishing and operating a factory of this type. In most cases, plans for actual installations will require expert engineering and financial advice in order to meet specific local conditions.

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

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This brochure was prepared in January 1957 by H. D. Nottingham & Associates, Arlington, Virginia.

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For further information and assistance, contact should be made with the local Productivity Center, Industrial Institute, Servicio, or United States Operations Mission.

Code Number

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ADHESIVE TAPE

INTRODUCTION

It is generally accepted that the best possible protection for many types of open wounds is a clean, sterilized bandage held in place by strips of adhesive tape. Surgical adhesive tape is also widely used to support back injuries and sprains. Although adhesive tape is normally produced in large plants using the latest mass production methods, there is still ample opportunity, and need, for the establishment of small, progressive plants for the manufacturing of this product. Once established, opportunities for branching into the production of related products such as electrical insulating tape, packaging adhesive tapes and other similar items are limitless.

ASSUMPTIONS

In order to more clearly picture the plant described herein, the following assumptions have been made:

1. For initial production, only one of the many possible types of adhesive tapes will be manufactured, and therefore, only that one type is described.
2. Maximum plant capacity will be 120 yards per day.
3. The plant will operate one 8-hour shift per day, 5 days per week.
4. To reduce initial capital investment, it has been assumed that the fabric will be purchased rather than produced by the tape manufacturer --- although if possible, it is preferable that the fabric should be produced by the tape manufacturer, or a subsidiary thereof, so that a reliable and economical source of material may be maintained.

5. All tape will be manufactured in rolls 36 inches wide, and distributed to buyers in a standard size - 12 inches wide by 10 yards long.
6. The market is, or can be readily made, available.
7. Adequate and suitable water, electrical, sewage, transportation facilities, and raw materials are readily available.
8. Although some water is used in the actual manufacturing process and should rightfully be included in material requirements, all water costs have been combined and included under overhead.
9. The tape to be produced will employ a heavy, unbleached muslin backcloth, and contains a water proofing layer.

PRINCIPLES OF MANUFACTURING

The production of surgical adhesive tape is divided into three fundamentally different operations. They are: (1) making the fabric, (2) compounding the "pressure-sensitive" adhesive, and (3) combining the fabric and adhesive to produce the finished tape.

Fabric: Several kinds of fabric are in general used to provide for specific needs: (1) a heavy, unbleached muslin backcloth for high tensile strength requirements; (2) a bleached muslin backing with embossed, water repellant coating; and (3) a light, flexible, 160 thread count fabric for reduced cost and greater flexibility. The heavy muslin cloth is best for strapping applications. Water-repellant cloth is widely used, but may result in reduced adhesion due to accumulated skin perspiration -- thus requiring more frequent dressing changes. The light fabric is used in quantity by hospitals and doctors because it conforms so well to body contours and is approximately 10% less expensive than the heavier material.

Adhesive: Compounding the pressure-sensitive adhesive is considered a "trade secret" and manufacturers select methods experimentally designed for the particular adhesive used. For latex adhesives, production involves cutting bales of rubber into thin sheets, milling them together with chemical additives, and then further cutting them into smaller pieces. The next step requires addition of softeners and resins, then mixing; solvents are added and agitation may be continued for as long as two days before the proper consistency is reached. The product is strained and then stored for use at a later date. Known formulations for pressure-sensitive adhesives include:

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Crepe rubber: 10 parts Coumarone-index: 2 parts Zinc Oxide: $\frac{1}{2}$ part | <ol style="list-style-type: none"> 2. Double breakdown crepe: 20 parts Para coumarone resin: 8.5 parts Wood rosin: 1.0 part Liquid parafin oil: 0.5 part |
|--|--|

Selection of a particular formulation depends on properties desired in the adhesive, experience of the producer and availability of raw materials. The major problem is usually one of producing an adhesive which does not form a permanent bond or have too great an adhesive bonding action --- rather than the opposite, as might be expected. In addition, the adhesive should be non-irritating to the skin and should possess good aging qualities in storage and in service. It should exhibit minimum "creep" in use, be easily applied to the tape, should not transfer to the back of the tape (offset) when rolled up, and should be stable under a wide range of climatic conditions.

Final Product: At least eight separate operations and frequently more (depending on the adhesive used and the qualities desired in the product) are required to produce a roll of finished adhesive tape once the fabric and adhesive have been made. Briefly, the fabric is unrolled and fed through treating procedures which increase fibre strength and prime the surface to promote adhesion of the adhesive layer. Next, the continuously moving fabric belt passes through a series of drying rollers before the adhesive is applied. When the adhesive is applied, a water proof layer may be calendered to the other side which will also tend to reduce adhesive offset to the back of the tape when it is rolled up. After adhesive application, the tape continues through a bank of drying and conditioning processes to the final roller where it is sliced into desired widths. Final inspection and packaging are the last steps. The finished product then consists of a four layer sandwich as follows:

1. Pressure sensitive adhesive,
2. Primer to promote adhesion to the fabric,
3. Fabric,
4. Anti-offsetting, water repellent finish coat.
(See Figures 1 and 2)

While sterility is not a requirement for rolled adhesive tape, the tape is frequently used in the manufacture of completed surgical dressings. Thus, the finished product should possess two additional characteristics. First, it should be exceptionally clean and free from dust and other impurities. In addition, it should be capable of sterilization at high temperatures without changing the adhesive properties and without offsetting.

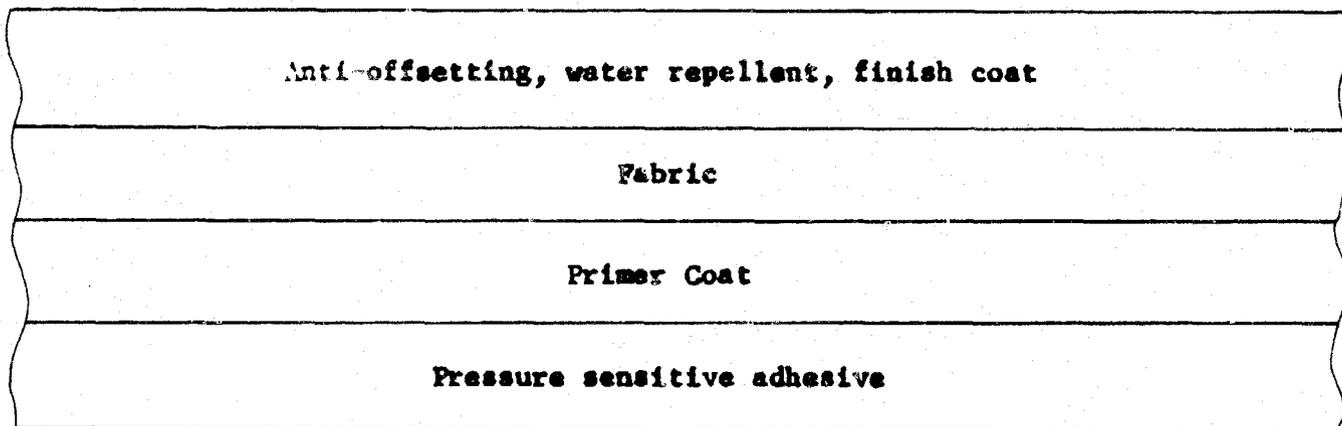


Figure 1. Cross-sectional sketch showing composition of four layer adhesive tape

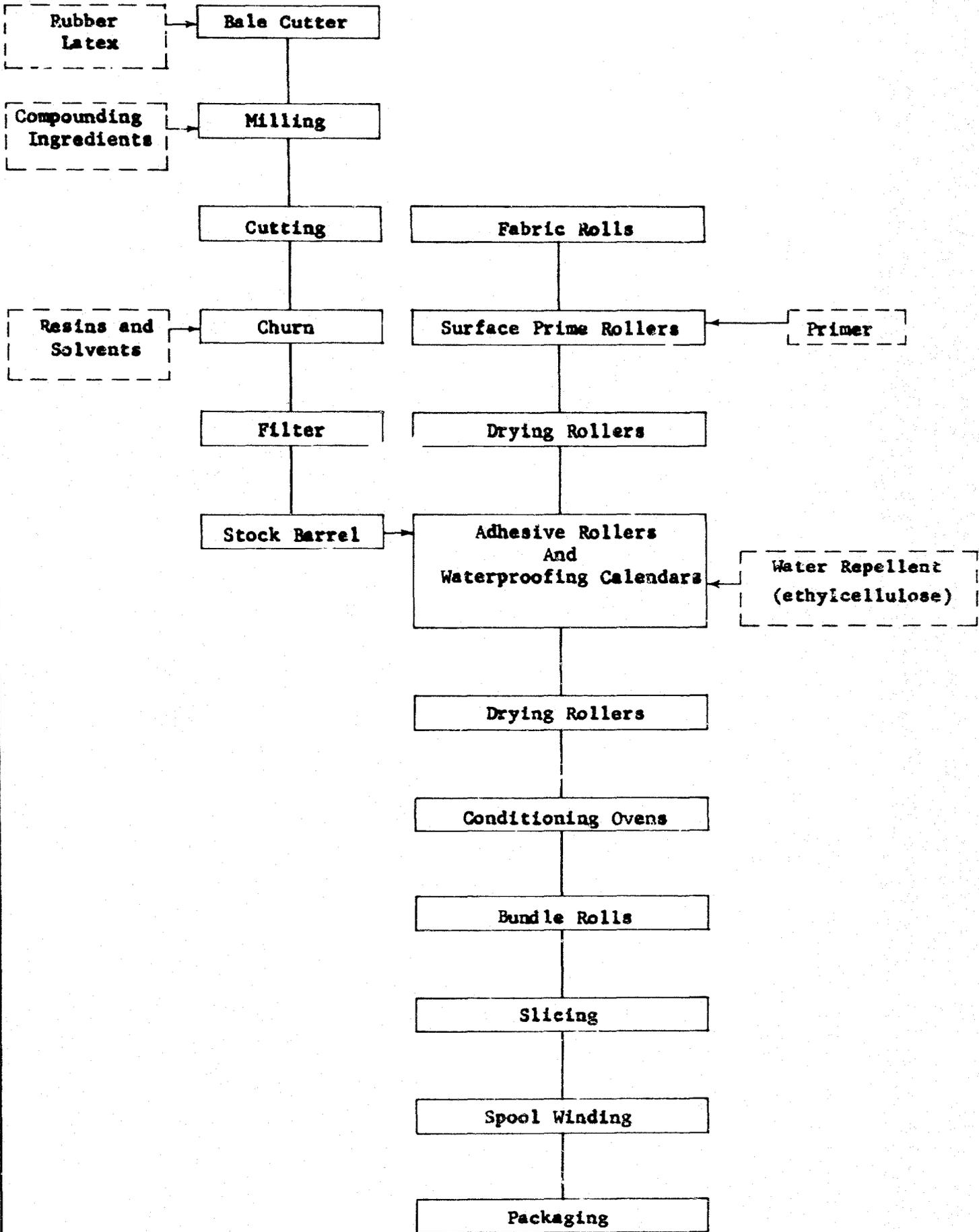


Figure 2. Diagrammatic Flow Sheet.

BUILDING REQUIREMENTS

PLANT LOCATION

Ideally, a plant of this type should be located near a source of cotton, or such other natural resource as may be used in the production of the backing material. Since it has been assumed for the purpose of this report that the backing material will be purchased from jobbers, this consideration can be by-passed at this time. Factors that cannot be so readily dismissed include such items as a railhead and good road net for ease of importation of raw materials and final distribution of the finished product. Other requisites to location are a ready source of water and electricity, and, at the least, semi-skilled labor. Finally, it is desirable, although not always feasible to locate the plant so that waste disposal will not pollute potential water sources, or prove to be a detriment to good community relationships.

PLANT LAYOUT

As with most manufacturing plants there is no example of a typical adhesive tape plant. Recommended area allocations and plant layouts are extremely variable, and depend a great deal upon the specific adhesive used and its technology. Therefore, the reader should realize that although the area allocations are considered to be sufficient, the actual location of production equipment will revolve around the individual ideas of the consulting specialists contacted for the final formulation of plant design.

Floor space allowances for a one-story structure capable of manufacturing 120 yards of adhesive tape a day is shown below and in Figure 3, and may be used as a guide:

	<u>Sq. Ft.</u>
1. Receiving Platform	50
2. Office	100
3. Materials Storage	100
4. Adhesive Mixing Room	150
5. Production Area	550
6. Packing and Storing	100
7. Shipping Platform	<u>50</u>
Total	1100 Sq. Ft.

NOTE: The above dimensions are liberal in nature, so as to allow for individual variations in planning and location of production equipment. The dimensions are such that each room may be reduced in size in the event that available capital is limited. Basic plant construction is assumed to be a poured concrete foundation and floor with frame, or other economical type, (although cinder block is preferred) exterior walls.

Interior walls are temporary in nature so that room modification in the event of future expansion will not be excessive in costs. Building cost as illustrated (to include electrical installations, sewerage, water, etc.) is estimated to be \$7,000.00.

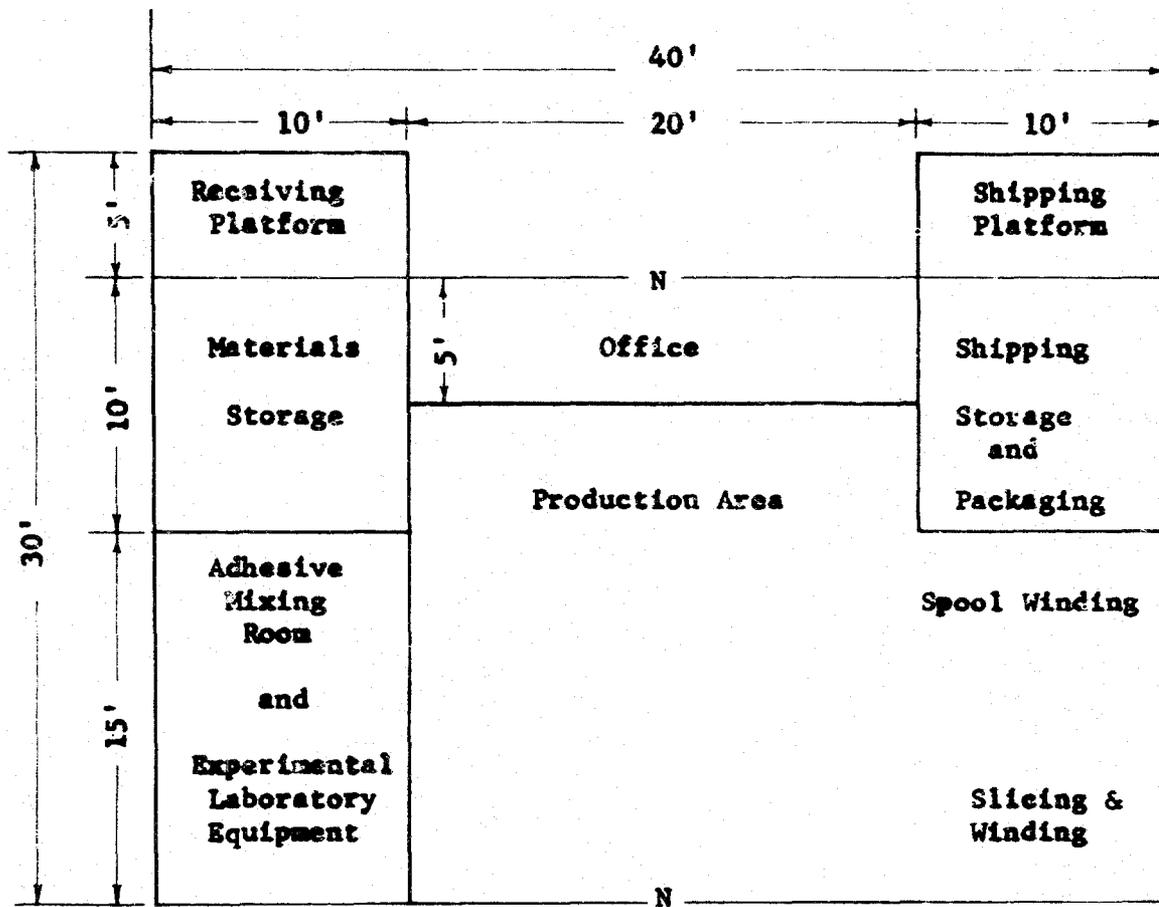
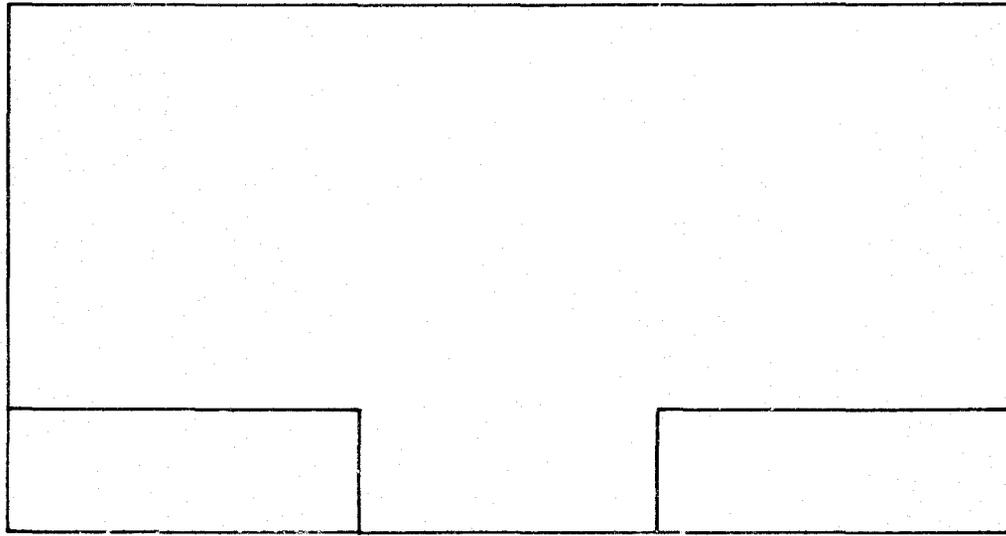
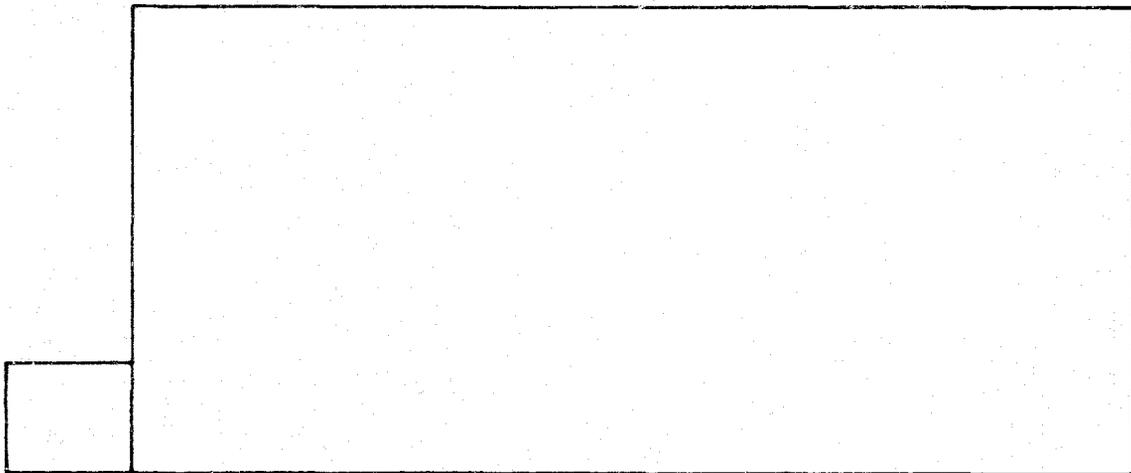


Figure 3. Plan of a possible layout for a one-story adhesive tape manufacturing plant.



40'

Front Elevation



5'

25'

Side elevation

Figure 4. Front and side elevations of proposed plant.

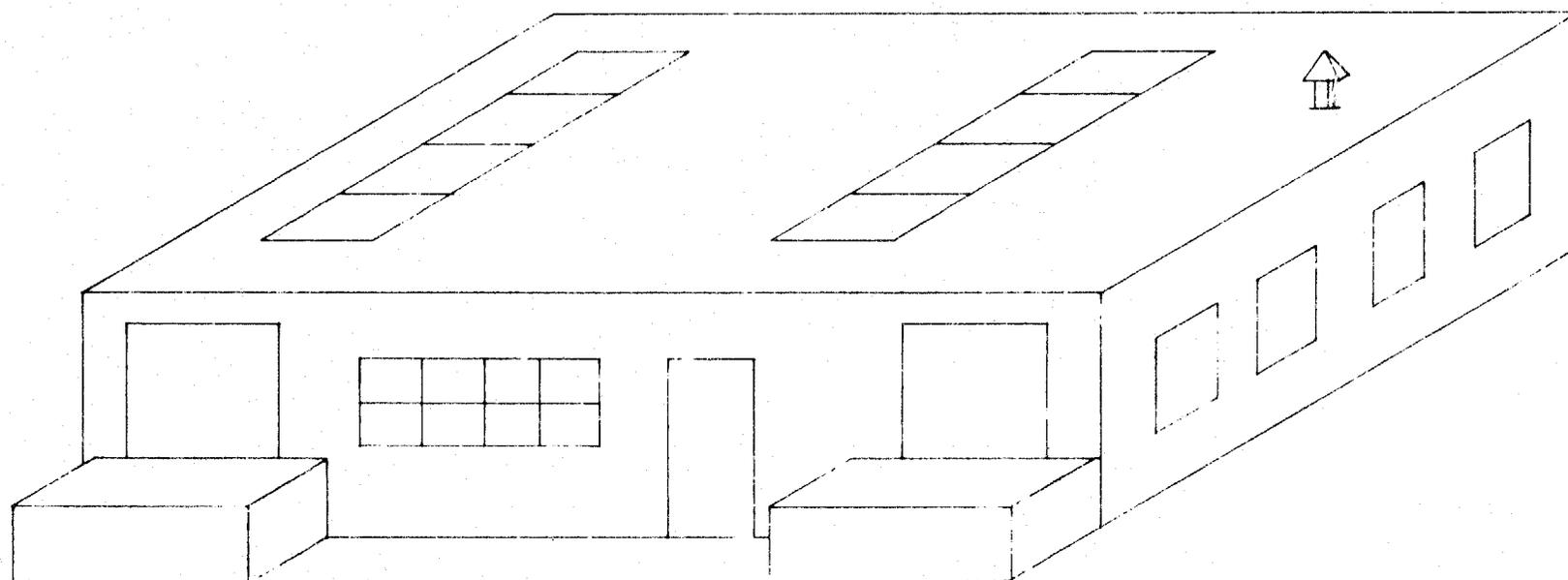


Figure 5. Isometric view of proposed plant.

EQUIPMENT REQUIREMENTS

	<u>Estimated Cost</u>
1. Adhesive Mixing Machine	\$1,500.00
2. Mixing and Solution Pots	500.00
3. Applicators, Gages and Pumps	1,000.00
4. Fabric Rolls	1,000.00
5. Pressure Rolls	1,500.00
6. Pull Rolls and Motors	2,000.00
7. Slicer	500.00
8. Conditioning and Processing Equipment	4,000.00
9. Dirt and Dust Filtering Equipment	4,000.00
10. Miscellaneous Production Equipment (Idler rolls, deflector blades, cutter.)	5,000.00
11. Quality Control Equipment (Multipurpose Reflectometer, Viscosim- eters.)	4,000.00
12. Experimental Laboratory Equipment	6,000.00
13. Work Benches (for Laboratory Equipment packaging.)	500.00
14. Maintenance Equipment	750.00
15. Office Equipment	500.00
16. Cleaning Equipment	250.00
Total Cost	<u>\$33,000.00</u>

NOTE: The above estimates reflect the equipment cost of a completely mechanical plant. Many of the items such as work benches, curing equipment, miscellaneous production equipment, etc., can either be handmade, or purchased second hand. For example, a used dough mixing machine might be substituted for the adhesive mixing machine and would only cost about \$400.00 to \$500.00 instead of the \$1500.00 shown. In this manner, a considerable reduction in initial capital outlay could be achieved in the event that investing capital is limited.

LABOR REQUIREMENTS

The labor force required for the efficient operation of a plant of this type is a variable factor which is dependent upon design and initial capital investment. It is estimated that with completely automatic equipment, this plant can be operated with a labor force of five full-time employees and one part-time employee in addition to the manager-engineer (who is assumed to be the owner). Although no skilled labor is essential, at least two of the laborers should have had some previous experience with equipment operation.

Based on a fully automatic plant, the labor force would be as follows:

<u>Position</u>	<u>Duties</u>	<u>Estimated Monthly Salary</u>
Manager-Engineer	Manage plant, maintain equipment, accomplish laboratory research work, keep records.)	\$400.00
Supervisory Laborer (1)	Assist manager, mix adhesive, help in production room	300.00
Laborers (2)	Handle production equipment (\$200.00 each)	400.00
Laborers (2)	One to handle cutting and re-winding, spool winding and capping (when required), and one to handle wrapping and packaging for final shipment. (\$175.00 each)	350.00
Office Assistant	Part time help. Assist in record keeping, sales, typing.	<u>100.00</u>
	Total Monthly Salaries	\$1,550.00

MATERIAL REQUIREMENTS

The material requirements listed below should be sufficient to keep the plant operating at maximum capacity for 1 month (20 working days). The estimated material costs shown are based on United States' prices and may vary considerably with any given locale.

	<u>Estimated Cost</u>
1. Fabric (2400 yards @ \$0.10/yard)	\$240.00
2. Adhesive ($\frac{1}{2}$ ounce per yard of finished product 2400 x 1/32 = 75 pounds. x \$0.50/pound.	37.50
3. Prime coat, waterproof coat, and anti- offsett coating layers (\$0.05/yard.)	120.00
4. Retail packaging (720 rolls/month x \$0.05/roll)	36.00
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Estimated monthly material requirements	\$433.50

NOTE: All tape will be packaged for use by hospitals, doctors, and others. As such, the standard package (12" wide by 10 yards long) will be used.

OVERHEAD RATE

Estimated Depreciation

<u>Item</u>	<u>Estimated Cost</u>	<u>Life (Years)</u>	<u>Estimated Yearly Depreciation</u>
Building	\$ 7,000.00	25	\$ 280.00
Production Equipment	25,000.00	15	1,250.00
Miscellaneous Equipment (Laboratory Equipment, maintenance tools, office equipment.)	8,000.00	15	480.00
Maintenance (Based on 3% of building and equipment cost)			<u>1,200.00</u>
			\$ 3,210.00

Estimated Monthly Depreciation and Maintenance

$$= \frac{\$3,210.00}{12} = \$267.50$$

Overhead

Electricity

Estimated to be \$0.04 per yard
\$0.04 per yard x 2,400 yards/month ----- \$ 96.00

Water

Estimated to be ½ gallon per yard of tape
2,400 yards/month x ½ gallon per yard =
1,200 gallons x \$0.05 per gallon ----- 60.00

Gas (propane)

Estimated to be \$0.01 per yard
\$0.01 x 2,400 yards/month ----- 24.00

OVERHEAD RATE

(Con't)

Total estimated monthly overhead

1. Electricity	-----	\$ 96.00
2. Water	-----	60.00
3. Gas	-----	24.00
4. Depreciation	-----	267.50
		<hr/>
		\$ 447.50

NOTE: The above depreciation estimates were based on the following figures:

1. Building ----- 4% annually on the total building cost.
2. Equipment ----- 5% annually on the total equipment cost.
3. Miscellaneous Equipment ----- 6% annually on the total cost.
4. Maintenance ----- 3% annually on the total building and equipment cost.

UNIT COST OF MANUFACTURING

<u>Item</u>	<u>Estimated</u> (per square yard)
Labor:	
<u>\$1,550.00</u> 2,400 yards/month	\$ 0.646
Overhead:	
<u>\$447.50</u> 2,400 yards/month	0.186
Materials:	
<u>\$433.50</u> 2,400 yards/month	0.18
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Total estimated unit cost of manufacturing -----	\$ 1.02

CAPITAL REQUIREMENTS

<u>Working Capital</u>	<u>Estimated Cost</u>
Material (for 1 month)	\$ 433.50
Operating Expenses	
Labor ----- \$1,550.00	
Water ----- 60.00	
Electricity --- 96.00	
Gas ----- 24.00	<u>1,730.00</u>
Total Working Capital (exclusive of insurance and taxes.)	\$2,163.50
Fixed Assets	
Land -----	
Building	\$7,000.00
Equipment	<u>33,000.00</u>
	\$40,000.00
Total Capital	
Working Capital	\$ 2,163.50
Fixed Assets	40,000.00
Reserves (operating and incidental expenses)	<u>10,000.00</u>
	\$52,163.50

SALES REVENUE

At current market prices of adhesive tape, the expected revenue from a plant of the type illustrated would be (based on 100% of production capacity) as follows:

Monthly Production:

120 yards/day x 20 working days per month equals 2,400 yards/month.

Monthly Revenue:

2,400 yards/month x \$1.50 per yard equals \$3,600.00/month.

Yearly Production:

2,400 yards/month x 12 months equals 28,800 yards/year.

Yearly revenue:

28,800 yards/year x \$1.50 per yard equals \$43,200.00.

PROJECTED PROFIT AND LOSS

The estimated profit and loss based on 100% production for the entire 12-month period would be:

Estimated yearly sales revenue -----	\$43,200.00
Less cost of production (\$1.02 per yard) -----	29,376.00
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Operating Profit -----	\$13,824.00
(before payment of principle and interest on loan, taxes, and insurance).	

NOTE: Although this estimated profit may appear to be somewhat low in relationship to the initial capital investment, the reader should be reminded that these estimates are based on the production and sale of only one type and size of tape. Additional sizes and types (band-aids, and friction tape.) may be produced with only a very small increase in material, and little or no increase in labor. This, in turn, would increase profits considerably. Also, there is the additional opportunity of branching into the production of other surgical supplies such as gauze bandages, compresses and others. Here again, profits will be increased far more than the amount of the added initial outlay.

SUMMARY

Most of the figures used in compiling this report are based on the experience of employees of actual adhesive tape plants, and on the past experience of the author. Additional data was obtained from brochures, notes, and technical publications. It is felt that the figures, although they are only estimates, are sufficiently accurate to lead to the following conclusions:

1. Dependent upon initial capital outlay, the plant described herein should be economically sound in most any geographical area.
2. It is advisable and profitable to establish a small adhesive tape manufacturing plant.
3. Little experience on the part of the laborers will be required.
4. Initial capital outlay can be reduced considerably by eliminating some of the equipment from costs estimates and compounding many of them yourself.
5. Further operational data, although somewhat hidden because of trade secrets, is obtainable.
6. Considerable opportunity exists for the plant to branch into the production of other types and tapes and related surgical supplies.