PLANT REQUIREMENTS FOR MANUFACTURE OF BLOCK ICE

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
COMMUNICATIONS RESOURCES DIVISION
Washington 25, 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 Agency for International Development, but merely a citation that is typical in its field.

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

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INTRODUCTION

The purpose of this report is to present basic information for establishing a manufacturing plant in a foreign country to produce block ice.

The value of ice as a preservative has been known since the time of primitive man. Nero, according to history, had snow cellars built high in the Alps where ice and snow were stored for use during the summer months. The ancient Egyptians used a method of cooling liquids by evaporation, a method still employed by many natives of India.

With the advance of civilization, natural means of cooling and preserving are no longer sufficient. Today's demands require the manufacture of ice on a 24-hour a day, year-round basis, and in quantities greater than can be economically harvested, stored, and shipped from nature's ice fields. Therefore, there is ever increasing growth and expansion in the manufacture of artificial ice.

GENERAL ASSUMPTIONS

In order to more clearly picture the size of the artificial ice plant described on the following pages, these general assumptions have been made:

1. Since ice plants are made in various capacities and the the plant size is dependent upon lc ation, need, and available capital, this report is based on a plant capacity of 10 tons per day, which should be economically sound in most any geographical area.

2. Adequate and suitable water, electrical, sewage, and transportation facilities are, or can be readily made, available at the site.

3. A substantial market either exists or can be made available.

4. The plant will operate 3 eight-hour shifts per day, 7 days per week, 52 weeks per year.

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

6. Equipment costs are based on 1961 delivered prices in the United States.

7. No provision is made for the training of new personnel. It is assumed that such training will be accomplished by the manager and that learners rates will be paid in such cases.

8. The plant layout illustrated, and the method of manufacturing described on the following pages are based on a dual pressure, ammonia compression (brine race) system.

9. Since the only raw material required is water, no provisions have been made for a warehouse or stockroom for incoming materials, and the water cost is included under "Overhead".

10. The following items cannot be estimated realistically:

    a. Land value
    b. Distribution and selling costs
    c. Freight-out
    d. Administrative costs
    e. Taxes

    Although estimates are made for each of these items, for the purpose of completing cost estimates, adjustments should be made in accordance with actual local costs. Columns are provided in the tables included in this report to facilitate the conversion of cost figures to conform with local costs.

PRODUCT SPECIFICATIONS

All information and figures contained in this report are based on the production of clear, pure ice in block form. Water is the only raw material used in the manufacturing process. This report is based on the production of ice made with water obtained from an approved municipal supply system. Prior to manufacture, the water must be subjected to a softening process to remove dissolved mineral compounds such as calcium, magnesium, and iron. If the water is obtained from natural sources such as wells, rivers, or lakes, it must be treated to remove impurities of a bacterial nature in addition to the softening process.

PRODUCTION CAPACITY

The plant is designed to produce 10 tons of ice per day or 3,650 tons per year in 300 pound blocks.

MANUFACTURING OPERATIONS

After treatment as described under Product Specifications, the water is placed in slightly tapered cans holding 300 pounds each. The cans are lowered into the freezing tank which is filled with a nonfreezing salt brine solution held at a temperature of 10° to 20°F by means of compressed ammonia forced through continuous coils placed between each row of cans as shown in figure 1.

The water in the cans is cooled to 32°F and begins to freeze. Ice initially forms on the sides of the cans and freezes slowly inward toward the center. The water is agitated during the freezing process by introducing compressed air into the can from the bottom. The air bubbles up through the water as it freezes into clear ice.

After the water is frozen, the cans are removed from the freezing tank and allowed to temper in the air for a short period. The cans are then dipped in a water tank to loosen the block of ice so that it can be easily removed. The cans are lifted from the water and tipped; the blocks of ice slide out of the cans and down a runway to the storage room.

The ice blocks await distribution in the storage room where the temperature is maintained at about 22°F. The walls, floor and ceiling of this

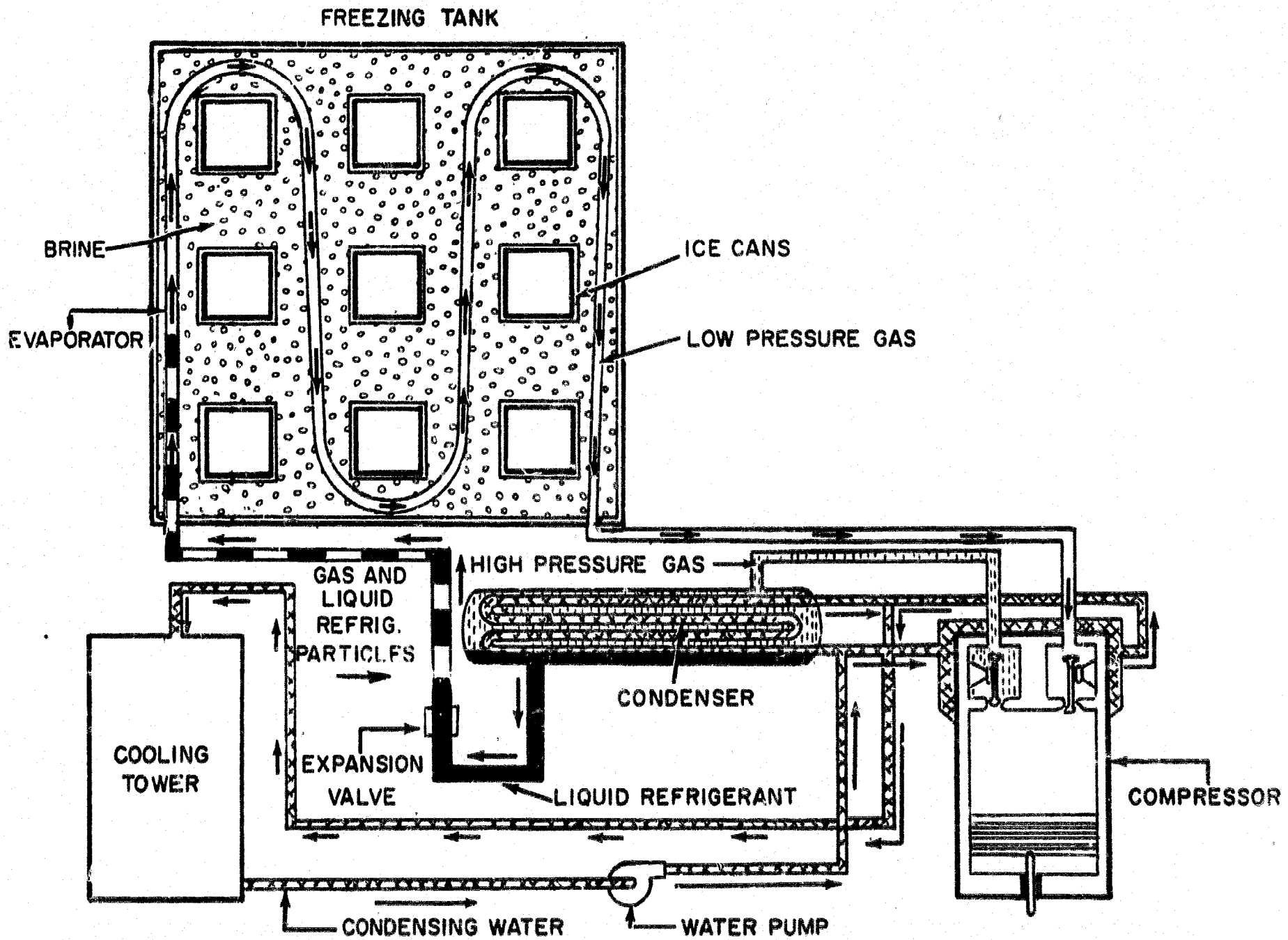

Figure 1. Typical Refrigeration System

room are insulated to keep the cold in and the heat out. Because low temperatures are maintained in the storage room, there is no need to pack sawdust or similar material between the blocks of ice. Before delivery, the blocks are usually scored (partially cut) by machinery into 25, 50, or 100 pound units.

PLANT LAYOUT

Plan and elevation views of a typical 10-ton ice plant for making block ice by the process just described are shown in figures 2 and 3.

PLANT SITE

The plant location for block ice manufacturing is extremely variable since considerations such as railhead for the delivery of incoming raw materials and export of the finished product are unnecessary. Water is the only raw material used in the manufacture and the availability of an adequate water supply should be the primary consideration in plant location. An area of about 1/2 acre will be sufficient to accommodate this operation, and its cost is estimated at $1,000.

BUILDING

A one story building, 30 feet by 75 feet, a total of 2,250 square feet, will be adequate for this plant. The total cost of the building, including heating, wiring, plumbing, and insulation is estimated at $12,000. The walls, floors, and ceiling of the entire building, except the office space, must be insulated for obvious reasons. No basement is required and a low, flat roof may be used. Local materials may be employed in the construction of the building.

POWER REQUIREMENTS

The total connected power requirements for this plant are approximately 32 kilowatts per hour, or a total of 23,000 kilowatt-hours per month. The costs are estimated at $6,000 per year or $500 per month. Even in the United States, power costs vary widely with locality.

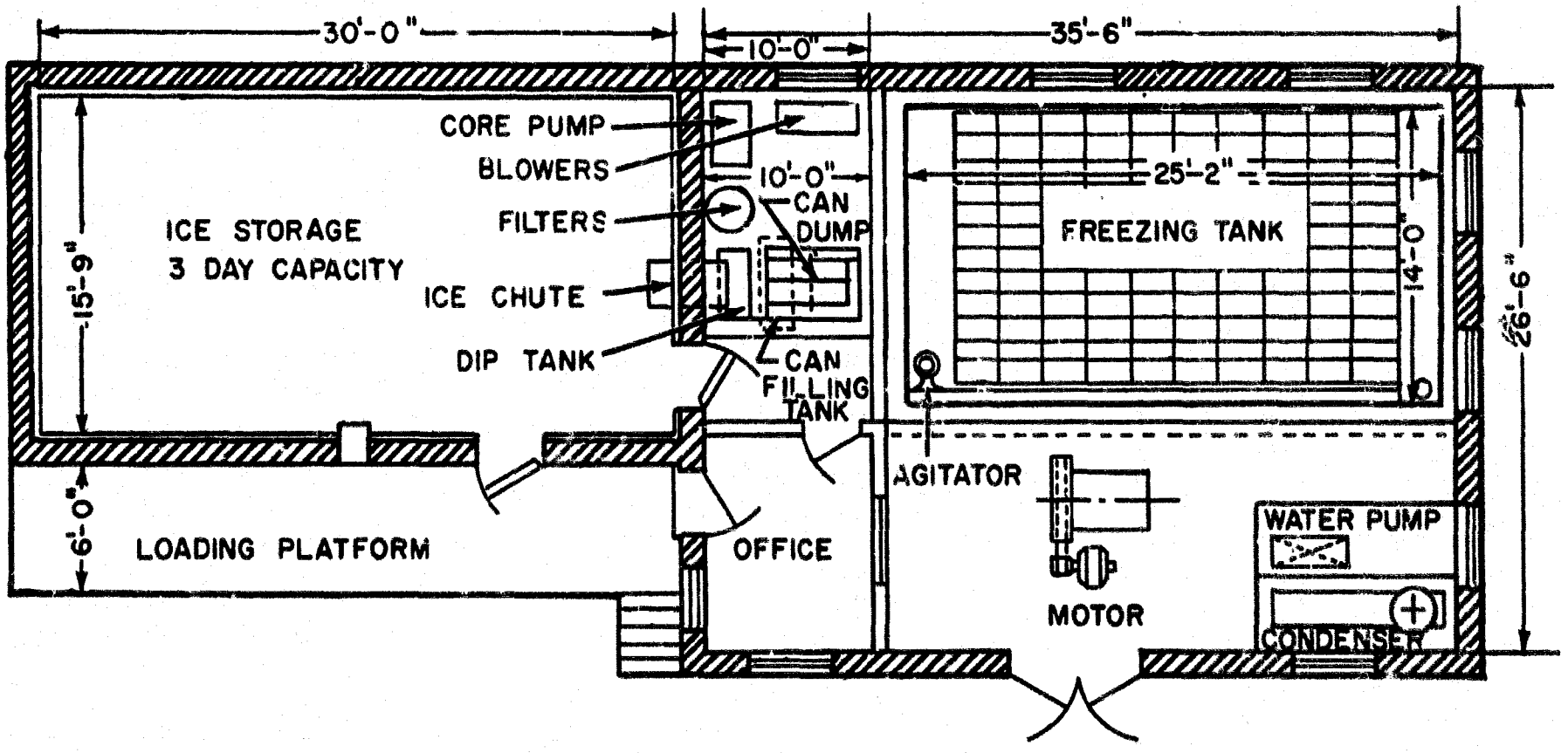

Figure 2. Plan View of a Typical 10-Ton Ice Plant

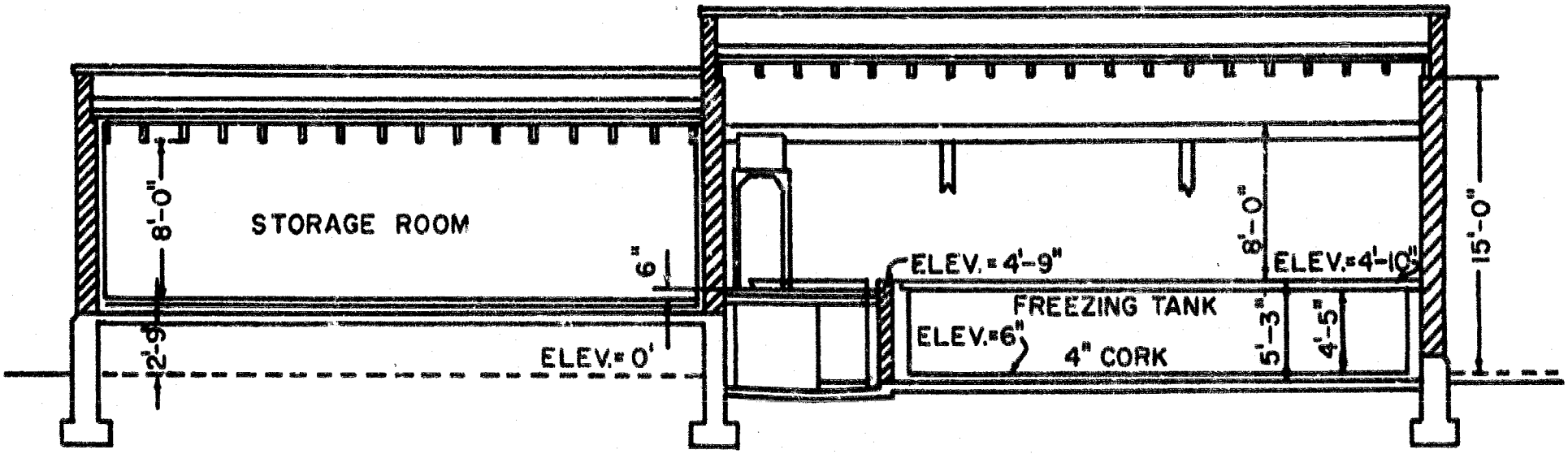

Figure 3. Elevation View of a Typical 10-Ton Ice Plant

WATER REQUIREMENTS

Water is the essential material in this operation. It is preferable to obtain the water from an approved municipal source if possible. However, natural water sources may be used if the water is first treated to remove impurities of a bacterial nature. If the water is obtained from a municipal supply, the estimated costs would be about $12 per month or $144 per year based on a monthly consumption of 225,000 gallons.

FUEL REQUIREMENTS

The office space is the only area requiring heat. Fuel costs are estimated at $5 per month or $60 per year.

LABOR REQUIREMENTS

This plant can be operated by one manager-engineer working 40 hours per week, one truck driver, three semi-skilled workers, and two part-time reliefmen. Labor costs are based on 56 hours per week, 52 weeks per year, for the numbers of personnel shown.

DIRECT LABOR

Occupation	Number Required	Hourly Rate	Annual Cost Estimated	Annual Cost Actual
Semi-skilled Workers	3	$ 1.75	$ 15,288	
Totals	3		$ 15,288	

INDIRECT LABOR

Occupation	Number Required	Hourly Rate	Annual Cost Estimated	Annual Cost Actual
Manager-Engineer	1		$ 7,200	
Truck Driver	1	$1.50	4,368	
Totals	2		$ 11,568	

DIRECT MATERIALS

Water is the only direct material used in the manufacture of block ice, and the cost is included under "Manufacturing Overhead".

SUPPLIES

Item	Annual Cost Estimated	Actual
Gasoline, Oil, and Maintenance for Truck	$ 825	
Lubrication and Hand Tools	100	
Maintenance and Spare Parts	500	
Office Supplies	100	
Cleaning Materials and Equipment	335	
Ammonia and Salt	60	
Total	$ 1,920	

FURNITURE AND FIXTURES

Description	Number Required	Unit Cost	Cost Estimated	Actual
Desk and Chair	1		$ 125	
File Cabinet	1		75	
Typewriter	1		150	
Adding Machine	1		150	
Total			$ 500	

PRODUCTION TOOLS AND EQUIPMENT

Description	Number Required	Estimated Cost	Actual Cost
Ammonia Compressor and Motor	1	$ 6,450	
Condenser and Float Regulator	1	2,150	
Purge Drum	1	410	
Freezing Tank	1	3,650	
Freezing Tank Coils	468 Feet	830	
Suction Trap	1	410	
Vertical Agitator	1	1,600	
Ice Cans	122	2,750	
Dip Tank	1	300	
Can Filling Tank	1	920	
Can Dump	1	335	
Electric Crane Hoist	1	2,500	
Core Syphoning Unit	1	335	
Core Sucker, Pocket Refiller, and Thawing Needle	1	170	
Low Pressure Air System	1	1,320	
Water Pump and Motor	1	670	
Cooling Tower	1	1,700	
Piping and Mains	---	1,635	
Hose, Wires, Framework, and Track	---	810	
Panels and Switchboard	---	830	
Insulation	---	4,200	
Total		$33,975	

OTHER TOOLS AND EQUIPMENT

Description	Number Required	Unit Cost	Cost Estimated	Cost Actual
Delivery Truck	1		$ 6,000	
Maintenance Tools			85	
Fire and Safety Equipment			450	
Ammonia	500 lbs	.45	225	
Salt	6 tons	$9.00	54	
Total			$ 6,814	

DEPRECIATION

Description	Estimated Cost	Years Life	Cost Estimated	Cost Actual
Building	$ 12,000	25	$ 480	
Production Tools and Equipment	33,975	15	2,265	
Other Tools and Equipment	6,814	5	1,363	
Furniture and Fixtures	500	10	50	
Total			$4,158	

MANUFACTURING OVERHEAD

Item	Cost Estimated	Cost Actual
Depreciation	$ 4,158	
Indirect Labor	11,568	
Power	6,000	
Water	144	
Fuel	60	
Supplies	1,920	
Total	$ 23,850	

MANUFACTURING COST

Item	Cost Estimated	Cost Actual
Direct Materials		
Direct Labor	15, 288	
Manufacturing Overhead	23, 850	
Total	$ 39, 138	

FIXED ASSETS

Item	Cost Estimated	Cost Actual
Land	$ 1, 000	
Building	12, 000	
Production Tools and Equipment	33, 975	
Other Tools and Equipment	6, 814	
Furniture and Fixtures	500	
Total	$ 54, 289	

WORKING CAPITAL

Item	Cost Estimated	Cost Actual
Direct Materials, 30 Days	$	
Direct Labor, 30 Days	1,274	
Manufacturing Overhead, 30 Days	1,988	
Reserve for Sales Collections, 30 Days	250	
Total	$3,512	

CAPITAL REQUIREMENTS

Item	Cost Estimated	Cost Actual
Fixed Assets	$54,289	
Working Capital	3,512	
Total	57,801	

SALES REVENUE

The estimates in this report are based on the production of 300 tons of block ice per month or 3,600 tons annually. Retail price for ice is estimated at $1.00 per hundred pounds or $20 per ton for a total sales revenue of $72,000 per year.

RECAPITULATION OF COSTS, SALES AND PROFITS

Item	ANNUAL COSTS Estimated	Total	Actual
Direct Materials	$ 0		
Direct Labor	15,288		
Manufacturing Overhead	23,850		
Total Manufacturing Costs		$39,138	
Interest on Loans	2,000		
Insurance	200		
Legal	200		
Auditing	200		
Unforeseen Expense (Bad Debts, Etc.)	1,000		
Total Administrative Costs		3,600	
Total Sales Costs *		3,000	
Profit Before Taxes		26,262	
Total Annual Gross Sales		$72,000	

* Includes Commissions, Travel, Freight-out, Discounts, Etc.

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 page 17.

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 in the table on page 16) 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.

In addition to the requisition form, a sample voucher check is shown on page 18. 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, as shown on page 16. If the expenditures exceed the budgeted monthly allowances of any of the accounts, the bookkeeper will furnish the manager with a breakdown 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		$ 217	$ 2,600	
20 Sales		250	3,000	
30 Direct Materials		0	0	
40 Supplies		160	1,920	
51 Power*		500	6,000	
52 Water*		12	144	
53 Fuel		5	60	
60 Unforeseen Expense (Reserve Account)		83	1,000	
71 Direct Labor*		1,274	15,288	
72 Indirect Labor*		964	11,568	
80 Depreciation (Reserve Account)		346	4,158	
Total		$ 3,811	$ 45,738	

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 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 report would be a profitable undertaking.

Provision is made for inserting local cost in connection with all cost figures shown in this report. A careful analysis should be made of all cost figures to determine the local potential profits in any location where such a plant is being considered.

There are some determinations, however, that should be made before a decision is reached to build and operate such a plant.

For example, what are the possibilities of future expansion within the country for this industry?

What other products could be manufactured with the machinery and equipment specified in this report?

Is there a market for such additional products?

How does this industry compare with other industries that may be needed in the country relative to the following factors:

1. The economic value to the country.

2. The needs of the majority of the people.

3. The amount of investment capital required.

Consideration should also be given to such factors as :

The amount of power required and the availability of a dependable supply. If an adequate supply is not available the installation of power equipment may be required.

The water requirements for all purposes including fire protection and potable water for drinking purposes.

The fuel requirements and availability. If local fuel can be used the boiler should be adaptable to such fuel.

The transportation facilities to and from the plant. If they are not adequate an investment in trucks may be required.

OTHER CONSIDERATIONS

There are other important subjects, shown below, that should be fully investigated and considered. Information on these subjects is usually available from such sources as banks, government agencies, exporters and importers, wholesalers, retailers, transportation companies and manufacturers.

MATERIALS AND SUPPLIES

1. Are all materials and supplies available locally?
2. Is the local material market competitive?
3. Is 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?

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?

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?