PLANT REQUIREMENTS FOR MANUFACTURE OF RICE BRAN OIL

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

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INTRODUCTION

The purpose of this report is to present basic information for establishing a rice bran oil plant in a foreign country.

GENERAL ASSUMPTIONS

In order to make realistic estimates in this report, 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 Statistics.

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 eight-hour shifts per day, three hundred days 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. Administrative costs.
   E. 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.

PRODUCT SPECIFICATIONS

Rice bran oil extracted from rice bran and bran meal are the products produced in this plant. Rice wax could be produced as a by-product. However, this would require additional equipment as indicated in this report.

PRODUCTION CAPACITY

The annual production of this plant is shown below:

Rice bran oil	4,000 tons
Bran meal	22,000 tons

MANUFACTURING UNIT

The manufacturing unit for this plant is one ton.

GENERAL INFORMATION

Rice is one of the world's oldest cultivated crops; it is also the main food of more people than any other cereal grain. In addition to head rice, which represents about 50 percent of the whole rough rice, there are several by-products which can be used economically if properly prepared. Of these, bran represents about 8.5% of the rough rice, and is especially rich in fatty materials, proteins and vitamins. The fatty materials, if extracted efficiently from freshly milled bran, can be processed into a merchantable, crude edible oil suitable for all purposes served by other vegetable oils such as cottonseed oil. Besides the considerable value of rice bran oil when extracted and processed as a by-product of rice milling, the bran itself is improved in quality as a poultry and livestock feed by the proportionately increased content of proteins and other nutritive components. Recovery of the oil in good merchantable grade represents a potential value far greater than that of the whole bran.

Extraction of Oil

Milled rice bran has an oil content of about 14-17 percent. A plant processing 100 tons of bran per day could separate some 28,000 to 34,000 pounds of oil, 650 to 750 pounds of potentially valuable wax, and about 160,000 pounds of bran meal. Although this report deals only with recovery of bran oil and bran meal, processes have been perfected for simultaneous recovery of both oil and wax from rice bran. Additional equipment and costs for the wax recovery process are not included.

Rice bran oil has been produced for years in Japan and other parts of the world by mechanical pressing, the traditional means of extracting most vegetable oils. Most rice bran oil thus produced is of poor quality and has been used chiefly for soap stock or sulfonation oil. Poor quality results from large percentages of rancid-causing free fatty acids, waxes, various emulsifying agents, and pigments that are hard to remove. Generally, mechanical pressing is not economical for raw vegetable materials containing less than 20 percent oil since four to seven percent residual oil is left in the cake or meal. Good extraction with organic solvents removes most of the oil and leaves the waxes in the meal.

Rice bran oil can be readily extracted in small batches by organic solvents, such as hexane, in a static-type extractor. Solvent extraction is the most promising method of removing oil from rice bran, although there are numerous difficulties involved. This method usually requires a high solvent-to-bran ratio, which is costly, both because of the extravagant amount of solvent used and because of the added processing required to handle and separate the solvent from the extracted oil. Also, large scale operations are generally impeded because of the difficulty of removing the fine solid materials in the bran. There is further difficulty in producing large enough flakes of optimum thickness and of sufficient strength to withstand the stresses during extracting, desolventizing, and drying.

In addition to the production problems caused by the excessive fine materials in the bran, there are other serious problems which conventional methods used with other oils have not wholly overcome. There is a tendency for the remaining oil in the bran to undergo rapid hydrolysis to free fatty acids and glycerol with resulting rancidity; there are abnormally high refining losses; the refined and bleached oil frequently has excessive pigment; and finished oil has a tendency to undergo flavor reversion. On the other hand, more complete removal of the oil leaves a more stable and more nutritive bran, and the oil is potentially an important edible oil. It is especially stable after hydrogenation, which further increases its usefulness and market value.

The potential advantages of processing rice bran oil stimulated extensive research work by the United States Department of Agriculture which resulted in the development of a new process, called filtration-extraction, that overcomes most of the problems of the older processes of extraction. At the same time, this new process promises economical operation with smaller volumes than had been possible with the older methods and also permits simultaneous recovery of both oil and wax if desired.

Advantages of Filtration-Extraction System

Especially for the new plant being set up to process rice bran oil, the filtration-extraction system described above offers many advantages.

1. From beginning to end, it is an integrated system for continuous operation with a consistent, high-grade product. Since the pigments remain with the solid residues in this process, the color of the crude oil is good, which promotes high quality of finished products when refined by the purchaser.

2. The system is designed for flexibility of operation so that rapid changeover is possible from one vegetable oil product to another. This facilitates processing of several different vegetable oils with the same plant, so that the operating season can be greatly lengthened.

3. The low solvent-to-bran ratio (as low as 1.1 to 1, compared with 2 to 1 in traditional systems), coupled with rapid extraction and low manpower requirement, cuts operating costs to a minimum. Unusually efficient recovery of solvent and installation of the

system in comparatively small floor space are further economies.

4. Economic operation is possible with much smaller volumes of bran than are required with other extraction systems. Volumes as low as 30 to 40 tons of bran processed per day should show a fair profit, while 100 tons per day had been considered near marginal with older systems.

5. With a moderate increase in initial outlay for additional equipment and space, rice bran wax can be produced simultaneously with the oil at a substantial increased margin of profit.

6. Pound-for-pound, the meal after extraction is superior to that resulting from other extraction processes.

7. There is considerable fire and explosion hazard in any industrial operation with large quantities of inflammable solvents. The filtration-extraction systems now being produced commercially guard against this fire hazard by thorough sealing of closed systems and by designing explosion-proof equipment throughout.

MANUFACTURING OPERATIONS

There are four groups of steps involved in rice bran oil separation by the filtration-extraction process. These include:

1. Materials preparation -- rolling, cooking, and crisping.

2. Oil extraction.

3. Oil and solvent recovery -- evaporating, stripping, condensing, and solvent handling.

4. Marc desolventizing.

A description of these four processing steps follows:

Materials Preparation

This is the most critical phase in the whole process, since treatment of the bran feed material before extraction largely controls the success of the extraction process. To avoid the accumulation of excess free fatty acids in the bran, only freshly-milled bran, or bran that has been sterilized and maintained at a low moisture content should be used.

Once the bran is started in to the filtration-extraction process, all operations are continuous. The bran is taken from a hopper or bin by a conveyor and elevator to the cooker where it is moistened and heated mildly. The cooker normally consists of a stacked series of five kettles, the bran feed entering the top one in a continuous stream and then passing successively downward through the series of kettles. The temperature usually ranges from 210° Fahrenheit to 225° Fahrenheit and the moisture content in the bran ranges from about 25 percent in the top kettle to about 15 percent in the bottom kettle. The material passes through the cooker in 50-75 minutes.

From the cooker, the hot, moist bran is fed continuously to the crisper, which is a conveyor designed to promote evaporative cooling. A blower attachment accomplishes aspirator action to both cool and dry the cooked bran. The cooking operation greatly reduces the amount of "fines" in the bran, increases the size of particles and gives them a hardened or "crisped" effect. At the same time, cooking promotes the release of oil. The nutritive protein content of the bran is virtually undamaged by this mild heat treatment. The hardened, granular particles resist breakage during further processing, which is especially important for rapid fi...ation in the later extraction step. The hardened perticles remain porous, aiding in efficient extraction of oil.

Following the crisping operation, the cooled bran is conveyed by elevator to a breaker where any "water balls" (lumps of moistened bran) formed during cooking are broken up. The materials are then screened and the tailings are passed back through the breaker.

The screened material is passed to a scale for measurement and then into a conveyor 1 transfer to a bin. From the bin, the screened material is fed into the extraction assembly. En route, the material passes through a magnetic separator where any ferrous contaminants are removed.

Oil Extraction

The processes of solvent extraction of oil, filtration to remove insoluble fraction, and washing to remove oil from the residual meal, are combined in a single, continuous operation in the filtration-extraction assembly. This accomplishes high percentage extraction with low solvent-to-bran ratios.

A variable speed feeder discharges the stream of screened, cooked, crisped bran into the extractor. This is a continuous flow conveyor in which the material is slurried with miscella (solvent containing oil) from the third stage of the extraction filter, and gently agitated for about 15 to 20 minutes at a temperature of 85-8[illegible]° Fahrenheit. A solvent-to-bran ratio of between 1.1 to 1 and 1.3 to 1 is used instead of a ratio of 2 to 1 or higher that is customary with traditional extraction processes. Speed of agitation and flow, temperature, and solvent ratio are under direct control so that optimum extraction conditions can be constantly maintained. The bulk of the bran oil goes into solution with the solvent during the time the slurry is agitated in the extractor.

The slurry being discharged from the extractor is conveyed to a horizontal rotary vacuum filter, which very efficiently separates the miscella from the meal. The filter rotates slowly, taking one to four minutes per revolution. The bran is deposited on a fine-mesh screen and is subjected to a constant washing from pipes above it. The solvent washes the bran and drains through the screen. There are six filter compartments through which the material passes successively. The first five compartments are connected by drains to corresponding sections of the miscella tank below the filter. The sixth compartment discharges the marc (oil-free meal) after which the filter screen in this compartment is cleaned by vapor blow-back. The five successive filtrates are kept separate by a multi-port valve. The first filtrate drain receives the bulk of the miscella filtered from the slurry as it enters the first compartment of the filter bed. This first filtrate is immediately recycled to the second compartment of the filter bed for further removal of fines. The second stage filtrate is called the "product miscella" because it contains the bulk of the bran oil and is sent on to the oil recovery system.

A large part of the third stage filtrate is cycled back to the extractor to be agitated in the slurry with the incoming bran. The fourth and fifth stage filtrates are cycled back to the third and fourth filter compartments as counter-current washes ahead of the third and fourth filtrate drains, respectively. Finally, pure heated solvent is counter-washed through the fifth compartment of the filter ahead of the fifth filtrate drain, after which the marc is discharged from the sixth filter compartment.

After discharge of the marc, saturated solvent vapor is continuously blown back through the filter screen to dislodge any adhering particles that might otherwise clog the screen as the bed is being formed in the first stage. This blow-back also promotes formation of a uniform cake bed. To speed up drainage of miscella in all stages, and to prevent hold up of solvent in the extracted cake, a low vacuum of 4-10 inches of mercury is maintained in the filter bed.

Oil and Solvent Recovery

Crude oil and solvent are continuously recovered from the filtered miscella by evaporation and steam stripping. The product, miscella, or second filtrate, is first pumped to polishing filters, which remove very small particles of meal that pass through the vacuum filter. The clarified miscella is then pumped to an evaporator feed tank where it is stored temporarily and brought to the temperature desired for best operating efficiency.

From the evaporator feed tank, miscella is pumped to the evaporator drum at a controlled rate. The flow rate from the drum to the rising film evaporator is established by pressure control in the drum. Steam supply to the evaporator is automatically controlled by the incoming liquid level so that evaporation rate is constantly adjusted to the rate of incoming miscella being processed. Vaporization is rapid in the rising film calandria of the evaporator. Liquid oil is entrained with the ascending solvent vapors discharging from the top of the evaporator column into the separator.

Solvent vapors pass continuously from the upper part of the separator to the solvent condenser, from which liquid solvent is pumped to the solvent receiver tank. A level controller on the condenser keeps a liquid head on the discharge pump, preventing air from entering the solvent recovery system.

The liquid entrained with the solvent vapor from the evaporator is drained continuously from the bottom of the separator. It consists of concentrated miscella from which the remaining small fraction of solvent must be removed. This is accomplished by the flash chamber and oil stripper assembly. The concentrated liquid is heated in the flash chamber and passed to the oil stripper column, where superheated blowing steam removes the final traces of solvent under high vacuum. The hot crude oil from the bottom of the oil stripper is pumped through a cooler and on to storage tanks as the final product ready for shipment or further processing.

The mixture of air, steam and solvent vapor from the stripping operation is fed to a set of condensers which have also received the vaporized solvent from the separator. Water at controlled temperatures condenses the steam. Final separation of water and solvent is accomplished in a second separator, from which water drains to the sewer, and the solvent to the receiver tank. This tank thus receives solvent from both the evaporator condenser where the crude oil is separated and from the solvent-water condensers and separator.

Recovered pure solvent is continuously pumped either to solvent storage, or in full operation of the system, it is pumped back to the extraction assembly as required and is supplemented by additional solvent from the storage tank. A further source of recovered solvent is that removed from the marc.

Marc Desolventizing

The marc consists of the solvent-damp bran meal discharged from the final compartment of the vacuum filter after the miscella has been drained away. The marc is dried or desolventized by a mechanism similar to the cooker. A conveyor feeds the marc continuously to the top of the stack-type desolventizer. Solvent vapors are removed as the marc passes down through successive kettles. The vapors are drawn off and discharged to a vapor scrubbing assembly where they are scrubbed with hot water to remove fine particles of meal. After scrubbing, the solvent vapors are conducted to the same condensing assembly that handles the solvent vapors from the oil recovery operation.

The marc, nearly free of solvent, passes from the desolventizer to a flash conveyor where final drying is accomplished. The small amount of vapor from this last-stage drying is exhausted as waste. The dried meal discharged from the flash conveyor is completely free of solvent odor. A transfer conveyor takes the meal to bins for packaging and shipment. The dried meal is especially nutritive and is a valuable by-product.

Processing for Shipment

The crude rice bran oil, after cooling, is frequently discharged directly to the purchaser's tanks, so that no additional handling or processing is necessary. The volume of crude oil delivered is merely tabulated, and routine care is taken to assure good sealing of the tanks. However, for the volume of operation described, it is recommended that two small storage tanks of 500-600 gallons capacity be provided.

The extracted and dried meal is weighed and bagged for shipment as feed for poultry and livestock. For the most part, the same bags in which raw bran is received may be used for bagging and shipping the meal.

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DIRECT MATERIALS

Item	Annual Requirements	Unit Cost	Annual Cost Estimated	Annual Cost Actual
Rice bran	30,000 tons	$ 40.00	$1,200,000	______
Solvent (hexane)	5,625 gallons	.16	9,000	______
Bags	100,000 bags	35.00 M	3,500	______
Total			$1,212,500	______

SUPPLIES

Item	Annual Cost Estimated	Annual Cost Actual
Lubrication and hand tools	$ 300	______
Maintenance and spare parts	9,000	______
Office supplies	300	______
Total	$ 9,600	______

DIRECT LABOR

Occupation	Number Required	Hourly Rate	Annual Cost Estimated	Annual Cost Actual
Foreman*	3	$2.50	$ 18,000	______
Operators	6	2.00	28,800	______
Weighing and bagging and shipping	3	1.50	10,800	______
Yard men	3	1.50	10,800	______
Total	15		$ 68,400	______

*Note: Each foreman is fully qualified to supervise the work. However, the foreman for each shift is a working foreman and operates the plant with the help of three other people.

INDIRECT LABOR

Occupation	Number Required	Annual Cost Estimated	Annual Cost Actual
Manager	1	$ 12,000	______
Office	2	8,000	______
Maintenance	2	12,000	______
Total	5	$ 32,000	______

PLANT LAYOUT

A schematic fl w chart showing the manufacturing operations described in this report is included on the last page of this report.

PLANT SITE

In order to provide for future expansion a plant site of about 20,000 square feet will be required. The plant site should be as advantageously located as possible with respect to transportation, power, water, fuel, sources of labor and markets.

The estimated cost of the plant site is $1,000.

BUILDINGS

The following buildings will be required. The building must be substantially constructed and should be of fire proof materials.

Bran Preparation, Meal Bagging	20' x 20' x 30' high
Filtration-Extraction Processing . . .	40' x 40' x 33' high
Bagged Meal Storage	20' x 30' x 14' high
Office	20' x 20' x 10' high

Total floor space required - 30,000 square feet.

Due to the height of two of the buildings, the sturdy construction and the fireproof requirements, the cost per square foot is estimated at $10.00. On this basis the totel cost of building would amount to $30,000.

POWER

Based on operating 24 hours per day, 300 days per year, the annual cost of power for this plant is estimated at $40,000.

WATER

About 4,000,000 gallons of water will be required. The annual cost of water is estimated at $1,000.

FUEL

It is estimated that the annual cost of fuel for this plant including production, heating, and sanitary purposes will amount to about $20,800.

PRODUCTION TOOLS AND EQUIPMENT

Processing plants of this type are usually designed and installed complete as packaged plant in accordance with existing local conditions, including the annual production capacity required and the recovery of by-products that can be produced and sold at an adequate profit.

The installations are often made on a turnkey basis. On this basis the plant must be operated at the rated production capacity for a certain period of time (usually two to three months) by the company that designed and installed the plant before final payment for the plant by the purchaser is made.

A processing plant of this type consists mainly of tanks, conveying equipment, pipes, pumps, extraction equipment, heaters and items of this nature especially designed to operate as a complete unit. Six of the outside storage tanks that would be used in a plant of this capacity are listed below.

Bran Storage (outside) . . 3 tanks, 20' diameter x 60' high
Oil Storage (outside) . . 2 tanks, 10' diameter x 10' high
Solvent Storage (outside). 1 tank, 20' diameter x 40' high

Because those plants are sold on a package plant basis the cost of individual items is not shown in this report.

The estimated cost of the equipment purchased complete and installed as an integrated system is $300,000.

The above estimate does not include land, buildings, furniture and fixtures, or the equipment that would be required for the recovery of rice wax.

If rice wax recovery equipment is installed, the additional cost for that equipment is estimated at about $100,000.

FURNITURE AND FIXTURES

Item	Number Required	Unit Cost	Cost Estimated	Cost Actual
Desks and chairs	3	$150	$ 450	_____
File cabinets	3	75	225	_____
Typewriter	1	175	175	_____
Adding machine	1	150	150	_____
Total			$ 1,000	_____

DEPRECIATION

Description	Estimated Cost	Years Life	Annual Cost Estimated	Annual Cost Actual
Buildings	$ 30,000	20	$ 1,500	_____
Equipment	300,000	10	30,000	_____
Furniture and fixtures	1,000	10	100	_____
Total			$ 31,600	_____

MANUFACTURING OVERHEAD

Item	Annual Cost Estimated	Annual Cost Actual
Depreciation	$ 31,600	______
Indirect labor	32,000	______
Power	40,000	______
Water	1,000	______
Fuel	20,800	______
Supplies	9,600	______
Total	$ 135,000	______

MANUFACTURING COSTS

Item	Annual Cost Estimated	Annual Cost Actual
Direct materials	$1,212,500	______
Direct labor	68,400	______
Manufacturing overhead	135,000	______
Total	$1,415,900	______

FIXED ASSETS

Item	Cost Estimated	Cost Actual
Land	$ 1,000	______
Buildings	30,000	______
Equipment	300,000	______
Furniture and fixtures	1,000	______
Total	$ 332,000	______

WORKING CAPITAL

Item		Cost Estimated	Cost Actual
Direct materials	30 days	$ 101,000	______
Direct labor	30 days	5,700	______
Manufacturing overhead	30 days	11,300	______
Reserve for sales collections	30 days	170,000	______
Total		$ 288,000	

CAPITAL REQUIREMENTS

Item	Cost Estimated	Cost Actual
Fixed assets	$ 332,000	______
Working capital	288,000	______
Total	$ 620,000	______

SALES REVENUE

The annual production capacity of this plant is as follows:

Rice bran oil 4,000 tons at $360	=	$1,440,000
Bran meal 22,000 tous at $30	=	660,000
Total annual sales revenue		$2,100,000

RECAPITULATION OF COSTS, SALES AND PROFITS

Item	Estimated Cost		Actual Cost
Direct materials	$1,212,500		____
Direct labor	68,400		____
Manufacturing overhead	135,000		____
Total manufacturing cost		$1,415,900	____
Interest on loans	$ 19,000		____
Insurance	2,000		____
Legal	2,000		____
Auditing	4,000		____
Unforeseen expense	50,100		____
Total administrative costs		$ 77,100	____
Sales commissions		50,000	____
Travel, bad debts, discounts and allowances, freight-out		30,000	____
Profit before taxes		527,000	____
Total annual gross sales		$2,100,000	____

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	$_____	$ 2,250	$ 27,000	$_____
20	Sales	_____	6,666	80,000	_____
30	Direct Materials	_____	101,041	1,212,500	_____
40	Supplies	_____	800	9,600	_____
51	Power*	_____	3,333	40,000	_____
52	Water*	_____	83	1,000	_____
53	Fuel	_____	1,733	20,800	_____
60	Unforeseen Expense (Reserve Account)	_____	4,175	50,100	_____
71	Direct Labor*	_____	5,700	68,400	_____
72	Indirect Labor*	_____	2,666	32,000	_____
80	Depreciation (Reserve Account)	_____	2,633	31,600	_____

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.

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, ever 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.

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?

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?

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SOURCES OF INFORMATION ON EQUIPMENT

The following lists indicate some of the United States suppliers of equipment used in vegetable oil processing. It is suggested that those interested in establishing new plants in other countries should also seek information concerning sources of supply in other countries through appropriate importers and consulates.

OIL PROCESSING EQUIPMENT

Wurster and Sanger, Inc.
5201 South Kenwood Avenue
Chicago, Illinois

Scott Ernest & Company
Summer and Anawan Street
Fall River, Massachusetts

Allis-Chalmers Manufacturing Co.
864 South 70th Street
Milwaukee, Wisconsin

Green Manufacturing Co., Inc.
4533 Armitage Avenue
Chicago, Illinois

Davenport Machine & Foundry Co.
3200 Lamp Street
Davenport, Iowa

M. Neumunz & Sons, Inc.
90 West Street
New York, New York

William W. Nugent & Co., Inc.
414 North Hermitage Avenue
Chicago, Illinois

American Machine and Metals, Inc.
Tolhurst Centrifugals Division
48 Thomas Street
East Moline, Illinois

Brighton Copper Works, Inc.
820 State Avenue
Cincinnati, Ohio

York Process Equipment Corp.
70 Glenwood Place
East Orange, New Jersey

Bags

Fulton Bag and Cotton Mills
170 Boulevard Elsas, S. E.
Atlanta, Georgia

Ames Harris Neville Co.
2800 17th Street
San Francisco, California

Chase Bag Company
306 S. Franklin Street
Chicago, Illinois

Bemis Bros. Bag Co.
408 Pine Street
St. Louis, Missouri

E. S. Halsted & Co., Inc.
76 Halladay Street
Jersey City, New Jersey

Arkall Safety Bag Co.
12 E. 40th Street
New York, New York

MANAGEMENT CONSULTANTS AND CONSULTING ENGINEERS

Ebasco Services, Inc.
Two Rector Street
New York 6, New York

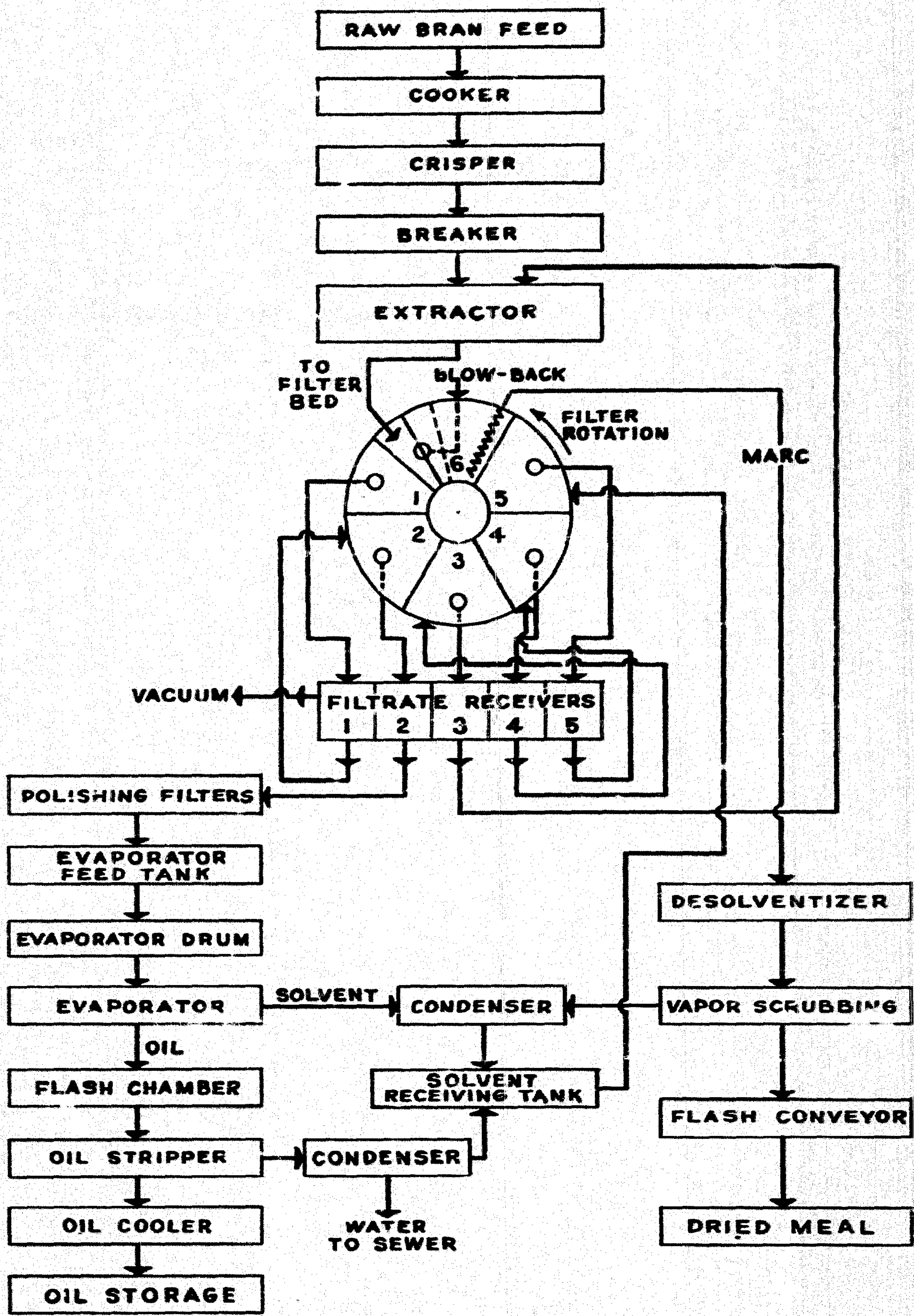
Booz, Allen and Hamilton International, Ltd.
1625 Eye Street, N. W.
Washington 6, D. C.

The Dallas Laboratories
P. O. Box 9215
Dallas 15, Texas

Truman B. Wayne & Associates
P. O. Box 13086
Houston, Texas

New York Produce Exchange
Bureau of Chemistry
2 Broadway
New York 4, New York

Morse Laboratories
316 Sixteenth Street
Sacramento 14, California



WORK-FLOW CHART
FOR
FILTRATION - EXTRACTION OF RICE BRAN OIL