PN-ABP-240

SUSTAIN

GUATEMALA

JULY 23 - AUGUST 1, 1992

PILOT PLANT ASSESSMENT

S haring
U nited
S tates
T echnology to
A id in the
I mprovement of
N utrition

A U.S. Private Food Industry initiative
in collaboration with the U.S. Agency for International Development
through a Cooperative Agreement with the National Cooperative Business Association

Upgrading the Food Processing Industries in Developing Countries.

Why SUSTAIN?

SUSTAIN represents a successful collaborative effort between the U.S. food industry and the Agency for International Development (A.I.D.) to upgrade food processing in developing countries. It provides an excellent model for similar private-public sector joint ventures in health, agriculture and other areas of concern to developing countries.

Food processing is a major contributor to development. It serves multiple roles. Food processing can increase the available food supply by extending the life of perishable food products. It can improve the nutritional quality of the diet by making nutritious foods available the year round. It can lead to the growth of related enterprises in transportation, storage, distribution and marketing. And, it can produce much needed foreign exchange by creating value added products both for export and for internal substitution of imported processed foods.

The U.S. food industry has embraced the concept that freely sharing its expertise and knowledge is of mutual benefit to recipient and donor - to the recipient by improving current operations - to the donor by contributing to a healthier global future.

How SUSTAIN Works

A.I.D. missions and trade associations in developing countries publicize SUSTAIN's goals and activities. Executives of U.S. food companies with technical expertise and overall knowledge of the food industry serve as the SUSTAIN Steering Committee, providing guidance and overseeing activities.

Food related companies in developing countries submit their requests to SUSTAIN through the A.I.D. mission or a designated organization in their country. SUSTAIN screens all incoming requests and if necessary asks for additional information. Appropriate U.S. companies are then invited to respond.

Some problems can be readily resolved by providing information. Others require that consultants be sent. When a consultant is sent, the usual assignment is for one to three weeks. Upon completion of the assignment, the consultant prepares a report describing findings and making recommendations. Depending on need, some consultants may return for follow-up visits to ensure that recommendations have been appropriately implemented.

SUSTAIN Helps

Requests are diverse. Help may be needed to solve processing problems, to identify equipment needs and sources of new and used equipment, to train personnel in the use of new equipment and new technologies, to find new uses for indigenous commodities, to establish or improve quality assurance procedures, to control insects and rodents in food processing plants and to improve plant layouts and materials handling.

In the past, U.S. food companies, large and small, have provided technical assistance in the form of information, consultants and training to food processors in Africa, Asia, Latin American and the Caribbean.

PN-ABP-240

SUSTAIN PROGRAM

PILOT PLANT ASSESSMENT MISSION

Guatemala

July 23 - August 1, 1992

SUSTAIN Mission Team:

Charles W. Long, Campbell Soup Co. (retired)

Arnold Denton, Ph.D., Campbell Soup Co. (retired) & Professor, Purdue University

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SECTION 1

PILOT PLANT MISSION

SUMMARY AND RECOMMENDATIONS OF
SUSTAIN MISSION TO GUATEMALA
July 23 - August 1, 1992

SUMMARY

The purpose of the July 23rd to August 1st 1992 SUSTAIN mission to Guatemala was to evaluate the pilot plant (building and equipment facilities) at the Institute for Nutrition in Central America and Panama (INCAP). The assessment conducted by the SUSTAIN team dealt primarily with recommendations for strengthening the physical and technical capabilities of the pilot plant. However, a more basic issue -- which was beyond the scope of this mission, but one that needs to be addressed -- is determining who might be the users of the pilot plant and what level of demand can be expected. To obtain this information, the SUSTAIN team recommended that INCAP should conduct market research on the demand for pilot plant services, as well as more direct communication with potential users of these services.

During the mission, INCAP presented background information on prior plans and strategies for up-dating and expanding the pilot plant. INCAP also summarized a proposal that they recently submitted to the Japanese government for furnishing and installing equipment necessary for the expansion. INCAP indicated that their plans for the pilot plant might include the following: training, research and development and technical assistance.

The SUSTAIN team made recommendations regarding building space, utilities, processing flow diagrams, equipment descriptions and arrangement, operations, personnel and training.

As an adjunct to the SUSTAIN team assessment of INCAP's pilot plant, Mr. Long also visited a juice processor, Alimentos Kern de Guatemala, Guatemala City. The purpose of this visit was to determine if their evaporator was contributing to the darkening of the their fruit concentrates. (See appendices 4 and 5.)

SUSTAIN TEAM MEMBERS

Dr. Arnold Denton is Professor of Food Science at Purdue University. He was formerly with Campbell Soup Company for 32 years, retiring as Senior Vice President of the company's International Division in 1990. Dr. Denton has served and serves on numerous boards and committees, including serving as Vice Chairman of the SUSTAIN Program Steering Committee.

Charles Long is a specialist in food engineering, retired in 1990

as Senior Project Manager for Campbell Soup Company. His experience included setting up pilot plant facilities, testing vendor equipment, and specifying equipment. Prior to his years with Campbell, Mr. Long was a project manager and process engineer for Johnson and Johnson.

RECOMMENDATIONS

1. Before any funding is committed for the expansion and improvement of the pilot plant, the SUSTAIN team feels it is very important that INCAP identifies the potential market for the services that could be offered through the pilot plant.

   To obtain this information, the SUSTAIN team recommended that INCAP should conduct market research on the demand for pilot plant services, as well as more direct communication with potential users of these services.

2. Establish the pilot plant as a training facility for both students of food science (in conjunction with local universities) and food industry personnel at all levels of the production cycle.

   As an initial focus for the training program, the pilot plant could be used to train people in food handling, sanitation and good manufacturing practices. There currently is not a facility in Guatemala to do this. The training would be for food industry employees, university students, government employees, etc. This would let industry know about the pilot plant, eventually leading to technical service opportunities. The training programs would fit well with INCAP's mission of food safety and protection.

3. Make this pilot plant the standard of excellence for the industry in Central America, Panama and Belize.

4. Establish and implement policies under which the pilot plant will be managed and operated.

5. Financing the operating costs of the pilot plant should not depend upon the commercial production and sale of food products. However, those products manufactured in the pilot plant as a result of research, training and teaching programs could be sold to generate some income. Additional sources of income could come from royalties, technical services and training and other programs.

6. Upgrade the building to make it a sanitary facility. (Refer to the U.S. FDA Good Manufacturing Practices for Guidance - p. 31, Appendix 3.)

7. Make the following general, but not exclusive building alterations: 1) Install a concrete pad with light structure roof to accommodate vegetable and fruit washing; 2) Install refrigeration space for meat processing; 3) Install refrigerated milk receiving tank; 4) install air currents over all external doors; 5) replace existing sliding door with an 8 x 8 foot roll up type and personnel door; 6) eliminate all glass in windows; 7) add additional internal doors as required; 8) upgrade existing locker and washroom facilities; and 9) provide cages for finished products and cleaning materials.

8. Hire an architectural engineering firm to design and specify building modifications as required and prepare cost estimates for construction bids.

9. Place pilot plant equipment in the designated areas according to discussion and mutual agreement. (Refer to p. 14a.)

10. Concentrate on placing one or two processing lines in operation before installing other lines. Equipment for the other lines can be ordered and stored until it can be installed.

11. Keep the facility and utilities flexible so that they can be used for different processing systems.

12. Equipment should be capable of multi-usage, be mobile and stored when not in use. Provide adequate storage space.

13. Have a sufficient and consistent supply of pure water, oil free compressed air, steam and electricity. A new boiler and electrical supply should be installed.

14. Keep building, grounds, equipment, storage areas, maintenance shops, etc. clean, neat and well organized. Discard obsolete, unused equipment.

15. Have a good sanitation and maintenance program and waste disposal capabilities.

16. Give special attention to having highly qualified people manage and operate the pilot plant. A pilot plant team must be selected and trained so that it is familiar with the pilot plant plans, sanitation and safety practices and are present at the time the equipment is installed.

17. Continue to seek market opportunities for technical service by contacting potential customers to determine the type of services desired. One way to help accomplish this may be to establish an industrial advisory board composed of top management people.

18. Have a program in place to acquaint people throughout Central America, Panama and Belize of the capabilities of the new pilot plant when it is operational.

19. Establish a time table to start the building modifications.

20. Resolve the issue of how to distribute revenue received for pilot plant activities (technical service, training, etc.) The way in which this is handled in the U.S. is that the department doing the work gets a significant portion of the revenue and a portion is given to the institution for general expenses.

SUSTAIN MISSION TO GUATEMALA

July 23 - August 1, 1992

TO: Ms. Elizabeth Turner, Program Director, SUSTAIN

FROM: Messrs. Charles Long and A. E. (Bud) Denton

SUBJECT: SUSTAIN's Mission to Guatemala 7/23 - 8/1/92

Background

The purpose of the July 1992 SUSTAIN team visit to Guatemala was to assist INCAP in assessing and planning for the expansion of its pilot plant. The SUSTAIN mission started with a meeting at INCAP with Dr. Delgado, Dr. Elías, Dr. Callier, Eng. Reyes and Eng. de León. (The itinerary for the full mission can be found in section 1, p. 12.)

Dr. Delgado explained that INCAP submitted a proposal to the Japanese Government to request equipment to update and expand the pilot plant and laboratory facilities at INCAP. A document outlining strategies for operation and use of these facilities were developed by INCAP (not included in this report, but in permanent file). We made some comments regarding the operational activities (section 4, p. 22-27). INCAP is in the process of soliciting approval from other Central American Countries for their proposal. This is important in fostering a regional approach for research, training and technical services.

Dr. Delgado emphasized the two beneficiaries of INCAP are both the social sector and the food industry. We suggested that by supporting the food industry jobs would be created, food losses would be decreased and vital nutrients would be preserved. Thus this would also support the social sector. He considers the pilot plant a key component of the Unified Laboratory effort. PAHO has asked INCAP to strengthen its food safety and protection capabilities and the pilot plant would aid this effort. The Unified Laboratory concept encourages more team-work and greater utilization of resources. This seems to be the right way to manage, especially with limited funds.

The policies under which the new pilot plant would operate are being defined. These are important and should be completed as soon as possible. However, we recommend that the pilot plant be used for the following purposes:

1) Hands-on training of food science and technology students. Industry looks favorably upon students or workers with hands-on training and are more apt to hire them. If there is a steady demand for trained students by industry, then university food science and food engineering programs would be vitalized.

2) Workshops and short courses for industry and governmental personnel on basic techniques of food processing. Areas of training could include Good Manufacturing Practices and Quality concepts of Quality Control. Moreover, the pilot plant could be used for demonstrating new processing or packaging techniques.

3) Development of new products on a contract basis for regional companies. Where product development facilities in some companies may be lacking, the pilot plant can serve this need. The pilot plant can be used in scaled-down production trials of new products.

How technical services will be charged needs to be defined as part of the policies. More information is needed on the type and extent of the need for technical service. We encourage the involvement of food companies because they will be major customers for these services.

Pilot Plant General

Dr. Elías and Messrs. Reyes and de León presented information on the pilot plant (p. 80 of INCAP proposal-not in this report, but with the permanent file) which covered objectives for the pilot plant, activities to be conducted, processing lines and raw materials. Also presented were general processing flow charts, modified by Charles Long, to contain more specific details for processing operations and equipment needs. A list of U.S. food machinery companies also prepared by Charles Long is in section 5, Appendix 2.

General principles for establishing a pilot plant (section 2, p. 14) were presented by Messrs. Long and Denton. These covered items to be considered to make the pilot plant be as capital, human resource, and operationally efficient as possible.

The proposed pilot plant calls for installing 5 processing lines for: cereals and legumes, fruits and vegetables, meat and poultry, milk and dairy products and fats and oils. The magnitude of this project will require that attention be given to: 1) establishing a priority for installing and operating the equipment; 2) qualified human resources to install, operate and maintain equipment; 3) the space requirements for efficient and safe operation of the equipment; 4) support personnel for ingredient preparation, cleaning and other activities. Plans should be developed to train people required for the critical jobs needed for the pilot plant.

This project affords the INCAP the opportunity, through its pilot plant, to set the standard of excellence for the food industry in the region. It is necessary, therefore, that the buildings and grounds be clean and neat, and the unused equipment and parts be stored in a clean, organized manner. The appearance of the buildings and grounds should reflect the high quality of the staff responsible for the pilot plant.

Pilot Plant Building Space

Present floor arrangement includes three rooms (section 2, p. 14a-c; source of drawings: INCAP), one for dry processing, one for wet processing and one for raw ingredient, receiving and storage. These rooms, especially the one for wet processing will need upgrading to meet general sanitary standards and to help make the pilot plant of greater interest to food companies. Some of the upgrading needed for the wet processing room includes: 1) plastering and sealing the walls; 2) sealing the floors; 3) improving the overhead structure to prevent foreign material (dust, wood, grease, etc.) from falling into product; 4) eliminating the glass in the windows; 5) increasing the lighting. The U.S. Good Manufacturing Practices (GMPs) (section 5, Appendix 3) and other world wide regulations should be consulted to help design the pilot plant.

The dry processing area also needs up-grading but to a lesser extent. Preventing flour dust from accumulating and protecting the product from foreign material contamination are necessary. Good vacuum cleaning equipment will be needed.

The proposed ingredient receiving/storage room is well located but it also will need upgrading depending upon the ingredients to be processed. A caged storage area is needed for storing cleaning and other inedible materials. This can be placed in the storage room. It was suggested that a concrete slab be put outside of the processing and receiving rooms and that dirty operations (vegetables and fruit washing, grain cleaning, etc.) be conducted on this slab. Processing equipment should be installed to allow a straight through flow of raw material to the finished product.

After several discussions and visits to the pilot plant a proposed arrangement for the new pilot plant was developed by the SUSTAIN and is shown in section 2, p. 14b. Proposed offices and laboratories on the existing mezzanines in the pilot plant are shown in section 2, p. 14c.

Pilot Plant Utilities

An evaluation was made of the current steam and electrical supply that is available to the pilot plant. The adequacy and purity of the water supply needs to be studied. A consistent supply of high pressure steam, electricity, water and oil free compressed air are needed. Industry will more likely use INCAP's

technical services if these are consistently available. We concluded that a new boiler and electrical supply should be installed for the pilot plant. Increasing the steam pressure on the current lines may cause them to rupture causing an interruption in service and probably creating a safety hazard. The current electrical supply is insufficient to operate some of the existing equipment.

Making the pilot plant operational

The items needed to make the pilot plant operational, including selecting a staff for a fully operational pilot plant and determining total costs are listed in section 4, p. 24-25. Job responsibilities, duties and training are described in section 4, p. 26-27. It is suggested that work on all the items listed proceed simultaneously with the exception of the installation of the equipment which should start with one line and have it fully operational with specific projects before starting the installation of the other equipment. This requires the selection of projects and funding for them and the availability of trained technical and pilot plant personnel. It should be planned to permanently install as few pieces of equipment as possible to provide for maximum processing flexibility and efficient and safe use of the space.

Current Pilot Plant Projects

There are several pilot plant projects currently being conducted by INCAP using some equipment at other institutions. These projects would benefit immediately if the new pilot plant were in existence. A list of the projects, their source of funds and the person responsible is as follows.

Pilot Plant Current Projects

Product	Source of Funding	Responsible
Sausage from chicken	PROAVISA (Guatemalan Co.)	Luis E. Reyes
Baby foods fruit compotes	UNIPHARM (Guatemala Co.)	Luis E. Reyes
Iron and vitamin "A" fortified cookie	INCAP	Leonardo de León
Macadamia processing and roasting	OSMOSIS (Guatemalan Co.)	Luis E. Reyes
Weaning food	INCAP/World Bank	Leonardo de León
Apple dehydration	Swedish Government	Leonardo de León
Panama's Incaparina	INCAP	INCAP's team

PROPOSED ITINERARY

Day	Time	Activity
July 24	08:00 - 08:30	Meeting with Dr. Elias
	08:30 - 09:00	Review agenda
	09:00 - 10:30	INCAP's Pilot Plant Equipment Project briefing
	10:30 - 12:00	Visit existing pilot plant facilities at INCAP
	12:00 - 14:00	Lunch
	14:00 - 17:00	Processing lines definition and priorities
July 28	08:00 - 12:00	Equipment needs and sizing
	12:00 - 14:00	Lunch
	14:00 - 17:00	Space needs and distributions
July 29	08:00 - 12:00	Cost estimation of: Installation Maintenance Operation
	12:00 - 14:00	Lunch
	14:00 - 15:00	Organizational structure needs
	15:00 - 16:00	Conclusions and follow-up
	16:00 - 17:00	Final meeting with Dr. Elias

MODIFIED ITINERARY

July 24	INCAP
July 25	Universidad del Valle (AGTA)
July 27	Long (Kern a.m., INCAP p.m.)
July 28	INCAP
July 29	INCAP
July 30	INCAP
July 31	AID (a.m.) INCAP - Wrap-up and debriefing (p.m.)

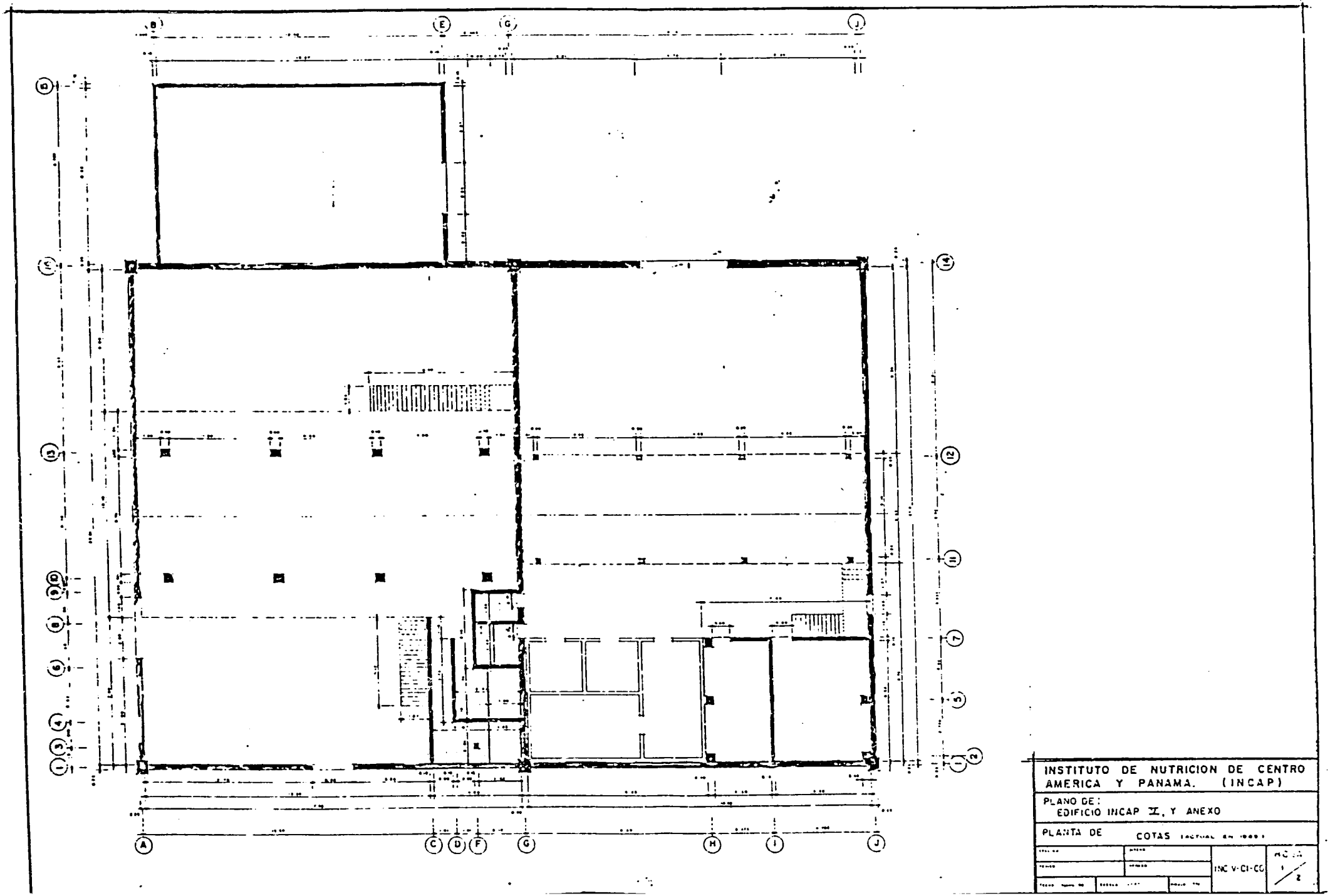
SECTION 2

PILOT PLANT BUILDING

GENERAL PRINCIPLES FOR ESTABLISHING A FOOD PILOT PLANT

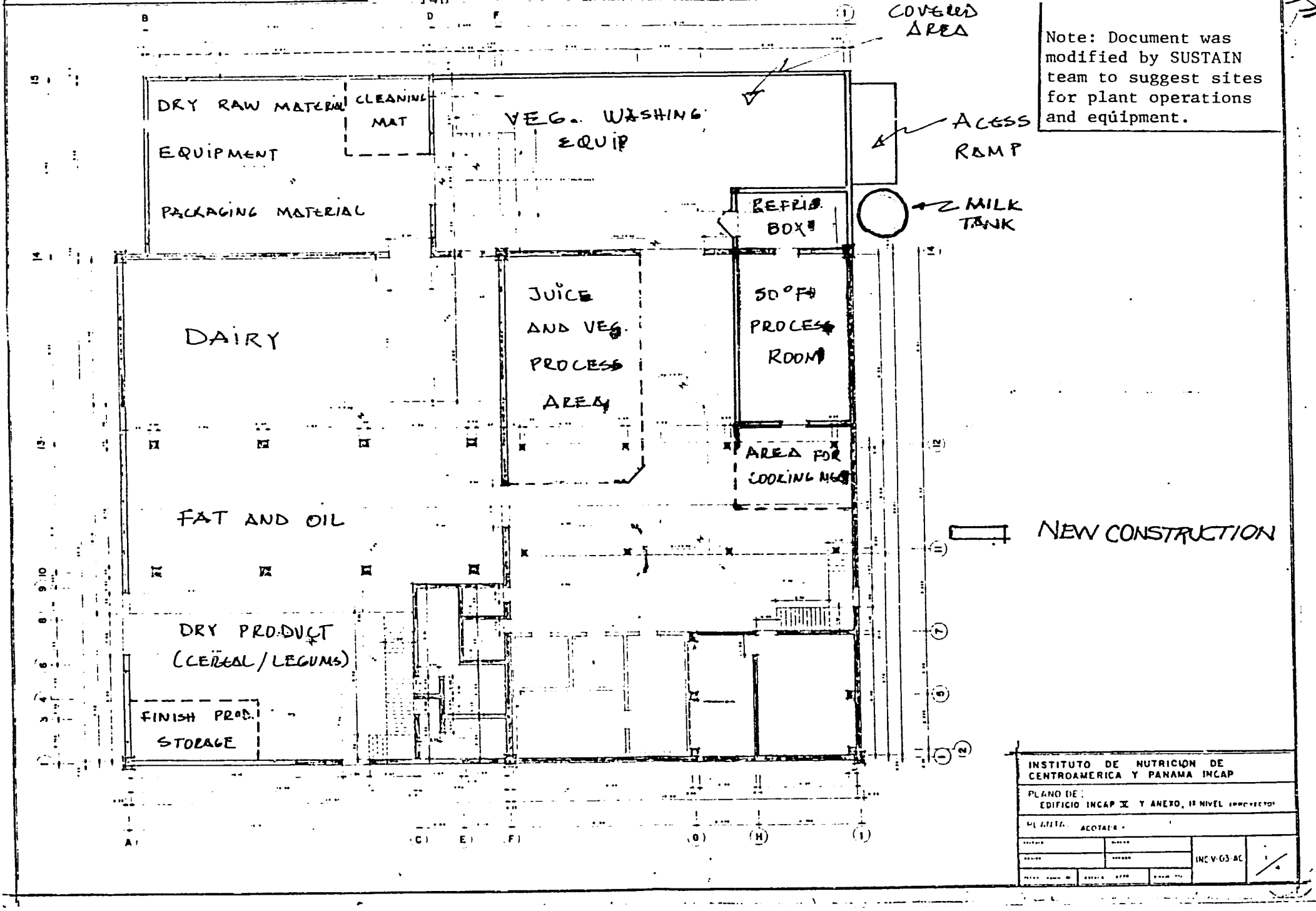
1. Keep the process simple.
2. Keep the facility and utilities flexible so that they can be used for different processing systems.
3. Equipment should be capable of multi-usage.
4. Equipment should be mobile and stored when not in use.
5. Have sufficient water, oil free compressed air, steam and electrical capabilities.
6. Have access to local sheet metal and machine shops.
7. Determine waste disposal capability.
8. Have a good sanitation program.
9. Have a maintenance schedule.
10. Have a well trained pilot plant supervisor - someone who is knowledgeable about process and equipment.
11. Maintaining building and equipment which are designed to meet government regulations in countries of interest.

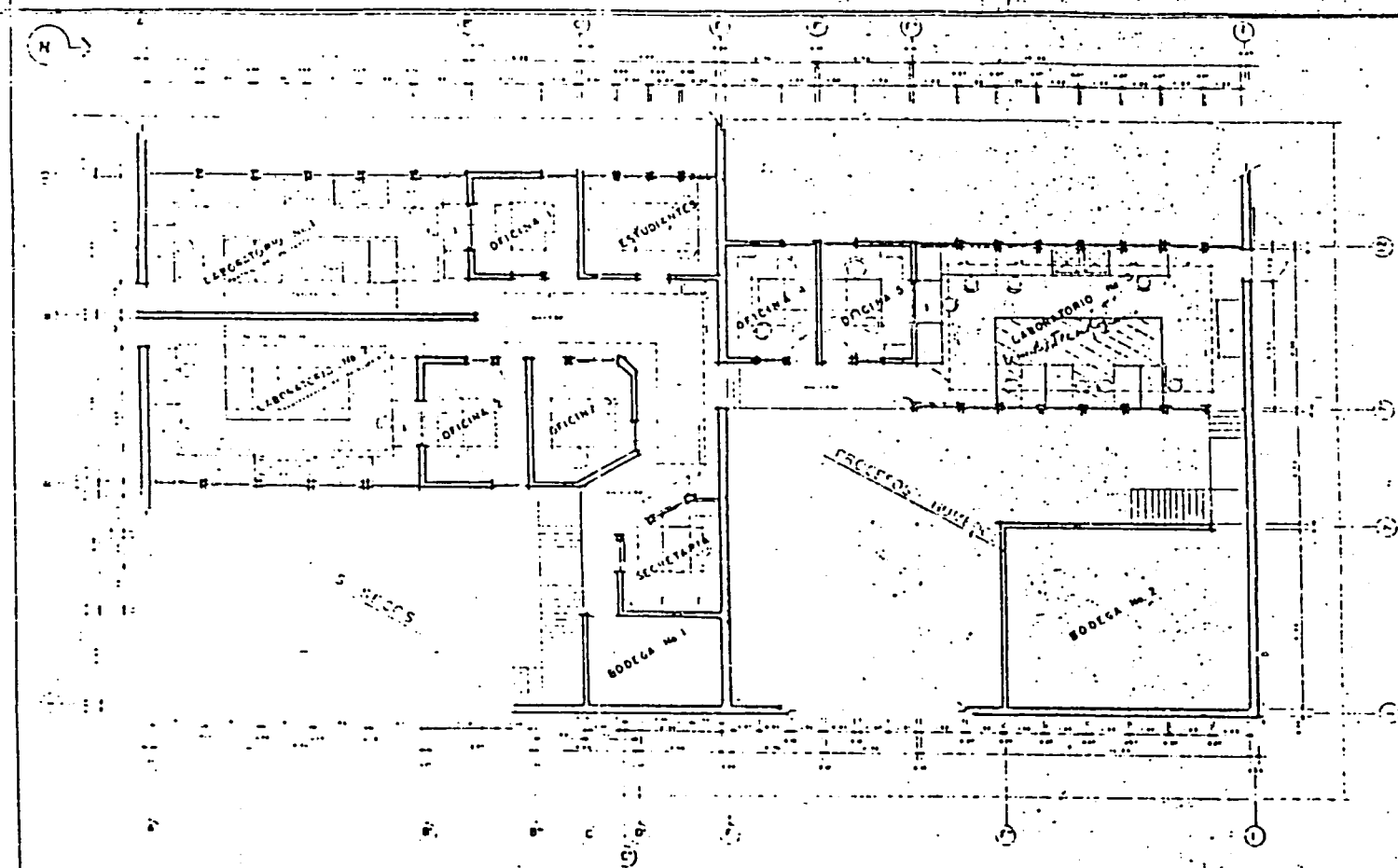
DOCUMENT SOURCE: INCAP



DOCUMENT SOURCE: INCAP

Note: Document was modified by SUSTAIN team to suggest sites for plant operations and equipment.





Escuela de Tecnologías

INSTITUTO DE NUTRICION DE CENTROAMERICA Y PANAMA INCAP

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REVISADO

SECTION 3

PILOT PLANT PROPOSED PROCESSES

GENERAL COMMENTS CONCERNING PILOT PLANT DESIGN

After reviewing equipment currently in the pilot plant and in storage, it was recommended that complete inventory list be made of the equipment present and its operational state. If operating manuals are not available, they should be obtained from he manufacturer and put in a file for reference. All equipment should be cleaned immediately after use and be kept in operational condition,

While some basic pieces of equipment are present, there is not enough to have a complete processing line for any raw commodity. Charlie illustrated a complete juice and jelly lines to demonstrate a pilot plant purchasing system.

New pieces of equipment purchased for the pilot plant should have many characteristics, including but not limited to: 1) proper size to allow a steady and continuous throughput, 2) be of sanitary construction with stainless steel food contact surfaces, 3) be of the type that industry can duplicate for commercial production, 4) be as flexible as possible to permit multiple uses. 5) be easily cleaned, assembled, and moveable and 6) be economically justifiable on a commercial scale.

It was recommended that INCAP should 1) define priorities for processing lines 2) select equipment most suited for transferring the technology, training, technical service, and research and 3) consult potential clients on these recommendations.

MULTIPLE RAW PRODUCT - JUICE LINE
BASIC EQUIPMENT

1. Scale - 4 ft. sq. base - 500 lb. capacity (Min.)

2. Washer - 18" wide x 5 ft. long x 2 ft. deep
   Elevator 7 - 0" long mesh with flights
   9" c to c c/v angle - 30°
   sprays above elv. HP - 1

3. Pulper Dixe or Langsenkamp lab. 1.5 HP with varidrive 585 to 1750 rpm drive

4. Finisher Dixe or Langsenkamp lab.
   HP - 2 Various screen sizes

5. Chopper - Fitzmill Various screens approx. 20 HP

6. Inspection Table - 18" wide by 8'-0" long 1 HP
   Rubber belt multi layer

7. Trim Table - As above

8. Brown Extractor - Screw type HP-15 Lab. size

9. Flash Pasteurization - Flow - 2 GPM
   Temp. In 60°F out 205°F hold - 30 sec.

10. Evaporator
    High Temperature short time type (taste) with essence recovery
    Evaporation Rate - 500 lbs./hr.

11. Deaerator - Feed 600 lbs. per hour - Flash 6%

12. Pumps. Product
    Positive displacement
    Wauhesha Universal Series - No.10 Speed range 50 - 150 rpm.
    Connections 1 1/2 OD Tri Clamp - 2 HP

13. Pumps - Vacuum Service Moyno - 2 stage Rectangular inlet - 1 1/2" O.D. outlet - triclamp 2 HP

14. Closer - Rooney Machine Co. RMC Model S10-A

15. Tanks - Misc. Sizes Type 304 Stainless steel construction Sanitary finish with anchor or propeller agitation as required

16. Kettle - Jacketed with scraper type agitation Jacket designed for 125 psi steam pressure

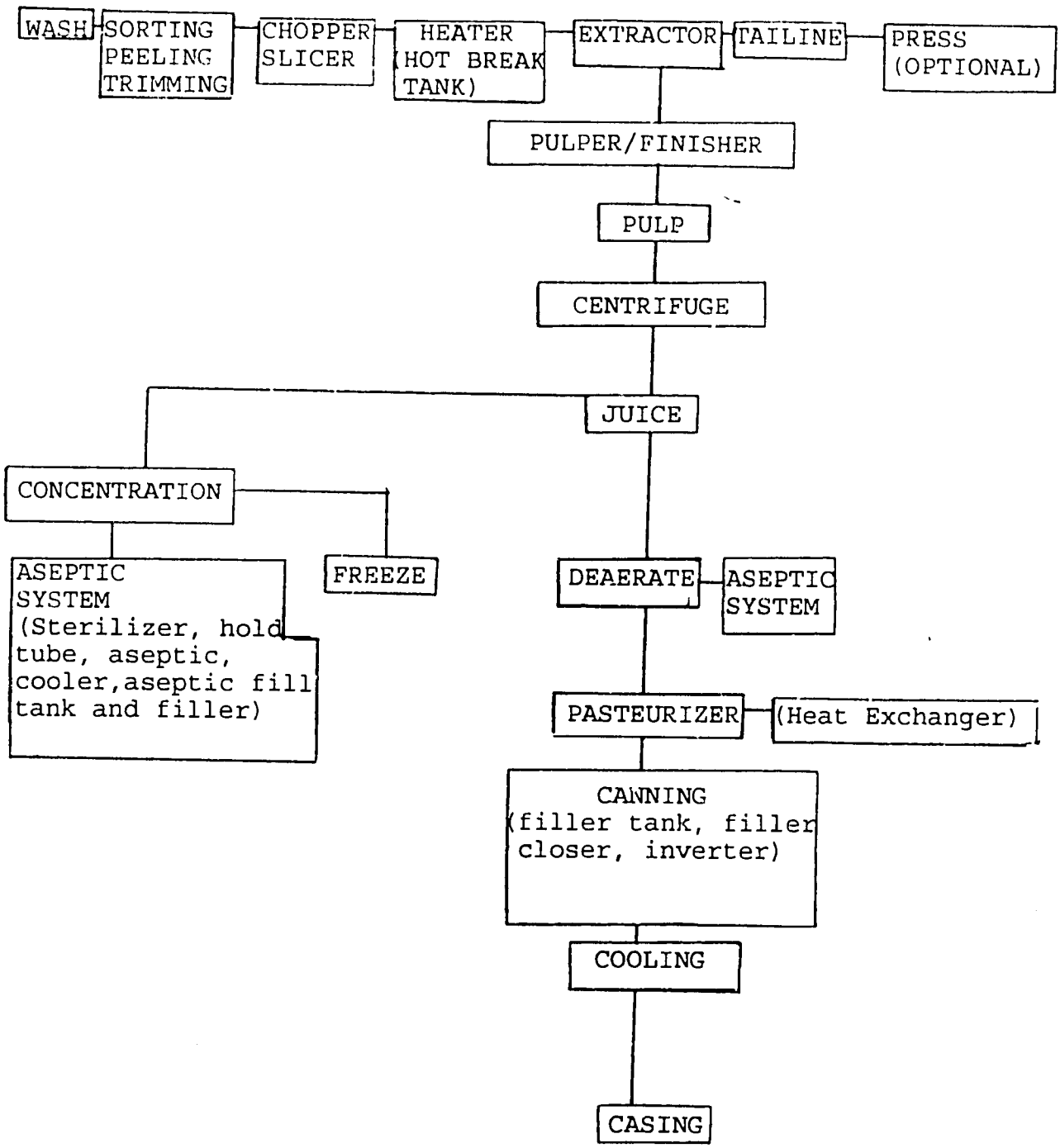
SPECIALIZED EQUIPMENT

1. Centrifuge - Centrico De Sludging type Pilot Plant size "Little Sam" - 25 HP

2. Steam Belt
   18" wide - 8 ft long s/s mesh belt, shroud with steam box s/s
   1" s/s sparger pipe Relief valve set for 5 psig 1 1/2 HP Drive

3. Hot Break Tank
   Rotary Coil - Volume approx. 15 gallons
   Coil Dia - 6"
   Service heat 3 GPM from 60° ---- 205°F
   Internal Chopper
   Steam 250 No./hr. HP - 2-1 1/2 HP motors

MULTIPLE RAW PRODUCT JUICE LINE
PROCESS FLOW DIAGRAM



JELLY/JAM/PUREE
BASIC EQUIPMENT

1. Hammer Mill - Fitzpatrick Co. Laboratory or Pilot Plant Model

2. Homogenizer - Gaulin - Laboratory or Pilot Plant Model

3. Pulper/Finisher - Laboratory type with 1 1/2 HP 585 to 1725 rpm drive

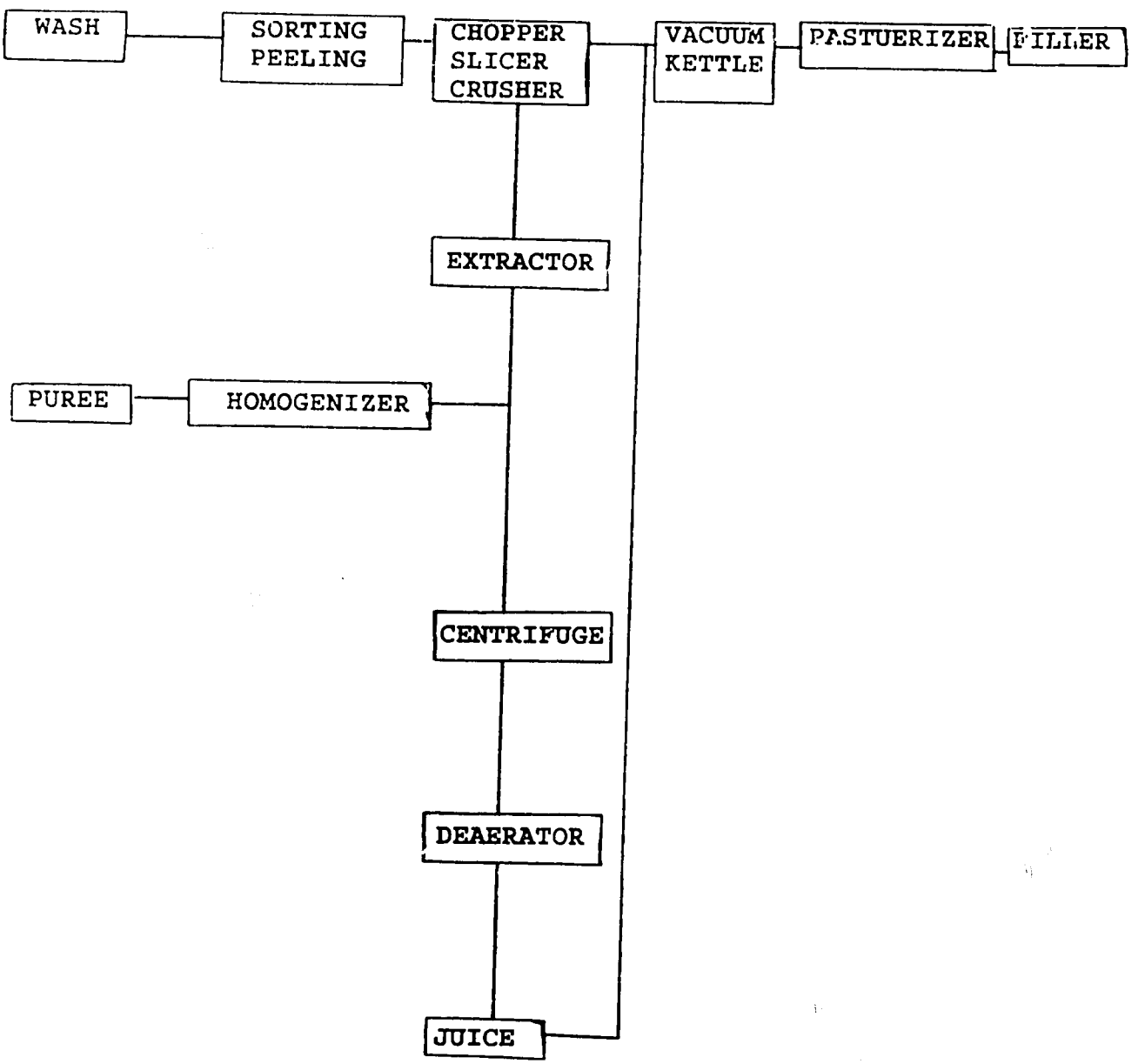
4. Extractor - Brown International - Laboratory or Pilot Plant Model

5. Centrifuge - Centrico - Desludger type centrifuge - Pilot plant model - "Little Sam"

6. Deaerator - 2 GPM 6 per cent flash feed temperature 80°F

7. Vacuum Kettle - 15 gallon design for processing under pressure of 15 psig or full vacuum floor mounted tilt mechanism and dome shaped gasketed cover. Agitator to be twin shaft scraper type mixer with variable speed drive. Kettle is fitted with a sanitary type flush drain value. Cover to be fitted with sight and light glass, pressure/vacuum gauge, rotary seals for dual agitator shafts, and thermometer extending down into the product.

MULTIPLE RAW PRODUCT
JAM/JELLY PROCESS FLOW CHART



SECTION 4

OPERATIONAL CONSIDERATIONS

ITEMS TO BE COMPLETED TO MAKE THE PILOT PLANT OPERATIONAL

(Assign responsibility for each item)

Process Equipment

- Finalize equipment selection and capacity.
- Obtain vendor prints and operation manuals of all equipment to determine equipment size and requirements.
- Design various conveyors, washers, steamers, etc.
- Locate the equipment.
- Design equipment supports and platforms as required.
- Design product piping systems.
- Prepare the "scope of the work" in order to select installation contractor. Supervise equipment installation and building modifications.
- Hydraulic drives are recommended for pump and agitator drives; design the hydraulic system and select components.
- Determine and order required spare parts for equipment.

Utilities

- Analyze the vendors prints and determine total plant requirements for: a) steam; b) water; c) compressed air (oil free); and d) electrical
- Determine size of boiler (125-150 psig) for capacity.
- Design steam distribution system, i.e. line sizes, runs, traps, insulation supports, etc.
- Design the condensate return system and select deaerator, water treatment and boiler feed system.
- Select and locate hose washdown stations.
- Investigate present water supply to determine if it is adequate. If not upgrade it for capacity and pressure.
- Design the water distribution system - Line size and runs.
- Design the ventilation and exhaust systems as required.
- Determine the adequacy of the waste water system.
- Design the electrical system so that the equipment can run plus have standby for (2) 50 hp. motors.

Building

- Specify necessary building repairs to up-grade it to a first class food processing facility.
- Design the floor drains.
- Design the lighting system.
- Design the ventilation and exhaust systems as required.
- Design the raw material receiving area.

DETERMINE THE TOTAL COST OF THE TOTAL PROJECT CONSISTING OF THE FOLLOWING AREAS

1. Equipment cost including delivery costs to Guatemala City (CIF)
   a. Process Equipment
   b. Utility Equipment (boiler, compressor, condensate set, etc.)

2. Installation costs for process and utility equipment laboratory and material
   a. Mechanical including process and utility piping, setting equipment, supports and structures, etc.
   b. Electrical including connecting motors, instrument and controls.

3. Cost of building modifications including wall sealing, painting, lighting, window replacement, locker room, toilet facilities, conference room, office, etc.

4. Engineering and architectural fees.

5. Miscellaneous
   a. Spare parts
   b. Shop tools, storage racks and bins, power tools, etc.
   c. Stock of pipe, fittings, sheet metal structural steel shapes, etc.
   d. Office equipment including phone service, desks, tables, chairs, file cabinets, computer, etc.

STAFFING FOR FINAL PILOT PLANT OPERATIONS

1. Supervisor - Overall administration.

2. Supervising operational foreman. Must know food processing Basic knowledge - Must know how to operate and maintain all of equipment. When research staff outlines product requirements, he must know what equipment should be employed and how the equipment should be set up to accomplish the objective. He must know how to improvise. He should supervise service personnel (3) for operation and clean up of equipment and area. Also direct maintenance personnel (3) for required mechanical and electrical work (3).

3. Service personnel (3). Know how to operate and understand operation of equipment. Know how to disassemble, inspect, clean and reassemble equipment.

4. Maintenance (3). Know how to disassemble, repair and reassemble equipment. Maintain and trouble shoot electrical circuits and instruments. Fit up piping as required for process changes. Build simple platforms (2), chutes, machine covers as required.

CONSIDERATIONS FOR TRAINING PILOT PLANT PERSONNEL

OPERATING SUPERVISOR AND EQUIPMENT OPERATOR

Must know:

1. Good Manufacturing Practices
2. Sanitation procedures(building and equipment)
3. Raw ingredient and finished product handling of

    a. vegetables
    b. fruits
    c. cereals and legumes
    d. meats
    e. fats and oils
    f. milk, etc.

Operating Supervisor's Duties:

1. Overall management
2. Scheduling Pilot Plant processing runs.
3. Sees that equipment is maintained, functioning and clean.
4. Keeps track of the time that equipment and labor are used.
5. Assures that all supplies necessary are available when needed.
6. Meets with customer to thoroughly understand what the customer wants.
7. Assists in the marketing effort (publicizing availability of pilot plant services to commercial food sector and other potential clients.
8. Records all necessary data (operating log).
9. Keeps up to date on hew equipment and processing systems.
10. Interacts with potential customers.
11. Develops budget.

Job Requirements for Operation Supervisor:

1. B.S. degree in Food Technology/Engineering
2. 3 - 5 years manufacturing experience in the food industry
3. Management capabilities (team work, good interpersonal skills)
4. Capable of working with little supervision (self-starter)
5. Innovative

Equipment Operator Duties:

1. Install process lines depending on material to be processed and product to be manufactured.
2. See that all equipment is cleaned and in operational condition.
3. Checks to see that all required supplies are on hand.
4. Operates equipment and records data.

Job Requirement for Equipment Operator:

1. High School education
2. 5 years experience in food manufacturing/maintenance
3. Capable of working with little supervision (self-starter)
4. Likes challenge and is willing to work on and with equipment
5. Innovative

Training opportunities:

1. University pilot plant
2. Government plot plant
3. Short courses
4. Technical libraries
5. Industry pilot plants

SECTION 5

APPENDICES

Appendix 1: Personnel Involved with INCAP Mission

Name	Position	Profession
From INCAP		
Leonardo de León	Chief, Development & Technology Transfer Program	Chemical Engineer
Luis Eduardo Reyes	Food Technologist	Chemical Engineer
Luiz G. Elías	Head, Division of Agriculture and Food Science	Food Science and Nutrition
From SUSTAIN		
Charles Long	Senior Project Manager, Campbell Soup Co.	Mechanical Engineer
Arnold Denton	Senior Vice-President, Campbell Soup Co.	Professor, Purdue University

Appendix 2: U.S. FOOD MACHINERY EQUIPMENT COMPANIES

COMPANY	EQUIPMENT
APV Crepaco, Inc.	Sterilizers, pasteurizers, evaporators, deoderization
Urshel Co.	Dicers, slicers
Fitzpatrick Co.	Hammer mills
Gulf Machinery Co.	Temperature accelerated high temperature evaporator
Waukesha Div. ABEX Corp.	Positive displacement pumps
Moyno	Positive displacement pumps - progressive cavity
Taylor	Process instruments
Triclover	Product stainless steel pipe, fittings, valves and pump
Gould	Water pumps
Cleaver Brooks	Boilers and support equipment
Centrico	Centrifugal separating equipment
Groen Div. DOVER Corp.	Process kettles
Luwa (Swiss import)	Agitated film evaporators
Langsenkamp	Laboratory pulper and finishers, hot break tanks
Rooney Machine Co.	Can closer - single stage

APPENDIX 3

GOOD MANUFACTURING PRACTICES
TITLE 21, CODE OF FEDERAL REGULATIONS, PART 110

terial or the designation of representative barriers, the Director shall advise the person making the proposal of the reasons for the Center's disapproval within 90 days of receipt of the proposal. All proposals for definition of classes and determinations of the Food and Drug Administration regarding such proposals shall be on file with the Dockets Management Branch (HFA-305), Food and Drug Administration, Rm. 4-62, 5600 Fishers Lane, Rockville, MD 20857.

(d) Any person who asserts that a barrier or class of barriers is functional shall submit the results of tests conducted to determine the functionality of the barrier or class of barriers to Contaminants Program Unit (HFF-421, or its successor), Food and Drug Administration, 200 C St. SW., Washington, DC 20204. All barriers or classes of barriers shall be tested with the four solid food receptors specified in "Test Procedures for Determination of PCB Permeability of Food Packaging, Inner-Wraps, September 1976, revised May 1983", which is incorporated by reference. The availability of this reference is given in paragraph (c) of this section. The test results as to each barrier shall be accompanied by (1) a description of the barrier's composition adequate to enable identification; and (2) a specific definition of the barrier by relevant technical characteristics. The Center for Food Safety and Applied Nutrition shall review submitted test results promptly. Within 60 days of the receipt of test results, the Director, Center for Food Safety and Applied Nutrition, shall notify the person submitting the test results whether the tests were conducted in accordance with the "Analytical Methodology for Polychlorinated Biphenyls; June 1979", which is incorporated by reference, or the "Test Procedures for Determination of PCB Permeability of Food Packaging, Inner-Wraps, September 1976, revised May 1983" and whether, therefore, the barrier or class of barriers is deemed functional within the meaning of paragraph (c) of this section. The test results and any response of the Food and Drug Administration shall be placed on file with the Dockets Management Branch, Food and Drug Administration, Rm. 4-62, 5600 Fishers Lane, Rockville, MD 20857.

[42 FR 52819, Sept. 30, 1977, as amended at 44 FR 38340, June 29, 1979; 46 FR 8459, Jan. 27, 1981; 48 FR 10811, Mar. 15, 1983; 48 FR 37021, Aug. 16, 1983; 54 FR 24892, June 12, 1989]

EDITORIAL NOTE: At 38 FR 22794, Aug. 24, 1973, the following appeared concerning § 109.30(a)(9) (formerly 122.10(a)(9)):

• • • § 109.30(a)(9) is hereby stayed pending full review of the objections and requests for hearing. • • •

In the interim, as stated in the final order (38 FR 18098) the Food and Drug Administration will enforce the temporary tolerance level established by § 109.30(a)(9) by seizing any paper food-packaging material shipped in interstate commerce after September 4, 1973 containing higher than the specified level of PCB's as adulterated in violation of sec. 402 of the act.

Subpart C—Regulatory Limits for Added Poisonous or Deleterious Substances [Reserved]

Subpart D—Naturally Occurring Poisonous or Deleterious Substances [Reserved]

PART 110—CURRENT GOOD MANUFACTURING PRACTICE IN MANUFACTURING, PACKING, OR HOLDING HUMAN FOOD

Subpart A—General Provisions

Sec.
110.3 Definitions.
110.5 Current good manufacturing practice.
110.10 Personnel.
110.19 Exclusions.

Subpart B—Buildings and Facilities

110.20 Plant and grounds.
110.35 Sanitary operations.
110.37 Sanitary facilities and controls.

Subpart C—Equipment

110.40 Equipment and utensils.

Sec.

Subpart D [Reserved]

Subpart E—Production and Process Controls

110.80 Processes and controls.
110.93 Warehousing and distribution.

Subpart F [Reserved]

Subpart G—Defect Action Levels

110.110 Natural or unavoidable defects in food for human use that present no health hazard.

AUTHORITY: Secs. 402, 701, 704 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 342, 371, 374); sec. 361 of the Public Health Service Act (42 U.S.C. 264).

SOURCE: 51 FR 24475, June 19, 1986, unless otherwise noted.

Subpart A—General Provisions

§ 110.3 Definitions.

The definitions and interpretations of terms in section 201 of the Federal Food, Drug, and Cosmetic Act (the act) are applicable to such terms when used in this part. The following definitions shall also apply:

(a) "Acid foods or acidified foods" means foods that have an equilibrium pH of 4.6 or below.

(b) "Adequate" means that which is needed to accomplish the intended purpose in keeping with good public health practice.

(c) "Batter" means a semifluid substance, usually composed of flour and other ingredients, into which principal components of food are dipped or with which they are coated, or which may be used directly to form bakery foods.

(d) "Blanching," except for tree nuts and peanuts, means a prepackaging heat treatment of foodstuffs for a sufficient time and at a sufficient temperature to partially or completely inactivate the naturally occurring enzymes and to effect other physical or biochemical changes in the food.

(e) "Critical control point" means a point in a food process where there is a high probability that improper control may cause, allow, or contribute to a hazard or to filth in the final food or decomposition of the final food.

(f) "Food" means food as defined in section 201(f) of the act and includes raw materials and ingredients.

(g) "Food-contact surfaces" are those surfaces that contact human food and those surfaces from which drainage onto the food or onto surfaces that contact the food ordinarily occurs during the normal course of operations. "Food-contact surfaces" includes utensils and food-contact surfaces of equipment.

(h) "Lot" means the food produced during a period of time indicated by a specific code.

(i) "Microorganisms" means yeasts, molds, bacteria, and viruses and includes, but is not limited to, species having public health significance. The term "undesirable microorganisms" includes those microorganisms that are of public health significance, that subject food to decomposition, that indicate that food is contaminated with filth, or that otherwise may cause food to be adulterated within the meaning of the act. Occasionally in these regulations, FDA used the adjective "microbial" instead of using an adjectival phrase containing the word microorganism.

(j) "Pest" refers to any objectionable animals or insects including, but not limited to, birds, rodents, flies, and larvae.

(k) "Plant" means the building or facility or parts thereof, used for or in connection with the manufacturing, packaging, labeling, or holding of human food.

(l) "Quality control operation" means a planned and systematic procedure for taking all actions necessary to prevent food from being adulterated within the meaning of the act.

(m) "Rework" means clean, unadulterated food that has been removed from processing for reasons other than insanitary conditions or that has been successfully reconditioned by reprocessing and that is suitable for use as food.

(n) "Safe-moisture level" is a level of moisture low enough to prevent the growth of undesirable microorganisms in the finished product under the intended conditions of manufacturing, storage, and distribution. The maximum safe moisture level for a food is based on its water activity (a_w). An a_w will be considered safe for a food if adequate data are available that dem-

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(o) "Sanitize" means to adequately treat food-contact surfaces by a process that is effective in destroying vegetative cells of microorganisms of public health significance, and in substantially reducing numbers of other undesirable microorganisms, but without adversely affecting the product or its safety for the consumer.

(p) "Shall" is used to state mandatory requirements.

(q) "Should" is used to state recommended or advisory procedures or identify recommended equipment.

(r) "Water activity" (a_w) is a measure of the free moisture in a food and is the quotient of the water vapor pressure of the substance divided by the vapor pressure of pure water at the same temperature.

§ 110.5 Current good manufacturing practice.

(a) The criteria and definitions in this part shall apply in determining whether a food is adulterated (1) within the meaning of section 402(a)(3) of the act in that the food has been manufactured under such conditions that it is unfit for food; or (2) within the meaning of section 402(a)(4) of the act in that the food has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health. The criteria and definitions in this part also apply in determining whether a food is in violation of section 361 of the Public Health Service Act (42 U.S.C. 264).

(b) Food covered by specific current good manufacturing practice regulations also is subject to the requirements of those regulations.

§ 110.10 Personnel.

The plant management shall take all reasonable measures and precautions to ensure the following:

(a) *Disease control.* Any person who, by medical examination or supervisory observation, is shown to have, or appears to have, an illness, open lesion, including boils, sores, or infected wounds, or any other abnormal source of microbial contamination by which there is a reasonable possibility of food, food-contact surfaces, or food-packaging materials becoming contaminated, shall be excluded from any operations which may be expected to result in such contamination until the condition is corrected. Personnel shall be instructed to report such health conditions to their supervisors.

(b) *Cleanliness.* All persons working in direct contact with food, food-contact surfaces, and food-packaging materials shall conform to hygienic practices while on duty to the extent necessary to protect against contamination of food. The methods for maintaining cleanliness include, but are not limited to:

(1) Wearing outer garments suitable to the operation in a manner that protects against the contamination of food, food-contact surfaces, or food-packaging materials.

(2) Maintaining adequate personal cleanliness.

(3) Washing hands thoroughly (and sanitizing if necessary to protect against contamination with undesirable microorganisms) in an adequate hand-washing facility before starting work, after each absence from the work station, and at any other time when the hands may have become soiled or contaminated.

(4) Removing all unsecured jewelry and other objects that might fall into food, equipment, or containers, and removing hand jewelry that cannot be adequately sanitized during periods in which food is manipulated by hand. If such hand jewelry cannot be removed, it may be covered by material which can be maintained in an intact, clean, and sanitary condition and which effectively protects against the contamination by these objects of the food, food-contact surfaces, or food-packaging materials.

(5) Maintaining gloves, if they are used in food handling, in an intact, clean, and sanitary condition. The gloves should be of an impermeable material.

(6) Wearing, where appropriate, in an effective manner, hair nets, headbands, caps, beard covers, or other effective hair restraints.

(7) Storing clothing or other personal belongings in areas other than where food is exposed or where equipment or utensils are washed.

(8) Confining the following to areas other than where food may be exposed or where equipment or utensils are washed: eating food, chewing gum, drinking beverages, or using tobacco.

(9) Taking any other necessary precautions to protect against contamination of food, food-contact surfaces, or food-packaging materials with microorganisms or foreign substances including, but not limited to, perspiration, hair, cosmetics, tobacco, chemicals, and medicines applied to the skin.

(c) *Education and training.* Personnel responsible for identifying sanitation failures or food contamination should have a background of education or experience, or a combination thereof, to provide a level of competency necessary for production of clean and safe food. Food handlers and supervisors should receive appropriate training in proper food handling techniques and food-protection principles and should be informed of the danger of poor personal hygiene and insanitary practices.

(d) *Supervision.* Responsibility for assuring compliance by all personnel with all requirements of this part shall be clearly assigned to competent supervisory personnel.

[51 FR 24475, June 19, 1986, as amended at 54 FR 24892, June 12, 1989]

§ 110.19 Exclusions.

(a) The following operations are not subject to this part: Establishments engaged solely in the harvesting, storage, or distribution of one or more "raw agricultural commodities," as defined in section 201(r) of the act, which are ordinarily cleaned, prepared, treated, or otherwise processed before being marketed to the consuming public.

(b) FDA, however, will issue special regulations if it is necessary to cover these excluded operations.

Subpart B—Buildings and Facilities

§ 110.20 Plant and grounds.

(a) *Grounds.* The grounds about a food plant under the control of the operator shall be kept in a condition that will protect against the contamination of food. The methods for adequate maintenance of grounds include, but are not limited to:

(1) Properly storing equipment, removing litter and waste, and cutting weeds or grass within the immediate vicinity of the plant buildings or structures that may constitute an attractant, breeding place, or harborage for pests.

(2) Maintaining roads, yards, and parking lots so that they do not constitute a source of contamination in areas where food is exposed.

(3) Adequately draining areas that may contribute contamination to food by seepage, foot-borne filth, or providing a breeding place for pests.

(4) Operating systems for waste treatment and disposal in an adequate manner so that they do not constitute a source of contamination in areas where food is exposed.

If the plant grounds are bordered by grounds not under the operator's control and not maintained in the manner described in paragraph (a)(1) through (3) of this section, care shall be exercised in the plant by inspection, extermination, or other means to exclude pests, dirt, and filth that may be a source of food contamination.

(b) *Plant construction and design.* Plant buildings and structures shall be suitable in size, construction, and design to facilitate maintenance and sanitary operations for food-manufacturing purposes. The plant and facilities shall:

(1) Provide sufficient space for such placement of equip- ment and storage of materials as is necessary for the maintenance of sanitary operations and the production of safe food.

(2) Permit the taking of proper precautions to reduce the potential for contamination of food, food-contact surfaces, or food-packaging materials with microorganisms, chemicals, filth, or other extraneous material. The potential for contamination may be re-

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duced by adequate food safety controls and operating practices or effective design, including the separation of operations in which contamination is likely to occur, by one or more of the following means: location, time, partition, air flow, enclosed systems, or other effective means.

(3) Permit the taking of proper precautions to protect food in outdoor bulk fermentation vessels by any effective means, including:

(i) Using protective coverings.

(ii) Controlling areas over and around the vessels to eliminate harborages for pests.

(iii) Checking on a regular basis for pests and pest infestation.

(iv) Skimming the fermentation vessels, as necessary.

(4) Be constructed in such a manner that floors, walls, and ceilings may be adequately cleaned and kept clean and kept in good repair; that drip or condensate from fixtures, ducts and pipes does not contaminate food, food-contact surfaces, or food-packaging materials; and that aisles or working spaces are provided between equipment and walls and are adequately unobstructed and of adequate width to permit employees to perform their duties and to protect against contaminating food or food-contact surfaces with clothing or personal contact.

(5) Provide adequate lighting in hand-washing areas, dressing and locker rooms, and toilet rooms and in all areas where food is examined, processed, or stored and where equipment or utensils are cleaned; and provide safety-type light bulbs, fixtures, skylights, or other glass suspended over exposed food in any step of preparation or otherwise protect against food contamination in case of glass breakage.

(6) Provide adequate ventilation or control equipment to minimize odors and vapors (including steam and noxious fumes) in areas where they may contaminate food; and locate and operate fans and other air-blowing equipment in a manner that minimizes the potential for contaminating food, food-packaging materials, and food-contact surfaces.

(7) Provide, where necessary, adequate screening or other protection against pests.

§ 110.35 Sanitary operations.

(a) *General maintenance.* Buildings, fixtures, and other physical facilities of the plant shall be maintained in a sanitary condition and shall be kept in repair sufficient to prevent food from becoming adulterated within the meaning of the act. Cleaning and sanitizing of utensils and equipment shall be conducted in a manner that protects against contamination of food, food-contact surfaces, or food-packaging materials.

(b) *Substances used in cleaning and sanitizing; storage of toxic materials.* (1) Cleaning compounds and sanitizing agents used in cleaning and sanitizing procedures shall be free from undesirable microorganisms and shall be safe and adequate under the conditions of use. Compliance with this requirement may be verified by any effective means including purchase of these substances under a supplier's guarantee or certification, or examination of these substances for contamination. Only the following toxic materials may be used or stored in a plant where food is processed or exposed:

(i) Those required to maintain clean and sanitary conditions;

(ii) Those necessary for use in laboratory testing procedures;

(iii) Those necessary for plant and equipment maintenance and operation; and

(iv) Those necessary for use in the plant's operations.

(2) Toxic cleaning compounds, sanitizing agents, and pesticide chemicals shall be identified, held, and stored in a manner that protects against contamination of food, food-contact surfaces, or food-packaging materials. All relevant regulations promulgated by other Federal, State, and local government agencies for the application, use, or holding of these products should be followed.

(c) *Pest control.* No pests shall be allowed in any area of a food plant. Guard or guide dogs may be allowed in some areas of a plant if the presence of the dogs is unlikely to result in con-

the temperature accurately within the compartment, and should be fitted with an automatic control for regulating temperature or with an automatic alarm system to indicate a significant temperature change in a manual operation.

(f) Instruments and controls used for measuring, regulating, or recording temperatures, pH, acidity, water activity, or other conditions that control or prevent the growth of undesirable microorganisms in food shall be accurate and adequately maintained, and adequate in number for their designated uses.

(g) Compressed air or other gases mechanically introduced into food or used to clean food-contact surfaces or equipment shall be treated in such a way that food is not contaminated with unlawful indirect food additives.

Subpart D [Reserved]

Subpart E—Production and Process Controls

§ 110.80 Processes and controls.

All operations in the receiving, inspecting, transporting, segregating, preparing, manufacturing, packaging, and storing of food shall be conducted in accordance with adequate sanitation principles. Appropriate quality control operations shall be employed to ensure that food is suitable for human consumption and that food-packaging materials are safe and suitable. Overall sanitation of the plant shall be under the supervision of one or more competent individuals assigned responsibility for this function. All reasonable precautions shall be taken to ensure that production procedures do not contribute contamination from any source. Chemical, microbial, or extraneous-material testing procedures shall be used where necessary to identify sanitation failures or possible food contamination. All food that has become contaminated to the extent that it is adulterated within the meaning of the act shall be rejected, or if permissible, treated or processed to eliminate the contamination.

(a) *Raw materials and other ingredients.* (1) Raw materials and other ingredients shall be inspected and segregated or otherwise handled as necessary to ascertain that they are clean and suitable for processing into food and shall be stored under conditions that will protect against contamination and minimize deterioration. Raw materials shall be washed or cleaned as necessary to remove soil or other contamination. Water used for washing, rinsing, or conveying food shall be safe and of adequate sanitary quality. Water may be reused for washing, rinsing, or conveying food if it does not increase the level of contamination of the food. Containers and carriers of raw materials should be inspected on receipt to ensure that their condition has not contributed to the contamination or deterioration of food.

(2) Raw materials and other ingredients shall either not contain levels of microorganisms that may produce food poisoning or other disease in humans, or they shall be pasteurized or otherwise treated during manufacturing operations so that they no longer contain levels that would cause the product to be adulterated within the meaning of the act. Compliance with this requirement may be verified by any effective means, including purchasing raw materials and other ingredients under a supplier's guarantee or certification.

(3) Raw materials and other ingredients susceptible to contamination with aflatoxin or other natural toxins shall comply with current Food and Drug Administration regulations, guidelines, and action levels for poisonous or deleterious substances before these materials or ingredients are incorporated into finished food. Compliance with this requirement may be accomplished by purchasing raw materials and other ingredients under a supplier's guarantee or certification, or may be verified by analyzing these materials and ingredients for aflatoxins and other natural toxins.

(4) Raw materials, other ingredients, and rework susceptible to contamination with pests, undesirable microorganisms, or extraneous material shall comply with applicable Food and Drug Administration regulations, guidelines, and defect action levels for natural or unavoidable defects if a manufacturer wishes to use the materials in manu-

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(5) Raw materials, other ingredients, and rework shall be held in bulk, or in containers designed and constructed so as to protect against contamination and shall be held at such temperature and relative humidity and in such a manner as to prevent the food from becoming adulterated within the meaning of the act. Material scheduled for rework shall be identified as such.

(6) Frozen raw materials and other ingredients shall be kept frozen. If thawing is required prior to use, it shall be done in a manner that prevents the raw materials and other ingredients from becoming adulterated within the meaning of the act.

(7) Liquid or dry raw materials and other ingredients received and stored in bulk form shall be held in a manner that protects against contamination.

(b) *Manufacturing operations.* (1) Equipment and utensils and finished food containers shall be maintained in an acceptable condition through appropriate cleaning and sanitizing, as necessary. Insofar as necessary, equipment shall be taken apart for thorough cleaning.

(2) All food manufacturing, including packaging and storage, shall be conducted under such conditions and controls as are necessary to minimize the potential for the growth of microorganisms, or for the contamination of food. One way to comply with this requirement is careful monitoring of physical factors such as time, temperature, humidity, a_w, pH, pressure, flow rate, and manufacturing operations such as freezing, dehydration, heat processing, acidification, and refrigeration to ensure that mechanical breakdowns, time delays, temperature fluctuations, and other factors do not contribute to the decomposition or contamination of food.

(3) Food that can support the rapid growth of undesirable microorganisms, particularly those of public health significance, shall be held in a manner that prevents the food from becoming adulterated within the meaning of the act. Compliance with this requirement may be accomplished by any effective means, including:

(i) Maintaining refrigerated foods at 45 °F (7.2 °C) or below as appropriate for the particular food involved.

(ii) Maintaining frozen foods in a frozen state.

(iii) Maintaining hot foods at 140 °F (60 °C) or above.

(iv) Heat treating acid or acidified foods to destroy mesophilic microorganisms when those foods are to be held in hermetically sealed containers at ambient temperatures.

(4) Measures such as sterilizing, irradiating, pasteurizing, freezing, refrigerating, controlling pH or controlling a_w that are taken to destroy or prevent the growth of undesirable microorganisms, particularly those of public health significance, shall be adequate under the conditions of manufacture, handling, and distribution to prevent food from being adulterated within the meaning of the act.

(5) Work-in-process shall be handled in a manner that protects against contamination.

(6) Effective measures shall be taken to protect finished food from contamination by raw materials, other ingredients, or refuse. When raw materials, other ingredients, or refuse are unprotected, they shall not be handled simultaneously in a receiving, loading, or shipping area if that handling could result in contaminated food. Food transported by conveyor shall be protected against contamination as necessary.

(7) Equipment, containers, and utensils used to convey, hold, or store raw materials, work-in-process, rework, or food shall be constructed, handled, and maintained during manufacturing or storage in a manner that protects against contamination.

(8) Effective measures shall be taken to protect against the inclusion of metal or other extraneous material in food. Compliance with this requirement may be accomplished by using sieves, traps, magnets, electronic metal detectors, or other suitable effective means.

(9) Food, raw materials, and other ingredients that are adulterated

within the meaning of the act shall be disposed of in a manner that protects against the contamination of other food. If the adulterated food is capable of being reconditioned, it shall be reconditioned using a method that has been proven to be effective or it shall be reexamined and found not to be adulterated within the meaning of the act before being incorporated into other food.

(10) Mechanical manufacturing steps such as washing, peeling, trimming, cutting, sorting and inspecting, mashing, dewatering, cooling, shredding, extruding, drying, whipping, defatting, and forming shall be performed so as to protect food against contamination. Compliance with this requirement may be accomplished by providing adequate physical protection of food from contaminants that may drip, drain, or be drawn into the food. Protection may be provided by adequate cleaning and sanitizing of all food-contact surfaces, and by using time and temperature controls at and between each manufacturing step.

(11) Heat blanching, when required in the preparation of food, should be effected by heating the food to the required temperature, holding it at this temperature for the required time, and then either rapidly cooling the food or passing it to subsequent manufacturing without delay. Thermophilic growth and contamination in blanchers should be minimized by the use of adequate operating temperatures and by periodic cleaning. Where the blanched food is washed prior to filling, water used shall be safe and of adequate sanitary quality.

(12) Batters, breading, sauces, gravies, dressings, and other similar preparations shall be treated or maintained in such a manner that they are protected against contamination. Compliance with this requirement may be accomplished by any effective means, including one or more of the following:

(i) Using ingredients free of contamination.

(ii) Employing adequate heat processes where applicable.

(iii) Using adequate time and temperature controls.

(iv) Providing adequate physical protection of components from contaminants that may drip, drain, or be drawn into them.

(v) Cooling to an adequate temperature during manufacturing.

(vi) Disposing of batters at appropriate intervals to protect against the growth of microorganisms.

(13) Filling, assembling, packaging, and other operations shall be performed in such a way that the food is protected against contamination. Compliance with this requirement may be accomplished by any effective means, including:

(i) Use of a quality control operation in which the critical control points are identified and controlled during manufacturing.

(ii) Adequate cleaning and sanitizing of all food-contact surfaces and food containers.

(iii) Using materials for food containers and food- packaging materials that are safe and suitable, as defined in § 130.3(d) of this chapter.

(iv) Providing physical protection from contamination, particularly airborne contamination.

(v) Using sanitary handling procedures.

(14) Food such as, but not limited to, dry mixes, nuts, intermediate moisture food, and dehydrated food, that relies on the control of a_w for preventing the growth of undesirable microorganisms shall be processed to and maintained at a safe moisture level. Compliance with this requirement may be accomplished by any effective means, including employment of one or more of the following practices:

(i) Monitoring the a_w of food.

(ii) Controlling the soluble solids-water ratio in finished food.

(iii) Protecting finished food from moisture pickup, by use of a moisture barrier or by other means, so that the a_w of the food does not increase to an unsafe level.

(15) Food such as, but not limited to, acid and acidified food, that relies principally on the control of pH for preventing the growth of undesirable microorganisms shall be monitored and maintained at a pH of 4.6 or below. Compliance with this requirement may be accomplished by any ef-

fective means, inc
of one or more of
tices:

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(ii) Controlling t
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as outlined in this pa

(17) Food-manufac
equipment used fo
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manufacture nonhu
animal feed or in
unless there is no re
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human food.

§ 110.93 Warehousing a

Storage and trans
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Subpart F [R

Subpart G—Defect

§ 110.110 Natural or ur
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health hazard.

(a) Some foods, ever
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hazardous to health.
Drug Administration
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produced under curre
facturing practice ar
levels in deciding whe
mend regulatory action

(b) Defect action le
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sary and feasible to do
are subject to change
opment of new techn
availability of new infor

(c) Compliance with
levels does not excuse
requirement in section 4

fective means, including employment of one or more of the following practices:

(i) Monitoring the pH of raw materials, food in process, and finished food.

(ii) Controlling the amount of acid or acidified food added to low-acid food.

(16) When ice is used in contact with food, it shall be made from water that is safe and of adequate sanitary quality, and shall be used only if it has been manufactured in accordance with current good manufacturing practice as outlined in this part.

(17) Food-manufacturing areas and equipment used for manufacturing human food should not be used to manufacture nonhuman food-grade animal feed or inedible products, unless there is no reasonable possibility for the contamination of the human food.

§ 110.93 Warehousing and distribution.

Storage and transportation of finished food shall be under conditions that will protect food against physical, chemical, and microbial contamination as well as against deterioration of the food and the container.

Subpart F [Reserved]

Subpart G—Defect Action Levels

§ 110.110 Natural or unavoidable defects in food for human use that present no health hazard.

(a) Some foods, even when produced under current good manufacturing practice, contain natural or unavoidable defects that at low levels are not hazardous to health. The Food and Drug Administration establishes maximum levels for these defects in foods produced under current good manufacturing practice and uses these levels in deciding whether to recommend regulatory action.

(b) Defect action levels are established for foods whenever it is necessary and feasible to do so. These levels are subject to change upon the development of new technology or the availability of new information.

(c) Compliance with defect action levels does not excuse violation of the requirement in section 402(a)(4) of the act that food not be prepared, packed, or held under unsanitary conditions or the requirements in this part that food manufacturers, distributors, and holders shall observe current good manufacturing practice. Evidence indicating that such a violation exists causes the food to be adulterated within the meaning of the act, even though the amounts of natural or unavoidable defects are lower than the currently established defect action levels. The manufacturer, distributor, and holder of food shall at all times utilize quality control operations that reduce natural or unavoidable defects to the lowest level currently feasible.

(d) The mixing of a food containing defects above the current defect action level with another lot of food is not permitted and renders the final food adulterated within the meaning of the act, regardless of the defect level of the final food.

(e) A compilation of the current defect action levels for natural or unavoidable defects in food for human use that present no health hazard may be obtained upon request from the Industry Programs Branch (HFF-326), Center for Food Safety and Applied Nutrition, Food and Drug Administration, 200 C St. SW., Washington, DC 20204.

PART 113—THERMALLY PROCESSED LOW-ACID FOODS PACKAGED IN HERMETICALLY SEALED CONTAINERS

Subpart A—General Provisions

Sec.
113.3 Definitions.
113.5 Current good manufacturing practice.
113.10 Personnel.

Subpart B [Reserved]

Subpart C—Equipment

113.40 Equipment and procedures.

Subpart D—Control of Components, Food Product Containers, Closures, and In-Process Material

113.60 Containers.

APPENDIX 4

MEMO FROM CHARLES LONG TO ELIZABETH TURNER
RE: VISIT TO ALIMENTOS KERN DE GUATEMALA
GUATEMALA CITY - JULY 27, 1992

July 29,1991

TO: Elizabeth Turner

FROM: Charles Long

SUBJECT: Visit to Alimentos Kern de Guatemala. Guatemala City - July 27, 1992

PURPOSE OF VISIT: Determine if the evaporator is contributing to the darkening of fruit concentrates, and, also, suggest what equipment might be of benefit to the Kern Pilot Plant.

CONCLUSIONS AND RECOMMENDATIONS:

1. Product Darkening:

Darkening is usually caused by subjecting a concentrated product to an elevated temperature for a prolonged period of time. The Kern evaporator was designed to process both tomato products and fruit juices. The processing of tomato products dictates the use of forced circulation in each effect. Forced circulation requires large volumes of liquid.

I recommended that they set up the evaporator to by-pass the first effect. This will reduce the temperature across the unit and also reduce the product volume.

I also suggested that they consider repiping the unit so that the concentrate can be removed from the third effect where the temperature is lowest. They were advised that none of these operations should be attempted until it is assured that the unit can be operated safely.

2. Recovery of flavor volatiles:

I recommended that they investigate the recover of flavor volatiles from the evaporation plant.

3. Pilot Plant:

It was recommended that they install a laboratory size hammer mill-Fitzpatrick and a small-10-15 gallon-vacuum kettle. They should also have a small can closer and retort, Volatile recovery can be investigated with lab equipment at this time,

DISCUSSION:

On Monday July, 27, 1992 Mr. Luis A. Garcia Vela, Manager of Technology and New Product Development, Alimentos Kern de Guatemala, picked me up at the hotel and took me to the Kerns Plant.

We first went on a plant tour before discussing the evaporator problem. The plant has a number of older lines but appeared to be well maintained and operated. They also have new equipment including a Tetra Pack line, and an Aseptic filling line that runs in conjunction with the evaporator.

At the time of my visit they were processing canned corn. ketchup, and pineapple concentrate.

The evaporator, a Rossi, fabricated in Parma, in 1989, Italy, was purchased to process tomato paste and fruit concentrates. The unit is a triple effect, with a double body second effect, and is set up for mixed product flow.

I believe that the design was a compromise. The processing of tomato concentrate necessitates the use of forced circulation because of the fouling characteristics of tomato paste. The forced circulation requirers large volumes of product which means increased time that the product is held at temperature.

In operation, on tomato products, all of the bodies are employed. When the unit process fruit juices one of the bodies of the second effect is by-passed. I believe that it was done in order to reduce the volume in the unit and the time it is exposed to temperature.

The best juice concentrate evaporators do not use forced recirculation but employ a single pass falling film configuration. This minimizes the exposure of the product to time and temperature. They are also equipped to recover the volatile flavors. The volatiles are added back to the concentrate to enhance the flavor of the product.

The pilot plant now contains a pulper and, I believe, a small mill. I recommended that they should obtain a small vacuum kettle in order to experiment with the concentration, of their products.

I will send Mr. Garcia information pertaining to

a. Vacuum kettles
b. TASTE type evaporator
c. Reverse osmosis equipment

I also met with Mr Carlos Enrique Godoy. Manager of Production to review my recommendations. I explained my thoughts on the evaporator and said that it was a very nice unit - a type used world wide - but that it is difficult to process all products with the same results. Some products will process better than others.

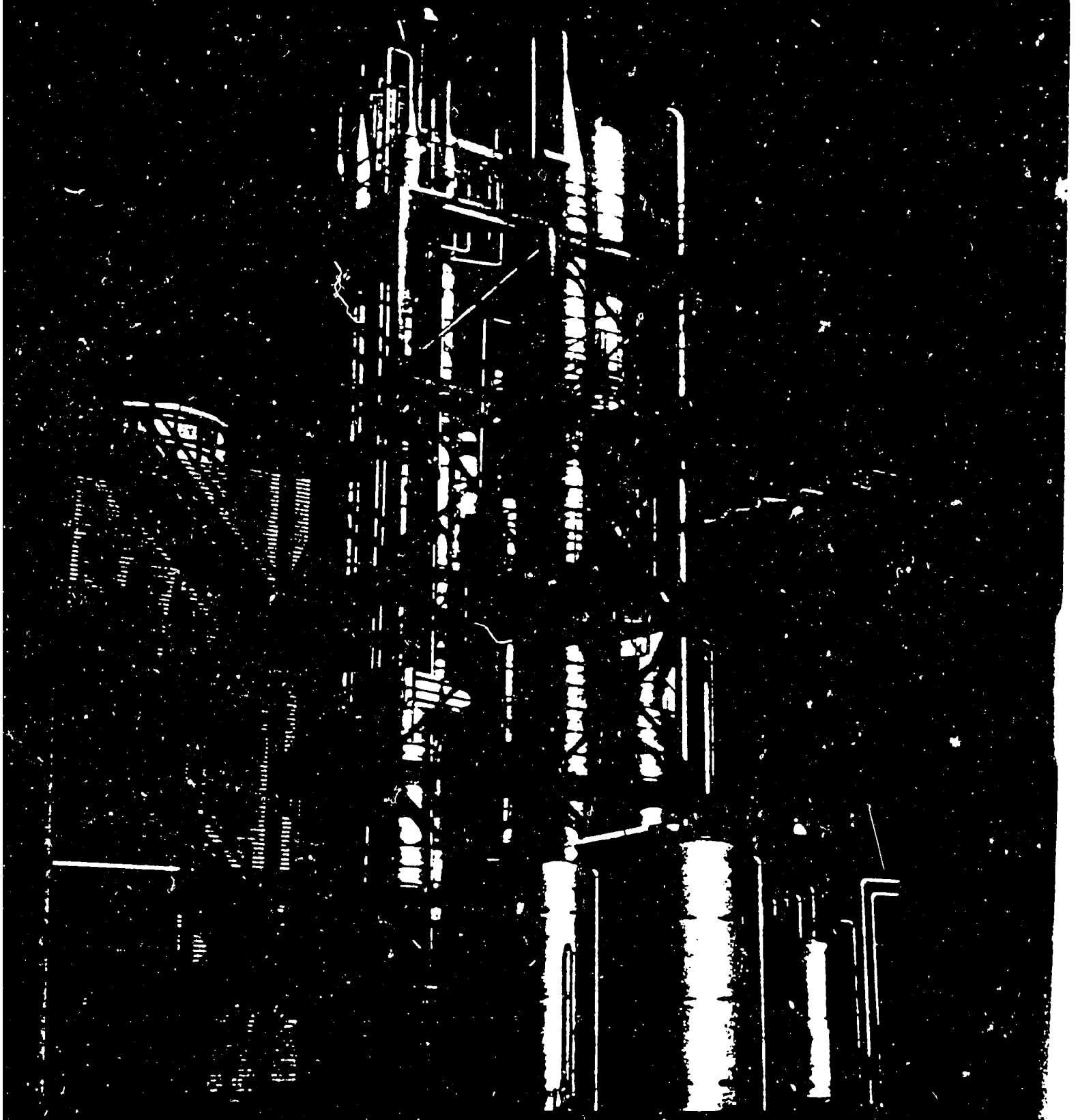
His plant was very well maintained and operated and all of the people I contacted were knowledgeable and very cooperative.

Charles W. Long

cc.: Mr. Luis A. García Vela
Mr. Carlos Enrique Godoy

GULF MACHINERY COMPANY

THERMALLY-ACCELERATED SHORT TERM EVAPORATOR (TASTE)



Food Processing Equipment

45

Gulf Machinery Company presents an evaporator that yields the highest-quality fruit or vegetable juice concentrate available anywhere. It's the Gulf Thermally Accelerated Short Term Evaporator—we call it TASTE.

The TASTE Evaporator is an efficient multiple-effect unit that is of a vertical tube design. The product (fruit or vegetable juice) enters the top of each long tube section and is accelerated by the expansion of the evolved vapor. Velocities to 400 feet per second result. This high turbulence produces good heat transfer rates, low holdup times and, in turn, excellent product quality. This high rate of heat transfer allows the most efficient use of energy. For those products containing delicate flavor elements normally lost in conventional concentration systems, a special system can be included to recover these valuable essences.

Each unit is tailored to give the best economy, taking the physical properties of the product into account as it progresses from point to point in the evaporator. Each unit is mounted in one, two, or 3 modular structures and shipped to the client's plant for immediate erection and easy installation. The control system and operating requirements for the unit are simple and easy to follow.

We have in existing juice plants units from 500 to 180,000 pounds per hour of water removal.

Advantages of the TASTE Evaporator

1) SIMPLE—Easy to put on-stream and operate.
2) SHORT RESIDENCE TIME—High rate of heat transfer.
3) EASY TO CLEAN—designed for cleaning in place.
4) GOOD ENERGY ECONOMY—Up to as many as 6 effects (5.0 pounds of water evaporated per pound of steam.)
5) MODULAR CONSTRUCTION—Easy to erect.
6) EXPERT FIELD HELP—Guide start-up.
7) Can be supplied with essence recovery unit.

Standard sizes of the TASTE Evaporator

Pounds of water per hour evaporated

Size	No. of Effects	Size	No. of Effects
500	3*	30,000	4-5-6*
3,500	3	40,000	4-5-6
5,000	3-4	50,000	4-5-6
10,000	3-4	60,000	5-6
15,000	4-5*	80,000	5-6
20,000	4-5	100,000	5-6
25,000	4-5	180,000	6

* 3 Effects 5 Stages *4 & 5 Effects 6 & 7 Stages * 6 Effects 7 & 8 Stages. These may vary with products other than fruit juices.

EFFICIENCY

No. of Effects	Lbs. of Water Evap/Lb. Steam*
3	2.7
4	3.2
5	4.0
6	5.0

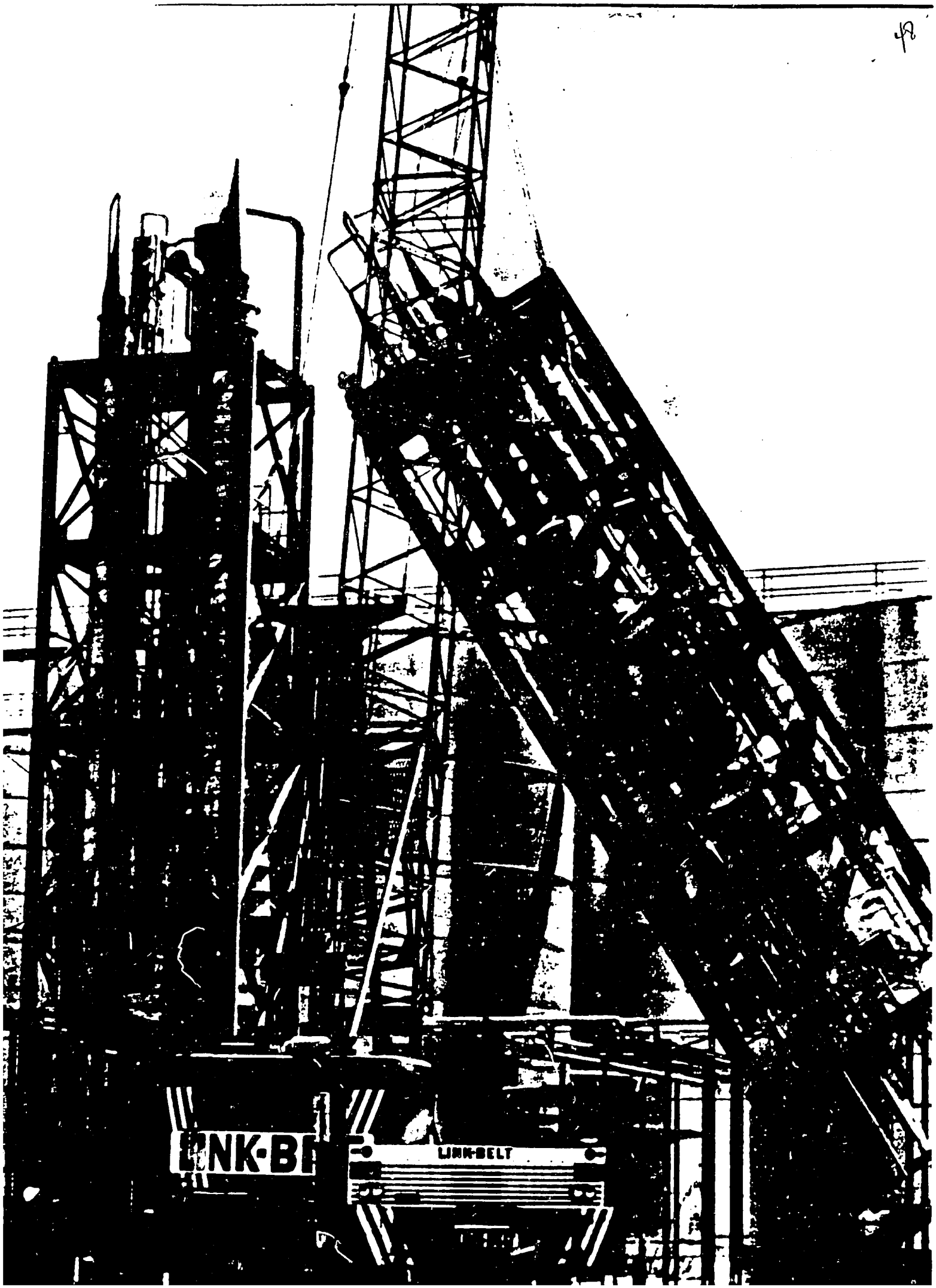
* This includes steam usage for JETS and Flash Cooler.

General Description

The 15,000 #/HR TASTE Evaporator is a 6-stage, 4-effect unit with a flash cooler and barometric type condenser, and it's single pass, so there's no backmixing. Juice enters the evaporator after passing through inter-stage preheaters where it is stabilized (pasteurized), at the top of the 1st stage. Here it passes through a nozzle and travels down through a distribution cone, where the juice is spread evenly over the tubes in the evaporator body.

Then the juice travels downward through the tubes, where it absorbs heat from the steam that enters the shell side. The juice immediately begins to boil, and the vapors that are released accelerate the downward flow of the juice through the tubes, which increases the rate of heat transfer. The juice and evaporated water vapors exit the tube nest at the bottom and enter a cyclone type separator, where the vapors are separated from the product. The juice travels downward through piping to the 1st stage pump, where it is pumped to the top of the 2nd stage.

The juice enters each stage at the top through a nozzle, where it is spread through the top distribution cone and accelerated downward through the tubes by the evaporated vapors. The vapors are separated from the juice in the cyclone separator in each stage. Approximately 25% of the total evaporation takes place in the 1st stage (which is also the 1st effect).


LINK-BELT

The 2nd and 3rd stage each evaporate approximately 25%. The 2nd stage (juice side) is in the 2nd effect (vapor side) and the 3rd stage is in the 3rd effect. The 4th, 5th, and 6th stages are in the final or 4th effect and evaporate the final 25%.

Vapors that are evaporated from the 1st stage become the heating medium for the 2nd stage and are the 2nd effect vapors. Vapors that are evaporated from the 2nd stage are the heating medium for the 3rd stage and are the 3rd effect vapors. Vapors evaporated from the 3rd stage are the heating medium for the 4th, 5th and 6th stages and are the 4th effect vapors. Water vapors evaporated from the 4th, 5th, and 6th stages are condensed in the barometric condenser.

There are four inter-effect preheaters installed in the vapor piping between the effects. Feed juice passes through the "tube side" of these preheaters, where it's heated in the first three preheaters and finally reaches stabilizing temperature in the 4th. After the 4th preheater, a holding loop allows the feed juice to remain at stabilizing temperatures long enough to effect deactivation before cooling. The juice cools by flashing it across the nozzle in the top of the 1st stage.

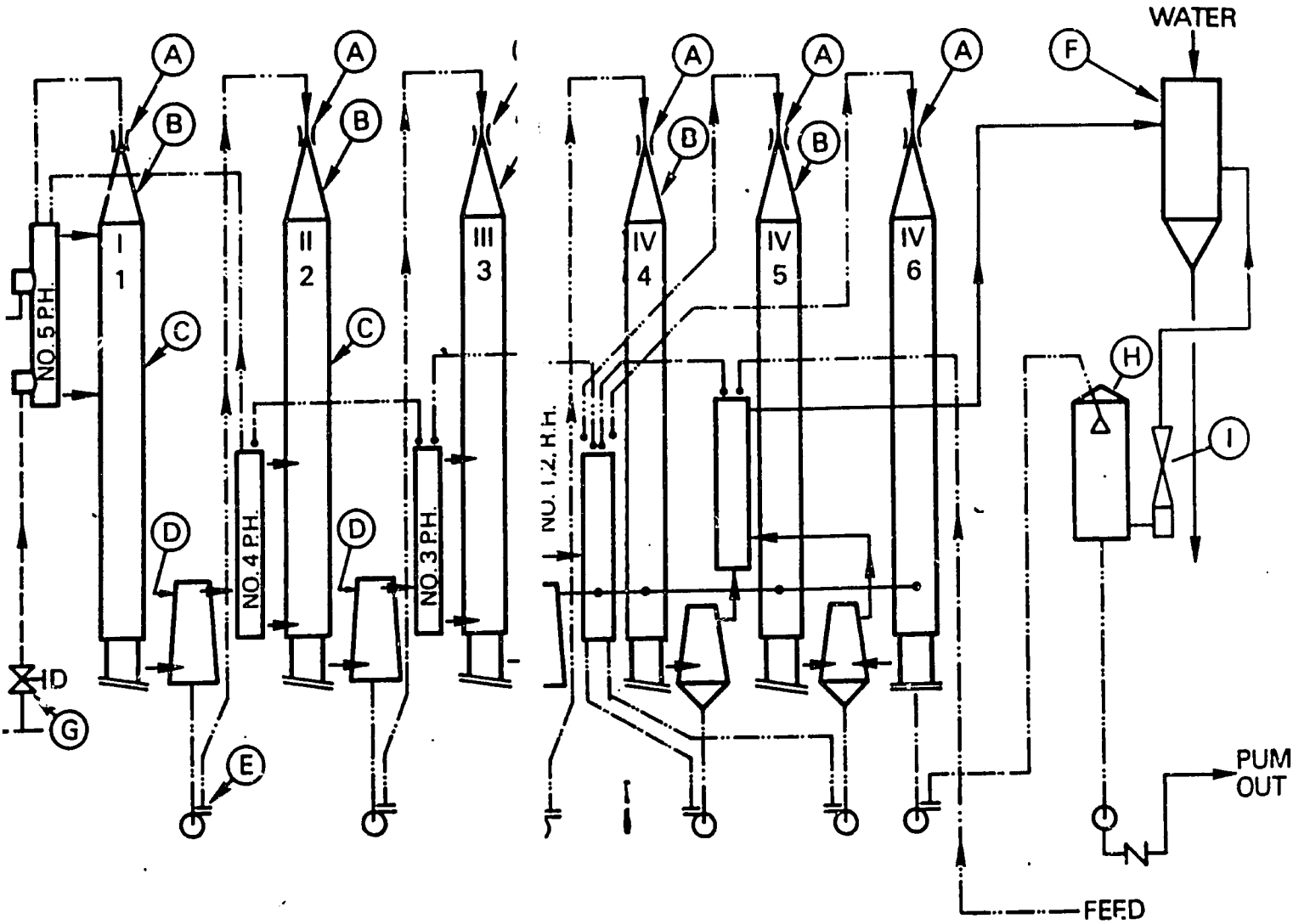
The No. 1 preheater has two additional tube circuits in its shell, called the No. 1 and No. 2 reheaters. After the juice exists the 4th stage it must be reheated to approximately 10°F above the temperature of the 5th stage "tube side" to allow flashing across the nozzle in the top of the 5th stage. This flashing of the vapors helps spread the juice over the tube surface in the top distribution cone. Reheating of the juice is repeated between the transfer from the 5th to the 6th stage.

Concentrate is pumped from the 6th stage to the flash cooler, where it enters through a nozzle and is cooled to a temperature of approximately 55°-60°F by flashing. The flash cooler is held at a very low absolute pressure by the cooling booster. This completes the process.

To learn more about how the TASTE Evaporator can help improve your operation, call or write:

GSE CORP.

4625 East Bay Drive
Suite 222
Clearwater, Florida 34624-5736
Phone: (813) 530-3550
FAX: (813) 530-3088



TOP NOZZLE
DISTRIBUTION CONE
TUBE NEST OR BODY

(D) SEPARATOR
(E) TRANSFER PUMPS
(F) BAROMETRIC COND ;ER

(G) PASTEURIZER CONTROL VALVE
(H) FLASH COOLER
(I) COOLING BOOSTER

SUBJECT ..... SHEET NO. 1 OF 1

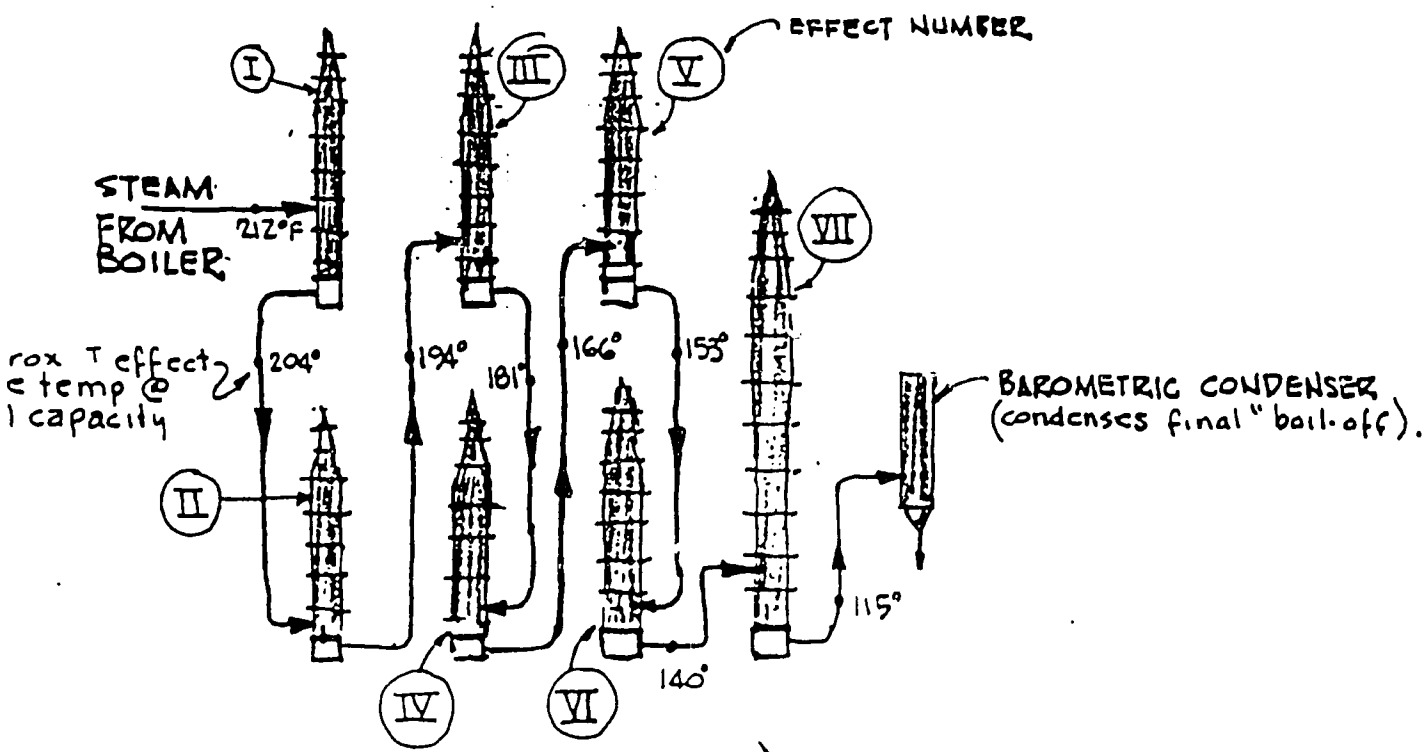
JOB NO. .....

ESSENCE SYSTEM FOR 7 EFFECT, 7 STAGE MIXED FLOW T.A.S.T.E.

To understand the essence system as shown on dwg 56-161-D a few definitions about the evaporator are necessary.

1. The "EFFECTS" of an evaporator refer to the steam (vapor/heat) flow, and the "first effect" always receives steam from a boiler. The "second effect" receives its steam (vapor) from the water "boiled-off" in the "first effect"; the third effect from the second, and so on. The effects are numbered with Roman numerals (I, II → VII) and in the direction of heat flow.

   The following diagram shows the vapor (heat) flow in the 7 EFFECT T.A.S.T.E.



VAPOR FLOWS

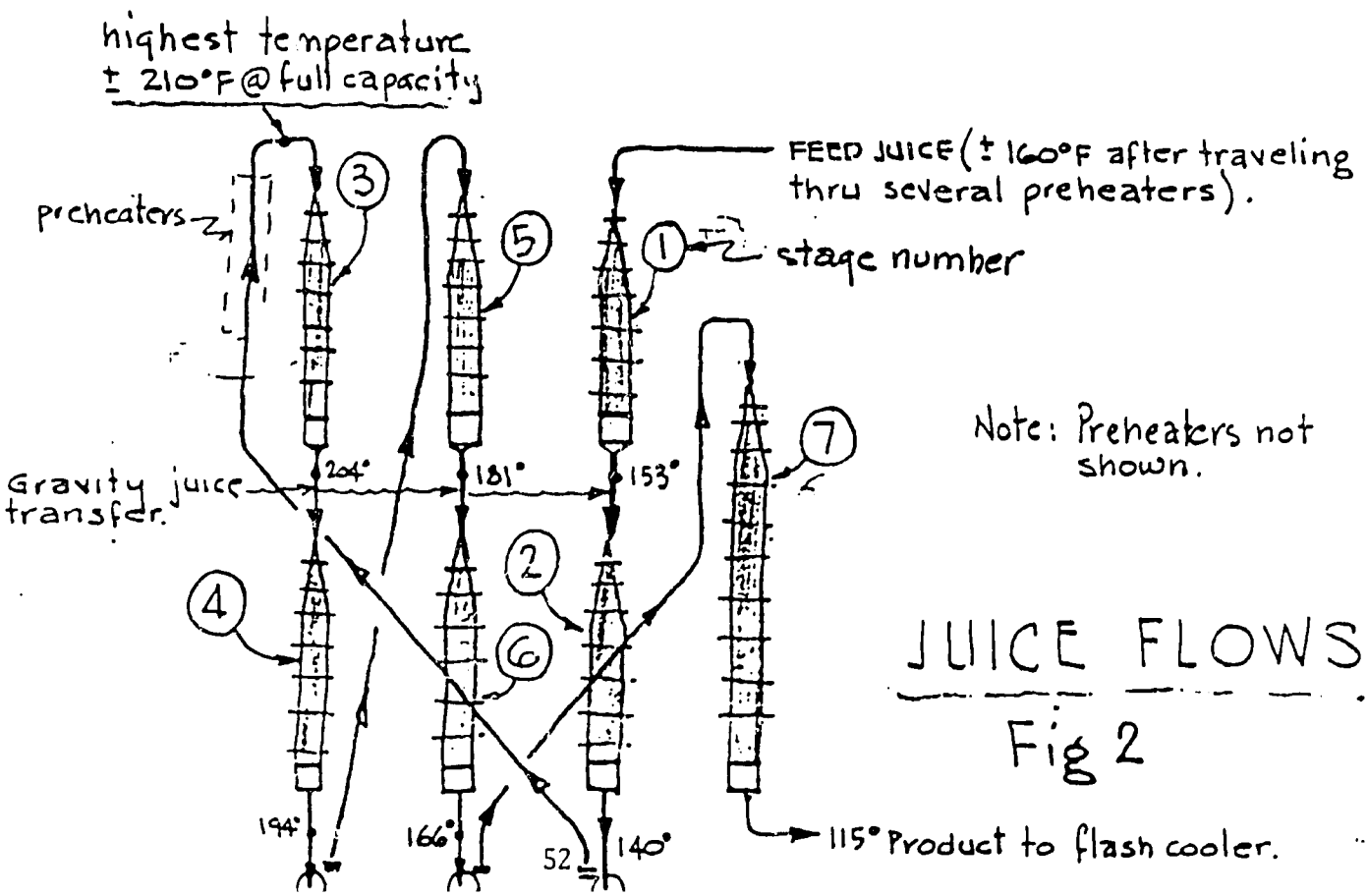
Fig 1

DESCRIPTION OF ESSENCE SYSTEM (CONTINUED)

2. The "STAGES" of an evaporator refer to the product flow, or more simply referred to as the juice flow in citrus, the term "product" saved to denote the the final pump out.

The "first stage" is in that "effect" which accepts the raw (feed) juice. In a "Forward-Flow" evaporator the "first stage" is also the "first effect, the "second stage" the "second effect, and so on down the line. "Reverse Flow" evaporators have their stages in opposite direction of the heat flow.

The 7 EFFECT-7 STAGE T.A.S.T.E. dwg 56-161-D shows a "MIXED-FLO evaporator which feeds the fifth (V) effect. The stages are numbered with Arabic numerals.



JUICE FLOWS

Fig 2

ESSENCE SYSTEM (CONTINUED)

3. The preheaters in the T.A.S.T.E. evaporator are used to heat the juice to a temperature slightly above (5° to 10°) the evaporation temperature of the effect to which it is fed. These "Inter-effect" preheaters are located in the vapor lines that transfer the steam (vapor) from one effect to another and consist of closed tube loops usually entering & exiting at the top of the vapor line.

In a "Forward Flow" T.A.S.T.E. The preheaters are numbered in series, the final preheater having steam on its shell and elevating the feed juice temperature to about 208°F with atmospheric condensing (212°F) on the first effect shell side.

The purpose of the "MIXED FLOW" T.A.S.T.E. is to feed the evaporator at a temperature somewhat lower than that in the "Forward-Flow" Thus removing the air, oxygen, essences and oils before the feed juice reaches the higher temperatures of the final preheater. Because of this and other considerations the 7 effect unit feeds the fifth effect with its "first boil-off" being condensed on the shell side of the sixth effect, and the "second boil-off condensing on the shell side of the seventh effect.

The 7 effect flow diagram shows the feed juice traveling through other heat exchangers besides the preheaters. Some of these exchangers are for heat pick-up (energy savings over using condenser water) and others are used for cooling since the raw feed juice most of the time in Florida is cooler than the water from a cooling tower.

Figure 3 shows diagramatically the feed juice flow through the preheaters & heat exchangers.

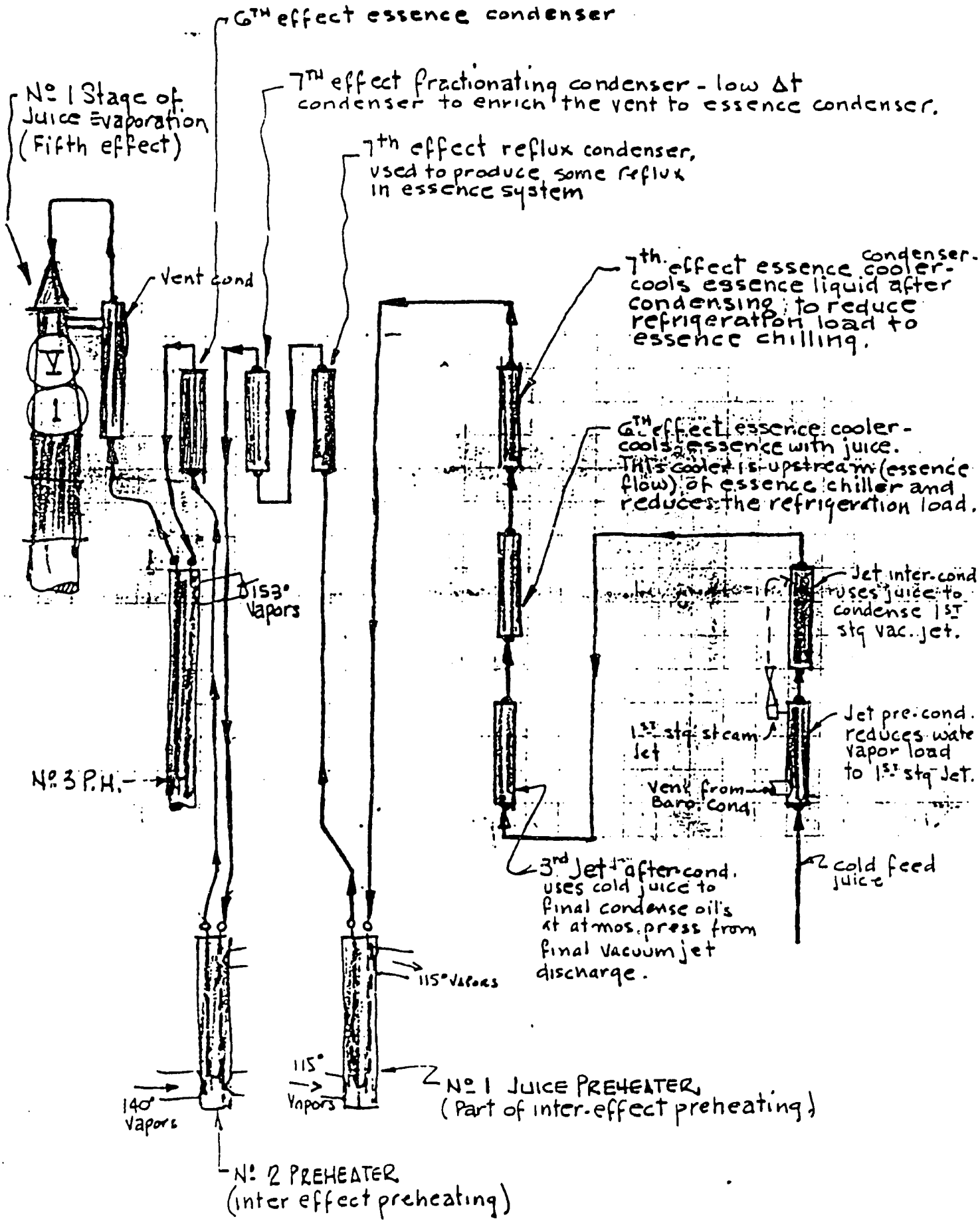


Fig 3. FEED JUICE PATH THRU EXCHANGERS.

The essence constituents in the feed juice are volitile and boil-off with the water in each stage of evaporation. Citrus essence consists of alcohols & aldehydes which are "low boilers" and oils which "steam distill".

± One seventh of the total evaporation takes in the first stage of the 7 effect T.A.S.T.E. Most of the essence is released from the juice in this first "boil-off" and travels with the water vapor to the shell side of the next EFFECT where the water vapors are condensed, giving up heat to boil the water (juice) on the tube side.

The essence bearing water vapors enter the sixth effect at the bottom. The "low boilers" are the last to condense and end-up at the top of the tube nest where they exit with sufficient water vapors to keep the condensate stripped at the bottom of the tube nest. These vent vapors then enter a fract. condenser where they are further strengthened by fractionation. The vent taken at the top of the fractionating condenser has a "minimum flow" nozzle for the strongest essence & a remotely adjusted valve to vary the flow for different strengths.

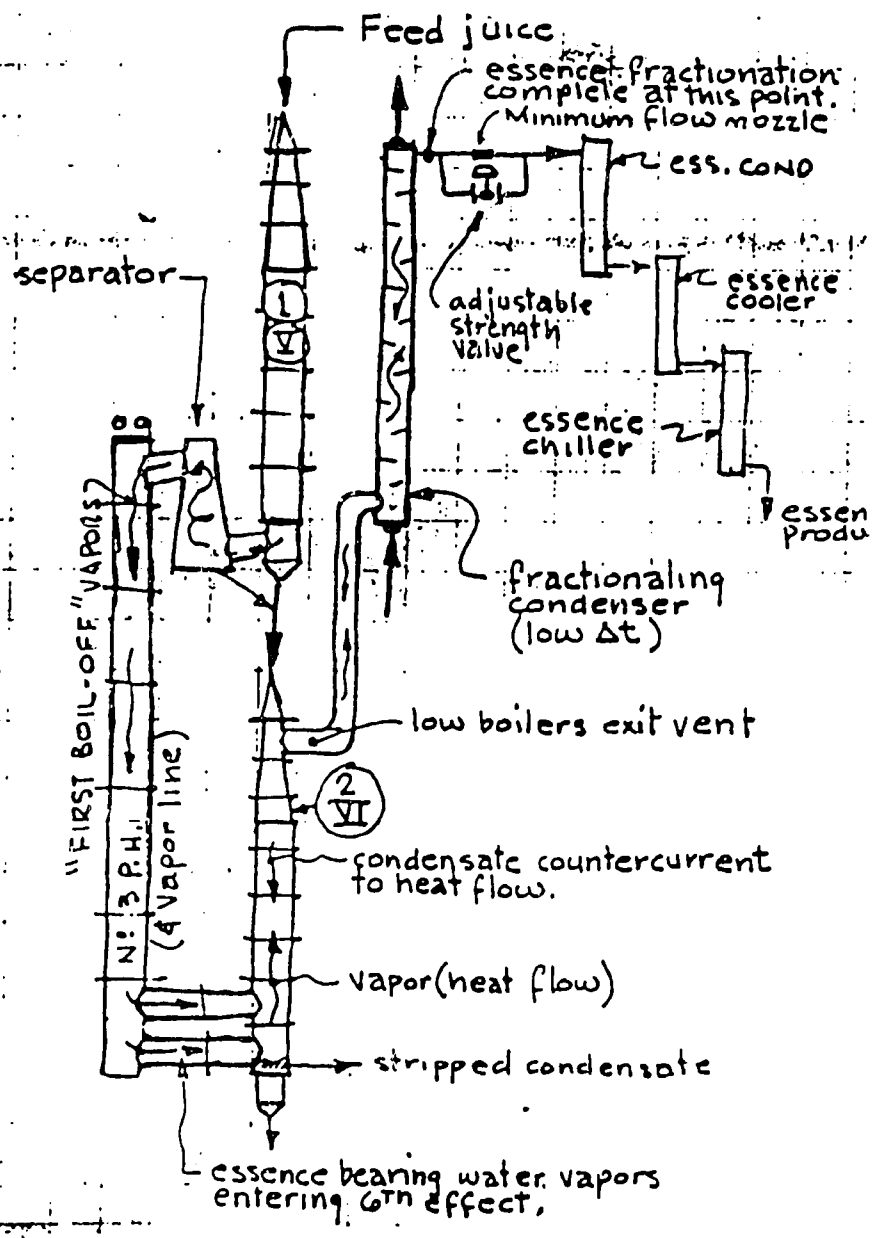


FIG 4 - Path of "1ST

from the first

The juice is fed, to the second stage by gravity, and pressure (vacuum) differential, thru a nozzle where it flashes, spreads, and enters the tubes of the sixth effect. The "boil-off" vapors in the 6TH effect are then the 2ND "boil-off" and though much weaker than the first, still contain some essence. These vapors condense on the shell side of the seventh effect (VII) an the "non-condensables" are treated similarly as those of the 6th effect.

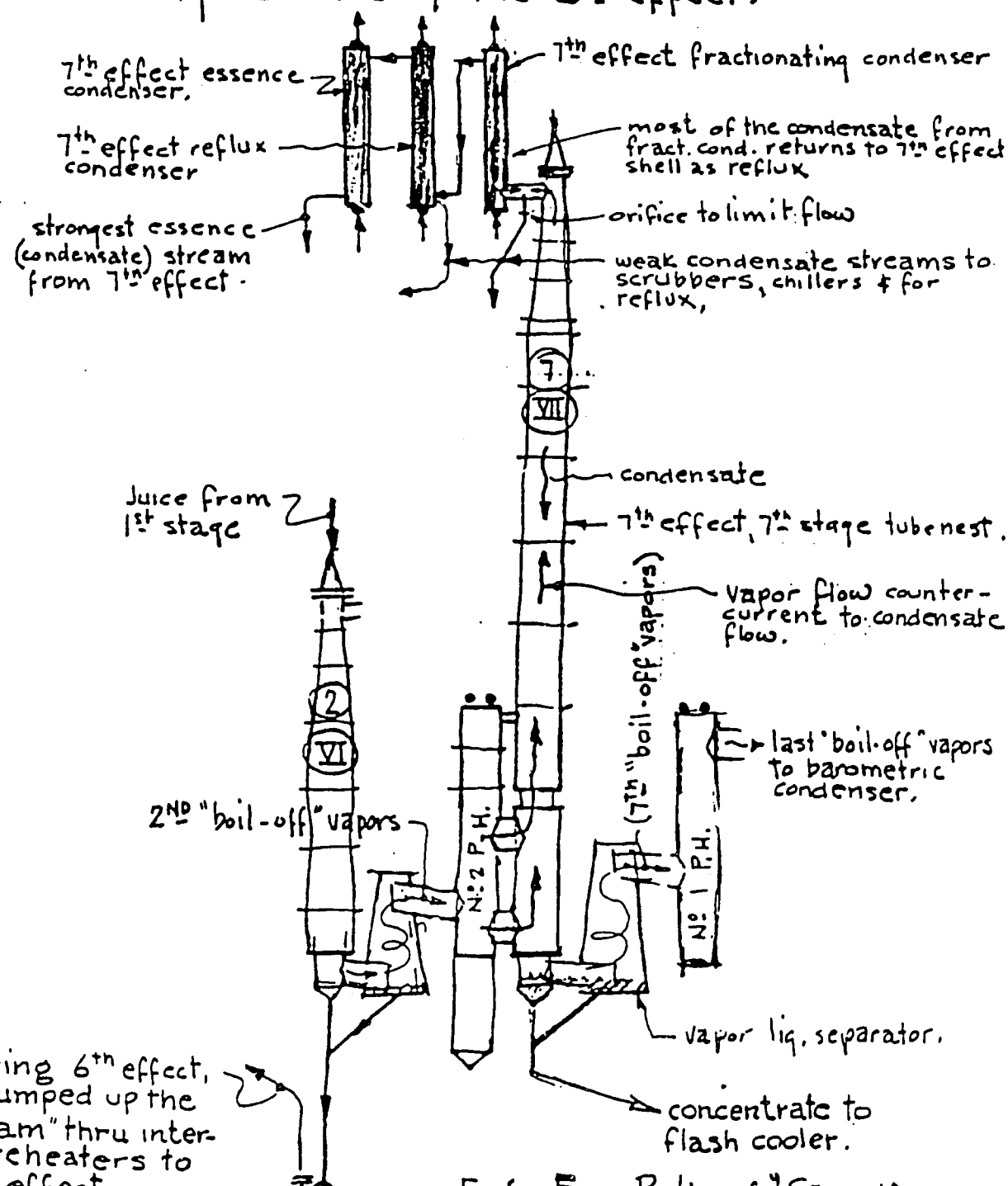


Fig 5 Path of "SECOND BOIL-OFF" vapors

Fig 6 demonstrates the essence flow from the venting point on the 6th & 7th effect evaporator tube nest shells. The quantity of "non-condensable" vent vapors exiting at this point is somewhat larger than normal for "purging" if an essence system was not included in the evaporator package. These vent vapors enter the fractionating condenser shell side and some of these vapors are condensed. The resulting condensate falls counter-current to the vent stream which exits at the top. The condensate falls back into the evaporator where continues to travel downward against the vapor flow until it all exits at the bottom of the evaporator shell after much stripping.

The heat transferred in the fractionating condenser is not lost since the vapor gives up its heat to the juice thus performing part of the preheating.

All of the heat exchangers in the essence system are shell & tube type with the essence treated on the shell side. The tube side is either juice or ammonia (refrigerant).

On the 6th effect shell side (or 1st "boil-off" side) the venting of the fractionating condenser follows the following route:

a) Thru the VI essence condenser with the condensate (product) and non-condensables flows parallel, traveling downward.

b) Thru the VI essence cooler with condensate & non-condensab' parallel. Here the condensed essence, ± 135°, is cooled by colder juice than that which was used for condensing

c) Thru the essence chiller with essence & vent in parallel, NH_3 refrigeration on the tube side.

Both the chilled essence product and vent enter the scrubber at the bottom. The liquid drops thru and down to a seal (decant) tank as final product. The vent or non-condensables

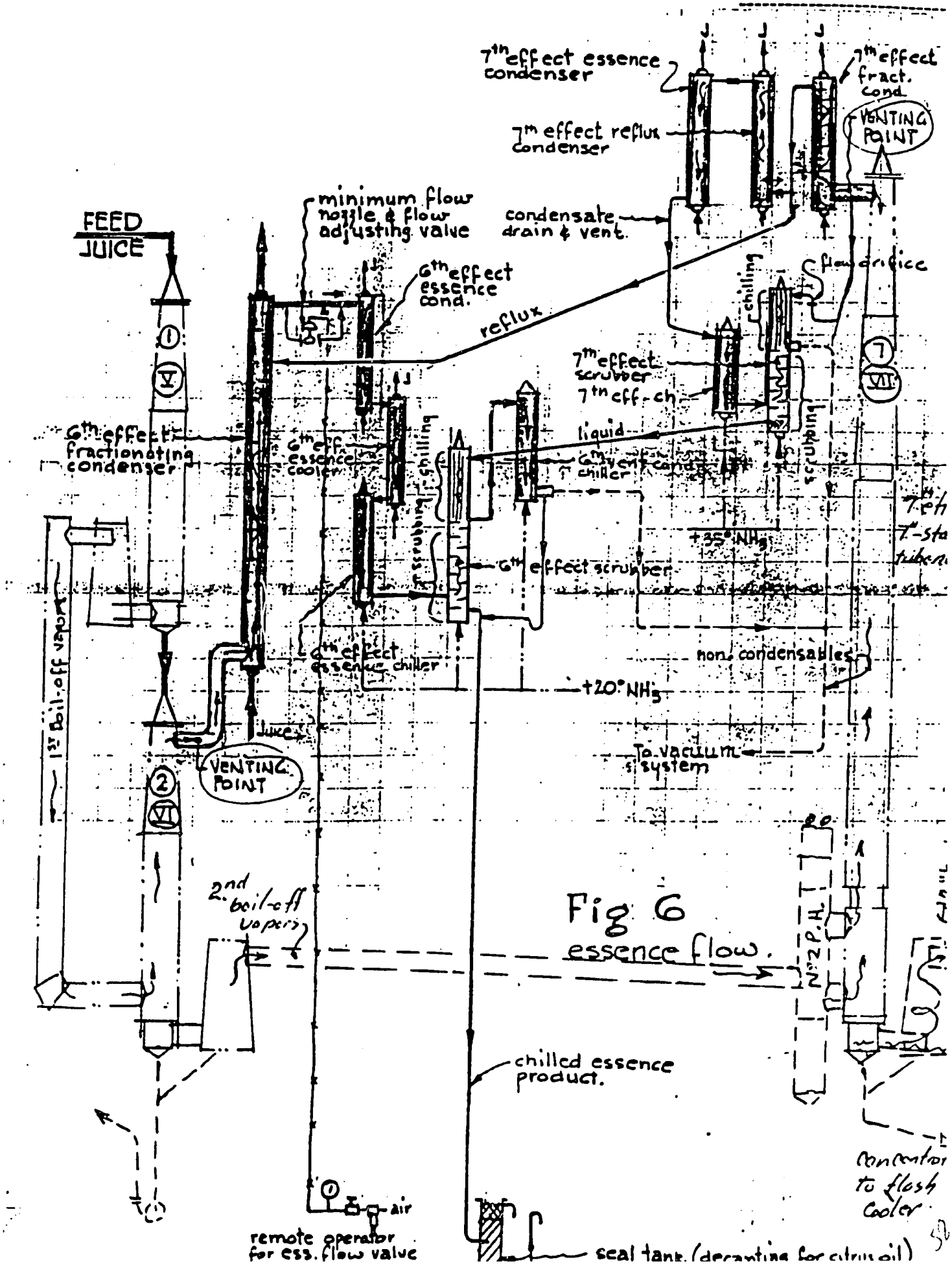


Fig 6
essence flow.

(continued)

travel upward thru a scrubber which gets its scrubbing liquid from the 7th effect shell side.

The vent vapors finally pass through the labyrinth on the shell side of the 6th effect vent cond.-chiller.

The 7th effect venting is treated similarly to that of the 6th effect. However the condensate formed in the essence heat exchangers is used for scrubbing & reflux.

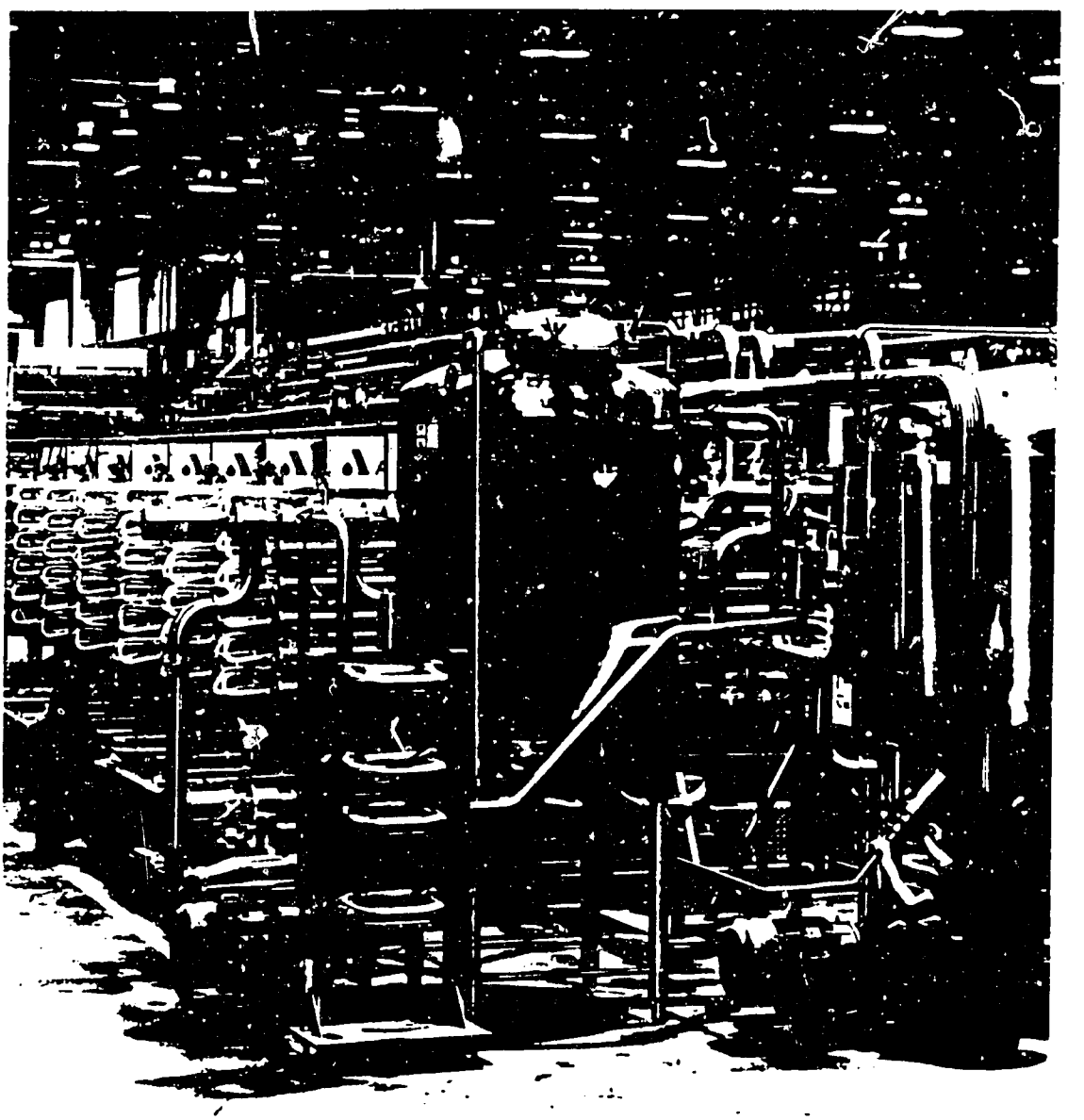
The 7th effect condensers & scrubber have sufficient elevation above the 6th effect to transfer the liquid by gravity thru flow orifices thus overcomming the pressure (vacuum) differential.

APPENDIX 5

INFORMATION ON REVERSE OSMOSIS PROCESSING EQUIPMENT FROM APV CREPACO, INC.

NOTE: Subsequent to the mission, Charles Long sent these documents to Mr. Luis A. Garcia Vela, Manager of Technology and New Product Development, Alimentos Kern de Guatemala.

APV



APV Crepaco Inc
Headquarters & International Operations

9525 W Bryn Mawr Ave
Rosemont, (Chicago) IL 60018

Tel (708)-678-4300
Fax (708)-678-4407
Telex 25-4537

APV Crepaco Membrane Systems
500 Research Drive
Wilmington MA 01887

Tel (508)-988-9200
Fax (508)-988-9111

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No one offers more separation technologies to meet your needs

4 technologies raise your productivity

APV Crepaco's experienced engineering staff can recommend which separation technology, or combination of technologies, will most economically accomplish your objectives.

APV Crepaco offers you the choice of reverse osmosis, nanofiltration, ultrafiltration, and microfiltration. That's important when determining the best membrane technology for separating or filtering components in your liquid streams.

Solve separation problems involving rain runoff, oily waste, colloidal silica, and normal plant-waste discharge at power plants.

Clarify, concentrate, or recover pharmaceutical or biotech products using membranes with different molecular-weight cutoffs.

Technology	Description	Application	Membrane Systems Available
Reverse osmosis	High pressure (up to 1000 psi).	Remove waste effluents. Reduce BOD. Process whey. Clarify beverages. Remove alcohol from beer. Purify water for semiconductor chips. Feed for boilers and cooling towers. Reduce cooling tower blowdowns. Desalinate seawater.	Spiral-wound and tubular.
Nanofiltration	Moderate pressure (up to 300 psi).	Separation of small molecular weight species like amino acids from biological streams.	Spiral-wound and tubular.
Ultrafiltration	Low pressure (up to 100 psi) separation by molecular weight.	Concentrate, separate, and purify macromolecules in chemicals, beverages, and pharmaceuticals. Remove waste effluents. Provide clean permeate for rinsing in electrocoat paint applications. Process whey protein concentrate. Pretreat seawater prior to desalination.	Spiral-wound, tubular, ceramic, hollow fiber, and plate and frame
Microfiltration	Low pressure (up to 100 psi) separation by particle size.	Remove fats. Concentrate bacteria. Clarify beverages. Recover yeast from beer-tank bottoms.	Spiral-wound ceramic, and plate and frame

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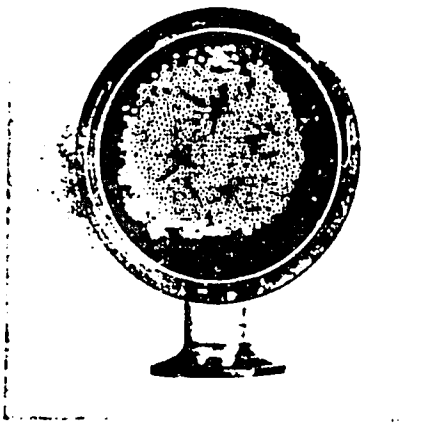
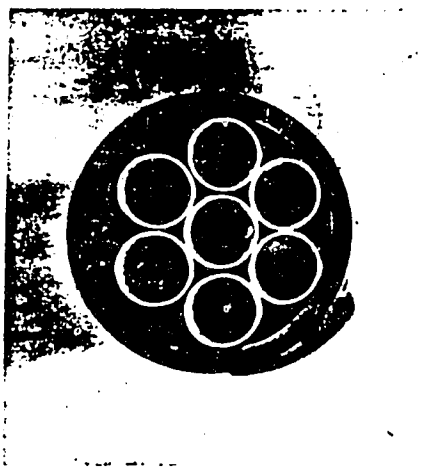
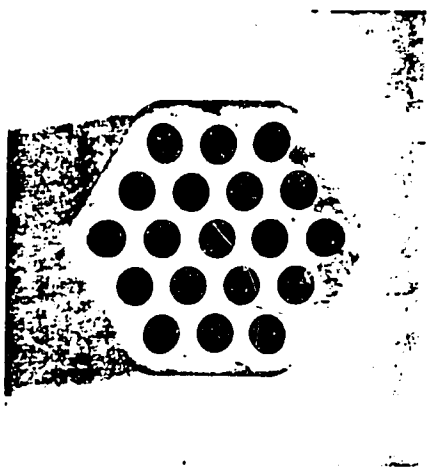
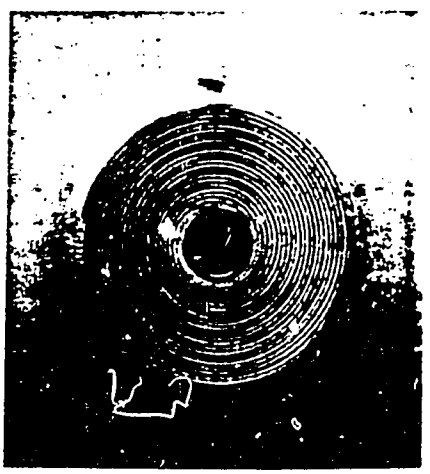
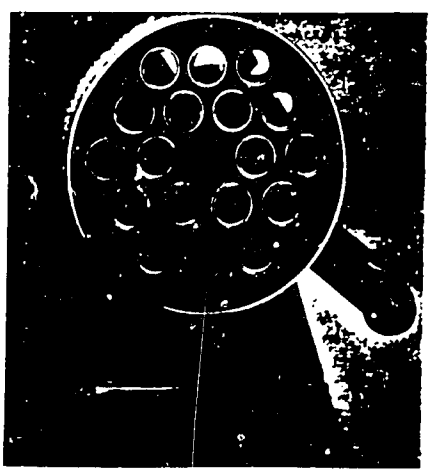
5 membrane configurations for maximum design flexibility

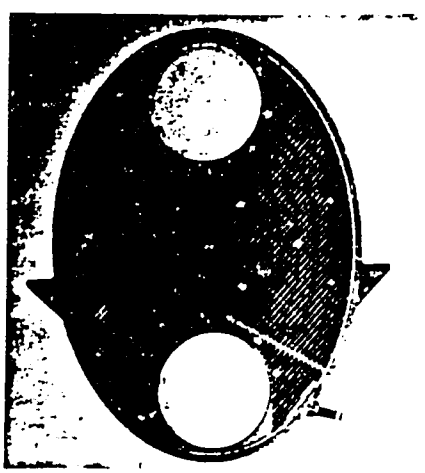












Choose spiral, tubular, ceramic, hollow fiber, and plate and frame.

APV provides membranes in spiral-wound, tubular, ceramic, hollow fiber, and plate and frame configurations with various pore sizes and membrane materials.

Each membrane type has specific characteristics that make it most effective for certain applications. APV Crepaco thoroughly evaluates your process and will design a system to meet your needs.

- *Feasibility tests.* Our engineers will analyze your streams and your process, and tell you if membrane technology can *economically perform* the separations you need.
- *Pilot tests.* If the answer is yes, we can perform all of the tests necessary to determine the optimum membrane. Tests can be at your facility or ours.
- *System design.* APV Crepaco will use the data from feasibility and pilot tests to determine the exact pressures, temperatures, pumping capacities, and cleaning methods necessary for your system to operate at peak efficiency. And, APV will supply a complete turnkey system.

APV offers several different membrane types and configurations. We recommend the one that's best for your separation requirements.

Simple operation saves money

Cut labor and chemical costs

APV membrane systems are simple and economical to use. There is little pretreatment needed, and less chemicals required than with other technologies.

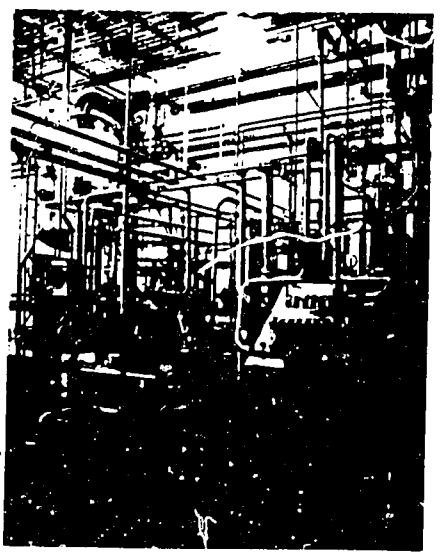
The systems can be designed to operate automatically, lowering your labor costs. We can also design the system for computer control, and interface with other computers in your plant.

How membrane separation works

The semipermeable membranes separate and concentrate suspended solids, colloids, and high molecular weight materials that are in solution.

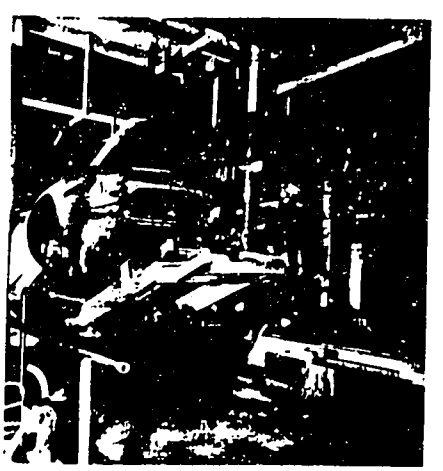
In cross-flow filtration, the feed solution flows parallel to the membrane surface, not perpendicular. As a result, there is no significant build-up on the membrane so it doesn't become plugged.

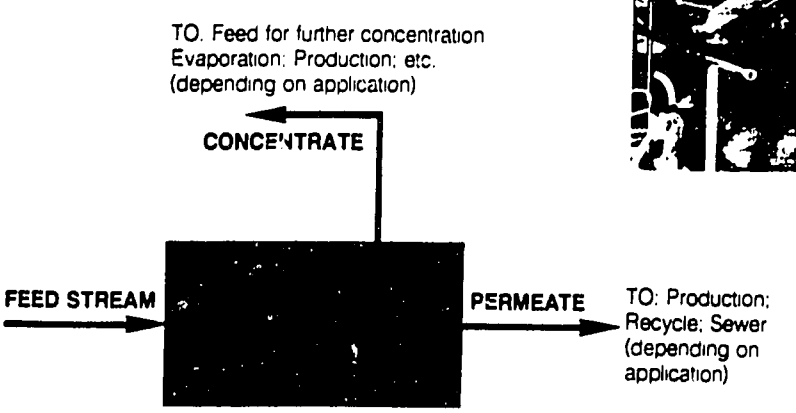
The membrane separation process results in permeate and concentrate. Each can be used as final product or discharged as waste, depending on the application.



Concentrate products, clarify fruit juices, recover whey, and increase yields in food and dairy applications.

Increase permeate from autobody and other electrocoat painting applications for more paint recovery and better rinsing.





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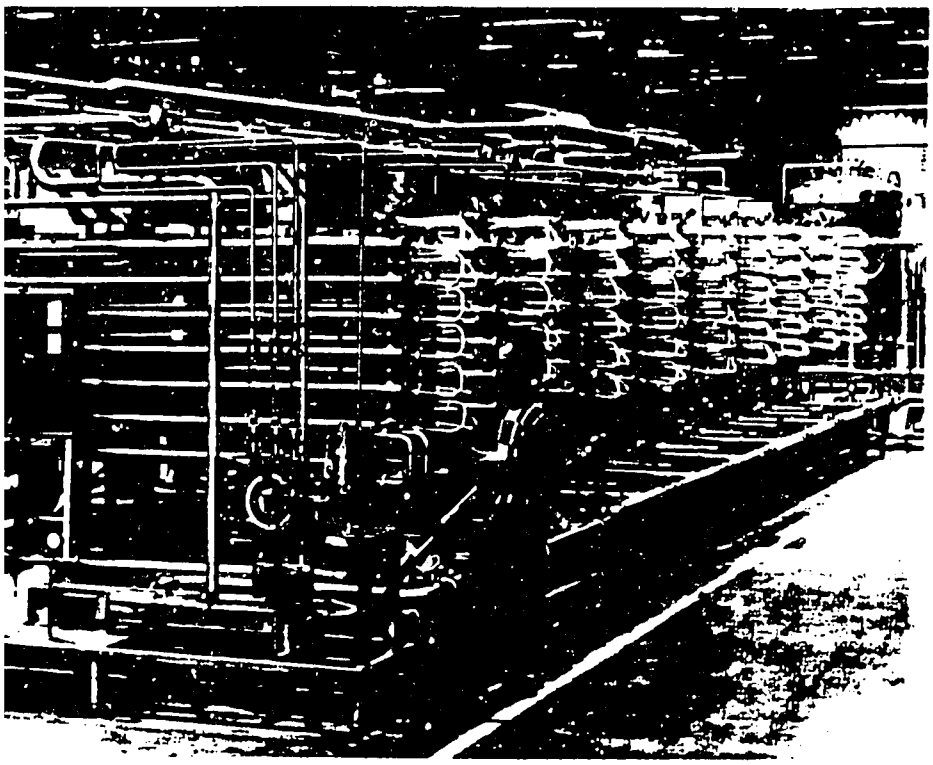
Together, we'll find the most economical solution to your liquid stream problems



Concentrate whole milk prior to cheesemaking.

APV can provide individual membranes or complete systems.

APV Crepaco will design your system, install it, and train you to operate it. In short, APV provides the in-depth technical support you need to keep your system running at peak efficiency.

APV is a worldwide company with divisions that supply equipment, systems, and technology to a variety of industries. The quality and value of our equipment is known around the globe.

We are totally committed to providing you the best separation system possible. Working as a team, we can prevent your process and waste streams from draining precious profits from your plant.

Rely on APV Crepaco to help you get the job done.

Bob Hockenbury 6/4/84
Attached are some
State of the Art
numbers for an
R.O. System
Steve

DEC

• (414) 922-1500

1984

C. W. Fong
J. Clarke
Return
HWA

Mr. Stev
Manager/
Campbell
Technol
Route 1, Box 1314
Davis, CA 95616

Dear Steve:

It was a pleasure meeting you and Kevin Scott at your office on May 1, 1984, to discuss reverse osmosis for the tomato industry. As a result of that visit, we are pleased to budget quote a 40,000 lbs/hr water removal Damrow/PCI reverse osmosis system for hot break juice.

Plant Design

The plant has been designed to concentrate 85,000 lbs/hr of tomato hot break juice at 4.5° Brix to 8.5° Brix, continuously for 21.5 hrs/day at a feed temperature of 160°F. The plant will have a membrane area of 4,620 square feet, housed in 165 of our type B1 12 foot long modules. The modules will be arranged in three recirculation stages as per PCI drawings 7858 and 7859.

Budget Quotation

The budget price as specified above, will be approximately $639,000, installed in your plant and commissioned. The price includes high pressure piston pump, three recirculation stages with PCI membrane modules fitted with our latest ZF99 membranes and stainless steel permeate shrouds, recirculation pumps, electrical starters, pipework with automatically controlled pressure control valve and cleaning is to be controlled automatically by microprocessor.

Below is an economic breakdown of the plant:

Reverse osmosis system to remove 40,000 lbs/hr.

1)	Electricity - 180 kW x 24 hrs/day x 85 days/season x $.07/kW =	$ 25,704
2)	Membrane Replacement - 165 sets at $450 per set, divided by 2 (2-season life) =	$ 37,000
3)	Cleaning Chemical Costs (Damrow) Estimate =	$ 1,500
	RO Total Operating Costs =	$ 64,204 per season

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Evaporator at 1.8 lbs of water/lb of steam (assume ($8.20 per 100 lbs based on 10% inflation rate for next season).

1)	Steam Costs - 40,000 lbs H20 divided by 1.8 = 22,000 lbs/hr steam. 22,000 lbs/hr steam x 21.5 hrs x 120 days x $8.20/1000 =	$ 329,681
2)	Electricity - 75 kW x 21.5 hrs/day x $.07/kW x 85 days =	$ 9,594
	TOTAL Cost of Evaporator/season =	$ 339,275

The overall operating cost savings is $339,275 - $64,204 = $ 275,071 per season.

The budget price of the RO system described above and specified in PCI drawing numbers 7858 and 7859 enclosed, is $565,000, minus the membranes. Membranes are treated as part of the daily operating costs. Initial membranes are $74,000 for a total cost of the system of $ 639,000.

Therefore, the payback for the system is $ 565,000 capital costs divided by $275,071 savings in operating costs equals 2.05 seasons.

After you have had a chance to review this, we will contact you for follow up discussions. We plan to attend the IFT Show in Anaheim during the week of June 10, 1984. If it is possible, we would like to set up a meeting during that week.

Thank you for your interest in Damrow/PCI membrane equipment. We look forward to working with you on this project.

Sincerely yours,

DAMROW COMPANY

Greg Haugen
Sales Engineer
Membrane Systems

kmh
enc.

cc: Warren Helmer/Campbell Soup Company
Camden, NJ

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INTER-DEPT. CORRESPONDENCE
CAMPBELL INSTITUTE FOR RESEARCH AND TECHNOLOGY

TO: Dr. J. R. Kirk DATE: October 8, 1984

FROM: W. M. Hildebolt

SUBJECT: PATTERSON CANDY INTERNATIONAL REVERSE OSMOSIS SEMINAR AND PLANT TOUR - MILAN, ITALY - SEPTEMBER 9, 10, & 11, 1984

1. A Reverse Osmosis Tomato Pulp Concentrating Seminar and two plant tours conducted by Patterson Candy International Ltd. (P.C.I.), of Hampshire, England, was attended by the writer. P.C.I. has installed two reverse osmosis installations with the capacity to concentrate tomato pulp at a rate of 3,000 liters per hour from 4.5% to 8.5% solids in two Italian tomato processing plants.

2. Copar, a large cooperative owned facility, was observed concentrating Passato di Pomodoro. This specialty sauce product was being bottled directly from the R.O. unit after pre-sterilization. At the ARP Plant, also a large cooperative, tomato pulp was pre-concentrated to 8.5% solids prior to being further concentrated in a Rossi & Catelli evaporator. Justification for the Copar installation was the superior color and flavor realized by non-thermal water removal in the manufacture of Passato di Pomodoro plus lower energy consumption. For the ARP Plant the sole reason given was one of economics due to less capital outlay for an equivalent evaporator capacity and lower energy costs.

CONCLUSIONS:

1. P.C.I.'s reverse osmosis system appears to be a well designed and thought out method for the non-thermal two-fold concentration of tomato juice or pulp. The utilization of reverse osmosis for the concentration of tomato, V-7, orange juice, apple juice and meat stock should be explored by Campbell Soup Company.

2. The quality of the 8.0% solids concentrated product was good and the pulpy textural characateristics of the Passato sauce were maintained enough though the pressure within the membrane tubes was quite high.

3. It should be noted that at the present time the P.C.I. membranes have not been approved by the F.D.A. This has blocked the installation of any of these units in the U.S. for food processing.

4. The reported energy cost savings in concentrating tomato pulp from 4.5% to 8.5%, which represents 55% of the total water removed in going to 32% solids, is 10:1 less for reverse osmosis versus evaporation. Based on a 5 cent kilowatt hour rate, a savings of $2,400 would be realized for each 20 ton line per hour. Detailed calculations are presented in the attached table. Also included for reference is a processing flowchart.

5. An additional positive aspect of reverse osmosis concentration is that no water is consumed in the process versus the large water requirements for thermal evaporation used in steam generation and condensing. In fact, for every 20 tons of tomatoes processed 9 tons of water at 60°C are generated. This could be an important consideration for dry areas such as California, Mexico and Australia.

CAMPBELL SOUP APPLICATIONS:

I. Tomatoes

A. Two-fold pre-concentration of tomato pulp to provide a constant solids feed stock for further thermal evaporation. Major evaporation efficiency improvements and energy cost savings should be realized. A further advantage of pre-concentration is that approximately half of the volume of tomato pulp must be passed through the D-31 unit for the collection of XXX. Reduced refluxing should be realized.

B. Concentration of XXX essence.

C. Non-thermal concentrate of sauce products such as Passsato di Pomodoro and Spaghetti Sauce.

D. Locations: Italy, Mexico, Australia, Napoleon, Chatham, Sacramento, Dixon, Valley.

II. Apples

A. Two-fold concentration (10% - 20%) of juice for storage and bulk shipment.

B. Concentration of acetic acid for storage and bulk shipment.

C. Locations: Canada, Luycks, Vlasic.

III. V-7

A. Concentration of Juice.

B. Concentration of essence.

C. Locations: Napoleon, Sacramento, Chatham, Mexico.

IV. Citrus

A. Two-fold concentration of orange and grapefruit juice for evaporation feed stock.

B. Concentration of essence.

Dr. J. A. [illegible]

P.C.I. REVERSE OSMOSIS SEMINAR AND PLANT TOUR - MILAN, ITALY - SEPTEMBER 9, 10, & 11, 1984

IV. Citrus (Continued)

C. Concentration of pulp wash.

D. Locations: Juice Bowl

V. Meat Stock

A. Concentration of beef, bone and chicken stocks.

B. Locaitons: U.S., Canada, Argentina.

VI. Pickle Brine Disposal

A. Remove excess water prior to disposal of brine solutions.

B. Locations: Vlasic and Luycks.

WMH

Vice President - International Research & Development

WMH:mat

Attachment

cc: Mr. A. A. Austin
Dr. A. E. Denton (w/att.)
Dr. D. R. Heldman
Mr. E. B. Hicks
Mr. R. W. Hockenbury (w/att.)
Mr. A. Rolli (w/att.)
Mr. C. Sanchez
Mr. F. Scaramuzza
Mr. W. A. Schmidt
Mr. E. Sorozan
Dr. M. A. Stevens
Mr. R. Subin
Mr. C. Thys
Dr. V. Vatinno
Mr. W. L. VonLersner
Mr. A. M. Williams (w/att.)

WATER REMOVAL COSTS

REVERSE OSMOSIS
VS.
THERMAL EVAPORATION

Solids	Water Removed From 38,000 Lbs. Of Pulp	Cost* Reverse Osmosis @ $.00067/Lb. of Water Removed	Cost** Evaporation @ .00659/Lb. Of Water Removed	Difference
4.5%			$117.82	$105.84
8.5%	17,879 Lbs.	$ 11.98	$ 83.69	$ 75.14
23.0%	12,692 Lbs.	$ 8.50	$ 13.77	
22.0%	2,090 Lbs.	***	$ 3.88	
36.0%	589 Lbs.		$ 4.51	
42.0%	684 Lbs.		$ 2.25	
46.0%	342 Lbs.		$ 2.00	
50.0%	304 Lbs.			

* Costs - Reverse Osmosis: Approximately $12.00 per hour which includes membrane life expectancy of three (3) seasons, clean up and 5¢/kilowatt hour electricity; does not include equipment depreciation.

** Costs - Evaporation: Approximately $118.00 per hour, does not include equipment depreciation.

*** Reverse Osmosis concentration above 12% for tomato products is impractical.

Summary: Reverse Osmosis savings per hour per 20 ton line is $105.84, a six (6) line paste plant processing 120 tons per hour would save $635.00 in energy costs per hour or $15,241.00 per day concentrating tomato pulp from 4.5% to 8.5% solids.

WMH:mat
10/8/84

-1- R 5

OF TOMATO PULP FLOW CHART

TOMATOES
4.5% Solids
40,000 lbs./Hour (20 tons/Hour)

↓

CHOP
Coarse Chop.

↓

HOT BREAK
Hot or Cold.

↓

EXTRACT
Standard paddle extraction and finishing.
(38,000 lbs./Hour, 96% Yield)

↓

HEAT EXCHANGER
Cool product, if higher than 65°C.

↓

PISTON PUMP
Five stage piston pump, raise pressure to 36 BAR (530 psi). Made by Bertoli of Parma.

↓

PULSATION DAMPER
Reduces surges created by piston pump.

↓

CENTRIFUGE PUMP
Raise pressure from 36 to 42 BAR (617 psi).

↓

CENTRIFUGE PUMP
Raise pressure from 42 to 48 BAR (705 psi).

↓

REVERSE OSMOSIS TUBES
Product retention time approximately 6 minutes.

→ **WATER** Potable quality, at approx. 60°C
(17,879 lbs./hour Water removed)

↓

FLOW METER
Computer controlled to regulate flow rates and recirculation (20,121 lbs./Hour Pulp at 8.5% solids).

↓

PRESSURE REDUCER COIL
Allows pressure drop without using a pressure valve, avoids product damage.

↓

VALVE
Controls final product flow, computer controlled.

↓

REFRACTOMETER
8.5% Solids.
Controls/Monitors solids and signals computer; master control point.

↓

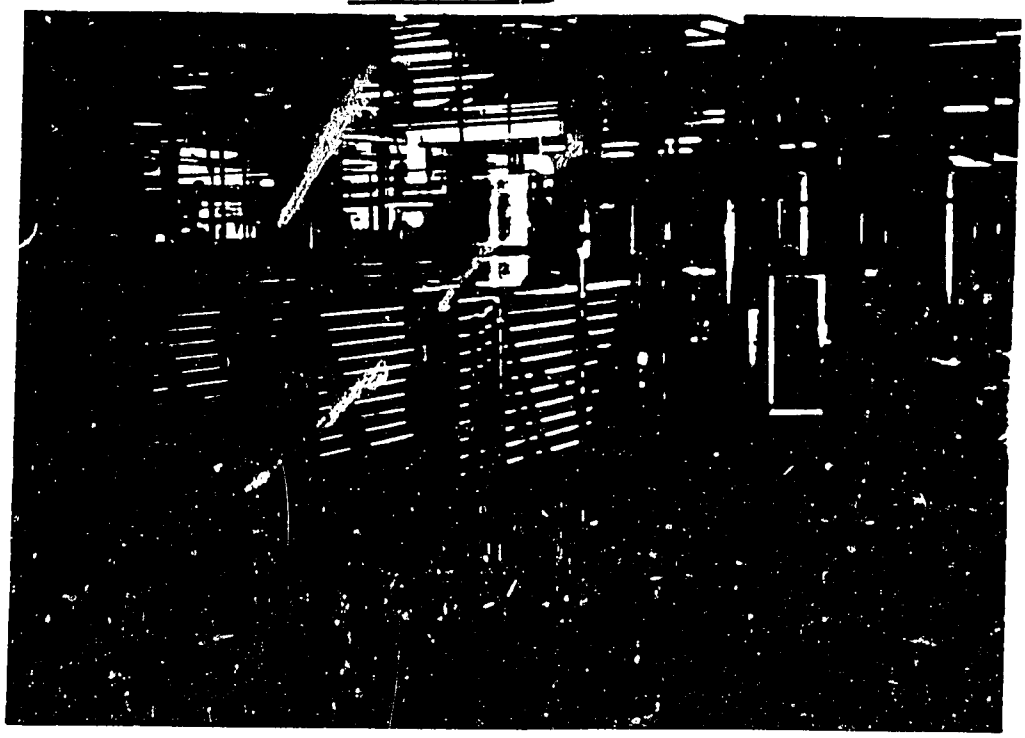
FINISHED PRODUCT FILLER
OR
EVAPORATOR TO CONCENTRATE TO HIGHER SOLIDS
Product exit temperature 60°C.

IV

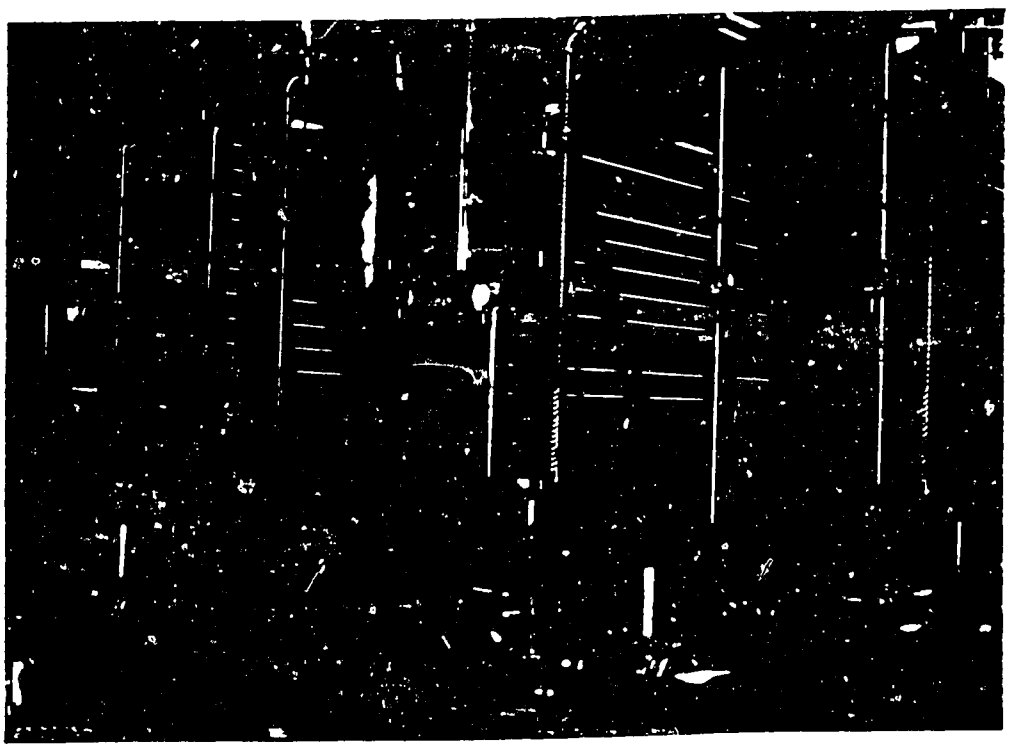
REVERSE OSMOSIS
OF
TOMATO PULP
FLOW CHART

NOTE: All operations, temperatures, flow rates, pressures, and solids levels constantly monitored and controlled by computer. Cleaning is conducted automatically C.I.P. on a programed basis. Pressure is used as the primary operational guideline for determining efficiency and clean up schedules. Eighteen (18) to twenty (20) hours were given as the average time between clean ups.

ATTACHMENT I



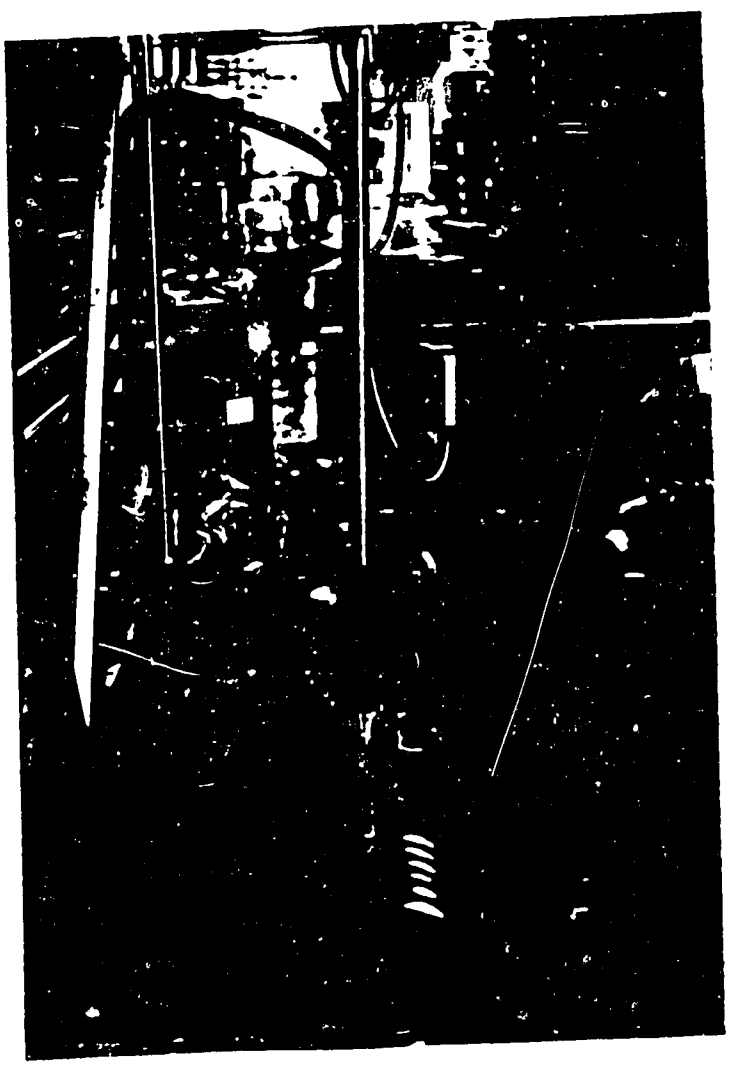
OVERVIEW OF THREE STAGE REVERSE OSMOSIS UNIT



CLOSE UP OF MEMBRANE TUBE BANKS. AUTOMATIC VALVES AND CENTRIFUGE PUMPS IN FOREGROUND.

ATTACHMENT 11

FIVE STAGE HIGH PRESSURE PISTON PUMP.
VERTICAL CYLINDER IS PULSATION DAMPER.



FINISHED PRODUCT EXIT.

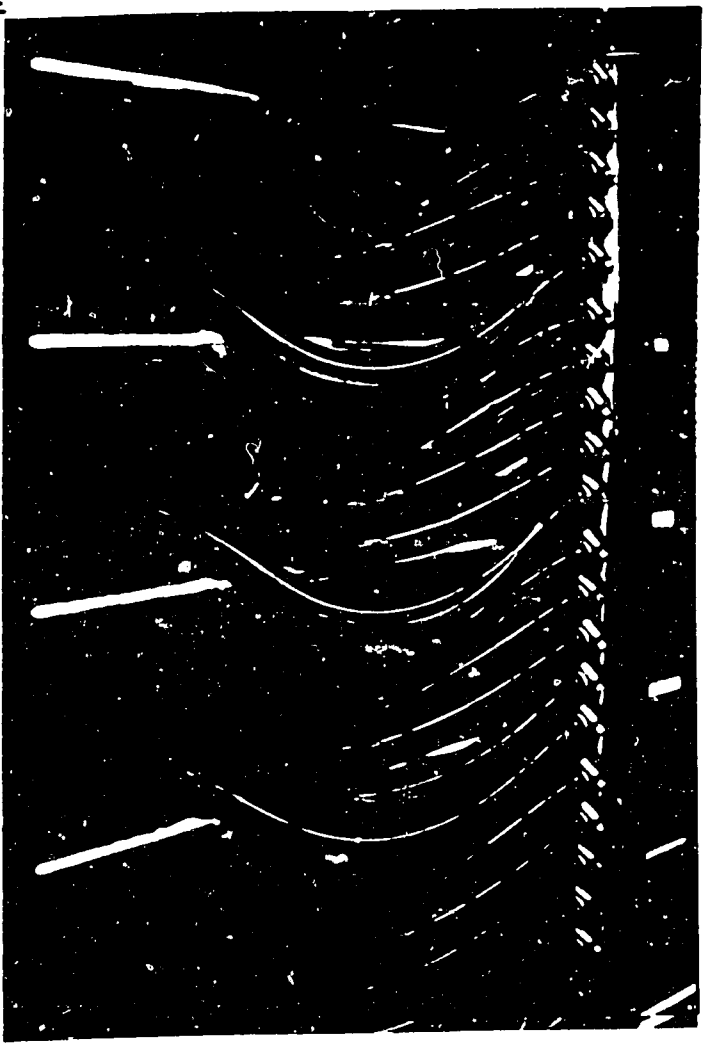
HELIX LOOP IN FOREGROUND IS FOR PASSIVE PRESSURE REDUCTION.

RED & BLUE DEVICE IS AUTOMATICALLY CONTROLLED PRESSURE VALVE.

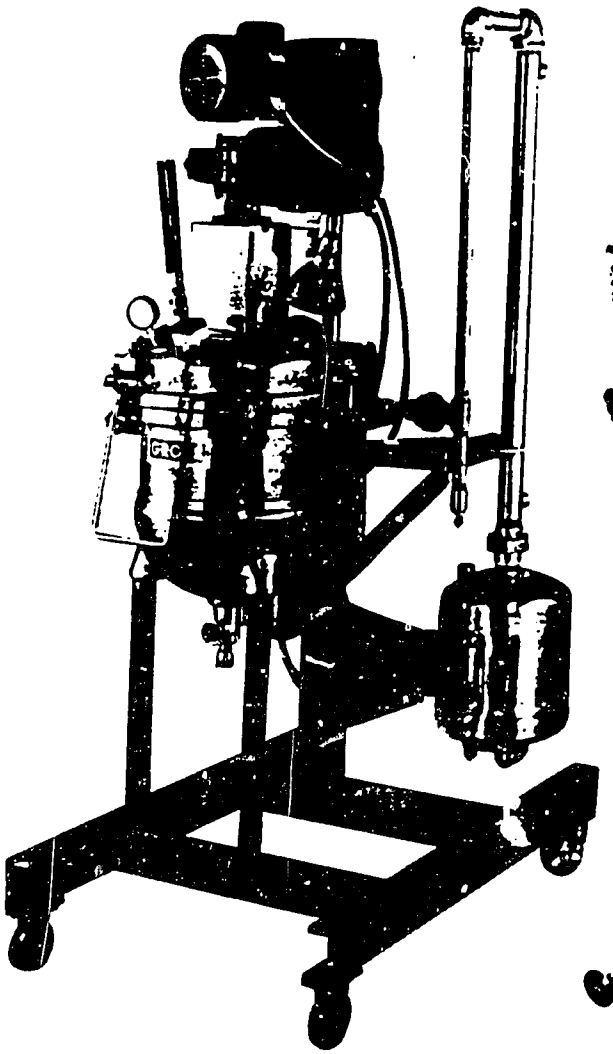
BLUE BOX ON VERTICAL PIPE IS AUTOMATIC COMPUTER CONTROLLED REFRACTOMETER.

ATTACHMENT III

WATER PERMEATE FLOW FROM TUBE MEMBRANES.



CUT AWAY OF TUBE MEMBRANE HOLDING CHAMBERS.

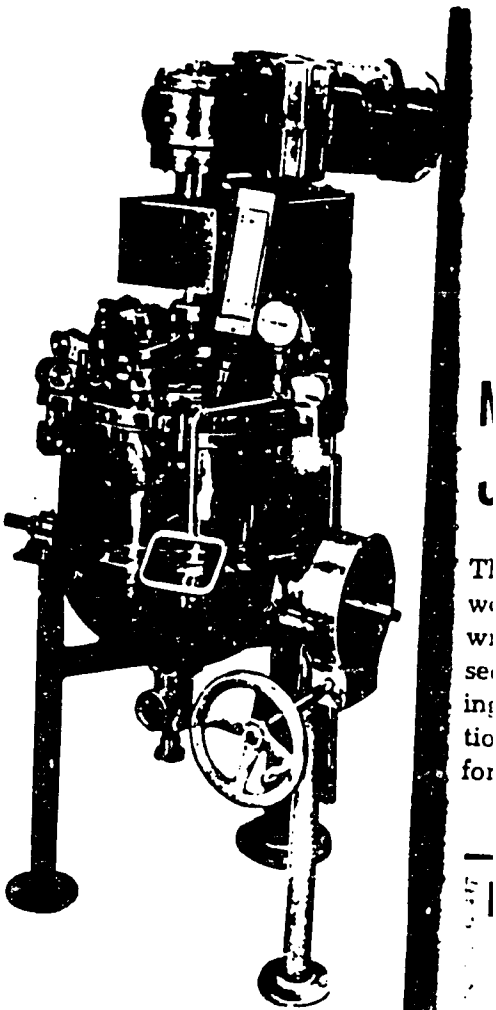


GROEN

MODEL NVA/RA (B)

[redacted] duty RA [redacted] surface [redacted] unit is designed for processing under vacuum or pressure [redacted] furnished with access manway, sight and light glass, shaft seals and instrumentation. Also available with other GROEN agitation systems. [redacted] vacuum system.

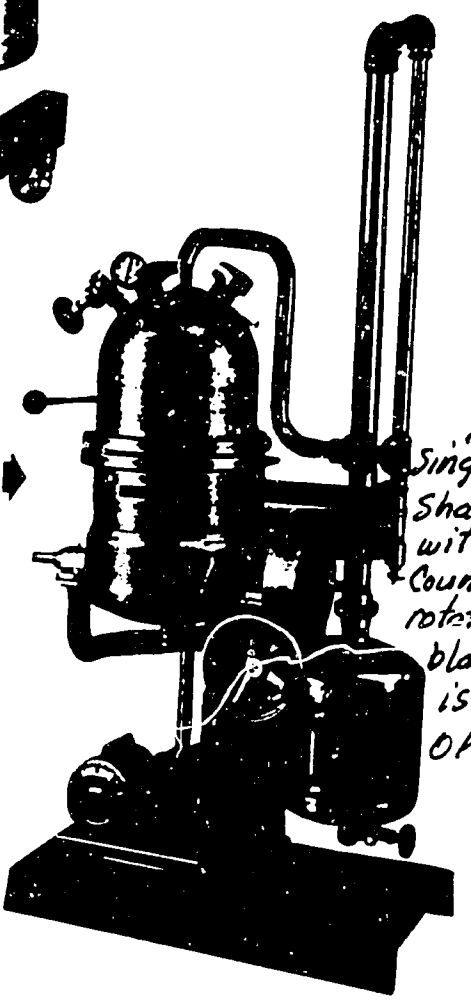
You will need a vacuum system



MODEL DN/TA-10 (SPECIAL)

10 gallon capacity, designed for processing under pressure of vacuum. Features the DN floor mounted tilting mechanism and a dome shaped, gasketed cover. Cover is fitted with sight and light glass, pressure/vacuum gauge, rotary seals for the dual agitator shafts, thermometer extending down into the product and quick acting eccentric type cover clamps. The unit is provided with a heavy-duty TA twin shaft scraper type mixer with variable speed drive. The cover and mixer unit is manually hinged out of the kettle assisted by a spring actuated counterbalanced mechanism, assuring fast, easy operation. Kettle is fitted with a sanitary type flush drain valve. (For additional data on the DN kettle, refer to Bulletin 51C. For the TA mixer unit, refer to Bulletin 52A.)

Single Shaft with Counter rotating blade is OK



MODEL DVA-20 (SPECIAL)

5 gallon jacketed kettle, designed for vacuum cooking. Unit includes a DN-20 Special 5 gallon jacketed kettle unit, hinged dome cover complete with vacuum line, vacuum breaker, sight and light glass and vacuum gauge. Vacuum line is provided with a rotary joint/hinge cover mechanism. In addition, the unit is provided with a condenser, receiver and vacuum pumping system. Particularly suited for producing hard candies and other confectionery products, fruit preserves, etc.

SINCE 1907 GROEN ®

The above units are designed for steam working pressures up to 125 Lbs. (A.S.M.E. Code construction optional). Construction materials: Type 304 and other 300 series alloys–Monel, Inconel, Incoloy, nickel, etc.

NOTE: VACUUM PROCESSING KETTLES AVAILABLE WITH CONDENSERS, RECEIVERS AND VACUUM PUMPING SYSTEMS. OPTIONAL EXTRA.

GROEN DIVISION DOVER CORPORATION

1900 PRATT BOULEVARD, ELK GROVE VILLAGE, ILLINOIS 60007
TEL: (312) 439-2400 TELEX NO. 28-7413

Appendix 7 7?

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