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MANAGEMENT HANDBOOK

To Aid Emergency Expansion of

Dehydration Facilities for Vegetables and Fruits

VOLUME I

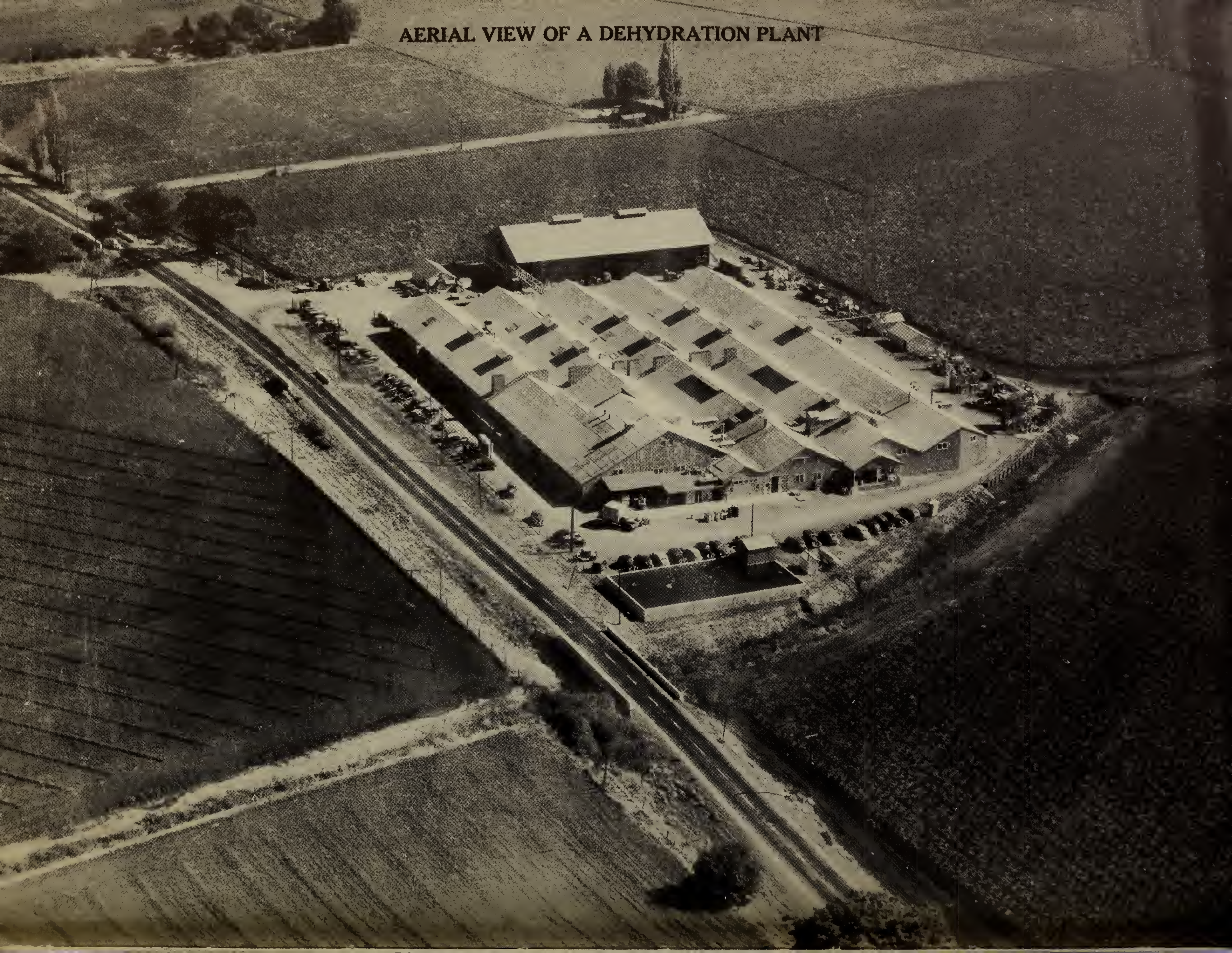
A Phase II Preparedness Study

Prepared at the Request of
Office of the Quartermaster General
Department of the Army
Washington, D. C.

By

Western Regional Research Laboratory
Bureau of Agricultural and Industrial Chemistry
Agricultural Research Administration
U. S. Department of Agriculture

MAY 1952



AERIAL VIEW OF A DEHYDRATION PLANT

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Volume II consists of eight Supplements:

In general, the information in each Supplement is presented under these Chapter headings: 1/

1/ The Apple Supplement and the Potato Supplement (granules) do not follow this method of presentation (see respective Supplements for explanation of deviation)

CHAPTER I

INTRODUCTION

General Considerations

Advances in processing, packaging, reconstitution, and cooking methods made during World War II have assured the continued military use of dehydrated foods. At the same time it has been recognized that additional technologic improvements must be made to take full advantage of their possibilities.

In the early part of 1951 Major General Herman Feldman, Quartermaster General of the U. S. Army, stated that, although the operations in Korea have shown operational rations much improved over World War II experience, one of the most important needs of the Armed Forces is to obtain still better dehydrated fruits and vegetables. 1/

To help in assuring the procurement of dehydrated food products having high and uniform quality, and to assist in any needed expansion of the industry in case of a national emergency, the Quartermaster Corps has requested the Bureau of Agricultural and Industrial Chemistry of the U. S. Department of Agriculture, to prepare an up-to-date dehydration Handbook.

Products Designated by QMC for Handbook

Product	Current QMC Specifications
Apples, Dehydrated (Type II--sliced)	MIL-A-1035A (23 Sept. 1949)
Cranberries, Dehydrated (Type II--sliced)	MIL-C-827A (4 Sept. 1951)
Beets, Dehydrated (Type I--diced)	MIL-B-3024 (3 Aug. 1949)
Cabbage, Dehydrated (Shredded)	MIL-C-826 (27 July 1949)
Carrots, Dehydrated (Type I--diced)	MIL-C-839 (28 July 1949)
Onions, Dehydrated (Type I--flaked)	MIL-O-3028 (8 Aug. 1949)
Potatoes, Sweet, Dehydrated (Type II-diced)	MIL-P-3025 (3 Aug. 1949) Amend. #1 (30 Nov. 1949)
Potatoes, White, Dehydrated (Type I--diced)	MIL-P-1073A (12 Dec. 1950)
Potatoes, White, Dehydrated (Type IV--granules) . . .	MIL-P-1073A (12 Dec. 1950)

1/ Address given May 7, 1951 at 4th Annual Meeting of Associates, Food & Container Institute (Chemical & Engineering News, 29, P 2053 - May 21, 1951)

Objectives of Handbook

The broad objectives of this Handbook are (1) to present specific information on raw materials, facilities, skills, and procedures required to produce 9 designated dehydrated foods that may be needed in the national preparedness program, and (2) to indicate the probable costs involved in establishing the production facilities and in producing the end products.

Sources of Information

This Handbook is based primarily on a comprehensive investigation and evaluation of the commercial practices of the dehydration industry. In addition to information obtained by extensive inspections of dehydration plants in various sections of the United States, the Handbook contains detailed information obtained from suppliers of seed, raw materials, equipment, utilities, and other essential materials, and from numerous state and Federal agencies, trade associations, finance groups, research organizations, and many others. A detailed list of the sources of information used in preparing the Handbook is given in Appendix "C".

General Organization of Handbook

The Handbook consists of two Volumes. Volume I contains generalized information useful in planning, establishing, and operating any of the nine types of dehydration plants covered in this study. The first three chapters are of an introductory nature. The next eight chapters give information concerning business considerations, management and services needed, plant location, raw commodity procurement, choice of plant size, selection of plant procedures and facilities, and principal operating considerations. The last chapter (Chapter XII) summarizes the basic assumptions used in planning the specific dehydration plants given in the Supplements of Volume II. Appendices of reference information also are included in Volume I.

Volume II consists of eight individual Supplements. Each Supplement contains detailed information for the establishment and operation of a specific plant to produce one of the nine products covered by this Handbook. 2/ Inasmuch as a considerable amount of the basic planning information is included in Volume I, a prospective dehydrator must have available both Volume I and the Volume II Supplement covering the commodity in which he is interested.

In order to simplify and unify discussion, and to permit ready reference to tables listing equipment and presenting cost data, a classification code has been adopted. This code is based primarily on the cost accounting system presented in "Operating Considerations" (Chapter XI). The complete code is given in "Operation Classification Code" (Appendix D). Starting with Chapter III of Volume I, all discussions and tables of plant procedures and facilities and costs are coded. The reader is urged to refer to the code presented in Appendix D in order to follow the discussions and to understand the manner in which the information is coded.

2/ The White Potato Supplement includes information for both dice (Type I) and granules (Type IV).

CHAPTER II

MILITARY USE OF DEHYDRATED FOODS

General Requirements for Military Foods

The feeding of both the armed forces and the civilian populations becomes increasingly complex for each succeeding war. Greater quantities of foodstuffs must be grown, and a major portion of these must be processed so that they will be suitable for use in the future. During such emergency periods, processing facilities are severely burdened for many important food items.

After production, one of the biggest problems is that of distribution -- getting sufficient foods of acceptable quality to fighting forces wherever they may be. To accomplish this, it is highly important to minimize space and weight requirements for these items.

The distribution and utilization of military foods further require that they be processed and packaged to withstand the many hazards of storage, shipping, and handling under extreme conditions. These include exposures to wide ranges of temperature and humidity, severe mechanical shocks and strains, spillage of other materials, bacteriological actions, attack by vermin and rodents, and other contingencies.

Above all else, at their ultimate destination military foods must be sufficiently palatable that they will be eaten by the soldiers. Furthermore, the foods must be easily prepared, and must be adequately nutritious.

Early Military Experience in Using Dried Foods

One of the oldest processes used to preserve foods for future use is that of drying. Peoples of ancient times sun-dried some fruits and meats as a means of preserving them. Dried meats, fish, and corn were common items to the Indians and early American colonists.

A few artificially dried foods, i.e., those dried by heat from sources other than the sun, were known and used in the Civil War. These were mostly lean beef and apples. Attempts were made to utilize certain artificially dried vegetables.

In World War I another method of drying foods -- termed "dehydration" -- was attempted as a means for preserving the foods and for saving shipping weight. So far as known, only vegetables were "dehydrated". The only dried fruits used in World War I were the ordinary dried products of commerce containing 15% to 30% moisture; they were mostly dried apples, prunes, and raisins.

The dehydrated vegetables produced in the War period of 1916-1918 were generally of poor quality and were not well accepted by the Army. There was a paucity of information on the techniques of dehydration (such as methods for enzyme inactivation) and on the need for a low moisture content in the final product for good storage stability. No official purchase specifications were available for guidance. The lack of information regarding proper preparation and cooking of these dehydrated foods further aggravated the problems of consumer acceptance.

During the period of American participation in World War I, approximately 7 million pounds of dehydrated vegetables were shipped overseas. Of this, nearly 6.5 million pounds were dehydrated potatoes; the remainder was mostly onions and carrots. In addition, there were shipped overseas nearly 2 million pounds of soup mixes containing varying quantities of dehydrated vegetables. 1/

By the end of World War I, 30 plants were dehydrating vegetables in the United States, and approximately 1900 were reported to be operating in Germany. The industry declined abruptly, however, after the War, and ultimately only six plants were operating in the United States (five of these in California), and only four plants were operating in Germany. (There are no production statistics available for the German plants, either during or following the War.) 2/

Role of Dehydrated Foods in World War II

A. Dehydrated Vegetables

Between 1918 and 1940 the civilian market for dehydrated vegetables slowly expanded. The products were principally seasoning materials (mostly onions and garlic), soup stocks, and white potato products.

At the beginning of World War II there were some 20 vegetable dehydration plants in the United States, of which 11 were in California. Within the next three years several hundred additional plants were authorized to be built, but only part of them actually got into production. Many of the poorly-operated, small capacity plants dropped out of the picture during the war period. The needed production was accomplished in the remaining plants.

The production of every dehydrated vegetable, except carrots, continued to increase throughout the War period. Production of dehydrated carrots was reduced in 1944 and 1945 due to lack of general acceptance by the ultimate consumers. Six of the commodities of current interest to the Quartermaster Corps -- beets, cabbage, carrots, onions, white potatoes, and sweetpotatoes -- represented 94% of the peak War production in 1944, with white potatoes accounting for nearly 70% of the total. 3/ The anticipated 1945-1946 requirements for these six products, as estimated in the early part of 1945 before Germany's surrender, are given in Table I.

The total amount of each vegetable used for dehydration purposes in the United States during the entire War period (1941-1945) is given in Table II. In comparing <u>all kinds of vegetables dehydrated</u> with <u>all kinds of vegetables canned</u>, statistics indicate that for 1944, the year of peak production, the vegetable dehydration industry required about one-sixth as much tonnage of raw commodities as did the total vegetable canning industry. 4/ The kinds of vegetables dehydrated were, in general, different from those canned.

1/ Preservation of Fruits & Vegetables by Commercial Dehydration, U.S.D.A. Circular #619 (Revised), p. 2 (1942)

2/ "Central Procurement of Dehydrated Vegetables for the Armed Forces", Marion Massen, Chicago QM Depot Historical Studies, Report No. 6 (1945)

3/ Western Canner and Packer, Statistical Review & Yearbook 1948, p. 283

4/ "Post-war Readjustments in Processing and Marketing Dehydrated Fruits & Vegetables", prepared by the Inter-Bureau Committee on Post-War Planning, U.S.D.A., Washington, D.C.--Mimeographed Report, p. 30 (May 1945)

Production of dehydrated foods to meet government purchases was confined chiefly to a few states. One reason was that such plants were established in or near extensive supplies of raw commodities suitable for dehydration purposes, and only a few States offered these opportunities. Table III shows the distribution of dehydration plants for the first half of the War period; this pattern was not altered much during the remainder of the War.

TABLE I

Planned Government Procurement of Dehydrated Fruits & Vegetables for Fiscal Year 1945-46 1/

Product	Quantity (Millions of pounds) Military	Lend-Lease
White Potatoes	134.0	30.5
Sweetpotatoes	19.4	none
Onions	12.7	10.2
Cabbage	8.7	5.2
Carrots	6.5	6.7
Beets	4.9	2.7
Apples (low moisture)	10.4	?
Cranberries	1.8	none

1/ Proceedings of the Fourth Annual Meeting of the National Dehydrators Association, Chicago, Feb. 6, 1945, pp 6 & 13

TABLE II

Total Estimated Quantities of Vegetables Used for Dehydration in U. S. during World War II (1941 - 1945) 1/

Commodity	Tons of Fresh Commodity
White Potatoes	1,000,000
Onions	350,000
Cabbage	350,000
Carrots	250,000
Sweetpotatoes	100,000
Beets	100,000
All Others	150,000
Total	2,300,000

1/ Western Canner & Packer, 1948 Statistical Review & Yearbook, p 283

TABLE III

Principal Sources of Government Procurement of Dehydrated Vegetables (1941 through First Half of 1943) 1/ 2/

	Beets	Cabbage	Carrots	Onions	White Potatoes
California	-	89.9%	95.5%	86.3%	7.8%
Idaho	-	-	-	11.0%	55.0%
Maine	-	-	-	-	9.5%
New York	67.0%	9.7%	4.3%	-	4.9%
New Jersey	30.0%	-	-	-	-
Oregon	2.5%	-	-	-	-
Washington	-	-	-	-	10.0%

1/ "Proceedings of the Maryland Dehydration Conference", p 19, University of Maryland, May 12 - 14, 1943
2/ Sweetpotatoes were processed in the Southern States; most of other vegetables (not listed) were processed in California

TABLE IV

Approximate Production of Dried Apples and Cranberries During World War II 1/

Year	Total Commercial Crop in U.S. (M Tons) (fresh)	Dried (M Tons) (fresh)	Dried (M lbs.) (Processed Product)	Dried Purchased by U.S. Military (M lbs.) (Processed Product)
		Apples	Based on 24% Moisture Content	
1941	2,933	143	34,000	9,000
1942	3,041	177	42,000	28,800
1943	2,095	161	35,000	11,700
1944	2,910	168	34,000	17,300
1945	1,603	112	29,000	8,200
		Cranberries	5% - 10% Moisture Content 2/	
1941	36	2.5	500	
1942	41	9.3	1,900	
1943	34	6.4	1,300	
1944	19	3.1	600	
1945	33	2.2	400	

1/ Computed from data given in U.S.D.A. "Agricultural Statistics", pp 179, 183, 205, 233 (1950); and Nat'l Canners Ass'n "Canned Food Pack", 1945
2/ Assumed that all these products purchased by U.S. Military

B. Dehydrated Fruits

Dried or "evaporated" apples, averaging 24% moisture content, have been an important commodity on the civilian market for many years. During World War II (1941-1945) between 5% and 8% of the total commercial apple crop was dried each year, with the Military taking an average of 43% of the total output of the "evaporated" product. A substantial portion of these military purchases was a low-moisture product containing about 3% water. More detailed information concerning the War period production of dried apple products is given in Table IV (on preceding page).

The production of dehydrated cranberries (a product containing 5% to 10% moisture) was a new industry at the beginning of the War and expanded to meet the needs of the Armed Forces. During the five War years over 14% of all cranberries grown were dehydrated — approximately the same percentage of the total production that was canned. It is understood that all of the dehydrated product went to the military. Additional information concerning cranberry production during 1941-1945 is given in Table IV.

How Production was Accomplished During World War II

The rapid increase in vegetable dehydration in World War II was accomplished in three ways:

1) Converting established processing plants

2) Building additional capacity in existing plants by moving and converting previously-used equipment

3) Building entirely new plants

The war-time expansion was carried out partially by experienced processors, but in addition, many inexperienced newcomers were attracted to this industry. The costliness of inexperience was illustrated many times in:

1) Slow, costly "learning periods" before acceptable products could be produced

2) Variable quality and erratic output of products

3) Production costs too high to operate on a competitive basis with other plants

By the mid-point of the War, 44% of the dehydration plants were those that had been converted from other methods of processing. Half of the 93 white potato dehydrators were new plants, and 14 of the 24 sweetpotato plants were new. The dehydration of other vegetables, however, was done mostly in either converted plants or in pre-war plants. 5/

5/ "Post-war Readjustments in Processing and Marketing Dehydrated Fruits & Vegetables", prepared by the Inter-Bureau Committee on Post-War Planning, U. S. D. A., Washington, D. C. — Mimeographed Report, pp 28 & 30 (May 1945)

By the end of the War, the management and operation of dehydration plants followed this pattern: 6/

1) 35% by people whose principal business was the operation of dehydrators

2) 52% by other food processors and manufacturers

3) 7% by shippers of fresh fruit and vegetables

The building of new dehydrators and the conversion of old plants were done solely to fill Government orders during war-time, and yet financing for this purpose was done largely by private capital. For some, loans from Federal agencies supplied the money needed, although the total of all such loans came to only about 10% of the total spent for such purposes. Although the Government made only limited loans for "operating capital" needs (about twice the amount of money loaned for "fixed capital"), nevertheless the plants received considerable financial assistance by virtue of having government contracts for their products. 6/

Probable Military Need for Dehydrated Vegetables and Fruits During a National Emergency

The Quartermaster Corps has made comprehensive studies, during and since World War II, concerning the food preferences of the American soldiers. The Quartermaster's conclusions concerning dehydrated fruits and vegetables, as reconstituted and served to the Military, may be summarized as follows: 7/

FIRST PREFERENCE: Onions; sliced cranberries; apples (very low moisture)

SECOND PREFERENCE: White potatoes; sweetpotatoes

THIRD PREFERENCE: Beets; carrots; cabbage

These findings will doubtless influence the formulation of plans for meeting the needs in any emergency.

A. Dehydrated Vegetables

With the coming of "V" days, 1945 Government contracts were rapidly reduced and cancelled. As a consequence, there began a rapid decline in the production of dehydrated vegetables. By the end of 1947 production had decreased to less than one-fourth of the peak war-time rate. 8/ The post-war commercial market for dehydrated vegetables did not amount to that anticipated, even though the forecast had been quite modest in comparison with the War requirements. In 1950 the reported production of all dehydrated vegetables for the United States was only 60 million pounds — 40 million pounds of potato products, 9 million pounds of onions and garlic, and 11 million pounds of other vegetables. 9/

6/ "Post-war Readjustments in Processing and Marketing Dehydrated Fruits & Vegetables", prepared by the Inter-Bureau Committee on Post-War Planning, U. S. D. A., Washington, D. C. — Mimeographed Report, pp 28 & 30 (May 1945)

7/ "Post-war Readjustments in Processing and Marketing Dehydrated Fruits & Vegetables", prepared by the Inter-Bureau Committee on Post-War Planning, U.S.D.A., Washington, D. C. — Mimeographed Report, p 63 (May 1945); "Proceedings of Dehydration Meeting" sponsored by The Associates, Food & Container Institute in cooperation with the QM Food & Container Institute, at Univ. of California (Sept. 15, 1950).

8/ Western Canner & Packer, 1948 Statistical Review & Year Book, p 283

9/ Western Canner & Packer, 1951 Statistical Review & Year Book, p 221

The experience with dehydrated vegetables in World War II pointed to certain general conclusions concerning specific items: 10/

1) Dehydrated White Potatoes -- This item typified the convenience aspect of dehydrated products. Its edible qualities were quite acceptable. For these reasons it may continue to be the most important dehydrated food in satisfying the requirements of the Armed Forces.

2) Dehydrated Onions -- The demands for a flavoring ingredient were satisfied by this product. It was a well-liked item. The onion dehydration industry seemed to have had the best post-war commercial prospects in proportion to the War-time plant capacity.

3) Dehydrated Sweetpotatoes -- This item has very good nutritive values. It apparently has important potentialities in any national emergency food program, provided its storage stability and acceptability can be improved sufficiently.

4) Dehydrated Cabbage -- This product puts stringent requirements on packaging to preserve the desired qualities. Cabbage -- either fresh or dehydrated -- was not a popular food in the Armed Forces of the recent War, and was used chiefly for its nutritive value.

5) Dehydrated Carrots -- Carrots, relatively easy to dehydrate, were overproduced during World War II. This item was similar to cabbage in requiring special packaging for proper preservation. It was unfortunate from a nutritional standpoint that dehydrated carrots were not well liked by World War II soldiers.

6) Dehydrated Beets -- This had never been a popular food with the Armed Forces and its future military use was reported as not promising.

B. Dehydrated Fruits 11/

Dried apples, as well as many other dried fruits, continued as established products in domestic and foreign commerce after World War II. The total pack of dried apples has been maintained on a level comparable with that of the War years, although the share going to the military has become insignificant. The low-moisture dehydrated product has continued to be manufactured on a small scale.

Dehydrated cranberries -- an item first commercially produced during World War II -- have been well accepted by the post-war civilian market and have continued in production.

The World War II military experience and the post-war civilian outlets for dried and dehydrated fruits indicated these general conclusions regarding specific items:

1) Dehydrated Apples — Ordinary "evaporated" apples do not have the storage life desired for military purposes, but the low-moisture dehydrated

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10/ "Post-war Readjustments in Processing and Marketing Dehydrated Fruits & Vegetables", prepared by the Inter-Bureau Committee on Post-War Planning, U. S. D. A., Washington, D. C. — Mimeographed Report, pp 69-71 (May 1945)

11/ Based upon information supplied by: (a) California Crop & Livestock Reporting Service, Bureau of Agricultural Economics, U. S. D. A.: (b) Agricultural Statistics, 1950, U. S. D. A., and (c) an industrial specialist (who was a member of the QMC dehydrated food procurement group during World War II).

products obtained during World War II apparently satisfied the requirements for both storage stability and palatability. In fact, this item was considered one of the best dehydrated products used by the Armed Forces, and is expected to be in considerable demand for any national preparedness program.

2) Dehydrated Cranberries — Military experience with dehydrated cranberries was quite favorable in World War II. This item enjoyed high consumer acceptance, and proved to have fair stability in storage. This product should be in good demand for future military use.

Organizations Responsible for Procuring Dehydrated Foods During Present National Preparedness Program (Both Military and Non-Military)

Changes in responsibilities of the various government agencies may become necessary to cope with ever-changing world affairs. It will be advisable, therefore, for any one interested in producing dehydrated foods for any national preparedness program, to make careful inquiry at the particular time to determine which agencies are involved in these procurement activities. At the time of writing this report, responsibilities of various Federal agencies applicable to the procurement of dehydrated foods were as outlined in the following paragraphs.

The Department of Agriculture has been given the over-all responsibility for the production and distribution of foods, feeds, and feedstuffs. Executive Order No. 10161, Section 901 (H), designated the following officers and agencies to do the procuring, through the Department of Agriculture, of foods needed in the present national emergency:

1. The Secretary of Defense with respect to the food requirements of the Armed Services, civilian relief food requirements for occupied areas administered by the Department of Defense, and the other military food needs of the Department of Defense. (The Quartermaster Corps has been designated as the responsible agency for the Department of Defense, and will procure the foods needed by the various organizations of the U. S. Armed Forces).

2. The Secretary of Commerce with respect to domestic uses of food for manufacturing non-food commodities or products.

3. The Administrator of the Mutual Security Agency with respect to non-military food requirements for those foreign countries in which the Economic Cooperation Administration has a program.

4. The Administrator of the Production and Marketing Administration with respect to non-military food requirements for those foreign countries in which the Mutual Security Agency does not have a program.

5. The Administrator of the Production and Marketing Administration with respect to domestic food requirements for United States civilians.

6. The Secretary of the Interior with respect to food requirements for civilians in the Territories and possessions of the United States and in the Trust Territory of the Pacific.

CHAPTER III

GENERAL PRINCIPLES OF DEHYDRATION

Definition of Dehydration

Dehydration, broadly defined, simply means the removal or loss of water from some material. The rate and extent of dehydration are affected by many factors.

Several terms have come into common usage to designate various methods for removing water from fruits and vegetables. "Sun-drying" is accomplished under uncontrolled climatic conditions. "Evaporation", as applied to moist solids, is usually defined as drying in an air stream with controlled heat supplied from some source other than directly from the sun (burning of gas, oil, wood, etc.) but with little or no control of air velocities and humidities.

In "dehydration" the drying is done by artificially produced heat under controlled conditions of temperature, humidity, and air-flow. Under proper conditions of "dehydration", practically all of the water content of many vegetables and fruits may be removed without seriously impairing their nutritive values and palatability.

Modern dehydration processes have substantial advantages over the older methods of drying:

1) In general, dehydrated products have better flavor, palatability, appearance, and nutritive qualities

2) Dehydration processes assure greater uniformity of quality and less contamination of materials during processing

3) Dehydration processing is largely independent of climatic conditions

4) Dehydration processes assure greater storage life of product

The essential operations and the principles involved in dehydrating fruits and vegetables are given in the following sections.

Major Manufacturing Steps

The information given below is of a general nature largely applicable to most kinds of dehydrated vegetables and fruits. As each vegetable and fruit has individual characteristics and requirements which must be taken into consideration for proper handling and processing, the reader also should study the detailed information given in the supplements of Volume II in considering the production of a specific item. The classification code used follows the system outlined in Appendix D.

CODE 100 -- RAW MATERIAL PROCUREMENT

The fundamental requirement for the operation of any dehydration plant is a plentiful supply of suitable raw commodities. A plentiful supply can only be assured for year after year operation through proper planning. The commodities must be of proper variety, maturity, and condition for dehydration purposes. Broad and fundamental information concerning procurement of raw commodities to meet the needs of the plants covered in this Handbook is given in Chapter VIII of Volume I. Specific information and requirements for each of the raw commodities is given in the respective sets of plant plans (individual Supplements in Volume II).

Harvesting, initial handling, transporting, and storing of fresh vegetables and fruits must be properly done. Otherwise, it is impossible to produce satisfactory dehydrated products. The methods to be used and the requirements for each of these operations must be clearly defined and understood by the grower and the plant operator. In this way each can help to maintain the fresh material in proper condition until it is processed.

All fresh products -- both in bulk and in containers -- must be shipped and stored so as to prevent bruising and other damage. Ample provision must be made for keeping them cool, ventilated, and protected against wilting, microbial spoilage, and damage from dust, fumes, moisture, insects, and rodents. The use of <u>properly controlled refrigeration, humidity, and ventilation</u> will lengthen the permissible time between harvesting and processing.

Leafy vegetables usually require greater care than root types and should, in general, be processed within a relatively short time after harvesting. On the other hand, certain root-type commodities (such as onions and potatoes) may be stored for weeks or months prior to processing. Many fruits (for example apples and cranberries) also may be stored for long periods in the fresh state.

CODE 200 -- MANUFACTURING OPERATIONS

<u>210</u> -- <u>Raw Material Handling in Plant</u>

<u>214</u> -- <u>Sizing and sorting</u>

The raw materials are inspected and the culls, stems, and other undesirable items removed. Classifying according to size is necessary for some types of automatic equipment used for the peeling and coring operations. This "sizing" is usually done by some mechanical "sorter". Inspecting and sizing may be done in the harvest fields to minimize costs of transporting and initial plant handling of the fresh commodities.

<u>220-230</u> -- <u>Preparing Raw Materials</u>

<u>221</u> -- <u>Washing</u>

The first processing step is removal of dirt and foreign materials. Root-type products (such as potatoes, carrots, and onions) may be passed first over a dry washer to remove as much loose dirt and trash as possible. Washing is the major cleaning operation and may be done in several steps, depending on the commodity and type of contamination. The initial washing may consist of tank-soaking, spray-washing, or fluming the raw material in water. If needed, additional washing may be done under high pressure sprays, in rotary drums, or in shaker washers. (In some cases washing is done after the raw material has been trimmed and/or cut.)

223 -- Peeling

Present Q.M.C. specifications require peeling of root-type commodities (potatoes, sweetpotatoes, onions, carrots, and beets). It is important that peeling be done effectively and with a minimum loss of edible material.

There are numerous methods of root peeling: abrasive, brine, lye, steam, flame, and manual. Steam and lye peelers usually give the most positive and uniform peeling results, and will handle a wider variety of products than the other methods. Steam peeling is in increasing usage.

For leafy-type vegetables (such as cabbage), the outer leaves are removed as they may have been damaged or may be undesirable for other reasons.

224 -- Trimming, coring, rooting and topping

After the peeling operation, the material is trimmed to remove undesirable portions such as discolored or damaged areas, "eyes" and deformities, and any remaining skin and stems. These are manual operations.

Some vegetables, such as onions and cabbage, are cored. Apples are peeled and cored.

226 -- Cutting

The trimmed material is then cut -- usually by some mechanical means -- into pieces of the desired shape and size for drying. The smaller the piece, the faster the drying can be accomplished. However, if the pieces are smaller than customary "bite" size, they have less consumer acceptance.

227 -- Blanching, cooking, sulfiting, and/or starch coating

Immediately after the foregoing preparation steps, most vegetables (notable exceptions are onions and garlic) and some fruits are given a blanching (or scalding) treatment. This consists of heating the pieces for a short period at a high temperature in steam, boiling water, or a boiling solution containing extracts from a previous blanching operation. The treatment is done batchwise or in continuous operation, and accomplishes four objectives:

1) Enzymes which cause discoloration of products prior to drying are largely inactivated by blanching

2) In subsequent operations or storage of the finished product, blanching prevents or retards:

    a) development of undesirable colors (either loss of color or "browning"), odors, and flavors

    b) undue loss of vitamins and other nutrients

3) Blanching assures optimum condition in the finished product for the eventual rehydration and cooking (blanched products rehydrate quickly and more completely, and result in cooked products that are more full-bodied in both texture and flavor)

4) In subsequent drying operations, blanched commodities usually will dry faster than unblanched ones

Steam blanching (most commonly used method in U. S.) results in less leaching of the nutritive materials than water (or solution) blanching (the usual British practice). With the latter method, however, uniform blanching is somewhat easier to attain.

Sulfiting of dried fruits has been an accepted practice for many years to overcome discoloration and darkening, as well as to give greater storage stability. The treatment consists of exposing the fruit pieces to the fumes of burning sulfur (sulfur dioxide) prior to and after the drying stage, or applying sulfite solutions to the pieces prior to the drying operation.

The sulfiting of vegetables, however, was not advocated in this country until after the U. S. entered World War II. During the early part of the War period, the beneficial effects of sulfiting dehydrated cabbage were established and accepted. Since then, sulfiting has been shown to be of value for such dehydrated products as potatoes, carrots, spinach, chard, string beans, and turnips. Vegetables are usually sulfited by spraying with (sometimes by dipping in) a solution containing sulfite and bisulfite salts.

Sulfiting retards color changes in the commodity during the drying process and during subsequent storage, and tends to prevent development of some types of off-flavors. It helps protect the carotene and ascorbic acid but has a deleterious effect on the thiamine content of the products. Sulfiting permits use of higher drying temperatures, thus shortening the drying time.

Sulfiting must be controlled carefully to attain the desired stablizing effects and at the same time to avoid off-flavors caused by the presence of too much sulfite.

It has been found that carrots may better retain their vitamin content if given a starch coating after the blanching operation. The pieces are treated with dilute starch solution -- a 2.5% corn starch solution being a typical one. Starch coating may be beneficial for other vegetables, but such usage has not been established sufficiently to be recommended at this time. (NOTE: At present, starch coating for dehydrated vegetables or fruits is not specified or permitted in Q.M.C. specifications.)

228-229 -- Pureeing, mashing, granulating or mixing

For a few specialized products, the whole or sliced raw commodity is cooked and then divided into pieces of desired size. The production of potato granules is an example. After the washing and peeling operations, the ~~whole~~ sliced potatoes are cooked in boiling water or steam, conditioned, and then comminuted by crushing, extruding, or whipping. In the preparation of dehydrated powdered cranberries, another example, the whole berries are cooked and then macerated in a "pulper".

240 -- Drying

The factors involved in the actual drying of a fruit or vegetable piece are quite complicated. During the initial drying period, when the water content of the commodity piece may exceed 90% of its total weight, the process is quite similar to the simple evaporation which occurs when a wick moistened with water is exposed to an air-flow of similar temperature, relative humidity, and velocity.

As the water content is lowered in the piece, however, the water has more and more difficulty in traversing the internal structure to the outer surface of the piece where it vaporizes. Toward the end of the drying operation, the rate of drying is almost entirely governed by the diffusion rate of the water through the food piece. High air temperatures at this stage will speed up the drying rate but will damage the product.

There is a dilemma in the dehydration of fruits or vegetables -- in general, the drier the dehydrated product (down to a very low moisture content), the more stable it is in storage; however, the drier the product the more difficult it is to handle without fracturing, and in many cases more difficult to reconstitute to its original form. Compromise among the various factors involved, including economic and production considerations, has led to the adoption of different specific moisture requirements for various dehydrated commodities, ranging from 2.5% to 7.0%, depending on the individual commodity.

Many procedures have been developed for drying vegetables and fruits. Some types of driers have specific advantages for drying certain products but may have limited versatility, i.e., may be capable of drying only a single kind of product. Some of the principal methods which have been used for drying vegetables and fruits are briefly described below.

241 -- Tunnel drying

One customary drying practice is to put the prepared fruit or vegetable on trays, which are stacked on small trucks and put through tunnel driers (i.e., truck-and-tunnel driers). Heated air, with controlled humidity, is circulated through the tunnels by either of the following methods:

a) One-stage counter-current drying: In this system the heated air is forced (by blowers) through the tunnel in the direction opposite to that which the cars travel. Thus, the incoming heated air (usually 135°F. to 170°F.) comes into contact first with nearly-dried product, and as the air travels through the tunnel it comes in contact with trucks carrying increasingly wetter pieces of the commodity. The evaporization of water from the commodity pieces requires heat, and this is furnished by the heated air. The air -- becoming cooler and cooler as it thus vaporizes a greater amount of water -- has less and less ability to vaporize moisture as it travels toward the exit end of the tunnel.

   The permissible temperature of the air entering the tunnel, in counter-current flow, is limited by the temperature at which the dried product is damaged by heat. The length of the tunnel and the operating conditions are usually established so that the material is dried to approximately 10% moisture content.

b) Two-stage drying: In the first stage, the heated air travels in the same direction as the loaded cars -- this is known as "parallel flow" or "co-current flow". Much higher initial air temperatures can be used (often in the range of 180°F. to 200°F.) than in counter-current flow as the heated air first comes into contact with the wettest commodity pieces. Thus, a very high moisture evaporation rate is achieved in the first stage. The usual practice is to reduce the moisture content of the commodity to approximately 50% in this first stage.

After leaving the first stage, the cars are put through the second stage, which has a counter-current arrangement similar to that described in (a) above. The product is dried to approximately 10% moisture in this second stage(if the product is to be given a final drying in bin -- See "248").

In general, two-stage drying is faster and permits more flexible operating conditions than the single stage counter-current type.

242 — Conveyor drying

Drying on a continuous belt conveyor is finding increasing usage for certain vegetables and fruit products, but is unsuitable for drying shredded cabbage and possibly some other commodities. In this system the prepared fresh commodity pieces are spread continuously on a moving belt which slowly travels through a drying chamber. This method has four advantages over ordinary truck-and-tunnel drying:

a) Less labor requirements for operating
b) Less floor space required
c) Has shorter drying time
d) Under optimum operating conditions, gives more uniform drying of the commodity pieces (better circulation of the heated air around the pieces, and the pieces can be turned over during the drying process)

Belt conveyor systems have two principal disadvantages when compared with truck-and-tunnel systems of similar drying capacity:

a) The installed cost of the system is higher
b) Greater quantities of critical metals are required

243 — Air-suspension and conveyor drying

Air-suspension driers are used for drying such commodities as potato granules. The granules are held in suspension and dried by a stream of heated air, and are then collected by any suitable means. In air conveyor driers, the granules are dried while being conveyed with the heated air stream.

244 — Drum drying

Powdered dehydrated cranberries are made by drum-drying the macerated cooked berries on the outside surface of an internally heated rotating drum, and then grinding the dried product.

245 — Kiln & vacuum drying

Kiln drying and vacuum drying are used mostly for fruit drying processes. For example, commercial dried apples may be "evaporated" (down to approximately 24% moisture) in kilns, and low-moisture apples (averaging about 2-1/2% water) are made by vacuum-drying the "evaporated" product.

246 -- Compartment drying

Cars loaded with trays of prepared raw commodities are passed through a tunnel divided into compartments. Heated air is passed through each compartment under individually controlled conditions of heat, humidity, and velocity. The heated air may be blown horizontally across or perpendicularly through the trays. In this system the drying conditions can be controlled within quite close limits.

247 -- Cabinet drying

Trays carrying prepared raw commodity are either set on shelves in the cabinet drier or the trays are placed on cars which are then put in the cabinet drier. Cabinet drying is a "batch" operation which permits close control of drying conditions. Although well-suited for experimental purposes or limited production of specialized products, it is not sufficiently economical for regular commercial use.

248 -- Bin drying

No matter how the major drying operation is done, the dried products (containing approximately 10% moisture) are usually given a drying and equalizing treatment preceding the actual packaging. Bin driers are commonly used for performing this operation largely for reasons of operating economy. The bin drier is essentially a metal or wooden box equipped with an air inlet at the bottom so that warm dry air can be passed through the nearly-dry bulk product.

This operation serves a dual purpose:

a) Removes the last small quantities of water (down to the desired moisture content in the finished product)

b) Equalizes the final moisture content of the finished product so that each piece contains approximately the same percentage of moisture

260 — Packaging and Packing

After the products have been dried and "conditioned" to the desired moisture content (usually 2% to 7% moisture, depending on the commodity specification), they must be packaged under conditions that assure freedom from contaminants and the uptake of moisture.

Since oxygen causes deterioration during storage, the container should be as free from air as possible. The replacement of air in the container with an inert gas (such as nitrogen or carbon dioxide) has been found advantageous for some products. In general, vacuum packing has not been found practical from a military standpoint.

The packaging must be of material and construction that will protect the dehydrated products against vermin, rodents, rain, sea water, the ingress of air and moisture, and other contingencies of military handling and storage.

Dehydration reduces the weight of vegetables and fruits to 5% to 20% of their fresh weight but results in products that are relatively bulky. For example, a 5-gallon container normally packed by vibration will contain approximately three pounds of dehydrated cabbage shreds, or 10 to 12 lbs. of beets or carrots in julienne strips, or 15 to 18 lbs. of beets or carrots in the diced form. Reduction of the bulkiness of such products has obvious advantages.

Methods have been developed for compressing certain dehydrated products. For instance, shredded vegetables (such as cabbage) have been compacted within the container by means of a hydraulic plunger to reduce the bulk to about one-fourth to one-half the bulk of the uncompressed dehydrated material.

Some dehydrated fruits and vegetables can be compressed even more, in the form of "bricks" of moderately high density, without giving rise to rehydration problems and without detracting from the quality of the reconstituted product.

Compression not only reduces the space requirements for containers, but also reduces the oxygen-to-solids ratio thus tending to minimize deterioration due to oxidation.

The principal disadvantage of extreme compression is that some highly compressed products are difficult to rehydrate quickly and uniformly. Another disadvantage is that compression causes fracturing of certain dehydrated products so that they will not reconstitute to form pieces of acceptable size and texture.

270 -- Warehousing and Shipping Finished Products

Deterioration of dehydrated vegetables and fruits starts before the drying process has been completed, and continues until the product is used or discarded. Blanching, sulfiting, starch coating, drying to an adequately low moisture content, packing in a tight container in an inert gas atmosphere, and storage at proper temperatures are employed to extend the useful life of the product. No single one of these is fully effective in itself; the proper combination of these control measures is necessary for each product.

Process requirements for blanching, sulfiting, starch coating, and gas packing have been established for the vegetables of primary concern and have been largely incorporated into the purchase specifications. The maximum permissible moisture content for each product is also specified. However, the useful life of the product may be extended by a factor ranging from 1.5 to as much as 4, depending upon the vegetable, by drying the product to a moisture level which is 2% below the currently specified moisture content. Such levels can not be obtained practically using present dehydration procedures.

The most important factor contributing to long storage life, and the only factor which may be controlled after the product is packed, is storage temperature. Proper storage and shipment of dehydrated vegetables is essential to the maintenance of acceptable quality in the products, otherwise the protective measures applied during processing are of little value. Proper storage means storage under cool conditions, preferably below 70°F.

The rate at which the most common dehydrated products (packed in nitrogen) deteriorate increases very rapidly as the storage temperature increases, as shown in the following generalization:

Storage Temperature (°F.) --	75	80	90	100	110	120
Approximate Relative Storage Life --	100	50	18	8	3	1

Obviously, exposure of dehydrated vegetables and fruits to high temperatures, even for a short time during storage or shipment, should be avoided. The product will remain palatable 100 times as long at 75°F. as it will at 120°F. The life of the product is halved if the storage temperature is increased only from 75°F. to 80°F. Proper care of dehydrated products during storage and shipment can not, therefore, be overemphasized.

Reconstitution and Cooking Principles

Restoring the water to dehydrated foods is known as "reconstituting" (sometimes as "rehydrating" or "refreshing") and is the first step in preparing them for consumption. A properly dehydrated food will absorb enough water when reconstituted to restore it almost to the original form and texture of the freshly-prepared food. Reconstitution of fruits and vegetables may be accomplished by (a) soaking in water, (b) absorption of water during the cooking process, or (c) combination of soaking and cooking.

In general, the need for any water-soaking prior to cooking is governed by the size, structure, and composition of the dehydrated food piece. The soaking process is held to a minimum to reduce leaching losses of nutrient materials, to save time, and to avoid the general disintegration of the food pieces during subsequent cooking.

Some dehydrated products (such as cranberries, potato granules, and apple slices) may not require a preliminary soaking treatment as sufficient water is absorbed during the cooking process. On the other hand, some dehydrated foods (such as cabbage, onions, and many fruits) may require a soaking period for as long as several hours prior to cooking.

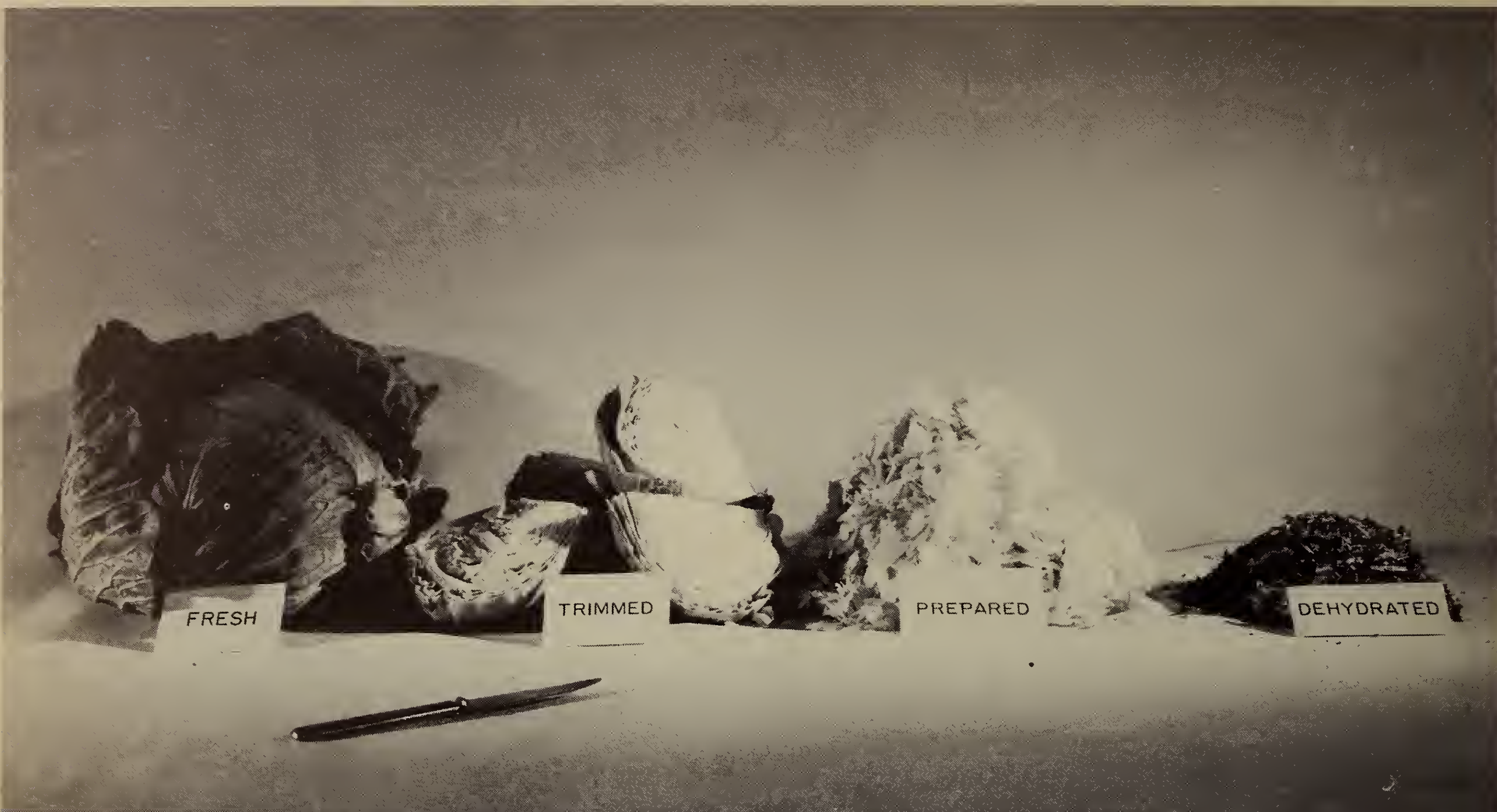
Cooking of dehydrated foods should largely follow modern practices for the same kinds of fresh foods. Three general principles for retaining good texture, optimum nutrient values, and desired flavors are:

1) Use the specified amount of water

2) Cook in same water used for soaking

3) Cook only until tender

A properly dehydrated fruit or vegetable that has been stored under suitable conditions can be reconstituted and cooked to give an attractive, flavorful, and nutritious food highly acceptable to the consumer. The accomplishment of this goal is not an accident but results from the diligence and application of skills of all involved -- the grower, the processor, the storage-and-transit handler, and the cook.



"A comparison of fresh, trimmed, prepared, and dehydrated cabbage."
(Courtesy of WESTERN CANNER AND PACKER)

"A graphic illustration of the great reduction in space gained through dehydration. The truck-trailer load of fresh cabbage, when dehydrated, will be reduced to the 'Jeep' load shown in the foreground."
(Courtesy of WESTERN CANNER AND PACKER)

CHAPTER IV

GUIDING PRINCIPLES FOR PLANNING AN EMERGENCY DEHYDRATION PLANT

The primary aim of the material presented in this Dehydration Handbook is to provide basic planning for establishing plants that are reasonably certain to produce products, under emergency conditions, of the required quality and quantity.

Information presented in this Handbook is considered to be the best of available and approved commercial practices that can be used readily by newcomers. These suggested plant plans are not necessarily similar to those that an experienced operator might follow. For example, an experienced dehydrator might successfully adopt some operations not yet in actual commercial practice, but a newcomer to the field of dehydration should attempt to use only well-established practices.

The plans, estimates, and procedures suggested in this Handbook have been based upon these guiding principles:

1. Primarily, from the standpoint of the military procuring agencies, a plant must be capable of producing acceptable quality products in accordance with scheduled requirements. No process or plant should be considered that cannot meet these needs. To help assure this, the procedures and facilities should be clearly beyond the experimental stages of development.

2. Since it is impossible to calculate in advance how long an emergency period may last, it is imperative that the facilities be built as substantially as practical under emergency conditions. In general, such plants should be as durable as those producing for todays' civilian markets.

3. The plants should be built in such a manner that a minimum of critical materials, utilities, and services are needed. The general circumstances and specific location of the plant will determine which items, and to what extent, are critical at the particular time. Among those items that are likely to be in short supply, at least in some areas, are: basic metals, rubber, lumber, cement, motors, electrical supplies, and any equipment that requires intricate machining or fabrication. The labor supply probably will be critical, the degree depending upon location and existence of competing industries. The supply of utilities (fuels, electric power, and water) is usually critical during an all-out emergency period. Operating supplies such as packaging materials, caustic soda, and chlorine are always scarce items during such times.

4. The plant should be constructed to operate as efficiently as practical to achieve. This is desired not only to minimize monetary cost but also to conserve raw commodity, supplies, utilities, labor, and other services. In an emergency, waste of manpower and materials likely will be more serious than the high monetary cost incurred.

TABLE I

Summary of Estimated Total Capital and Credit Requirements for Vegetable and Fruit Dehydration Plants 1/

	Beets (Type I-Diced) 100 Tons/day		Cabbage (Shredded) 100 Tons/day		Carrots (Type I-Diced) 100 Tons/day		Onions (Type I-Flaked) 100 Tons/day		Potatoes (Type I-Diced) 100 Tons/day		Sweetpotatoes (Type II-Diced) 100 Tons/day		Cranberries (Type II-Sliced) 50 Tons/day	
Fixed Capital and Credit Requirements:														
Plant Equipment	$438,700		$250,000		$287,000		$365,000		$284,000		$612,400		$ 186,000	
Buildings & Grounds	190,000		155,000		180,000		235,000		210,000		205,000		130,000	
Construction Engineering Fees	30,000		30,000		30,000		30,000		30,000		30,000		20,000	
6-Months General Expense	37,300	$ 696,000	46,000	$ 481,000	52,000	$ 549,000	45,000	$ 675,000	52,000	$ 576,000	47,100	$ 894,500	34,000	$ 370,000
Operating Capital and Credit Requirements:														
Estimated Advance Payments to Growers, Insurance, Utilities, etc.	25,000		25,000		25,000		25,000		25,000		------		25,000	
75-day Operating Cost	520,000		487,500		573,500		778,000		750,000		900,000		1,125,000	
75-day Supply of Raw Commodity	------		------		------		300,000		------		450,000		------	
25-day Inventory of Manufacturing Supplies	22,500	567,500	23,500	536,000	27,500	626,000	24,000	1,127,000	42,500	817,500	44,500	1,394,500	16,000	1,166,000
Sub-total		$1,263,500		$1,017,000		$1,175,000		$1,802,000		$1,393,500		$2,289,000		$1,536,000
General Contingency Fund: (Approx. 10% of sub-total)		126,500		100,000		120,000		180,000		139,500		230,000		154,000
ESTIMATED TOTAL CAPITAL AND CREDIT REQUIREMENTS		$1,390,000		$1,117,000		$1,295,000		$1,982,000		$1,533,000		$2,519,000		$1,690,000
	(15,400 pounds of product per day at 45¢ per pound)		(10,000 pounds of product per day at 65¢ per pound)		(18,200 pounds of product per day at 42¢ per pound)		(14,815 pounds of product per day at 70¢ per pound)		(28,600 pounds of product per day at 35¢ per pound)		(33,400 pounds of product per day at 36¢ per pound)		(10,000 pounds of product per day at $1.50 per pound)	

1/ Estimated total cash, credit, and other assets needed to establish the plant and operate it the first season. No allowances have been made for depreciation, interest, ~~etc.~~

CHAPTER V

BUSINESS CONSIDERATIONS

Preliminary Questions

A. How Successful is a Dehydration Venture Likely to Be?

The varied successes that were experienced by the dehydrators who started in the dehydration business during World War II ranged from complete failures to highly successful and profitable enterprises. Many factors contributed to these varying degrees of success. Among the factors that contributed to the failures are the following:

1) Inadequate working capital. Even though the plant may be completely paid for, the need for capital is large. The output from a 100-ton per day (raw basis) potato dice plant will cost around $10,000 a day. Obviously a great amount of working capital is needed for such a scale of operation. A prospective dehydrator must not venture into this business unless he has an ample supply of necessary funds or definite assurance of funds or credit from reliable sources. Not only must normal operation be covered, but also many possible costly contingencies.

2) Inadequate, unsuitable, or poorly arranged plant facilities. The importance of proper engineering is evident.

3) Poor raw material purchasing practices.

4) Careless or ignorant management.

5) Poor location of plant with respect to raw material.

6) Costly fire losses stopping plant operations.

7) Emergency shortages and delays in obtaining equipment, raw material, packaging supplies, and labor.

8) High cost of production — often the result or existence of one or more of the above factors.

9) Poor location of plant with respect to sewage disposal. One plant, at least, was forced to suspend operations because it had no suitable way of disposing of its liquid wastes.

Much could be written about each of the foregoing factors. One of the purposes of this Handbook is to point out what must be done to avoid these pitfalls. The prospective dehydrator must inquire further into each of these factors for the particular situation he is evaluating. His ultimate success will depend upon the care he has taken to avoid these as well as other causes of failure.

The dehydration plants that were properly set up during World War II experienced very successful and profitable operations. It is obvious, therefore, that during emergency conditions such as those found during World War II, a dehydration venture has a reasonable chance for success provided that the requisites for successful operation are available or are provided for.

B. What Does It Cost to Get Into This Business?

For plants of 100-tons per day capacity (raw commodity) considered in this Handbook, the building and equipment costs range from slightly less than a half million dollars to nearly a million dollars depending upon the commodity and upon the type of dehydrator used. Total capital and credit requirements are estimated to range from over a million dollars to two and a half million dollars. It is evident, therefore, that such a dehydration plant cannot be built and operated on a "shoe-string". Unless the prospective dehydrator is prepared to consider an investment of the magnitude mentioned, he should stay out of the vegetable or fruit dehydration business. Obviously there are many ways of reducing the amount of capital required; but unless investment economies are made prudently, the dehydrator may end up with an unprofitable operation. The dehydrator should maintain good relations with the local banks because they may be in a position oftentimes to render a great deal of assistance.

C. How Complex is the Dehydration Business?

Organic materials with a high degree of perishability are processed in these dehydration plants. Furthermore, slight differences in operating procedures may make the difference between the production of an acceptable or unacceptable end-product. It is important, therefore, that management and technologic skills of high caliber be obtained. Up to 100 people per shift are employed in the plants contemplated in the Supplements of Volume II.

Processes range from highly automatic to completely manual. Expert advice on equipment and processes is mandatory.

D. Can the Plant be Used in Off-Season?

It is recognized that an idle plant is a costly one and that year-round operation would be desirable. Location of the plant in an area where raw commodity supplies are available during a long harvest season is advantageous. Additional types of commodities, however, are not available in either sufficient quantity or satisfactory quality in such areas. The best white potatoes for dehydration, for example, are grown in the northern states; the same statement applies to cranberries, beets, and apples. White potatoes are available from storage for a sufficiently long period of time to permit the plant to run eight or nine months a year. Beet and cranberry dehydration plants, on the other hand, probably could not run over four months a year.

In general, the food processing industry is highly seasonal. Some vegetable and fruit plants run only six weeks a year, yet they are apparently operated profitably. With such a record of highly seasonal production in food processing, it is unreasonable to assume that emergency dehydration plants could do much to find satisfactory off-season operation. Probably the best solution lies in the use of the plants to dehydrate other commodities. The beet plant might operate on white potatoes from storage for four months of the year provided that the plant is originally set up to handle potatoes satisfactorily and that suitable potatoes are available at reasonable cost. The cranberry dehydration plant might be used in off-season to make sauce and juice from frozen cranberries.

E. How Long Does It Take to Get Started in This Business?

The estimates of capital requirements in this Handbook assume that six months will be needed to build the plant and get it into operating condition. Preliminary surveys, planning, and engineering may take an additional six months. Delays in building or receiving equipment may greatly increase the time needed to get the plant in operation.

One of the special problems involves the procurement of suitable raw commodity supplies. A whole year may be required, from the time of activating plans for a dehydration enterprise, to place contracts for and obtain the raw commodity from the growers. If price considerations are waived, a plant may be able to get into production much quicker by buying at least its first season's commodity requirements on the open market.

Relation of Federal Agencies to the Establishment and Financing of Emergency Production Facilities

The information given herein concerning Federal agencies, laws, and procedures for establishing national emergency plants is only a broad guide. Changes may be expected from time to time in these matters to fit changing world conditions.

Until recently the Reconstruction Finance Corporation has had the responsibility for Federal assistance in the financing of private industries. In general, this agency has followed the practices of banking institutions, i.e., usually financing to a maximum of 40% to 60% of the fixed capital requirements and rarely granting money for operating needs.

During 1950 the increased requirements for the national preparedness program became so critical that the usual Reconstruction Finance Corporation handling of finances was found inadequate, and a new pattern was established for investigating and granting such loans. The Administration's broad plan has been to grant existing government organizations the authority for investigating and granting loans to private industry, rather than to create many new agencies which might have conflicting or paralleling responsibilities.

Since November 1950 there has been, of necessity, considerable re-organization and re-assignment of such responsibilities to different Federal agencies. However, since January 1951 the general organization structure and definition of responsibilities seem to have attained a practical working basis for expanding American industry to meet the national preparedness needs.

At the top of the industrial mobilization structure is the Office of Defense Mobilization. There are two agencies under the Office of Defense Mobilization which are primarily responsible for expanding or creating industrial production: (1) the Defense Production Administration and (2) the National Production Authority.

A. Defense Production Administration

This agency is responsible for the over-all planning for defense production. In addition to general planning, production scheduling, and general administration of all defense production activities, it also makes final decisions concerning applications for Federal loans to expand any industrial production needed in the defense effort. It passes final judgment on the amount of loan (if any) and the extent of tax amortization (granting certificates of necessity according to its opinion of the justification), determines the method for repaying loan, sets the rates of interest to be paid, and passes on all other requirements for the making and retiring of the loan.

B. National Production Authority

This organization, set up as a part of the Department of Commerce, actually authorizes all construction of new buildings (type of construction, availability of materials, and other requirements). Applications for construction of buildings under $1,000,000, or requiring less than 50 tons of steel, are filed at the local regional National Production Authority office of the applicant; all applications above that amount are made direct to the National Production Authority Headquarters in Washington, D. C.

National Production Authority acts in a similar capacity for allocating and making available any critical equipment, and assists in actually obtaining such equipment needed for an essential production enterprise.

National Production Authority, responsible for defining basic allocations of materials and equipment, has designated a single-band priority system known as the Defense Order (D.O.). Authorization for granting these Defense Order priorities has been extended to:

1) Department of Defense
2) Atomic Energy Advisory Commission
3) Atomic Energy Commission Contractors
4) National Advisory Commission for Aeronautics
5) Coast Guard

C. Other Industrial Mobilization Agencies

Obviously, the two top administrative organizations (DPA and NPA) can not handle directly all of the many applications for permission to construct facilities or for Federal financial assistance in such enterprises. It has been necessary, therefore, to establish suitable channels for screening and carefully considering them. In general, four organizations have been designated as having this primary responsibility regarding priorities, allocations, and requisitioning operations:

Department of Commerce (Secretary)	Department of Interior (Secretary)	Department of Agriculture (Secretary)	Defense Transportation Administration (Administrator)
Production and distribution of industrial products (except as otherwise designated); air transportation; coast-wise, intercoastal and overseas shipping	Petroleum; solid fuels; power; minerals and metals; commercial fisheries	Food for human and feed for animal consumption; domestic distribution of farm equipment and commercial fertilizer; food for industrial use	Domestic surface transportation, storage, and port facilities

D. Suggested Procedures for Obtaining Authority and Financial Assistance to Construct a Food Dehydration Plant

1) Obtain, if possible, an official letter from the Office of The Quartermaster General, Washington, D. C., requesting that these new production facilities be made available to meet the critical needs of the Armed Forces for the products which the proposed plant will produce. Wherever possible, include production schedule requirements for this proposed plant to meet Quartermaster Corps contracts. Make photostatic copies of the Quartermaster Corps letter and the production schedule requirements, and attach these to each application form filed (as detailed below).

2) Apply to National Production Authority for authority to construct the needed buildings and facilities.

3) Amortization Possibilities

The following laws and regulations are applicable: Public Law 814, Section 216, 81st Congress, 2nd Session (cited as the "Revenue Act of 1950"); Regulation "Part 600 — Issuance of Necessity Certificate under Section 124A of the Internal Revenue Code".

A Necessity Certificate may be issued to cover the cost of constructing or expanding a facility which is needed (a) to produce materials required for national defense and (b) to meet existing or prospective shortages in productive facilities as compared with requirements. If a facility meets both of these basic criteria, the portion of the cost which would be certified depends primarily upon the probable usefulness at the end of the emergency period.

There is no blanket regulation governing the extent and amount of amortization (for tax purposes) which may be granted. Each application is decided on its own merits and treated as an individual case.

Certificates issued by the National Production Authority to date have ranged from 25 to 100 per cent of the cost of the facility, and permit amortization for income tax purposes of the specified portion of the cost during a stipulated period plus normal amortization on the balance of the cost.

Amortization for income tax purposes applies only to depreciation of capital assets and has no bearing on operating capital.

Application for a Necessity Certificate is made to the Division of Defense Expansion, Defense Production Administration, Washington 25, D. C. Proper application forms are available at Department of Commerce and at state offices of Production Marketing Administration, U. S. Department of Agriculture.

Direct inquiry should be made by the prospective dehydrator, through the Federal agency which will purchase the products produced by the proposed plant (assumed to be the Quartermaster Corps in the case of dehydrated fruits and vegetables), concerning amortization possibilities at the time such a plant is being considered.

4) General Information Concerning Federal Loans

In cases where there may be need for Federal financing assistance, the following Federal laws are applicable: Public Law 774, Sections 301 and 302, 81st Congress, 2nd Session (cited as the "Defense Production Act of 1950"); Regulation "Part 601 — Loans under Section 302 of the Defense Production Act of 1950".

The extent of a Federal loan, if any, will depend upon the factors in each individual case such as amount required, equity investment, collateral, past and prospective earnings, etc. Each application is an individual case.

5) Possibilities for Obtaining Fixed Capital Loans

Federal financing for fixed capital requirements may be obtained from two Federal sources:

(a) Reconstruction Finance Corporation, if the applicant's financial status meets the requirements for a regular "4(a)" loan

(b) Department of Agriculture under authority of Section 302 of the Defense Production Act of 1950, if funds are not available from normal commercial sources or from RFC.

For a food dehydration plant loan, file application with the Office of Materials and Facilities, Production and Marketing Administration, U. S. Department of Agriculture, Washington 25, D. C. (application forms are obtainable at RFC field offices, at Dept. of Commerce field offices, and at state PMA offices).

6) Possibilities for Obtaining Operating Capital Loans

(a) Application forms and suggestions concerning loans for operating capital requirements are obtainable at Federal Reserve Banks.

(b) The Department of Defense can indirectly assist in loans for operating capital needs by acting as the guaranteeing agency under Section 301 of the Defense Production Act of 1950, for a private or public loan to provide operating capital needed to carry out deliveries under a government contract.

E. Other Information Concerning Defense Financing

The following information is taken from "How to Sell to the United States Army" issued October 1, 1951. It is a pamphlet designed to assist the business man as to the procedure for negotiating with and doing business with the Army.

The Government desires to help contractors with financing when necessary, and has employed the methods outlined below for achieving this goal. A prospective contractor should communicate with the contracting officer for his district, a government small-business specialist, or his local bank for additional information.

Partial payments may be made by the Army under certain circumstances to a contractor after a portion of the total quantity of supplies or services have been accepted by the Army, rather than have the contractor wait until the entire contract has been completed before he receives payment.

Progress payments may be made by the Army under certain circumstances to reimburse a contractor for a percentage of such costs as tooling up, inventory purchases or commitments, or valid costs in connection with work in process prior to actual delivery of any of the supplies or services called for in the contract. A lien is given in favor of the Government in connection with the assets against which the progress payments are made.

In order to facilitate the defense effort, a program of guaranteed loans patterned after the V-Loan program of World War II has been inaugurated. Under the authority of Public Law 774 of the 81st Congress and Executive Order 10161 dated 9 September 1950, the Department of the Army is authorized to guarantee loans to be made by banks or other financing institutions for the purpose of financing contractors, subcontractors, and other persons in connection with the performance of any contract deemed by the Army to be necessary to expedite production and deliveries or the performance of services for the National Defense. Guarantee of loans under this law will be made by the Department only to the extent reasonably required for prompt and efficient performance of Government contracts. Loans will be guaranteed in cases where the production or service is essential and no alternative source is readily available.

Advance payments may be made by the Army under certain circumstances in the form of loans or advances prior to and in anticipation of complete performance of a contract, and can be made prior to any performance or monetary obligation by the contractor regarding a particular contract. They are only made in limited cases, and there must be a clear need for such a payment. Furthermore, such advance payments may create a lien by the Government against the company, and will be made only against adequate security.

Depreciation Factors

The amount of yearly depreciation charged off for income tax purposes is of utmost importance, from a financing standpoint, for a plant established to produce goods needed in a national emergency. The financing of many types of emergency plants may be predicated upon reasonable assurance that the facilities will be all or largely amortized during the period of the emergency.

Depreciation has not been included in the cost estimates for the plants covered in this Handbook because of the uncertainty as to what portion of the facilities costs may be granted accelerated amortization. The cost figures presented, therefore, are incomplete. A proper allowance for depreciation must be made, before total production cost can be calculated.

For the dehydration plants discussed in this Handbook, two possibilities exist for determining the write-off period that may be allowed for Federal income tax purposes: (a) normal useful life expectancy; or (b) an accelerated write-off. Calculations are made in the Supplements of Volume II to illustrate what the depreciation charges would be for each period of write-off. It is probable, however, that obsolescence plays bigger part in the useful lives of property in dehydration plants than indicated in write-off period (a). The actual write-off time used by plants, therefore, is probably less than considered in calculations (a).

A. Normal Useful Life Expectancy

The consumption of trade or business capital represented by depreciation is recognized by the Bureau of Internal Revenue as an operating cost that should be deducted in the computation of each year's net taxable income in a business operated for profit. The Internal Revenue Code defines depreciation as follows: "Depreciation — A reasonable allowance for the exhaustion, wear and tear of property used in the trade or business, including a reasonable allowance for obsolescence."

Two principal forms of obsolescence are recognized: (1) normal obsolescence such as would be attributable to the normal progress of the art, economic changes, inventions, and inadequacy to the growing needs of the trade or business, and (2) extraordinary or special obsolescence which may be caused by revolutionary or radical changes unforeseen and unpredictable by their nature when the property was acquired. Only the first form mentioned (normal obsolescence) is included in the allowable depreciation charge together with the allowance for physical wear and tear. Deductions for extraordinary or special obsolescence may be charged over the period beginning with the time such obsolescence is observed and ending with the time the property becomes obsolete. One recognition of this extraordinary obsolescence is the granting of accelerated write-offs as discussed in "B. Accelerated Write-Off".

The allowable charge for depreciation is calculated by spreading the net cost of the property over its estimated useful life. This net cost is the original installed cost plus any additions, improvements, and betterments, minus estimated salvage value at the end of its useful life. The period of time over which the cost of the property is spread is called the write-off period.

For depreciation calculations in the usual peace-time manner, an indication of the expected useful lives of buildings and equipment is given in Bulletin "F" — Income Tax Depreciation and Obsolescence Estimated useful Lives and Depreciation Rates, issued by the Bureau of Internal Revenue, U. S. Treasury Department. The rates given in that publication are not to be considered as actual for any particular case. The rates given, however, will serve as a general guide for calculating the normal rates for depreciation. A summary of the life-expectancy period for the buildings and various items of equipment likely to be needed by a vegetable or fruit dehydration plant is given in Table #I at the end of this section.

There are many methods for apportioning the total amount to be depreciated over the normally estimated life of the property. These methods are reviewed on pages 751 to 778 of Accountants' Handbook edited by W. A. Paton (published by The Ronald Press Company, New York, 1943). The methods most generally in use also are discussed in Bulletin "F" previously cited. The Bureau of Internal Revenue does not require that any specific method be used, but the method used must be reasonable and cannot be changed in subsequent years without the approval of the Commissioner of Internal Revenue. Commonly used methods include:

1) The most commonly used method is the Straight-Line Method in which the amount to be depreciated is divided equally over the life of the property. This method is in very wide use, is essentially reasonable, and is simple to understand and apply. The method is claimed to have the following disadvantages: (a) the amount charged to operation will accumulate more, if placed on interest, than the amount to be depreciated; (b) the asset will usually require greater repairs in later periods, and thus the method will not result in uniform operating charges (including maintenance); and (c) production may vary from season to season and from year to year, with resulting relatively high cost per unit of output when production is low. 1/ The second objection, see (b), will undoubtedly be more serious when the capital investment is represented by a few large items. When the plant is made up of a large number of individual items and where replacement is fairly evenly divided over the years, this objection would have less significance.

1/ See page 753, Accountants' Handbook, edited by W. A. Paton, The Ronald Press Company, New York, 1943.

2) The Unit of Production Method will overcome the third objection to the straight-line method. Use of this method, however, must be confined to those items of property whose lives are determined by the factors of wear and tear or where the extent of use or rate of production measures the rate of exhaustion of the property.

   A variation of this method is the "time-used" basis, wherein the life of the asset is estimated in hours and the cost to depreciate is spread on the basis of hours the property is actually used.

3) Another method provides for a Diminishing Depreciation Charge each accounting period. There are several variations of this method, but each accomplishes somewhat the same objectives: (a) to adjust the depreciation downward each year as maintenance costs increase so that a more constant total annual charge is possible for both depreciation and maintenance, and (b) to fit better those instances in which property has a greater proportion of the production confined to the early part of the useful life.

4) Other methods, more complex, involve the factor of interest. One is the Sinking-Fund Method, wherein the sum of the annual depreciation charges plus accumulated interest (assuming a fund is being built up) will equal the amount to be depreciated.

   The Accountants' Handbook, page 753, states, "The practical value of such (interest) methods ... is minimized by the variety and complexity of depreciable property found in many enterprises, and by the difficulty of estimating earning power. They are most reasonable when applied to costly and relatively long-lived units such as a railway terminal or large bridge, or to assets having a contractual income such as a building yielding a fixed rental."

The wide-spread use of the Straight-Line Method, its simplicity, and its reasonableness in most cases make this a preferred method for these types of plants. Special or unusual circumstances would have to exist in order to justify the use of a more complicated method in an industry such as dehydration. Regardless of what method is used, the differences in actual total operating costs will be relatively insignificant when the facilities have reached a normal status of replacement, repair, and maintenance. This statement is especially applicable to an emergency plant that may be closed down before the property has become worn-out or fully depreciated. Whether or not an accelerated write-off can be taken is, therefore, of greater importance than the method used for depreciation accounting.

B. Accelerated Write-Off

Accelerated write-offs of manufacturing facilities, during recent emergencies, usually have been amortized over a five-year period. The amount of accelerated write-off permitted has varied from 25% to 100% of the total cost of the facilities — the actual percentage allowed being based upon the need for the products to meet the national security requirements and upon the anticipated post-emergency opportunities for the plant's products. A discussion of the procedures employed to obtain the necessary approval has been given previously in "Relation of Federal Agencies to the Establishment and Financing of Emergency Production Facilities" of this chapter.

TABLE VI

Estimated Average Useful Life of Buildings and Equipment 1/

Item	Years
Food Processing Equipment	
Blanchers	10
Blowers	15
Casing machines	15
Choppers	12
Closing machines	15
Conveyors	15
Cookers	15
Corers	20
Crates, Process	10
Cutting tables & seats	15
Dicing machines	10
Dryers	15
Elevators, boot, bucket, or chain	15
Fans, blower or exhaust	15
Fillers, can	12
Graders	17
Hoists	20
Kettles, cooking	20
Labeling machine	15
Mixers	20
Parers	20
Pulp machines	15
Pumps	20
Retorts	25
Retort cars, steel	20
Retort trays, steel	10
Rinsers, rotary	15
Scalders	12
Scales, platform	20
Sealing machines	15
Seamers	12
Shakers	15
Sizers	15
Slicers	15
Sorters	17
Stencil machine	20
Tanks, cypress or redwood	17
glass lined	25
steel	25
Thermometers	10
Trucks	15
Washers	15

Item	Years
Factory Buildings	50
Warehouses	75
Office Equipment	
Safes and vaults	50
Furniture, etc.	20
Mechanical equipment	8
Restaurants, Bars, & Soda Fountains	
Average life from 10 to 14 years	
Motor Vehicles	
Passenger autos	5
Trucks - Light	4
Medium	6
Heavy	8
Trucks (inside)	15
Tractors	6
Farm tractors	10
Trailers	6
Agriculture Facilities	
Buildings	50
Equipment	15

1/ Income Tax Depreciation and Obsolescence Estimated Useful Lives and Depreciation Rates (Bulletin "F"), Bureau of Internal Revenue, U. S. Treasury Department, Washington, D. C., 1942.

Contingency Considerations

Every business enterprise should take cognizance of the likelihood of the occurrence of certain events and creation of conditions outside its ordinary procedures. Plants operating during a national emergency may have many of these unpredictable and out-of-the-ordinary situations to contend with, and certainly these emergency plants should provide in advance for means of meeting as many of these out-of-the-ordinary situations as practical.

Although each contingency is a specific problem, a great majority of them will come within categories which may be anticipated in a general way. Suggestions are given below, based upon experience gained particularly during World War II, concerning many of the possible realms in which such problems may be expected to occur in the operation of an emergency type dehydration plant. There is no attempt to list these contingencies in any order of importance or their likelihood of occurrence. Furthermore, by definition, no list of possible contingencies can be complete.

Personnel. Personnel problems may arise at any level — from the General Manager to the workers harvesting the field commodity. Perhaps one of the biggest problems may arise from personnel getting opportunities to work at other defense plants at higher skill levels paying more wages. Armed Forces recruiting also will take its toll of workers. Generally, wage levels are lower in food processing plants than in competing industries. The large number of unskilled workers needed, and the type of work done, make possible the employment of a big proportion of women workers.

Supply of Raw Material. The uncertainties of climatic conditions may seriously affect the date and rate of harvesting the raw commodity. There will be seasonal differences in the quality and quantity of raw commodity which will affect production rates and total plant output. There is a possibility of virtual crop failure.

During a season of generally short supply of a commodity, growers may break their contracts, with the resulting necessity of the dehydrator having to pay much higher prices for the commodity. Bumper crop production from contracted acreage will create storage or/and marketing problems for the excess commodity.

There are always the problems of getting sufficient seed, fertilizer, insecticides, irrigation water, and suitable land acreage to supply the commodity needs of the plant.

Waste Disposal. Changes in operating conditions or sanitation laws may seriously affect the disposal of wastes from a dehydration plant. Establishment of other manufacturing plants in the area may force the dehydration plant to change completely its methods for waste disposal. Enforcement of heretofore ignored regulations may prohibit further use of existing waste disposal methods.

Water Supply. Seasonal variation in rainfall or additional demands on the water source may curtail the supply of water to the dehydration plant. The water source may become contaminated to the extent it is unsuited for use in a food processing plant, or at least may require costly treatment prior to use.

Other Utilities. The total demand of the area for electric power or gas may increase during an emergency period to the extent that the dehydration plant can not operate at its expected rate. Break-downs in the utility supply facilities can cause serious production delays and markedly increase production costs. Operation under an "interruptible gas schedule" may result in occasional shut-downs unless a reserve supply of tank gas or oil is available to permit continuous plant operation.

Facilities. In any plant, there is always the possibility of break-downs of critically-short equipment. Replacement or expansion of facilities during an emergency is always difficult.

Patents. There is some possibility of incurring patent litigations or having to pay royalties for use of certain processes and equipment. An emergency type of plant producing for the Armed Forces, however, may get assistance in these problems from the Government contracting agency. A prospective dehydrator should make a careful investigation of the patent status of facilities and processes he proposes to use prior to establishing his plant.

Producing Products to Meet the Military Needs. Military requirements, of necessity, may be a constantly changing picture. Changes in specifications for the products may be necessary, and may require drastic changes in the processing steps. The needed quantities of the products may abruptly change, causing a re-negotiation of the original contract — for either more or less of the product.

There may be unexpected changes in packaging and packing requirements. Changes in shipping schedules may cause unexpected demands for warehousing finished products at the plant.

There is always a possibility that the finished products may not fully comply with the contract agreement. Such products may be rejected entirely, or paid for at a reduced price. During the period of making a final decision as to what is to be done with the questionable goods, there will be a tie-up of product, of management time, and of funds invested in the product.

Time Requirement for Receipt of Payment for Product. Government procurement during an emergency period is usually a complex procedure. Many people and groups are required to test and approve the finished product, to approve payment on the contract, and to make payment. Delays may occur at any point, and the dehydrator may experience considerable delay in actually receiving the money due him. At an expenditure rate of approximately $10,000 per day during the operating season, the dehydrator may tie up a very substantial amount of operating capital during the interim awaiting payment for delivered goods.

Contracting With The Government 1/

A. Basic Regulations

All procurement of the Armed Forces are governed by basic policies and procedures as set forth in a document called the Armed Services Procurement Regulations (ASPR). The Army has implemented the ASPR with a document which goes into more detail regarding Army procurement. This latter document is titled the Army Procurement Procedure. These two documents govern all Army procurement. They may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

1/ Items A, B, C, and D have been excerpted verbatim from "How to Sell to the United States Army", dated 1 Oct. 1951, generally available from all Department of Army procuring agencies.

B. Participation in Procurement

The Army has decentralized its procurement to many purchasing offices located throughout the United States, each responsible for the purchasing of certain classes of commodities. No central list of bidders is maintained in the Army. Each purchasing office keeps its own lists of the commodities it purchases and of prospective bidders who may be solicited when procurement is contemplated. The same list is used for both formally advertised and negotiated procurements.

To receive an opportunity to bid, the prospective supplier should communicate with the appropriate purchasing office and request that the name of his company be included on the mailing list of prospective suppliers to be solicited when requirements develop for those commodities he has to offer.

To insure best results, prospective bidders should submit lists by individual item rather than by category. This will help to obviate the possible inadvertent nonlisting of some specific item by the purchasing office which you, as a supplier, might consider as belonging in a category. You should also make sure that the item you offer is the type and quality desired by the Army. If possible, quote the applicable specification. It is reiterated that it is important to describe as completely as practicable the items on which it is desired to bid in order to receive complete coverage. All bidders lists are arranged by individual items or categories of items.

Solicitations are mailed only to listed potential suppliers of the items being purchased. However, individual copies may be obtained at the procurement office concerned by calling in person or by letter request.

C. Principal Methods of Effecting Procurement

The Army utilizes two principal methods of effecting procurement as outlined below.

1) Procurement by formal advertisement and competitive bidding

Procurement in time of peace is generally effected by formal advertising and competitive bidding. Formal advertising is especially effective in buying standard items such as nonperishable subsistence (including dehydrated foods), clothing, general supplies, and other commonly used items of a commercial nature or which are adequately described by specification. This method of procuring is as follows:

The purchasing office prepares a form called "Invitation for Bids" which contains data of the following nature: Name of purchasing office and location, invitation number, mailing date, date and hour and location where bids are to be opened, quantity and description of items to be purchased, reference to pertinent specifications, shipping schedules and destinations, packing and packaging requirements, standard clauses to be included in the contract, and other data pertinent to the particular purchase.

These Invitations for Bids are usually mailed in triplicate to the prospective suppliers whose names are included on the mailing list of bidders at the purchasing office. After receipt of these Invitations for Bids, the bidder then enters his prices and quantities in the space provided, together with such other information as may be called for on the Invitation for Bids form, and returns them sealed, in duplicate. If the prospective bidder does not desire to submit a bid on a particular invitation but does desire to continue to receive future Invitations on the same items, the Invitation should not be returned to the purchasing office; instead, a letter or post card should be sent to the purchasing office advising that future Invitations for the type of supplies or services covered by the Invitation are desired.

2) Procurement by Negotiation

Not all of the Army's requirements can be met by formal advertising and competitive bidding. There are 17 conditions under which exceptions from formal advertising are permitted. Some of these are a National Emergency, research and development contracts, purchases under $1,000, and purchases of perishable subsistence. All of these conditions are explained fully in the Armed Services Procurement Regulation and the Army Procurement Procedure.

As a basis for negotiation, the purchasing office will invite qualified sources of supply to submit quotations and may, in some cases, request that they be accompanied by estimated production costs. Suppliers whose proposals are low enough to be considered may be contacted, at which time the purchasing office will endeavor to secure the best possible contract, taking into account quality, delivery, price, business reputations, and other factors. By their nature, negotiated contracts often require individual tailoring to fit the circumstances involved in each instance.

The fact that a contract is negotiated rather than formally advertised does not mean that competition between suppliers is lacking. In most cases it merely means that the needs of the Armed Services cannot be satisfactorily met by the formal advertising procedures, but that they can be met by sitting down and working out an agreement with potential sources.

Procurement by negotiation is less automatic than, and does not have the rigid limitations of, formal advertising bid and award procedures. It allows to a greater extent than formal advertising the exercise of sound business judgment, but in no way decreases the responsibility for properly protecting the interests of the Government. Contracting officers conduct contract negotiations to the best advantage of the Government.

It is the policy of the Army to secure "close prices", which will be fair both to the Government and the contractor, and which will provide an incentive for efficient performance by establishing an adequate margin of profit and by eliminating allowances for contingencies to the greatest extent possible. The objective of this policy is to keep management alert in an effort to avoid increased costs, and to reduce costs, if possible, in order to increase the opportunity for additional profit.

Profit or fee allowances are determined separately under each contract, and "across-the-board" agreements with contractors as to rates of profit or fee are not made. The determination of a fair and reasonable profit or fee is a matter of sound business judgment. There are no conclusive rules or formulas which would be suitable for uniform application; however, in arriving at a fair and reasonable profit or fee, the following factors are considered:

a) Type of contract

b) Performance risks

c) Record of efficiency in production

d) Character and extent of subcontracting

e) Reliability of contractor's cost estimates

f) Equipment, facilities or financial assistance furnished by the Government

g) Invested capital

h) Possible present or future benefit to the contractor

i) Value added by the manufacturing processes

j) Contingency factors

B. Types of Contracts

Contracts, whether they result from advertised procurement or procurement by negotiation, follow the same general pattern. The final form of a negotiated contract will, in most instances, carry clauses in addition to those carried in advertised contracts, due to the necessity of tailoring to fit the nature of the item being procured or special circumstances involved.

1) Cost-plus-a-percentage-of-cost contracts are prohibited by law and are never used.

2) Fixed price contracts provide for a firm price or prices for the supplies or services which are being procured. The majority of Army contracts are of this type. Under some circumstances this type of contract will contain special provisions for redetermining upward or downward the price or prices in the contract. Price redetermination is used to obtain reasonable prices whenever contingency charges would otherwise be included in the contract price because of such factors as prolonged delivery schedules, unstable market conditions for material or labor, or uncertainty as to cost of performance. By use of the price redetermination feature, the Government assumes the risk of contingencies which a contractor would otherwise assume and would include in his contract price. The contract price is ultimately redetermined only to the extent that such contingencies actually occur. Price redetermination is also used to assure to the Government the benefits of reduced costs of performance.

3) Cost contracts provide for the payment to the contractor of allowable costs, to the extent prescribed in the contract, incurred in the performance of the contract. This type of contract is utilized only after it has been determined that this method of contracting is likely to be less costly than any other method, or that it is impractical to secure supplies or services of the kind or quality required without the use of such type contract.

4) Cost-plus-a-fixed-fee contracts are similar to cost contracts in that they provide for payment to the contractor of all allowable costs and establish an estimate of the total cost. These contracts differ from cost contracts in that they also provide for payment of a fixed fee

based on the estimated cost of the contract. This fixed fee does not vary with actual cost but only with a change in the estimated cost as a result of a change in the scope of work under the contract. This type of contract, as in the case of the cost type of contract, is used only after it has been determined to be less costly than other methods, or when it is impractical to secure supplies or services of the kind or quality required without the use of such type of contract.

5) Time and materials contracts provide for the purchase of supplies or services on the basis of (a) direct labor hours at specified hourly rates (which rates include direct labor, overhead and profit), and (b) material at cost. This type of contract is not used if any other type of contract is equally advantageous to the Government. Representative of the situations in which this type of contract might be used are engineering and design services in connection with the production of supplies, contracts for repair, maintenance, or overhaul, and contracts for the production of supplies in special cases of emergency.

6) Letter orders are preliminary contracts with tentative prices or specific amounts agreed to therein, and with such other basic terms set forth as can be agreed to at that time. A Letter Order authorizes the contractor to commence work, incur costs, and make commitments pending negotiation and execution of the final definitive contract. A Letter Order is superseded as soon as possible by a final definitive contract. It is used only when one of the following conditions exists: (a) when it is essential to give the contractor a binding commitment in order to permit him to commence work immediately; or (b) when the nature of the work involved does not permit the preparation of definitive requirements or specifications, thereby making it impossible to negotiate a final contract at that time.

7) Purchase orders. The Purchase Order as a contractual instrument in procurement is generally used where the contractor has previously furnished the Government with either an oral or written quotation, or the price of the item is based on a standard price list or catalog. The Purchase Order is usually used to secure ready-made or off-the-shelf items and contains short delivery schedules; this instrument may also be used where the total contract price is within certain limits and no special contract provisions are required which would unduly complicate the form.

8) Open-end contracts. This type of contract is used where the requirements of the Government fluctuate from time to time although it can be determined that a minimum procurement is desired. In effect, it is a continuing offer on the part of the contractor to furnish certain items to the Government, which must be delivered upon short notice.

E. Renegotiation Aspects and General Accounting Requirements of Contracts Subject to Renegotiation

Premise: The material submitted on this subject has been developed as it would concern prospective Contractors to whom awards will be made subject to the provisions of the Renegotiation Act of 1951. Notwithstanding the provisions of this Act, an effort has been made to generalize its essential factors in order to provide a concise and brief analysis for Contractor consumption.

1) Renegotiation aspects

a) In the role of taxpayer all Contractors to whom Government Contracts have been awarded are aware that sound execution of the National Defense Program requires the elimination of excessive profits from Contracts made with the United States of America and from related subcontracts in the course of said program.

b) By act of Congress, therefore, the renegotiation of Contracts has been lawfully adopted as the method whereby, in the interests of the National Defense and the General Welfare of the Nation, such excessive profits would be determined and eliminated. The term "excessive profits" means the portion of profits derived from contracts and subcontracts which are determined to be excessive.

c) All publicly advertised requests for bids or proposals clearly indicate whether the resultant contract award is subject to the renegotiation Act. All contracts and subcontracts thereunder are subject to renegotiation unless they are exempt. The resultant contract will contain, if applicable, an article entitled "Renegotiation" which clearly indicates that the contract (and subcontracts as required) is subject to the Renegotiation Act and all of its provisions.

d) The determination of excessive profit is a prime duty of the Renegotiation Board, to which members are appointed by the President. The Renegotiation Board may delegate in whole or in part certain of its powers, however, no delegation or redelegation of any function, power or duty will be made to any person directly concerned with procurement functions or to any person engaged on behalf of any Department in the making of contracts for the procurement of supplies or services.

e) In determining excessive profits favorable recognition will be given to the efficiency of the contractor or subcontractor with particular regard to attainment of quantity and quality production, reduction of costs, and economy in the use of materials, facilities and manpower. In addition, there will be considered reasonableness of costs and profits with particular regard to volume of production, normal earnings and comparison of war and peacetime products; the net worth, with regard to the amount and source of public and private capital employed; extent of risk assumed, including risk incident to reasonable pricing policies; nature and extent of contribution to the defense effort, including inventive and development contributions and cooperation with the Government and other contractors in supplying technical assistance; character of business, including source and nature of materials, complexities of manufacturing technique, character and extent of subcontracting, and rate of turnover; such other factors the consideration of which the public interest and fair and equitable dealing may require.

f) The provisions of the Renegotiation Act of 1951 are applicable to all contracts and related subcontracts unless otherwise exempt, to the extent of the amounts received or accrued by a Contractor or subcontractor on or after the first day of January 1951, whether such contracts or subcontracts were made on, before, or after such day. After 31 December 1953, however, the provisions of the Renegotiation Act of 1951 shall not be applicable to receipts or accruals attributable to performance under contract or subcontracts. Any amounts received or accrued by a Contractor or subcontractor on or after the first day of January 1951 which are attributable to performance, under such contracts, prior to 1 July 1950 are not subject to the Renegotiation Act of 1951.

g) Renegotiable type of business of $250,000 or less is exempt from the provisions of the Renegotiation Act of 1951 and renegotiation of a larger amount may not reduce the aggregate selling pricing below $250,000.

2) Government Accounting Requirements

a) Profits derived from contracts and subcontracts and from which excessive profits will be eliminated means the excess of the amount received or accrued under such contracts and subcontracts over the costs paid or incurred with respect thereto or determined to be allocable thereto.

b) Costs are determined in accordance with the method of accounting regularly employed by the contractor or subcontractor in keeping records. If no such method of accounting is employed, or if the method so employed does not, in the opinion of the Board properly reflect such costs, such costs shall be determined in accordance with such method as in the opinion of the Board does properly reflect such costs.

c) The Renegotiation Board has the right to audit the books and records of any contractor or subcontractor subject to Renegotiation for the purpose of making examinations and audits under the Renegotiation Act.

d) Persons who hold contracts or subcontracts subject to Renegotiation shall in such form and detail as the Renegotiation Board may be regulations prescribe, file with the Board not later than the first day of the fourth month following the close of his fiscal year a financial statement setting forth such information as the Board may by regulation prescribe as necessary to Renegotiation. The contractor's or subcontractor's fiscal year constitutes the renegotiable year unless the Board and the contractor or subcontractor agree otherwise. In addition every such person shall, at such time or times and in such form and detail as the Board may by regulations prescribe, furnish the Board any information, records or data which are also determined by the Board to be necessary to Renegotiation.

e) The costs, allowances and deductions allowed under the Renegotiation Act of 1951 are those allowed for income tax purposes which are allocable to renegotiable business except for the loss carry forward and carry back.

Financial Requirements

The estimates of capital and credit requirements that are presented in this Handbook are based upon normal operating conditions and make no allowances for the many contingencies that a plant must face and for the obviously higher operating costs that a new plant will experience. In order for the prospective dehydrator to estimate more accurately the capital and credit requirements for his particular situation, he should analyze the figures given in the summary table in light of the discussion in this chapter on "Contingency Considerations" and the discussion in Chapter XI on "Operating Costs in New Plants".

A. Fixed Capital and Credit Requirements

It is assumed that all costs incurred in establishing the physical facilities to the point of operating conditions are considered as fixed capital requirements. In addition to key personnel of plant, it may be necessary to use outside consulting services while getting the plant into actual operation. It is assumed that having such services available during the 6-month period preceding the first operating season will be sufficient for getting the facilities into operating condition. (Such services also may be needed to improve processing, reduce costs, and render other assistance during the operation of the plant.)

The prospective dehydrator is warned, however, that he may incur many additional expenses before he gets the plant into satisfactory operating status. Price changes and various contingencies may materially affect the total fixed capital requirements estimated in original plans.

B. Operating Capital and Credit Requirements

There are many factors involved in estimating operating capital needs of a newly-established dehydration plant. The size of the plant, cost of materials and labor, and the length of the operating season are obviously some of the major factors determining the operating capital requirements.

One of the most difficult questions, affecting both fixed and operating capital needs, is that of how much time and money must be spent to get the plant to producing satisfactorily — i.e., operating at the normal production rate and packing a finished product which conforms with the specifications. It is not uncommon for a new plant to make considerable modifications in some of the originally installed processing operations in order to meet these requirements.

Another major factor affecting the operating capital requirements is the length of the time that elapses after production is started until the dehydrator actually receives payment for his finished product. Government procurements cannot be handled as informally as private transactions often are, and the required procedures may consume considerable time. Government payment for procurements during an emergency period may be delayed beyond normal expectancy. From World War II experience, it is believed reasonably safe to assume that the maximum time between shipment of accepted finished product and receipt of payment will not exceed 90 days (equivalent to 75 operating days). In the light of the uncertainties in any emergency period, the dehydrator should check to see what payment procedures may be expected for his situation and plan his financial requirements accordingly.

Oftentimes it is agreed that the dehydrator will make advance payments to the growers. The advance payments are customarily for seed, but may include fertilizer, irrigation cost, insecticides, etc. It may be necessary for the plant to make substantial deposits for the utilities services needed. Insurance coverage of the physical facilities is usually paid in advance.

C. Estimated Total Capital and Credit Requirements to Establish a Dehydration Plant and to Operate it the First Season

After the plans for a dehydration plant have been firmly established, a realistic budgetary plan should be formulated to determine the estimated expenditures and incomes for the business. The budgetary planning should be done on a month-by-month basis from the starting of any expenditures (planning and erecting facilities) to a time well past the anticipated "break-even" point. It is only in this way that a true picture can be established as to when, and how much capital (both fixed and operating) will be required.

The capital requirements may be met partly by assets invested by the owners and partly by credit from sources such as:

1) Government financing or advances

2) Loans secured by physical assets

3) Open account or credit purchasing

4) Contract agreements with growers for delayed payment for raw commodities

5) Bank loans on production contracts and/or on bonded warehouse inventories of finished product awaiting shipment to the purchaser

6) Unsecured loans from financial institutions

The fixed capital requirements will be considerably reduced if suitable buildings and grounds, and perhaps equipment, are leased rather than purchased and the rentals are paid as operating charges.

A summary of the estimated total capital requirements (fixed capital, operating capital, and a suggested contingency fund) for the dehydration plants covered in this Handbook are given in Table V (page 22).

CHAPTER VI

ORGANIZATION AND MANAGEMENT SERVICES REQUIRED FOR A DEHYDRATION PLANT

Principal Key Personnel Needs

It is highly desirable for the management of a dehydration plant to have a background of sound experience in the processing phases of dehydrating, canning, or freezing of foods. Experience in the fresh produce business is also very valuable. Lack of the proper background may result in a costly initial operating period for gaining the experience necessary to produce satisfactory products. Such delays and waste of materials can hardly be afforded during a national crisis.

The successful operation of a food dehydration plant requires sound and energetic management, technical skills, and "know how" in food processing. These abilities must be organized and the work coordinated in such a way that satisfactory products are manufactured in accordance with desired schedules. The purpose of this chapter of the Handbook is to indicate the key personnel and the special services required to operate successfully a plant to produce dehydrated vegetables or fruits for the Military Forces during a national emergency.

The organization and lines of responsibility for a dehydration plant, of a size suitable for emergency production needs, are shown in Figure 1. The plant organization provides four key administrative men (office manager, field agent, production superintendent, and quality control technologist) who are responsible directly to the General Manager. 1/ These four men are on approximately equal organization levels, and there must be close liaison between them to assure smooth operation of the plant.

The size of the plant will determine whether or not each job shown on the chart will require a separate individual; in smaller plants several functions shown on the chart may be filled by one person. 2/ Most of the men filling these key positions may be employed the year-round because repairs, plant modifications, planning the next year's production, and obtaining operating supplies will require their services. It is also important that a national emergency dehydration plant make every effort possible to retain all the key personnel, even in off-seasons, as finding properly qualified people for the next operating season will be more and more difficult as the emergency conditions continue.

A. General Manager

The General Manager preferably should have a broad and successful background in planning and administering complete organizations, i.e., organizations that perform (or are at least responsible for) all the fundamental operations of manufacturing,

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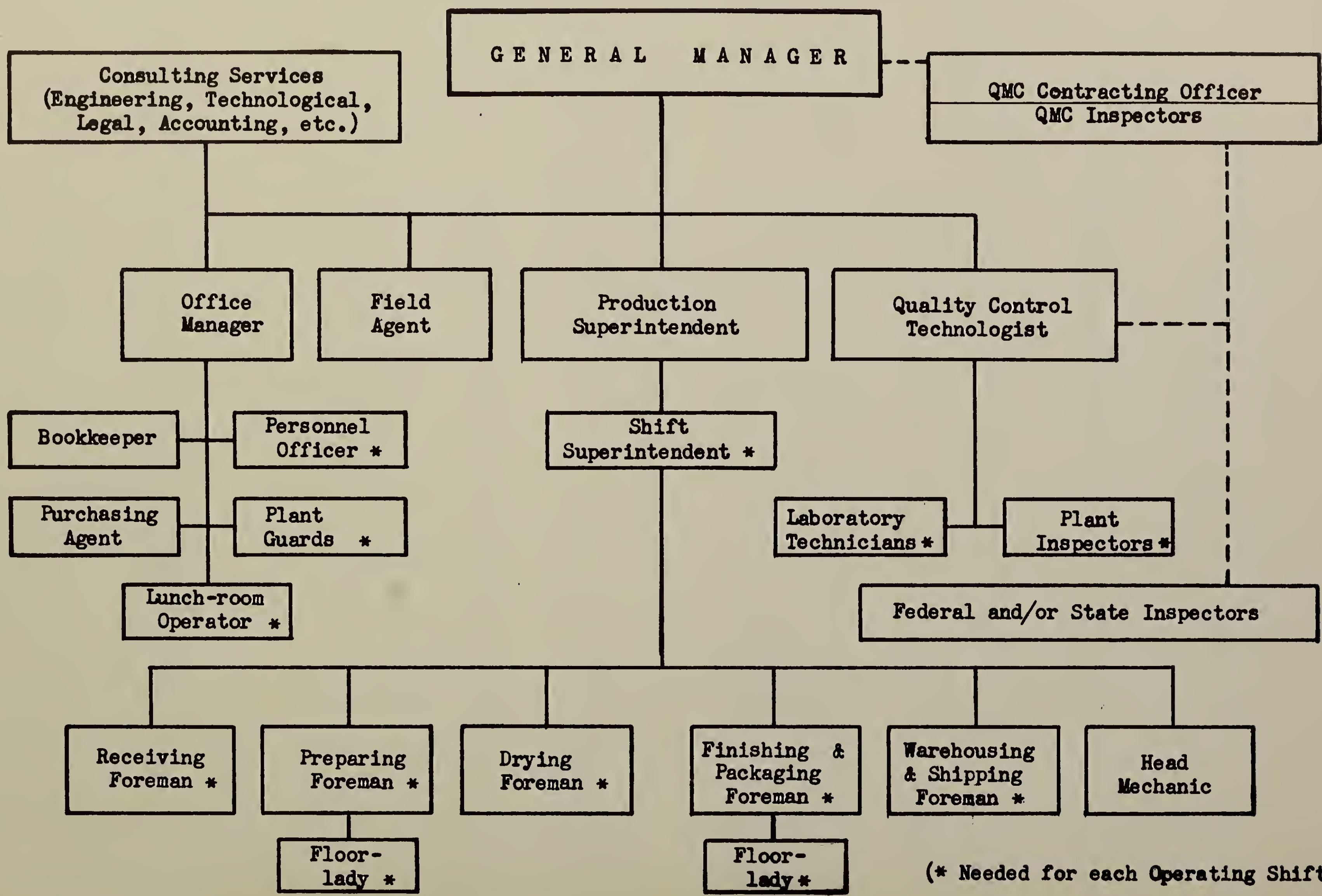
1/ A civilian market plant also will need a sales manager, directly responsible to the General Manager, but he will not be required for the kind of plant under consideration in this Handbook.

2/ For example, an office manager also might fill the job of purchasing agent, the production superintendent also might be the day-shift superintendent, one foreman might be in charge of "receiving" and "preparing" operations, etc.

FIGURE 1 -- ORGANIZATION CHART FOR A VEGETABLE OR FRUIT DEHYDRATION PLANT



(* Needed for each Operating Shift)

selling, and any necessary development of the products and methods for their manufacture. A knowledge of food processing is essential. Successful experience in dealing with and buying from fruit or vegetable growers is extremely valuable. Some successful dehydration plant managers during World War II had been shippers of fresh produce.

The General Manager must know all the requisites for supplying the Quartermaster Corps with the dehydrated products that his plant is capable of producing. These requisites include the methods of contracting, shipping requirements, renegotiation aspects, and many other similar points.

Managing a dehydration plant of any size is a full-time job, and will not permit the General Manager to have other responsibilities and interests that keep him away from the plant. During the operating season many problems may arise each day that require careful consideration and immediate action. Even an hour's delay pending a decision can be very costly in commodity spoilage, labor costs, overhead charges, and other expenses. It is imperative that the General Manager not only have the "know how" for solving these problems, but he also must have the ability, courage, and authority to make these decisions quickly. An owner-manager combination is considered ideal for this position.

B. Field Agent

One of the key men for a dehydration business is the field agent responsible for negotiating the purchases and deliveries of fresh commodities needed. The plant is dependent on this man to keep it supplied with adequate quantities of raw commodites of the varieties and quality suitable for dehydration. The most crippling production limitation of World War II dehydration plants was the lack of adequate procurement and properly scheduled deliveries of raw commodites.

In order to do a sound job of procurement and scheduling of deliveries, the field agent must know the amount of raw material required to be on hand at all times in the plant, the storage characteristics of the raw commodity, and the storage facilities available in the plant and in the nearby areas. He works cooperatively with the General Manager, production superintendent, and the quality control technologist (1) to establish detailed schedules for the daily requirements of raw material desired throughout the entire operating season, and (2) to determine the quality required to meet the military purchase specifications and the operating lay-out of the plant.

The field man should have a background of specialized training, equivalent to a degree in agricultural sciences from a reputable college or university, plus several years of experience in all phases of producing the particular raw commodity -- soils and fertilizers; irrigation; plant varieties; planting, growing, and harvesting practices; and packing and transportation methods. It is very important that he have specific knowledge of the growing areas which will be supplying the plant's needs.

The field man should have sales ability so he can convince the prospective grower of the need, importance, and probable profit in growing the particular crop, and furthermore, to grow it in such a way that good yields of high quality will result. The field agent will be more successful if he is well known in the district and has a good professional reputation.

C. Production Superintendent

The production superintendent has the full responsibility for directing all of the processing operations -- from the receiving of the raw material to the shipping of the finished products. A shift superintendent, directly responsible to him, has charge of operating the processing plant when the production superintendent is not there.

The qualifications and functions of a successful production superintendent include:

1) A practical working knowledge of all plant operations (it may not be necessary for him to be a specialist in any particular phase unless it is a small plant where he actually performs certain specialized duties; an engineering background is extremely valuable).

2) Planning and achieving efficient production

3) Maintaining good personnel relations within the plant, and doing his part to keep good relations with the growers, labor unions, and the community

The duties of the various foremen shown on the organization chart are obvious from a study of any of the specific plant plans (Volume II). These foremen should be men with practical industrial experience of some kind, although they may have to be trained for the specific job in this plant.

There will be need for a head mechanic who will be in charge of plant maintenance, repairs, and modifications. He should be experienced and capable of supervising or/and performing equipment mechanics, piping work of all kinds, sheet metal work, welding, carpentry, painting, simple concrete and masonry work, and ordinary electrical wiring.

The floor ladies supervise the groups of women workers (principally in the preparation department and the finishing-and-packaging department). The duties of the floor ladies include: (1) on-the-job training of new women workers, (2) supervising the work done by the groups of women workers, and (3) acting as spokesmen and advisers for the women workers.

D. Quality Control Technologist

All plant operations must be carefully and continuously controlled (1) to retain the maximum of the original flavor, appearance, and nutrient values of the fresh materials, and (2) to insure that the product fully complies with the Military purchase specifications. This vital function requires a quality control technologist with considerable ability because he must set up testing facilities, supervise or perform testing of many kinds, interpret test data as to the adequacy of the processing operations, and recommend (and assist in putting into practice) operational modifications where needed. In many plants, the quality control technologist has the authority to have the plant change any operating procedures that do not achieve the desired results, or, in extreme cases, he may have the authority to shut down the plant if a satisfactory end-product is not being produced. Usually, however, the quality control technologist makes his recommendations to the General Manager who decides what action should be taken. Regardless of the administrative procedure used, the actual responsibility for quality control and for producing acceptable products rests with the quality control technologist.

The quality control technologist should be a food technologist or an industrial chemist; training in bacteriology and sanitation is quite helpful. Comprehensive experience in food processing, particularly in frozen fruits or vegetables, is invaluable for a person in this position.

One or more laboratory technicians (the number depending upon the size of the plant) will be needed for each shift to make the routine tests that are required for proper quality control. These people preferably should have some technical training. A substantial part of the test work can be done satisfactorily, however, by an intelligent person with only on-the-job training by the quality control technologist.

There should be plant inspectors, under the supervision of the quality control technologist, on the preparation line and for the finishing-and-packaging operations to assure maintenance of desired quality.

The following government inspection services can be of material assistance in maintaining controls that assure production of acceptable products. These inspectors are not administratively responsible to the plant management but have functional responsibilities which can be best coordinated through the quality control technologist.

1) Inspection of raw materials -- Federal and/or State inspectors may be obtained on a contract-fee basis from the Fresh Products Inspection Service Division, Production & Marketing Administration, U. S. Department of Agriculture, or from the various State departments of agriculture, to inspect the raw commodities used by the plant. A more detailed discussion of the functions and costs of such services is given in Chapter VIII ("Supply of Raw Material").

2) Inspection of processing operations and of finished products -- The Processed Products Standardization & Inpection Division, Production & Marketing Administration, U. S. Department of Agriculture, will supply inspectors, on a contract fee basis, for inspecting the processing operations and finished products. An advantage of using these Federal inspectors is that the plant's requirements for its own inspectors may be reduced and there will be an added assurance of acceptable quality in the final products.

   The Quartermaster Corps, responsible for the actual acceptance of the products, will make whatever inspection and testing it deems necessary in accordance with the specification requirements for the particular product.

E. Office Manager

The office manager is usually responsible for the nonproduction functions of the organization plus those responsibilities not specifically assigned to the field agent, production superintendent, or quality control technologist. In large plants, some of the duties of persons who would ordinarily report to the office manager may be sufficiently important that they may be directly responsible to the General Manager. This variation from the proposed organization chart may apply particularly to the personnel officer and the purchasing agent.

One of the most important responsibilities of the office manager is the maintaining of adequate records of all business transactions of the organization -- bookkeeping, cost accounting, payrolls, banking activities, contract agreements (purchases, sales, equipment, services, etc.), tax calculations and records, inventories of all physical assets, and budgetary plans for current and future fiscal periods. It is his responsibility to keep up-to-date on Government regulations regarding procurement procedures (for equipment, manufacturing supplies, equipment parts, etc.), transportation of materials and finished products, labor and plant operations, taxes and amortization, and other factors affecting the operation of the business.

The office manager should have had prior experience in these functions. Formal training in business management with emphasis on accounting is probably the best single type of background for this particular job. Any additional experience in manufacturing, selling, and distribution is very helpful.

In addition to a field man for procuring the raw commodities for processing, a general purchasing agent may be needed by a dehydration plant. Most of the items to be purchased -- particularly metal containers, packing materials, equipment and equipment parts, automotive supplies, water-conditioning and sanitizing chemicals, etc. -- require considerable negotiating and expediting efforts to obtain them during an emergency, even with proper allocations and priorities.

There is a real need for a personnel officer who will interview and hire labor, and maintain good personnel relations both within the plant and with the labor unions of the area. He is responsible for payrolls, timecards, and other personnel records. During a national emergency it may be necessary for the personnel officer to recruit labor to meet the plant's needs.

The plant guards (watchmen, gate keepers, etc.) and the lunch-room operators are, as a rule, responsible to the office manager.

Management Services Needed

Seldom are any two processing plants -- in any field of manufacturing -- built and operated alike. Food dehydration plants are no exception. This Dehydration Handbook can be only a guide to the broad planning of such a plant. Each plant must be specifically and completely planned to fit the particular conditions anticipated for that plant.

Any group which contemplates going into the food dehydration business should seek assistance from:

1) Any advisory committee which may be appointed by the Office of the Quartermaster General from the operating dehydration industry (active processors, equipment manufacturers, suppliers, growers, etc.)

2) The Industrial Preparedness Planning Group of the Quartermaster Corps (Industrial Mobilization Staff)

3) Competent consultants or consulting organizations serving the dehydration industry

A. Technical Consulting Services and Assistance

These individuals and organizations can offer sound advice in the broad considerations of such projects, can help develop a usable set of plans for a complete plant, and can assist in compiling valid estimates of the costs of establishing and operating such plants.

Specific consulting needs may comprise or cover any or all of the following:

1) Government procurement and inspection requirements and policies

2) Management planning

3) Raw commodities and manufacturing supplies needed

4) Process engineering and quality control

5) Facilities and construction needs

6) Fixed and operating capital needs and cost controls required

Few plants can afford to hire, on a permanent basis, management and technical skills equivalent to the services offered by a competent consultant or consulting organization. The use of consulting services to supplement well-chosen plant personnel, however, can accomplish the desired goals and will be much more economical than costly trial-and-error methods.

It may be advisable to retain such consultants or consulting groups on some sort of continuing basis to assure optimum quality in the products and to keep operational costs at a minimum. The cost of consulting services may be minimized by calling on the consultants only as the need arises, but this procedure places a considerable burden on management and is likely to result in failure to take full advantage of the consultants' knowledge.

Be sure to select consultants or consulting organizations that have an established reputation for doing a sound and ethical job for their clients. A poor consultant is worse than none at all.

In addition to independent consulting organizations, plant builders and manufacturers of dehydration plant equipment may be good sources of assistance. Caution should be exercised by the plant management in following this type of advice, however, as sometimes an over-zealous builder or equipment manufacturer may make recommendations that sell more materials, services, or equipment, but may not meet the customer's needs. Advice should be heeded only from reputable and well established builders and manufacturers.

Many dehydration plants have been built and equipped in the past that could not be operated successfully. The consultant, consulting firm, or builder responsible for designing and constructing the facilities should be required to put the plant in operating condition, according to the terms of the contract, before the plant is accepted by the owners and management. For such test purposes, actual full-scale production runs should be made on fresh commodities from their proposed sources.

Improvements in food dehydration equipment and techniques are constantly being developed. The terms of military specifications for dehydrated fruits and vegetables change from time to time in recognition of these advances. The General Manager of a dehydration plant producing for the Quartermaster Corps should be farsighted enough to recognize the certainty of change in dehydration procedures and to insist that his technical staff keep abreast of all new developments. Some of the necessary information will be available in technical and trade journals and from the Quartermaster Corps inspectors stationed at the plant. Close contact should be maintained with (a) the Research & Development Branch, Military Planning Division, Office of the Quartermaster General, Washington, D. C.; (b) Food and Container Institute for the Armed Forces, Chicago Quartermaster Depot, Chicago, Ill.; and (c) Associates, Food and Container Institute (headquarters at Chicago Quartermaster Depot). 3/

Trends in food dehydration may often be recognized in the findings of research laboratories which are interested in this field; many of these laboratories

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3/ Associates, Food and Container Institute is a quasi-official organization whose members are experienced and/or doing work in the dehydration field.

are Federal- or State-supported, and information can be obtained from them without cost or obligation. Acquaintance with the agricultural experts of the State Colleges and State Agricultural Experiment Stations serving the area in which the plant is located is important. Raw material production, transportation, and storage problems are special responsibilities of the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture. Dehydration technology and processing problems are under constant study in the field laboratories of the Bureau of Agricultural and Industrial Chemistry, U. S. Department of Agriculture. The dehydration plant can and should make full use of these public services. A list of research agencies is included in Appendix "C" ("Additional Sources of Information").

B. Accounting and Bookkeeping Services

A dehydration plant operating to fill government contracts will have complex and changing requirements in its bookkeeping and cost accounting records. It is urged that a new plant employ, in the very beginning, a well-qualified accounting firm to establish an accounting system that will serve all the purposes. This accounting firm should be retained as a consultant to see that the plant's records are kept in accordance with changing laws and regulations. Properly kept records are necessary for obtaining materials and equipment under priority systems, for tax computations and amortizations, and for possible re-negotiations of prime or sub-contracts.

C. Legal Services

It is hardly necessary to point out that a dehydration plant, like almost any business enterprise, will need to retain competent legal counsel for assistance in establishing valid contracts and for advising in many other business matters.

CHAPTER VII

SELECTION OF A PLANT LOCATION

In this discussion of factors affecting the choice of a location for a vegetable or fruit dehydration plant to meet national emergency needs, the following broad assumptions have been made:

1) These emergency plants are planned only for helping supply military or national emergency needs, and thus many factors which affect civilian competitive marketing and civilian economy may not be applicable.

2) The general area in which an emergency type of dehydration plant is to be located will be influenced by policies and decisions of Government groups specifically charged with responsibilities for planning and authorizing emergency production facilities at the time the new plant is under consideration.

3) Military or other reasons may require that these emergency plants be established in locations which do not meet the requirements outlined herein, but an effort should be made to satisfy as many of the requirements as possible.

4) The availability of the capital necessary for such an enterprise imposes no unreasonable geographic limitations.

5) The needed management and technical skills for operating such a plant can be brought to the selected location.

A general warning: if this is to be the first food processing plant in an area it will be worthwhile to find out, as a general consideration in the choice of a plant location, why others have not been established there. There may be good reasons for the lack of such plants in the particular region that can seriously affect the operation of the proposed plant. The possible bad features of the locality should be sought; they may be sufficient to warrant seeking another location.

Location and Adequacy of Raw Materials

After a general area capable of supplying the required raw commodities has been selected, as discussed in Chapter VIII ("Supply of Raw Material") and the various Supplements of Volume II, the next step to consider is the specific location of the plant itself. Figure 2 shows the location of existing vegetable and fruit dehydration plants, as well as other such plants that received procurement contracts from government agencies during World War II.

Ordinarily it is best, particularly for a new plant, to plan to dehydrate only one commodity, and preferably in an area with a long operating season. A 6- to 10-month operating season is possible for vegetables and fruits in certain locations. This is a very important consideration in choosing the location of a dehydration plant.

A dehydration plant, for meeting national emergency needs, should be located as near the sources of raw commodities as practical. 1/ There are three principal reasons for this: 2/

1) It is absolutely necessary that the raw fruits and vegetables reach the plant in excellent condition. The farther the raw materials must be transported the greater will be their requirements for more careful crating, loading, ventilation, and refrigeration. Obviously, this can have a serious effect upon the costs of the finished products, and oftentimes, upon the quality of the products.

2) Transportation facilities may be impaired seriously during a national emergency, thus making long and regular hauls of perishable goods very uncertain and perhaps impossible.

3) The high shrinkage ratio between the raw commodities and the dehydrated products (ranging from 5 : 1 to 25 : 1, depending on the type and condition of the particular commodity) puts the far greater burden on the handling and shipping of the raw materials than on the finished products. Thus, unnecessarily long hauls of the fresh commodities waste transportation facilities.

Labor Availability, Labor Relations, and Living Conditions in Area

A careful survey must be made of the prospective area to see if there is a sufficient supply of suitable labor. A new plant entering a community which is already experiencing a labor shortage may expect high labor turnover and may be forced to pay premium wages. (The Bureau of Labor Statistics, U. S. Dept. of Labor, publishes periodic reports showing areas of labor scarcity and surplus.) The survey should include study of the record of local labor-management relations and of the responsibility shown by labor union groups with which the management will have to deal.

Since the majority of the workers required in a dehydration plant can be trained in a relatively short period of time, it is not necessary to select an area having concentrations of skilled labor. In fact, the absence of other plants to compete for labor may be highly desirable. Smaller towns in farming areas have been found to be good sources of labor for vegetable and fruit dehydration plants. Many of these plants can operate on certain products through the winter months when farm work and most other food processing plants have the least call for labor. In these smaller communities labor conditions are generally quite stable.

Public transportation is generally not adequate for carrying workers to and from the plant, and transportation is largely dependent upon private automobile. Transportation of personnel to and from the plant must be assured in some way. The use of company-operated buses may be necessary to provide transportation for workers.

Where a high percentage of the labor consists of transients the housing problem oftentimes becomes acute, and provisions must be made in the form of company-sponsored housing projects, trailer camps, or other housing facilities. Community-wide recreation facilities are distinct assets. Adequate fire and police protection are necessary.

1/ Information concerning principal growing areas for the commodities considered in this Handbook is given in Chapter VIII as well as in the individual Supplements of Volume II.

2/ "Plant location in agricultural process industries", W. L. Faith, Chemical Engineering Progress, Vol. 45, No. 5, pp 304-313, (May 1949).

Community Attitude

Community attitude is an important point. A plant built in a community that sincerely welcomes its establishment — as something worthwhile for the national emergency effort and that promises to benefit the community in some way — will find easier answers to many of its problems. A reciprocal "play fair" attitude by both sides will assist materially in the smooth and uninterrupted operation of a plant.

The plant management must understand and comply with the local customs and laws to avoid constant bickering with the authorities concerning control of odors, dusts, insects, rodents, waste disposal, and transportation. Strict observation of the zoning regulations and cognizance of the zoning trends in a community will pay good dividends.

Of particular importance in maintaining good relations with the community is the matter of plant odors. A plant should be located so that the prevailing winds do not carry the odors from the waste disposal or the processing operations (such as from an onion dehydration plant) across populated areas.

Transportation Facilities

A successful plant must have adequate transportation facilities to get its raw materials into the plant and to ship out the finished goods. Raw materials are preferably brought in by truck from the nearby areas. Raw materials from remote areas, however, may arrive by rail. Rail transportation is ordinarily used for getting the packaging materials to the plant and for shipping out the finished products, although trailer-trucks are also extensively used. Unless the plant is served by its own rail spur, extra handling costs will be incurred for rail shipments.

It is urged that a plant have both rail and truck facilities. The likelihood of breakdowns, strikes, shortages, and other contingencies occurring simultaneously to both types of transportation is very remote. Thus shipments seldom will be interrupted if both types of facilities are initially available.

There will be need for trucking services even at plants depending largely on rail facilities for bringing in the raw commodities. The scale of operation, length of operating seasons, and proximity to raw material sources are major factors in determining whether or not the plant should own its trucks or contract for this service.

Ample roadways, parking space, and turning areas sufficient for long trailer-trucks must be provided. They should be hard-surfaced to reduce dustiness, improve general safety, and provide all-weather use.

Utilities

The utility needs for the proposed plant should be discussed with the respective suppliers of these services. Inquiry should be made concerning reserve capacities, peak load requirements of the area, and plans for expanding these services to meet anticipated future needs of the locality.

A. Water

One of the principal utility requirements for a dehydration plant is an ample supply of good water. The water should be well within the tolerance limits established for food processing plants. 3/ Sub-standard water may cause the finished products to be contaminated with bacteria and foreign matter, or to have off-flavors.

It is desirable, but not mandatory, that the water be of moderately low hardness for the processing operations. Boiler feed-water must be properly conditioned or the resultant scale formation in boilers and pipe-lines will be a continuing source of trouble. The water used in the processing operations and for cleaning and sanitizing equipment must be of a standard of purity that would make it suitable for drinking. If the plant water supply is not obtained from an approved municipal system, filtration and treatment (such as chlorination) may be required.

An adequate supply of water is becoming one of the principal criteria for selecting plant sites in many areas. A 100-ton per day vegetable dehydrator may require between 300,000 gallons and 900,000 gallons of water each 24 hours, and perhaps more, depending upon the commodity being processed and the procedures employed. During World War II some plants could not be erected in otherwise desired locations due to an obvious lack of water, and a number of plants were, unfortunately, built without having adequate provision for the desired quantity of suitable water. The problem is even more acute today.

Since this plant is for national emergency production, and is not planned as a long-range enterprise to meet peacetime competitive markets, the water supply problems may be somewhat simplified. For instance, if the water supply is of poor quality, it may be converted to useable condition by installing water-treating facilities (to reduce hardness and bacteria, and to filter out objectionable materials such as color, odor, etc.). This will increase production costs, but may make possible the operation of a much-needed plant for national emergency production. In general, any area having sufficient water for growing the fresh commodities should have enough water for a dehydration plant.

Water conservation is an important consideration in most areas, but some food processing plants have erred in using too small amounts of water — for cleaning and handling commodities. This practice results in products of lowered quality.

Over-all water savings can best be accomplished (a) by better planning of how the water is to be used, (b) by recirculation or reuse of water where permissible, and (c) by maintaining equipment at optimum efficiency to make most effective use of water.

More detailed information concerning water standards, practices in food plants, and suggestions for conserving water supplies may be found in:

1) Parker, M. E., Food Plant Sanitation (1948), McGraw-Hill Book Co., New York, Chapter 3

2) Miles, H. V., Correction of defects in water used for food manufacture, Proc. Inst. Food Tech., 1944, pp 59-67

3) Reichmann, Irving, Ways to save water in the food plant, Food Industries, Nov. & Dec. 1945

3/ Parker, M. E., Food Plant Sanitation (1948), McGraw-Hill Book Co., New York, Chapter 3

B. Fuel

Contaminants in the fuel used for direct-fired driers (whether the fuel is gas, oil, or other types) will have marked effects upon the dried products. Of particular importance is the sulfur content of fuels for direct-firing because it may result in excessive sulfite in the finished product.

Gas is one of the most commonly used fuels for direct-fired dehydrators. Either natural or manufactured gas may be used. The type of service available to the area should be determined. And, no matter how assured the gas supply may appear, a sufficient amount of "tank" gas should be maintained which is capable of operating the plant for at least 24 hours in an emergency. This is good insurance against loss of perishable raw materials already in the plant for processing as well as against loss of man-hours.

Oil-firing has been used successfully in direct-fired dehydrators but requires much more careful control from the standpoint of avoiding contamination of the products, particularly by smoke resulting from incomplete combustion and by excess sulfur content in some oils. Oil is an excellent "stand-by" fuel for plants using gas; suitable oil-burning combustion units must, of course, be provided.

Heating with electricity is too expensive for general use. (It takes about 40 kilowatt-hours in a resistance type of heater to produce as much heat as that obtained from one gallon of fuel oil.)

The quality of fuels used in <u>indirect-firing</u> is not so critical as that of fuels used in <u>direct-firing</u> operations. Emergency dehydration plants should give consideration to installing indirect-fired dehydration facilities for areas lacking top-grade fuel supplies.

The average fuel requirement for a 100-ton per day dehydration plant amounts to approximately 25,000,000 B.T.U./hr. — equivalent to either 25,000 cu. ft. of gas or 185 gallons of light fuel oil per hour. For indirect-fired dehydration, the fuel requirements may be slightly more (perhaps 15% additional) than for direct-fired, but there may be tangible gains through (a) better control of operating conditions and (b) use of cheaper and lower grades of fuels.

C. Electric Power

Sufficient capacity of 440-volt, 3-phase (or 220-volt, 3-phase) electric current must be available. A standby generator is a good precaution against possible plant shut-downs due to curtailment of the normal supply. The electric power requirement for lighting and for motivating the equipment in a 100-ton per day dehydrator varies from 200 to 400 kilowatts.

<u>Local Factors Affecting Plant Sanitation and Quality of Product</u>

A. Atmosphere Pollution

During the course of vegetable or fruit dehydration, enormous quantities of air pass over the material being dehydrated. Serious damage to the product will result if this air is contaminated with such gases as ammonia, hydrogen sulfide, chlorine, nitric oxide, hydrogen chloride, and others found in many industrial areas. <u>No food dehydration plant should be located in an area where these noxious contaminants are</u>

present in the atmosphere.

Airborne dust particles can also contaminate products being dehydrated. Of course, it will be impossible to choose a location where the air never contains any dust particles, but small amounts will usually do no particular harm under normal operating practices. For areas subject to dust storms of any serious magnitude, it may be necessary to install air filters for the plant.

B. Water Supply Pollution

The wastes and water disposal methods of nearby plants vitally affect the water supply of the surrounding vicinity. Milk processing, leather tanning, paper manufacturing, and metals processing can be some of the worst offenders. Careful investigation of these matters is well worth the time and effort before making final decision as to the plant location.

C. Insects and Rodents

Successful rodent and insect control is a cooperative matter of all the inhabitants of an area. Each business enterprise must do its part.

It is advisable, however, to avoid establishing a dehydrator in a locality known to be highly infested with insects and rodents because their presence indicates a general sanitation level unacceptable for food processing purposes. Although insect contamination of dehydrated fruits and vegetables has not been a serious problem to date, it must be remembered that all food products are more or less subject to infestation by storage insects. Most food and grain warehouses harbor these pests to various degrees, and an infected neighboring warehouse can easily start an insect problem in the dehydration plant. Proper plant and warehouse construction, plus periodic fumigation, will help materially to minimize infestation problems.

Weather Conditions

The weather experienced during the period of the year corresponding to the processing season of a prospective dehydration plant has some bearing in the selection of a plant site. The following points are among those which should be considered:

A. Hampering of Harvesting Operations

Some commodities, such as carrots, beets, and cabbage are processed immediately after harvesting. The operation of the plant is therefore dependent upon the commodity's being harvested without serious interruption. Weather conditions which interrupt the harvest for periods longer than is provided for in the plant storage of raw commodity may cause the plant to shut down.

B. Interference with Drying Operations

Localities which have high atmospheric humidity conditions many days during the anticipated processing season should not be considered for a plant site. On days of high humidity it is very difficult, if not impossible, to adjust the drying operations to produce products of a satisfactory quality which will be low enough in moisture content to meet military specifications. If the commodity is best grown in areas of high atmospheric humidity, then provision must be made for dehumidification of at least that part of the air which performs the final drying operation.

C. Heat Requirements in Cold Areas

It must be recognized that most plants are designed for common atmospheric temperature ranges. Special precaution should be taken, when the plant is to be located in areas with severely cold seasons, to provide adequate heating facilities for driers, storage areas, working areas, etc.

D. Absenteeism Caused by Weather

Weather conditions which make it difficult for employees to get to the plant, or which make it uncomfortable to work, may cause enough shortage of operating personnel so as to seriously reduce plant efficiency.

Waste Disposal or Utilization

A. Waste Disposal Problems

One of the biggest problems of a vegetable or fruit dehydration plant is the disposal of its waste products. These wastes come principally from the grading, washing, peeling, trimming, cutting, and blanching operations. A 100-ton per day plant (of raw commodities) will have as much as 15 to 35 tons of solid wastes and as much as 300,000 to 900,000 gallons of liquid wastes per day.

Disposal of the two phases (solid wastes and liquid wastes) depends on the products being processed, the terrain and types of soil in the immediate area, proximity of surface streams or bodies of water, and the sanitation regulations for the locality. Treatment of the wastes prior to final disposal is usually classified as (1) mechanical, (2) biological, or (3) chemical. However, the first step, as a usual practice, is to separate as much as is practical of the solid wastes from the liquid phase by mechanical screening. The subsequent treatment, utilization, or disposal methods are governed by a number of considerations.

The solid wastes are oftentimes disposed by being used for stock-feed in the local area. Such disposal rarely affords any economic gain to the plant as the wastes are usually given in exchange for their removal, or the plant may even have to pay for the removal of the wastes. In some cases the solid wastes are disposed by dumping in pits or on open ground sufficiently distant from the plant that the wastes will not be a nuisance. These solid wastes will require some kind of treatment and handling that safeguards against odor-formation, bacterial and fungus growth, vermin and rodent infestation, and contamination of adjacent lands and bodies of water.

The liquid wastes usually are run into sewers, drainage canals, streams,or into disposal beds on open land. Some of these disposal methods are tolerated by the communities only as temporary or emergency methods, and are subject to abatement measures at any time. Plants in isolated areas must provide and operate their own liquid waste treatment units; plants in areas served by public sewer lines may have a simpler disposal problem for this liquid phase. Location of plant at elevations higher than that of the adjacent area will permit maximum utilization of gravity in the disposal of liquid and solid wastes.

Wastes that are disposed of through sewage treatment plants can greatly disturb the treatment processes in the sewage system through excess quantities of solid matter, harmful chemicals from the peeling or other operations, and clogging of lines from sediments — especially starch from potatoes or sweetpotatoes. Cleaning agents and sanitizing products used for maintaining plant cleanliness can complicate the handling and disposal of plant wastes. They may adversely affect settling and flocculation of solids, as well as desired biological digestion, in sewage units. Some of these surface-active materials have long-lasting, residual toxic effects and thus complicate the final disposal of the wastes. It may be necessary in such cases to divert these washing and treating solutions to a disposal unit separate from the principal wastes.

Failure to provide satisfactory waste disposal has resulted in the closing of many plants. The waste disposal problems for the plant should be discussed thoroughly with the city, county, state, and Federal sanitation officials and their recommendations heeded. At least 35 states require approval of plans for waste treatment systems; 9 states classify their streams and require waste disposal be governed accordingly; and 16 states rank the disposal of food processing wastes as one of the major sources of stream pollution. 4/

B. Possible Utilization of Plant Wastes

Although general experience to date has been that utilization of dehydration plant wastes is not practical, such potentialities as exist should be investigated prior to establishing the plant, as plans for utilization may affect the design of the entire waste disposal system and may even affect the processing operations.

The liquid phase is usually so dilute that its best value probably lies in returning it to the water reserves of the area after it has been suitably treated. The liquid phase may be used for irrigation purposes provided it is not contaminated with peeling chemicals, cleaning and sanitizing compounds, and other harmful materials.

The utilization of solid waste material is often considered. The possibilities include using these wastes as stock feed ("green", silage, or dried), in fertilizer composts, and, particularly in the case of potato wastes, for the recovery of starch or the manufacture of alcohol.

Even under the most favorable conditions, only very large dehydration plants can hope to find by-products utilization feasible, because economical conversion processes can be accomplished only on a substantial scale of operation. Furthermore, the low value of the waste materials makes it mandatory that the by-product conversion facilities be quite near to the dehydration plant in order to minimize transportation and handling costs.

An example of a situation in which a by-product operation might be successful is that of a large potato dehydration plant operated in conjunction with a packing and shipping operation for supplying fresh markets. Such a combined operation can buy "field run" potatoes at prices lower than would be paid for graded potatoes — the top-grades are either dehydrated or sold to the fresh markets, and the culls are used for starch production. Additional economies may be gained by utilizing the solid wastes from the dehydration preparation line in the starch production.

4/ "Pollution abatement — appraisal of current regulations" A. Anable and R. P. Kite, Chemical Engineering Progress, Vol. 44, pp 3-16 (1948)

Additional Information Concerning Plant Location

Additional information concerning the choice of a plant location may be found in the following publications:

1) Anable, A., and Kite, R. P. Pollution abatement -- appraisal of current regulations, Chemical Engineering Progress, 44: 3-16 (January 1948)

2) Eldridge, E. F. Industrial Waste Treatment Practice, McGraw-Hill, New York (1942). Chapter VI -- Canning-factory wastes (147-173)

3) Faith, W. L. Plant location in agricultural process industries, Chemical Engineering Progress, 45 (5): 304-313 (May 1949)

4) Warrick, L. F., McKee, F. J., Wirth, H. E., and Sanborn, N. H. Methods of Treating Cannery Wastes, National Canners' Association Bul. 281 (1939)

5) Wood, H. A. Industrial plant location, Canadian Chemistry & Process Industries, 33 (7): 609-612 (July 1949)

6) Pollution Control (a feature report) — Chemical Engineering, 58 (5): 111-159 (May 1951)

General

Water Pollution Control

Air Pollution Control

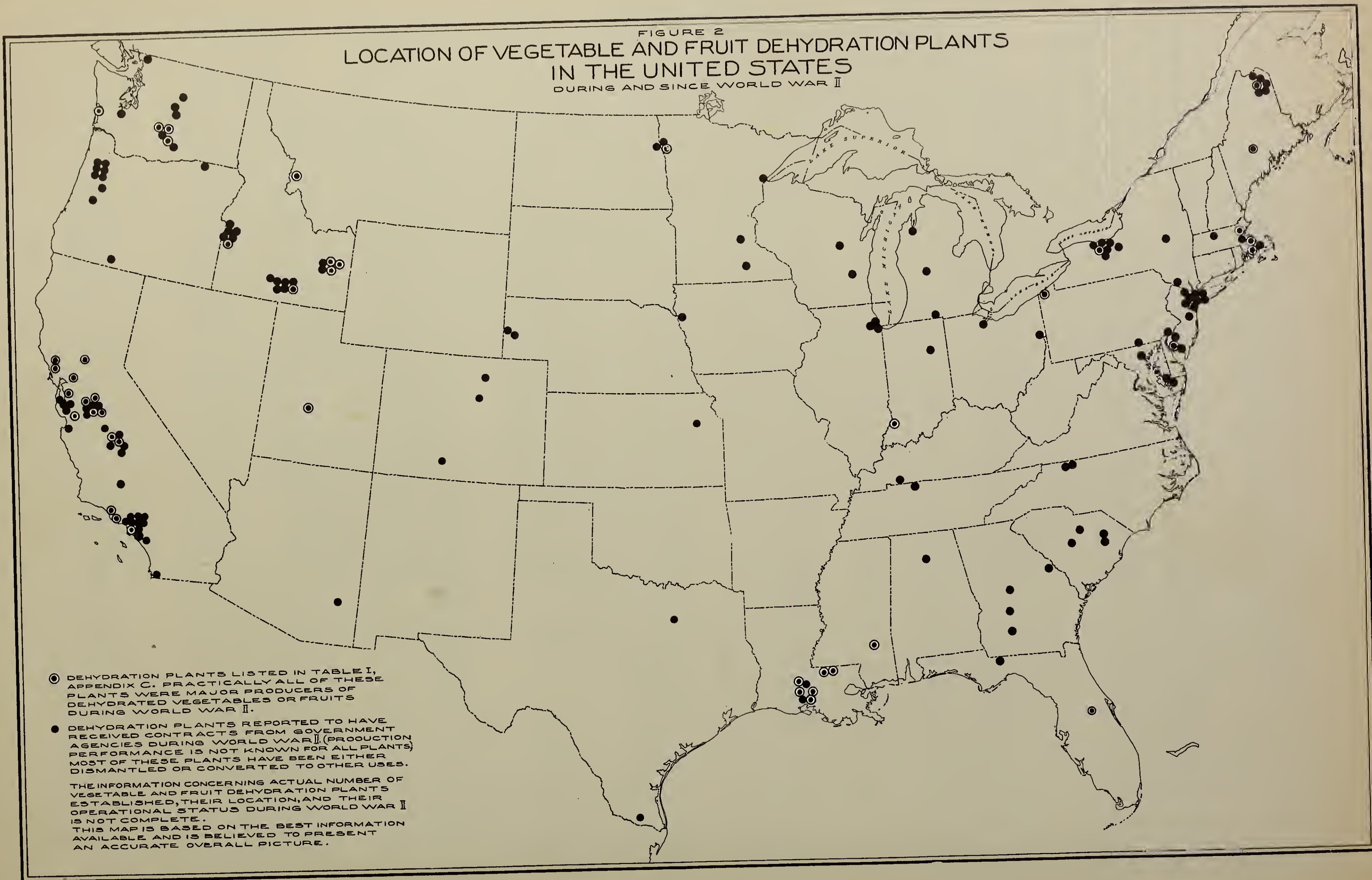


FIGURE 2

LOCATION OF VEGETABLE AND FRUIT DEHYDRATION PLANTS IN THE UNITED STATES

DURING AND SINCE WORLD WAR II

CHAPTER VIII

SUPPLY OF RAW MATERIAL

Of the many factors that contribute to the success of a dehydration plant, the availability of a constant and suitable supply of raw material is one of the most important. Unfortunately, the importance of this factor often has been overlooked in the establishment of some dehydration plants. There have been many failures of plants because the available raw material was not suitable for dehydration, or because sufficient quantities of raw material could not be obtained regularly or at satisfactory prices.

Areas that have been important in supplying raw material for vegetable and fruit dehydration during and since World War II are shown in Figure 3. Reference to Figure 2 (page 60) will show the relation of these various commodity-growing areas to the location of existing dehydration plants.

Raw Material Requirements

The specific requirements for each vegetable and fruit are discussed in the respective Supplements of Volume II. There are some generalizations, however, that apply to all of the commodities. Among the more important generalizations are the following:

A. Quantity Considerations

1) Other things being equal, a producing area with a long period of availability of raw commodity is to be preferred. Some vegetables, for example, carrots and cabbage, are harvested practically the year around in certain sections of the country. Location of a plant in these areas is preferred over location in an area where the harvest season is of short duration.

   Commodities like potatoes and sweetpotatoes are available from storage for several months during the year in addition to the period of harvesting. Areas that have suitable storage facilities and follow desired curing and storage practices are to be preferred (assuming, of course, that the quality of the commodity is satisfactory).

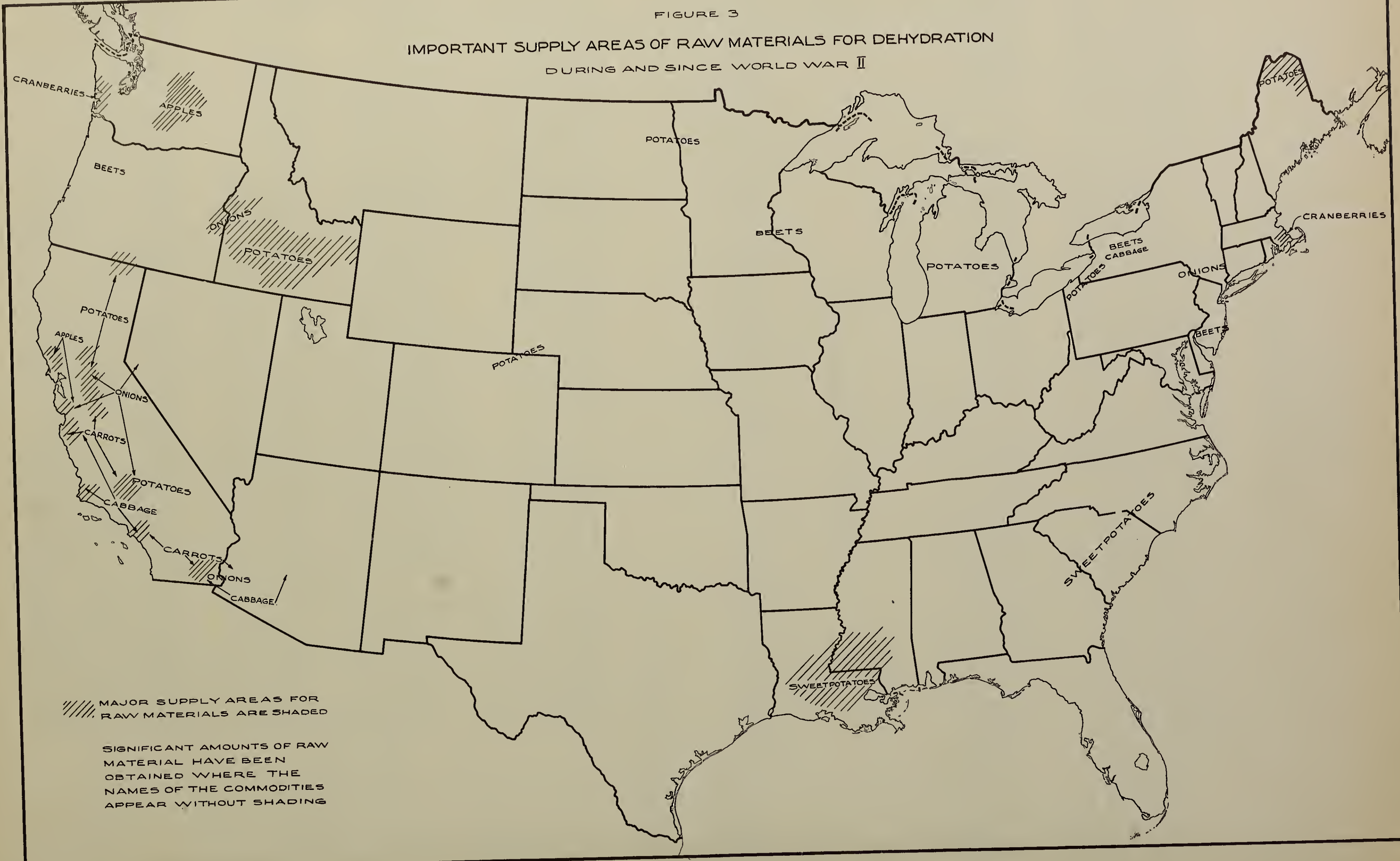
   A great amount of careful planning and arrangement is needed to assure the availability at the plant of suitable raw material each day for processing. The latter part of this chapter is devoted to a discussion of procedures, to achieve this objective, in contracting for or in purchasing raw material for a dehydration plant.

2) Considerable thought should be given to the possibility of running the dehydration plant in off-season on some other vegetable or fruit. Among the combinations of raw commodities that have been successfully processed in the same plant are the following: (a) Carrots and potatoes; (b) onions, peppers, and garlic; and (c) beets and potatoes. The individual items in the following combinations require somewhat different processing equipment; nevertheless, the different commodities are dehydrated in the same plant because of the favorable raw material supply, or

FIGURE 3

IMPORTANT SUPPLY AREAS OF RAW MATERIALS FOR DEHYDRATION

DURING AND SINCE WORLD WAR II



perhaps because of the market outlets available to the dehydrator: (a) onions, potatoes, and carrots; (b) onions and cabbage; (c) cabbage and peppers; (d) sweetpotatoes and peppers; and (e) cranberries and apples.

A plant located most favorably for one vegetable or fruit may have to process a second commodity under circumstances that are not most favorable for that commodity. For example, high hauling costs may be incurred to obtain a supply of the second commodity from a distant growing area, or the quality and quantity of the raw commodity obtainable locally may be somewhat less than desirable. The higher production costs likely to be incurred on the commodities processed during off-season may be offset by the reduced indirect and overhead unit charges on the total yearly production.

B. Quality Considerations

1) Varietal characteristics. Not all varieties of vegetables and fruits make good dehydrated products, nor is a variety which has proved best when grown in one location necessarily superior, or even acceptable, when grown in another part of the country. A variety of vegetable or fruit, known to be suitable for dehydration, must be grown in an area to which it is adaptable and under conditions which give satisfactory yields and quality. The prospective dehydrator must make a thorough investigation of the raw material available in a proposed area and be assured that it has the desired characteristics for dehydration.

2) Over-all shrinkage ratio. The over-all shrinkage ratio, or the ratio of the weight of raw material fed to the line to the weight of finished product packaged, is one of the most important factors determining the unit cost of production. Many things affect this shrinkage ratio, including both raw material and processing considerations. Among those factors that concern raw material are: (a) moisture content of raw commodity; (b) presence of undesirable material such as "rots", bruised portions, thick skins, deep "eyes" requiring considerable trimming, etc.; (c) chemical composition which may affect quality of finished product and result in excessive rejects of dehydrated products; and (d) size and shape of the individual units (the smaller or oddly-shaped units usually have higher proportionate peeling and trimming losses).

3) Maturity. Vegetables and fruits for dehydration must be of proper and uniform maturity. Over-mature commodities may be woody, fibrous, mushy, and generally lacking in quality. Immature commodities may be small in size, low in solids content and desired flavoring power, and otherwise unsuited to produce an acceptable quality dehydrated product at low cost. The major pitfall usually arises from over-maturity of the commodity because of a natural desire on the part of the grower to obtain the highest yields by letting the crop grow as long as possible.

4) Cultural practices and growing conditions. The conditions under which a crop is grown are vitally important in determining the quality of the harvested commodity. Proper cultural practices — prudent use of water, fertilizers, and insecticides, and proper cultivation — are necessary even in a favorable location for growing the commodity.

5) Harvesting and handling raw commodity. In order to assure receipt at the plant of raw material of optimum quality, it must be harvested, sacked or boxed, cured, stored, and hauled according to acceptable practices.

The various points mentioned above are discussed more fully in connection with the specific commodities covered in the various Supplements of Volume II. The importance of satisfactory raw material procurement hardly can be emphasized enough; the dehydrator who has assured himself of a suitable supply of raw material will have taken a major step toward the successful operation of his dehydration plant.

Techniques of Procurement

The normal production of food in the United States is rather closely geared to peace-time domestic and export demands. If a sudden emergency develops which causes an unusual demand for specific foods, the normal supply and demand forces may become drastically unbalanced. The logical method for avoiding the disruption of the economy as it pertains to these specific foods is to encourage an increased production of them to the extent needed to cover the emergency demands. This is not always a practical solution, however, especially during the first year of such an emergency. Until the required increase in production can be built up, some dislocation of established lines of distribution and price relationships may be inevitable. Under such conditions the dehydrator operator who has contracted to deliver a finished product should, as promptly as possible, contract with growers to supply all or a substantial part of the raw material he will need to meet his commitment.

Another general means for meeting emergency needs is by encouraging growers, already supplying these desired commodities to the civilian trade, to expand their acreage of these needed commodities on acreage which has been devoted previously to crops that are less important in wartime.

During World War II various methods of purchasing raw material were used by different operators handling identical products. Some dehydrators depended upon supplies from acreage contracted by the particular dehydration plant for its exclusive use, while others depended solely upon "breaks" in the open market for purchases of fresh commodities. These two general methods of procurement — contracting for future supply and open market purchases — are discussed below.

A. Contracting for Future Supply

The practice of contracting for the future delivery (future sale, acceptance, or purchase) of farm commodities is very widespread in the United States for supplying food processors. This has proved to be the most practical and satisfactory method for procuring such commodities as cabbage, carrots, beets, and onions.

The dehydrator who is already established in the business of handling the fresh commodity, whether as a fresh-market packer or shipper, warehouseman, or distributor, will be in a particularly advantageous position. He will have dependable contacts with growers and will be familiar with local contracting customs and the natural and human risks he must guard against.

The processor should develop a reputation for integrity and must make good on all his obligations, especially his obligations to the growers. He should take care that the growers with whom he deals have a similar reputation. Both parties also should have sufficient financial resources to meet their obligations even if certain contracts result in losses instead of profits.

Oftentimes a grower-contract stipulates that the buyer (processor) is to furnish the necessary seed. This seemingly unimportant practice has many advantages.

Some growers seem to have a greater respect for the contract when the purchaser has an investment or risk in the crop. The processor is often better situated to obtain seed in time of scarcity and may be able to obtain better quality seed than the grower. With the seed supply under the control of the processor, production of the desired varieties is assured, a somewhat better control of the planting schedules is possible, and still more important, a steady flow of raw material into the dehydration plant thus can be maintained.

The custom is to contract for the total yield from fields of specified acreage rather than for a specified weight, and thus the supply of commodity will vary greatly from different fields. Another factor to consider is that the average yield of commodity per acre varies from locality to locality and from State to State, even though all of the areas being compared are commercial producers of the commodity. A typical example is the production of cabbage, which is grown on a commercial scale in eleven States. The 10-year average production (1940-1949) in these eleven States is 7.7 tons per acre, the lowest one (Texas) being 4.7 tons per acre and the highest one (Colorado) being 12.0 tons per acre. 1/ Yields from different localities within the growing areas differ even more widely.

A grower contract has definite advantages to both parties. Such a contract provides the grower:

1) A sure market or outlet for the entire crop

2) A specified price which should assure a reasonable profit

3) Assistance in obtaining priorities, during emergency conditions, for critical supplies and equipment (During World War II every county of any agricultural importance in the United States had an "Agricultural War Board" to pass on applications for draft deferments, farm machine priorities, etc. A contract showing production of an essential crop was the best evidence for obtaining favorable action from this Board.)

4) An aid in getting credit for financing the crop (banks and production credit associations usually welcome reasonable applications for loans from farmers with contracts)

5) Growers receive benefits of research projects conducted by processors as affecting cultural practices and improved varieties

The advantages of these contracts to the processor are:

1) Assurance of a raw material supply of desired variety, quality, and quantity delivered according to a schedule that assures his meeting military contract requirements.

2) Assurance of a fixed price of raw material independent of market prices at the time of harvest

3) Affords a sound basis for planning plant operations, deliveries of finished products, and financing requirements

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1/ U. S. Bur. of Agric. Economics. Commercial Truck Crops ... for Commercial Processing, 1951. Washington, D. C., 1951 (Dec.)

U. S. Bur. of Agric. Economics. Commercial Truck Crops ... for Fresh Market ... 1951. Washington, D. C., 1951 (Dec.)

In addition to the general content, form, signatures, etc., of any valid contract, the following points should be covered in a grower contract:

1) Map showing location of field with a legal description of the property and the total number of acres involved

2) Variety and source of seed; if seed is furnished by buyer, state the price charged to grower and terms of payment

3) Date of planting with or without definite substitute dates (based upon desired harvesting and delivery dates)

4) Statement as to (a) who decides when crop is ready to harvest or (b) what standards of maturity determine harvesting time

5) State who decides the rate of harvesting and method of harvesting (in case there are several alternate methods)

6) Point of delivery, whether roadside, field, shipping point, or dehydration plant

7) Weighing to be done at a public weighmaster and only certified weights to be used (duplicate copies to each party), or weighing to be done at plant

8) Quality standards (minimum or grades) and allowances or tolerances for dirt, injury to the commodity, small sizes, etc., definitely stated

9) Specify how inspection and grading is to be done and by whom (duplicate copies of these certificates to both parties)

10) Minimum quantities to be delivered to plant

11) Price per unit (according to grade if mutually agreeable, with or without premium for low shrinkage commodities, or perhaps based on average solids content of fresh commodity)

12) Adjustment clause in case harvest yields greatly exceed that normally expected or that specified in contract

13) Responsibility in case of delay and/or deterioration of commodities in transit from farm to plant

14) Cancellation rights of both parties due to fire, strikes, flood, and other acts beyond control of the parties

15) Statement of rights of grower as a sub-contractor in case the prime contract held by the processor is cancelled or terminated by the Governmen

16) Transferability of contract

17) Provision for handling disputes

Typical growers' contracts can be obtained from the various associations of growers, canners, and freezers. The College of Agriculture and the Agricultural Experiment Station of the University of Wisconsin, Madison, have done considerable research on problems of contracting with farmers supplying processing plants.

B. Open Market Purchases

Operators who do not contract for future supplies of raw commodities must depend on open market purchases. Such practices often lead to inefficient use of plant and labor, and cause delays or non-fulfillment of contracts for delivery of dehydrated products. This is a serious consequence in a time of national emergency.

Fresh vegetable production is quite variable from year to year, because the number of acres planted is readily changed in response to changing market conditions; in addition, there is seasonal variation in yield per acre. Thus, dependence upon open market purchases of fresh vegetables can be doubly precarious from a price standpoint. Still more important, there may not be sufficient raw commodity available at any price due to curtailment of acreage.

On the other hand, the production of fresh fruits is more stable because the acreage in production is relatively fixed. Price fluctuations from season to season are, however, if anything, wider than they are in the case of truck crops; an increase in demand which happens to coincide with a short crop will bring about an altogether disproportionate increase in price. The dehydrator runs grave production and financial risks if he relies upon open market purchase for more than a minor part of his needs.

Open market purchases and sales are often used as "adjusters" by processors who normally operate on a contract basis. In case of delays in delivery of raw material caused by late planting, unseasonable weather, low yields, or other factors, spot purchases of entire crops in fields or storage can be made if prices are within practical limits. In this way a plant may be kept in operation that might otherwise be halted.

Open market operations also may be used in the opposite way by a plant, even though it depends largely on contract purchasing. Open marketing can be the answer to the problem of disposing of excess fresh commodities resulting when the yield per acre on contracted fields is much larger than anticipated, or when abnormal peak yields occur due to late plantings catching up with earlier plantings. Such surpluses usually can be sold on the open market to shippers, other processors, or commission merchants in nearby markets.

The practice of using open market purchases and sales as a supplement to contract purchases is recommended, but the use of open market purchases as the principal method for obtaining all needed supplies is not a sound basis for operating a dehydration plant.

C. Special Problems in Procurement

One of the most difficult problems of raw commodity procurement is to find dependable and interested growers. Suggested sources of information for locating qualified growers are:

1) Agricultural supply companies of equipment, fertilizers, seed, and insecticides

2) County agricultural agents (sometimes known as county agents, farm managers, county farm agents, etc.)

3) Production and Marketing Administration, U. S. Department of Agriculture

4) Rural financing organizations in the areas

The avoidance of marginal growers is a major problem to be solved by procuring agents. Growers may be marginal in general ability, land, equipment and other resources, or finances. Undependable growers cause continuous anxiety and trouble, and may ultimately cause either shortages or surpluses in raw material supply. As a general policy, the best growers are those who have been successful in past years; this is usually reflected in the condition of their farms, equipment, and homes, and by their financial stability.

A few growers will be tempted to break their contracts if market prices are much higher at harvest time than the original contract price, even though the contract price affords a profit. A certain amount of vigilance on the part of the field agent is necessary in dealing with growers lacking an established reputation for dependability. Cases have been known of growers selling part, or all, of a crop grown under contract. Examples also have been known of growers under contract attempting to deliver a neighbor's or a relative's crop as a part of their contract when open market prices are very low at the time of harvesting.

A continuous problem in procurement is that of avoiding surpluses and shortages in raw materials, i.e., how to maintain smooth delivery schedules for raw commodities. If yields and harvest periods can be anticipated with reasonable accuracy by the field agent, the dehydration plant possibly can make corresponding adjustments in its operating schedule — increasing production schedules to take care of surplus supplies and decreasing production plans to offset insufficient deliveries. As stated previously, resort to open market purchases and sales will oftentimes help maintain regular production schedules.

All contracted fields should be accurately measured to prevent misunderstandings. Careful measurement will discourage growers from planting extra acreage with the intent of either (a) delivering the entire crop should the market price at harvest-time be lower than the contract price, or (b) selling the yield from the extra acreage on the open market should the market prices at the time of harvesting exceed the contract price.

Poor cultural practices during the growing season will materially affect both the quality and the quantity of the harvested commodity. The field agent must be constantly alert to prevent such bad practices; he must be tactful and professionally skillful to achieve the overall objectives of good crop yields having acceptable quality. The growers should be warned against using some of the recently introduced insecticides because some have been found to impart objectional odors and flavors to processed foods — many of the adverse affects appearing only after a period of storage.

The degree of maturity a commodity should attain is often a point of disagreement between the grower and the field agent. The grower wants the maximum tonnage possible, which usually means over-maturity. The processor wants top-grade dehydration quality, which usually means harvesting in the early stages of maturity. Over-maturity in such vegetables as cabbage, carrots, and beets causes serious defects in the dried products. To assure the proper quality and to maintain desired delivery schedules, it is very important that contracts be written so that the processor, through his field agent, is the sole judge as to the time to start harvesting and as to the rate of harvesting.

D. Need for Competent Field Agents

It is no easy task to plan and develop a source of raw material that will attain optimum quality at the right period of time, and that will yield the desired quantity over a calculated period of operation. The successful operation of a dehydration plant requires that these plans be made many months and sometimes years in advance, particularly when new areas are to be brought into production. Some of the problems that may be encountered are those connected with (1) education of growers in the production of a new crop, (2) proper crop rotation and other cultural practices, (3) the procurement of an adequate supply of suitable seed, (4) the assurance that sufficient water is available for irrigation (if needed), and (5) selection of a suitable soil.

A field agent (raw commodity purchaser) has a key role in such work. The average grower leans heavily upon the advice of the field agent regarding many of the operations involved in producing the contracted crop, and the agent should be ready and willing to assist in an advisory capacity at any time.

In areas having a very long or nearly year-round growing season, the operating of a 100-ton per day (or more) dehydration plant can be facilitated by providing an assistant for the field agent. The field agent primarily will be responsible for contract negotiations with the growers and for supervising the planting and growing of the crops. The assistant could determine the rate of harvesting and shipping in order to coordinate raw material supply with the plant requirements, and could be responsible for checking the maturity, freedom from disease and insect-infestation, and other factors of quality of the harvested crop.

E. Licenses and Inspections

Vegetable and fruit dehydration plants will be required to take out certain State licenses and be subject to a certain amount of State and Federal supervision.

The Production and Marketing Administration of the U. S. Department of Agriculture requires a food broker's license for handling vegetables or fruits which move in interstate commerce before or after processing. Most States have their own additional requirements, and the prospective dehydrator should inform himself about the requirements of the State in which he intends to operate. In California, for example, the plant must obtain annually, from the Bureau of Market Enforcement of the Division of Marketing of the State Department of Agriculture, a processor's license and an agent's license for each field agent contracting to purchase crops. The processor is obliged also to file with the California State Director of Agriculture a bond in the amount of $5,000 to assure payment of his obligations to growers and producers, and his purchasing agents must furnish an additional bond of $1,000.

The dehydration plant is always subject to unannounced inspection by agents of the Federal Food & Drug Administration. These inspections are made to assure the Food & Drug Administration that injurious matter does not become a part of the dehydrated product — as it is assumed that the product may be involved in interstate commerce. This agency is able to enforce its decisions by (1) seizure of goods, (2) criminal prosecution, or (3) enjoining the processor from introducing his product to interstate commerce. If the Federal Food & Drug Administration is notified when a new dehydration plant is to be put in operation, it can give an early inspection to point out any unsanitary or illegal practices that need correcting. In this way the loss of large quantities of finished products may be prevented.

In certain areas the dehydration plant is also subject to inspection by State, and sometimes county, public health agencies which may or may not cover some of the same questions as the Food and Drug Administration. These additional inspections usually are for the purpose of insuring sanitation, purity, and proper labeling of the product, and of safeguarding the safety and welfare of the employees.

There is also an optional non-regulatory Federal-State inspection service that is available to dehydration plants in nearly all districts which commercially produce fruits and vegetables in the United States. This is known as "shipping point inspection service". Under this service a Federally trained and licensed inspector can be obtained for the continuous inspection of all raw material coming into the plant.

He will inspect upon the basis of United States Standards for grade and size, or upon any additional specifications included in the grower's contract for which the inspector is equipped. Because speed is essential in inspecting raw products so that deliveries to the plant will not be impeded, considerable attention should be given to providing good and properly arranged equipment for facilitating the work of the inspector.

In California, as an example, it is possible to obtain the services of a Federal-State inspector by application to the Bureau of Shipping Point Inspection, Division of Marketing, California State Department of Agriculture. He is a State employee and the dehydration plant can obtain his services by paying a fee to the State, currently about $30 per day. This shipping-point inspection service is so widely used in California that the receipts from inspection fees for this service alone amounted to $1,176,500 in the fiscal year 1950. A large share of this expenditure is for inspection at processing plants.

The military specifications for five of the dehydrated vegetables covered by this Handbook (beets, cabbage, carrots, onions, and sweetpotatoes) require that the raw material used shall meet certain U. S. Standards established by the Production and Marketing Administration. In order to insure that these raw materials confirm with such standards, it is recommended that the Federal-State inspection service be utilized whenever raw commodities are being received for production under a contract for the military forces.

F. Suggestions for Helping Meet National Emergency Needs

A national emergency will necessitate expanded and accelerated operations to produce the needed quantities of dehydrated vegetables and fruits. To help meet these emergency needs, the Quartermaster Corps will probably establish a procedure which would bring together the interested parties in each of the States or major growing areas involved. These conferences would include representatives of Government agencies responsible for procurement, substantial growers, and the key personnel of existing and prospective processing plants. The purpose of the conferences would be to define the problems, to exchange up-to-date information pertinent to solving them, and to point out the need for a fully coordinated effort by all parties concerned. The discussions would be led by experienced and well qualified representatives from the various groups, and would include discussion of:

1) Quantity and quality of vegetables and fruits to be dehydrated for the armed forces

2) Existing and prospective growing areas

3) Necessity for scheduling of plantings, harvestings, and deliveries

4) Practical cultivation needs such as quality of seed, fertilizers, insect controls, water requirements, and equipment and labor

5) Harvesting, packing, inspection, and transportation requirements

In this way a better understanding would be gained as to how to do the job of producing the needed dehydrated foods. Better cooperation — and better end-results -- will be obtained if each party knows definitely what he should do and how to do it.

CHAPTER IX

CHOICE OF PLANT SIZE

Selection of the scale of operation for a food processing plant is usually based largely upon economic factors. In a peace-time economy low operating costs are essential to profitable operation. In an emergency period, however, factors other than economics must also be carefully considered in deciding the scale of operation. Many of these factors cannot be reduced to numerical terms, and the determination of their relative importance becomes largely a matter of judgment.

There is no such thing as the most efficient plant or the proper scale of operation for any given commodity. The best plant in one situation may be unsuitable under other conditions. The same basic principles must be used in appraising each situation, however. The following discussion is concerned mainly with a consideration of various factors that must be taken into account by a prospective dehydrator in deciding on his scale of operation.

Each plant plan in Volume II is based upon a stated size of operation. Most of the plants are based on a daily input of 100 tons of raw commodity a day. Capacities either greater or smaller may prove to be more economical in certain instances. The absolute cost differential might not be significant, however, in an emergency period. Other factors may be more important in determining the size of plant or scale of operation.

A size of plant, in an emergency period, should be determined in the light of:

1. Emergency needs
2. Resources of an area and of the prospective dehydrator
3. Management and technology needs
4. Production of a quality product
5. Initial plant cost
6. Production costs
7. Use of plant after emergency
8. Anticipated length of emergency
9. Availability of equipment sizes

Emergency Needs

Timely production of acceptable end product is the first essential. Plant sizes must be chosen that will insure this result.

It is not consistent with good military planning to allow concentration of effort in only a few very large plants. The procurement contracts must be spread among enough plants so that the loss or poor operation of one or two would not seriously jeopardize the whole procurement effort. For example, the anticipated Government procurement goal for dehydrated onions for 1945-46, as shown in Table I, Chapter I, was 23 million pounds. Onion plants normally operate 6 months a year, so the desired production would be 4 million pounds a month. It would take about 10 onion plants of the size (100 tons of raw onions a day) contemplated in Volume II, Onion Supplement, to meet this requirement. The loss of one or two of these plants through fire, sabotage, etc., therefore, would not be disastrous. Present operating plants are somewhat larger than the size of the plant covered in this Handbook, so the total number of plants required to meet the production specified actually may be less than ten.

The total number of plants required should not be so great as to complicate Government procurement operations. This naturally places a top limit on the number of plants which would be practical to operate in an emergency period. A balance must be achieved, therefore, between choosing a rather large number of plants for security reasons, and choosing a small number of plants for simplicity in procurement.

A factor that favors the large size plants for the sake of meeting procurement schedules is the shortage of trained and experienced personnel. A few large plants could more effectively utilize the limited number of technical people available. A large number of small plants may spread the experienced personnel so thin that they will be less effective in the overall program.

If a shortage of certain construction materials occurs, the most expedient use of these materials can be made in the larger plants. The capacity of some items of equipment may be doubled while the weight of construction materials used may increase only about 50%. Critical materials should be used efficiently and not be dispersed ineffectively over a large number of small plants. Thus, with a given quantity of critical construction material, the production potential would be greater if that material were put into large plants than if it were put into a number of smaller plants.

Small plants, (e.g., those processing less than 30 tons of raw material a day) cannot be depended upon as a major factor in the production of large volumes of dehydrated foods needed in an emergency. The number of plants involved would be out of proportion to their productive capacity, there is doubt that the very small plants could maintain acceptable quality output, and the scarce materials and skills would not be most efficiently utilized.

During World War II the greatest number of new plants established were of small to medium size. Only five or six very large plants were built. These large plants, however, had excellent production records and contributed substantially to the total production of dehydrated foods.

The record among the small plants was variable. Failures during the war period were almost entirely of plants of capacities less than 100 tons per day. This, of course, was not caused so much by the size of the plant as it was by the lack of proper management and planning and inadequate financial backing. Many prospective operators seriously underestimated their capital requirements. Nevertheless, many small and medium plants operated efficiently and successfully. It is likely in any future emergency, however, that the smallest plants will be larger than in the past. During World War II many plants of 25 to 50 tons a day were in operation. Since that period, the minimum size has increased to around 60 to 70 tons a day for the dehydrated vegetables and fruits that have sufficient market demand.

Newcomers in the dehydration industry may favor building the medium size plants of capacities ranging from perhaps 50 to somewhat over 100 tons a day of raw material. Since this Handbook is intended primarily for use by newcomers in the dehydration field, plant sizes have been chosen in the Supplements of Volume II that would most nearly reflect their needs. After satisfactory operation of these medium size plants has been attained, the operator could more confidently expand the capacity if necessary. Likewise, presently established companies, with their personnel of proved experience in successful operation, will be in the best position to construct the large plants.

Resources of an Area and of the Prospective Dehydrator

The ability of an area to supply raw material, labor, utilities, etc., for a dehydration plant must be considered in the choice of a scale of operation. No plant should be built so large that it cannot readily secure enough raw material or a sufficient number of employees. Present dehydration plants are operating in areas that can support any reasonable size of plant. The problem of plant size would be encountered only if a prospective dehydrator considers locating a plant elsewhere.

If there is any doubt that an area has sufficient resources to operate a plant of economic size, that area should be avoided. The usual variations that occur in the growing of the raw commodity and the possible competition from other industries or plants for labor supply make any marginal area clearly undesirable for the establishment of any size of dehydration plant.

The limited financial resources of prospective dehydrators may place a top limit on the size of plants and tend to keep them smaller than might otherwise be justified. The financing methods available and the tax amortization possibilities will determine the maximum scale of operation, particularly for groups with limited resources.

Management and Technology Needs

An organization capable of paying the most for management and technologic skills is in a favorable position to obtain the best talents available. Larger plants, therefore, are most favored in this respect.

Some small plants have excellent management and technical staffs. When smaller plants cannot meet the pay offered by large plants, some other incentives must be available such as advantages of a particular location and the desire of the individual to work in a smaller plant. It would be inadvisable for small plants to attempt to hire all of the personnel indicated on the organization chart in Chapter VI. Small plants, then, would depend largely on multiple-function personnel. Because of the wide divergence in the types of skills required in the management of a dehydration plant, only exceptional men can function effectively in a number of different capacities. The success of small plants, therefore, will depend upon their ability to obtain these exceptional men.

Most of the skills specified in the aforementioned organization chart could be provided in the medium size plants without imposing a serious financial burden upon the plant. The all-around abilities of key personnel, however, will still be important in determining the success of these plants, because some individuals will be performing more than one function.

Only large plants of over 150-200 tons a day capacity will be able fully to staff the plant with specialists for each important function. The resulting delegation of authority and responsibility to qualified personnel will lighten the load on top management people and allow them to concentrate on important general management functions.

Because the supply of experienced management and technical personnel is limited in the field of dehydration, the very large plants should be able to make the most efficient utilization of the available skills. Present dehydrators could readily build and operate large new plants by using the experienced key personnel now on their staffs. Newcomers would probably be compelled to build medium size plants, in part because their successful operation might be achieved with fewer management and technical employees.

Production of a Quality Product

It may be very difficult for very small plants to maintain production of dehydrated vegetables or fruits of satisfactory quality. In fact, this was proved during World War II when government procurement agencies had very unfortunate experiences in contracting with some small dehydrators.

The very small dehydrator may experience difficulty in obtaining a satisfactory supply of raw commodity. His operation may not be of sufficient size to permit contracting with large commercial growers. The small dehydrator, therefore, must rely on the open market or upon small-scale growers whose cultural practices may vary widely. If the dehydrator has inadequate control over raw material supply, the quality of end-product will suffer accordingly.

Adequate equipment and controls must be installed to permit the production of a quality product, and consistent and careful operating procedures must be adopted and enforced. It is doubtful, however, if the very small dehydrators can afford to provide these necessary requisites.

Medium and large size plants should be able to maintain a constant production of satisfactory quality product, provided, of course, that the factors for quality production are present. It is difficult to specify a dividing line between an adequate size plant and one too small. It is probable, however, that plants processing more than 60 to 70 tons of raw commodity per day will not experience any serious difficulty in producing quality products for reasons relating only to plant size.

Initial Plant Cost

Detailed costs of plants have been presented in the various Supplements of Volume II for only one size of plant for each commodity. In planning a plant, prospective dehydrators may desire to consider more than one plant size. Accurate cost information for plant sizes other than shown in Volume II, is not readily available. The following discussion indicates how one would obtain rough estimates on costs of various plant sizes, using methods and data which may be available.

Chilton 1/ showed that for process plants, the cost versus size relation could be closely approximated by the ratio:

$$\frac{\text{Cost of plant, size A}}{\text{Cost of plant, size B}} = \left[\frac{\text{Capacity, plant A}}{\text{Capacity, plant B}}\right]^{0.6}$$

It is believed that costs for construction of plants for dehydration may deviate somewhat from this rule because of the multiple equipment units required in such plants as the size is scaled upward. A revised formula similar to the one above may be derived specifically for dehydration plants. For this purpose we may use other cost data 2/ which show the estimated costs for constructing various sizes of dehydration plants in 1943.

From these data one may derive a ratio similar to the Chilton formula, which we may apply to dehydration plants:

$$\frac{\text{Cost of plant, size A}}{\text{Cost of plant, size B}} = \left[\frac{\text{Capacity, plant A}}{\text{Capacity, plant B}}\right]^{0.8}$$

This formula may be used for calculating the approximate cost of constructing a plant of the desired size when the cost of constructing a plant of another size is known. For example, when the estimate for constructing a 100 ton potato dehydration plant is $530,000 (see Potato Supplement, Volume II), one may calculate the approximate costs for constructing potato dehydration plants of various sizes:

Plant Size, Tons Raw Commodity Input per Day	Estimated Construction Cost, 1952
25	175,000
50	300,000
100	530,000
150	730,000
200	910,000

This procedure may be repeated for each commodity for which a plant is described in Volume II.

A factor that tends to keep the investment costs of the very small plants in line with this empirical factor is that the smaller plants rely largely on hand labor to do many operations that are done mechanically in larger plants. Thus the

1/ Chilton, C. H. Chemical Engineering, pp. 112-114, April 1950.
2/ Misc. Pub. No. 540. U.S.D.A. June 1944.

investment costs are kept lower than would otherwise be possible. Any change to manual operation, however, is made at the expense of production cost which will be correspondingly greater in the smaller plants.

The effect of capital investment on product costs is relatively minor as long as the size of the plant is above 25 tons a day capacity. Based upon the capital investment estimated above and upon a normal life expectancy, the depreciation charge for the 100-ton-a-day potato dice plant would be about $.004 a pound, of product (see Potato Supplement, Volume II). In the 50-ton plant this charge would be increased only to about $.0046 a pound, a rather small difference. The depreciation charge in the 5-ton plant, however, would be about $.008 a pound, twice as much as in the 100-ton plant.

Of greater importance than the capital investment in judging the economical size of a plant are the design and operating efficiency of the plant. The plants must be engineered so as to handle raw materials without damage and waste, and to make the most efficient use of labor, equipment, and floor space, if low operating costs are to be attained. Larger plants usually are able to provide efficient low-cost operation because they can take advantage of the best that is available in facilities and can attain somewhat greater efficiency through more effective use of labor.

Production Costs

Differences in operating costs between plants of the same size are likely to be greater than differences in costs between efficiently operated plants of various sizes. This assumes, of course, that the sizes considered are beyond the clearly uneconomical small sizes.

Many factors contribute to the successful and profitable operation of a dehydration plant. Among the most important are the following:

1) High yield of finished product from raw material, (the overall shrinkage ratio). The importance of this factor in determining production costs is illustrated by Figure 4 of Chapter XI. This factor is almost independent of plant size, for a medium size plant can obtain yields comparable to those from larger plants. The quality of the raw material procured and the manner in which a plant is operated largely determine the over-all shrinkage ratio. Both of these elements are closely related to management and technologic skills rather than to plant size.

2) High throughput. A plant must operate continuously at or near capacity for most profitable operation. Any size plant can suffer from lack of raw material, shut-downs, etc. This factor, also, is largely unrelated to plant size.

3) Efficient labor utilization. Efficient utilization of labor is only partly related to plant size. Labor requirements for such operations as trimming and coring and inspecting are almost directly related to throughput, and labor efficiency in these operations is largely a matter of good management, training, and morale. Perhaps half of the direct labor in a plant is independent of plant size, and the other half is only partially dependent on plant size.

The three factors listed above are so vitally important in the successful operation of a dehydration plant that plants of any size failing in these respects will certainly fail in total. Inasmuch as large plants do not have a monopoly on these factors, properly planned and well managed small size plants can operate successfully and compete with the larger plants.

Approximately 3/4 of the unit cost of producing potato dice, for example, is largely independent of plant size and includes these major cost items: raw material (estimated at $40 a ton), packing supplies, utilities, and about 1/2 of the direct labor cost. The other 1/4 of production cost may be partially related to plant size and includes about 1/2 of direct labor cost, and depreciation, indirect, and administrative costs. It takes a considerable variation in this 1/4 portion of cost to affect total production costs significantly. If these indirect costs are 10% greater in a smaller size plant, total production costs are increased only 2-1/2%, corresponding to a 22-1/2% decrease of a 10% profit.

To illustrate the relative importance of one of the three factors discussed above, a seemingly small change in the over-all shrinkage ratio of from 7 to 1 to 8 to 1 would increase production costs from 33-1/2 cents a pound to 37-1/2 cents a pound on potato dice, a 12% increase, resulting in turning a 10% profit into a 2% loss if the sales price were 37 cents.

It is important, therefore, that a newcomer to dehydration build a plant of a size he can operate efficiently. If he builds a plant larger than he can handle properly, his costs will be greater than would have been experienced in a smaller but efficiently operated plant.

Use of Plant After Emergency

The prospective dehydrator, in choosing a plant size, must look ahead to see what the prospects are for the plant after the emergency. If a peace-time market may exist for the output from a plant of given capacity, the operator would be hesitant to build a larger plant with private funds.

If no use for the building and equipment as a food processing plant appears likely, the salvage value of the facilities must be considered. A building of a size suitable for other uses must be considered in keeping with the resources and capabilities of the area.

Anticipated Length of Emergency

The longer the emergency, the larger the plants that may be justified. Anyone investigating the dehydration business probably would be hesitant to invest in a large plant, to the extent of millions of dollars, if the emergency promised to be of short duration.

Availability of Equipment Sizes

This factor is important mainly in limiting plant sizes to within certain ranges and in setting a minimum size.

Some items of equipment in a dehydration plant are installed in multiples of the basic unit. For example, a "twin" tunnel drier may have a capacity of 25 tons of raw material per 24 hours. The next step for increasing drier capacity is to install another "twin" tunnel, thus giving a capacity of 50 tons per 24 hours. Since the drier is the major item of equipment in a plant, plant capacities should be chosen to correspond to probable drier capacity. Thus, if "twin" driers are installed, the preferred plant capacities in this example are in multiples of 25 tons.

Other items of equipment also may be installed in multiples of the basic unit. These items include automatic tray-stackers, slicers and dicers, tray unloaders, and certain types of washers and graders. Some items of equipment may be available in only a limited number of sizes, for example, one type of washer may be manufactured in only three different sizes: 1 ton, 5 tons, and 15 tons per hour.

While it is desirable that such facility be of the size and capacity required for normal operation (plus a reasonable excess capacity), this is not practical for many of the operations. A plant is usually scaled to the capacity of the dehydrator, the most costly item of equipment, but the other facilities will often not be of the exact capacity desired. Under these conditions, obviously, many items of equipment must be chosen that have larger capacity than desired. The smaller the plant, the more difficulty the builder will have in matching available equipment units to give a balanced production line.

CHAPTER X

SELECTION OF PLANT PROCEDURES AND FACILITIES

A summary of the applicable Military Specifications 1/ is presented in Table I. The text of each specification must be referred to for exact requirements since abridgement in tabular form has necessarily resulted in generalizations in many instances. Nevertheless, this summarized information will assist the reader in readily determining the essential requirements for raw commodity quality, processing and packaging procedures, and finished product specifications for the various commodities.

The generalized discussions of procedures and facilities in this chapter are largely applicable to most of the commodities considered. Specific information, and particularly any variations from this general information, is given for each commodity in the respective Supplements of Volume II.

The designation of any manufacturer or brand-name equipment in this Handbook is given for illustrative purposes only, and does not imply a recommendation by the Department of Agriculture. Such designations mean only that these particular items have been found satisfactory for the purpose indicated; other sources and items may prove equally satisfactory. Additional information concerning suggested manufacturers of equipment may be found in APPENDIX "C" (Additional Sources of Information).

The Importance of Proper Preliminary Planning

The successful operation of a dehydration plant will largely depend upon the care with which the plant was planned prior to its location and construction. Even though the initial cost of the plant and equipment may appear high, it is only a minor consideration in determining the processing cost per pound of product. The operating charges for raw material, labor, packaging supplies, etc. are far greater than the capital charges. The construction of the plant must, however, be given careful consideration. The type of building, kind of equipment, the process installed, and the plant layout are governing factors in the efficient operation of a dehydration plant. The plant must be engineered to make efficient use of labor, equipment, floor space, supplies, and utilities, to process raw materials without damage and waste, and to maintain satisfactory production schedules.

A properly planned dehydration plant is not designed rigidly around a particular piece of equipment, or around a certain step in the process. The various operations must be balanced — without "bottlenecks". The design of each piece of

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1/ For specifications issued and in effect on Nov. 1, 1951. Subsequent revisions must, however, be considered by any prospective dehydrator.

TABLE I

SIGNIFICANT REQUIREMENTS OF MILITARY SPECIFICATIONS

(The text of each specification must be consulted for exact requirements since abridgement

Final Product	Military Specification	Raw Material Requirements	Processing Requirements: Preparation	Processing Requirements: Sulfiting	Processing Requirements: Blanching
APPLES, DEHYDRATED (Type I - sauce type) (Type II - pie type)	MIL-A-1035A 23 September 1949	Evap. or dried apples of such qualits that dehydr. product will meet defect tolerances. Clean, wholesome, bright, light yellow to white, from latest crop. For Type I any variety or blend of varieties may be used; for Type II the chosen variety or blend (having at least 75% hard type apples) must produce tender non-mushy cooked slices.	Cut the evap. or dried apples into pieces which will yield a final dehydr. product of acceptable size. (For Type I they may be ground.)		
CRANBERRIES, DEHYDRATED (Type II - sliced)	MIL-C-827A 4 September 1951	Well-developed, sound, mature, clean, & dry, of characteristic red color, free from soft, brown, or rotted berries. From current unfrozen crop.			
BEETS, DEHYDRATED (Type I - diced)	MIL-B-3024 3 August 1949	U.S. No. 1 Grade (except for size); clean, sound, mature; of a dark red variety, free from light rings, possessing tender texture when cooked.	Washed; sorted; root bases & tops removed; peeled & trimmed; cut into dice (3/8" cubes) or half-dice (3/8"x3/8"x3/16")		Cut beets shall be adequately blanched or precooked.
CABBAGE, DEHYDRATED (shredded)	MIL-C-826 27 July 1949	U.S. No. 1 Grade (except for size); clean, sound, mature, good cooking quality. Danish, Domestic Pointed, Savoy, or other green varieties preferred. Avoid red varieties.	Trimmed, washed; cored; sprayed with potable water; cut into 1/8" to 1/4" shreds.	By dipping or spraying uniformly with solutions of sodium sulfite or other specified sulfites.	Cut cabbage shall be blanched in live steam until midribs are translucent.
CARROTS, DEHYDRATED (Type I - diced)	MIL-C-839 28 July 1949	U.S. No. 1 Grade (except for size); Red Cored Chantenay, Imperator, or similar varieties. Clean, mature, sound, good cooking quality, and good typical orange color.	Washed; sorted; peeled & trimmed; cut into dice (3/8" cube) or half-dice (3/8"x 3/8"x3/16").	By dipping or spraying uniformly with solutions of sodium sulfite or other specified sulfites.	Cut carrots shall be blanched in live steam until satisfactory peroxidase test is obtained.
ONIONS, DEHYDRATED (Type I - flaked)	MIL-O-3028 8 August 1949	U.S. No. 1 Grade (except for size); clean, sound, mature; white, yellow, or red varieties having prominent pungent characteristics. Avoid onions yielding bitter or mild products.	Washed; sorted; root bases & tops removed; outer & discolored scales removed before or after drying; cut into 1/8" to 1/4" slices.		
POTATOES, SWEET DEHYDRATED (Type II - diced)	MIL-P-3025 3 August 1949 Amendment 1, 30 November 1949	U.S. No. 1 or No. 2 Grades; moist-type, clean, sound, mature, deep yellow to pink color that will not discolor or become soggy after cooking. Sweetpotatoes of cream or light yellow overall-color shall not be used.	Washed; sorted; preheated (130-135°F.) for at least 30 min.; peeled & trimmed (both ends clipped); cut into dice (3/8" cubes) or half-dice (3/8"x3/8"x3/16").	By dipping or spraying uniformly with solutions of sodium sulfite or other specified sulfites.	Cut & sulfited sweetpotatoes shall be blanched in live steam until satisfactory peroxidase test is obtained.
POTATOES, WHITE DEHYDRATED (Type I - diced) (Type IV, Class 1, granules)	MIL-P-1073A 12 December 1950	Sound, mature, of similar drying characteristics, and of mealy texture when cooked. No "sunburns" to be used, nor potatoes which discolor or become soggy after boiling. Russet Burbank, Rural Russet, Green Mountain, Triumph, Katahdin, or similar varieties suggested.	Washed; sorted; peeled & trimmed; cut in half-dice (3/8"x 3/8"x3/16") for Type I; & cut into pieces suitable for cooking for Type IV.	Sulfite treatment shall be given so as to insure a uniform distribution of the sulfite.	Type I cut potatoes blanched so peroxidase test shows color value of 50 or less. Type IV cut potatoes shall be thoroughly cooked but not to the extent of disintegration.

TABLE I

FOR DEHYDRATED PRODUCTS COVERED IN THIS HANDBOOK

in table form has necessarily resulted in generalizations in many instances)

Dehydrated Product Requirements						
Color	Aroma or Flavor	Moisture Content	Particle Size	Sulfite Content	Defect Tolerance	Packaging Requirements and General Remarks
Bright, light yellow to white color characteristic of varieties used, & free from heat discoloration.	Rehydrated cooked product must have color & flavor of cooked apples.	2½% maximum	100% of Type I shall pass a #4 sieve & not more than 2% by wt. shall pass through a #16 sieve. See Remarks for Type II	200 ppm or less measured as SO_2	2% (7%) by wt. of units affected by core; & 3% (7%) damaged by calyxes, etc. (Type II in ())	Approx. 2¼ lbs. of Type I to be packed in #10 (size 603x700) can; the approx. 1-3/4 lbs. for Type II was modified by 1951 QMC procurement exception calling for an average of at least 2 lbs. (obtained by compressing). At least 75% of Type II pieces shall be 3/4" in longest dimension, with at least 50% 1" or more. 85% of Type II retained on #4 sieve, & 98% on #8 sieve.
Bright skin area, somewhat darker than fresh. Uniform dark red when reconstituted.	Sweet, tart cranberry flavor, free from haylike or scorched flavor.	5% maximum			Must be free from scorch, rot, worm damage, or mold.	Packaging based on units of 1 lb. of product compressed into #2½ (size 401x411) or #3 cyl. (407x700) cans or a 4½"x2-3/4"x4¼" carton. Final product must contain no chemical preservatives or artificial coloring.
Good, typical, reasonably uniform, dark red color.	Good, typical beet aroma, free from haylike or other objectionable odors.	5% maximum	Not more than 1% by wt. through #8 sieve.		Not more than 2% by wt. of defective units.	Pack greatest commercially practicable quantity into #10 can. Rehydrated and cooked product must be free from woodiness.
Bright, typical color.	Good, typical aroma; free from haylike or other objectionable odors.	4% maximum	Not more than 15% by wt. through #8 sieve.	1500 to 2500 ppm measured as SO_2.	Not more than 2% by wt. of defective units.	Pack greatest commercially practicable quantity into #10 can in nitrogen or CO_2. Fines are determined on product remaining after clumps & matted pieces are removed.
Good, bright, typical color.	Good, typical aroma, free from haylike or other objectionable odors.	4% maximum	Not more than 1% by wt. through #8 sieve.	500 to 1000 ppm measured as SO_2	Not more than 2% by wt. of defective units.	Pack approx. 2-3/4 lbs. into #10 can in CO_2 or nitrogen. Rehydrated and cooked product must be free from woodiness.
Characteristic bright dehydr. onion color & practically free of brown, pink, or gray flakes.	Typical aroma, free from scorched or other objectionable odors. Must be pungent when cooked.	4% maximum	Not more than 2% by wt. through #14 sieve.		Not more than 2% by wt. of defective units.	Pack approx. 2½ lbs. into a #10 can; regular commercial packaging acceptable for domestic shipment.
Reasonably bright, uniform, typical color characteristic of variety used.	Good, typical aroma; free from haylike or other objectionable odors.	5% maximum	Not more than 1% by wt. through #8 sieve.	200 to 500 ppm measured as SO_2	Not more than 2% by wt. of defective units.	Pack approx. 3 lbs. into a #10 can. Rehydrated & cooked product shall not be gummy or soggy.
Bright, uniform, typical white potato color ranging from light cream to pale yellow.	Free from haylike or other objectionable odors.	7% maximum	Not more than 1% by wt. of Type I through a #8 sieve. 100% of Type IV through #40 sieve.	200 to 500 ppm. measured as SO_2 for Type I; nor more than 300 ppm for Type IV.	Not more than 3% by wt. of defective units for Type I; & practically free of skin, etc. for Type IV.	Regular commercial packaging acceptable for domestic shipment. Pack into #10 cans either the greatest commercially practicable quantity of Type I product, or 6-1/8 lbs. of Type IV, class 1 with nitrogen (leaving less than .2% oxygen). Cooked potatoes for Type IV product shall be mascerated & dried without destroying cellular structure. No gumminess, pastiness, or lumps to be in rehydrated cooked product.

equipment should allow variable capacity so that an operating balance can be obtained without seriously impairing the efficiency of any part of the plant.

The plants presented in this Handbook are not intended as a guide for the expansion of present dehydration companies but as a guide to any newcomers that might be required in the dehydration industry during an emergency. <u>During such a period, production is paramount. This means that the plants will operate continuously as long as the raw commodity is available.</u> Because of the continuous operation and the long processing seasons likely, the plant and equipment must be of rugged construction. Furthermore, an inventory of vital replacement parts must be on hand or readily available. Every possible effort must be made to avoid all shut-downs due to equipment failure. Planning for an emergency dehydration plant must take these considerations into account; the use of flimsy, short-lived equipment with the probable result of interrupted production and high maintenance costs would be folly.

To insure continuous operation and to provide reserve capacity, it may be desirable to install duplicate or reserve equipment for certain critical processing steps. Some equipment in the larger plants will normally be multiple-unit; for example, tunnels and dicers will be installed in multiples and failure of one will not close down the plant. Due consideration should be given also to applying this principle when installing (or holding as "spares") peelers, washers, trim tables, blanchers, boilers, packaging equipment, etc., to avoid complete shut-downs in case of failure of any one critical piece of equipment.

Procedures and Equipment

A. General Considerations

The basic principles outlined in Chapter III need but little amplification insofar as process descriptions are concerned. The basic processes for dehydrating most of the vegetables and fruits considered in this Handbook have become well established by both industry custom and by the requirements of the Military Specifications. The production of potato granules is an exception, however, as the process is still in the development stage.

Differences in operating procedures, as between plants, result mainly from differing methods of applying the basic processing steps. The discussions and conclusions presented in this Handbook pertain to equipment and operating procedures which can be effectively utilized in an emergency expansion of the vegetable and fruit dehydration industry as acceptable commercial practices.

General considerations for individual decisions in choosing the methods for performing the various processing steps are discussed in the following sections. Some of the basic principles pertinent to influencing these decisions are:

1) Any essential procedure considered must be clearly beyond the experimental stage of development. An emergency period is no time for experimentation with a machine or a processing step, unless it does not hinder

production. Only procedures and machines of proved or unquestionable performance should be considered. Consequently, prospective dehydrators must rely heavily on present dehydration practices and on commercially available items of equipment.

2) The processing steps chosen must be efficient, trouble-free, and not damaging to or wasteful of the raw commodity. It has been pointed out before that the initial cost of plant and equipment is not nearly as important in determining production costs as is the effectiveness of the process chosen. Thus, if two procedures are available, one of which involves a sizable investment but has been proved to be efficient and foolproof, and the other of which involves a modest investment but is of doubtful efficiency and surety of operation, there should be little question that the former is to be preferred.

3) Processing methods which require a reasonable minimum of labor should be installed. There is always the question of whether a plant should be highly mechanized or largely dependent on labor. In a plant for an emergency period anticipated to be of short duration, there are important reasons to favor emphasis on hand labor. Experience in World War II, however, was such that in some areas plants had great difficulty in properly staffing each operating shift. Competition from other industries, general shortage of help, and an independent attitude on the part of many employees were contributing factors. The selection of the processing method, therefore, amy be very important in assuring continued and maximum production in the plant in a critical labor area.

4) Highly complex machinery and processes should be avoided unless the required machinery is readily available and has been thoroughly proved in commercial operation. If the choice in a processing step is between using a complicated mechanized procedure or a more costly manual operation, the existence of a ready source of the necessary equipment may be the deciding factor. Not only is the complexity of the machine involved, but also the ability of the plant to develop successful operating procedures quickly. A long period of experimenting and testing must be avoided if possible. The seemingly most costly manual method may thus prove actually to be the least costly if it ensures immediate and successful application.

5) The availability of information or advice on a procedure should be considered. A highly successful and economical procedure may of necessity be avoided because its use is the secret knowledge of one company or person. If, in spite of the demands of an emergency, the procedure remains a secret, the newcomer to dehydration must not consider that procedure. So far as he is concerned, it is in the experimental stage, and may require years to perfect its application. Equipment manufacturers are usually very helpful in aiding customers in choosing proper equipment and in seeing that the equipment works successfully. Prospective operators must avail themselves of this and other sources of consulting services and advice, which will materially aid in the choice of desirable operating procedures.

An allowance for engineering services has been included in the estimated costs for constructing the plants covered in Supplements of Volume II.

6) In the matter of operating costs, reference to the production costs estimated in the Supplements of Volume II should aid in an appraisal of the important factors in process evaluation.

B. Specific Procedures and Equipment

The following discussion bears specifically on each operating step and is coded in conformance with other parts of the Handbook.

100 — RAW COMMODITY PROCUREMENT

130 — Field Grading

Raw commodity may be brought into the plant as field run or as pre-graded material. If procurement has been contracted directly with the growers, field run material will likely be sent to the plant. If the raw commodity is purchased from commercial sources such as packing or shipping houses, it may have been graded.

A rigid grading operation may be performed in the field by field graders. If a large proportion of the crop is of undesirably small sizes, it would be advantageous to remove these in the field and save cost of shipping to and handling at the plant. The field sizer used also would serve to remove dirt, rocks, etc.

150 — Transportation and Weighing

The custom of the area may establish whether the plant or the grower is responsible for hauling. In an emergency situation trucks may not be available for rental, and the plant may have to buy its own trucks. A long haul is obviously undesirable, especially in times of emergency.

The loads may be weighed on public scales, if available, or at the plant (see Code 211).

160 — Storage

With the exception of cabbage, carrots, and beets, the commodities considered in this Handbook are usually stored in order to extend the processing season. Beets may sometimes be stored under proper conditions.

Storage space for raw commodity greater than that which is needed at the plant to assure a steady operation is not provided in the plant plans. (See Chapter XII — "Basic Assumptions Used in Planning the Dehydration Plants Covered in This Handbook").

Where long-term storage of the raw commodity is required, such as for potatoes, onions, and sweetpotatoes, the requirements for raw commodity storage space may be greater than for the entire dehydration process itself. All phases of raw commodity curing and storing problems must be carefully studied when planning the raw commodity handling.

170 — Crate, Box, and Sack Expense

The raw commodity may be packed into crates, baskets, or sacks, or it may be hauled in bulk in large trucks and/or trailers. Sometimes it is received by rail cars. Bulk hauling is often used when the material is not subject to mechanical damage. Cabbage is commonly hauled in bulk, as are potatoes in some areas.

It is usually customary for the dehydration plant to furnish the boxes, crates, or sacks.

Generally, in the plant plans of Volume II, provision has been made for sufficient boxes, crates, or sacks, to handle the fresh commodities processed during the harvest period plus the commodities which must be stored for later processing.

180 — Federal and/or State Inspection

Military specifications usually require that the raw commodity conforms to a grade standard. Government inspection provides a better basis for payment to the grower as a result of the unbiased inspection of the material sent to the plant (see Chapter VIII).

200 — MANUFACTURING OPERATIONS

210 — Raw Commodity Handling

211 — Weighing (at plant)

A scales large enough to handle large truck-trailer combinations is advisable. The ready availability of public scales, however, may eliminate the need for a scales at the plant.

Considerable quantities of dirt are sometimes included in the raw crated or sacked commodity; some provision must be made for removing this dirt and adjusting the prices paid for the raw commodity.

212 — Unloading and storing at plant

Lift-truck operation is recommended for commodities hauled in bags, crates, or boxes. The plant floors, therefore, may be at ground level. In order to make use of the lift truck for unloading, the raw commodity is loaded on pallets on the trucks at the field. The raw commodity is then held on the pallets during hauling, unloading, and plant storing until it is placed at the starting point of the preparation line. Studies have shown that the use of pallets and pallet-handling equipment can cut in half the time and reduce the labor needed to unload a highway truck; (also, standby time of truck operator waiting for his truck to be unloaded is reduced). A further saving in time and labor results from the rapid and efficient handling of the palletized loads within the plant.

Fundamental requirements for successful storage include sufficient ventilation and proper temperature and humidity in the storage area. Protection from excessive heat and cold is necessary.

Code 210 — Raw Commodity Handling

BULK HANDLING OF RAW CABBAGE

(Courtesy of Western Canner & Packer)

Code 210 — Raw Commodity Handling

PALLETIZED HANDLING OF SACKED RAW COMMODITY

(Courtesy of Basic Vegetable Products, Inc.)

Provision should be made for the blending of two or more lots of raw commodity when necessary to maintain efficient plant operation. This frequently arises, such as when one lot of raw commodity is exceptionally free of defects and another below standard in this respect. The former may require only half the trimmers normally used, and the latter, if used exclusively, would greatly decrease plant output. A proper blend of the two lots would allow a reasonable plant operation rate and efficient utilization of all labor.

213 — Feeding to line

Provision for supplying a steady and continuous flow of raw commodity to the processing line is necessary. Flow-control through the processing line is necessary, and the head of the processing line is usually the major control point. Control of feed-rate at this point is done by signal or other arrangement.

The method of handling raw commodity from storage to the processing line may be selected from several common practices. The use of fluming for some root vegetables is highly successful; fluming decreases bruising and serves as a pre-washing step. For other commodities which are initially handled dry, conveyors or lift trucks are more satisfactory.

Many types of conveyors, elevators, etc., are used in feeding raw commodity to the line. Portable conveyors are convenient means of transferring commodity from a large part of the receiving area. Washer-elevators, in addition to conveying, provide a preliminary washing or soaking of the commodity. Feed conveyors also serve as a convenient preliminary sorting or grading point. Feed hoppers may provide soaking or washing preliminary to feeding to line.

214 — Sizing and sorting

Sizing operations may be necessary in some plants to remove sizes and shapes undesirable for processing and to divide the raw material into sized lots for more efficient processing. In the processing procedures considered in the Supplements (Volume II), the onion plant is the only one providing this operation.

215 — Handling and loading sacks and boxes

Storage space will be required for holding empty sacks and boxes from one season to the next. If the boxes are durable and sturdy, they may be stacked (bottom side up) in piles outdoors. Sacks and lightweight boxes may be stored indoors in raw commodity storage areas. Sacks must be kept dry to prolong their life.

220-230 — Preparing

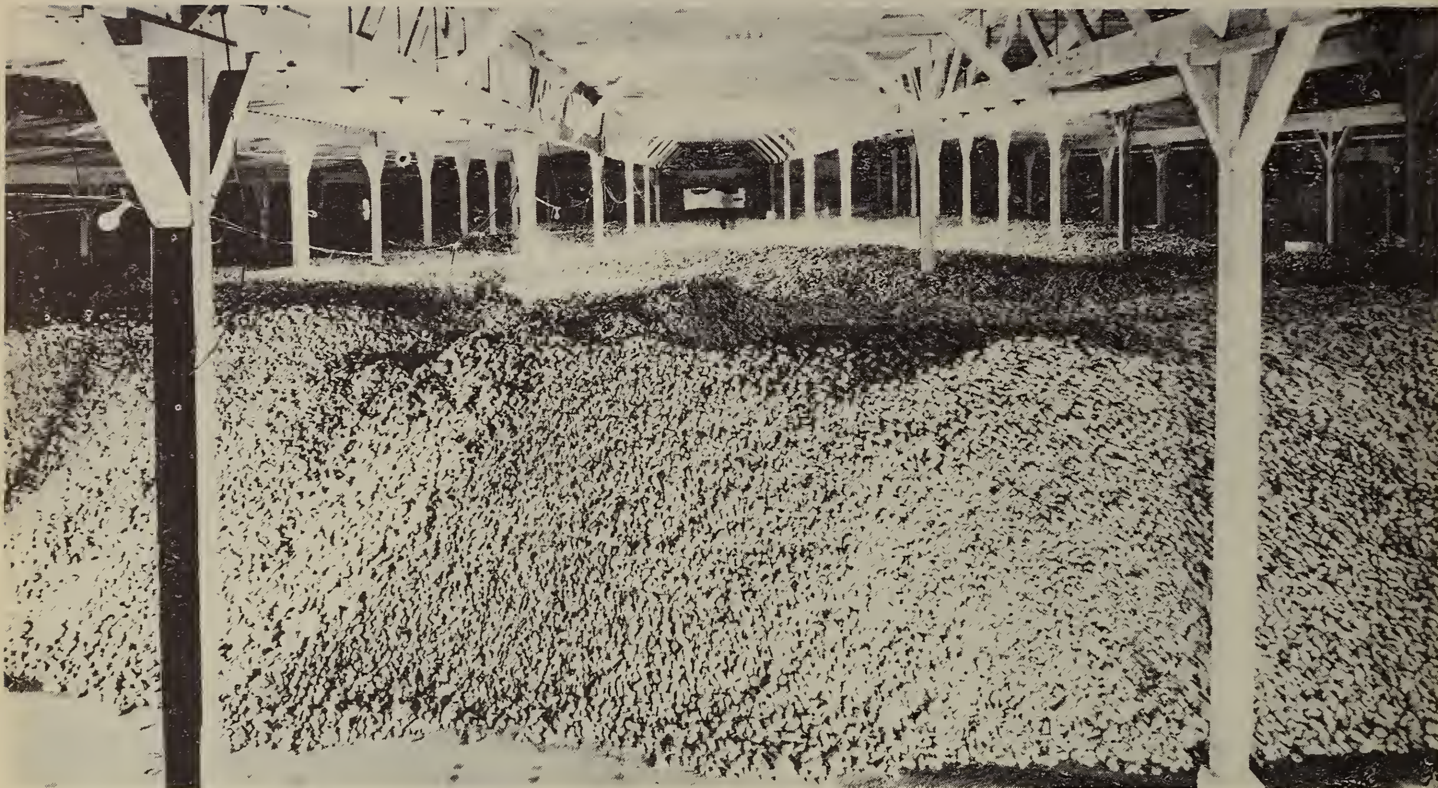
221 — Washing

Root type vegetables, excepting onions, should always be washed before peeling. If they are harvested in rainy weather they

Code 212 — Storage of Raw Material at Plant

BULK STORAGE OF POTATOES IN CELLAR

(Courtesy of Western Canner & Packer)



Code 213 — Feeding to Line

EMPTYING SACKS OF FRESH ONIONS INTO HOPPER FEEDING PREPARATION LINE

(Courtesy of Basic Vegetable Products, Inc.)

may have considerable dirt adhering to their surfaces. Dirt, sand, rocks, and other foreign matter must be removed from the surface of the vegetables in order to aid peel removal in steam or lye peeling. Complete removal of abrasive foreign materials protects such equipment as steam peelers or cutting knives. Lye consumption for peeling is increased by the presence of foreign material.

When it is necessary to remove large quantities of dirt and debris from the raw material, a "dry washer" preceding a standard water washer offers definite advantages. A "dry washer" usually consists of a horizontal rotating drum with bars, slats, or coarse screen in the outer shell. The commodity is tumbled continuously while passing through the "dry washer", and the bulk of the dirt adhering to the raw material is shaken loose and falls out through the drum openings. The commodity then passes on to conventional water washers. This procedure is advantageous in that: (a) less water is required than when all the cleaning is done with water, (b) a large amount of the foreign matter may be removed and disposed of without danger of blocking the water washer or the sewer line, and (c) excessive dirt in the raw commodity shipment may be removed and weighed so that price adjustments may be made (if agreed upon in the purchase contract).

222 — Preheating

Vegetables which are to be peeled by treatment of lye or steam should be preheated in many instances. The preheating treatment varies for different commodities. For example, sweetpotatoes are heated at 130° F. to 135° F. for 30 minutes; white potatoes are heated at 140° F. to 160° F. for four to seven minutes. A preheating operation is intended to serve one or both of two purposes:

1) "Conditioning" before processing

   It has been shown by test that preheating of vegetables such as potatoes or sweetpotatoes improves the efficiency of the peeling processes and the quantity and quality of the finished product. Discoloration after peeling and during drying is reduced, thus minimizing trimming and inspection labor and product losses.

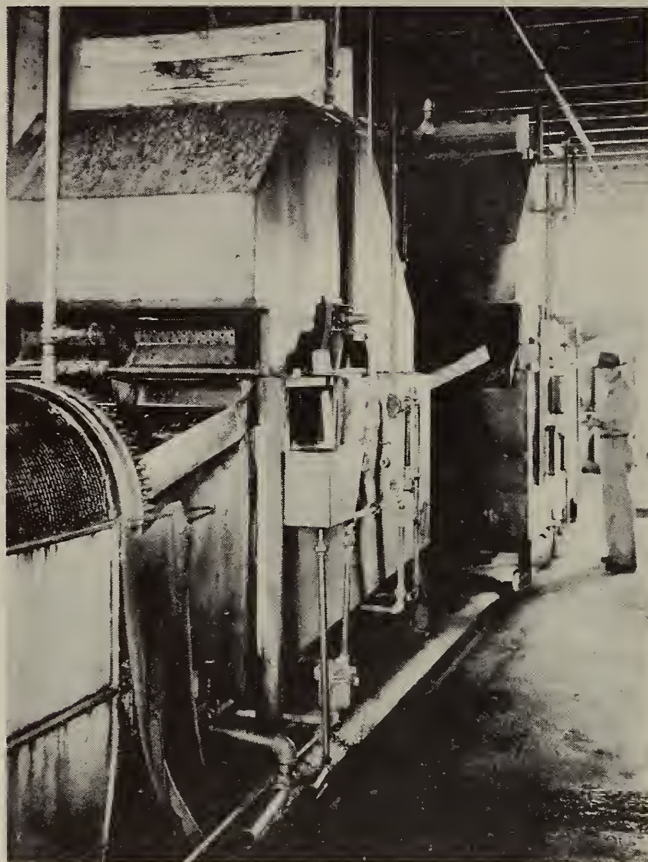
2) Reducing and controlling heat load on peeler

   The peeling operation has been found to be easier to control and to do a more uniform job when the material has been preheated. Also, the capacity of the peeling device is increased by operating on preheated feed material.

The preheating operation may be as long as 30 minutes, so the equipment used may be large. Two types are in use. One is a rotary machine much similar to the lye peeler illustrated in the "Potato Supplement" of Volume II. The other is a long tank through which the vegetables are moved slowly by means of either a screw or a draper belt.

Code 222 — Preheating and 223 — Peeling Root Vegetables

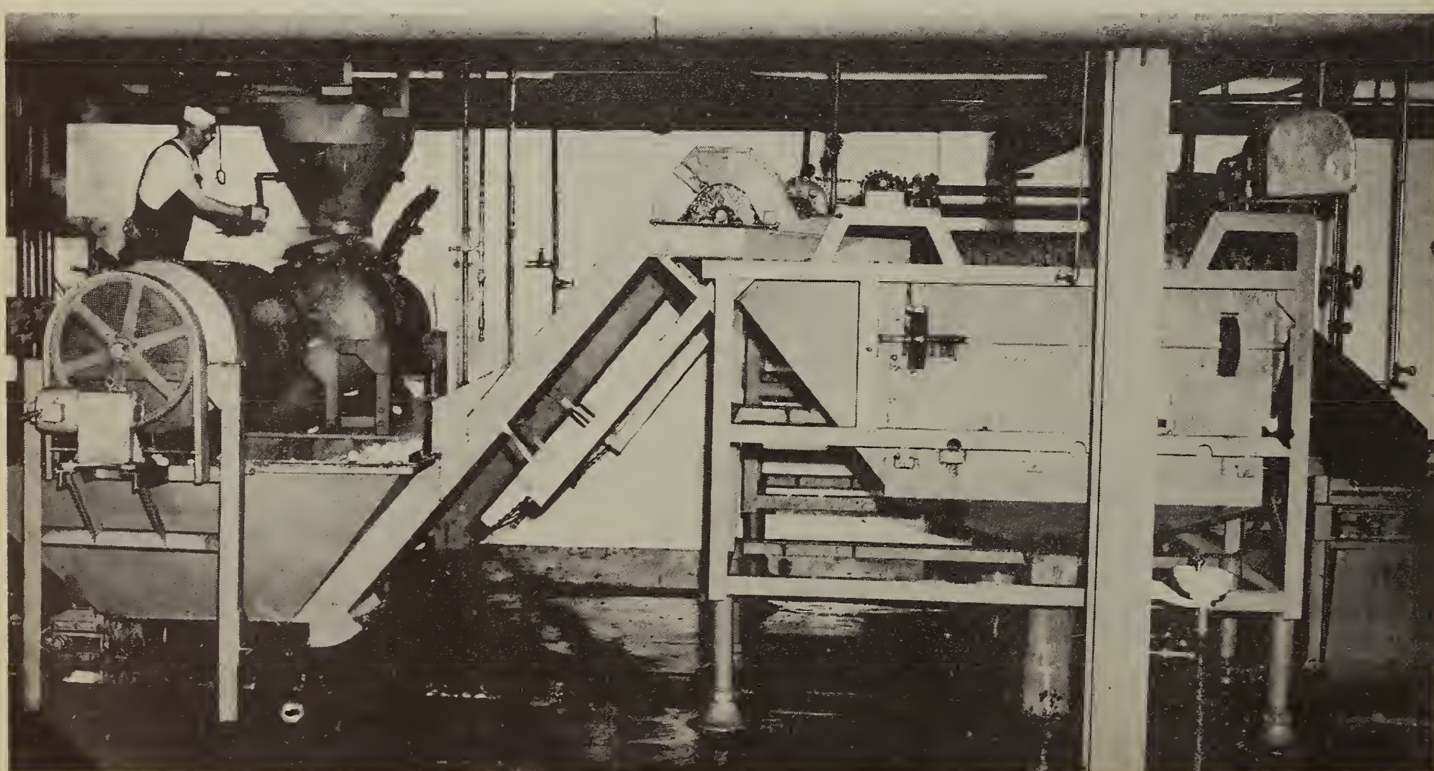
ROTARY PREHEATER AND LYE PEELER IN PROCESSING LINE



Code 222 — Preheating and 223 — Peeling Root Vegetables

STEAM PEELERS AND WASHERS

(Courtesy of Idaho Potato Growers, Inc.)



223 — Peeling

The special problems of peeling the various commodities are discussed in the respective Supplements of Volume II. The following generalized discussion applies mainly to root-type vegetables.

223.2 — Lye peeling

Lye peeling was used widely during World War II. It is effective and certain on a wide range of raw commodities. The main objections to lye peeling methods include:

a) Penetration is deeper, hence peeling losses are higher than with some of the other available methods

b) Corrosiveness and health hazard of lye must be considered

c) Disposal of spent lye may offer a serious problem

d) Lye storage and make-up facilities and labor must be provided

e) During an emergency, shortages of lye, steel drums, and tank cars, and delays in lye shipments, may limit operations

f) Laboratory control of lye-concentration in the peeler is necessary for best results

Notwithstanding these objections, lye peeling methods are still being used, mainly because operators experienced in its use have less difficulty in adapting this method to commodities which may vary in peeling characteristics, and because they desire the smooth, clean appearance of the lye-peeled product.

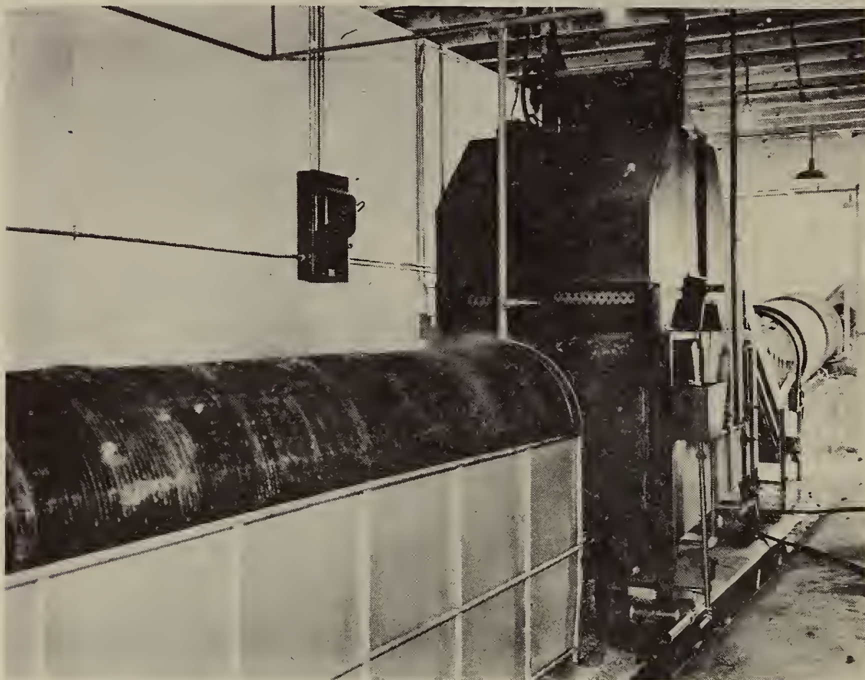
Equipment of the draper-belt type is available commercially for lye peeling. Rotary types of lye peelers (illustrated in the "Potato Supplement" of Volume II) are not as yet standard commercially-produced items, but several custom-built models have been used successfully in the dehydration industry.

223.3 — Steam peeling

This method is coming into greater use and has many strong proponents. Steam peeling can be done batchwise (in retorts) or done continuously (in relatively new types of machines) at steam pressures up to 125 pounds

Code 223 — Peeling Root Vegetables

HIGH PRESSURE WASHING AFTER LYE PEELING



Code 224 — Trimming, Halving, and Coring

PREPARING CABBAGE FOR DEHYDRATION

(Courtesy of Western Canner & Packer)

per square inch. The continuous operation is desirable, but the continuous type of machine involves considerably more investment.

Steam peeling has advantages in its simplicity of operation. Some operators report poor operation of steam peelers on vegetables that have withered in storage. However, the maximum steam pressures that could be used in their equipment was 75 lb./sq. in. or less. Other operators and one manufacturer of continuous type peelers report no peeling troubles with machines which allow pressures up to 100 to 125 lb./sq. in. to be used when required.

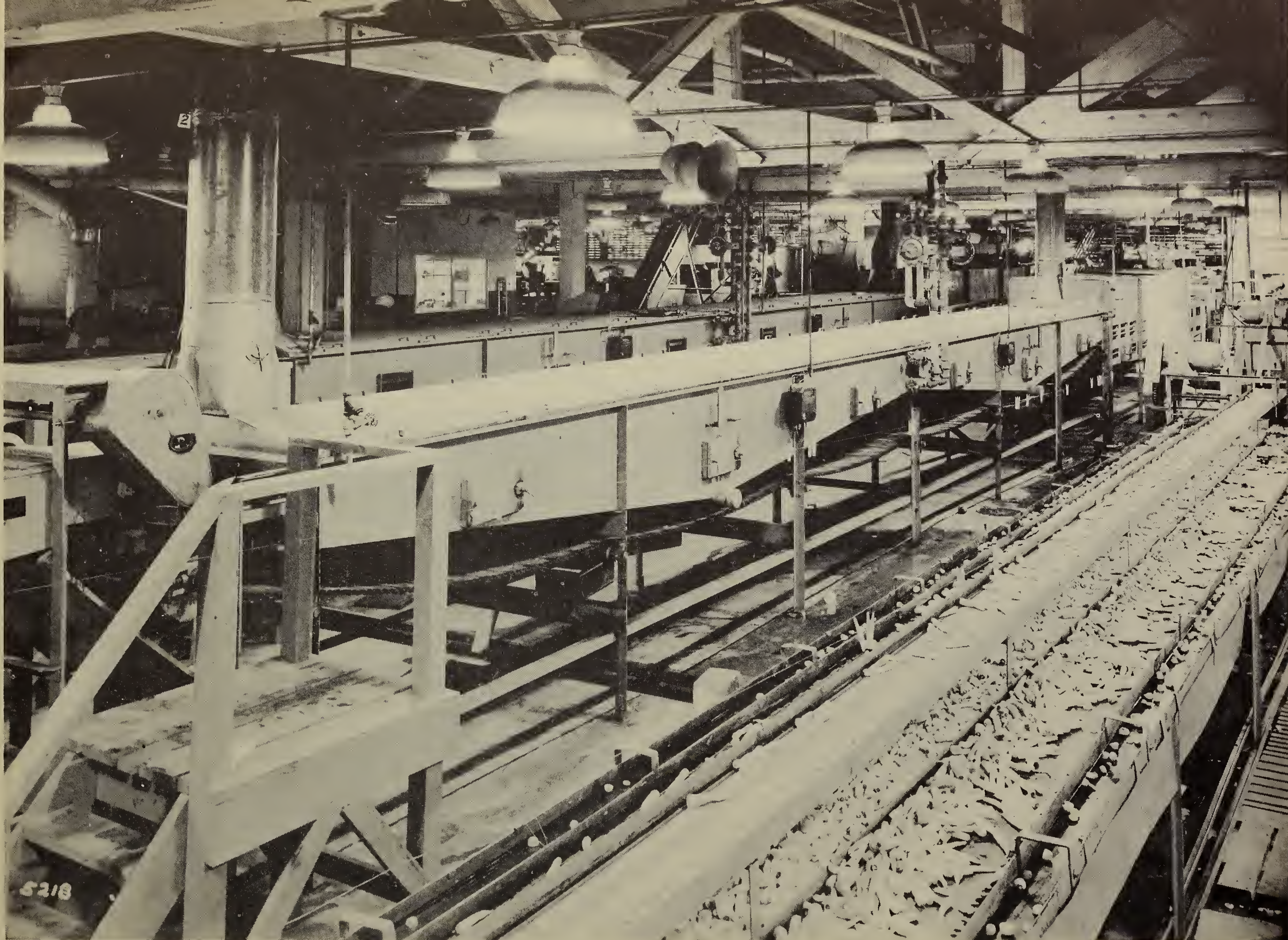
For potatoes, sweetpotatoes, carrots, and beets, steam peeling will usually result in lower peeling losses than will lye peeling.

223.4 — Abrasive peeling

This method is used successfully for small batches in hotels and restaurants. It is wasteful of the product and not adapted to irregularly-shaped vegetables or vegetables of various sizes. Irregularly-shaped vegetables may be overpeeled in raised parts and not peeled at all on concave surfaces. Abrasion peeling may be acceptable when a very light and incomplete peeling may be tolerated (Volume II "Potato Supplement", Section on Potato Granules).

223.5 — Flame peeling

Flame peeling has been used with but limited success on root vegetables; onions have been successfully flame-peeled by one dehydrator. Essentially, flame peeling consists of conveying the vegetables through an oven which is kept at a high temperature by means of either gas or liquid fuel. When commodities are subjected to temperatures in the range of 1000° F. to 2000° F. for a short period of time, the outer surfaces (peel) will first be dried and then burned to a char. This carbonaceous layer can be removed by high pressure water jets, leaving the product in a peeled condition. Flame peeling equipment is costly and difficult to obtain because it must be custom-built. It is limited in its field of application. Fuel and maintenance costs are likely to be high. Operators who have used flame peelers successfully have usually gone through a long and costly period of experimentation and research. In an emergency period a newcomer in the dehydration industry could hardly hope to develop and perfect the process or equipment. The newcomer, therefore, should rely upon the more commonly accepted methods which are more certain of immediate successful application.



Code 224 — Trimming and 227 — Blanching

PREPARATION AREA SHOWING MERRY-GO-ROUND TRIMMING CONVEYOR AT LOWER RIGHT AND BELT BLANCHER IN MIDDLE OF PHOTOGRAPH
(Courtesy of Food Machinery & Chemical Corp.)

223.7 — Manual peeling

Manual peeling is time- and labor-consuming and is therefore costly. It could be justified only if other suitable methods were not available, if the raw material were of such condition that other methods would not work, or if the plant were so small that machine peelers were unjustified.

223.9 — Washing (to remove peel)

Vegetables which have been peeled with steam, lye, or flame, are subjected to a washing action under high pressure sprays which removes loosened pieces of skin and any foreign material.

224 — Trimming, coring, rooting, topping, and inspecting

Root-type vegetables that have been machine-peeled must be trimmed to remove any remaining peel, "eyes", roots, tops, and to remove any damaged, decayed, bruised, blemished, or otherwise undesirable portions.

The trimming operation usually is done manually for potatoes, sweetpotatoes, carrots, and beets. Onions may be rooted and topped manually, but a small water-driven coring machine is widely used.

The trimming operation involves inspection of the raw commodity to insure that it is of desired quality and condition for further processing. Some operators depend on the trimmers to perform this function; some operators put additional people along the belts used to convey the product from the trimming belts to the cutter for this job. Roller conveyors are sometimes provided to aid this inspection operation.

In order to make efficient use of the trimmers, it is important that they always have material at hand so that they do not stand idle. The "merry-go-round" type of conveyor has been found especially good for maintaining a steady supply of vegetables and fruits. The units provided in Volume II for the various vegetable plants consist of three parallel belt conveyors with the center belt positioned above the other two so that its return (or bottom side) is at the same level as the top side of the other belts. The top sides of the three belts travel in the same direction. The outer belts carry the untrimmed material to the trimmers. Any vegetables that are not picked up by the time they reach the end of the belt are diverted to the bottom side of the center belt by a diagonal scraper. The center belt returns them to the beginning of the line where the vegetables are again diverted to the outer belts. The trimmed material is placed on the top side of the center belt by the trimmers and continues on to the next operation.

Waste trimmings may be handled by either of the following methods:

1) Each of the outer belts of a "merry-go-round" conveyor is divided into two lanes by a steel strip suspended over the belt. The inner of these lanes is used for supplying untrimmed material, the outer to carry off the waste.

2) Chutes may be placed along the sides of the conveyor. These lead either to the return side of the outer belts or to gutters or flumes in the floor to carry off the waste.

225 — Washing

Post-trimming washing insures that the product is clean before it is further processed. This washing can be done in conventional washers or in various other ways including water sprays located over conveyors, elevators, or chutes.

226 — Cutting (slicing, dicing, stripping, shredding, etc.)

All products considered in this Handbook are cut before they are dehydrated. This cutting serves two main purposes: (1) to facilitate cooking, blanching, and drying; and (2) to allow the dehydrated product to be rehydrated easily when prepared for food use. Satisfactory commercial equipment is available for cutting the vegetables and fruits into dice, slices, shreds, or strips. As a safeguard against serious damage to the cutter knives, precautions should be taken to remove small rocks, bolts, nuts, nails, etc., from the raw material being processed. Knife sharpening facilities are a "must" in a dehydration plant.

227 — Blanching or cooking (includes any sulfiting, starch-coating, or other treatment done in the blanching operation)

Of the commodities considered in this Handbook, cabbage, potatoes, sweetpotatoes, carrots, and beets must be blanched. These vegetables may be blanched either in steam or in hot water. In the method provided in this Handbook, the prepared product is loaded directly onto the belt of a continuous belt blancher (except cabbage which is blanched on the drying trays). The belt, or trays, loaded with the product travels through an enclosed section which is fitted with steam nozzles (both above and below the belt) throughout its effective length. Among the factors that may influence the required blanching time are the following:

1) Size of pieces. Since the product should reach a temperature of at least 190° F. in the center of each piece, it is obvious that the larger the piece, the longer will be the time to reach this temperature.

2) Depth to which the material is loaded on the blanching trays or belt. It is obvious that the greater

the depth of load the longer will be the time required for penetration of heat to the center of the load.

3) Uniformity of distribution of heat in the blancher. If there are pockets or areas in the blancher in which the temperature is low, a longer blanch will be required to compensate for the low temperatures.

4) Adequacy of the steam supply to maintain a high temperature. If the temperature should drop, it is obvious that a longer blanch will be required to obtain the same degree of blanch. Entrance of air to the blanching chamber through leakage or drafts will cause reduced temperatures in the blancher.

5) Characteristics of the raw material (such as variety and maturity of the product).

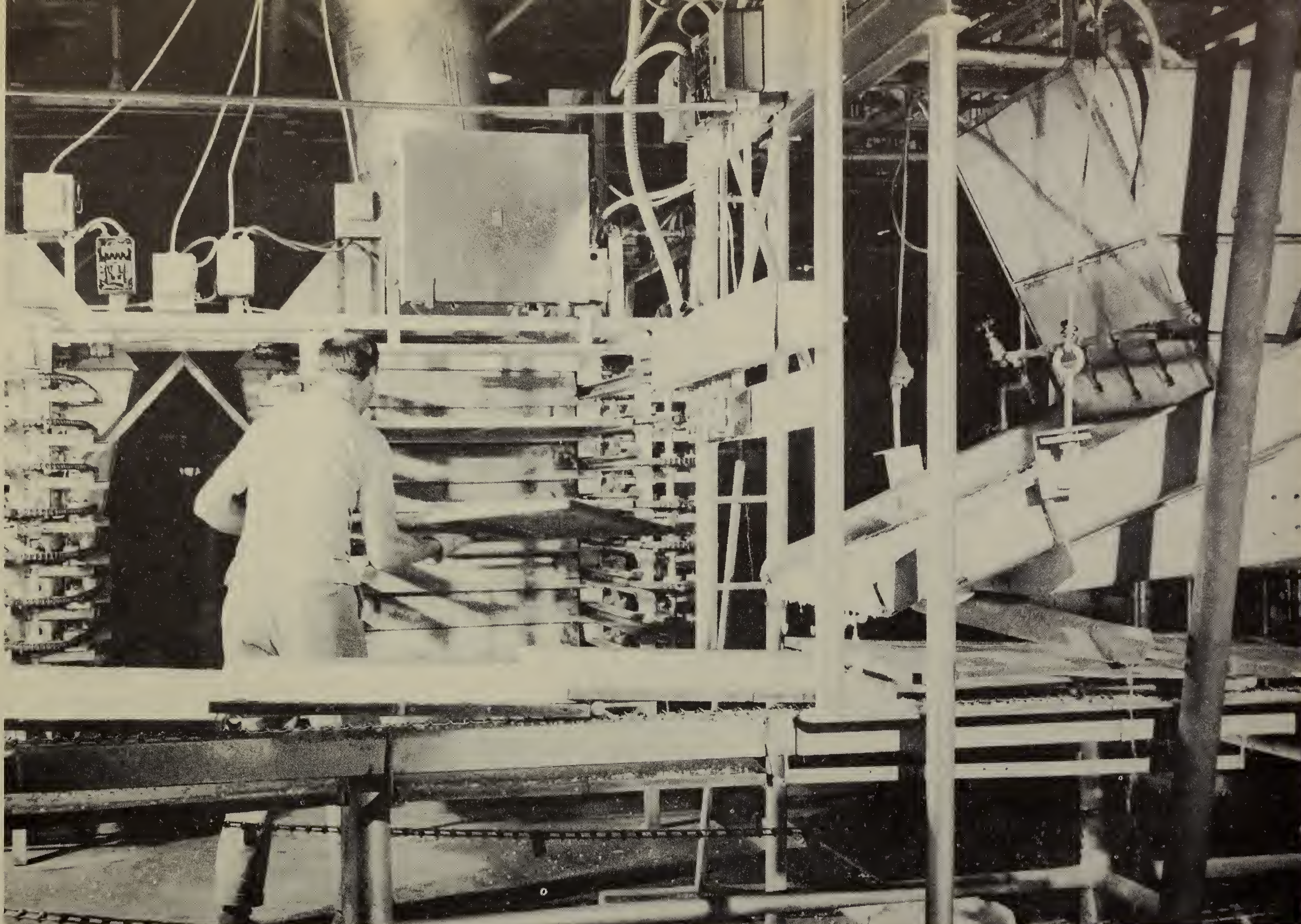
It is important that the cut material be spread evenly over the belt or trays to insure uniform blanching. Various feeding and spreading devices are used, such as vibrating feeders, rotating spreaders, and straight, curved, or angular stationary bars.

Of the commodities considered in this Handbook, potatoes, sweetpotatoes, carrots, cabbage, and apples are sulfited. The procedure that has been adopted for the vegetables consists of applying the sulfite in a spray either in the blancher (as for cabbage), or on the belt section immediately following or preceding the blancher. The sulfiting should be done with spray nozzles so that a good distribution of the sulfite solution will be obtained. Some plants have tried to apply sulfite by allowing the solution to run out of holes drilled in a pipe, but this method gives poor distribution and hence poor sulfiting results. A pump should be provided to deliver the sulfite solution to the nozzles at suitable pressure.

Adequate drainage should be provided after blanching and sulfiting to remove excess sulfite solution from the commodity before it is loaded in trays or belts for drying. Blanchers in which the material is loaded directly onto the belt should have stainless steel belts. The additional cost of stainless steel is well justified as less corrosion and longer equipment life will result, smooth and continuous operation will be assured, and rust contamination of the product will be eliminated.

Solutions for sulfiting vegetables before dehydration are generally made up from the salts sodium sulfite and sodium bisulfite in approximately equal proportions. Solutions of sulfur dioxide gas in water are also used successfully, but require frequent laboratory control tests. The rate of applying sulfite solutions must be adjusted as required for each commodity, but generally one gallon is applied to 10 to 50 pounds of prepared commodity.

Sulfiting is also accomplished in direct-fired driers by the burning of sulfur-bearing oils. (See Volume II — "Potato Supplement".)



Code 241— Tunnel Drying

TRAY LOADING BLANCHED PRODUCT IN FOREGROUND;
VIBRATING SPREADER SHOWN AT RIGHT
(Note: Tunnel drier in background is of unconventional design)
(Courtesy of J. R. Simplot Co.)

240 — Drying

The principles of drying are discussed briefly in Chapter III. The reader is advised to read AIC-300 entitled "Principles of the Drying Process with Special Reference to Vegetable Dehydration" published by the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. D. A.

Selection of Driers

The plant plans in Volume II provide truck-and-tunnel dehydrators for drying potato dice, carrots, onions, cabbage, and cranberries. Conveyor-type driers are provided for sweetpotatoes and beets. These selections are based both on technical reasons and on industry practices.

Tray type driers are generally satisfactory for all of the commodities covered in this Handbook. Conveyor driers can be used successfully on commodities that can be spread evenly on the drying belt to give a uniform distribution of voids so that drying air passing through the bed of material contacts all pieces uniformly. The material must be able to withstand the mechanical handling involved in the deep-bed loading required for economical use of conveyor driers.

Of the commodities covered, only cabbage, onions, and potato granules are not adapted to conveyor-type drying. For commodities which are diced or cut in small pieces — white potatoes, carrots, beets, cranberries, and sweetpotatoes — either tunnel or conveyor driers work satisfactorily. These small pieces can be spread out in thin layers (one to two pounds per square foot) for drying on the trays of a tunnel drier, or they can be loaded several inches deep for drying on the belt of a conveyor drier. Air flow is <u>across</u> the surface of the product for the <u>thin layers</u>, and <u>through</u> the bed of product for <u>thick layers.</u>

Some differences in the characteristics of the finished products may be expected as a result of the type of drier used. Conveyor driers, which allow the use of higher temperatures and shorter drying time, often produce a more porous and bulky dried product than do tunnel driers. This greater porosity makes reconstitution of the dried product faster and easier. The greater bulk may cause trouble, however, in getting the required weight into the cans as specified by Quartermaster Corps.

Initial investment and use of critical materials normally will run much higher on conveyor driers than on tunnel driers for the same capacity. The savings in labor and floor space when conveyor driers are used, however, may off-set the higher initial cost of the conveyor driers. Processing cost data are not available for an exact comparison, but in general these costs for the two drying methods should not be greatly different.

Western dehydrators have used tunnel driers almost to the exclusion of conveyor driers. Eastern and Southern dehydrators have used both types, but currently the conveyor driers are more popular.

<u>Either type of drier can be designed with one or more drying stages</u>. The use of more than one stage permits the use of higher temperatures during the initial part of the drying cycle when the product is moist; however, more complex equipment and sometimes more operating labor is required.

One company has built most of the conveyor driers now used in the vegetable dehydration industry. Its plans are standardized and the driers are usually built with two drying stages. These driers have been found to be very satisfactory when properly operated. Detailed information on design features of conveyor driers can best be obtained directly from the equipment manufacturers.

Tunnel driers for vegetable dehydration have been built by many different people and the designs have not been standardized. One-, two-, and three-stage units may be found in industry. The builder of new tunnels has a definite problem in deciding the number of stages to use. All of the products covered in this Handbook may be dried satisfactorily in any number of stages. For an emergency plant that is to be operated when competent workers may be scarce, the use of three (or more) stages does not seem justified because of the additional operating labor required. For commodities that will not stand a high final drying temperature (onions — 135° F. to 140° F.) or for those that have a very high percentage of water that can be removed rapidly (such as cabbage), two-stage tunnel driers are definitely to be preferred to single-stage units. For other commodities which have lower initial moisture content and will stand a reasonably high final drying temperature, the choice between one-and two-stage tunnel driers becomes more of an arbitrary decision. Since white potatoes (dice), carrots, and cranberries meet these general requirements, single-stage drying has been chosen for them in this Handbook because of its simplicity of operation and construction.

The dehydration of potato granules and apples requires specialized equipment that is discussed in the respective Supplements of Volume II.

Sources of Heat for Dehydration Use

Heating systems for dehydrators can be divided into two broad classifications: (1) direct combustion heating and (2) indirect heating. With direct heating, the gaseous products of combustion are mixed with the drying air and thus come in direct contact with the product. A shielded, but otherwise open gas flame in the main air stream of the drier is an example of this type of heating system. With indirect heating, the combustion gases do not mix with the air used for dehydration. Heating surfaces are used to transfer the heat from the heat source to the drying air. A dehydrator using steam heating coils is an example of indirect heating.

1) Direct combustion heaters are commonly used in tunnel-and-truck dehydrators and in potato granule driers. Since there are no transmission losses, maximum heating efficiency is possible. The fuel used is usually either natural or manufactured gas, bottled gas (such as butane), or fuel oil. Gas — either natural, manufactured, or bottled — is usually preferred to fuel oil because of ease of handling, the simplicity of the control equipment, and the fact that the products of combustion are not likely to affect the quality of the product being dried. Fuel oil is used by some dehydrators, but considerable care must be exercised in the selection of the oil so as to avoid using oils of high sulfur content. Fuels with high sulfur content cannot be used satisfactorily in direct combustion dehydrators, particularly potato granule driers, because the product picks up

excessive sulfur dioxide liberated during combustion. The sulfur content of fuel oils, as marketed, is not usually closely controlled. As a result, the risk of contaminating the product with excessive sulfur dioxide varies from one batch of oil to the next, unless the dehydrator buys his fuel oil on definite specifications.

Gas burners should, in all cases, be of the "pre-mix" type, installed in accordance with the recommendations of the National Board of Fire Underwriters. Burners may be installed directly in the drier air stream, shielded from the cooling effect of the surrounding air currents by a simple unlined sheet metal combustion chamber built around the burner.

Oil burners can be of many different types — atomizing, rotary, pressure, centrifugal, etc. They should, of course, be installed in accordance with the Underwriters' recommendations. Fuel oils, especially the heavier grades, cannot be burned satisfactorily in an open flame because the chilling effect of the surrounding air currents will cool some of the atomized oil particles below the ignition point. These particles do not burn completely and form smoke and soot which contaminate the product in the dehydrator.

A satisfactory way of burning fuel oil is in a refractory-lined steel shell combustion chamber divided into a primary and a secondary combustion zone by a refractory checker-brick partition. The partition serves to confine the radiant heat to the primary zone. In operation, this primary zone becomes incandescent, so that combustion of the fuel occurs at incandescent temperatures. The checker-screen also serves as a baffle which largely prevents the escape of unburned oil droplets, since impingement of the droplets on the incandescent screen results in combustion of the fuel.

The secondary zone is an added precaution against smoking due to incomplete combustion. Any unburned particles of oil escaping from the primary zone will burn at an accelerated rate when they come into contact with the high velocity, high temperature gases flowing through the checker-wall restrictions. The oil particles have sufficient time in the secondary zone to burn completely before entering the main air stream.

Although not essential as a combustion aid when using gaseous fuels, a refractory-lined combustion chamber can also be used with gas burners to insure complete, and therefore more efficient, combustion of the fuel.

2) Indirect heating systems for dehydrators involve, in most cases, steam-to-air heaters, although combustion-gases-to-air heaters are to be found, particularly in apple dehydrators. Steam-to-air heaters, or steam heating coils, are used in conveyor, bin, tunnel-and-truck, and air conveyor driers (such as for potato granules). The principal advantage of using an indirect heating system is that the risk of contaminating the commodity with the products of combustion is completely eliminated, because the

combustion gases are isolated from the drying air. This can be especially important in the case of finish-drying, such as is done in bin driers, because one of the normal products of combustion is moisture vapor. In direct-heat driers, this moisture added to the air by the combustion gases may seriously reduce the drying rate or may limit the moisture content to which the finished product can be dried. Indirect heating of the air is, therefore, advisable for bin drying, particularly if the product is to be dried to a very low moisture level.

The principal disadvantages of using an indirect heating system are the additional equipment required and lower heat economy. If oil is being used in an indirect heating system, the cost of the fuel may be no greater than for direct heating due to the possibility of using cheaper grades of oil in an indirect heating system.

Control Devices Needed in a Dehydration Plant

Instruments used in dehydrator operation include (a) a temperature controller to automatically regulate the dry-bulb temperature of the air in each stage or section of the drier, and (b) thermometers to check the dry-bulb and wet-bulb temperatures (these two temperature readings enable calculation of the humidity conditions in the drier). These would be the minimum control devices for satisfactory operation. A better set-up would include continuous recording as well as control of the dry-bulb temperatures, and, in some cases, continuous recording of the wet-bulb temperatures. In rare cases, the wet-bulb temperatures in the primary driers are also automatically controlled.

Temperature controllers for use in air drying equipment are, in most cases, of the modulating or throttling control type. "On-off" type control is used satisfactorily where two burners are employed; one burner is set manually for continuous operation, the other on control; this practice is for minimizing temperature fluctuations.

Modulating or throttling type controllers are available in wide variety, ranging from simple and inexpensive non-indicating type units to expensive electronic-pneumatic instruments. The simple non-indicating controllers, such as the Minneapolis-Honeywell Regulator Co. T915 series temperature controllers, are generally used in conjunction with a separate temperature recorder, such as the Taylor Instrument Co. 76J series recording thermometer. Commonly used instruments, which both record and control, are the filled-bulb, air-operated 2/, recorder- controllers, such as the Taylor Instrument Co. 121-R series, Fulscope controller, or the Brown Instrument Co. 602-P series temperature controller. This type of instrument is capable of controlling temperatures very accurately when properly installed and adjusted, but it is much more expensive than the simple non-indicating type of controller. Many operators consider the more accurate instrument necessary only when temperature control is critical, as for example in the operation of bin driers at comparatively high temperatures.

2/ For air-operated controllers it is necessary to have a supply of compressed air available in the plant.

Fans or Blowers Used in Air Driers

Fans or blowers commonly used in air driers are of three different types: propeller, axial-flow, and centrifugal. Propeller fans are usable only in driers in which the resistance to air-flow is low. Axial-flow fans and centrifugal fans are used in high-performance driers in which both the air velocity and the resistance to air flow are high, for example, conveyor and tunnel-and-truck dehydrators. Centrifugal fans are usually somewhat more efficient than the axial-flow type, but efficiency is oftentimes sacrificed in favor of compactness, ease of maintenance, and ease of installation.

Propeller and axial-flow fans are somewhat similar in appearance. Both have disk or air-foil section blades mounted on a central shaft. The major difference is to be found in the fan housing. In the case of the propeller fan, the housing is usually a simple panel with a circular opening cut to fit the fan wheel. In an axial-flow fan, the wheel is mounted in a cylindrical tube; the tubular housing is responsible, primarily, for the pressure characteristics of this type of fan. In some axial-flow units, stationary vanes are installed at the intake and discharge, to improve their efficiency by minimizing the swirling motion of the air stream leaving the fan.

Centrifugal fans used in dehydrators are either of the backwardly-inclined-blade type or the forwardly-inclined-blade type. The former is used whenever there is any possibility that the air flow resistance of the drier system will drop below the normal operating resistance. This could happen, for instance, if the doors nearest the fan discharge in a tunnel-and-truck dehydrator were to be opened without first closing the shut-off damper at the fan discharge.

Forwardly-inclined-blade centrifugal fans, whenever they can be used, are generally more compact in size, and are less noisy than the backwardly-inclined-blade type because they usually operate at a lower speed for the same air delivery. Centrifugal fans of both types are generally much quieter in operation than either the axial-flow or the propeller types of fans, particularly the latter.

241 — Tunnel drying

Design of tunnels

Certain features of tunnel driers are being standardized. Most dehydrators use 3' x 6' trays with about 25 trays per car. Most of the recently built tunnels have walls made of hollow building blocks.

An important point in dehydrator design is the choice between side-fired tunnels and overhead-fired tunnels. Side-fired tunnels are built on one level with the fans and combustion chamber beside the drying chambers. Overhead-fired tunnels are built on two levels with the fans and combustion chambers over the drying chambers. Both types are doing a satisfactory job in industry. Advocates of the side-fired tunnels claim:

1) Better air distribution at the hot end of the tunnels

2) Firmer foundations on which to set the combustion chamber and fans

ROW OF SIDE-FIRED DRYING TUNNELS SHOWING LOCATION OF BURNERS, CARS IN ENTRANCE TO TUNNELS, AND TRANSFER TRACK

(Courtesy of J. R. Simplot Co.)

3) Easier access to the burners for adjustments

Advocates of the overhead-fired tunnels claim that:

1) Equally good air flow can be attained by proper design (one desired design feature is to provide space at the hot end of the drier to act as a plenum chamber)

2) Adequate support for overhead fans and combustion chamber is provided by a hollow block wall with a small additional amount of steel

3) A big savings in floor space is accomplished

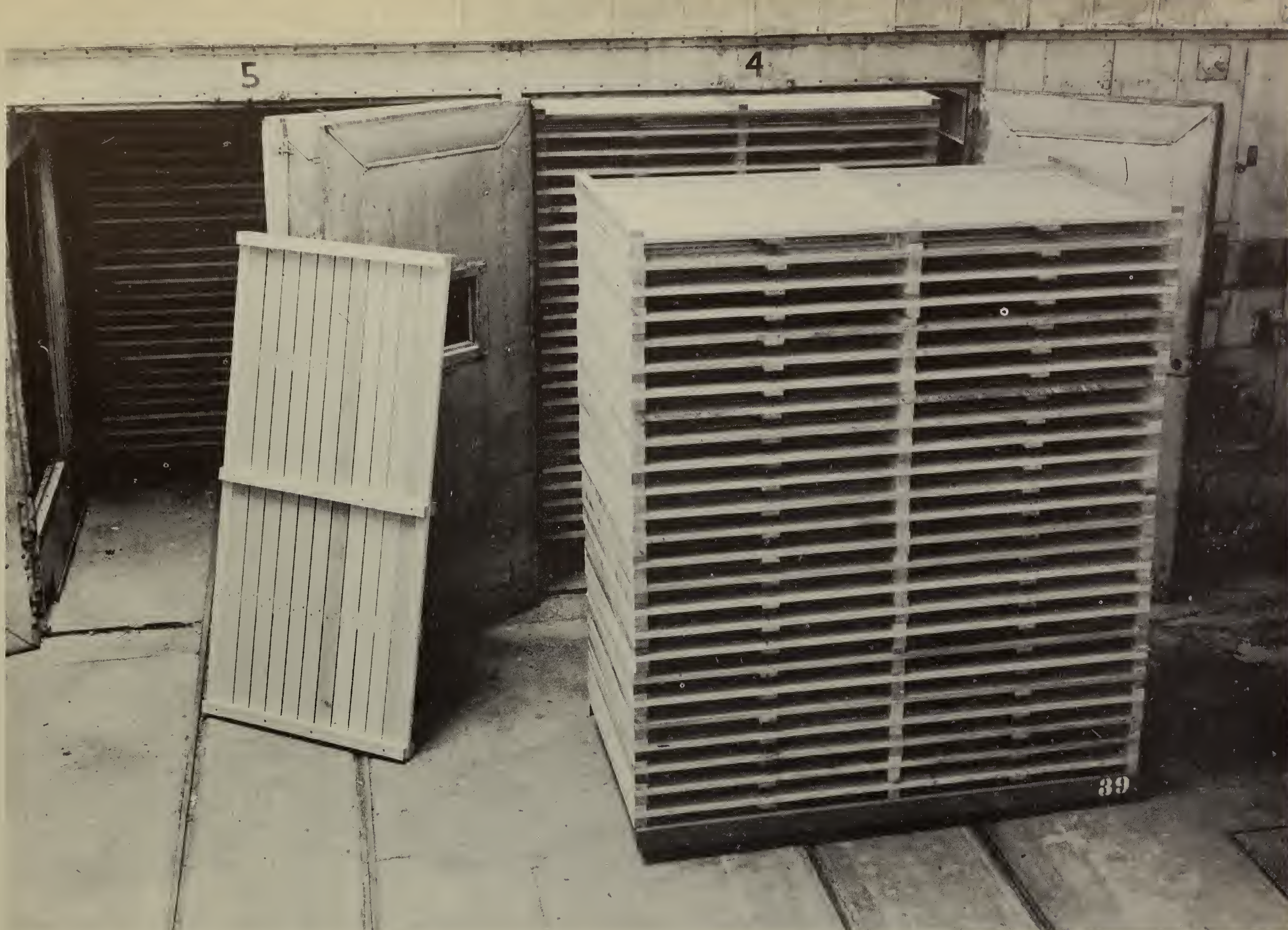
Recent plant constructions tend to favor the overhead design. For the emergency plants under consideration in this Handbook the overhead-fired tunnels were chosen mostly because of their economy in floor space. Approximately one-half as much floor space is occupied by overhead-fired tunnels as by side-fired tunnels.

Tunnels (either overhead-fired or side-fired) may be built as "singles" in which each drying chamber is served by a combustion chamber and fan, or as "twins" in which two drying tunnels are served by one combustion chamber and one fan. The latter type requires less equipment and has been chosen for the tunnel driers in the plants considered in this Handbook. To equalize air flow in each tunnel of a "twin" arrangement, the number of cars in each tunnel must be the same or dampers must be used to control the air flow into each tunnel. This problem normally is not a serious one in a plant operating at maximum production.

The trays may be transported through the tunnels and to the tray unloading and loading stations on either of two types of vehicles: (a) a flanged-wheel type that runs on steel rails, or (b) a caster-wheel type that runs either on flat surfaces or in channel irons through the tunnels. The former is referred to as a "<u>car</u>" and the latter as a "<u>truck</u>" in the discussion immediately following. <u>Throughout the remainder of the Handbook the terms "car" and "truck" are used interchangeably</u>.

The rails required for carrying <u>cars</u> are set in the floor, so they should be installed when the concrete tunnel floors are poured. To move cars at right angles to their line of movement in the tunnels, turntables or transfer cars and tracks are used. A turntable turns the car so that the car can travel on track laid in any direction. Transfer tracks are laid across both ends of a bank of tunnels. The tracks are recessed so that the rails on the top of the transfer cars are flush with the tunnel rails. Cars loaded with drying trays are pushed onto the transfer car and are moved at right angles to their usual path of travel.

The use of <u>trucks</u> for holding the trays permits a simpler installation when tunnels are to be built on existing floors. Also



Code 241 — Tunnel Drying

WOODEN DRYING TRAY AND CAR LOADED WITH TRAYS, STANDING AT THE ENTRANCE TO THE DRYING TUNNELS
(Courtesy of Gentry Division, Consolidated Grocers Corp.)

the conversion of a dehydration plant to other use is easier if trucks have been used in place of cars, as there will be no problems of removing the steel rails imbedded in the floor or filling in the transfer track areas.

For further discussion of tunnel dehydrators, the reader is referred AIC-308 entitled "Tunnel and Truck Dehydrators as Used for Dehydrating Vegetables" published by the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, United States Department of Agriculture.

241.1 — Tray loading

Two types of trays are generally used. If the tray is not intended for use in a blancher, the tray is generally made of wood. Some operators follow the practice of treating wooden trays with a water-proofing material to increase their life. For a commodity which is blanched on trays (such as cabbage), the tray may be constructed with a wooden frame and a wire-mesh bottom (see discussion in "Cabbage Supplement" of Volume II).

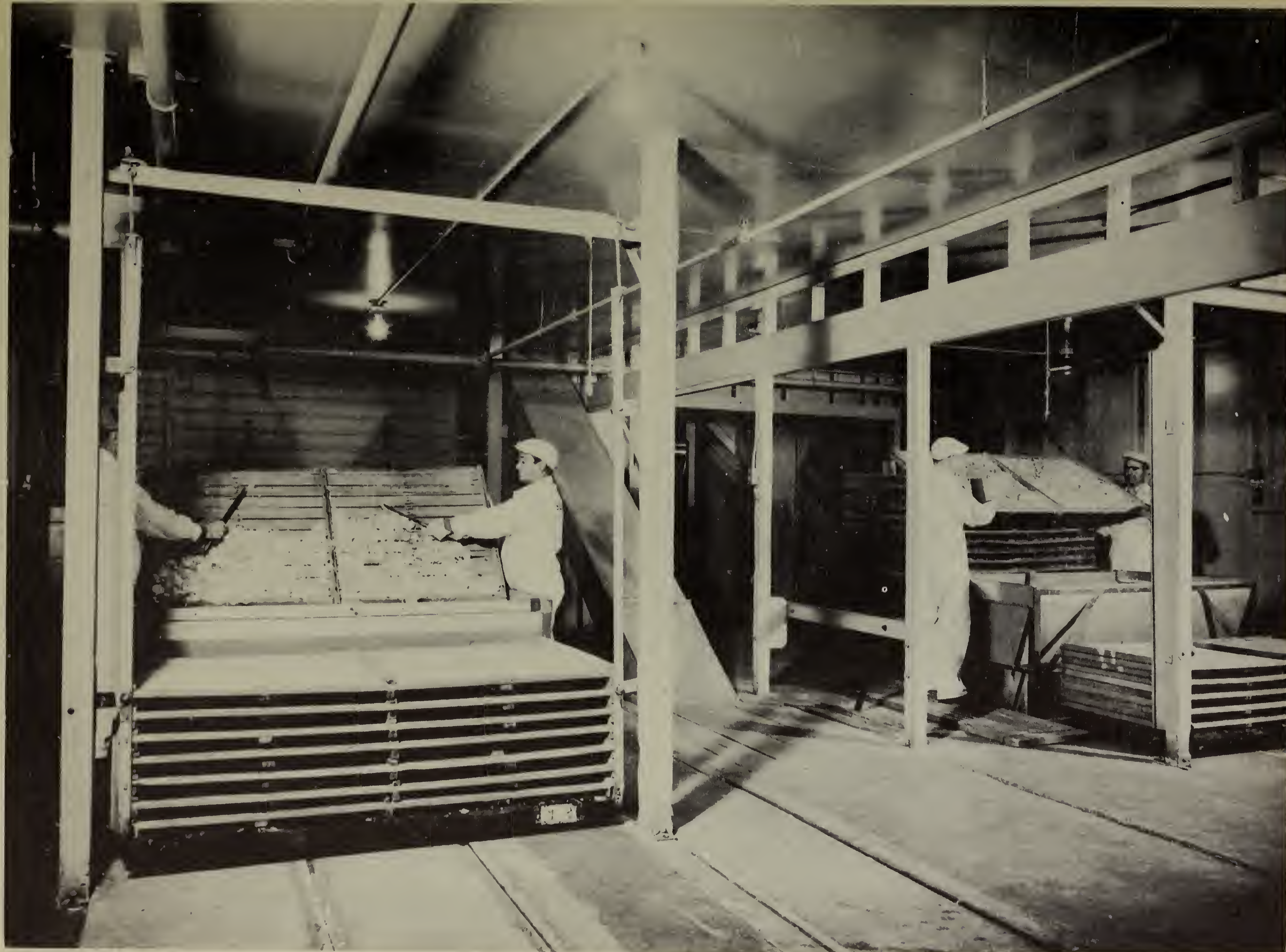
In order to achieve uniform drying it is especially important that the cut material be loaded evenly on the drying trays. Lightly loaded areas will dry quickly and may scorch. Areas loaded too heavily will not dry sufficiently. Tray loading, therefore, is a critical operation which warrants considerable attention.

If the product is loaded directly onto the trays before blanching, then the methods used for spreading might be the same as those discussed under "Code 227 — Blanching". Commodities which are first blanched on a belt and then unloaded on trays present a somewhat less difficult tray spreading problem because they have already been uniformly spread on the blancher belt. A vibrating chute at the end of the blancher has been found very satisfactory to spread diced material uniformly across the full width of the trays. Other arrangements are also successfully used. The speed at which the trays move under the spreader should be readily adjustable so that the speed can be matched to the rate at which the material comes from the blancher. Provision should be made for keeping the cut material off of the frames of the trays since such material (a) will tend to become scorched during the drying operation or, (b) may be caught between the trays as they are stacked on the truck.

241.2 — Tray stacking

As the trays come off the tray loading conveyor they are stacked onto the trucks. During World War II most of this stacking was done manually. More recently, commercially-available automatic tray stackers have proved very successful.

MANUAL TRAY STACKING
(Tray loading and spreading in background)
(Courtesy of Basic Vegetable Products, Inc.)



Code 241 — Tunnel Drying

TRAY UNLOADING AND STACKING
(Courtesy of Basic Vegetable Products, Inc.)

241.3 — Weighing

In order to provide a check on tray loading and also on preparation losses, the loaded cars may be weighed on scales recessed in the floor. Each car may be weighed, or check-weighing may be periodic.

241.4 — Tunnel operating

One of the problems involved in tunnel operation will be the amount of air to recirculate in the driers. Fuel economy is realized by recirculation of some of the drying air; however, the amount of recirculation is limited by the increased humidity of the recirculated air, which may reduce the drying capacity of the tunnel. For maintaining steady drying conditions in tunnels, the recirculation has to be changed as the outside air temperature and humidity change. Some dehydration plant operators prefer to operate the tunnels without recirculation at any time in order to simplify the job for the tunnel operators. Designs proposed in Volume II provide means of recirculation in single-stage tunnels and in the first stage of two-stage tunnels (no means of recirculation is provided for the second stage as the air from this stage is used in the first stage).

Information covering the design of and operation of the tunnel driers for specific commodities is given in the Supplements of Volume II.

241.5 — Tray unloading and stacking

This operation may be performed manually, or by semi-automatic or fully-automatic equipment. In semi-automatic equipment the tray-handling is done manually and the tray-scraping is done mechanically by a rotating blade or brush. Semi-automatic equipment does not reduce materially the labor requirement for the medium-sized plant, but it will assure a uniform scraping of trays. Semi-automatic type of tray scraper is available as a standard equipment item.

Fully-automatic equipment unloads and removes the dry product from each tray, and reloads the trays on a truck. The fully-automatic unit has not been manufactured as a standard unit, however.

241.7 — Tray washing

In the dehydration industry the frequency of tray washing varies from three to four times a season to each time the trays are unloaded. For the plants proposed in this Handbook, it is assumed that the trays will be washed once a week by a special crew working on Sundays or other days when the plant is not in operation. The tray washing can be conveniently done in the line between the slicer or point of blancher discharge, and the stacker. Banks of spray nozzles both above and below the tray level on the conveyor can be provided for use when the trays are to be washed.

242 — Conveyor drying

The conveyor drier is fundamentally automatic in operation and may therefore be preferred in a highly mechanized type of plant, provided, of course, that the particular commodity can be dried successfully in this type of a drier. Unless a relatively thick layer of commodity is carried on the conveyor belts at all times — thus drying a large amount of material per unit of belt space — the size of drier required becomes excessive. For example, if 30 tons of moist vegetable are to be dried each 24 hours, a 7-foot wide dehydrator belt, loaded 1.2 lbs. per sq. ft. (such a loading is comparable to the loading of trays in tray-type driers), must move at a speed of 300 feet per hour. On the other hand, the same belt loaded with 12 lbs. per sq. ft. must move at a speed of only 30 feet per hour. For a 2-hour first-stage drying time, the first stage of the drier would be 600 feet long in the first case (1.2 lb./sq. ft.) and 60 feet long in the latter case (12 lbs./ sq. ft.).

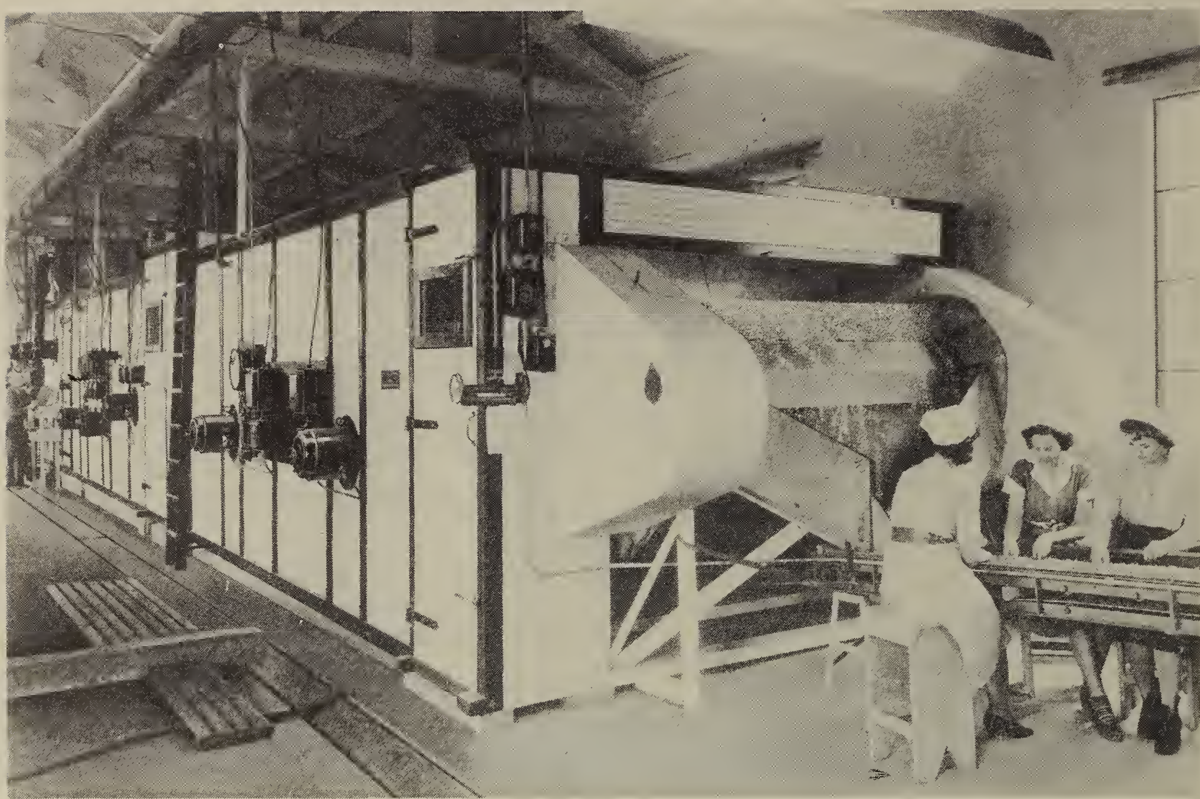
Drying a thick layer of moist material is practical only if the flow of air is through the layer. Conveyor belt driers are therefore built for through-circulation of air. Special precautions must be taken to assure uniform loading of the conveyor-belt and to avoid packing, and/or matting. Heavily loaded areas or those in which the product has packed tightly will fail to receive their share of drying air and the whole conveyor will have to be slowed down to meet the abnormally slow rate of drying of those spots. Conveyor drier units usually include a satisfactory belt loading device.

Conveyor belt driers must be operated continuously 24 hours a day. Interruption in the continuity of the bed of material on a belt causes short-circuiting of air through the open spaces and results in non-uniform drying.

It is usual to divide the conveyor into at least two or three sections in each of which the temperature and humidity of the circulating air may be maintained at values appropriate to that stage of drying. The temperature and humidity of the air entering the moist layer of commodity will be substantially the same throughout the entire length of each section. This fact limits the air temperature to that which may safely be used on the driest product leaving the section. At the end of the first section there will ordinarily be a considerable gradient of moisture content through the layer — the bottom of the layer will be much drier than the top (when using up-flow air). The air temperature in the entire first section must be limited to that which is safe for the driest portion of the product. The direction of air-flow is reversed in successive sections, (i.e., top-to-bottom, bottom-to-top, etc.), so that the variation of moisture content within the layer may be decreased. The material is then re-piled on a slower moving conveyor at two or three times the bed-depth as on the first conveyor. This re-piling is desirable as a means of mixing the material prior to the final stage of drying and reducing the required length of dehydrator materially.

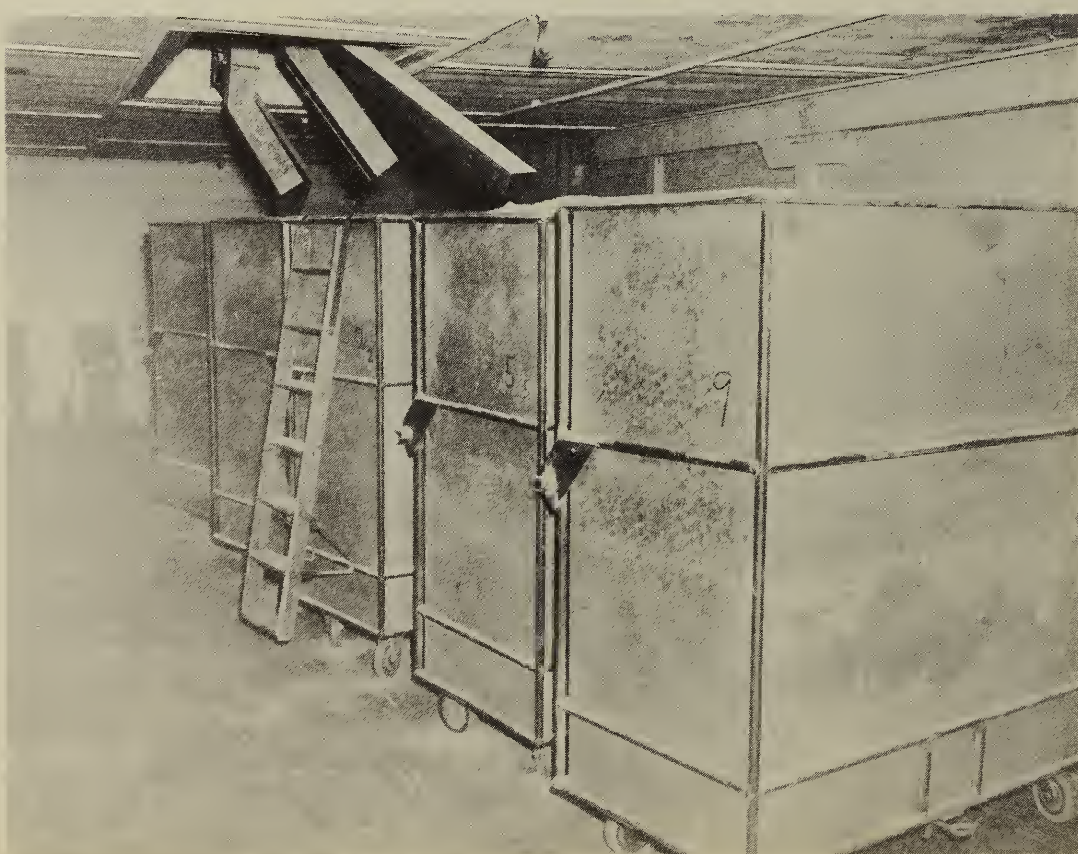
Code 242 — Conveyor Drying

CONVEYOR DRIER AT DISCHARGE END
(Courtesy of Proctor & Schwartz, Inc.)



Code 248 — Bin Drying

PORTABLE DRYING BINS
(Courtesy of Idaho Potato Growers, Inc.)



One of the main advantages of the conveyor-type drier is the low requirement for operating labor. On the other hand, the initial investment for the conveyor-type drier may be very high, as compared with the tunnel-type drier. However, its salvage or resale value may be greater. The conveyor-type drier is probably not as flexible in its operation as the tunnel-truck-and-tray drier and probably cannot be used on as many different commodities. For items such as potatoes, sweetpotatoes, carrots, and beet dice, the conveyor-type drier has been used very successfully. The belts must be thoroughly cleaned at least once a week in addition to the usual devices for continuously scraping and cleaning during operation. The belt may be treated or coated to reduce sticking and to decrease the need for frequent cleaning.

243 — Air suspension drying is a special method of drying which, in this Handbook, applies only to the production of potato granules. The facilities and operations are given in the "Potato Supplement" of Volume II.

245 — Vacuum drying is another special method of drying which, in this Handbook, applies only to the production of dehydrated apples. The facilities and operations are briefly presented in the "Apple Supplement" of Volume II.

248 — Bin drying

The present dehydration industry uses both fixed and portable bins for final drying. The principal advantages of bin drying are:

1) Bins provide means for more closely controlling the moisture content of the finished product

2) Tunnel capacity and flexibility of operation are improved by the use of bins

3) During the slow drying stage (toward the end of the dehydration process) bins provide cheaper means of finishing-drying and for holding

It has been assumed in this Handbook that the portable type bins would be used. The bins have several advantages:

1) Have great flexibility and convenience in operation

2) Are less expensive, and are easy to construct and maintain

3) Reduce the conveying equipment required, thus reducing the "fines" produced

4) Are easily cleaned

Either steel or plywood construction makes satisfactory bins. Steel construction is recommended, if available, as it is

Code 250 — Inspecting

INSPECTING DEHYDRATED ONIONS
(Courtesy of Basic Vegetable Products, Inc.)

more durable and prevents contamination of the product with splinters. The bin is essentially a box on wheels. It is fitted with an air inlet-port at one end, a false bottom, and a screen on which the product rests. Air is blown into the bin under the screen and up through the product. It is desirable to have this screen quickly removable for both ease in cleaning and ease in replacement if the screen becomes damaged. The contents of a bin are dumped into a hopper by up-ending the bins; for this purpose, an electric hoist is used.

In areas of relatively high humidity it may be necessary to dehumidify the air entering the bins. In order to reduce the investment in dehumidifiers, some of the plant plans included in Volume II provide for using dehumidified air directly in only half of the bins, the other half using air recirculated from the other bins or using outside air directly. Thus, the product coming from the primary driers is dried first in the section using the recirculated or undehumidified air, and then the product is finished in the section using dehumidified air.

250 — Screening and Inspecting

252 — Screening

The Military Specifications for some of the commodities considered in this Handbook require that not more than a certain percentage by weight of the dehydrated product which is put into the final package may pass through a screen of specified mesh. Screening is therefore required to remove the material that is too fine in size to meet these requirements. The small pieces that pass through the screens are called "fines". Although some "fines" are always produced in the normal operation of a dehydration plant, extreme care should be exercised in the operation of the cutters and in the handling of the dried product to minimize production of "fines" since this fraction usually represents a financial loss to the operation (see "Code 393"). The dehydrated products are usually very brittle (especially those of onions and cabbage) and each handling step will produce more "fines". The operation should be laid out, therefore, in such a manner so as to avoid any unnecessary handling of the dehydrated product.

253 — Aspirating
254 — Cutting and screening

These operations are applicable only to onions and are discussed in the "Onion Supplement" of Volume II.

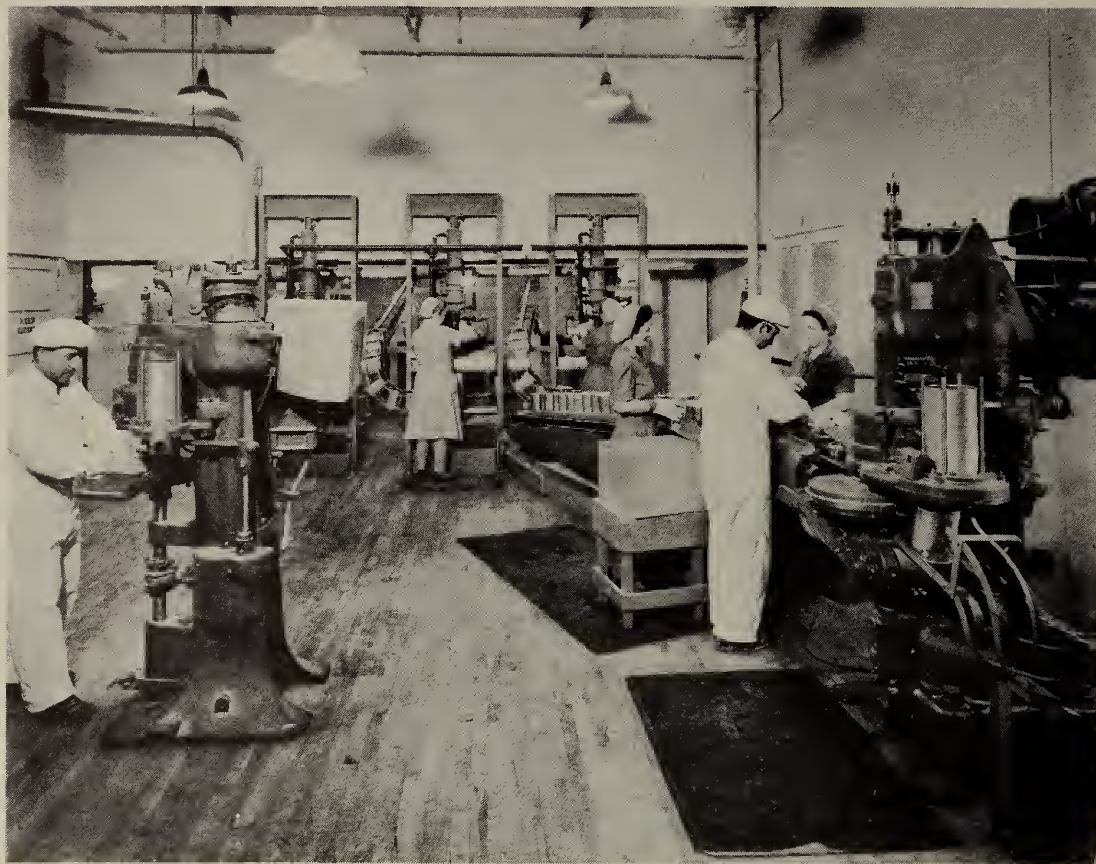
255 — Inspecting

After the finished product has passed the bin drying operation (and screening operation, if used) it is inspected for discolored pieces and for the presence of any foreign material. Inspection is done while the dehydrated product is carried along on a continuous belt. Inasmuch as this is the last opportunity that the operator has to ensure that the product to be packaged is satisfactory, it is important that this final inspection operation be

Code 261 — Filling, Packing, and Sealing

CAN FILLING, COMPRESSING, AND SEALING LINE

(Courtesy of Basic Vegetable Products, Inc.)



Code 261 — Filling, Packing, and Sealing

GAS PACKING LINE

(Courtesy of J. R. Simplot Co.)

carried out carefully. The material should not be spread too thickly on the inspection belt nor should the belt travel too rapidly. Adequate lighting must be provided and adequate space on the inspection belt must be provided for enough workers to do a careful job of inspection.

The dried product may contain small pieces of iron or steel which have been picked up during processing and which may escape observation on the inspection belt. Therefore, provision should be made for a plate magnet to remove this "tramp" iron before it reaches the packaging line.

259 — Dehumidifying

In areas of excessively high atmospheric humidities, it may be desirable to provide dehumidified air for the final inspecting and packaging rooms to prevent moisture pick-up by the dehydrated products.

260 — Packaging and Packing

261 — Filling, packing, and sealing

The type of equipment to do the filling and weighing varies from plant to plant in the dehydration industry. The rate of handling the containers or cans is necessarily slow, due to the great reduction in weight and bulk of the commodity during the processing, so that expensive or complicated equipment is usually not justified. More manual operations are permissible in packaging dehydrated products than will be found in most can-filling lines. Workers may have multiple duties, and packaging and packing may be scheduled for intermittent operation as required.

Some of the commodities must be packaged in inert gas. Two methods have been used for removing oxygen from the can and replacing it with an inert gas such as nitrogen. In one method the can is filled with product to the required net weight 3/, the lid is placed on the can, but the can is only partially sealed. The cans are then put into a chamber and a vacuum is drawn on the chamber. After the desired evacuating time, the vacuum is relieved with the inert gas which fills the cans. The cans are then completely sealed.

Another method, which is assumed for cabbage, carrots, and potato granules in this Handbook, involves the use of lids with small holes. The can is sealed completely except for the small hole, and then placed in the gassing chamber. After the vacuum has been held as required, nitrogen is introduced into the chamber and enters the can through the hole in the lid. When the can is removed from the chamber, the hole is immediately sealed by soldering.

3/ Occasionally the dried products are too bulky and the required weight of product cannot be put into the can. If the desired quantity of product cannot be compressed into the can, this difficulty sometimes may be remedied by changing the drying procedures or operating conditions (see "Drying — Code 240" and AIC-300).

262 — Case-forming, filling, sealing, and marking

These operations are standard and should present no special problems with but two exceptions: (1) rate of output is relatively low, and (2) heavier casing materials are used than are customary in the food processing industry.

270 — Warehousing and Shipping

The cased goods are best handled on pallets which are carried and stacked by lift trucks. The lift trucks also may carry the loaded pallets to the railroad car or truck. The cases are removed from the pallets and stacked into the cars, and the pallets are returned to the warehouse.

If the goods are to be shipped on pallets, then the pallets may be of cheaper construction than assumed in the various plant plans. Shipping costs would be higher than those shown here because of the additional cost of expendable pallets.

Warehouses with ceiling clearances of 14 feet (as provided in the plant plans in the Supplements of Volume II) permit the stacking of packed product three pallet-loads high. Higher building height in the warehouse area would provide inexpensive additional storage space. The relatively light weight of palletized loads of dehydrated products will permit higher warehouse stacking than is used for most other types of processed foods.

300 — GENERAL MANUFACTURING SERVICES

320 — Utilities

321 — Water supply

All plant plans in this Handbook assume that water will be pumped by means of electric power from company-owned wells.

Operation of a dehydration plant is greatly dependent upon an adequate, steady and assured water supply at all times. Normally, an electric motor drives the well pump. However, during electric power interruption or motor breakdown, other means of driving the well pump must be provided. In these plans a diesel engine has been specified as optional standby equipment. Among other advantages, for plants located in rather remote areas, this helps to minimize the risk of fire damage.

Some of the plant plans in Volume II provide for equipment for water chlorination. This treatment of water improves plant sanitation by reducing bacterial and mold growths. Equipment is thereby less slimy and more easily kept clean. Also, reduction of slime on the floors reduces accidents.

322 — Fuel supply

The facilities provided for fuel supply would, of course, depend upon the type of fuel used. Oil, butane, or propane would require storage tanks. Reserve storage capacity should be provided to take care of serious delays in receipt of these liquid types of fuels.

No storage facilities are needed for gas which is piped in, but some standby fuel service may be advisable for two main reasons: (1) in case of some emergency condition that may stop the supply of gas, or (2) to permit the purchase of gas at "interruptible" service rates ("interruptible" type of service gives a plant the benefit of a very low cost rate, but gives the gas company the right, in case of gas shortages, to temporarily stop supplying gas).

Standby facilities for tank gas or oil have been suggested in the "Optional Equipment" of the plant plans in Volume II for those plants which will ordinarily use piped gas.

323 — Electric power

Power is generally available in most sections of the country that would be considered for a dehydration plant. Only in exceptional cases would lack of sufficient power be a factor in plant construction or operation.

324 — Steam supply

The plant plans provide fully-automatic "package" boilers. Such boilers will have low installation costs and can be easily removed to another location if need be. If the boilers are located away from the main plant, some savings can be realized in insurance costs and in housing construction costs for the boilers. The boiler house should be located so as not to obstruct expansion or rearrangement of processing line. Heat losses in the transmission of steam favor locating the boiler near point of greatest steam usage. Three locations for the boiler are shown in the illustrative material in Volume II: (1) location in the plant building proper; (2) location in adjoining structure; and (3) location in a separate building away from main plant. Each location has advantages and disadvantages, and each plant will have to determine which best suits its own conditions.

325 — Waste disposal

The plans provide for screening of the liquid wastes for removal of coarse suspended solids. State and local ordinances regulate the mesh of screen to be installed. It is assumed that the solids from the screens, plus the trimmings, rejects, etc., will be held in garbage bins until hauled away for disposal.

The screened waste water may be run into sewers, streams, irrigation ditches, seepage ponds, lagoons, waste land, or other facilities, depending upon what is available and upon local and State regulations. Treatment of the screened waste water may be necessary in some cases before disposal.

330 — Maintenance and Repairs

331 — Maintenance equipment

The amount of shop equipment needed will depend largely upon the extent to which the dehydration plant must be self-sufficient in this respect. The existence of good, nearby repair shops will lessen the need for elaborate shop equipment at the plant.

In addition to the usual hand tools needed for carpentry, masonry, electrical, plumbing, and metal work, the shop may need these items: welding and cutting equipment; drill presses; cut-off saws; sheet metal cutting facilities; pipe threading and cutting equipment.

The equipment needed for doing plant and grounds clean-up also is included in this category.

332— Maintenance parts and supplies

Practically no piece of mechanical equipment in the plant is free from the possibility of occasional breakdown. If good machine shop service and machinery supply houses are nearby, the plant inventory of maintenance parts and supplies need not be great. If not available, an inventory of essential items should be maintained.

Maintenance parts and supplies should include the following: motors, pumps, conveyor belts, switches, cutting machines, trays, trucks, pipe of various sizes, plumbing supplies, welding and brazing supplies, tanks of oxygen and acetylene, sheet metal and angle iron, an assortment of construction lumber, paints, brushes, electrical wire and conduits, and the various supplies needed for doing plant and grounds clean-up.

370 — Packaging and Packing Supplies and Expense

The finished product warehouse space will probably also be used for the storage of empty cans and cases. If shipments of finished product are frequent and regular, a larger proportion of the warehouse can be used for packaging supplies.

Upon signing a contract with the Government procurement agency, the operator must immediately arrange for purchase of all packaging and packing materials needed to fulfill the contract. Some items, such as metal cans, are usually delivered according to schedules, so the storage space required at the plant depends chiefly on the dependability of the transport facilities and the distance the supplies must be shipped. On other items (such as cases, cooking instruction sheets, etc.), it is sometimes necessary to take delivery of the entire quantity ordered at one time.

The storage space provided in the plant plans is based upon certain assumptions which must be re-appraised for each individual case. Generally, space has been provided for about a 30-day production of finished product plus a small amount of packaging and packing supplies. The actual utilization of the space will vary greatly, however, and in many cases the space may be largely occupied by packaging and packing supplies.

380 — Inspection and Control

The producer of dehydrated vegetables or fruits deals with a perishable commodity throughout the handling of material from the field to the finished product. The product is purchased or rejected by the Armed Forces on the basis of rigid specifications which describe the standards to be met. Strict control of production operations is necessary, therefore, to maintain a consistent output of acceptable product, thus protecting the producer against serious financial loss.

The number of factors which must be controlled, and the technical nature of the controls, require that the producer maintain a process control department. This department must be adequately staffed with technically-trained personnel who are capable of conducting necessary tests and maintaining proper operating conditions throughout the plant.

Effective utilization of a process control department includes more than testing of the final product. The department should check frequently on all processing operations in order to ensure that the plant output meets specifications in all respects. Long-established experience of food processors shows that constant technical guidance is well-justified. Operating without technical guidance, and attempting to correct improper conditions only when serious trouble is encountered may be costly. The functions of a process control department are:

1) To conduct necessary laboratory tests on operations and products to make certain that specifications are met

2) To maintain control over plant operations for effective and efficient processing

3) To maintain adequate plant sanitation to ensure against loss of material through spoilage during processing or after packaging

4) To provide service to field personnel (a) in formulating standards for acceptance of raw material, and (b) in control and inspection of raw material prior to processing

5) To maintain accurate information on shrinkage ratio (or yield), including losses incurred in the various processing operations)

The most essential product tests are discussed briefly in the following paragraphs. These and related tests that are made during the processing operations provide the necessary basis for quality control over plant operations. Plant sanitation is largely a matter of good housekeeping, with limited amounts of bacteriological testing when specific and severe problems are encountered. Service to field personnel includes tests on raw materials to establish their suitability for processing.

Moisture Content

A low moisture content is one of the most important factors in reducing the rate of spoilage of dehydrated vegetables and fruits. The maximum permissible moisture content is, therefore, always an important part of the specification for a product. A moisture content substantially below specification requirements may be desirable from the viewpoint of the purchaser to increase the useful life of the product. Because the drying rate is extremely slow below the moisture level required by specifications, however, the producer seldom dries the product to a moisture content significantly lower than that required.

In view of these considerations, a properly-operating dehydration plant strives to make a product which is slightly below the moisture level required. A safe margin in staying within the maximum permissible moisture content is important, however, because reprocessing of rejected material is very expensive.

Determination of moisture content in dried vegetables and fruits is not well-defined. For this reason, Military Specifications for these dried products not only specify the maximum amount of moisture permitted in a product, but also the method by which the moisture content is to be determined. The Military Specification method is too slow, however, for use in routine plant control. Several rapid, but approximate, methods of measuring moisture content are frequently used for plant control; however, such methods must be checked frequently against the method required by specifications.

Enzyme Inactivation

Certain naturally-occurring enzymes in fresh vegetable tissues must be inactivated prior to the drying operation to reduce deterioration of the dried product. In current practice, enzymes in fresh vegetables are inactivated by heat-treating (i.e., by blanching) the cut commodity in live steam or hot water for a predetermined period of time. Tests for residual enzyme activity in blanched material should be made frequently as a check on the completeness of the blanching operation.

Sulfite Content

Sulfite in dehydrated fruits and in some dehydrated vegetables help prevent browning and loss of natural flavor and color. The dried products are not palatable, however, if too much sulfite is present. Sulfited vegetables tend to lose sulfite during drying. Commodities also may take up sulfite from combustion gases during the drying process. Process control is necessary, therefore, to ensure maintenance of proper sulfite levels in the finished products.

Oxygen in Gas-Packed Containers of Dehydrated Foods

Military Specifications require that some products be packaged in metal containers in an atmosphere of nitrogen. The purpose is to minimize oxidative spoilage of the product by atmospheric oxygen which would normally be present in the container. In most nitrogen-packing techniques, air is removed by drawing a partial vacuum on the packed container, and then refilling the container with nitrogen. This process may be repeated if necessary to reduce the oxygen content of the gas within the container to the required level. Samples of the final packaged product must be taken at intervals and tested to maintain proper control over the gas-packing operation.

A laboratory doing process control work in a vegetable or fruit dehydration plant will require furnishings and equipment as indicated below. The specific requirements of the particular product being produced will determine the laboratory facilities actually needed. In some instances the laboratory installed may be less than indicated, and in some cases the cost may be considerably more.

Furniture, including 2 desks, 1 four-drawer filing case, and 1 table	$ 400
Laboratory furnishings, including sink and drain rack, benches, chemical cabinet, glassware cabinet, and utilities	850
Technical library	100
Cooking stove	100
Refrigerator	250
Analytical balance, with weights, Ainsworth Type BB	400
Gas analyzer, Orsat-Muenke, portable	75
Laboratory grinding mill, Wiley intermediate model	225
pH meter, Beckman Industrial Model M	200
Steinlite Moisture Tester, Fred Stein Laboratories, Inc.	500
Vacuum ovens, two, Precision Freas Model 510 . .	900
Vacuum pump, Cenco Megavac, Central Scientific Co.	200
Assorted heat-and-chemical-resistant glassware	200
Assorted laboratory heaters, hot plates, and burners	200
Miscellaneous laboratory equipment and supplies	400
Total	$5,000

Code 380 — Inspection and Control

TESTING AND CONTROL LABORATORY
(Courtesy of J. R. Simplot Co.)

390 — Miscellaneous Plant Services

391 — Lunch room

A nominal amount has been allowed for equipping a lunch room for employees. While some plants operate without a lunch room, better employee morale and relations will be assured if a satisfactory eating place is provided. It is assumed in the production cost estimates that the income from the lunch room will just equal costs.

392 — Chemicals

The chief chemicals used in a dehydrating plant are caustic soda and sulfites (for some commodities), cleaning compounds, and chlorine used in connection with plant sanitation. A separate storage room for chemicals is desirable; the main storage requirement is that the space must be kept dry.

Caustic soda (lye or sodium hydroxide) may be purchased in dry or liquid form. Many plants are now using liquid caustic and have only a standby supply of dry caustic in case delivery of the liquid material is delayed. Liquid caustic (usually 50% concentration) is delivered in tank cars, or trucks, and is pumped to storage tanks. This is diluted according to the peeling requirement of the particular commodity. Some concentrations of liquid lye will solidify at room temperatures, and provision must be made to convert it to liquid by heating it prior to use.

393 — Sale of trimmings, "fines", etc.

Some solid wastes, such as cabbage leaves and cores, sweetpotato trimmings, etc., should have demand as cattle feed. It is assumed that farmers would haul this material away at no cost to the dehydrator. It is conceivable, in a feed shortage area, that some return might be had for this material.

Other solid wastes, such as onion and beet skins, trimmings and peels from lye-peeled vegetables, etc., may have no feed value and may have to be hauled away at some cost to the dehydrator.

Rejects from the final inspection line may have some value as stock feed. The "fines" screened out prior to final packaging are just as nutritious as the acceptable finished product; some market may exist, therefore, for the sale of these "fines" to make soup stocks, flavoring materials, and other food items. Some provision must be made to put the "fines" into containers for shipment or storage. No allowance has been made in the processing costs for income or expense from the "fines", as it has been assumed that the income will balance the expenses.

Plant Layout

It would appear from the many different layouts that have been used in various food processing plants, that almost any type of layout will work. Just how well each works, though, is the important consideration. The differences in operating efficiency due to differences in plant layout have a large effect on processing costs.

Many of the decisions made in designing a plant depend on personal judgment, and the choice of the final layout may be dependent largely upon what the designer opines as important. There are, however, some general points that should be considered:

1) Sufficient room should be provided for each person, machine, or process, so that it can function freely without being hampered by lack of space. Workers along an inspection or trimming belt should have ample space for movement to do the required job. For equipment, it is important to provide accessibility and sufficient space for workmen to repair or maintain the machines. A processing step should not be confined to an unduly limited area because additional equipment or facilities may be needed to overcome an unanticipated difficulty.

2) Straight-through operation is preferred. Cross-flow may be permitted if such condition does not hamper operations. For example, two conveyors may cross but obviously must be at different elevations. Probably the most serious problems arise from the movement of workers and such equipment items as lift trucks. The plant and equipment should be laid out so as not to obstruct normal plant traffic.

3) The various functions and facilities in a plant should be located conveniently to their related functions. Several examples may be cited. The steam boiler should be located as near as feasible to point of greatest steam usage. The shop should be convenient to equipment that will require repair, to receiving or shipping areas for the handling of equipment and supplies, and to open or unobstructed areas in which items of equipment can be placed for repair. The laboratory should be convenient to the points in the processing line from which samples are drawn. The rest rooms should be located near the greatest concentration of workers. Packaging supplies should be stored adjacent to the packaging room; raw commodity should be stored in close proximity to the feeding point of the preparation line.

4) Where obnoxious odors are involved, due consideration must be given in arranging the plant to the direction of prevailing winds.

5) Building and grounds should be planned to provide for further expansion if needed. Expansion of a particular function, drying for example, should be possible without the necessity of rearranging or disturbing other functions. Locating the important functions on the perimeter of the building is one way of achieving this desired goal.

The premises of the processing plant should be free from conditions objectionable to food processing operations, such as offensive odors, litter, waste, refuse, and dusty road approaches, yards, and parking lots. There should be no poorly drained areas within the immediate vicinity of the premises.

6) Adequate facilities such as rest rooms, locker rooms, and lunch rooms should be provided for employees. This is important from the standpoint of both morale and desirable plant operation. Operating areas of the building should not be cluttered with coats and packaged lunches as would probably be the case if locker rooms or space were not provided. In order to avoid delay in having employees return to work, rest room and lunch room facilities should be sufficient to handle quickly all employees likely to use these facilities at any one time. Hot and cold water should be available in rest rooms, and in some cases, showers for personal cleanliness of plant personnel.

   Suitable protective clothing should be required, such as rubber gloves, hair nets, etc.

7) Adequate lighting, heating, and ventilation are imperative to assure that labor functions efficiently. Good, non-glare lighting is required, particularly for operations involving trimming and inspecting.

8) In some cases it may not be feasible to locate all parts of the plant within the limits of a rectangular building. Boiler rooms and sewage separation units can be conveniently located in small adjoining buildings or in an extension of the main building. To take advantage of possible lower fire-insurance rates, it may be desired to locate the boiler in a separate building. Rooms — such as the office, laboratory, and rest rooms — not requiring over 8 or 9 foot ceilings might be located outside the main building.

9) Provision must be made to permit employees to cross long preparation lines so they will not have to traverse the entire length of the line. Two methods are commonly used: (1) passageways under elevators or elevated equipment, and (2) stairs or bridges over conveyor belts, etc.

Building Requirements

The type of building provided will be influenced by the climatic conditions of the area, the physical characteristics of the plant site chosen, and the local building code and ordinances. These factors are difficult to appraise in advance and must be left to the prospective operator to evaluate for his particular situation. Certain basic points, however, will apply to all buildings wherever located.

It is desirable to plan a well-constructed, general-purpose building rather than one which solely meets the requirements of a specialized dehydration plant. In the event the dehydration operation is not continued either during or after the emergency period, the building would have a value for other purposes.

A rectangular building is generally useful and adaptable for other needs. Good typical wall construction might be concrete, cinder, or pumice block, reinforced as necessary, or wooden frame covered with sheet metal or asbestos board. The roof should be constructed so that the processing and storing areas are not unduly broken by supporting columns. An inside clearance of 14 feet normally will be sufficient.

The floor of the building should be concrete throughout, and provided with proper drainage gutters recessed into the floor. Many food processing plants have raised floors, at a level even with the beds of railroad cars and trucks. However, lift-trucks (carrying materials loaded on pallets) permit ground-level floors to be used at a considerable saving in building cost.

ELEVATOR AND HOPPER FOR HANDLING PROCESSING WASTES

(Courtesy of Gentry Division, Consolidated Grocers Corp.)

ONE TYPE OF CONSTRUCTION SUITABLE FOR A DEHYDRATION PLANT OR STORAGE WAREHOUSE

CHAPTER XI

OPERATING CONSIDERATIONS

The operation of a dehydration plant during emergency conditions may confront the management with many problems that are not likely to occur in a peace-time economy. These problems, plus the usual operating problems, must be carefully appraised during the planning and plant construction stages in order to assure a reasonably successful and profitable operation. The following discussion is intended only to point out briefly some of these operating considerations. For a more detailed and technical discussion of plant operations, the reader is referred to Miscellaneous Publication No. 540, entitled "Vegetable and Fruit Dehydration -- A Manual for Plant Operators", published by the U. S. Department of Agriculture.

Raw Commodity Conservation

With the great demand, during emergency periods, upon the farmer to grow more and more food, there should be no unnecessary waste of that which is produced. It is not enough that a dehydration plant operate so that monetary costs are low. The plant should process the raw commodity in such a manner that the greatest quantities of acceptable dried product are produced. It is the responsibility of the individual operator to keep the over-all shrinkage ratios as low as possible. He must apply the most effective techniques to his operations through careful analysis of his own procedures and by keeping informed of the latest developments in process and equipment research.

Careful selection of the best variety of raw commodity for dehydration, proper control of growing and harvesting conditions, selection of the proper size, shape, and grade of raw commodities, and provision for suitable storage conditions are essential to assure maximum yield and quality of finished product at the lowest cost. In past years, operators have run various grades of raw commodities depending on availability and cost factors. When offered a choice of various acceptable grades (as may be allowed by the government procuring agency), the operator usually chooses the most economical ones considering such factors as purchase price, processing costs (particularly preparation and inspection labor), and yields of finished product.

The raw commodities should be received and processed in an orderly and uniform manner to assure highest finished product yields. If a larger than normal supply is received and held for an excessive period of time, high losses may be experienced.

Raw commodity received at the plant should be segregated and stored according to lot. The size of the lot may vary from one truckload to a whole purchase of raw commodity, depending partly on how much of the purchase is graded at each inspection. Thus, raw commodity of known characteristics may be processed together. It is sometimes necessary, however, to blend lots having different qualities in order to give an acceptable composite lot for satisfactory processing.

For root vegetables, it will be necessary to determine the best balance between peeling and trimming procedures. The need for trimming can be reduced by excessive peeling, but the yield of finished product is thereby reduced. Care in trimming is important. A large saving in commodity can be accomplished when the trimmers are well trained and supervised. Plenty of "elbow room" along the trimming belt, adequate lighting, proper and well-maintained trimming tools, and a steady and adequate flow of product along the belt are all factors that help minimize trimming losses and increase efficiency.

Machines should be provided and operated in such a manner as to waste as little commodity as practical. Cutting machines produce less chaff when the feed rate is within the desired range. The knives on the cutting machinery should be kept sharp. The use of dull knives will result in pieces having irregular shape and lacking in well-defined cut surfaces. Furthermore, considerable bruising or tearing of the tissues will occur which has the effect of accelerating certain chemical processes, leading to rapid deterioration of vitamin and other quality factors. Washing after cutting may cause excessive leaching if the wash is more severe than necessary.

Conservation of Labor

Careful plant layout coupled with all possible labor-saving devices is important. One of the most effective ways of reducing the need for labor is in the choice of a process and plant that are highly mechanized. It should be remembered, however, that highly mechanized operations necessitate a large fixed capital investment and usually require considerable amounts of critical materials.

The construction of dehydration plants in larger sizes is another effective way of utilizing labor more efficiently. It is a general rule that the output per employee increases as the size of the plant increases. (See Chapter IX -- "Choice of Plant Size").

A large percentage of the workers are women in the preparation, drying, and packaging operation of a dehydration plant. It may be possible to use these women more efficiently, or employ a higher percentage of women, if the operations and equipment are planned for these objectives. For example, the use of light-weight units or the use of automatic or semi-automatic equipment may make a task physically suited to women workers.

Effective supervision is one of the most important factors to save labor. It is a wise policy to maintain a training problem which will provide adequate replacements for supervisory personnel.

The piece-work method of pay has been used successfully in increasing output per employee. The quality of work performed sometimes suffers, however, so this method of pay must be carefully investigated before adoption.

Selection, Training, and Utilization of Personnel

A new dehydration plant is usually attended with very discouraging results at first, at least until the equipment has been tested and properly adjusted and the employees have become efficient in their work. Some of these initial headaches can be considerably minimized by the employment of personnel who have had previous experience in a similar plant. A starting nucleus of only a few experienced people will greatly expedite getting a plant into successful operation.

The training of employees is best accomplished by first explaining the specific task to be done (verbally, actual demonstration, etc.), and then having the individuals "learn by doing" under close supervision. The plant operations will be at a rather slow rate during any breaking-in period. It may be advisable to operate only one shift per day until the equipment and processing steps have been tested and adjusted and a number of employees trained to help start other shifts. The rate of doing the various operations should be gradually increased, as fast as testing and training permit, until full-scale operation is attained. Shutdowns will be necessary to repair or replace any equipment that fails to operate properly. An early official inspection of the finished product is advisable to see if the raw commodity and the process used are satisfactory.

Considerable effort is necessary to make a smooth running, efficient organization. A part of this includes the choosing of supervisory personnel, establishing and posting the responsibilities and wage scales for the various positions, and developing real teamwork. Weekly conferences should be held between supervisory personnel and management to discuss policies and to make improvements in operating techniques. Good employee morale is essential. There are many ways the management can help in maintaining good labor relations. Efficiency awards, such as are given by the Army, Navy and other governmental agencies to outstanding plants are great morale boosters. The management should make every effort to earn such awards. Other ways of maintaining good labor relations include providing a fair means of settling grievances, installing necessary safety devices, and rewarding good service as may be warranted.

The "day" shift is under closer and more direct scrutiny of the general manager and other key personnel than the other two operating shifts. It is natural to expect that the "day" shift perhaps will be the best staffed and oftentimes will seem to receive special favors and considerations. On the other hand, the "night" and "swing" shifts have a more difficult situation. These shifts frequently operate short handed, mostly due to absenteeism, may have less laboratory and maintenance assistance, and usually receive the least supervision and encouragement from the top management.

Every effort should be made to care for the needs of each operating shift and to make each shift feel its importance to the enterprise. Provisions for adequate transportation facilities, lunch rooms, recreation facilities, quick and just settlement of disputes, and maintaining sanitary plant conditions will do much to maintain employee morale and efficiency at a satisfactory level, particularly if special attention is given to the problems of the "swing" and "night" shifts.

Production records of each shift, and competition between different shifts should be encouraged to a certain degree. The competitive factor should not be overemphasized, however, or product quality may suffer.

Operation of Equipment

Constant maintenance must be provided for all facilities. A competent maintenance man must make a daily check (or as often as required) of the lubrication and adjustment requirements for each piece of equipment. Standard items of equipment may need some modification to permit proper maintenance while the equipment is in operation.

Efficient plant operation requires frequent sharpening of cutting devices such as mechanical dicers or slicers and the hand knives used by the trimmers. Drying trays should be kept in good repair. Trays that have broken slats or frames make tray handling difficult and slow, are more likely to leave splinters in the final product, and may affect proper drying of the commodity by obstructing or short-circuiting the flow of air. Conveyor and blancher belts must be kept in good condition. The tension on the belt should be adjusted to insure positive motion. Some types of wire-mesh belt have a tendency to stretch, thus requiring frequent adjustment of the tension to give satisfactory operation.

In addition to the physical maintenance of the equipment, each critical processing operation must be checked and serviced by persons directly assigned to that function. The lye-peeler, for example, should be frequently checked and proper adjustments made as required to maintain properly the concentration of the lye solution, the operating temperature, and its peeling efficiency.

Lot Control

The output of finished product is usually divided into lots. Laboratory tests are made on each lot, and records kept accordingly. The packaged goods are stored and shipped according to lots. Military inspection of the finished product will likely be by lot, and acceptance and rejections are made accordingly. Provision must be made, therefore, in the plant-planning stages for testing, coding, and handling the finished product by lots.

Several methods for establishing lots have been used. The most common system is to establish the production of each shift, or portion of a shift, as a lot. In this way, a ready check can be made on both the quantity and quality of production of various shifts. Another method is to delegate authority to the laboratory to change lots in accordance with laboratory sample results. Still another method is based upon the lot classification of the original raw commodity. Combinations of these methods may be useful.

Cost Control

High production costs may be tolerated only if it is impossible to fill the needs of the government for dehydrated foods at costs which are considered reasonable during normal times. In any case, costs should be only as high as absolutely necessary to produce the desired amount and kind of goods. Maintaining reasonable production costs in a time of high raw material costs, labor shortages, high labor rates, and equipment scarcities may be a most difficult task. A partial solution may be found in more efficient operation.

The existence and ready availability of an accurate record of costs is of value to many concerned. Such a record:

1) Serves the buyer as a guide to proper prices

2) Gives the processor a yardstick with which to measure the efficiency of his operations

3) Aids in reducing costs by making cost information available

4) Enables the industry and public to compare dehydration prices and costs with those of other methods of food preservation

By being cost-minded at all times, the industry is in a better competitive position for post-emergency conditions.

In order for an operator to determine the efficiency in effecting savings in costs, it is essential that he maintain an accurate cost control. Ordinarily, cost control is thought of in terms of monetary values only. The types of control needed cover many factors. In setting up such controls, the operator must have two things in mind: (1) the information should be segregated and analyzed in such manner that it will assist him in future operations; and (2) this information could be readily available for the use of others in the dehydration business. To aid the national dehydration program in times of emergency, improved operating procedures, new and improved equipment, and the results of cost saving studies should be made readily available to all concerned.

A record should be kept of the performance of the plant in producing the product when, and as, desired. This record can be sub-divided by contract to show: (1) date the bid was submitted and details of computations, (2) date accepted, (3) conditions and terms, (4) date completed, (5) acceptability of product as proved by government inspection tests, (6) record of monetary costs for each contract, (7) record of raw commodity used, (8) yields obtained, (9) important changes occurring during the fulfillment of the contract, (10) other factors of importance concerning the contract itself. Analysis of this record to show output per unit of time will tell the operator the degree of his success in fulfilling his contract.

Apparently slight changes in the raw commodity being processed can profoundly affect the production costs. The major items that bear continuous checking to control costs include the following:

1) Overall shrinkage ratio, i.e., the pounds of raw commodity input compared with the pounds of finished product produced

2) Production rate (pounds or cases produced per shift)

3) Production per trimmer per unit of time

4) Percentage of finished product passing inspection

Each of these items must be kept within bounds at all times, or the plant faces failure. The first three items are greatly affected by the quality of raw commodity used, and the last item is affected by practically all plant operations as well as raw commodity quality.

A daily cost summary should be made so that the plant manager will have access to an analysis of the previous day's operations, and thus be in a position to make what changes are necessary to bring any excess cost item into line. It is not always feasible to measure each factor individually, but occasional checks should be made to determine limits of normal plant operation.

The production rate is affected principally by factors involved in determining the shrinkage ratio, but is also affected by weather conditions, by efficiency of dehydration equipment operations, and by factors affecting the trimming rate such as the physical defects and size (or size variation) in the raw material.

Trimming efficiency greatly affects operating costs because such a large portion of the total labor cost is involved in this operation. Trimming efficiency is affected partly by the nature of the raw commodity, but frequently is affected sharply by the operation of the peeling equipment. On root vegetables, excessive peeling can cut down the trimming costs at the expense of yield. Studies should be made to determine the most profitable degree of peeling. Analyses should be made to determine just how processing various grades of raw commodity will affect the costs of the final product.

The percentage of product passing specifications should be maintained at or near 100%, but frequently falls below this figure, particularly in the early stages of operation. At first glance this may appear to be purely a processing problem, but frequently the only cure for rejections is a tightening up in one or more of the plant operations and acceptance of the increased cost this involves. Cost analyses are necessary in these cases to determine how close to the line the operation in question can afford to run. The field department, laboratory and control personnel, and management must work very closely together to establish efficient plant operation.

Labor saving studies offer a wide range of possibilities for reducing costs. Perhaps labor turnover is one of the biggest labor problems in a dehydration plant operating in an emergency period. Determination of the costs of training new labor and the effect of labor turnover on production rate are suggested types of analyses to make. Reports on causes of labor idleness, coupled with a determination of possible remedies, present a valuable means of studying and affecting savings in labor. Comparisons of actual labor output with a suitable standard, studies of labor-saving devices and installations, and careful preparation of a labor budget, are all examples of a type of control that should be maintained on labor by the plant operator. Output per unit of labor is the chief criterion in judging labor efficiency.

Raw material control will consist mainly of maintenance and analyses of records containing information concerning the relative advantages of different varieties, sizes, and grades of raw commodities -- showing preparation losses, drying ratios, yields of dried product from the unprepared material, and processing costs of each batch of raw commodities. Analyses of the best handling methods should be included. Among the most important to consider, record, and analyze are: (1) effects of storage, (2) effects of peeling procedures, (3) effects of various amounts of washing (especially on the cut material), and (4) studies of hand operation versus machine as related to the yield of dry product. Records should be kept of weather conditions during the growing and harvesting of each lot of raw commodity processed. Analyses of these records form a basis upon which to judge future raw material purchases and to choose the best time of planting and harvesting.

Operating Costs in New Plants

A new plant will experience higher operating costs than one that has operated successfully for more than one season. Items affecting cost that bear the special attention of the management are discussed briefly below. Other pertinent information also is given in Chapter V ("Business Considerations") under the Section entitled "Contingency Considerations".

1) Over-all shrinkage ratios. A new plant will most likely experience high shrinkage ratios until the best operating procedures have been determined and put into effect. Such things as excessive leaching losses, excessive peeling, trimming, and coring and rooting, and

excessive production of "fines" will lower the yield of finished product. Improper drying and blanching techniques may cause the production of discolored or otherwise unacceptable product. The procurement of improper quality raw commodity will adversely affect the shrinkage ratio. Usually, experience is the only cure for these ills. The new plant, therefore, must expect higher over-all shrinkage ratios than the average plant conditions that have been used for estimating the costs given in the individual Supplements of Volume II. The use of different varieties of raw commodity than those assumed (in these plant plans) also may adversely affect the shrinkage ratios, because in most cases the varieties of higher solids content have been recommended. The relation of various over-all shrinkage ratios to total production costs is shown in Figure 4. The costs illustrated are taken from the "Onion Supplement" (Volume II). Normal depreciation charges are included.

2) Acceptance of finished product. No allowance has been made in the operating cost calculations of the various Supplements for the rejection of any finished product. Rejections likely will be high in the beginning stages of operation but should become negligible as the plant gains experience.

3) Output of product. While most of the operating costs are based on the "wet-end" of the process, the output of finished product actually determines the unit costs and profits. In addition to the factor of yield (over-all shrinkage ratio), output depends upon rate of production and time lost in shut-downs. The new plant will experience a lower rate of production and will be plagued with more shut-downs than the experienced plant. Costs will be affected accordingly.

4) Procurement of raw commodity. A plant inexperienced in procuring and scheduling raw commodities usually will incur higher production costs than a previously existing plant. Both quality and quantity factors are involved. Even with the most careful scheduling, adverse weather conditions will affect delivery of the raw commodity, and the newcomer to this business will have difficulty in maintaining a smooth operating schedule.

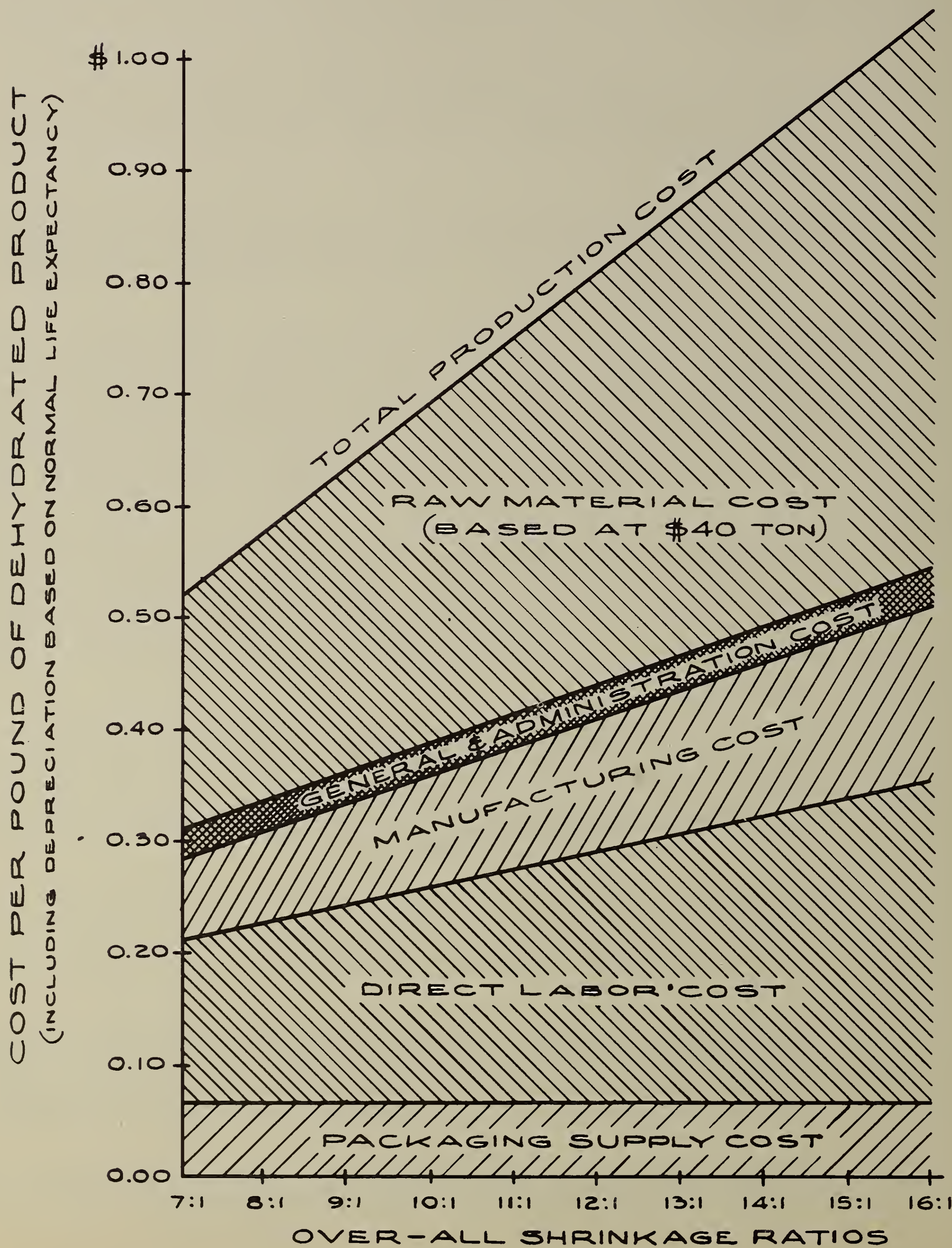
5) Procurement of supplies and replacement of equipment. An emergency plant will in all likelihood obtain its various supplies and equipment under a priority system. New plants in particular will have greater difficulties in maintaining smooth delivery schedules of these needed items. Strong management policies and a capable purchasing agent can do much to minimize such operating hardships.

6) Efficiency of labor. The labor requirements anticipated in the operating cost calculations of the various individual Supplements of Volume II are based upon normal operation with a crew of average experience and ability. During the learning and breaking-in period, labor costs will be higher.

7) Labor rates. A new plant may have to pay higher labor rates because it offers little job security for the employees. Many employees will work at lower rates for an established and permanent plant than for a new plant of doubtful life. On the other hand, a new plant offers better opportunities for advancement.

8) Plant maintenance and modification. Plant "house-keeping" costs may be high in new plants until responsibilities and procedures become routine

FIGURE 4 EFFECT OF VARIOUS OVER-ALL SHRINKAGE RATIOS ON COST OF PRODUCING DEHYDRATED ONIONS.



matters. On the other hand, a new plant has the advantage that it is easier to maintain in good condition than one which has deteriorated through use and age. Any new plant can expect to make some modifications in its original facilities before attaining efficient operation.

9) Utilities. Cost of utilities will be relatively high in the first operating season until the processing operations have been properly synchronized and the personnel become experienced in ways to effect economies in the operations.

10) Insurance rates. New plants, having no record of successful performance and general plant care, likely will pay higher fire insurance rates. Furthermore, highly seasonal plants, and especially new ones, usually pay a higher unemployment insurance rate on labor.

11) Cost of plant. New plants built in high cost times will incur higher capital charges (such as depreciation) than will older plants built in low cost times. The new plant, on the other hand, may have the advantage of being in a position to install newer and more efficient processing equipment.

Cost Accounting for Vegetable and Fruit Dehydration Plants

The installation of a cost accounting system in a dehydration plant requires considerable study of the operations involved and a consideration of the information that is desired from the cost records. The cost accounting outline presented herein has been developed to cover only the products included in this Handbook, and is based upon the assumption that each plant handles only one commodity to produce one type of product. The collection and classification of costs is therefore somewhat simpler than where two or more products, or types of products, are produced. 1/ This basic system can be readily expanded, if needed, to fit the needs of multi-product plants.

Certain main purposes have been considered in preparing this accounting system:

1) Ready calculation of the total costs for producing the finished product, and determination of the profit or loss resulting from the production and sale of the finished product

2) Comparison of costs for different lots or types of raw material

3) Comparison of costs of different methods for preparing, drying, and packaging

4) Assistance in controlling each operation and cost

5) Detailed records for reference and audit

1/ For a description of the problems involved and the methods of accounting used in the canning and food processing industry when two or more end items are involved, see: (a) "Cost Accounting for the Canning Industry" (Ralph H. Barr) in Handbook of Cost Accounting Methods, J. K. Lasser, Editor, D. Van Nostrand Co., Inc., New York, 1949; and (b) "Cost Accounting for Food Processors", Wayne E. Mayhew, National Assoc. of Cost Accountants Bulletin, XXVIII, No. 11, Feb. 1, 1947, New York, N. Y.

Table I gives a suggested account classification system for the types of dehydration plants covered in this Handbook. This system utilizes eight general controlling accounts:

1) Account series No. 100 -- Raw Material Procurement

2) Account series No. 200 -- Manufacturing Operations

3) Account series No. 300 -- General Manufacturing Services

4) Account series No. 400 -- Automotive Expense 2/

5) Account series No. 500 -- Selling Expense 2/

6) Account series No. 600 -- General & Administrative

7) Account series No. 700 -- Sales

8) Account series No. 800 -- Total Cost of Finished Product

The degree to which each general controlling account is subdivided into specific accounts will depend upon (a) the size and complexity of the operation, and (b) the amount of cost detail required. Many plants may find it desirable to sub-divide the accounts still further than those indicated in Table I. For example, "Preparing" (Account No. 220-230) may be divided to show individual items of cost such as "peeling", "trimming", "blanching", etc. (Note: In the cost estimates prepared for the specific plants in the Supplements of Volume II, use has been made of some sub-dividing of basic accounts.)

Crating and warehousing costs are included as "Manufacturing Expense" (Account 300) because they are usually handled in the same operation as packaging. The sales price of the finished product is based upon the total cost in the crate or box, and the "Total Cost of Finished Product" (Account 800) should be established on that basis.

Whether or not "Manufacturing Expense" (Account 300) and "General & Administrative Expense" (Account 600) are distributed among the various processing steps will depend upon the degree of cost analysis desired. If only a determination of cost and profit-or-loss is desired, no such distribution is necessary when only one end-product is manufactured. Should management wish an analysis of costs according to each operation, however, a distribution of these indirect costs must be made upon some equitable basis. Many distribution bases are in use. The "direct labor cost" basis is perhaps most commonly used. Its principal advantage is simplicity; its principal disadvantage is that such a distribution may not be entirely equitable. Suggested ways in which indirect costs can be distributed are shown in Table II.

Compilation of costs by unit operation is valuable for determining relative costs of different plant operations and for evaluating alternative methods for doing a given operation.

A suggested classification for Balance Sheet Accounts, numbered from "00" to "99", is given in Table III.

2/ These costs not classified separately for these accounts in the cost estimates included in this Handbook.

TABLE I

Descriptive Chart of Accounts for Vegetable or Fruit Dehydrating Plants

Account Number	Account	Explanation
100	Raw Material Procurement	
110	Purchase price	Amount paid to seller or broker for raw commodities
120	Buying expense	Buyers' salaries and expenses; brokerage; etc.
130	Field grading	Grading costs at field paid by dehydrator
140	Field packing	Crating and boxing costs at field paid by dehydrator
150	Transportation and weighing costs	Hauling costs of raw commodities; returning of empty packing; charges for weighing
160	Storage	For storage charges before delivery to dehydration plant
170	Crate, box, and sack expense	Labor and supplies for replacing and repairing crates and boxes
180	Federal-State inspection	Raw commodity inspection fees
190	Other raw product costs	Seed supplied by dehydrator; crop control costs paid by dehydrator
200	Manufacturing Operations	
210	Raw material handling	Weighing at plant; unloading raw material; hauling material into storage; handling and washing empty crates or boxes; preliminary storing and grading; hauling to preparation room; cleaning up
220-230	Preparing	Operating and servicing preparation equipment; peeling; trimming; sorting; coring; cutting; blanching; waste handling
240	Drying	Costs segregated according to each type of drying operation used in the plant
241	Tunnel drying	
242	Conveyor drying	

(Continued)

TABLE I

Account Number	Account	Explanation
243	Air suspension drying	
244	Drum drying	
245	Vacuum drying	
248	Bin drying	
250	Screening and inspecting	Operating screens; removing defects from the dried product
260 270	Packaging & packing Warehousing & shipping	Packaging, exhausting, and sealing; labeling; boxing and crating; trucking to warehouse; providing empty containers and boxes for filling; unloading packaging supplies from trucks or railroad cars (See also Account 540)
290	Payroll taxes and insurance	For Social Security; Unemployment Insurance; Workmen's Compensation Insurance. These are direct labor costs and are charged to each operation on the basis of direct labor costs
<u>300</u>	<u>General Manufacturing Services</u>	
310	Indirect labor	Superintendent, guards, and boiler operator, etc.
320	Utilities	Water, fuel, electric power, sewage disposal
330	Maintenance and repairs	Records should be kept of each repair job to enable charging to proper operation
340	Depreciation	Depreciation on factory building and equipment
350	Taxes and insurance	Taxes and insurance on factory buildings and equipment
360	Rental of factory and equipment	Rentals and royalties paid for use of equipment
370	Packaging and packing supplies & expenses	Packaging and packing supplies; freight and hauling of supplies; and other miscellaneous charges

(Continued)

TABLE I

Account Number		Account	Explanation
380		Inspection and control	
	381	Laboratory expenses	Costs of operating own laboratory including salaries and expenses
	382	Inspection and testing fees	Fees paid to outsiders for inspection and testing of the raw material and finished product
390		Miscellaneous plant services	
	391	Lunch room operation	Charge with all lunch room expenses; credit with receipts from Lunch Room
	392	Chemicals	Caustic soda and other chemicals used in plant
	393	Sales of trimmings, fines, etc.	Credit with receipts
	394	Other miscellaneous expenses and income	
400		Automotive Expense	This account can be distributed on a mileage basis among Accounts 120, 150, 381, 394, 520, 540, 550, 620, and 690; the detail for this account depends upon the amount of expense involved
500		Selling Expense	
510		Salaries	Salaries of employees engaged in making up bids, selling, etc.
520		Travel expenses	
530		Brokerage and commissions	For goods sold
540		Shipping labor and expenses	Loading trucks and RR cars; cost of out-freight, etc. Ordinarily the costs of labeling and crating are considered shipping expenses. In fruit or vegetable dehydration plants, all packaging, sealing, labeling, and crating are usually handled by one crew and all at the same time. It is, therefore, more convenient to charge these expenses to Accounts 260, 270, and 370

(Continued)

TABLE I

Account Number	Account	Explanation
550	Miscellaneous supplies and expenses	
600	General and Administrative	
610	Office salaries	General office management and clerical
620	Travel expense	
630	Utilities	Lights, heat, and telephone for general office
640	Rental of general office	(If separate from plant)
650	Interest expense	
660	Taxes and insurance	Taxes and insurance on finished goods on hand will be charged to this account
670	Association dues and assessments	
680	Consulting services	Includes legal, accounting, technical, and other consulting services
690	Miscellaneous supplies and expenses	
700	Sales	
710	Sales	Income from sales
720	Sales returns, allowances, and rejects	Adjustments to sales
800	Total Cost of Finished Product	Charge with Raw Material Cost (Acct. 100); Direct Labor Costs (Acct. 200); Manufacturing Expense (Acct. 300); and General & Administrative Expense (Acct. 600)

TABLE II

Cost Summary Sheet to Indicate Raw Commodity Cost and to Distribute Processing Costs Among the Various Operating Steps 1/

Cost Item	Total	Raw Material	Raw Material Handling	Preparing	Drying	Screening and Inspecting	Packaging and Warehousing	Basis of Cost Distribution 2/
Total Cost of Finished Product	Acct. 800							
Raw Material Procurement	Acct. 100	Acct.100						
Manufacturing Operations	Acct. 200		Acct.210	Acct.220-230	Acct.240	Acct. 250	Acct.260) Acct.270)	Daily time cards. Distribute Acct.290 on basis of direct labor cost
General Manufacturing Services	Acct. 300							
Indirect labor	Acct. 310							Direct labor
Utilities	Acct. 320							Use basis
Maintenance and repair	Acct. 330							Repair analysis
Depreciation	Acct. 340							Bldg. & Equip. Cost
Taxes and insurance	Acct. 350							Bldg. & Equip. Cost
Rental of factory and equipment	Acct. 360							Floor space for factory rental 3/
Packing supplies and expenses	Acct. 370						Acct.370	
Inspection and control	Acct. 380							Any equitable basis
Miscellaneous plant expenses	Acct. 390							Any equitable basis
General and Administrative	Acct. 600							No set basis. Use direct labor, processing cost, or other equitable basis
Office salaries	Acct. 610							
Travel and other business expense	Acct. 620							
Utilities	Acct. 630							
Rental of general office	Acct. 640							
Interest expense	Acct. 650							
Taxes and insurance	Acct. 660							
Assoc. dues and assessments	Acct. 670							
Consulting services	Acct. 680							
Misc. supplies and expenses	Acct. 690							

1/ For a business organized solely for manufacturing and having no selling expense
2/ Many companies distribute indirect expenses on the basis of direct labor
3/ Rentals and royalties for labor-saving machines allocated to operating step wherein the labor is saved

TABLE III

Balance Sheet Accounts for Vegetable or Fruit Dehydrating Plants

ASSETS Account No.	ASSETS Account	LIABILITIES AND NET WORTH Account No.	LIABILITIES AND NET WORTH Account
00	Current Assets	50	Current Liabilities
1	Cash	51	Accounts and Notes Payable
2	Accounts and Notes Receivable	52	Accrued Labor
3	Raw Material Inventory	53	Accrued Taxes
4	Goods in Process Inventory	54	Accrued Insurance
5	Finished Product Inventory	55	Interest Payable
6	Advances to Contract Growers	56	Advances from Government Procuring Agencies
7	Other Current Assets		
		60	Fixed Liabilities
10	Fixed Assets	61	Long Term Indebtedness
11	Land		
12	Sewerage Equipment	70	Contingent Liabilities
12a	Reserve for Depreciation--Sewerage Equipment	71	Reserve for Notes Receivable Discounted
13	Building		
13a	Reserve for Depreciation--Building	80	Deferred Credits and Reserves
14	Equipment and Facilities	81	Advance Payments Received on Contracts
14a	Reserve for Depreciation--Equipment and Facilities	82	Reserve for Spoiled or Rejected Product
15	Laboratory Equipment		
15a	Reserve for Depreciation--Laboratory Equipment	90	Net Worth
16	Office Equipment	91	Proprietor's Investment (Capital Stock)
16a	Reserve for Depreciation--Office Equipment	92	Earned Surplus
17	Automotive Equipment		
17a	Reserve for Depreciation--Automotive Equipment		
20	Deferred Charges and Prepaid Expense		
21	Organization and Experimental Expense		
22	Prepaid Insurance and Taxes		
23	Manufacturing Supplies Inventory		
24	Fuel Inventory		
25	Office Supplies		
26	Laboratory Supplies		
27	Maintenance Parts and Supplies		
30	Investments		
40	Other Assets		

CHAPTER XII

BASIC ASSUMPTIONS USED IN PLANNING THE DEHYDRATION PLANTS COVERED IN THE SUPPLEMENTS OF THIS HANDBOOK

Tables I to IV present summaries of the assumptions used in the various Supplements of Volume II for equipment selection and for estimating labor requirements and production costs. Inasmuch as different basic assumptions are inherent in each plant plan -- depending upon such factors as the commodity dehydrated, type of drier used, and location of plant -- the data presented are not always comparable and are given only for general information purposes. These specific data, as well as the other information presented in the Supplements of Volume II, are based upon certain general considerations discussed below.

1. The cost data supplied herein are intended to serve as a general outline and guide to prospective vegetable and fruit dehydrators, and should not be taken as actual for a specific plant. These estimates require adjustment for the specific conditions of a particular plant if they are to be used for accurate determination of costs. Consideration of the relative importance of various items of cost will aid the processor, however, in proper evaluation of the specific conditions with which he is faced. Such considerations may also aid him in avoiding undue emphasis on minor items or failure to consider those of major importance.

   The cost figures given, both capital and operating costs, apply only to conditions assumed in making up these estimates. In actual practice, no plant will experience these conditions exactly. In fact, two plants operating in the same area to produce identical products and presumably operating in the same manner, may experience different costs. This difference, which may be considerable, will be caused not only by an actual variance in the cost of doing business, but by a difference in bookkeeping methods.

2. Building and equipment costs in these plants are based upon new facilities. This assumption provides a uniform basis for evaluation of the various plants. On this basis good equipment performance over a long period of time is assumed. Substantial reductions in the initial capital investment requirements may be made if "used" equipment is utilized, an existing building is leased, or the dehydration operation is made an adjunct to an operating food processing plant.

3. The plant plans provide only sufficient storage space for raw commodity in the plant to assure smooth and efficient plant operation. This usually amounts to a 5- to 10-day supply of the raw commodity. It is assumed that most raw commodities will be delivered to the plant ready for processing (except for size-grading, cleaning, etc.), and that any extensive curing, conditioning and/or storing already will have been provided elsewhere. Storage and

conditioning facilities are omitted in these plans for several reasons: Storage conditions vary widely. In one area, sufficient storage space may be entirely inadequate. Storage procedures are quite variable. For example, potato storage is done in cellars in some parts of the country and in ground-level buildings in other sections. Some areas may depend on farm storage for a large part of a given commodity crop; other areas may depend chiefly upon commercial storage warehouses. If the prospective dehydrator finds that he must provide his own storage facilities, he will be faced with the necessity of making a very substantial capital investment exceeding that which is indicated in this Handbook. In fact, this extra capital requirement may be so large that it will be a serious deterrent to his decision to enter into the dehydration business in that location.

4. No trucks or other equipment for hauling raw commodity to the plant have been included in the equipment list. It is anticipated that commercial trucking services will be available. In a peace-time operation commercial trucking companies ordinarily have sufficient equipment to serve all needs. In an emergency, however, such may not be the case, and a dehydration plant may be forced to operate its own hauling facilities.

5. For each processing step, the Handbook designates procedures and facilities that commercial experience indicates will function satisfactorily under the conditions anticipated for an emergency plant. In some cases, the choice admittedly has been rather arbitrary. Operators presently producing satisfactory products are using some methods which may better suit their requirements than the methods suggested in this Handbook. Thus all of the proposed procedures and designs may not be the same as those that present operators might choose if they were to build new plants.

6. Standard items of equipment have been specified if satisfactory commercial models are available. Many items of equipment can be custom-built by competent machine-shops, but the success of such equipment will vary considerably. The surest way to provide facilities that are certain to meet the operating needs of the plant is to install commercially-proved equipment. For major items of equipment not known to be commercially available, sketches have been included that show the basic features. It is believed that this information is sufficient for a competent engineer to prepare the shop-drawings necessary for constructing such items.

7. The equipment lists do not provide duplicates ("spares") for items of equipment. There will be justification to have duplicates for some vital items of equipment. In remote locations, many duplicates or alternates may be necessary. Spare parts must be available for at least the ordinary types of repairs and maintenance.

8. Over-all shrinkage ratios (pounds of raw commodity entering the processing line compared with the pounds of finished dehydrated product) are extremely variable, depending not only upon the condition and variety of raw material but upon the manner in which it is stored, handled, and processed. The plant operations, costs, and output are based upon an assumed shrinkage ratio for each commodity that is likely to be experienced under good

operating conditions. Other operating conditions and output may give shrinkage ratios different from those selected. For indicative purposes only, summaries of hypothetical costs also are given for (a) a lower shrinkage ratio and (b) a higher shrinkage ratio.

9. Design and cost estimates are based upon an operation consisting of three 8-hour shifts per day, six days per week, and 25 operating days per month. Net operating time per day is assumed to be 20 hours. Each shift will have a 30-minute lunch period and two 10-minute rest periods; for three shifts these periods will amount to 2-1/2 hours. The remaining 1-1/2 hours per day is an allowance for the time lost in starting up and in minor equipment adjustments, plant clean-up, and other miscellaneous activities. Some allowance is needed also for loss of capacity caused by uneven feeding of raw materials to the processing line. The potato granule plant is an exception to this.

   The labor costs are based on rates calculated from typical labor rates in the specific area suggested for the plant. Adjustments have been made in the local rates to fit the bracket classification used in the various plant plans.

10. Equipment prices are based, for the most part, on quotations obtained during the last quarter of 1951. The prices indicated are not to be interpreted as firm quotations in any sense, as prices may fluctuate considerably from time to time for many reasons. An estimated freight charge of 5¢ per pound of shipping weight has been included for shipping the factory-made equipment from point of manufacture to the proposed plant site. The 5¢-per-pound charge is sufficient for shipping the equipment approximately 2,000 miles. An allowance of 25% of the equipment cost (including freight charge) has been made for the cost of installing the equipment in the plant; the allowance also takes care of small related items of the equipment such as chutes, hoppers, etc.

11. Labor requirements and costs given are based upon a normal through-flow of material and upon the use of an experienced crew. The labor requirements and costs, particularly during the first operating season, will be higher than normal. These higher costs should be anticipated, but cannot be calculated with any accuracy in advance. Training of new personnel, inefficiency of labor, and shut-down in any plant operation will increase the labor costs.

   It is assumed that the provisions of the Walsh-Healy Act apply to the military procurement contracts. This Act requires time-and-a-half pay for overtime work exceeding 8 hours each day or 40 hours each week. In the event special exemptions are granted that permit a greater number of hours to be worked at regular hourly rates, the cost estimates should be adjusted accordingly.

12. Storage space has been provided for a packaged product output of approximately 30 days plus approximately a 10-day supply of empty cans and cases, or any desired combination of these items. This is by no means an ideal situation insofar as storage facilities are concerned, but it is believed satisfactory for meeting minimum requirements for an emergency plant.

In many cases, a plant could advantageously use more storage space, than is proposed in the plans, for such things as supplies, spare equipment, replacement parts, etc. The proposed plants should function satisfactorily, however, for the emergency conditions assumed. Plants located great distances from supply sources will need more than a normal inventory of various items and provision must be made for their storage.

The storage requirements are largely dependent upon the shipping orders of the Federal procuring agency. The prospective dehydrator should thoroughly investigate what shipping schedules are in prospect so that he can provide the necessary storage space for finished product.

13. The operating costs given for the various plant plans do not include (a) interest on investment, (b) reserves for contingencies, (c) depreciation charges, (d) cost of storing of raw commodity beyond the normal 5 to 10 days in the plant, or (e) losses due to rejection of finished product by the purchaser (failure to meet specifications).

14. The calculation of selling prices for products (for use in bidding on contracts) from the cost data given in these plans will apply only to the specific conditions stated. Inasmuch as costs will vary throughout the processing season for many reasons, it may be advisable to submit bids applicable to different times of the year. For example, dehydrated vegetables delivered early in the season, when raw material prices are high and perhaps the yields are low, may be priced several cents higher per pound than the product delivered during the regular processing season. Long storage periods for the raw commodity also will increase the cost of the raw material.

15. A nominal allowance for engineering services has been included in the estimated costs for constructing each of the plants covered in the Supplements of Volume II.

TABLE I

Summary of Preparation and Packaging Assumptions Used in the Various Supplements of Volume II for Equipment Selection and for Estimation of Labor Requirements and Production Costs

(Effective Operating Time 20 Hours per Day)

	Units	Beets	Cabbage	Carrots	Onions	Potato Dice	Sweet-potatoes	Cran-berries
Over-all shrinkage ratio		13:1	20:1	11:1	9:1	7:1	6:1	10:1
Preparation losses	%	25	31	20	10	20	32	10
Packaged weight of dried product	lb/#10 can	2.75	1.75	2.75	2.5	2.75	3.0	1/
Plant capacity								
Raw material	tons/day	100	100	100	100	100	100	50
	lb/hr	10,000	10,000	10,000	10,000	10,000	10,000	5,000
Prepared product	lb/hr	7,500	6,900	8,000	9,000	8,000	6,800	4,500
Dried product	lb/hr	770	500	910	740 2/	1,430	1,670	500
	lb/day	15,400	10,000	18,200	14,800	28,600	33,300	10,000
	#10 cans/hr	280	286	330	296	520	557	1/
	#10 cans/day	5,600	5,720	6,600	5,920	10,400	11,140	-
	cases/hr	47	48	55	49	87	93	-
	cases/day	940	960	1,100	980	1,634	1,860	-
Processing data								
Trimming and coring								
Rates for trimming or coring								
Raw material	lb/hr/woman	222	500	222	400	286	143	-
Prepared material	lb/hr/woman	167	345	178	360	229	97	-
Trimming labor for above plant capacities	women/shift	45	20	45	25	35	70	-
Blanching								
Blancher loading	lb/sq.ft	3	1	4	-	3-4	2	-
Blanching time	minutes	6	2	6-7	-	3-6	6	-
Area of blancher	sq.ft	280	240 3/	240	-	240	280	-

1/ Cranberries are packed into 1-pound cartons with 17 cartons per 5-gal can (500 cartons per hour; 30 5-gal cans per hour)

2/ 10,000 pounds of onions yield 740 pounds of flakes and 370 pounds of "fines". The latter product is considered a loss in this Handbook

3/ Cabbage is blanched on the drying trays

TABLE II

Summary of Drying Conditions and Data Assumed for the Various Supplements of Volume II for Equipment Selection

	Units	Beets	Cabbage		Carrots	Onions		Potato Dice	Sweet-potatoes	Cran-berries
Capacity of Plant (raw commodity)	Tons per 3-shift day	100	100		100	100		100	100	50
Tunnel Drying										
Tray loading	lb/sq.ft		1.0		1.25	1.25		1.50		1.0
Weight per tray (3'x6')	lb/tray		18		22	22		27		18
Weight per car (25 trays/car)	lb/car		450		550	550		675		450
Car loading rate	cars/hr		15		15	16		12		10
Tray loading rate	trays/min		6		6	7		5		4
Stages in tunnels			Primary	Secondary	Single	Primary	Secondary	Single		Single
Pairs of twin tunnels required			3	3	4	4	4	4		3
Direction of air flow compared to movement of product through tunnel			Parallel	Counter-current	Counter-current	Parallel	Counter-current	Counter-current		Counter-current
Air velocity between trays	ft/min		1,000	600	800	1,000	600	800		500
Volume of air per pair of twin tunnels	cu.ft/min		50,000	30,000	40,000	50,000	30,000	40,000		25,000
Hot-end air temperature	°F		180	145	160	160	135	160		170
Maximum number of trucks per single tunnel 1/			8	14	12	8	19	12		12
Moisture content of product entering	%		93	75	88	87	50	80-82		87
Moisture content of product leaving	%		75	7	8	50	7	10-11		11
Drying time	hours		2	4	7	3	8	7		6-8
Conveyor Drying										
No. of dehydrators		3							3	
Heated belt length - Stage 1	feet	38							38	
Stage 2	feet	18							18	
Belt width	feet	7							7	
Belt loading	lb/sq.ft	11.5							10.5	
	inches deep	3.3							3	
Belt speed - Stage 1	ft/hr	33							33	
Stage 2	ft/hr	6							6	
Stages in drier		2							2	
Hot air temperatures - Stage 1 - Section 1		205							225	
Section 2		205							180	
Stage 2		160							160	
Moisture content of product entering	%	89							73	
Moisture content of product leaving	%	11							11	
Drying time - Stage 1	hours	1.2							1.2	
Stage 2	hours	3.0							3.0	
Bin Drying										
Bulk density of product	lb/cu.ft	22-25	9		23	8-12		23	25-30	10-12
Dimension of bins	ft	3x5x5	3x5x5		3x5x5	4x8x5		3x5x5	3x5x5	4x8x5
Depth of product in bins	ft	4	4		4	4		4	4	4
Capacity of bin	lb	1300-1500	540		1380	1000-1500		1380	1500-1800	1200-1500
Air flow rate	cu.ft/sq.ft/min	100	100		100	25		100	100	25
Hot air temperature	°F	145	120		140	120		140	140-160	150
Moisture content of product entering bins	%	11	7		8	7		10-11	11	11
Moisture content of product leaving bins	%	5	4		4	4		7	5	5
Drying time	hours	6-12	7		6	30		3-4	6-8	2-10
Number of bin stations on hot air ducts		8	7		6	26		6	12	5

1/ Actual number of cars placed in tunnels will vary according to operating needs

TABLE III

Summary of Personnel Requirements Assumed for the Various Supplements of Volume II for Estimation of Production Costs and Equipment Requirements

(Fractions result from having some employees perform more than one function)

	100-ton per day plants												50-Ton per Day Plant	
	Beets		Cabbage		Carrots		Onions		Potato Dice		Sweet-potatoes		Cranberries	
	M	W	M	W	M	W	M	W	M	W	M	W	M	W
TOTAL PERSONNEL REQUIRED PER 3-SHIFT DAY	55	177	79	120	73	208	85	159	70	177	70	265	47	58
Direct Labor Required Per 3-Shift Day	36	171	60	114	54	201	66	153	51	171	51	258	33	54
Direct Labor Required Per 8-hr. Shift	12	57	20	38	18	67	22	51	17	57	17	86	11	18
Raw material handling	3-1/2	-	3-1/2	-	4-1/2	-	6-1/2	-	4-1/2	-	4-1/2	1	2-1/4	-
Preparing	1-1/2	46	3	21	2-1/2	46	2	32	2-1/2	36	3-1/2	71	1-1/2	4-1/4
Drying	3	-	6-1/2	8	6	8	7-1/2	8	6	8	3	-	3	5-1/4
Screening & inspecting	1-1/4	6-1/2	1-3/4	3-1/2	3/4	8-1/2	2-1/4	6-1/2	3/4	8-1/2	3/4	8-1/2	3/4	4-1/4
Packaging & packing	1-1/2	4-1/2	4	5-1/2	3	4-1/2	2-1/2	4-1/2	2	4-1/2	3	5-1/2	3	4-1/4
Warehousing & shipping	1-1/4	-	1-1/4	-	1-1/4	-	1-1/4	-	1-1/4	-	2-1/4	-	1/2	-
Indirect & Administrative Personnel Required per Day	19	6	19	6	19	7	19	6	19	6	19	7	14	4
Raw material procurement	1	-	1	-	1	-	1	-	1	-	1	-	1	-
Indirect labor	9	-	9	-	9	-	9	-	9	-	9	-	7	-
Maintenance	5	-	5	-	5	-	5	-	5	-	5	-	3	-
Inspection & control	1	3	1	3	1	3	1	3	1	3	1	3	1	2
General & administrative	3	3	3	3	3	4	3	3	3	3	3	4	2	2

TABLE IV

Summary of Utilities Requirements Assumed in the Various Supplements of Volume II for Equipment Selection and for Estimating Production Costs

	100-ton per day plants						50-ton per day plant
	Beets	Cabbage	Carrots	Onions	Potato Dice	Sweet-/ potatoes	Cranberries
Assumed geographic location of plants	Wisconsin	California	California	California	Idaho	Louisiana	Massachusetts
Fuels - per hour							
Boilers							
Horsepower rating	600	150	150	80	150	600	80
Type of fuel	#6 oil	gas	gas	gas	#6 oil	gas	#1 oil
Maximum rated consumption - gallons or cu.ft. 1/	180	6,300	6,300	3,350	45	25,200	24
Average consumption - gallons or cu.ft. 1/	135	4,700	4,700	1,700	34	18,800	12
Heat equivalent of average consumption - million B.T.U.	20.3	4.7	4.7	1.7	5.1	18.8	1.7
Driers							
Type of fuel	(Steam from Boilers)	gas	gas	gas	#1 & #2 oil	(Steam from Boilers)	#1 oil
Maximum rated consumption - gallons or cu.ft. 1.		30,000	28,200	40,000	200		87
Average consumption - gallons or cu.ft. 1/		17,600	16,200	18,000	157		66
Heat equivalent of average consumption - million B.T.U.		17.6	16.2	18.0	22.0		9.0
TOTAL heat equivalent of average consumption - million B.T.U.	20.3	22.3	20.9	19.7	27.1	19.8 2/	10.7
Power - per hour							
Connected load - Kilowatts	256	240	235	383	238	312	138
Estimated consumption - Kilowatts	205	190	186	300	190	223	115
Water - per minute							
Maximum that is required unless raw material is flumed - gallons	500	100	500	500	500	500	110

1/ Oil: #1 - 137,500 B.T.U./gallon
#2 - 140,000 B.T.U./gallon
#6 - 150,000 B.T.U./gallon

Gas: 1,000 B.T.U./cu.ft.

2/ Includes 1,000,000 B.T.U. for gas-fired dehumidifier

APPENDIX "A" - GLOSSARY OF TERMS AS USED IN DEHYDRATION HANDBOOK

APPENDIX "B" - LIST OF APPLICABLE SPECIFICATIONS

APPENDIX "C" - ADDITIONAL SOURCES OF INFORMATION

APPENDIX "D" - CODE FOR CLASSIFYING MATERIALS, OPERATING STEPS, FACILITIES, EXPENSES, AND INCOME

APPENDIX "A"

GLOSSARY OF TERMS AS USED IN DEHYDRATION HANDBOOK

Air conditioning. Control of the moisture content and temperature of air. For dehydration purposes, this usually means reducing the moisture content of air to be used as a drying medium.

B.T.U. (British Thermal Unit). The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.

Blanching. The processing of vegetables or fruits in steam or hot water prior to dehydration in order to inactivate constituents which might otherwise tend to speed up deterioration of quality during dehydration and storage.

c.f.m. Cubic feet per minute.

Calyx. The hard and withered remains of protective leaves at the bottom end of an apple.

Car. See "Truck".

Carpel. The hard and tough seed-case tissue in the core of an apple.

Case hardening. Hardening of the surface on material being dried as the result of very rapid drying.

Caustic solution. A solution of sodium hydroxide (also known as caustic soda or lye) used for the peeling of root vegetables and some fruits.

Chemical analysis. Any of a large number of chemical tests carried out in the laboratory to determine the characteristics of materials in process.

Comminuting. The process of cutting, grinding, or pulverizing a material into small pieces or a powder.

Compression. Reduction in the volume of dehydrated products by application of pressure, to increase the bulk density so that a larger weight of material can be put into a package.

Compression ratio. The ratio of the volume occupied by a given weight of a dehydrated product before compressing (or compacting) to the volume occupied by the same weight of the product after compressing (or compacting).

Conditioning. The pretreatment of commodities prior to dehydration--especially the holding of cold-storage potatoes at a temperature high enough to dissipate the concentration of reducing sugars.

Continuous conveyor belt drier. A dehydrator in which the product is carried on a continuous metallic perforated sheet or mesh belt and is dried by hot air passing through the product bed.

Counter-flow. In a dehydrator, the movement of air in a direction opposite to the movement of product.

Cross-flow of air. The arrangement within a drier whereby the air stream flows across or parallel to an exposed layer of material to be dried.

Curing. The holding of commodities under controlled atmospheric conditions for a period after harvesting in order to preserve certain properties and lengthen storage life.

Dehumidifier. A device for removal of water vapor from air in order to increase the drying effectiveness of the air at low temperatures and low levels of product moisture.

Dehydration. The process of evaporating water from moist solid materials by the application of artificial heat under controlled conditions of air flow, temperature, and humidity.

Direct fired. Any drying system in which the combustion gases mix with the air stream used for drying.

Draper or draper belt. A continuous metallic mesh belt used to convey materials through a treating solution.

Dry-bulb temperature. The temperature of air as measured by an ordinary thermometer. (See "Wet-bulb temperature".)

Drying ratio. The weight-ratio between the prepared raw material and the same material after drying.

Enzyme. Any one of a class of complex organic materials (usually proteins) which accelerate specific chemical changes in organic materials.

Evaporation. The process of changing a liquid into vapor. As applied to the drying of wet solids the word "evaporation" has a specialized meaning as defined in the Handbook section on "Definition of Dehydration" (Chapter III).

Fines. Pieces of dehydrated vegetables and fruits formed as the result of cutting and handling during processing, and which are too fine to be acceptable as a part of the packaged product.

Flow sheet. A narrative or diagrammatic outline, showing the successive steps through which materials pass in a manufacturing operation.

Gassing. Displacement of the air in cans of dehydrated products by an inert gas, usually nitrogen or carbon dioxide.

h.p. or hp. Horsepower.

Heat damage. Quality deterioration in dehydrated products characterized by the development of yellow to brown color, resulting especially from high product temperatures during drying.

Humidity (absolute). The weight of water vapor in a volume of moist air containing one pound of dry air, commonly expressed as grains or pounds of water per pound of dry air.

Humidity (relative). The ratio of the pressure of water vapor in air to the vapor pressure exerted by pure water at the same temperature. (Usually expressed on a percentage basis.)

Inert gas. Chemically unreactive gasses used to replace the air in containers of dehydrated products. Nitrogen and carbon dioxide are the two gasses commonly used.

k.w.h. or kw.-hr. Kilowatt hours.

Leaching. The loss of solubles from vegetables or fruits by solution in the water used for washing or conveying during the processing operations or in the water formed by condensation of steam in the blanching operation.

Lye peeling. A commonly-used method for the peeling of root vegetables, involving immersion in a hot solution of caustic soda. (See "Caustic solution".)

Moisture content. The weight percent of water in a material.

Moisture vapor proof. Not allowing the passage of water vapor.

Multi-stage drier. A drier in which the material being dried is subjected to one or more separate and distinct air streams in order to maintain optimum drying conditions.

Over-all shrinkage ratio. The ratio between the weight of raw material entering the processing plant and the weight of acceptable packaged product. Onions are an exception to this definition. See Onion Supplement, Vol. II.

Overhead-fired tunnel. A tunnel dehydrator in which the furnace or heating section and air circulating fan are located above the tunnel section in which drying is conducted.

Oxidation. The process by which oxygen becomes chemically combined with a material or some constituent thereof.

p.p.m. Parts per million.

p.s.i. Pounds per square inch.

Pallets. Portable, load bearing platforms used to facilitate the handling of materials during transportation and storage.

Parallel flow. In a dehydrator, the movement of air in the same direction as the movement of product.

Plant waste. Materials resulting from processing operations, which must be disposed of in order to prevent nuisance or health hazards.

Plenum chamber. A pressure equalizing chamber in an air-flow system.

Pureeing. The process of converting fruit or vegetable materials to a uniform, pulpy, fluid product, containing most of the original solids.

Raw commodity. The raw vegetable or fruit before processing - used loosely to refer either to the freshly harvested commodity as it comes into the plant or to the partially processed material at any time prior to blanching.

Raw material. The fresh commodity as it enters the processing plant. Sometimes used interchangeably with "raw commodity."

Reconstitution. The process by which water is added back to dehydrated products in the course of preparation for eating.

Rehydration. Same as reconstitution.

Rotary drum drier. A drier comprising a pair of internally heated drums on which pureed or liquid materials can be dried in a thin film which is removed continuously by a scraper blade.

Sanitizing chemicals. Chemicals used to facilitate the cleaning and sterilizing of plant and equipment.

Side-fired tunnel. A tunnel dehydrator in which the furnace or heating section and air circulating fan are located on the same level as the tunnel section in which drying is conducted.

Single-stage drier. A one compartment drier in which the material being dried is exposed to a uniform progression of drying conditions.

Spray drier. A drier in which finely sprayed droplets of a solution are evaporated to dryness while suspended in a hot air stream.

Starch spray. A spray of starch solution.

Steam peeling. Removal of the peeling from root vegetables by a short exposure to high pressure steam, followed by washing to remove loose peel.

Sulfiting. The process of impregnating materials with sulfur dioxide or certain of its compounds, in order to minimize darkening during drying and lengthen the storage life of the dried product.

Surplus states. States in which the crop of a given commodity is normally in excess of the demand within the state.

Through-flow of air. The arrangement within a drier whereby the air stream flows upward or downward through an exposed layer of material to be dried.

Trayloading. The amount of material on the drying tray before dehydration, usually expressed in pounds per square foot of tray area.

Truck. A rack mounted on wheels for carrying the drying trays in a tunnel dehydrator. (Also called a car.)

Two-stage drier. A drier in which the material being dried is exposed to a new and separate air stream after initial drying has been accomplished in the primary air stream. (See also "Multi-stage drier".)

Vacuum drier. A drier in which removal of moisture is accomplished by maintaining the pressure in the drier substantially below the moisture vapor pressure of the product at the temperature in the drier.

Vaporization. Conversion of a liquid into a vapor - for example, water into water vapor.

Wet bulb depression. The difference between the dry-bulb temperature and the wet-bulb temperature of air.

Wet-bulb temperature. The temperature registered in an air stream by a thermometer whose sensitive bulb is covered with a clean wick which is kept moist with pure water. (See "Dry-bulb temperature".)

APPENDIX "B"

LIST OF APPLICABLE SPECIFICATIONS

Copies of or information about specifications can be obtained from the various government agencies referred to in Appendix "C" under "U. S. Government Publications" or from the Commanding General, Chicago Quartermaster Depot, 1819 West Pershing Road, Chicago 9, Illinois

COMMODITY SPECIFICATIONS

Specifications	Number	Date
Apples, Dehydrated	MIL-A-1035A	23 Sept. 1949
Cranberries, Dehydrated	MIL-C-827A	4 Sept. 1951
Beets, Dehydrated	MIL-B-3024	3 Aug. 1949
Cabbage, Dehydrated	MIL-C-826	27 July 1949
Carrots, Dehydrated	MIL-C-839	28 July 1949
Onions, Dehydrated	MIL-O-3028	8 Aug. 1949
Potatoes, White, Dehydrated	MIL-P-1073A	12 Dec. 1950
Potatoes, Sweet, Dehydrated	MIL-P-3025	3 Aug. 1949

SUPPORTING SPECIFICATIONS

Federal Specifications

Beets, Fresh	HHH-B-166b	27 Apr. 1951
Cabbage, Fresh	HHH-C-26b	12 Dec. 1950
Carrots, Fresh	HHH-C-81a	27 May 1947
Onions; Northern-grown type, Fresh	HHH-O-536 Amend. 1	28 Oct. 1941 28 Jan. 1942
Boxes, Wood, Nailed and Lock-Corner	NN-B-621b	26 June 1950
Boxes, Wood, Wirebound (for Domestic Shipment)	NN-B-631c	27 Feb. 1951
Boxes, Fiber Corrugated (for Domestic Shipment)	LLL-B-631c	13 Mar. 1951
Boxes, Fiber, Solid (for Domestic Shipment)	LLL-B-636c	13 Mar. 1951
Paper; General Specifications and Methods of Testing	UU-P-31b	3 Mar. 1949
Tape; Paper, Gummed (Sealing and Securing)	UU-T-111b	23 Apr. 1951

Military Specifications

Specification	Number	Date
Boxes, Wood, Wirebound (Overseas Type)	MIL-B-107A	20 Sept. 1951
Coatings, Exterior, for Food Cans	MIL-C-10506	8 Sept. 1950
Labeling and Marking of Metal Cans for Subsistence Items	MIL-L-1497	28 Oct. 1949
Milk, Dry; Whole and Nonfat Solids	MIL-M-1495	28 Oct. 1949
Marking of Shipments	MIL-STD-129	9 Aug. 1951
Sampling Procedures and Tables for Inspection by Attributes	MIL-STD-105A	11 Sept. 1950

Joint Army-Navy Specifications

Specification	Number	Date
Coatings: Exterior, Air-drying, Camouflage and Rust-Inhibiting, for Food Cans (Also see MIL-C-10506, 8 Sept. 1950)	JAN-C-237 Army No. 3-208 Navy No. 42C26	30 June 1945
Coatings, Exterior, Camouflage and Rust-inhibiting (for Processed and Nonprocessed Food Cans) (also see MIL-C-10506, 8 Sept. 1950)	JAN-C-238 Army No. 3-209 Navy No. 42C32	30 June 1945
Packaging and Packing for Overseas Shipment -- Boxes: Wood, Nailed	JAN-P-106A Army No. 100-22A Navy No. 39P16C Section VI	1 Aug. 1946
Packaging and Packing for Overseas Shipment -- Boxes, Fiberboard (V-Board and W-Board), Exterior and Interior	JAN-P-108 Amend. 4 Army No. 100-21 Navy No. 39P16b Section VIII	30 June 1944 9 May 1950
Packaging and Packing for Overseas Shipment -- Cartons, Folding, Paperboard	JAN-P-120 Amend 1 Army No. 100-27 Navy No. 39P16b Section XX	30 Sept. 1944 15 Oct. 1945

U.S. Army Specifications

Marking, Exterior, Domestic and Export Shipment, by Contractors (Also see MIL-STD-129, 9 Aug. 1951)	94-40645-B	11 June	1947
Specifications for Marking of Outside Shipping Containers by Contractors (Also see MIL-STD-129, 9 Aug. 1951)	OQMG 94B	21 Mar.	1949
Index Quartermaster Corps Specifications	OQMG	31 May	1951

Navy Specifications

Navy Shipment Marking Handbook - Bureau of Supplies and Account	Navsanda Publication 9 - 5th Ed.	June	1950

APPENDIX "C"

ADDITIONAL SOURCES OF INFORMATION

The information in this Appendix is given to help a prospective dehydrator find the assistance he may need to plan, build, and/or operate a vegetable or fruit dehydration plant. The inclusion of any individual or organization does not imply a recommendation by the Department of Agriculture, nor does the omission of the name of any individual or organization imply a lack of recommendation.

Existing Vegetable and Fruit Dehydration Plants

The plants listed in Table I either presently dehydrate the products indicated, or have the basic facilities for dehydrating the commodities listed. Practically all the plants listed had dehydration experience during World War II. Products that are now being produced, or that can be produced with only minor modifications in the facilities, are designated by an asterisk (*).

TABLE I

Existing Vegetable or Fruit Dehydration Plants

Dehydration Plant	Commodities Processed 1/
American Food Products Corp. Richfield, Utah	Potatoes (D and J) 2/
Basic Vegetable Products Co., Inc. Vacaville, California	*Carrots *Celery *Kale *Onions *Potatoes (D and J) *Tomatoes
Baxter, H. C., & Bro. Hartland, Maine	*Potatoes (D and J)
Behen Fruit Service, Inc. Everett, Mass	*Cranberry Powder
Bitter Root Co. Hamilton, Montana	Beets Potatoes (D and J)
Cal-Compack Foods, Inc. Santa Ana, Calif.	*Cabbage *Celery *Peppers
California Vegetable Concentrates, Inc. Huntington Park, Calif.	*Cabbage *Celery *Kale *Onions *Parsley *Squash *Tomatoes
Modesto, Calif.	*Beets *Carrots *Potatoes (D and J) *Rutabagas

* Products that are now being produced or that can be produced with only minor plant modification

1/ If more than one commodity is processed, the commodities are listed alphabetically with no intent of indicating the order of importance in that plant

2/ "Potatoes" are for "white potatoes"; "D" for diced; "J" for "Julienne"; "G" for granules"; "S" for "shredded or riced"; "F" for "flour"

(Continued)

(Table I, continued)

Dehydration Plant	Commodities Processed
California Vegetable Concentrates, Inc. Ventura County, Calif.	*Parsley
Chapman Dehydrater Company Modesto, Calif.	Beets Carrots Potatoes (D and J) *Raisins
Dezauche & Sons Opelousas, La.	Sweetpotatoes
Evangeline Pepper & Food Prod. Co. St. Francisville, La.	Peppers Sweetpotatoes
Fewel Brothers Selma, Calif.	Carrots Potatoes (D, J, and F) *Raisins
Florida Dehydrators Zellwood, Fla. (Branch of Sokol Co. Chicago, Ill.)	Beets Cabbage Carrots Potatoes (D and J)
Frank Tea & Spice Co. New Iberia, La.	Sweetpotatoes
French, R. T., Company Shelley, Idaho (Plant ready for operation Aug. 1952)	*Potatoes (G)
Rochester, N. Y.	*Beets and other vegetables
Gentry Division Consolidated Grocers Corp. Gilroy, Calif.	*Garlic *Onions
Oxnard, Calif.	Cabbage *Peppers Potatoes (D and J)
Idaho Potato Growers, Inc. Idaho Falls, Idaho	*Potatoes (D,J and F)

(Continued)

(Table I, continued)

Dehydration Plant	Commodities Processed
Knipschild Dehydrator Co. Yuba City, Calif.	Beets Cabbage Carrots Potatoes (D and J)
Little & Co., Inc. Lafayette, La.	Beets Sweetpotatoes
Makepeace, A. D., Co. Wareham, Mass.	*Cranberries
Maxson Maine Potato Co. Washburn, Maine	Potatoes (D and J)
Miller Fruit Co. Healdsburg and Forestville California	*Apples (evaporated) Carrots *Potatoes (D and J)
Naman - Krum Co. Fresno, California	*Apples (dehydrated) Potatoes (D)
National Cranberry Association Hanson, Mass.	*Cranberries
Grayland, Washington	*Cranberries
Northwestern Potato Co. N. Girard, Pa.	Carrots Potatoes (D and J)
Potato Products Corp. E. Grand Forks, Minn.	*Potatoes (D, J, and G)
Puccinelli Packing Co. Turlock, Calif.	Beets Cabbage Carrots *Potatoes (D) Sweetpotatoes
Livingston, Calif.	*Garlic *Onions
Rogers Bros. Seed Co., Inc. Idaho Falls, Idaho	*Potatoes (S and F)

(Continued)

(Table I, continued)

Dehydration Plant	Commodities Processed
Ross Packing Co. Selah, Wash.	*Apples (evaporated) Potatoes (S)
Seabrook Farms Bridgeton, N. J.	Beets Potatoes (D and J) Sweetpotatoes
Simplot, J. R., Company Caldwell, Idaho	*Onions *Potatoes (D, J, and G)
Burley, Idaho	*Potatoes (D, J, and G)
Sweet Potato Growers, Inc. Laurel, Miss.	Sweetpotatoes
Trappey's, B. F., Sons New Iberia, La.	Sweetpotatoes
Vacu-Dry Co. Oakland, Calif.	*Apples (dehydrated)
Selah, Wash.	*Apples (dehydrated)
Vincennes Packing Corp. Vincennes, Indiana	Carrots Hominy Potatoes (D and J)
Wapato Evaporating Co. Wapato, Washington	Potatoes (D and J) *Apples (evaporated)
Warriner Products Co. St. Francisville, La.	Onions Sweetpotatoes

Partial List of Manufacturers of Vegetable and Fruit Dehydration Equipment

The inclusion in Table II of any manufacturer and the respective classifications as to types of equipment manufactured does not imply a recommendation by the Department of Agriculture, nor does any omission from this Table II imply a lack of recognition. The sources for the information given include: (a) manufacturers' catalogs, (b) trade journal advertisements, (c) *Thomas' Register of American Manufacturers*, (d) *Food Industries Classified Directory of Manufacturers*, (e) engineering firms, (f) direct contact with equipment manufacturers, and (g) knowledge obtained from present dehydrators.

The equipment listed is that which is specifically applicable to the dehydration of vegetables or fruits. The list does not include firms which do only general plant construction work as almost any area has organizations of this type available.

APPENDIX "A" - GLOSSARY OF TERMS AS USED IN DEHYDRATION HANDBOOK

APPENDIX "B" - LIST OF APPLICABLE SPECIFICATIONS

APPENDIX "C" - ADDITIONAL SOURCES OF INFORMATION

APPENDIX "D" - CODE FOR CLASSIFYING MATERIALS, OPERATING STEPS, FACILITIES, EXPENSES, AND INCOME

APPENDIX "A"

GLOSSARY OF TERMS AS USED IN DEHYDRATION HANDBOOK

Air conditioning. Control of the moisture content and temperature of air. For dehydration purposes, this usually means reducing the moisture content of air to be used as a drying medium.

B.T.U. (British Thermal Unit). The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.

Blanching. The processing of vegetables or fruits in steam or hot water prior to dehydration in order to inactivate constituents which might otherwise tend to speed up deterioration of quality during dehydration and storage.

c.f.m. Cubic feet per minute.

Calyx. The hard and withered remains of protective leaves at the bottom end of an apple.

Car. See "Truck".

Carpel. The hard and tough seed-case tissue in the core of an apple.

Case hardening. Hardening of the surface on material being dried as the result of very rapid drying.

Caustic solution. A solution of sodium hydroxide (also known as caustic soda or lye) used for the peeling of root vegetables and some fruits.

Chemical analysis. Any of a large number of chemical tests carried out in the laboratory to determine the characteristics of materials in process.

Comminuting. The process of cutting, grinding, or pulverizing a material into small pieces or a powder.

Compression. Reduction in the volume of dehydrated products by application of pressure, to increase the bulk density so that a larger weight of material can be put into a package.

Compression ratio. The ratio of the volume occupied by a given weight of a dehydrated product before compressing (or compacting) to the volume occupied by the same weight of the product after compressing (or compacting).

Conditioning. The pretreatment of commodities prior to dehydration--especially the holding of cold-storage potatoes at a temperature high enough to dissipate the concentration of reducing sugars.

Continuous conveyor belt drier. A dehydrator in which the product is carried on a continuous metallic perforated sheet or mesh belt and is dried by hot air passing through the product bed.

<u>Counter-flow</u>. In a dehydrator, the movement of air in a direction opposite to the movement of product.

<u>Cross-flow of air</u>. The arrangement within a drier whereby the air stream flows across or parallel to an exposed layer of material to be dried.

<u>Curing</u>. The holding of commodities under controlled atmospheric conditions for a period after harvesting in order to preserve certain properties and lengthen storage life.

<u>Dehumidifier</u>. A device for removal of water vapor from air in order to increase the drying effectiveness of the air at low temperatures and low levels of product moisture.

<u>Dehydration</u>. The process of evaporating water from moist solid materials by the application of artificial heat under controlled conditions of air flow, temperature, and humidity.

<u>Direct fired</u>. Any drying system in which the combustion gases mix with the air stream used for drying.

<u>Draper or draper belt</u>. A continuous metallic mesh belt used to convey materials through a treating solution.

<u>Dry-bulb temperature</u>. The temperature of air as measured by an ordinary thermometer. (See "Wet-bulb temperature".)

<u>Drying ratio</u>. The weight-ratio between the prepared raw material and the same material after drying.

<u>Enzyme</u>. Any one of a class of complex organic materials (usually proteins) which accelerate specific chemical changes in organic materials.

<u>Evaporation</u>. The process of changing a liquid into vapor. As applied to the drying of wet solids the word "evaporation" has a specialized meaning as defined in the Handbook section on "Definition of Dehydration" (Chapter III).

<u>Fines</u>. Pieces of dehydrated vegetables and fruits formed as the result of cutting and handling during processing, and which are too fine to be acceptable as a part of the packaged product.

<u>Flow sheet</u>. A narrative or diagrammatic outline, showing the successive steps through which materials pass in a manufacturing operation.

<u>Gassing</u>. Displacement of the air in cans of dehydrated products by an inert gas, usually nitrogen or carbon dioxide.

<u>h.p. or hp.</u> Horsepower.

<u>Heat damage</u>. Quality deterioration in dehydrated products characterized by the development of yellow to brown color, resulting especially from high product temperatures during drying.

<u>Humidity (absolute)</u>. The weight of water vapor in a volume of moist air containing one pound of dry air, commonly expressed as grains or pounds of water per pound of dry air.

Humidity (relative). The ratio of the pressure of water vapor in air to the vapor pressure exerted by pure water at the same temperature. (Usually expressed on a percentage basis.)

Inert gas. Chemically unreactive gasses used to replace the air in containers of dehydrated products. Nitrogen and carbon dioxide are the two gasses commonly used.

k.w.h. or kw.-hr. Kilowatt hours.

Leaching. The loss of solubles from vegetables or fruits by solution in the water used for washing or conveying during the processing operations or in the water formed by condensation of steam in the blanching operation.

Lye peeling. A commonly-used method for the peeling of root vegetables, involving immersion in a hot solution of caustic soda. (See "Caustic solution".)

Moisture content. The weight percent of water in a material.

Moisture vapor proof. Not allowing the passage of water vapor.

Multi-stage drier. A drier in which the material being dried is subjected to one or more separate and distinct air streams in order to maintain optimum drying conditions.

Over-all shrinkage ratio. The ratio between the weight of raw material entering the processing plant and the weight of acceptable packaged product. Onions are an exception to this definition. See Onion Supplement, Vol. II.

Overhead-fired tunnel. A tunnel dehydrator in which the furnace or heating section and air circulating fan are located above the tunnel section in which drying is conducted.

Oxidation. The process by which oxygen becomes chemically combined with a material or some constituent thereof.

p.p.m. Parts per million.

p.s.i. Pounds per square inch.

Pallets. Portable, load bearing platforms used to facilitate the handling of materials during transportation and storage.

Parallel flow. In a dehydrator, the movement of air in the same direction as the movement of product.

Plant waste. Materials resulting from processing operations, which must be disposed of in order to prevent nuisance or health hazards.

Plenum chamber. A pressure equalizing chamber in an air-flow system.

Pureeing. The process of converting fruit or vegetable materials to a uniform, pulpy, fluid product, containing most of the original solids.

Raw commodity. The raw vegetable or fruit before processing - used loosely to refer either to the freshly harvested commodity as it comes into the plant or to the partially processed material at any time prior to blanching.

Raw material. The fresh commodity as it enters the processing plant. Sometimes used interchangeably with "raw commodity."

Reconstitution. The process by which water is added back to dehydrated products in the course of preparation for eating.

Rehydration. Same as reconstitution.

Rotary drum drier. A drier comprising a pair of internally heated drums on which pureed or liquid materials can be dried in a thin film which is removed continuously by a scraper blade.

Sanitizing chemicals. Chemicals used to facilitate the cleaning and sterilizing of plant and equipment.

Side-fired tunnel. A tunnel dehydrator in which the furnace or heating section and air circulating fan are located on the same level as the tunnel section in which drying is conducted.

Single-stage drier. A one compartment drier in which the material being dried is exposed to a uniform progression of drying conditions.

Spray drier. A drier in which finely sprayed droplets of a solution are evaporated to dryness while suspended in a hot air stream.

Starch spray. A spray of starch solution.

Steam peeling. Removal of the peeling from root vegetables by a short exposure to high pressure steam, followed by washing to remove loose peel.

Sulfiting. The process of impregnating materials with sulfur dioxide or certain of its compounds, in order to minimize darkening during drying and lengthen the storage life of the dried product.

Surplus states. States in which the crop of a given commodity is normally in excess of the demand within the state.

Through-flow of air. The arrangement within a drier whereby the air stream flows upward or downward through an exposed layer of material to be dried.

Trayloading. The amount of material on the drying tray before dehydration, usually expressed in pounds per square foot of tray area.

Truck. A rack mounted on wheels for carrying the drying trays in a tunnel dehydrator. (Also called a car.)

Two-stage drier. A drier in which the material being dried is exposed to a new and separate air stream after initial drying has been accomplished in the primary air stream. (See also "Multi-stage drier".)

Vacuum drier. A drier in which removal of moisture is accomplished by maintaining the pressure in the drier substantially below the moisture vapor pressure of the product at the temperature in the drier.

Vaporization. Conversion of a liquid into a vapor - for example, water into water vapor.

Wet bulb depression. The difference between the dry-bulb temperature and the wet-bulb temperature of air.

Wet-bulb temperature. The temperature registered in an air stream by a thermometer whose sensitive bulb is covered with a clean wick which is kept moist with pure water. (See "Dry-bulb temperature".)

APPENDIX "B"

LIST OF APPLICABLE SPECIFICATIONS

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COMMODITY SPECIFICATIONS

Specifications	Number	Date
Apples, Dehydrated	MIL-A-1035A	23 Sept. 1949
Cranberries, Dehydrated	MIL-C-827A	4 Sept. 1951
Beets, Dehydrated	MIL-B-3024	3 Aug. 1949
Cabbage, Dehydrated	MIL-C-826	27 July 1949
Carrots, Dehydrated	MIL-C-839	28 July 1949
Onions, Dehydrated	MIL-O-3028	8 Aug. 1949
Potatoes, White, Dehydrated	MIL-P-1073A	12 Dec. 1950
Potatoes, Sweet, Dehydrated	MIL-P-3025	3 Aug. 1949

SUPPORTING SPECIFICATIONS

Federal Specifications

Beets, Fresh	HHH-B-166b	27 Apr. 1951
Cabbage, Fresh	HHH-C-26b	12 Dec. 1950
Carrots, Fresh	HHH-C-81a	27 May 1947
Onions; Northern-grown type, Fresh	HHH-O-536 Amend. 1	28 Oct. 1941 28 Jan. 1942
Boxes, Wood, Nailed and Lock-Corner	NN-B-621b	26 June 1950
Boxes, Wood, Wirebound (for Domestic Shipment)	NN-B-631c	27 Feb. 1951
Boxes, Fiber Corrugated (for Domestic Shipment)	LLL-B-631c	13 Mar. 1951
Boxes, Fiber, Solid (for Domestic Shipment)	LLL-B-636c	13 Mar. 1951
Paper; General Specifications and Methods of Testing	UU-P-31b	3 Mar. 1949
Tape; Paper, Gummed (Sealing and Securing)	UU-T-111b	23 Apr. 1951

Military Specifications

Specification	Number	Date
Boxes, Wood, Wirebound (Overseas Type)	MIL-B-107A	20 Sept. 1951
Coatings, Exterior, for Food Cans	MIL-C-10506	8 Sept. 1950
Labeling and Marking of Metal Cans for Subsistence Items	MIL-L-1497	28 Oct. 1949
Milk, Dry; Whole and Nonfat Solids	MIL-M-1495	28 Oct. 1949
Marking of Shipments	MIL-STD-129	9 Aug. 1951
Sampling Procedures and Tables for Inspection by Attributes	MIL-STD-105A	11 Sept. 1950

Joint Army-Navy Specifications

Specification	Number	Date
Coatings: Exterior, Air-drying, Camouflage and Rust-Inhibiting, for Food Cans (Also see MIL-C-10506, 8 Sept. 1950)	JAN-C-237 Army No. 3-208 Navy No. 42C26	30 June 1945
Coatings, Exterior, Camouflage and Rust-inhibiting (for Processed and Nonprocessed Food Cans) (also see MIL-C-10506, 8 Sept. 1950)	JAN-C-238 Army No. 3-209 Navy No. 42C32	30 June 1945
Packaging and Packing for Overseas Shipment -- Boxes: Wood, Nailed	JAN-P-106A Army No. 100-22A Navy No. 39P16C Section VI	1 Aug. 1946
Packaging and Packing for Overseas Shipment -- Boxes, Fiberboard (V-Board and W-Board), Exterior and Interior	JAN-P-108 Amend. 4 Army No. 100-21 Navy No. 39P16b Section VIII	30 June 1944 9 May 1950
Packaging and Packing for Overseas Shipment -- Cartons, Folding, Paperboard	JAN-P-120 Amend 1 Army No. 100-27 Navy No. 39P16b Section XX	30 Sept. 1944 15 Oct. 1945

U.S. Army Specifications

Marking, Exterior, Domestic and Export Shipment, by Contractors (Also see MIL-STD-129, 9 Aug. 1951)	94-40645-B	11 June	1947
Specifications for Marking of Outside Shipping Containers by Contractors (Also see MIL-STD-129, 9 Aug. 1951)	OQMG 94B	21 Mar.	1949
Index Quartermaster Corps Specifications	OQMG	31 May	1951

Navy Specifications

Navy Shipment Marking Handbook - Bureau of Supplies and Account	Navsanda Publication 9 - 5th Ed.	June	1950

APPENDIX "C"

ADDITIONAL SOURCES OF INFORMATION

The information in this Appendix is given to help a prospective dehydrator find the assistance he may need to plan, build, and/or operate a vegetable or fruit dehydration plant. The inclusion of any individual or organization does not imply a recommendation by the Department of Agriculture, nor does the omission of the name of any individual or organization imply a lack of recommendation.

Existing Vegetable and Fruit Dehydration Plants

The plants listed in Table I either presently dehydrate the products indicated, or have the basic facilities for dehydrating the commodities listed. Practically all the plants listed had dehydration experience during World War II. Products that are now being produced, or that can be produced with only minor modifications in the facilities, are designated by an asterisk (*).

TABLE I

Existing Vegetable or Fruit Dehydration Plants

Dehydration Plant	Commodities Processed 1/
American Food Products Corp. Richfield, Utah	Potatoes (D and J) 2/
Basic Vegetable Products Co., Inc. Vacaville, California	*Carrots *Celery *Kale *Onions *Potatoes (D and J) *Tomatoes
Baxter, H. C., & Bro. Hartland, Maine	*Potatoes (D and J)
Behen Fruit Service, Inc. Everett, Mass	*Cranberry Powder
Bitter Root Co. Hamilton, Montana	Beets Potatoes (D and J)
Cal-Compack Foods, Inc. Santa Ana, Calif.	*Cabbage *Celery *Peppers
California Vegetable Concentrates, Inc. Huntington Park, Calif.	*Cabbage *Celery *Kale *Onions *Parsley *Squash *Tomatoes
Modesto, Calif.	*Beets *Carrots *Potatoes (D and J) *Rutabagas

* Products that are now being produced or that can be produced with only minor plant modification

1/ If more than one commodity is processed, the commodities are listed alphabetically with no intent of indicating the order of importance in that plant

2/ "Potatoes" are for "white potatoes"; "D" for diced; "J" for "Julienne"; "G" for granules"; "S" for "shredded or riced"; "F" for "flour"

(Continued)

(Table I, continued)

Dehydration Plant	Commodities Processed
California Vegetable Concentrates, Inc. Ventura County, Calif.	*Parsley
Chapman Dehydrater Company Modesto, Calif.	Beets Carrots Potatoes (D and J) *Raisins
Dezauche & Sons Opelousas, La.	Sweetpotatoes
Evangeline Pepper & Food Prod. Co. St. Francisville, La.	Peppers Sweetpotatoes
Fewel Brothers Selma, Calif.	Carrots Potatoes (D, J, and F) *Raisins
Florida Dehydrators Zellwood, Fla. (Branch of Sokol Co. Chicago, Ill.)	Beets Cabbage Carrots Potatoes (D and J)
Frank Tea & Spice Co. New Iberia, La.	Sweetpotatoes
French, R. T., Company Shelley, Idaho (Plant ready for operation Aug. 1952)	*Potatoes (G)
Rochester, N. Y.	*Beets and other vegetables
Gentry Division Consolidated Grocers Corp. Gilroy, Calif.	*Garlic *Onions
Oxnard, Calif.	Cabbage *Peppers Potatoes (D and J)
Idaho Potato Growers, Inc. Idaho Falls, Idaho	*Potatoes (D,J and F)

(Continued)

(Table I, continued)

Dehydration Plant	Commodities Processed
Knipschild Dehydrator Co. Yuba City, Calif.	Beets Cabbage Carrots Potatoes (D and J)
Little & Co., Inc. Lafayette, La.	Beets Sweetpotatoes
Makepeace, A. D., Co. Wareham, Mass.	*Cranberries
Maxson Maine Potato Co. Washburn, Maine	Potatoes (D and J)
Miller Fruit Co. Healdsburg and Forestville California	*Apples (evaporated) Carrots *Potatoes (D and J)
Naman - Krum Co. Fresno, California	*Apples (dehydrated) Potatoes (D)
National Cranberry Association Hanson, Mass.	*Cranberries
Grayland, Washington	*Cranberries
Northwestern Potato Co. N. Girard, Pa.	Carrots Potatoes (D and J)
Potato Products Corp. E. Grand Forks, Minn.	*Potatoes (D, J, and G)
Puccinelli Packing Co. Turlock, Calif.	Beets Cabbage Carrots *Potatoes (D) Sweetpotatoes
Livingston, Calif.	*Garlic *Onions
Rogers Bros. Seed Co., Inc. Idaho Falls, Idaho	*Potatoes (S and F)

(Continued)

(Table I, continued)

Dehydration Plant	Commodities Processed
Ross Packing Co. Selah, Wash.	*Apples (evaporated) Potatoes (S)
Seabrook Farms Bridgeton, N. J.	Beets Potatoes (D and J) Sweetpotatoes
Simplot, J. R., Company Caldwell, Idaho	*Onions *Potatoes (D, J, and G)
Burley, Idaho	*Potatoes (D, J, and G)
Sweet Potato Growers, Inc. Laurel, Miss.	Sweetpotatoes
Trappey's, B. F., Sons New Iberia, La.	Sweetpotatoes
Vacu-Dry Co. Oakland, Calif.	*Apples (dehydrated)
Selah, Wash.	*Apples (dehydrated)
Vincennes Packing Corp. Vincennes, Indiana	Carrots Hominy Potatoes (D and J)
Wapato Evaporating Co. Wapato, Washington	Potatoes (D and J) *Apples (evaporated)
Warriner Products Co. St. Francisville, La.	Onions Sweetpotatoes

Partial List of Manufacturers of Vegetable and Fruit Dehydration Equipment

The inclusion in Table II of any manufacturer and the respective classifications as to types of equipment manufactured does not imply a recommendation by the Department of Agriculture, nor does any omission from this Table II imply a lack of recognition. The sources for the information given include: (a) manufacturers' catalogs, (b) trade journal advertisements, (c) *Thomas' Register of American Manufacturers*, (d) *Food Industries Classified Directory of Manufacturers*, (e) engineering firms, (f) direct contact with equipment manufacturers, and (g) knowledge obtained from present dehydrators.

The equipment listed is that which is specifically applicable to the dehydration of vegetables or fruits. The list does not include firms which do only general plant construction work as almost any area has organizations of this type available.

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KNOWN SUPPLIERS OF EQUIPMENT FOR VEGETABLE AND FRUIT DEHYDRATION

NAME OF COMPANY	HOME OFFICE	AIR HANDLING & CONDITIONING	BELTS — PEELING, TRIMMING, INSPECTING	BLANCHERS	CLEANING & SANITIZING PRODUCTS & EQUIPMENT	CONTROL & MEASURING DEVICES	CONVEYORS	CORERS	CUTTERS, SLICERS, GRATERS, DICERS, RICERS	ELEVATORS	GRADERS, SORTERS, SIZERS	HEATING, DRYING & BURNING EQUIPMENT	INSPECTION & TESTING FACILITIES	PACKING & PACKAGING	PEELERS & PARERS	TRUCKS, FORK-LIFT	WASHERS	WASTE HANDLING	WATER SUPPLY & CONDITIONING
Adrian Manufacturing Co.	San Jose, Calif.																		X
Aerofin Corp.	Syracuse, N.Y.											X							
Air Devices, Inc.	New York, N.Y.	X																	
Ajax Flexible Coupling Co.	Westfield, N.Y.						X				X						X		
Allis-Chalmers, Inc.	Milwaukee, Wis.	X				X	X			X	X	X					X		
Aluminum Goods Mfg. Co.	Manitowoc, Wis.								X										
Alvey Conveyor Mfg. Co.	St. Louis, Mo.		X				X												
American Blower Corp.	Detroit, Mich.	X																	
American Can Co.	New York, N.Y.													X					
American Machinery Corp.	Orlando, Fla.						X		X		X						X		
American Machine & Foundry Co.	New York, N.Y.		X				X												
American Slicing Machine Co.	Chicago, Ill.								X										
American Well Works	Aurora, Ill.																	X	
Anderson, J. P., & Co.	Philadelphia, Pa.								X										
Anetsberger Bros.	Northbrook, Ill.	X	X																
Anstice Co., Inc.	Rochester, N.Y.								X		X				X				
Arid-Aire Mfg. Co.	Minneapolis, Minn.											X							
Atkins, E. C., & Company	Indianapolis, Ind.								X										
Atlas-Pacific Eng. Co., Inc.	Emeryville, Calif.			X								X			X				

KNOWN SUPPLIERS OF EQUIPMENT FOR VEGETABLE AND FRUIT DEHYDRATION

NAME OF COMPANY	HOME OFFICE	AIR HANDLING & CONDITIONING	BELTS --- PEELING, TRIMMING, INSPECTING	BLANCHERS	CLEANING & SANITIZING PRODUCTS & EQUIPMENT	CONTROL & MEASURING DEVICES	CONVEYORS	CORERS	CUTTERS, SLICERS, GRATERS, DICERS, RICERS	ELEVATORS	GRADERS, SORTERS, SIZERS	HEATING, DRYING & BURNING EQUIPMENT	INSPECTION & TESTING FACILITIES	PACKING & PACKAGING	PEELERS & PARERS	TRUCKS, FORK-LIFT	WASHERS	WASTE HANDLING	WATER SUPPLY & CONDITIONING
Bailey, H. R., Company	South Carver, Mass.										X			X					
Baker Bros. Engr. Co.	Muscatine, Iowa			X															
Baker Perkins, Inc.	Saginaw, Mich.		X																
Basalt Rock Co.	Napa, Calif.											X							
Bauer Bros. Co.	Springfield, Ohio		X																
Beach-Russ Company	New York, N.Y.													X					
Beaird, J. B., Co.	Shreveport, La.											X							
Beckley Perforating Co.	Garwood, N. J.			X															
Benner-Nauman, Inc.	Oakland, Calif.			X											X		X		
Berlin Chapman Co.	Berlin, Wis.		X	X					X		X	X	X				X		
Blakeslee, G.S., & Co.	Cicero, Ill.														X		X		
Blickman, S., Inc.	Weehauken, N. J.		X																
Bloxham Engineering Co.	Berkeley, Calif.											X							
Bluffton Slaw Cutter Co.	Bluffton, Ohio								X										
Bodinson Mfg. Co.	San Francisco, Calif.									X			X						
Boggs Manufacturing Corp.	Atlanta, N.Y.										X								
Boutell Mfg. Co.	Rochester, N.Y.			X					X						X				
Bridge Food Machinery Co.	Philadelphia, Pa.								X						X		X		
Bristol Company, The	Waterbury, Conn.					X													

KNOWN SUPPLIERS OF EQUIPMENT FOR VEGETABLE AND FRUIT DEHYDRATION

NAME OF COMPANY	HOME OFFICE	AIR HANDLING & CONDITIONING	BELTS --- PEELING, TRIMMING, INSPECTING	BLANCHERS	CLEANING & SANITIZING PRODUCTS & EQUIPMENT	CONTROL & MEASURING DEVICES	CONVEYORS	CORERS	CUTTERS, SLICERS, GRATERS, DICERS, RICERS	ELEVATORS	GRADERS, SORTERS, SIZERS	HEATING, DRYING & BURNING EQUIPMENT	INSPECTION & TESTING FACILITIES	PACKING & PACKAGING	PEELERS & PARERS	TRUCKS, FORK-LIFT	WASHERS	WASTE HANDLING	WATER SUPPLY & CONDITIONING
Bruce & Hubbell Engr. Co.	Brockton, Mass.													X					
Bryant Heater Div., Affiliated Gas Equipment Co., Inc.	Cleveland, Ohio	X																	
Buffalo Forge Co.	Buffalo, N.Y.	X																	
Buflovak Equip. Div., Blaw Knox Co.	Buffalo, N.Y.											X							
Carrier Corporation	Syracuse, N.Y.	X										X							
Central Scientific Co.	Chicago, Ill.												X						
Chain Belt Co.	Milwaukee, Wis.		X				X			X								X	X
Chisholm-Ryder Co., Inc.	Niagara Falls, N.Y.		X	X			X		X	X	X			X	X		X		
Clad, Victor V., Co.	Philadelphia, Pa.														X				
Clarage Fan Co.	Kalamazoo, Mich.	X																	
Clark Equipment Co., Industrial Truck Div.	Battle Creek, Mich.															X			
Cleaver-Brooks Co.	Milwaukee, Wis.											X							
Cochrane Corp.	Philadelphia, Pa.																		X
Continental Can Co.	New York, N.Y.													X					
Crane Co.	Chicago, Ill.					X													
Culligan Zeolite Co.	Northbrook, Ill.																		X
Curtis Manufacturing Co.	St. Louis, Mo.	X																	
Cyclotherm Corporation	New York, N.Y.											X							
Day, J.H., Co., Inc.	Cincinnati, Ohio								X										

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KNOWN SUPPLIERS OF EQUIPMENT FOR VEGETABLE AND FRUIT DEHYDRATION

NAME OF COMPANY	HOME OFFICE	AIR HANDLING & CONDITIONING	BELTS --- PEELING, TRIMMING, INSPECTING	BLANCHERS	CLEANING & SANITIZING PRODUCTS & EQUIPMENT	CONTROL & MEASURING DEVICES	CONVEYORS	CORERS	CUTTERS, SLICERS, GRATERS, DICERS, RICERS	ELEVATORS	GRADERS, SORTERS, SIZERS	HEATING, DRYING & BURNING EQUIPMENT	INSPECTION & TESTING FACILITIES	PACKING & PACKAGING	PEELERS & PARERS	TRUCKS, FORK-LIFT	WASHERS	WASTE HANDLING	WATER SUPPLY & CONDITIONING
Ditzen Engr. & Sales Co.	Oakland, Calif.									X				X					
Diversey Corporation	Chicago, Ill.				X														
Dorr Company	New York, N.Y.																	X	
Doherty, W. F., & Sons	Philadelphia, Pa.														X				
Drying Systems, Inc.	Chicago, Ill.											X							
Dunkley Company	Kalamazoo, Mich.								X		X				X				
Durand, Fred A.	Woodbury, Ga.										X						X		
Eimer & Amend	New York, N.Y.												X						
Elgin Softener Corp.	Elgin, Ill.																		X
Elliott Manufacturing Co.	Fresno, Calif.													X					
Enterprise Mfg. Co. of Pa.	Philadelphia, Pa.								X										
Exact Weight Scale Co.	Columbus, Ohio					X													
F. & E. Company	Centerville, Calif.											X							
Fabreeka Products Co., Inc.	Boston, Mass.		X				X												
Fairbanks, Morse & Co.	Chicago, Ill.					X													
Felins Tying Machine Co.	Milwaukee, Wis.																X		
Ferrell, A. T., & Co.	Saginaw, Mich.						X				X						X		
Ferry, J. D., Co., Inc.	Harrisburg, Pa.						X		X						X		X		
Fibreboard Products, Inc.	San Francisco, Calif.													X					

KNOWN SUPPLIERS OF EQUIPMENT FOR VEGETABLE AND FRUIT DEHYDRATION

NAME OF COMPANY	HOME OFFICE	AIR HANDLING & CONDITIONING	BELTS --- PEELING, TRIMMING, INSPECTING	BLANCHERS	CLEANING & SANITIZING PRODUCTS & EQUIPMENT	CONTROL & MEASURING DEVICES	CONVEYORS	CORERS	CUTTERS, SLICERS, GRATERS, DICERS, RICERS	ELEVATORS	GRADERS, SORTERS, SIZERS	HEATING, DRYING & BURNING EQUIPMENT	INSPECTION & TESTING FACILITIES	PACKING & PACKAGING	PEELERS & PARERS	TRUCKS, FORK-LIFT	WASHERS	WASTE HANDLING	WATER SUPPLY & CONDITIONING
First Machinery Corp.	New York, N.Y.		X						X										
Fitzpatrick, W. J., Company	Chicago, Ill.								X										
Food Machinery & Chemical Corp.	San Jose, Calif.		X	X			X	X	X	X	X				X		X		
Foster Engineering Co.	Union, New Jersey											X							
Fostoria Pressed Steel Corp.	Fostoria, Ohio											X							
Foxboro Company, The	Foxboro, Mass.					X													
Fruit Packers Supply & Equip. Co.	Yakima, Wash.										X						X		
Fuller-Huron Co.	Catasauga, Pa.						X												
Gardner-Smith, Inc.	San Jose, Calif.		X							X	X						X		
General Amer. Transp. Corp. Process Equipment Div.	Chicago, Ill.											X							
General Filter Co.	Ames, Iowa																		X
General Slicing Machine Co.	Walden, N.Y.								X										
Gifford-Wood Co.	Hudson, N.Y.						X			X									
Goder, Joseph, Inc.	Chicago, Ill.											X							
Greer, J. W., Co.	Cambridge, Mass.													X					
Gruendler Crusher & Pulverizer Co.	St. Louis, Mo.						X			X									
Gump, B. F., Co.	Chicago, Ill.						X	X		X									
Hamachek, Frank, Machine Co.	Kewaunee, Wis.								X						X				
Hamilton Metal Products Co.	Hamilton, Ohio								X										

KNOWN SUPPLIERS OF EQUIPMENT FOR VEGETABLE AND FRUIT DEHYDRATION

NAME OF COMPANY	HOME OFFICE	AIR HANDLING & CONDITIONING	BELTS --- PEELING, TRIMMING, INSPECTING	BLANCHERS	CLEANING & SANITIZING PRODUCTS & EQUIPMENT	CONTROL & MEASURING DEVICES	CONVEYORS	CORERS	CUTTERS, SLICERS, GRATERS, DICERS, RICERS	ELEVATORS	GRADERS, SORTERS, SIZERS	HEATING, DRYING & BURNING EQUIPMENT	INSPECTION & TESTING FACILITIES	PACKING & PACKAGING	PEELERS & PARERS	TRUCKS, FORK-LIFT	WASHERS	WASTE HANDLING	WATER SUPPLY & CONDITIONING
Hamilton Tool Co., The	Hamilton, Ohio															X			
Handy Mfg. Co.	Chicago, Ill.								X										
Hartford-Empire Co.	Hartford, Conn.													X					
Hayden Cranberry Separator Mfg. Co.	Wareham, Mass.								X		X								
Hobart Mfg. Co.	Troy, Ohio								X						X				
Horix Mfg. Co.	Pittsburgh, Pa.		X				X							X			X		
Howes, S., Company, Inc.	Silver Creek, N.Y.								X		X						X		
Hungerford & Terry, Inc.	Clayton, N.J.																		X
Huntley Mfg. Co.	Brocton, N.Y.									X									
Hydraulic Press Mfg. Co., The	Mt. Gilead, Ohio								X		X								
Hyster Co.	Peoria, Ill.															X			
Ideal Grader & Equip. Co.	Hood River, Oreg.										X						X		
Illinois Water Treatment Co.	Rockford, Ill.																		X
Imperial Machine & Fdry. Corp.	Lindenhurst, N.Y.														X		X		
Industrial Filter & Pump Mfg. Co.	Chicago, Ill.	X									X								
Industrial Wire Cloth Products Corp.	Wayne, Mich.										X								
Infilco, Inc.	Chicago, Ill.																	X	X
Inman Tank Pipe & Cross-Arm Co.	San Leandro, Calif.																		X
Jeffrey Mfg. Co., The	Columbus, Ohio		X	X			X		X	X	X	X					X	X	

KNOWN SUPPLIERS OF EQUIPMENT FOR VEGETABLE AND FRUIT DEHYDRATION

NAME OF COMPANY	HOME OFFICE	AIR HANDLING & CONDITIONING	BELTS --- PEELING, TRIMMING, INSPECTING	BLANCHERS	CLEANING & SANITIZING PRODUCTS & EQUIPMENT	CONTROL & MEASURING DEVICES	CONVEYORS	CORERS	CUTTERS, SLICERS, GRATERS, DICERS, RICERS	ELEVATORS	GRADERS, SORTERS, SIZERS	HEATING, DRYING & BURNING EQUIPMENT	INSPECTION & TESTING FACILITIES	PACKING & PACKAGING	PEELERS & PARERS	TRUCKS, FORK-LIFT	WASHERS	WASTE HANDLING	WATER SUPPLY & CONDITIONING
Johnson, Ed. E., Inc.	St. Paul, Minn.																		X
Johnson, S. T., Company	Oakland, Calif.	X										X							X
Joy Manufacturing Co.	Pittsburgh, Pa.	X																	
Kaustine Co., Inc.	Perry, N.Y.																	X	
Kiefer, Karl, Machine Co.	Cincinnati, Ohio		X																
Koven, L. O., & Bros., Inc.	Jersey City, N.J.																X		
King-Wyse Mfg. Co.	Archbold, Ohio										X								
Knipschild Dehydrator Co.	St. Helena, Calif.											X							
Kreamer, A., Inc.	Brooklyn, N.Y.								X										
Landers, Frary & Clark	New Britain, Conn.								X										
Langsenkamp, F. H., Co.	Indianapolis, Ind.		X	X					X		X				X		X		
LaPorte Mat & Mfg. Co.	LaPorte, Ind.						X												
Leahy Manufacturing Co.	Los Angeles, Calif.					X						X							X
Leeds & Northrop Co.	Philadelphia, Pa.					X													
Lift Trucks, Inc.	Cincinnati, Ohio															X			
Link-Belt Company	Chicago, Ill.		X				X			X	X							X	
Long-Eakins Co.	Springfield, Ohio								X						X				
Magnuson Engr. Co.	San Jose, Calif.					X		X	X										
Market Forge Co.	Everett, Mass.		X																

KNOWN SUPPLIERS OF EQUIPMENT FOR VEGETABLE AND FRUIT DEHYDRATION

NAME OF COMPANY	HOME OFFICE	AIR HANDLING & CONDITIONING	BELTS --- PEELING, TRIMMING, INSPECTING	BLANCHERS	CLEANING & SANITIZING PRODUCTS & EQUIPMENT	CONTROL & MEASURING DEVICES	CONVEYORS	CORERS	CUTTERS, SLICERS, GRATERS, DICERS, RICERS	ELEVATORS	GRADERS, SORTERS, SIZERS	HEATING, DRYING & BURNING EQUIPMENT	INSPECTION & TESTING FACILITIES	PACKING & PACKAGING	PEELERS & PARERS	TRUCKS, FORK-LIFT	WASHERS	WASTE HANDLING	WATER SUPPLY & CONDITIONING
Mathews Conveyor Co.	Ellwood City, Pa.						X			X							X		
Mercoid Corp., The	Chicago, Ill.					X													
Merryway Co.	Poughkeepsie, N.Y.								X										
Miller, L. N., Dehydrator Co.	Eugene, Oreg.						X					X							
Minneapolis-Honeywell Regulator Co.	Philadelphia, Pa.					X													
Miskella Infra-Red Co.	Cleveland, Ohio						X					X							
Mixers, Inc.	Philadelphia, Pa.								X										
Mobilift Corp.	Portland, Oreg.															X			
Modine Manufacturing Co.	Racine, Wis.											X							
Moore Dry Kiln Co.	Jacksonville, Fla.											X							
Morral Bros.	Morral, Ohio								X										
Munson Mill Machinery Co.	Utica, N.Y.								X										
Myers, F. E., & Bros. Co., The	Ashland, Ohio								X										
Nat. Airoil Burner Co., Inc.	Philadelphia, Pa.											X							
Nat. Drying Machine Co., The	Philadelphia, Pa.											X							
Nelson, Herman, Corp., The	Moline, Ill.	X										X							
Nemec Combustion Engineers	Whittier, Calif.					X						X							
New York Blower Co., The	Chicago, Ill.	X										X							
Oakite Products, Inc.	New York, N.Y.				X														

KNOWN SUPPLIERS OF EQUIPMENT FOR VEGETABLE AND FRUIT DEHYDRATION

NAME OF COMPANY	HOME OFFICE	AIR HANDLING & CONDITIONING	BELTS --- PEELING, TRIMMING, INSPECTING	BLANCHERS	CLEANING & SANITIZING PRODUCTS & EQUIPMENT	CONTROL & MEASURING DEVICES	CONVEYORS	CORERS	CUTTERS, SLICERS, GRATERS, DICERS, RICERS	ELEVATORS	GRADERS, SORTERS, SIZERS	HEATING, DRYING & BURNING EQUIPMENT	INSPECTION & TESTING FACILITIES	PACKING & PACKAGING	PEELERS & PARERS	TRUCKS, FORK-LIFT	WASHERS	WASTE HANDLING	WATER SUPPLY & CONDITIONING
Oat, Joseph, & Sons, Inc.	Philadelphia, Pa.			X											X				
Ogden Iron Works Co.	Ogden, Utah								X										
Olney and Floyd	Westerville, N.Y.										X						X		
Olson, Samuel, Mfg. Co., Inc.	Chicago, Ill.						X			X							X		
Orr & Sembower, Inc.	Reading, Pa.											X							
Owens-Corning Fiberglas Corp.	Toledo, Ohio	X																	
P. & L. Welding Corp.	Anaheim, Calif.											X							
Pacific Wood Tank Corp.	San Francisco, Calif.																		X
Paramount Mfg. Co.	Stockton, Calif.						X				X						X		
Parma Water Lifter Co.	Parma, Idaho										X						X		X
Patterson Foundry & Machine Co., The	East Liverpool, Ohio											X							
Peerless Pump Div., Food Mach. Corp.	Los Angeles, Calif.																		X
Permuttit Co., The	New York, N.Y.																		X
Pfaudler Company, The	Rochester, N.Y.														X		X		
Phillips Refrigeration Products, Inc.	San Francisco, Calif.	X																	
Pittsburgh Lectrodryer Corp.	Pittsburgh, Pa.	X																	
Pneumatic Scale Corp., Ltd.	North Quincy, Mass.													X					
Proctor & Schwartz, Inc.	Philadelphia, Pa.											X							
Productive Equipment Corp.	Chicago, Ill.										X								

KNOWN SUPPLIERS OF EQUIPMENT FOR VEGETABLE AND FRUIT DEHYDRATION

NAME OF COMPANY	HOME OFFICE	AIR HANDLING & CONDITIONING	BELTS --- PEELING, TRIMMING, INSPECTING	BLANCHERS	CLEANING & SANITIZING PRODUCTS & EQUIPMENT	CONTROL & MEASURING DEVICES	CONVEYORS	CORERS	CUTTERS, SLICERS, GRATERS, DICERS, RICERS	ELEVATORS	GRADERS, SORTERS, SIZERS	HEATING, DRYING & BURNING EQUIPMENT	INSPECTION & TESTING FACILITIES	PACKING & PACKAGING	PEELERS & PARERS	TRUCKS, FORK-LIFT	WASHERS	WASTE HANDLING	WATER SUPPLY & CONDITIONING
Puccinelli Packing Co.	Turlock, Calif.		X				X					X							
Rapids Standard Co., Inc., The	Grand Rapids, Mich.						X												
Ray Oil Burner Co.	San Francisco, Calif.											X							
Rees Blow Pipe Mfg. Co.	San Francisco, Calif.											X							
Reynolds Electric Co.	River Grove, Ill.	X				X			X						X				
Richmond Manufacturing Co.	Lockport, N.Y.										X								
Rietz Manufacturing Co.	San Francisco, Calif.																	X	
Robbins & Myers, Inc.	Springfield, Ohio	X								X									
Roberts Filter Mfg. Co.	Darby, Pa.																		X
Robins, A. K., & Co., Inc.	Baltimore, Pa.		X	X			X		X		X				X		X		
Robinson Mfg. Co.	Muncy, Pa.								X										
Rockwell Packaging Machines, Inc.	Hudson, N.Y.													X					
Rotary Lift Co.	Memphis, Tenn.															X			
Sargents, C. G., Sons Corp.	Graniteville, Mass.											X							
Scott, Ernest, & Company	Fall River, Mass.	X										X							
Scott Viner Co., The	Columbus, Ohio			X					X	X	X						X		
Service Caster & Truck Corp.	Albion, Mich.															X			
Sinclair-Scott Co.	Baltimore, Md.								X		X				X		X		
Southwestern Engineering Co.	Los Angeles, Calif.										X	X							

KNOWN SUPPLIERS OF EQUIPMENT FOR VEGETABLE AND FRUIT DEHYDRATION

NAME OF COMPANY	HOME OFFICE	AIR HANDLING & CONDITIONING	BELTS --- PEELING, TRIMMING, INSPECTING	BLANCHERS	CLEANING & SANITIZING PRODUCTS & EQUIPMENT	CONTROL & MEASURING DEVICES	CONVEYORS	CORERS	CUTTERS, SLICERS, GRATERS, DICERS, RICERS	ELEVATORS	GRADERS, SORTERS, SIZERS	HEATING, DRYING & BURNING EQUIPMENT	INSPECTION & TESTING FACILITIES	PACKING & PACKAGING	PEELERS & PARERS	TRUCKS, FORK-LIFT	WASHERS	WASTE HANDLING	WATER SUPPLY & CONDITIONING
Spence Eng. Co., Inc.	Walden, N.Y.					X													
Sprout, Waldron & Co., Inc.	Muncy, Pa.						X		X	X	X								
Standard Conveyor Co.	North St. Paul, Minn.						X			X									
Standard Steel Corp.	Los Angeles, Calif.											X							
Stearns Company	Chicago, Ill.														X				
Stearns-Roger Mfg. Co.	Denver, Colo.																	X	
Stokes, F. J., Machine Co.	Philadelphia, Pa.											X		X					
Stokes & Smith Co.	Philadelphia, Pa.													X					
Stortz, John, & Son, Inc.	Philadelphia, Pa.							X											
Stuber & Kuck Co.	Peoria, Ill.								X										
Sturtevant Div., Westinghouse Elec. Co.	Boston, Mass.	X																	
Superior Combustion Industries, Inc.	New York, N.Y.											X							
Sutton, Steele & Steele, Inc.	Dallas, Tex.										X						X		
Syntron Corporation	Homer City, Pa.										X								
Taylor Instrument Co.	Rochester, N.Y.					X													
Thermoid Company	Trenton, N.J.						X												
Toledo Scale Co.	Toledo, Ohio					X													
Towmotor Corp., Div. 35	Cleveland, Ohio															X			
Trescott Company, Inc.	Fairport, N.Y.										X								

KNOWN SUPPLIERS OF EQUIPMENT FOR VEGETABLE AND FRUIT DEHYDRATION

NAME OF COMPANY	HOME OFFICE	AIR HANDLING & CONDITIONING	BELTS --- PEELING, TRIMMING, INSPECTING	BLANCHERS	CLEANING & SANITIZING PRODUCTS & EQUIPMENT	CONTROL & MEASURING DEVICES	CONVEYORS	CORERS	CUTTERS, SLICERS, GRATERS, DICERS, RICERS	ELEVATORS	GRADERS, SORTERS, SIZERS	HEATING, DRYING & BURNING EQUIPMENT	INSPECTION & TESTING FACILITIES	PACKING & PACKAGING	PEELERS & PARERS	TRUCKS, FORK-LIFT	WASHERS	WASTE HANDLING	WATER SUPPLY & CONDITIONING
Tri-Clover Machine Co.	Kenosha, Wis.				X														
Tucker-Dorsey Mfg. Corp.	Indianapolis, Ind.								X										
Union Steel Products Co.	Albion, Mich.								X										
United Company	Westminster, Md.						X		X										
Urschel Laboratories, Inc.	Valparaiso, Ind.								X						X				
U. S. Bottlers Mach. Co.	Chicago, Ill.		X																
Van Range, John, Company, The	Cincinnati, Ohio														X				
Vaughn Novelty Mfg. Co., Inc.	Chicago, Ill.														X				
Wallace & Tiernan Co., Inc.	Belleville, N.J.				X													X	X
Warner Lewis Company	Tulsa, Okla.																		X
Washburn Co.	Worcester, Mass.							X									X		
Webster Mfg., Inc.	Tiffin, Ohio		X				X			X									
Weigh Right Automatic Scale Co.	Joliet, Ill.					X								X					
Western Blower Co.	Seattle, Wash.	X																	
Western Precipitation Corp.	Los Angeles, Calif.	X									X								
Wolf Company, The	Chambersburg, Pa.									X	X						X		
Wyandotte Chemicals Corp.	Wyandotte, Mich.				X														
Yale & Towne Mfg. Co.	New York, N.Y.															X			
York Corporation	York, Pa.	X																	

Seed Companies of Interest to Dehydrators

Considerable assistance and suggestions concerning production of the fresh commodities needed by a fruit or vegetable dehydration plant may be obtained from the commercial seed companies. It is suggested that the prospective dehydrator confer with any of the companies listed below, or with any others in a position to serve the area being considered for a plant location.

Associated Seed Growers, Inc.
New Haven, Conn.

Burpee, W. Atlee, Co.
18th St. & Hunting Park Ave.
Philadelphia, Pa.

Burrell, D. V., Seed Growers Co.
Rocky Ford, Colorado

Cooperative G.L.F. Exchange, Inc.
Chamber of Commerce Bldg.
Buffalo, N. Y.

Dickinson, Albert, Co.
1335 W. Randolph
Chicago, Ill.

Dreer, Henry A., Inc.
202 N. 21st
Philadelphia, Pa.

Ferry-Morse Seed Co.
Brush & Monroe
Detroit, Mich.

Germain Seed & Plant Co.
747 Terminal St.
Los Angeles, Calif.

Pacific Guano Co.
Berkeley, Calif.

Peppard Seed Co.
1101 W. 8th
Kansas City, Mo.

Pieters-Wheeler Seed Co.
Gilroy, Calif.

Roger Bros. Seed Co., Inc.
308 W. Washington
Chicago, Ill.

Scarlett, Wm. G., & Co.
632 President
Baltimore, Md.

Washburn-Wilson Seed Co.
Moscow, Idaho

Woodruff, F. H., & Sons, Inc.
Milford, Conn.

Wallace & Morley Co.
Bay Port, Michigan

Industrial Consultants in the Field of Fruit and Vegetable Dehydration

The manufacturers of equipment listed in Table II can render very helpful consulting services to a prospective dehydrator. The industrial consultants listed below are suggested additional sources of assistance in planning, building, and/or operating a dehydration plant. Most of these consultants have done consulting work in the field of food dehydration.

It is impossible, however, to make a complete list of all competent consultants because of the non-existence of sufficiently comprehensive directories. The inclusion of any individual or organization does not imply a recommendation by the Department of Agriculture, nor does the omission of any individual or organization imply a lack of recommendation.

Benjamin, J. Malvern
Mechanical Engineer
18 W. Chelton Ave.
Philadelphia, Pa.

Bishop & Associates, J. Paul
P. O. Box 348
Champaign, Ill.

Bloxham Engineering Inc.
2610 - 9th Street
Berkeley, California

Bowen Research Corp.
Garwood, New Jersey

Chapman Dehydrator Co.
360 S. Daly Ave.
Modesto, California

Chilson, Francis
Harwood Bldg.
New York City, N. Y.

Douthitt, F. H., Corp.
221 N. LaSalle St.
Chicago, Ill.

Food Research Laboratories, Inc.
48-14 33rd Street
Long Island City, N. Y.

Ganteaume & McMullen
99 Chauncy Street
Boston, Mass.

General Equipment, Ltd.
317 W. Pender Street
Vancouver, B. C.,

Girdler Corporation
224 East Broadway
Louisville, Kentucky

Guthier, E. H. & Co.
2376 N. Flower Street
Santa Ana, California

(Continued)

Hale, James F.
R. D. #5
Bridgeton, N. J.

Hanson-Gorrill-Brian, Inc.
1 Continental Hill
Glen Cove, N. Y.

Holzcker, Richard
Lake Wales, Fla.

Hoskins, Glenn G.
520 N. Michigan Ave.
Chicago, Ill.

Lewin Associates
1775 Broadway
New York, N. Y.

Magnuson, Roy
509 Emory Street
San Jose 10, Calif.

Main, Charles T., Inc.
Boston, Mass.

McBean, Douglas M., Inc.
315 Alexander
Rochester, N. Y.

Montgomery, J. M., & Co. Inc.
900 S. Robertson
Los Angeles, Calif.

New Brunswick Potato Products, Ltd.
P. O. Box 64
Harland, N. B., Canada

Norton, Karl B.
North Compo Road
Westport, Conn.

Peck Associates, Henry
12 S. Main
Fairport, N. Y.

Reich, Gustave T.
1422 Chestnut Drive
Philadelphia, Pa.

Richert, Paul
Coast Laboratories
1859 S. Van Ness Ave.
Fresno, California

Scheurer, Paul, Engineering Co.
1318 - 8th St.
Wichita Falls, Texas

Schrader, G. K.
California Prune and Apricot
Growers Assoc.
Campbell, California

Schwarz Laboratories, Inc.
202 E. 44th St.
New York City, N. Y.

Sirrine, J. E., & Co.
215 S. Main
Greenville, South Carolina

Spengler, Warren D.
Box 35
Hudson, Ohio

Widmer Engineering Co.
122 N. 7th Street
St. Louis, Missouri

Research and Development Organizations of Interest to Vegetable and Fruit Dehydrators

The sources of information cited in this section may be of considerable assistance in keeping an existing dehydrator up to date on developments of new methods and new types of products. In many cases, particularly some of the government agencies listed, these sources of information will be of material help in the initial planning of a dehydration business.

The inclusion of any individual or organization does not imply a recommendation by the Department of Agriculture, nor does the omission of any individual or organization imply a lack of recommendation.

A. Commercial Research and/or Testing Organizations

Organizations which have done research and/or testing in various food processing and related fields are listed below.

Al Chem Laboratory
702 E. Locust Street
Bloomington, Ill.

Armour Research Foundation
Dearborn Street
Chicago, Ill.

Batelle Memorial Institute
Columbus, Ohio

BIC Manufacturing Corp.
318 - 320 E. 39th Street
New York, N. Y.

Food, Chemical & Research Laboratories, Inc.
1201 E. 38th St.
Seattle, Wash.

Freud Laboratories, Inc.
655 Sixth Avenue
New York, N. Y.

Griffith Laboratories, Inc.
1415 W. 37th Street
Chicago, Ill.

Hale, George A.
116-20 N. Fourth Street
St. Louis, Mo.

Killian Research Laboratories, Inc.
49 W. 45th Street
New York, N. Y.

Little, Arthur D., Inc.
30 Memorial Drive
Cambridge, Mass.

Mellon Institute
4400 Fifth Avenue
Pittsburgh, Pa.

Miner Laboratories
9 So. Clinton St.
Chicago, Ill.

(Continued)

National Research Corp.
100 Brookline Ave.
Boston, Mass.

Pacific Chemical Laboratories
617 Montgomery Street
San Francisco, Calif.

Pease Laboratories, Inc.,
39 W. 38th Street
New York, N. Y.

San Antonio Analytical Laboratory
Medical Arts Bldg.
San Antonio, Texas

Southern Research Institute
917 S. 20th Street
Birmingham, Alabama

Southwest Research Institute
San Antonio, Texas

Stanford Research Institute
Stanford, Calif.

Strasburger & Siegel
15 S. Gay Street
Baltimore, Md.

Straub, W. F., and Co.
5520 Northwest Highway
Chicago, Ill.

Superior Laboratories
10 West Ohio Street
Indianapolis, Ind.

Supplee, G. C., Research Corp.
Bainbridge, N. Y.

Terven, Lewis A., Company
P. O. Box 192
Salinas, Calif.

United Western Laboratories
619 - 22nd Street
Denver, Colorado

von Goehde Laboratories
5 St. Albans Road
Boston, Mass.

Wahl, Manfred
Alden Park, Germantown
Philadelphia, Pa.

Wahl-Henius Institute
64 E. Lake Street
Chicago, Ill.

Wallerstein Laboratories
180 Madison Ave.
New York, N. Y.

Wander Company
360 N. Michigan Ave.
Chicago, Ill.

Way Laboratory Service
308 Western Reserve Bldg.
Cleveland, Ohio.

B. Colleges, Universities, and Experiment Stations

It is suggested that the prospective dehydrator confer with the departments of horticulture, agronomy, food technology, chemistry, and chemical engineering of the universities and agricultural colleges in the state in which he proposes to locate a dehydration plant.

The various state agricultural colleges and experiment stations are listed in Table III. Information obtainable within the state may be augmented by reference to agricultural colleges and other universities that have given extensive study to dehydration technology, or have an especially strong background of dehydration knowledge and/or experience, such as Massachusetts Institute of Technology (Cambridge, Mass.), University of California (Berkeley and Davis, California), University of Illinois (Urbana, Illinois), Illinois Institute of Technology (Chicago, Illinois), and Oregon State College (Corvallis, Oregon).

TABLE III

Land - Grant Colleges and Experiment Stations 1/

State	Name and Location
Alabama	School of Agriculture and the Agricultural Experiment Station of the Alabama Polytechnic Institute (Auburn)
Alaska	University of Alaska (Division of Agriculture), the Agricultural Experiment Station, and the Extension Service (College)
Arizona	College of Agriculture, the Agricultural Experiment Station and the Agricultural Extension Service of the University of Arizona (Tucson)
Arkansas	College of Agriculture and the Agricultural Experiment Station of the University of Arkansas (Fayetteville)
California	College of Agriculture and the Agricultural Experiment Station of the University of California (Berkeley and Davis)

1/ Source: U. S. Office of Experiment Stations. Workers in Subjects Pertaining to Agriculture in Land-Grant Colleges and Experiment Stations, 1950-51. Washington, D.C., 1951. (U.S. Dept. of Agriculture, Agriculture Handbook 15)

(Continued)

(Table III, Continued)

State	Name and Location
Colorado	Colorado Agricultural and Mechanical College and the Agricultural Experiment Station (Fort Collins)
Connecticut	College of Agriculture and the Storrs Agricultural Experiment Station of the University of Connecticut (Storrs)
Delaware	School of Agriculture, the Agricultural Experiment Station, and the Agricultural Extension Service of the University of Delaware (Newark)
Florida	College of Agriculture, Agricultural Experiment Station, and Agricultural Extension Service of the University of Florida (Gainesville)
Georgia	College of Agriculture, University of Georgia (Athens)
	Georgia Agricultural Experiment Station (Experiment)
	Georgia Coastal Plain Experiment Station (Tifton)
Hawaii	University of Hawaii (Department of Agriculture), the Hawaii Agricultural Experiment Station, and the Agricultural Extension Service (Honolulu)
Idaho	College of Agriculture and the Agricultural Experiment Station of the University of Idaho (Moscow)
Illinois	The College of Agriculture, the Agricultural Experiment Station, and the Extension Service in Agriculture of the University of Illinois (Urbana)
Indiana	School of Agriculture, the Agricultural Experiment Station, and the Department of Agricultural Extension of Purdue University (La Fayette)
Iowa	The Division of Agriculture, the Agricultural Experiment Station, and the Extension Service in Agriculture of the Iowa State College of Agriculture and Mechanic Arts (Ames)

(Continued)

(Table III, Continued)

State	Name and Location
Kansas	Kansas State College of Agriculture and Applied Science and the Agricultural Experiment Station (Manhattan)
Kentucky	College of Agriculture and the Agricultural Experiment Station of the University of Kentucky (Lexington)
Louisiana	The Louisiana State University and Agricultural and Mechanical College, the Agricultural Experiment Station, and the Agricultural Extension Service (University Station, Baton Rouge 3)
Maine	College of Agriculture and the Agricultural Experiment Station of the University of Maine (Orono)
Maryland	College of Agriculture, Agricultural Experiment Station, and the Extension Service of the University of Maryland (College Park)
Massachusetts	School of Agriculture and the Agricultural Experiment Station of the University of Massachusetts (Amherst)
Michigan	Michigan State College of Agriculture and Applied Science and the Agricultural Experiment Station (East Lansing)
Minnesota	Department of Agriculture (College of Agriculture, the Agricultural Experiment Station, and the Division of Agricultural Extension) of the University of Minnesota (University Farm, St. Paul 1)
Mississippi	Mississippi State College and Agricultural Experiment Station (State College)
Missouri	Division of Agricultural Sciences, College of Agriculture, and the Agricultural Experiment Station of the University of Missouri (Columbia)
Montana	Montana State College and the Agricultural Experiment Station (Bozeman)

(Continued)

(Table III, Continued)

State	Name and Location
Nebraska	College of Agriculture and the Agricultural Experiment Station of the University of Nebraska (Lincoln)
Nevada	College of Agriculture and the Agricultural Experiment Station of the University of Nevada (Reno)
New Hampshire	College of Agriculture and the Agricultural Experiment Station of the University of New Hampshire (Durham)
New Jersey	State College of Agriculture and Mechanic Arts and the Agricultural Experiment Station of Rutgers University (the State University of New Jersey), and the State Agricultural Experiment Station (New Brunswick)
New Mexico	New Mexico College of Agriculture and Mechanic Arts, the Agricultural Experiment Station, and the Extension Service (State College)
New York	New York State College of Agriculture and the Agricultural Experiment Station at Cornell University (Ithaca)
	New York State Agricultural Experiment Station (Geneva)
North Carolina	North Carolina State College of Agriculture and Engineering and the Agricultural Experiment Station of the University of North Carolina (State College Station, Raleigh)
North Dakota	North Dakota Agricultural College and the Agricultural Experiment Station (State College Station, Fargo)
Ohio	The College of Agriculture of Ohio State University (Columbus)
	Ohio Agricultural Experiment Station (Wooster)

(Continued)

(Table III, Continued)

State	Name and Location
Oklahoma	Oklahoma Agricultural and Mechanical College and the Agricultural Experiment Station (Stillwater)
Oregon	School of Agriculture, the Agricultural Experiment Station, and the Federal Cooperative Extension Service of Oregon State College (Corvallis)
Pennsylvania	School of Agriculture and the Agriculture Experiment Station of the Pennsylvania State College (State College)
Puerto Rico	College of Agriculture and Mechanic Arts (Mayagüez) and the Extension Service of the University of Puerto Rico (Rio Piedras)
	Agricultural Experiment Station of the University of Puerto Rico (Rio Piedras)
Rhode Island	School of Agriculture, Agricultural Experiment Station, and Extension Service in Agriculture of the University of Rhode Island (Kingston)
South Carolina	Clemson Agricultural College and the Agricultural Experiment Station (Clemson)
South Dakota	South Dakota State College of Agriculture and Mechanic Arts and the Agricultural Experiment Station (Brookings)
Tennessee	College of Agriculture and the Agricultural Experiment Station of the University of Tennessee (Knoxville)
	Tennessee Agricultural and Industrial State College (Nashville)
Texas	Agricultural and Mechanical College of Texas, the Agricultural Experiment Station, and the Extension Service (College Station)

(Continued)

(Table III, Continued)

State	Name and Location
Utah	Utah State Agricultural College, the Agricultural Experiment Station, and the Agricultural Extension Service (Logan)
Vermont	College of Agriculture and the Agricultural Experiment Station of the University of Vermont and State Agricultural College (Burlington)
Virginia	Virginia Polytechnic Institute and the Agricultural Experiment Station (Blacksburg)
	Virginia Truck Experiment Station (Norfolk)
	Virginia State College (Petersburg)
Washington	State College of Washington, The Institute of Agricultural Sciences (Agricultural Experiment Station, Extension Service, College of Agriculture) (Pullman)
West Virginia	College of Agriculture and Agricultural Experiment Station of West Virginia University (Morgantown)
Wisconsin	College of Agriculture and the Agricultural Experiment Station of the University of Wisconsin (Madison)
Wyoming	College of Agriculture and the Agricultural Experiment Station of the University of Wyoming (Laramie)

C. State and Federal Government Agencies

A prospective dehydrator should consult with the state departments concerned with agriculture and public health in the state he is considering for a plant location, and with various Federal agencies. Particular organizations which will be most helpful are those concerned with agricultural production statistics, horticulture, agronomy, food processing technology, and quality control of food products.

Federal Government Agencies:

Department of the Army

Food and Container Institute for the Armed Forces, 1849 W. Pershing Road, Chicago, Ill.

Department of Agriculture

Bureau of Agricultural & Industrial Chemistry:

a) Western Regional Research Laboratory, Albany, California

b) Southern Regional Research Laboratory, New Orleans, Louisiana

c) Eastern Regional Research Laboratory, Philadelphia, Pennsylvania

Bureau of Plant Industry, Soils, & Agricultural Engineering, Beltsville, Maryland

Bureau of Agricultural Economics, Washington, D. C.

Production & Marketing Administration, Fruit & Vegetable Branch, Washington, D. C.

Trade Associations of Interest to Vegetable & Fruit Dehydrators

American Society of Refrigerating Engineers
40 W. 40th Street
New York 18, New York

Association of Food Industry Sanitarians
c/o National Canners Association
322 Battery Street
San Francisco 11, California

Association of New York State Canners
266 Taylor Building
Rochester 4, New York

Associated Independent Canners
60 E. 42nd Street
New York 17, New York

Associates, Food & Container Institute
1849 W. Pershing Road
Chicago 9, Illinois

California Dried Fruit Research Institute
(also California Foods Research Institute)
1 Drumm Street
San Francisco 11, California

California Processors & Growers
Financial Center Building
Oakland, California

Can Manufacturers Institute
60 E. 42nd Street
New York 17, New York

Canadian Food Processors Association
104 Sparks Street
Ottawa, Ontario, Canada

Canners League of California
64 Pine Street
San Francisco 11, California

Canners League of Florida
Lakeland, Florida

Canning Machinery & Supplies Association
Lock Box 430
Battle Creek, Michigan

Dried Fruit Association of California
1 Drumm Street
San Francisco 11
California

Eastern Shore of Virginia Packers Association
Cape Charles, Virginia

Florida Canners Association
Chamber of Commerce Building
Tampa, Florida

Frozen Food Foundation
600 W. Genesee Street
Syracuse 4, New York

Frozen Food Institute
90 W. Broadway
New York 7, New York

Georgia Canners Association
Griffin, Georgia

(Continued)

(Industry Ass'ns., Continued)

Illinois Canners Association
322 Murray Building
Streator, Illinois

Indiana Canners Association
424 Illinois Building
Indianapolis, Indiana

Institute of Food Technologists
222 W. Adams Street
Chicago 6, Illinois

Iowa-Nebraska Canners Association
Audubon, Iowa

Louisiana-Mississippi-Alabama
Vegetable Processors Association
c/o Southern Shell Fish Company
Harvey, Louisiana

Maine Canners Association
P. O. Box 319
Brunswick, Maine

Michigan Canners Association
1145 Chippewa Drive
c/o Stokely Foods, Inc.
Grand Rapids, Michigan

Minnesota Canners Association
303 Wesley Temple Building
Minneapolis 4, Minnesota

National Apple Driers Association
336 Sherlock Building
Portland 4, Oregon

National Association of Frozen
Food Packers
1415 K Street N.W.
Washington 5, D. C.

National Canners Association
1133 - 20th Street N.W.
Washington 6, D. C.

National Dehydrators Association
520 N. Michigan Avenue
Chicago 1, Illinois

National Food Brokers Association
Munsey Building
Washington 4, D. C.

New Jersey Canners Association
Greenwich, New Jersey

Northwest Canners Association
Board of Trade Building
Portland 4, Oregon

Northwest Frozen Foods Association
507 Title & Trust Building
Portland 4, Oregon

Northwest Dried Fruit Association
336 Sherlock Building
Portland 4, Oregon

Northwest Packers & Growers
811 Dekum Building
Portland, Oregon

Nutrition Foundation
Chrysler Building
New York 17, N. Y.

Ohio Canners Association
Clyde, Ohio

Ozark Canners Association
Fayetteville, Arkansas

(Continued)

(Industry Ass'ns., Continued)

Pennsylvania Canners Association
210 Manufacturers Association
Building
York, Pennsylvania

Refrigeration Research Foundation
Colorado Springs, Colorado

Santa Clara County Canners
Association
64 Pine Street
San Francisco 11, California

Southern California Food Processors
Association
649 S. Olive Street
Los Angeles 14, California

South Florida Canners Association
c/o Sunrise Products, Inc.
Fort Pierce, Florida

Southwest Canners Association
329 Tyler State Bank Building
Tyler, Texas

Tennessee-Kentucky Canners
Association
c/o Tennessee Foods, Inc.
Portland, Tennessee

Texas Canners Association
P. O. Box 447
Weslaco, Texas

Tidewater Canners Association
of Virginia
c/o Unruh Brokerage Company
Kinsale, Virginia

Tri-State Packers Association
Masonic Building
Easton, Maryland

Utah Canners Association
321 Keisel Building
Ogden, Utah

Virginia Canners Association
c/o S. G. Wimmer & Sons
Christiansburg, Virginia

Western Frozen Food Processors
Association
244 California Street
San Francisco 11, California

Wisconsin Canners Association
103 Tenney Building
Madison 3, Wisconsin

Selected Literature References

The references and suggested sources of information given herein have been chosen to cover the most up-to-date practices and principles in dehydration and other information of primary interest to management groups contemplating entry into the dehydration field.

It is believed advantageous to limit these references largely to American practices because: (1) American industrial and agricultural practices are substantially different from those of other countries, and (2) American technology appears to be superior to, or at least equal to, that found elsewhere. The dehydration techniques in Great Britain are not too different from those in the United States -- differing mostly in blanching and sulfiting procedures. Dehydration processes in Australia and Canada are largely based on American procedures. Germany and, of late years, Egypt have dehydrated fruits and vegetables, but the processing has been done mostly in very small and rather inefficient plants; the dehydrated products are considered quite inferior to those produced in the United States.

The organization of this reference material has been rather arbitrarily chosen, but appears to be particularly useful from the standpoint of a prospective management group. The references are classified under the following categories:

1) Directories
2) Books, Pamphlets, and Bulletins
3) Periodicals
4) U. S. Government Publications
5) References from Journals

The most important references have been designated with a "#".

Directories

<u>Food Products Directory</u>. Issued by Miller-Freeman Publications, San Francisco. Classified according to products and includes section on dehydrated items.

National Dehydrators Assoc. <u>Classified Directory of United States and Canadian Dehydrated Food Processors (exclusive of milk driers), Distributors, Equipment Manufacturers, and Packaging Material Manufacturers, Etc., and Their Products</u>. 3rd ed. Washington,D.C.,The Assoc.,1945. 47 p.

<u>Thomas' Wholesale Grocery and Kindred Trades Register</u>. Regularly revised and issued by the Thomas Pub. Co., New York. Includes section on dehydrated fruits and vegetables, lists of produce dealers, brokers, and wholesalers. Classified according to products (including a section on dehydration), trade names, and manufacturers, dealers, brokers, and wholesalers.

<u>Thomas' Register of American Manufacturers</u>. Revised and published yearly by Thomas Publishing Co., New York. Manufacturers classified according to type of items manufactured.

Especially important references.

Books, Pamphlets, and Bulletins

American Society of Agronomy. Hunger Signs in Crops - a Symposium. 2nd ed. Washington,D.C.,The Society and the National Fertilizer Assoc.,c1949. Imperfect plant nutrition is shown to diminish yield and damage product quality. 390 p.

Association of Food Industry Sanitarians, Inc. Sanitation for the Food-Preservation Industries. New York,McGraw-Hill,1952. 284 p.

Clark, C.F., and Lombard, P.M. Descriptions of and Key to American Potato Varieties Washington,D.C.,1946. (U.S. Dept. of Agriculture Circular 741) 50 p.

Cruess, W.V. Commercial Fruit and Vegetable Products. 3rd ed. N.Y.,McGraw-Hill, 1948. 906 p. Presents standard commercial methods of processing fruits and vegetables - dehydration, sun-drying, canning, pickling, etc.

Cruess, W.V., and MacKinney, G. The Dehydration of Vegetables. Berkeley, 1943. (Calif. Agricultural Experiment Station, Bulletin 680) 76 p. Theoretical discussions, industrial methods, and a 3-page bibliography of additional information.

Dehydration conference, 3rd, Jan.1944, Berkeley, Calif. (Proceedings) under the auspices of the Fruit Products Division, College of Agriculture, University of California, Berkeley, 1944.

Ede, A.J., and Hales, K.C. The Physics of Drying in Heated Air with Particular Reference to Fruit and Vegetables. London,1948. (Great Britain Dept. of Scientific and Industrial Research. Food investigation special report 53) 50 p.

Eidt, C.C. Principles and Methods Involved in Dehydration of Apples. Ottawa,1938. (Canada. Dept. of Agriculture Technical Bulletin 18 - Publication 625) 36 p.

Eldridge, E.F. Industrial Waste Treatment Practice. New York,McGraw-Hill,1942. Includes a chapter on canning-factory wastes. 401 p.

Food Industries. Flow Sheets of Food Processes. Rev. ed. New York,McGraw-Hill, 1949. Associated processes are included along with those for dehydration 154 p.

Great Britain. Ministry of Food. Vegetable Dehydration in the United Kingdom. London,1946. (A publication in the Ministry's Scientific and Technical Series.) 177 p. A detailed review of British dehydration experience during World War II.

Herrick, A.D. Food Regulations and Compliance. New York,Revere Pub.Co.,c1944(v.1)-1947(v.2). This work covers both Federal and State requirements and enforcement. 1288 p.

Jacobs, M.D.,ed. The Chemistry and Technology of Food and Food Products. 2nd ed. New York, Interscience,1951. 2,580 p. in 3 vol. Both theory and practice are covered. Includes chapters on: "The Dehydration of Foods," by E. Mrak and G. MacKinney; "Unit Operations and Processes," by K. N. Garver; and "Industrial Waters," by F. C. Nachod and E. Nordell.

Especially important references.

Kleinfeld, V.A., and Dunn, C.W. Federal Food, Drug, and Cosmetic Act: Judicial and Administrative Record 1938-1949. New York,Commerce Clearing House, 1949. 895 p. This fully documented volume covers descriptions of actual cases with administrative opinions and judicial decisions.

Knott, J.E. Vegetable Growing. 4th ed. Philadelphia,Lea & Febiger,c1949. 314 p. Includes cultural and handling practices for commercial vegetable crops.

Linsley, E.G., and Michelbacher, A.E. Insects Affecting Stored Food Products. Berkeley,1943. (Calif. Agricultural Experiment Station, Bulletin 676.) 44 p. Identification, life history, probable damage likely are included.

Long, J.D., Mrak, E.M., and Fisher, C.L. Investigations in the Sulfuring of Fruits for Drying. Berkeley,1940. (California Agricultural Experiment Station Bulletin 636) 56 p.

Lutz, J.M., and Simons, J.W. Storage of Sweetpotatoes. Rev. ed. Washington,D.C., 1948. (U.S. Dept. of Agriculture Farmers' Bulletin 1442) 50 p.

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Vasak, O.R., and Shaw, W.L. A Selected Bibliography of Periodical Literature on Fruit and Vegetable Wastes. Albany, Calif., 1949. (U.S. Bureau of Agricultural & Industrial Chemistry, Western Regional Research Laboratory, AIC-232) 12 p. The most significant articles of 1937 to 1948 are indexed with annotations.

von Loesecke, H.W. Drying and Dehydration of Foods. New York, Reinhold, 1943. 302 p.

Warrick, E.F., and others. Methods of Treating Cannery Wastes. Washington, D.C., National Canners' Assoc., 1939. (The Association's Bulletin 28-L) 91 p.

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Periodicals

AGRICULTURAL INDEX (monthly) Published monthly by the H.W.Wilson Co., New York. An index of significant publications on agricultural subjects including the processing of agricultural commodities.

FOOD ENGINEERING. Published monthly by the McGraw-Hill Publishing Co., New York. Formerly issued under the title "Food Industries" until Apr.1951. Follows the trend in food processing toward better engineered processes, equipment, products, and packages.

FOOD INDUSTRIES, with Vol. 23, no. 4 became FOOD ENGINEERING (see above)

FOOD PACKER, Published monthly by the Vance Publishing Corp. of Chicago. Formerly known as "Canning Age," this trade publication contains articles on dehydration as well as food processing in general.

FOOD PROCESSING. Published monthly by the Putnam Publishing Co., Chicago, Primarily to emphasize the latest developments in equipment for food plants.

FOOD RESEARCH. Published six times a year by the Institute of Food Technologists, Chicago, Ill. This journal is primarily concerned with the technology of food processing and utilization.

FOOD TECHNOLOGY. Published monthly by the Institute of Food Technologists, Chicago, Ill. Scientific contributions concerning food preparation and utilization.

INDUSTRIAL ARTS INDEX. Published monthly by the H.W.Wilson Co., New York. Trade items and management articles indexed by subject.

MODERN PACKAGING. Published monthly by the Modern Packaging Corp., New York. Development, trends, performance characteristics of packaging and materials.

WESTERN CANNER & PACKER (monthly) and its annual Statistical Review and Yearbook number. Published by the Miller Freeman Publications, San Francisco, Extensive statistical tables and reviews of current processing season appear in the annual.

United States Government Publications

A Printed List of Available Publications of the U.S. Dept. of Agriculture (Miscellaneous Publication No. 60) may be obtained from the Office of Information, U.S. Dept. of Agriculture, Washington 25, D.C.

The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., distributes free price lists of currently available Federal publications. The following lists include many publications of interest to dehydrators:

- Price List 11 - Foods and Cooking
- Price List 44 - Plants: culture of fruits, vegetables, grasses, and grains
- Price List 46 - Agricultural chemistry, soils, and fertilizers
- Price List 75 - Federal specifications
- Price List 78 - Industrial workers

Especially important references.

Military Specifications of interest to dehydrators may be obtained from the Commanding General, Chicago Quartermaster Depot, 1819 West Pershing Road, Chicago 9, Ill.

Food and Drug Regulations are issued by the U.S. Food and Drug Administration, Washington 25, D.C. In their series of service and regulatory announcements, Series No. 1 is "Federal food, drug, and cosmetic act and general regulations for its enforcement," and Series No. 2 is "Definitions and standards for food."

U.S. Standards and Tentative U.S. Standards are available from the Production and Marketing Administration, U.S. Dept. of Agriculture, Washington, 25, D.C. A list is available.

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Specific titles of Federal publications of particular interest to dehydrators include the following:

U.S. Agricultural Research Administration. Experimental Compression of Dehydrated Foods. Washington,D.C.,1948. (U.S.Dept. of Agriculture, Miscellaneous Publication 647) 57 p. Reports experimental research carried on by three Bureaus of the ARA and one Branch of the PMA, on seven vegetables, five fruits, egg powder, and several other products.

U.S. Bureau of Agricultural & Industrial Chemistry. Vegetable and Fruit Dehydration - a Manual for Plant Operators. 1944. (U.S. Dept. of Agriculture Miscellaneous Publication 540) 218 p. Although now out-of-print, many libraries have it available. It contains general and specific information concerning theory, practice, and costs of commercial dehydration, with specific attention to the most likely commodities for drying.

U.S. Bureau of Human Nutrition & Home Economics. Cooking Dehydrated Vegetables. Washington,D.C.,1944. (U.S.Dept. of Agriculture AIS-8) 20 p. Convenient recipes are given in this publication prepared for the civilian consumer.

U.S. Dept. of Agriculture. Agricultural Statistics. Published annually. Includes data on production, yield, and price concerning fruits and vegetables with details given by the important regions of production.

U.S. Dept. of Agriculture. Commercial Dehydration of Vegetables and Fruits in Wartime. 1943. (U.S. Dept. of Agriculture Miscellaneous Publication 524) 29 p. This publication summarizes the methods used in the early part of World War II.

U.S. Dept. of Agriculture. Inter-Bureau Committee on Post-War Planning. Post-War Readjustments in Processing and Marketing Dehydrated Fruits and Vegetables. Washington,D.C.,1945. 99 p.

U.S. Dept. of Agriculture. Library. Bibliography on Dehydration of Foods 1938-1943. Washington,D.C.,1945. (U.S. Dept. of Agriculture Bibliographical Bulletin 6) 120 p. Includes subject index.

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U.S. Dept. of the Army. Field Manual Series and Technical Bulletin Series on food preparation. Washington,D.C. Various manuals used for instruction purposes in food preparation, serving, conservation, etc.

U.S. Munitions Board. Office of Manpower, Industrial Security Division. Principles of Plant Protection. Washington,D.C.,1950. 24 p. Requirements and suggestions for safeguarding plants from sabotage and other war-time dangers.

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Anon. "Dehydration of carrots in a California plant." WESTERN CANNER & PACKER 36(12):53-58, Nov.1944.

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Especially important references.

APPENDIX "D"

CODE FOR CLASSIFYING MATERIALS, OPERATING STEPS, FACILITIES, EXPENSES, AND INCOME

This classification code has been adopted for simplifying and unifying the discussions, for making cost estimates, and for presenting various information concerning each type of plant. This code is based primarily upon the cost accounting system presented in Chapter XI -- "Operating Considerations".

This basic classification code is applicable to all types of dehydration plants covered in this Handbook, although a particular type of plant may not require the use of the entire classification system. Some items included in the code are not utilized in the Handbook but are given for illustrative purposes only.

In all cases, the facilities themselves are designated by letters (a, b, c, etc.) under the respective numbered classification.

100 -- RAW MATERIAL PROCUREMENT

<u>110</u> -- <u>Purchase Price</u>

<u>120</u> -- <u>Buying Expense</u>

<u>130</u> -- <u>Field Grading</u>

a. Field grader

<u>140</u> -- <u>Field Packing</u>

<u>150</u> -- <u>Transportation and Weighing Costs</u>

<u>160</u> -- <u>Storage</u>

<u>170</u> -- <u>Crate, Box, and Sack Expense</u>

a. Sacks
b. Boxes
c. Crates

<u>180</u> -- <u>Federal and/or State Inspection</u>

<u>190</u> -- <u>Other Raw Product Costs</u>

200 -- MANUFACTURING OPERATIONS

<u>210</u> -- <u>Raw Material Handling</u>

211 -- Weighing (at plant)

a. Scales
b. Pit and housing for scales

212 -- Unloading & storing (at plant)

a. Lift truck
b. Pallets
c. Hand trucks

213 -- Feeding to line

a. Elevator
b. Conveyor
c. Portable conveyor

214 -- Sizing and sorting

a. Sizer
b. Conveyor or elevator
c. Bagger
d. Tote boxes

215 -- Handling & loading crates, boxes, and sacks within plant

220 & 230 -- Preparing

221 -- Washing

a. Washer
b. Conveyor

222 -- Preheating

a. Elevator
b. Preheater
c. Controls

223 -- Peeling

223.1 -- Elevating

a. Elevator

223.2 -- Lye peeling

a. Lye peeler
b. Lye make-up equipment
c. Controls

223.3 -- Steam peeling

a. Steam peeler

223.4 -- Abrasive peeling

a. Abrasive peeler

223.5 -- Flame peeling

a. Flame peeler

223.6 -- Machine paring

a. Paring machine

223.7 -- Manual peeling

a. Knives, cutters, & misc.

223.8 -- Other peeling methods

223.9 -- Washing (to remove peel)

a. Washer
b. Pump
c. Elevator

224 -- Trimming, coring, rooting, topping, inspecting

a. Cross conveyor
b. Trimming & coring tables
c. Coring equipment
d. Booster pump
e. Cross conveyor

225 -- Washing (cleaning trimmed material)

a. Washer
b. Pump

226 -- Cutting (slicing, dicing, stripping, shredding)

a. Elevator
b. Cutter
c. Hood & fan

227 -- Blanching or cooking (includes any sulfiting, starch coating, or other treatment done in the blanching operation)

a. Spreader
b. Blancher or cooker (including sulfiting & starch coating equipment)
c. Sulfite make-up equipment
d. Starch make-up equipment
e. Controls
f. Conveyor for cooling

228 -- Mashing

a. Mashing rolls

229 -- Mixing, granulating, sulfiting

a. Weighing machine (for mashed potato)
b. Weighing machine (for "seed granules")
c. Ribbon mixer
d. Granulator
e. Sulfiting equipment

230 -- Granule conditioning

a. Conveyor
b. Belt washer

231 -- Fluffing

a. Fluffer

<u>240</u> -- <u>Drying</u>

241 -- Tunnel drying

241.1 -- Tray loading

a. Conveyor
b. Spreader

241.2 -- Tray stacking

a. Tray stacker

241.3 -- Weighing

a. Scales

241.4 -- Tunnel operating

a. Trays
b. Tunnel drier

241.5 -- Tray unloading & stacking

a. Tray scraper

241.6 -- Elevating & conveying

a. Elevator
b. Conveyor

241.7 -- Tray washing

242 -- Conveyor drying

242.1 -- Elevating, conveying, & spreading

a. Elevator
b. Conveyor
c. Spreader

242.2 -- Conveyor drier operating

a. Drier

242.3 -- Elevating and conveying

a. Elevator
b. Conveyor

243 -- Air lift drying

243.1 -- Preliminary drying

a. Preliminary drier
b. Granule cooler
c. Screen

243.2 -- Finish drying

a. Finishing drier
b. Granule cooler

244 -- Drum drying

245 -- Vacuum drying

246 -- Compartment drying

247 -- Cabinet drying

248 -- Bin drying

248.1 -- Bin loading

a. Bins
b. Hopper & conveyor

248.2 -- Bin operating

a. Dehumidifier
b. Blower
c. Heating coils
d. Ducts
e. Hood and ducts

248.3 -- Bin unloading

a. Hoist
b. Hopper

<u>250</u> -- <u>Screening and Inspecting</u>

251 -- Elevating

a. Elevator

252 -- Screening

a. Magnet
b. Shaker screen

253 -- Aspirating

a. Aspirator

254 -- Cutting and screening

a. Cutter
b. Shaker screen

255 -- Inspecting

a. Cross conveyor
b. Inspection belt
c. Cross conveyor
d. Magnet

259 -- Dehumidifying

a. Dehumidifier

260 -- Packaging and Packing

261 -- Filling, packing, and sealing

a. Elevator & conveyor
b. Heating unit
c. Filling and weighing unit
d. Pressing unit
e. Air compressor
f. Gas or vacuum packer
g. Closing machine
h. Can conveyor
i. Stamper
j. Wax coating unit

262 -- Case forming, filling, sealing, marking

a. Marking equipment
b. Case sealing machine

270 -- Warehousing & Shipping

271 -- Palletizing

a. Pallets

272 -- Warehousing

a. Lift trucks
b. Hand trucks

273 -- Shipping

300 -- GENERAL MANUFACTURING SERVICES

310 -- Indirect Labor (Superintendent, guards, boiler operator, etc.)

320 -- Utilities

321 -- Water supply

a. Water pump
b. Chlorinator
c. Water-well

322 -- Fuel supply

a. Gas storage tanks
b. Oil storage tanks
c. Coal storage bin

323 -- Electric power

a. Stand-by generator

324 -- Steam supply

a. Boiler

325 -- Waste disposal

a. Sewage screen
b. Elevator & conveyor
c. Hopper
d. Disposal unit

330 -- Maintenance & Repairs

a. Maintenance equipment
b. Maintenance parts and supplies

340 -- Depreciation

350 -- Taxes & Insurance

360 -- Rental of Factory & Equipment

370 -- Packaging and Packing Supplies & Expense

a. Packaging supplies
b. Packing supplies

380 -- Inspection & Control

381 -- Laboratory testing

a. Laboratory equipment & supplies

382 -- Inspection & testing by outside concerns

390 -- Miscellaneous Plant Services

391 -- Lunch room operation

a. Lunch room equipment

392 -- Chemicals

393 -- Sales of trimmings, fines, etc.

394 -- Other miscellaneous

a. Fire fighting equipment

400 -- AUTOMOTIVE EXPENSE

a. Utility truck
b. Waste hauling truck
c. Passenger vehicles

500 -- SELLING EXPENSE

<u>510</u> -- <u>Salaries</u>

<u>520</u> -- <u>Travel Expenses</u>

<u>530</u> -- <u>Brokerage and Commissions</u>

<u>540</u> -- <u>Shipping Labor and Expenses</u>

<u>550</u> -- <u>Misc. Supplies and Expenses</u>

600 -- GENERAL AND ADMINISTRATIVE

<u>610</u> -- <u>Office Salaries</u>

<u>620</u> -- <u>Travel Expense</u>

<u>630</u> -- <u>Utilities</u>

<u>640</u> -- <u>Rental of General Office</u>

<u>650</u> -- <u>Interest Expense</u>

<u>660</u> -- <u>Taxes and Insurance</u>

<u>670</u> -- <u>Association Dues and Assessments</u>

<u>680</u> -- <u>Consulting Services</u>

<u>690</u> -- <u>Miscellaneous Supplies and Expense</u>

a. Office furniture and fixtures

700 -- SALES

<u>710</u> -- <u>Sales</u>

<u>720</u> -- <u>Sales Returns, Allowances, and Rejects</u>

800 -- TOTAL COST OF FINISHED PRODUCT

GPO 86-093978