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THE OPERATION MANUAL FOR SMALL CANNING FACILITIES

4th Edition

1977

Virginia Polytechnic Institute and State University
Department of Food Science and Technology
Blacksburg, Virginia

INTRODUCTION TO THE FOURTH EDITION

The International Cooperation Administration (predecessor to the Agency for International Development) originally published this manual in 1956, as an aid in the establishment and operation of community and small-scale canning facilities overseas. It remains unique in its presentation and coverage, and it has been in continuous use by government and private sectors abroad and in the United States since then.

In reissuing this manual in the revised form, the Agency for International Development is responding to the request of the U.S. A.I.D. Missions in the developing countries. This manual is also used in the United States for training purposes, especially with international participants.

In this fourth edition the contents have been revised under a contract the United States Agency for International Development of the Department of State had with the Department of Food Science and Technology at the Virginia Polytechnic Institute and State University, Blacksburg, Virginia, U.S.A. with Charles B. Wood as Project Leader. The revision includes the latest technology that would be applicable to most small multi-products canning operations. The cost figures used in the economic analysis are based on January 1, 1977 prices.

Acknowledgement is made to Dr. J. David Baldock, Extension Specialist in Food Science and Technology, Virginia Polytechnic Institute and State University, Mr. G. L. Buckner, Building Construction Engineer, Virginia Electric Power

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In most cases, man can greatly improve his health and reduce his anxiety about his food supply by preserving it for consumption throughout the year. This introduction gives several methods of preserving foods, the major method being canning. Two general classes of canning plants are discussed. In the first, the plant is operated for the benefit of the community residents in general, and in the second, the plant is operated as a commercial enterprise. Some of the most important problems, including spoilage microorganisms, type and size of the plants and equipment, containers and the training of supervisors, are also included.

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INTRODUCTION

In much of the world, man's most basic problem is finding sufficient quantities of nutritious food to sustain the population. Frequently, there is plenty of food available during some seasons; yet a shortage exists at other times. There are very few portions of the world in which all of man's food requirements can be met throughout the year by the available supply of freshly grown foods. Even in sections where the supply of fresh food is more or less adequate throughout the year, there is apt to be a certain amount of monotony in the meals and a scarcity of some necessary vitamins when the daily fare must be drawn from the limited variety of fresh foods.

At some seasons, in almost every part of the world it is possible to grow more food than can be eaten in fresh form. At times, when the yield of crops is greater than usual, much fresh food spoils. The supply of most meats is more or less seasonal, and preserving certain portions will substantially prolong the period of consumption. Furthermore, some areas have great quantities of seafoods available during only a part of the year.

Obviously the preservation of food in one way or another may be an answer to a year-round food supply. The preservation method must keep the food from spoiling and, at the same time, the food must be in such a form that its nutritive values are not lost. It is important that the preserved food approach, as nearly as possible, the attractiveness and the palatability of fresh food. Of course, the cost of the process must also be considered.

There are many ways of preserving foods so that they can be eaten months or years after harvest. Some of these methods were known and used long before historical records began.

Drying: Drying is a method used in many areas of the world to preserve many different kinds of food. In Newfoundland, boned codfish are spread on special drying racks in the open air. In southwestern United States, slices of squash, apples, or peaches are spread on wire screen to allow air circulation underneath and are dried in the sun for several days. Coffee beans are similarly heat- and air-dried in places like Costa Rica. Dried foods are stored in bags or covered containers, do not need to be kept cold, and may be eaten after many years. Obviously, however, dried foods invariably acquire many bacterial and mold spores from air and dust, or from insects such as flies.

Modern industrial methods have produced many new forms of dried foods milk powders, powdered eggs, even dishes like spaghetti or salad dressings which are prepared and then dehydrated. The consumer reconstitutes the food powder by adding water or some other liquid to prepare it for eating.

Smoking: Smoking is a related preservative process in which foods, genera meat or fish, are hung directly over a smouldering fire, or smoke is blown by fans through ducts into the room where the foods are. The smoke contains bactericidal substances which the food absorbs and which help to maintain the food during storage. Salts, spices, and other ingredients may be added to aid in preservation. However, smoked foods may still be susceptible to mold spoilage, and must be kept dry while in storage.

Salting: Salting is another ancient method of preserving food, especially meats and seafoods. In Newfoundland, boned codfish are packed in barrels, each layer of fish being salted as it is packed. The brine that results as water is drawn out of the food is usually discarded. However, there

are many bacteria, called halophiles (salt loving), which grow best in high concentrations of salt, and many other bacteria and molds are salt-tolerant.

Pickling: Pickling, while ancient, is still a popular method of preserving many foods, particularly vegetables and fruits. Moisture is drawn out of the food by salt and/or spices, and the food is then pickled in a sweet or sour acid.

Fermenting: Fermenting is an ancient method of food preservation which is still popular in every part of the world. The sugar in the food, or added to it, is converted to alcohol by yeasts. Almost any non-fatty food can be fermented if enough sugar is added, but fruits and grains are the most frequently fermented foods. The resultant wine, beer, cider, rum, brandy, or whiskey cannot be considered a practical food for nourishment because there is a very great expenditure of sugar for the amount of food value remaining in the fermented product.

Modern Methods: A number of modern methods of food preservation have been developed, including freezing, vacuum packaging, using antibiotics or gamma radiation. These methods require special expensive equipment either for the preparation of the food, for its processing, or for its storage after processing. Therefore they are not practical in many parts of the world.

One modern method of food preservation, however, has been found to be both possible in nearly every part of the Earth and practical for nearly every food. That method is heat treatment or canning. The food - fruit, vegetable, meat, fish, or a combination - is packed into a glass or metal container, the air is exhausted, the contents are hermetically sealed inside,

and the container is given a heat treatment that will render the canned food commercially sterile. The container is cooled as quickly as possible and is stored in as cool and dry a place as possible.

Three kinds of microorganisms - bacteria, yeasts, and molds are the major causes of food spoilage, and must be killed or their growth inhibited if the preserved food is to be usable. All of these organisms have certain requirements for growth and development; they must have air (or no air), moisture, nutrients, a certain temperature, etc., if they are to grow and spoil the food. The first requirement, of course, is that they merely be in or on the food in sufficient quantity to reproduce. Some of these requirements are environmental and some are nutritional, and it is often the combination of circumstances - a lack of one requirement, say, oxygen, coupled with too much of another, say low pH - that inhibits or destroys the microorganism's growth.

If, through proper sanitation and other procedures discussed later in this book, all the dangerous microorganisms and their spores are removed from the food or killed, spoilage will not occur. Often this goal is achieved through a combination of food preservation methods. The food may be pickled, sweetened, smoked, or cooked before it is canned; the exhaustion of air before sealing the can is one form of vacuum packaging which protects the food from spoilage in a number of ways. When proper procedures, like those specified in this book, are followed, canning has been proved to be the most reliable, the most practical, and the safest of all food preservation methods.

Most fruits, vegetables, and meats, including poultry and fish, can be suitably canned. Many juices can also be canned. The quality of the canned

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products which may be expected from the various foods is indicated in Table in the appendix of this manual.

The life of canned foods varies greatly for different foods and for different storage temperatures. However, in general, it is reasonable to assume that most canned foods can be stored for two years.

Types of Plants: This manual includes a discussion of three types of plants. The actual size of these plants is more or less arbitrary. The important difference in the plants is in the equipment which is used.

The smallest plant, Plant A, includes only the most elementary utensils. It is unlikely that a plant of this size or type could be a practical commercial plant under any conditions. However, it may be practical to establish such a plant for cooperative use. If so, every effort should be made to improvise as much of the equipment as possible from locally available supplies.

While Plant B is an intermediate size plant it utilizes commercial equipment and can be expanded into a larger and more efficient operation by just increasing the size of the building and the quantity of equipment without taking a loss on replacement of small inefficient equipment. Centralized steam-generating equipment is recommended for this plant.

Plant C is very similar to Plant B, but differs in that it is larger and has a greater capacity per man hour because of the labor saving devices that have been incorporated into its design.

Plant Planning: The outline of these plants should be sufficient to allow persons who are not familiar with canning plants, but who have experience with other types of industrial facilities, to decide on the type of facilities which will best serve the needs of the community. The desired capacity of

the plant should be estimated. These calculations, similar to the examples given in Chapter 6 of this manual, should be used to determine which of the three plant types would best serve the needs of the particular area being considered.

If a plant of different capacity from those described in this manual is to be built, great care should be exercised to see that all the functions (e.g., preparing, cooking, sealing, etc.) have the same capacity. In most cases the company from which the equipment is to be purchased will be in a position to advise in balancing the various functions.

Containers: If the canning plant is to be established in an area where canning is not already practiced, there will be considerable difficulty in obtaining suitable containers. The availability of containers, their cost and type should be one of the first considerations in establishing a canning plant. To be satisfactory for canning, glass jars must have very uniform top edges which make possible perfect seals. Uniform top edges are not ordinarily found on reasonably priced jars except when they are made on precision equipment such as that used in mass production of very large quantities of jars.

Tin cans also must be produced in large quantities in order to be economical. Neither preformed cans nor jars can be shipped for great distances economically. However, cans can be purchased in collapsed form and shipped at a reasonable cost; but even these cans must be purchased in minimum quantity of 100,000 of single size per order. If smaller quantities are ordered, they will not be manufactured until additional orders for the same size are received. Thus, it seems especially desirable for several small canning plants to pool or combine their orders in an effort to improve this service.

Before any plant is put into operation it is necessary for it to have a well trained supervisor. If a trained supervisor is not available it will be necessary to send a person to an established plant where the person can receive firsthand experience. It is even more desirable to have a supervisor who is trained in food technology. One possibility which deserves careful consideration is for several plants to cooperate by having their future supervisors trained together. It may prove practical to have a special course also for the benefit of the training group. If so, the course may be taught in the country or area to be served.

CHAPTER ONE

MICROBIOLOGY OF CANNED FOODS

The primary goal in canning foodstuffs is to preserve it in edible, wholesome and nutritious condition and thereby prevent spoilage. Since production is seasonal, canning provides a way to conserve the oversupply of fresh produce at its season of maturity for consumption during the remainder of the year. However, it is also necessary that the canned product be attractive, palatable, wholesome, and nutritious. Occasionally in commercial canning plants, and all too frequently in home operations, one or more of these objectives is not attained. When one or more of these objectives is not attained, food is wasted unnecessarily; and illness or death may result if spoiled food is eaten. It is therefore, of the utmost importance that each of these goals be kept in mind in planning a canning plant.

Food Spoilage: Everyone is familiar with the fact that food which is perfectly tasty and nutritious one day, if left to sit at room temperature for several days will no longer be edible, much less tasty and nutritious. When this occurs, one or all three of the following things has happened:

(1) Such spoilage may have been caused by enzymes. Enzymes are complex chemical (proteinaceous) substances that are produced in both animal and plant cells. Foods are, of course, composed of such cells, which undergo changes due to chemical reactions; and these reactions may be caused or accelerated by enzymes without the enzymes themselves undergoing any marked destruction in the process. Such enzyme activity is especially likely in the presence of oxygen (air), and occurs rapidly even at room temperatures. Some of these enzymes are responsible for the

necessary ripening of the food; but that ripening must be stopped at a particular point, called the *peak* of ripeness, for the food to be most nutritive and tasty. Fresh sweet corn is a good example of a food in which the enzymes naturally present in the food cause both flavor and nutrients to deteriorate rapidly after the ripe corn has been picked. This particular reaction can be slowed by the cooling of ears of freshly harvested corn in cold water at 4.5 C (40 F) or less. Canned peaches which have become soft after several months' storage at a temperature of 32 C (90 F) are typical of enzyme-caused changes in the physical properties of a canned product. Both corn and peaches in which enzymes have caused such chemical changes are safe to eat, but they will be lacking in desirable flavor and texture and will probably have lost some of its nutritional value.

Vegetables harvested at their peak stage of ripeness or readiness to eat should be processed immediately or placed under refrigeration at 4.5 C (40 F) until they can be processed. Temperatures used in processing are usually sufficient to inactivate most enzymes that can cause deterioration of canned foods, but certain heat-resistant enzymes will not be inactivated at normal processing temperatures. Some enzymes have been reported to survive temperatures as high as 190 C (375 F). Therefore, to help retard enzymatic reactions, canned foods should have a vacuum of 15 inches of mercury or higher (see chapter on operating and processing procedures) and should be stored at temperatures below 27 C (80 F) if possible. Many properly canned foods stored at higher temperatures for a year or longer can be expected to lose some of their nutritive value, color, flavor and texture because of enzyme activity.

Food spoilage caused by enzymes is not as dangerous to the person eating the food as is spoilage caused by some microorganisms - that is, the food will not cause serious illness or death. The main concern in enzyme spoilage is the loss of nutrients from the food, and the deterioration of some of its desirable physical properties, such as color, texture, and flavor.

(2) The second cause of food spoilage is due to oxidation. Oxidation of foods occurs when foods, which are composed of complex organic chemical compounds - some of which are relatively unstable - are exposed to oxygen, as found in air, for long periods of time, particularly in elevated temperatures. Foods containing lipids, such as oils and fats found in nuts and meats, become oxidized in the presence of oxygen to form compounds which cause these foods to become rancid. Carotenoids, such as beta-carotene as found in many yellow fruits and vegetables, are readily oxidized to form compounds that produce off-flavors and lower the nutritional value of these foods by reducing the vitamin A content. When levo-ascorbic acid, vitamin C, becomes oxidized to form levo-dehydroascorbic acid in aqueous solution at pH levels above 4.0, it may undergo a further irreversible change to L-diketogulonic acid devoid of any vitamin C activity thus reducing the foods' nutritional values.

The oxidation of compounds in foods should be kept at a minimum to retain the nutritive value of foods, containing these compounds, at a high level. Therefore, procedures for processing foods must be followed closely to minimize these and other nutritional losses as well as those of flavor and other physical properties.

(3) The third cause of food spoilage is the presence of microorganisms in or on the food. A number of different kinds of living organisms, mostly microscopic, normally live in or on many of the same foods that human beings eat. Other similar microorganisms are present in air or water or on the hands

of the persons who have handled the food. Some of these organisms are harm less, and some are desirable - the yeast that makes bread rise, the mold th flavors cheese, the yeasts that ferment wine, for example. But many other these organisms, when allowed to grow on or in the food, are harmful, in th by their growth they make the food either unpalatable to the taste or alter it so that it is no longer edible and may even be poisonous or deadly to th person who eats it.

Just as foods must be protected from over-ripening and other enzymatic activity, if the foods are to be eaten weeks or months after harvest, so mu foods be protected from the growth of these potentially harmful organisms. Thus, anyone who wishes to preserve a food needs to be aware of the different kinds of organisms that cause different foods to spoil, and how these organisms may be prevented or inhibited from growing. Since different organisms affect different foods, and affect foods in different ways, the food preserver must also understand something about the composition of the food itself, and how its composition affects the microorganisms that may be present in it.

One of the first and most important factors that canners must take into consideration is the hydrogen-ion concentration - or acidity - of the food that is to be canned. The hydrogen-ion concentration is usually an effective measurement of the acidity of a food - the higher the concentration of hydrogen-ions in the food, the higher the acidity. Hydrogen-ion concentration is measured by an instrument called a pH meter. pH may be defined scientifically as the negative logarithm of the effective hydrogen-ion concentration in gram equivalent per liter; in other words, the higher the pH number the lower the hydrogen-ion concentration and the lower the

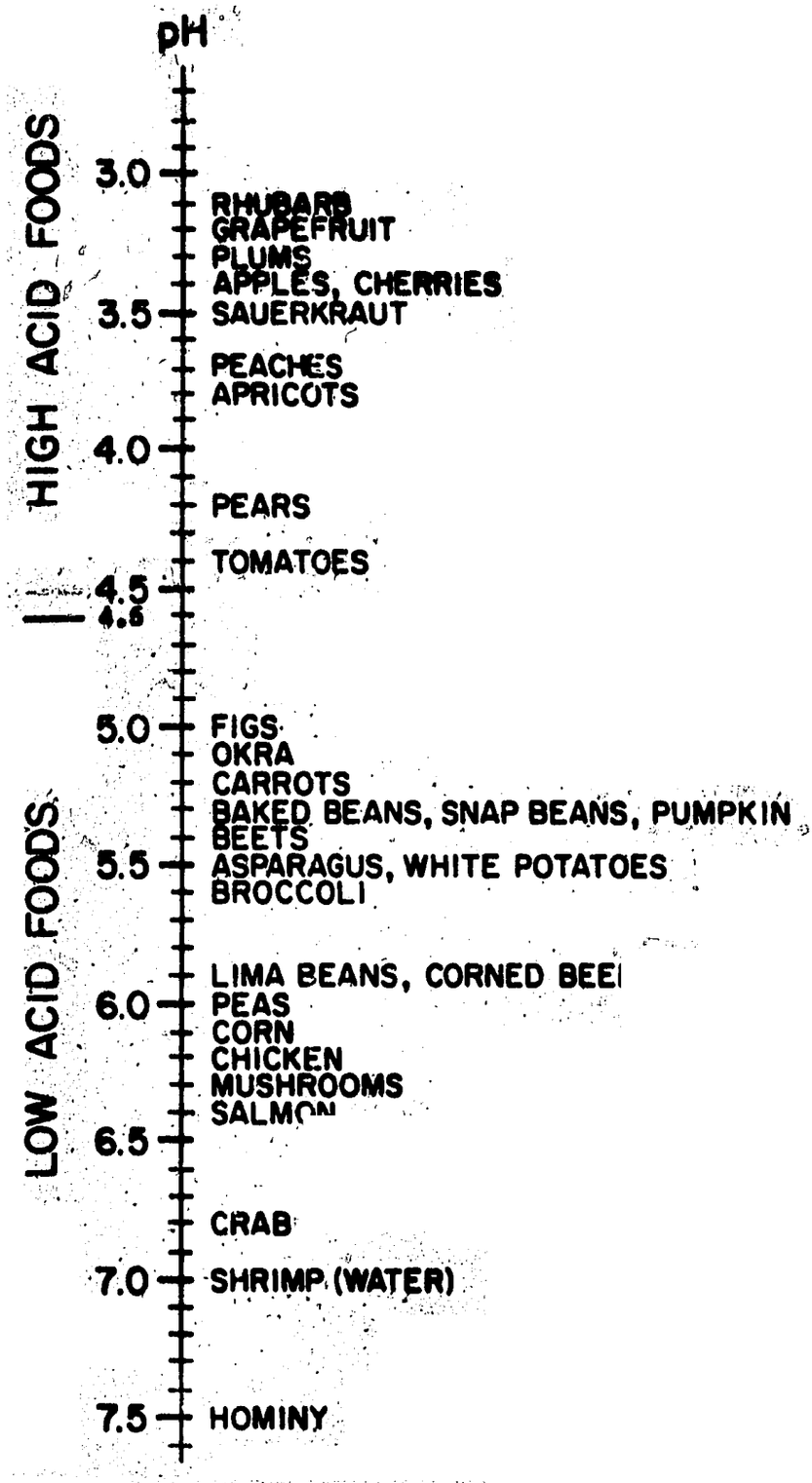


Figure 1 The pH Value of Some Foods

acidity. A pH value expresses the acidity or alkalinity (non-acidity) on a scale of values from 0 to 14, with 7 - the median - representing neutrality, neither acid nor alkaline. On this pH scale, numbers less than 7 indicate increasing acidity and numbers greater than 7 indicate increasing alkalinity. A food with a pH of 2 (vinegar) would be highly acid; one of pH 7.5 (like hominy) would be mildly alkaline.

Most foods have a pH less than 7 but many approach the neutrality point of 7 on the pH scale (see Figure 1, page 5). Foods for canning are usually classified as either acid or low-acid foods - foods with a pH value less than 4.6 are considered acid foods, and those with a value between 4.6 to 7 are considered low-acid foods.

People responsible for operating a food processing plant must know the pH of the food they are processing because the temperature and the time at which the food is processed depend on the pH of the food. One kind of spoilage organism will develop and grow only in acid foods (pH less than 4.6) while another may develop and grow well only in a low-acid food (pH above 4.6). Some spoilage organisms can grow in both acid and low-acid foods; however, sometimes their growth depends also on the temperature or the sweetness or saltiness as well as on the acidity.

The organisms that preserved and stored foods must be protected against are classified into three groups - molds, yeasts, and bacteria.

<u>Molds</u>: Everyone has seen, on the surface of bread or cheese or jam that has been left uncovered at room temperature, a white, greenish, or brownish, fuzzy, fluffy, or velvety growth. These growths are molds. Molds grow on the surfaces of foods, rather than in foods, because they need air to survive.

Molds are plants, without roots, stems, leaves, or chlorophyll; instead they consist of masses of branching, intertwined filaments called hyphae. Molds can grow by the chance transplantation of a piece of mycelium (the name for the whole mass of hyphae) onto a favorable growth medium such as a food. But molds most often reproduce by spores, which may be either sexual or asexual. Asexual spores spread through the air because they are tiny and very light. Wherever these spores land on a favorable medium they can start a new plant. A special kind of asexual spore called a chlamydospore or resting cell can be formed by many species of molds; these cells store up food, swell, and form a thick wall that can withstand conditions unfavorable to the parent mold or to normal spores, and can later grow into a new mold plant. Both sexual and asexual spores are resistant to drying, and thus can germinate after long periods of resting or hibernation.

SPORE HEADS OF PENICILLIUM MOLD

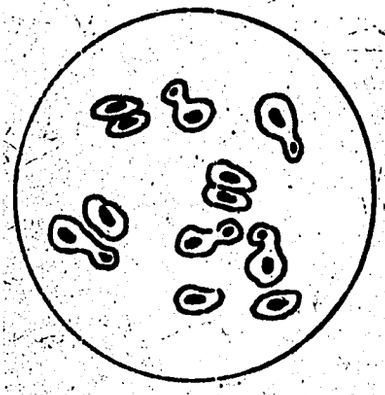
Figure 2

Molds need certain environmental conditions, particularly air and moisture in order to grow. Temperature is also important in helping or inhibiting mold growth. Most molds grow well at or just above normal room temperature, 25-30 C or 77-86 F. A few molds grow at higher temperatures, and some grow at temperatures at or even below freezing. Most molds are usually killed by moist heat at 100 C (212 F) -- the boiling temperature of water at sea level. Because molds are aerobic - that is, they need free oxygen as available in air - they are more likely to grow on uncovered foods than on foods that are sealed in an airtight container. Molds can grow in both acid and non-acid foods, but if conditions are favorable for all three of the microorganisms,

molds tend to lose out because they grow more slowly than do yeasts and bacteria. Warm, humid climates are more favorable for mold growth than are cold or dry climates.

Yeast: Generally, the presence of yeasts in a food cannot be observed by the naked eye; yeasts show their presence by causing changes in the food - the bread rises, the fruit juice ferments.

Like molds, yeasts are plants without leaves, stems, chlorophyll, or roots. They are usually single cells, consisting of a cell wall or membrane which encloses a cytoplasm with a nucleus and various granules. The cell wall is permeable, that is, it absorbs nutrients in solution - for example, the sugar in a fruit juice. Yeast cells may be round, oval, or elliptical. Yeasts may reproduce by fission (cell division), by forming spores, or by budding, which is the most important reproductive method for yeasts of importance in food preservation. Yeasts may be aerobic, growing as a film or scum on the surface of a liquid, or anaerobic, growing without oxygen within a liquid. Yeasts require nitrogen in some available form (hydrolyzed proteins or peptone), an energy food like sugar, and certain vitamins, minerals, and other growth factors.



BUDDING SACCHAROMYCES CREVISIAE YEASTS

Figure 3

The growth of yeasts may be inhibited by temperatures above 35 C (95 F), by too little acid, or by lack of vitamins and other growth factors. Yeasts are generally killed by moist heat of 82 C (180 F).

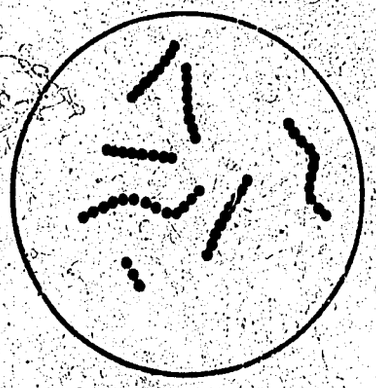
Bacteria: The most troublesome and dangerous of the food spoilage microorganisms are the bacteria. Molds may be inhibited by a lack of oxygen or of water, and yeasts by a high temperature, but some bacteria actually grow best under anaerobic conditions and at temperatures above 55 C (131 F).

Like yeasts, bacteria cannot be seen in or on food with the naked eye; their presence can be determined by observing the results of their growth - a sour taste, a slime or film or discoloration of the surface of a liquid, cloudiness or sediment within a liquid. But the most dangerous of all food bacteria, *Clostridium botulinum*, cannot be tasted and leaves no other obvious warning of its presence in a food. However, bacteria, like many yeasts and molds, are desirable or useful in the production and preparation of certain foods. For example, buttermilk, yogurt, sour cream, cottage cheese, and cream cheese are made by the action of certain bacteria (*Streptococcus cremoris*, *S. lactis*) on milk and cheeses and get their characteristic taste and texture by a similar bacterial fermentation.

Bacteria also are plants which do not have stems, roots, branches, or leaves. Each bacterium is a single cell. Most bacteria must absorb all the nutrients necessary for their growth, either as raw materials like ammonia or organic acids, from which the cells manufacture the protein or carbohydrate they need, or as more complex compounds like amino acids. Some groups of bacteria can synthesize some or all of the materials needed for growth, while other kinds of bacteria require an outside source of one or more specific compounds in order to live and develop.

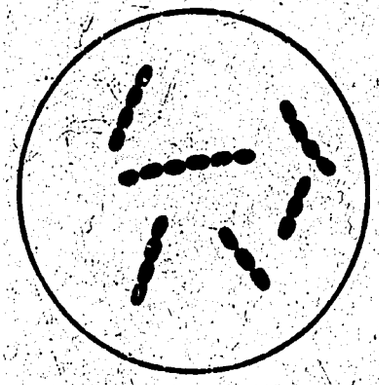
Some genera, *Bacillus* and *Clostridium* bacteria, produce spores which,

like mold spores, develop a dense cell wall and can rest in a sort of hibernation for a considerable period of time. Such spores can withstand temperatures or other environmental conditions that will kill the normal bacterial cells. When conditions become favorable, the spores then start development of a new bacterial colony



STREPTOCOCCI

Figure 4



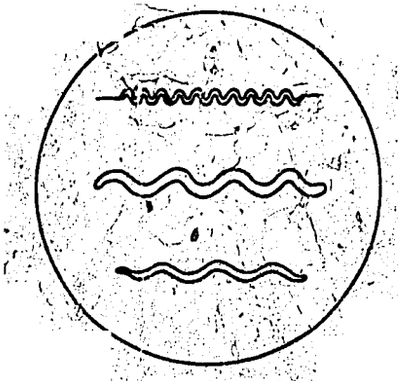
CHAINS OF RODS

Figure 5

Bacteria, because of their diversity, are classified in several different ways. One method is by shape - whether round or spheroidal, cylindrical or rod-like, or spiral.

The scientific names of bacteria are related to these three shapes: spheroidal bacteria being the *Cocci*, (Fig. 4).....

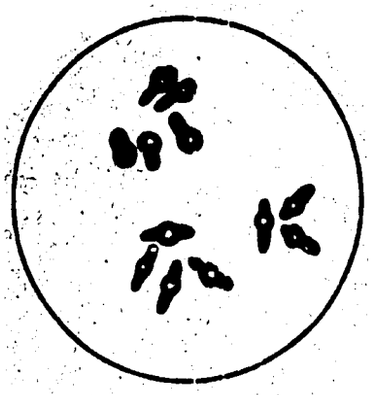
.....rod-like bacteria - the *Bacilli* (Fig. 5), and spiral bacteria - the *Spirilla* (Fig 6). Familiar *Cocci* bacteria include the *Streptococcus* and *Staphylococcus*, which are not of great importance in food canning operations because of their low resistance to heat.....



SPIROCHETES

Figure 6

.....Although some *Staphylococcus* organisms produce an enterotoxin that can cause food poisoning in such foods as potato salad or cream pies. Most of the bacteria that cause canned foods to spoil belong to the *Bacilli* group.



SPORING RODS
Figure 7

Temperature Requirements: An important method of classification of bacteria for persons concerned with food preservation is based on temperature requirements or preferences. Each bacterial species has an optimum temperature, that temperature at which it reproduces most rapidly, and a temperature range, that series of temperatures between a minimum and maximum in which it can grow normally. Bacteria which can grow well at temperatures ranging from 0 C (32 F) to 4 C (40 F) - refrigerator temperatures - are called psychrophiles or cold-resistant bacteria. While this group of bacteria grow well at these lower temperatures, their optimum temperature approaches a much warmer range of 15.5 C (60 F) to 38 C (100 F). Mesophiles are bacteria that grow well in a temperature range 15 C (60 F) to 50 C (122 F) and have an optimum temperature between 20 and 45 C (68 and 113 F). Those bacteria that have an optimum growth temperature of 55 C (131 F) or higher are classified as thermophiles - heat-resistant organisms.

Only two classes of bacteria, mesophiles and thermophiles, are of importance to food canning. Mesophilic bacteria spores are destroyed at temperatures and times employed in thermally processing foods to make them commercially sterile. Thermophilic bacteria spores are not generally destroyed at these temperatures and times because of their high resistance to heat. If foods were processed at temperatures and times sufficient to destroy thermophilic organisms, the palatability and nutritional value of the canned product would be substantially reduced. To control thermophiles with minimum damage to palatability and

nutritional value, canned processed food must be cooled to a temperature of 38 C (100 F) immediately after heat processing, and must be stored at temperatures lower than 40.5 C (105 F). Thermophilic bacteria do not produce a toxin that will cause food poisoning, but some do produce an acid that causes off-flavors in the food and thus cause food spoilage.

Oxygen Requirements: Another classification of bacteria of importance to food canners is based on oxygen requirements. Anaerobic bacteria cannot develop in the presence of oxygen (air); aerobic bacteria require molecular oxygen (air) in order to grow; facultative bacteria can grow with or without the presence of oxygen; and micro-aerophilic bacteria grow in an oxygen tension less than that in air.

Therefore, simply sealing up a can or jar does not guarantee that the food inside will be safe from all bacteria - those that are able to grow without oxygen will still be able to develop. In fact, some of the most dangerous, like *Clostridium botulinum*, cannot grow under any other condition. Also, spores of the spore-forming bacteria can withstand conditions unfavorable to other cells and may survive when the other cells are all destroyed.

The numerous other ways in which bacteria are classified will not be discussed here, but certain characteristics of bacteria that effect food canning procedures will be mentioned when those procedures are discussed later.

CHAPTER TWO

PRINCIPLES OF FOOD PRESERVATION

The purpose of preservation of food, by canning or any other method, is to delay the decomposition of the food (1) by its own natural enzymes - as fruits may ripen until they rot even if no spoilage organisms are present, and meats gradually *digest* themselves if kept too long uncooked or unfrozen - or (2) by the microorganisms which may develop in or on the food, as yeasts may discolor and ferment a fruit juice.

Basically, there are only two methods of keeping microorganisms from spoiling food: one is to prevent the microorganisms from getting in or on the food, or to remove those that are already there. The other method is to destroy the microorganisms or to inhibit their growth. To *kill* or *destroy* a microorganism, which cannot be seen, means to prevent it from reproducing even when growth conditions for that organism are favorable.

To accomplish the first prevention method, the food preserver takes all the sanitary precautions possible, as detailed in chapter 2. To accomplish the second, while the food preserver may try one or more of the food preservation methods given in the introduction, he will find that none of these alone is a certain and reliable method for removing or inhibiting <u>all</u> microorganisms that may be present; and none of these other preservation methods is as readily available and as applicable to as many foods as is the method called canning - heating a food hermetically sealed in a container until it is commercially sterile.

To understand why canning is the safest and most reliable method for preserving foods, it is important to know something about the way bacteria, in particular, grow and develop. First, the more bacteria that are present,

The more likely it is that some will live and grow and reproduce, no matter how much effort is put into removing or destroying them. Since a bacterial *infection* that will spoil a food requires a great many bacteria (perhaps millions or more), the fewer to begin with, the fewer present at any stage of development. The number of microorganisms present is referred to as the load, and the quality of a food is often measured in terms of the load of bacteria in it.

All microorganisms have an optimum as well as maximum and minimum temperatures for growth. As with any other group of living cells, some individuals in the group will have more resistance and some will have less resistance to the same set of environmental conditions. The food preserver must take measures that not only will kill the majority of microorganisms but destroy or inhibit the development of even the most resistant of the spores or cells that are present.

Microorganisms that have been grown in an unfavorable environment, one in which the lag phase has been extended, have greater difficulty in reproducing than do microorganisms coming from a more favorable environment. Therefore, the more unfavorable the environment for the microorganism, the better the chance to get a well-preserved, safe canned food.

One such combination of unfavorable factors of especial importance to the food canner is the relationship between temperature and time. As the temperature is increased, generally, the amount of time at which the food must be held at that temperature decreases. At 100 C (212 F) - boiling temperature of water at sea level), for example, it may take 20 hours to kill all spores of the thermophilic flat sour bacteria - that is, the food must be held at boiling for 20 hours. Such treatment would, of course, not leave the food palatable, or even recognizable! If the temperature can be

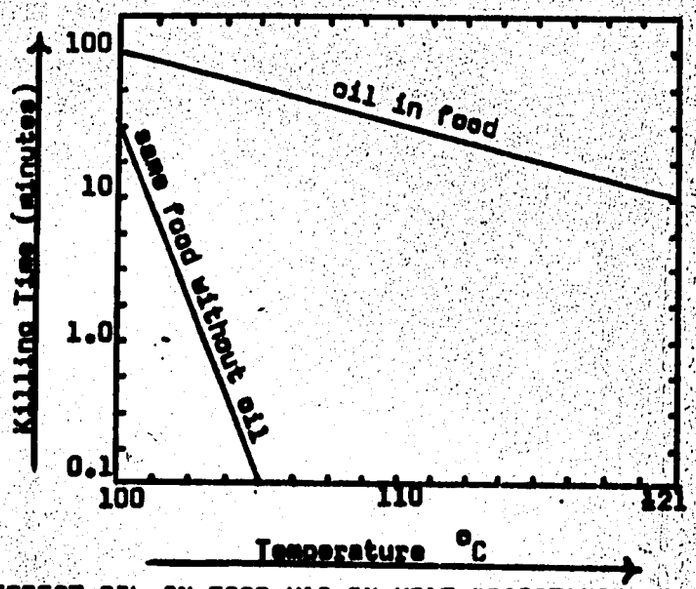
21, 22, 23, 24

increased to 130 C (266 F), however, such spores could be destroyed in only 3 minutes. It is not necessary to destroy all the thermophilic organisms if the canned foods are stored at temperatures below 38 C (100 F).

Factors Affecting Heat Resistance

Spores of most bacteria will be more or less resistant to heat, depending on a variety of other factors, including:

1. Age: heat resistance of spores varies with their age. Very young immature spores may be less resistant than mature ones. Generally speaking, dried spores of some bacteria which are often found in the air, soil, etc. are more difficult to kill by heat than those which are kept moist by their environment.



EFFECT OIL IN FOOD HAS ON HEAT RESISTANCE OF BACTERIA

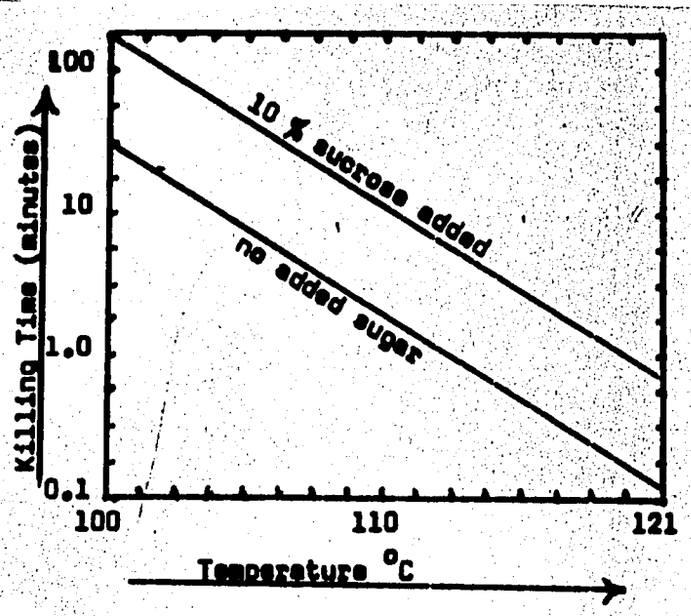
Figure 8

2. Composition of the growth medium: the presence of fat may increase heat tolerance because the fat in effect insulates the spore against heat, whereas a lack of calcium, iron, or other nutrients may decrease heat tolerance or resistance. More salt may mean fewer bacteria, but the effect of salt depends also on the concentration, the medium, and the kind of organisms. Increased sugar tends to increase heat resistance, as does increased protein.

3. Growth temperature: bacteria grown at temperatures much higher or lower than the optimum for that species may have less heat resistance than those grown at the optimum.

4. Physical nature of the Food: whether the food consists of large or small particles in a liquid or gravy, or is in the form of a puree, may affect the heat resistance of the bacteria present.

5. Recovery Medium: if the medium in which the bacteria are is nutritionally adequate or favorable, more bacteria are likely to survive the heat treatment.

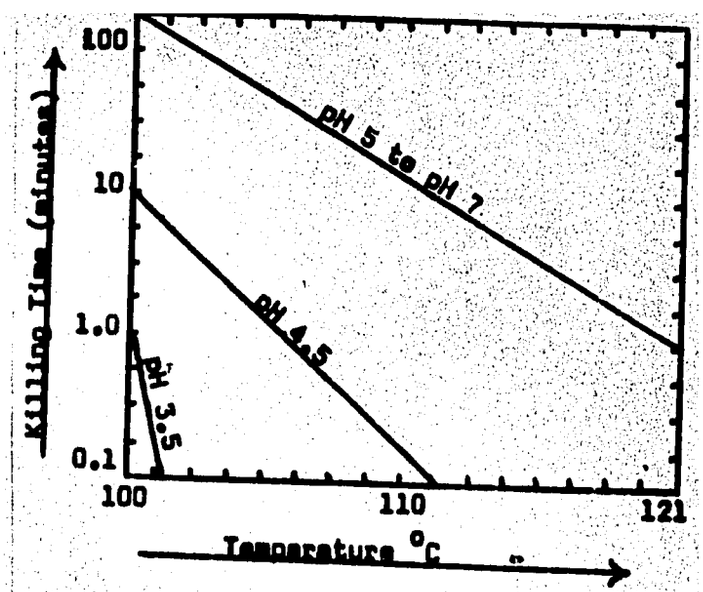


EFFECT ADDED SUGAR IN FOOD HAS ON HEAT RESISTANCE OF BACTERIA

Figure 9

6. pH: for spore-forming bacteria, a pH near neutral will cause the greatest heat resistance because it is a more favorable growth medium; in general, the lower the pH the less the required heat-time to destroy the bacteri

7. Lethal agents: chem cals, such as sulfur dioxide in fruit juice, will significantly decrease the heat resistance of micro-organisms. Other inhibitor



EFFECT pH OF FOOD HAS ON HEAT RESISTANCE OF BACTERIA

Figure 10

agents, depending on the food, are spice oils, (mustard, garlic, cinnamon, and extracts from edible plants).

8. Antibiotics, particularly nisin and subtilin: while heat resistance of microorganisms seems to lessen when antibiotics are added, the effect is variable

Heat Penetration

Anyone who has observed something being heated recognizes that the parts of the object being heated that are closest to the source of heat will get hot soone than the parts that are farther away. In order to ensure that all the food in a can has come to the proper temperature for the proper time, it is necessary to determine the point or place in the can which heats the slowest. When the food at that point reaches the desired temperature, then measurement of the time needed for the destruction of microorganisms can begin.

The point of slowest heating varies, depending on the composition of the food If the food is a liquid, heat is transferred by convection as the liquid boils setting up currents within the container of food. In conduction, heat passes from one molecule to the next; this form of heat transfer is characteristic of more solid pack foods. To measure the length of time for heat to reach the point of slowest heating in a container of food, special equipment is necessary. The time data for each product, type, style and size of container is then used in

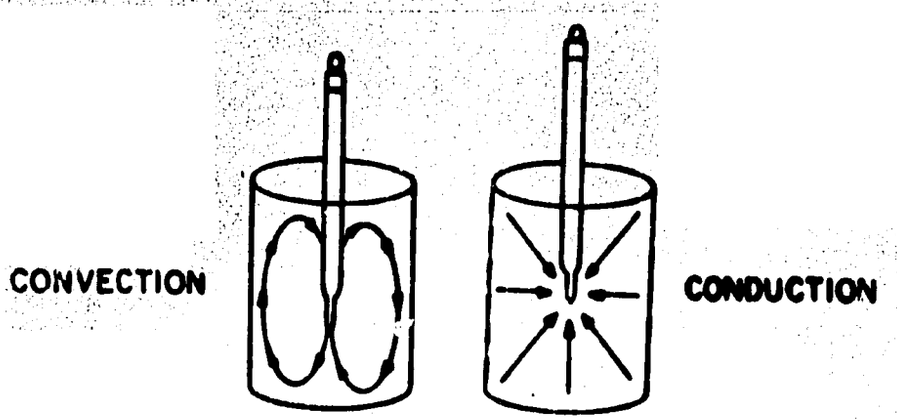


Figure 11. The Coldest Point of a Can Heated by Convection Is Between the Geometrical Center and the Bottom of the Can. The Coldest Point of a Can Heated by Conduction Is the Geometrical Center of the Can.

Figure 11

formulas by trained personnel in calculating the processing time and temperature. Except for the very large canning companies, most companies obtain this technical service from special laboratories. It is essential that such information be carefully followed, to ensure that foods are given the necessary heat treatment to ensure a safe and wholesome product.

For cans or jars heating mainly be conduction, that coldest point is at the geometrical center of the can (see Figure 11); for convection heating, the coldest point is slightly below the geometrical center, or about 1/3 of the way from the bottom of the can to the geometrical center. Thermocouples are used to determine such temperature gradients.

A number of factors affect the time required to get the food, at this coldest point, up to the required temperature, including:

1. the material of which the container is made - metal cans heat faster than glass jars.
2. the size and shape of the container -- large cans obviously heat to the geometric center more slowly than small or tall thin cans or jars.
3. the composition and physical state of the food -- small pieces in liquid such as peas or whole grain corn or slices of peaches or pears will heat more quickly because the basic heating mechanism is convection and because the smaller pieces heat through more quickly than do large pieces; pieces that cook soft or mushy, like pumpkin or creamed corn, will heat more slowly because the heat movement is mostly by conduction; and pieces that *layer* as asparagus layers vertically and so interferes with convection currents.
4. initial temperature of the food -- food which goes into the can at a higher temperature rises to the lethal temperature for bacteria more quickly than food which goes into the can cool.
5. rotation or agitation -- if the food is fluid, heat penetration is speeded by agitation or rotation of the cans, and such movement is helpful in processing foods that layer, like peach halves or tomatoes.

However, agitation may cause physical damage to some foods such as asparagus spears.

The removal of heat, or cooling, takes place by the same principles as heat penetration, but in reverse, of course. Rapid cooling of cans is necessary to ensure that the food is not overcooked and that thermophilic bacteria do not begin to grow (see 1, page 12). Glass jars must be cooled more slowly than metal cans, but should be cooled as rapidly as is safe.

A variety of methods and processes have been developed for determining the thermal process requirements for a particular food in a particular medium. The entire period during which the temperature of the food is rising above the maximum temperature for growth for the spore-forming organisms (say approximately 200 F) and the entire period during which the food is cooling from its maximum temperature back down to 200 F is the lethal time for that organism.

These methods include inoculation and trial process methods; graphical, formula and nomogram methods of mathematical calculation; and newer methods which take into account the total number of bacteria in the whole can. In all methods, a safety margin must be incorporated, to allow for a possible slower heating or cooling than expected.

The temperature and time chosen for a particular food canning process depends not only on the food, but also on the degree of sterility of the food before preparation, the kind of medium in which it is preserved, how and where it is to be stored, the kinds of microorganisms likely to be involved, etc.

Pasteurization

There are three basic methods for the heat treatment of foods, based on the highest temperature attained in the process. Pasteurization kills

29+30

vegetable cells or bacteria, molds and yeasts but not all of the microorganisms present, as it involves the use of temperatures less than 100 C (212 F) - boiling temperature of water at sea level. Such heat treatment may be by steam, hot water, dry heat (as in an oven), or electricity, and is used when boiling of the food would harm its quality (milk); when other preservative methods are to follow, as chilling milk or fermenting of fruit juices or cheeses; or when mesophilic (pathogenic) rather than thermophilic bacteria are the problem.

Atmospheric Thermal Processing

Heating at about 100 C (212 F) boiling) is a heat treatment safe for processing acid foods having a pH value below 4.6 such as sauerkraut or acid fruits or pickles; such a temperature may be attained by boiling the food and then packing into heated containers which receive no other treatment. Or the can or jar may be immersed in boiling water for a period of time or (rarely in home canning) exposed to steam.

Pressure Thermal Processing

Heating above 100 C (212 F) is usually accomplished in a steam pressure cooker, or retort. As pressure increases, temperature of anything enclosed in the cooker increases - this is the essential meaning of canning. The food in the cans in the cooker is held at a particular temperature-pressure combination for a particular time, which has been calculated on the basis of the kind of food, the size and kind of can, the sea level, the spoilage organisms to be guarded against, the storage and ultimate use of the canned food, and so on. Any food having a pH value above 4.6 must be thermally processed under pressure.

CHAPTER THREE

SOURCES OF CONTAMINATION

There are many natural and unavoidable sources of food contamination, which are present where the foods are grown or are a part of the process of harvesting those foods. The person who wishes to preserve the food in its best quality must see to it that the effects of these natural sources of contamination are minimized and that good sanitation practices are diligently exercised.

Contamination by Natural Sources

(1) The most important natural source of contamination is in the soil in which the food has grown or on which the animal has lived. Both great variety and great numbers of microorganisms are found in fertile soils, in the dust blown up from the soil, and in water which has flowed over such soil on its way to a river or lake. Microorganisms from soil are generally found in great numbers on the skin or outer covering of the plant, while the inner body tissues are generally quite free of microorganisms unless there has been insect, bird, or other damage. The surface skin of a tomato, for example, may have several thousands of microorganisms per square centimeter, and a cabbage's outer leaves may have one to two million microorganisms per gram. Foods for canning must be carefully washed in clean water before the skin is removed so that the proper heat process can be accomplished.

Other possible causes of contamination in foods grown in soil are the pesticides, herbicides, fertilizers, and other products which may have been used on or around the plant while it was growing.

Perhaps the most dangerous of all food spoilage microorganism, *Clostridium botulinum* is present in many soils and is found on foods grown in non-acid soils. If eaten on fresh vegetables, this bacterium does not harm children

and adults, but if millions of spores are allowed to remain on the food that is to be canned and the food is improperly heat processed, they may not all be destroyed and may live to grow and develop poison toxin in the canned food. Careful washing of raw foods in clean water, and protection from soil dust, are the first requirements in protecting the canned food from C. botulinum spores.

(2) Air is a second major source of contamination of foods, although air does not contain any microorganisms of its own - that is, all the microorganisms in air have come there accidentally, on a droplet of water or a grain of dust, and they do not grow while they are suspended in air. Coughing, sneezing, talking, sporulating molds (see chapter 1), water sprays, lint or dusts used around foods - are all vectors for getting microorganisms into air, where they may then fall into or on the food and begin to cause spoilage. In a canning plant air can be purified by passing it through a filter.

(3) Water is another major source of contamination of foods, partly because water is used in so many ways in the preparation and processing of the foods, including washing the food, cooking it, cleaning utensils, cooling the cans after processing, or washing the hands of food handlers. Water may become contaminated in many ways: by microorganisms picked up from soil as it flows over the soil on its way to the lake or river; by microorganisms introduced by animals (including man) which use the water for bathing, sewage treatment, laundering, cleaning, swimming, by the fish and other animals and plants which live in the water. An abundant supply of water which is safe for drinking is an essential requirement for preparing foods for canning.

Food becomes contaminated most frequently through man's activities. Use of untreated sewage as fertilizer, or use of waterways to carry away

untreated sewage, or industrial activities which use water to cool or clean the factory, are perhaps the greatest sources of contamination of both soil and water, as that contamination affects food.

(4) Animals cause many kinds of contamination directly, through the microorganisms that may be in their hair, hooves, or skins. Fish and other sea foods have a natural slime coating that is a potential source of contamination and spoilage. The major cause of animal contamination of foods, however, is from their body wastes, which may be heavily contaminated with coliform and other bacteria (which are necessary for the health of the live animal but cause trouble in water or soil) or with parasites. Animals may also cause contamination of food because of mechanical damage - bites which cause breaks in the skin and allow microorganisms to enter and grow.

Contamination During Handling and Processing

Food may become contaminated from natural sources before or during harvest, or contamination may occur during the handling and processing of the food. This additional contamination may come from equipment which comes in contact with the food, from packaging, and from people who handle the food or equipment.

(1) Foods which have been harvested at their peak of readiness for eating or preserving may, nevertheless, arrive at the canning plant in a less than perfect state, having been contaminated with spoilage organisms en route. If the crates in which oranges or tomatoes are packed are dirty or moldy, for instance, or contain spots of dried juice from the last use, it will be very easy for the fresh fruits to become contaminated. Or fruits

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with broken skins or bruised or spoiled spots or worm holes may contaminate perfect fresh fruits with which they have been packed. Obviously, fish or animal meats that have not been properly cleaned, with all viscera removed, carry their own potential spoilage organisms right with them. Foods that are not kept cool while being transported or stored before canning are more likely to develop spoilage (from enzyme action as well as microorganisms) than are properly chilled foods.

(2) Less obvious but very important potential sources of contamination in canned or preserved foods are the other ingredients that may be added. Sugars, starches, milk powders, and spices, in particular, may contain spores of thermophilic bacteria that can contaminate foods, which are in themselves perfectly safe or pure. Therefore, not only the food to be preserved but also the other ingredients added to make the food more tasty, more edible, or more capable of being preserved - the sugar in jelly, the dill seeds in pickles, the salt in tomatoes - must be handled with the same care as is given to the fresh food.

(3) The containers in which foods or added ingredients are stored, washed, cooked, and preserved, and the utensils which are used to handle or stir the foods, must be kept clean and sanitary, if not sterile. Containers and other utensils should be cleaned thoroughly after each use, before a new batch of food is added. Detailed directions are given later in this book.

It is especially important to be sure that, after canning foods containing fats - beef stew or vegetable soup - all utensils are carefully and thoroughly cleaned so that there is no residue of fat to contaminate the next batch or cause an off taste. It has been shown that materials like proteins and fats tend to protect microorganisms against heat.

(4) Workers who handle the foods must be clean and healthy - many foods can be contaminated by viruses or spores emitted by workers who cough, sneeze, or touch foods or utensils with hands that have not been washed or that have boils or sores on them. Canning plant supervisors must provide sanitary facilities that are regularly cleaned, and must see that workers in the plant maintain personal cleanliness and hygiene. Suggestions for training workers in hygienic habits and for maintaining a sanitary plant are given in subsequent chapters.

CHAPTER FOUR

SPOILAGE OF CANNED FOODS

Even though the cannery follows all the basic rules for sanitation and heat processing, it is always possible that some of its canned products will be defective or even spoiled. It is advisable, therefore, to run periodic checks on the canned products to ensure the safety and quality of the canned foods being produced. The sooner the defect or spoilage is found, the sooner the problem can be corrected and the fewer the canned foods that will suffer the same damage.

There are only two basic causes of microbial spoilage in canned foods: underprocessing and recontamination through leaking seams. However simple it may seem, at first thought, to correct such clear problems, these problems are actually quite a bit more complicated and perhaps cannot be solved simply by longer processing or tighter-made seams. For one thing, what causes a seam to fail in a can holding one kind of food may not cause any problem with a different food, with a different kind of can for the same kind of food, or under different storage, handling, or processing conditions. And, as we have seen earlier in this book, the kind of bacterial spoilage that can happen to a food depends on a number of variables - its acidity; presence or absence of sugar, salt, or fats; available moisture; temperature of processing or of storage; amount of contamination in the raw food or in other ingredients. Therefore, pinning down the specific cause of a specific spoilage event may be difficult, but it is essential nevertheless if the problem causing the spoilage is to be corrected.

Usually it is possible to tell that a can is spoiled or damaged merely by looking at it. That is, some kinds of spoilage may cause a change in the can appearance and because those changes are specific and characteristic, they have been given names. A normal can has flat ends; that is, they are

perpendicular to the sides of the can or even slightly indented (concave). If, when you increase the temperature of the can or strike the side of the can sharply, one of the ends bulges (becomes convex) the can is called a flipper. If the convex end is pushed in, the opposite end may bulge. If both ends are bulged (convex), the can is a springer, if one end will stay concave when pushed in. When both ends are bulged and can be dented but cannot be forced into the normal position, the can is sufferent from soft swell. When the bulges cannot be dented by hand pressure, the can is in the hard swell stage. By this point in the development of spoilage, the seams of the can may be showing some buckling or distortion. If the pressure inside the can continues to build, the can may burst at a seam, usually the side seam. A can with a tiny break, usually in a seam, that allows air or other gases to move in and out is termed a breather. Any can that exhibits these conditions is of course, assumed to contain spoiled food, that is, a food that is not safe to eat, even though it is possible that such spoilage has not occurred. When rust or discoloration appears on the can label or on the exposed metal of the can, spoilage of the contents has not necessarily happened; the rust or discoloration may have been caused by glue on the label or moisture during the storage and cooling of the can. However, such cans should be closely examined for possible interior damage.

Not all spoilage of canned foods causes the release of gases and the subsequent buildup of pressure that causes the bulges. Frequently there is no apparant damage; that is, the can looks normal and such spoilage must be determined by other means -- sight and odor.

Workers in the cannery should understand the various ways in which canned food may become spoiled, so that they can constantly be aware of the

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effect of their work and sanitary habits on the safety of the product.

(1) Canned food may become spoiled through the growth and development of microorganisms in the food that have somehow survived the heat treatment in numbers large enough to start a growth cycle. How could they have survived? For one reason or another, the can may have been underprocessed -- that is, it did not receive sufficient heat for a sufficient time. Underprocessing may occur when the retort is not properly vented or the containers improperly stacked in the retort crate, so that the saturated steam does not completely surround each container. The retort itself may be poorly designed or not operating correctly or the pressure-temperature gauges may be faulty, or there may be less acid in a particular batch of food than expected, so that the standard heat treatment is not as effective. For example, in recent years in the United States, new strains of tomatoes have been developed that are less acid than the older strains. They require heat processing for a longer time or at a higher temperature or pressure if they are to be safe -- the old recipe will no longer suffice!

Foods may also be underprocessed -- that is, the microorganisms capable of causing spoilage have not all been destroyed -- because the food has been contaminated during the processing itself by a buildup of the microorganisms in the equipment. If the equipment was poorly cleaned and a few microorganisms were left in it overnight, a time sufficient for a healthy start on the growth cycle, the first cans processed in the beginning shift the next day would be badly infected. If the buildup of microorganisms occurs during the day's processing, those cans processed at the end of the shift, just before cleaning of the equipment, would be most heavily infected. If the marking and labelling of the cans has recorded such facts, then it will be somewhat easier to determine the source of contamination.

The kind of spoilage caused by underprocessing is generally the fault of only one species of microorganism; if the food is a low or medium acid, probably a spore forming bacteria; if the food is acid, possibly a yeast or mold, or a non-sporing species of bacteria, or even a spore-forming bacteria that is *aciduric* (can endure acid conditions).

(2) A second kind of microbial spoilage is caused by <u>inadequate cooling</u>. Because a food may be rendered unpalatable if it receives too much heat for too long a time, the canner cannot always destroy every single spore of the thermophilic bacteria that may be present. Instead, he must rely on destroying most of the spores, and count on keeping any that may survive the heat treatment from multiplying by quickly cooling the cans to about 38 C (100 F) -- a temperature at which the thermophils are unlikely to develop. Such cans must also be stored in small units in a well-ventilated area to allow further cooling and drying.

(3) Microbes may enter the food after it has been heat processed, if there is even a tiny break in a seam. In fact, such spoilage has been the greatest economic loss in many plants. Microorganisms enter through breaks in the can seams most often during the water-bath cooling -- thus it is essential that the water used for the cooling bath be safe to drink (potable) so that as few microorganisms as possible are available to enter the cans. Breaks in the can seams may, of course, be caused by rough handling, either in the retort or later, and if the still-wet cans are touched by the hands of workers, microorganisms on the skin may enter such breaks.

(4). When some of the ingredients in a can are precooked, such as the meat for a stew, and such precooked foods are allowed to stand for a period of time before being combined with the other ingredients and heat processed, microorganisms in the precooked food may have ample time and favorable conditions for development. Precooked ingredients, therefore, should be chilled until ready to be added to the cans for exhausting and heat processing, or should be used (canned) immediately after being cooked.

Some chemical spoilage may not actually harm the food. The food may become discolored because of a reaction with the material of the can, or develop an off-flavor or off-odor, or the interior of the can itself may become discolored. Such problems are termed hydrogen swell because of the release of hydrogen gas when the acid of the food reacts with the iron of the can, and foods so affected should be suspected of spoilage.

Another kind of spoilage is caused by physical damage to the cans, and may not necessarily affect the food within. Again, however, foods in such cans are suspect. When the steam pressure in the retort is reduced too rapidly after the completion of the heat treatment, the can may swell or buckle because of its internal pressure. The can may swell because of under-exhaustion; that is because all the air and other gases in the food were not removed (exhausted) before the can was sealed. The high temperature during processing causes the gases left in the food to expand and bulge the can. A third physical cause of swells or peaks is simple over-filling; as the food's temperature increases, the food expands, building up pressure against the sides and ends of the can. Panelling may occur, especially with large cans, when a high vacuum has

been created in the containers during exhausting and/or sealing under vacuum or steam atmosphere thus causing the atmospheric pressure to force the sides of the containers inward. The same difficulty can occur when containers are cooled under too high air, steam or water pressure.

Stack burning is another form of food spoilage. It occurs when cans of food are placed in shipping cases and the cases are stacked in warehouses before the cans have been thoroughly cooled after processing. When stack burning does occur the can contents become soupy, darken and take on an off-flavor. Care should be taken to cool all cans to at least 37.7°C (100°F) before placing them in cases.

Quality Control, then, helps insure that the canned food will be safe, palatable, and tasty, and that the can it is processed and stored in will protect the food rather than allow it to become spoiled - which is, of course, the idea behind canning.

CHAPTER FIVE

ESTABLISHING A CANNING PLANT

Before any serious consideration is given to the establishment of a canning plant, it is necessary to determine that there will be an adequate supply of raw products. An adequate supply means enough to keep the plant operating at an efficient level after the usual demand for fresh food has been supplied. It would be wise to prepare a chart similar to Figure 1 in Appendix in order to determine the season in which the canning plant is likely to be used. Naturally, the longer the canning season, the greater the chance for the plant to be a useful project. After the availability of the raw materials has been determined, it is necessary to study the need or market for the canned food. If it is to be operated as a cooperative plant, there must be enough families with a desire to can food for their own use to justify the cost of the plant. As used in this manual, the term *cooperative plant* refers to plants which are run almost as a public utility. They are frequently built by the individuals who plan to use the facilities or, more often, by the government. Such plants do not seek to make a profit.

Cooperative plants may be organized and financed by local groups of people or they may be financed wholly or in part from public funds. Such matters are naturally determined by local policies, but it may be of interest to point out some of the procedures followed in the United States. Usually the local canning plants are built by the county, parish, township, or city governments. Frequently in the past, many of the canning plants were tied in with high school educational programs. In such instances, the supervision of the plants was often carried out by the high school agriculture instructor and by the high school home economics instructor. These plants were built and used for the primary purpose of youth and adult education in preserving food. More recently, however, in addition, these plants

are used as canning centers for the community in which they are located. The plant is usually part of the high school and is used for canning instruction of the high school students. The more recent trend in the United State is that now the local governing bodies are placing the supervision of the plants under local individuals who have received special training in operating community canning plants. Under the new requirements regulating community canning centers, trained personnel are required to be present in the plant at all times that the plant is in operation.

The cost of using the facilities includes the cost of the cans and the operating costs of the canning plant. It may or may not include a charge to pay the salary of the supervisor and other necessary assistants. It usually does not include the cost of the building and equipment. The charges in plants of this type do not include a profit for the plant operators; they represent only the costs of operation. Some plants of this type charge a flat fee regardless of the type food being processed, while others make a differentiation in charges for different foods depending upon the length of time required to prepare and process the food. To process and can 24 containers of tomato paste will require considerably more time and energy than to can an equal number of whole canned tomatoes. Cost will vary with the size of container in all canning plants. Most plants charge patrons a slight extra amount for the use of special equipment such as pea shellers and corn cutters.

A considerable part of this manual is devoted to a discussion of the canning plant as a commercial enterprise. Nevertheless, the manual is intended as a guide for the establishment of a cooperative plant. The inclusion of the material on commercial operations is thought to be the best way

to explain the overall economics of the canning operation. It should be remembered that the cost of operating the two types of plants is actually closely related. The primary difference being in the fact that the cooperative plants do not have to stock a large inventory of finished goods, and they do not have to have a large labor supply and reserve capital for operation during emergency periods. The cooperatively operated plants do not have to provide a storage space for the finished canned goods, and hence, there is some saving in the initial cost of the plant. In the cooperative plant, the patrons perform most of their own labor, and they grow or purchase their own raw products. Consequently, the apparent cost of the canned goods in the cooperative plant is much less than in the commercial plant. Actually, however, the individual patrons make up most of the difference. In most cases, the use of an individual's time allows him to have a supply of canned goods at a price he can afford.

In spite of the subordinate role given to commercial plants in this discussion, they may be the most practical type of canning facility in some areas. If the economy of an area is sufficiently well established for the citizens to purchase canned goods, a commercial plant should be considered. This is particularly true in areas which include sizeable non-agricultural populations. If a commercial plant appears desirable, an attempt should be made to interest private capital in building and operating one.

In some instances in the United States, groups of individuals will pool their resources and establish a canning plant for their own use and the use of the public. In general, such plants are run to make a profit. Even the persons who establish the plant pay the standard amount for the use of the facilities. Periodically the profits of such a plant are split among the persons who own the plant. Such an arrangement may make possible

the establishment of a canning plant in cases where the local government is unable to undertake the project. The persons who help establish the plant have the facilities available for their own use and at the same time the plant serves as a public benefit, providing excessive charges are not made to general users. The profits derived from such ventures are not especially large but they should more than repay the organizers' costs if the demand for the use of the plant is substantial and the plant is well managed.

Some cooperatively run plants permit persons to use the canning plant even though they do not have the money to pay for use of the facilities. In such cases, a portion of the person's canned goods is given to the canning plant instead of money. The canning plant then sells the goods just as a commercial plant would. It is possible that an arrangement of this type would be practical in many places where the families using the canning plant do not have adequate funds.

After establishing the need and the decision has been made on the type of canning plant that would be most feasible to meet that need, consideration must be given to its location. The location will depend upon several important factors: 1) adequate supply of potable water, 2) sufficient-sized tract of land having good drainage to build the plant with parking areas and to locate waste disposal systems, and 3) accessibility to the patrons, labor, markets, power and fuel supplies.

CHAPTER SIX

ECONOMICS OF CANNING OPERATIONS

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Canning operations and procedures can be carried out with small equipment such as that used in home canning or with much larger equipment as is used in industrial plants. The costs of performing the canning operations in three differently sized and equipped plants, operated for single 8-hour shifts or for two 8-hour shifts per day, under commercial and cooperative operation, will be shown in this chapter. The effect of the use of labor saving food preparation equipment will be shown in the larger plant C, the smallest plant in which the equipment would be justified.

In comparing the three plants, the following assumptions are made:

1. Equipment costs are based on 1977 prices for equipment in United States. The estimated costs include overseas freight, but not packaging for shipment.
2. Labor rates are the same as those found in typical, small-size canning plants in the United States.
3. Individual workers work 8 hours per day, 5 days per week and 6 months per year.
4. The smallest plant would be unable to afford steam-generating equipment. Both the smallest and middle size plants would not be able to afford labor-saving equipment.

It should be noted that with the assumed labor costs and other factors, canned goods would be excessively expensive in plant A operated commercially.

Under some conditions, however, this plant may prove to be a practical commercial plant, by utilizing *local* labor.

The three types of plants are discussed primarily to illustrate the use of the various types of equipment available for processing. The capacity of either plant B or plant C can be increased or decreased considerably. While the operation of plant A can be increased in size, it would probably be preferable to use a plant similar to plant B or plant C rather than greatly increase plant A beyond its capacity when utilizing two shifts.

In the cooperative operation, the patrons furnish all raw products, except additives, most of the direct labor, and storage for the canned products.

A table listing the items of equipment and new costs available to the plant is given for each of plants A, B and C. Also, a schematic diagram of each of the plants is provided. In addition, seven tables are given for each of the 16 cases presented involving the three plants.

In plants such as these it is assumed that individual workers would be given primary responsibility for a given operation and a secondary responsibility to help out in other operations as needed, as long as such assistance would not jeopardize the operation for which they had primary responsibility.

Times given in tables entitled, "Unit Times for Processing No. 2 Cans," are the times required to prepare, fill, exhaust, seal, etc. as many cans as are in a single processing unit, pressure cooker or retort. Thus, for plant A which uses three 39.4 liter (41.5 Quart) pressure cookers, holding 36 No. 2 cans, all times except those for processing and cooling would be multiplied by three to obtain the man-minutes required to complete one cycle of processing in the plant. In plant A, it is assumed that only 6 cycles can

TABLE I

COMPARISON OF ITEMS OF COST IN SIXTEEN DIFFERENT TYPES OF PLANT OPERATIONS

Type of Plant Operations	Fixed Capital	Working Capital	Total Capital	Direct Labor	Indirect Labor	Total Labor	Overhead	Unit Cost	Capacity Number of No. 2 Cans/Season
	Dollars								
Commercial									
Plant A									
1 Shift	34,145	59,529	93,674	31,853	12,000	43,853	19,410	.8243	81,648
2 Shifts	39,710	115,177	154,887	63,706	18,000	81,706	29,364	.7664	163,296
Plant B									
1 Shift	100,608	161,497	262,105	53,222	23,285	76,507	46,642	.5025	326,340
2 Shifts	106,428	306,193	412,621	106,445	34,927	141,372	68,730	.4649	652,680
Plant C									
1 Shift	170,036	295,072	465,106	100,397	23,285	123,682	61,757	.4449	652,680
2 Shifts	187,557	572,544	760,101	200,794	34,917	235,711	92,970	.4215	1,305,360
Plant C - Optional Equipment									
1 Shift	183,591	278,120	461,711	74,189	23,285	97,474	64,600	.4095	652,680
2 Shifts	201,112	538,955	740,067	153,618	34,917	188,536	95,813	.3876	1,305,360
Cooperative									
Plant A									
1 Shift	28,580	17,406	45,986	5,645	12,000	17,645	23,634	.4450	81,648
2 Shifts	28,580	33,407	61,987	11,290	18,000	29,290	37,914	.3877	163,296
Plant B									
1 Shift	94,788	62,067	156,855	11,963	23,285	34,978	55,746	.3263	326,340
2 Shifts	94,788	118,657	213,445	23,386	34,917	58,303	87,588	.2897	652,680
Plant C									
1 Shift	152,516	115,874	268,390	11,693	23,285	34,978	68,048	.2598	652,680
2 Shifts	152,516	227,847	380,363	23,386	34,917	58,303	105,527	.2363	1,305,360
Plant C - Optional Equipment									
1 Shift	166,071	116,156	282,227	11,963	23,285	34,978	71,084	.2644	652,680
2 Shifts	166,071	228,162	394,233	23,386	34,917	58,303	108,613	.2387	1,305,360

be completed per shift; but, in plant B and plant C, 7 cycles should be completed per shift. In plant A, 648 No. 2 cans can be processed in an 8-hour shift, compared with 2,590 in plant B, and 5,180 in plant C. In plant A, it requires 12 workers in the direct labor force compared with 20 in plant B and 38 in plant C without labor saving equipment. With labor saving equipment in plant C, the labor force was reduced to 28 per shift.

Table I ,"Comparison of Items of Cost in Sixteen Different Types of Plant Operations," compares certain items of cost for the 16 cases presented. The table shows that capital requirements increase as plant capacity increases but not as fast, thus making more efficient use of capital at the higher plant capacities. In comparing the commercial operations of plants A and C, when operated on an 8-hour shift basis without optional equipment, it can be seen that as daily volume increased from 648 to 5,180 cans or 8 times, fixed capital increased 5.0 times and working capital increased 5.0 times.

At the same time, total overhead costs increased from $19,410. for plant A to $61,757. for plant C or 3.2 times. The over-all costs of canning dropped from $0.8243 per No. 2 can in plant A when operating commercially one shift per day to $0.3876 per No. 2 can in plant C operating commercially 2 shifts per day with labor saving equipment. This is a reduction of 53% in unit costs.

With these plants operating as cooperatives the building costs were less because of no need for inventory storage. Working capital was lower because of patron furnishing of the raw produce and most of the general labor. The volume of product canned in one shift increased 8 times as in the commercially

operated plants while fixed assets capital increased 5.34 times and working capital increased 6.66 times. Direct labor was always a small factor in the cooperative plants as most of the general labor was furnished. Direct labor increased from $5,645. in plant A to $11,693. for plant C or 2.04 times. Total labor increased from $17,645. for plant A to $34,978. for plant C or 1.98 times. Total overhead increased from $23,625. for plant A to $68,043 for plant C or 2.88 times while overall unit cost decreased from $0.4450 in plant A, operating on a one shift basis to $0.2363 in plant C on a two shift basis without optional equipment or a reduction of 47%. While the labor saving equipment used in plant C reduced canning cost by more than 3 cents per can in the commercial operation, the cost in the cooperative operation was increased by $0.0046 per can. However, patrons might prefer the labor saving equipment, as they saved only $0.24 per hour by foregoing it.

THE ECONOMICS OF OPERATING CANNING PLANT A COMMERCIALLY

It is estimated that plant A, utilizing elementary utensils, three pressure cookers, 39.4 liters (41.5 liquid quarts) capacity, and three atmospheric cookers, 33.25 liters (35 liquid quarts) capacity, can produce approximately 648 No. 2 cans per 8-hour day. If the plant operates six months per year (126 work days), the annual production will be 81,648 No. 2 cans.

Land Requirements

Important considerations should be given in selecting the site for a canning plant. Guidelines for selecting building sites are given in Chapter 7, "Selection of Plant Site." Suitable sites are usually located on

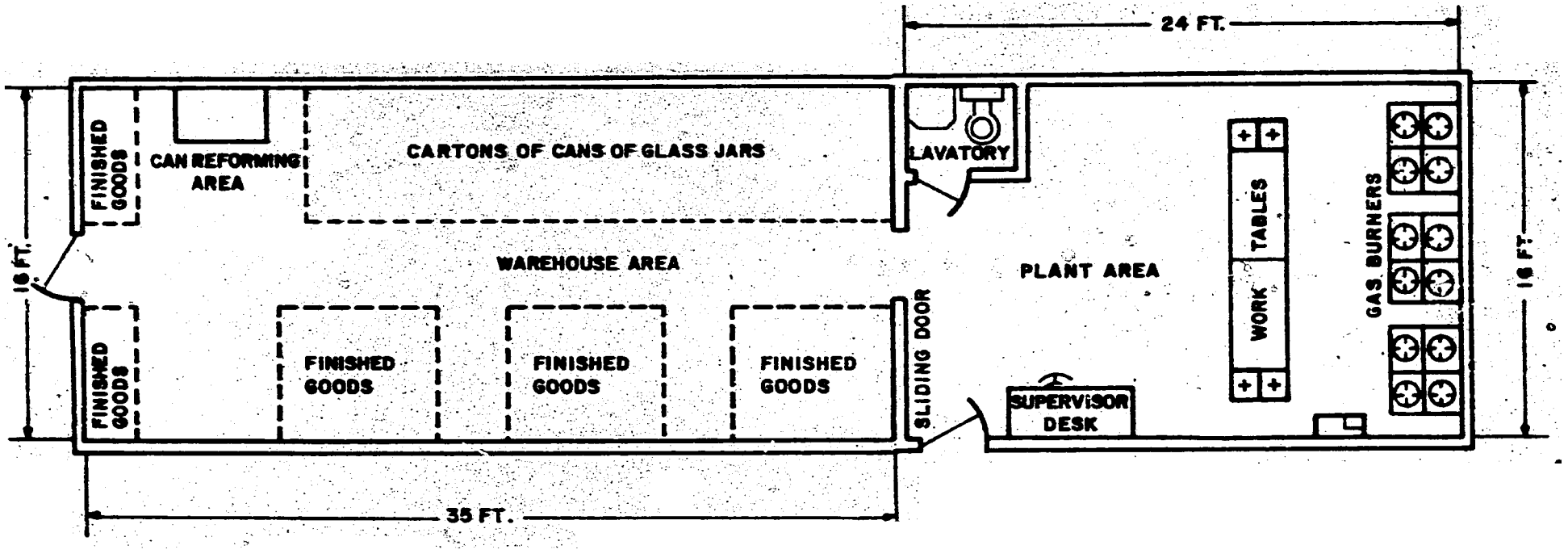

Figure 12 Layout forcPlat A

relatively inexpensive land which is not near highly populated areas. It is estimated that the land required for plant A may be acquired for $1,500.00.

Building Requirements

Major considerations need to be given in planning a building on the proper site. These are size and design. The next consideration is its construction, see Chapter 10, "Building Construction." A one-story masonry type structure having a minimum ceiling height of 4 meters (13 ft.) is the most desirable type of building. A schematic diagram of a suggested floor plan for plant A is given in Figure 12. Plant A should have at least 55.75 square meters (600 sq. ft.) of floor area in the processing room and 118.9 square meters (1280 sq. ft.) of floor space in the storage and warehouse areas. The cost of building this type and size building for plant A would be approximately $28,200.00. This type of structure can be built in the United States for approximately $161.50 per square meter ($15.00 per sq. ft.) of floor space.

Equipment Requirements

The basic production equipment and office furniture and equipment necessary to operate plant A are itemized in Table 11, "Equipment Requirements for Plant A." The production equipment for this small canning plant using elementary utensils costs approximately $6,237. which does not include packing costs, but does include installation and 15% of the total cost for overseas shipment. A description of specialized equipment is given in the Chapter 12, "Equipment Description." Many items of equipment can probably be purchased locally at a saving to the prospective plant owner.

TABLE II

Equipment Requirements for Canning Plant A

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
1	3	39.4 liters (41½ Liquid qt.) Pressure Cookers	$132.00	$396.00
2	12	Natural or artificial Gas Burners, 25,000 BTU/hr.	20.00	240.00
3	2	Hand Sealer set to close No. 2 Cans, size 307 x 409 complete with regular equipment	340.00	680.00
4	2	Chuck & Base Plate for 2½ Cans, size 401 x 411 (one for each sealer).	60.00	120.00
5	3	Atmospheric Cooker complete with rack, lid and thermometer, 33.25 liters (35 qt.) liquid capacity.	60.00	180.00
6	3	19 liters (5 gallon) Aluminum Stock Pot.	35.00	105.00
7	3	Cover for 19 liter (5 gallon) Stock Pot.	9.00	27.00
8	2	Style "A" Stainless Steel Table, 0.82 meters (33 inch) x 1.725 meters (69 inch)	400.00	800.00
9	2	Sink Rack	30.00	60.00
10	2	Two Compartment Stainless Steel Sinks, Each Compartment .45 meters (18 inch) x .45 meters (18 inch) x .35 meters (14 inch)	260.00	520.00

TABLE II (Continued)
Equipment Requirements for Canning Plant A

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
11	1	Flange reformer for No. 2 Cans	$ 30.00	$ 30.00
12	1	Flange reformer for No. 2½ Cans	30.00	30.00
13	3	Dish Pan, Aluminum 11.4 liters (12 qt.) capacity	23.00	69.00
14	6	Dish Pan, Aluminum 20 liters (21 qt.) capacity	39.50	237.00
15	3	Bucket - 15.2 liters (16 qt.) S/S	25.00	75.00
16	2	Dipper, 0.95 liters (1 qt.) capacity S/S	17.00	34.00
17	4	S/S Dipper, 1.9 liters (2 qt.) capacity	19.00	76.00
18	2	Boning Knife, 15 cm (6 in.) High Carbon Steel Blade	3.00	6.00
19	6	Paring Knife, 8.125 cm (3¼ in.) High Carbon Steel Blade	2.25	13.50
20	3	Solid Stainless Steel Spoons	5.00	15.00
21	3	Funnel - S/S 15 cm (6 in.) diameter	8.50	25.50
22	1	62.5 cm (25 in.) Meat and Bone Saw	15.00	15.00
23	3	Hot Lift Tongs	5.00	15.00
24	1	Heavy Duty Plastic Garbage Can with cover	36.00	36.00
25	2	Cutting Boards, 30 cm (12 in.) x 45 cm (18 in.) x 5 cm (2 in.) thick	30.00	60.00

TABLE II (Continued)
Equipment Requirements for Canning Plant A

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
26 Optional	1		$1200.00	
Optional	1		2000.00	
27 Optional	1		2185.00	
			306.00	
28	1		300.00	300.00
29	1		250.00	250.00
30	2		14.00	28.00
31	1		200.00	200.00
	2		54.00	108.00
32	1		35.00	35.00
33	3		27.00	81.00
34	1		14.00	14.00
35	1		10.00	10.00
36	1		22.00	22.00
37	1		50.00	50.00
38	1		20.00	20.00
39	1		6.00	6.00
				$4,989.00

TABLE II (Continued)
Equipment Requirements for Canning Plant A

Item Number	Quantity	CAPITAL EQUIPMENT Description	Example Price Only Unit	Example Price Only Total
		OFFICE		
40	1	Desk and Chair	$325.00	$325.00
41	1	Typewriter	300.00	300.00
42	1	File Cabinet	75.00	75.00
43	1	Calculator	200.00	200.00
44	2	Chairs	75.00	150.00
		TOTAL COST OF OFFICE EQUIPMENT		$ 1,050.00

TABLE II (Continued)

Equipment Requirements for Canning Plant A

Item Number	Quantity	EXPENDABLE EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
45	3	Exhaust Test Thermometers -17.8-104.4 C (0-220 F)	$ 11.00	$ 33.00
46	6 pair	Cotton Gloves	3.00	18.00
47	3 pair	Rubber Gloves - Thin Canner's Type	2.00	6.00
48	2	Extra Meat Saw Blades	1.50	3.00
49	2	Pot Brushes	2.25	4.50
50	3	Vegetable Brushes	3.00	9.00
51	1	Metal File	5.00	5.00
52	2	Brooms	5.00	10.00
53	2	Mops	5.00	10.00
54	1	First Aid Kit	20.00	20.00
		TOTAL COST OF PLANT EXPENDABLE EQUIPMENT		$ 118.50

TABLE II (Continued)

Equipment Requirements for Canning Plant A

Item Number	Quantity	EXPENDABLE EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		OFFICE		
55		Record Books, Forms and File Folders	$ 75.00	$ 75.00
56		Stationery	25.00	25.00
		TOTAL COST OF EXPENDABLE SUPPLIES		$ 100.00

TABLE III

SUMMARY OF EQUIPMENT COST FOR PLANT A

CAPITAL		
Plant	$4,989.00	
Plus 15 % for Overseas Freight (Estimated)	748.35	
Subtotal		$5,737.35
Office	$1,050.00	
Plus 15 % for Overseas Freight (Estimated)	57.50	
Subtotal		1,207.50
TOTAL CAPITAL EXPENDITURES		$6,944.85
EXPENDABLE		
Plant	118.50	
Plus 15 % for Overseas Freight (Estimated)	17.78	
Subtotal		136.28
Office	100.00	
Plus 15 % for Overseas Freight (Estimated)	15.00	
Subtotal		115.00
TOTAL EXPENDABLE EXPENDITURES	$	251.28

The office furniture and equipment required in Plant A cost approximately $1,200. Used equipment and furnishings, when available, can probably be purchased locally at considerable savings.

Labor Requirements

For estimating the labor requirements for plant A, Table IV, "Estimated Unit Times for Processing 108 No. 2 Cans in Plant A" was used. The times appearing in the table are the average times required for the various operations involved in canning a number of different fruits and vegetables. Although the actual times vary from product to product, the average times were used for estimating plant capacity. In using these times, it was estimated that an average of six cycles for each pressure cooker could be made within an 8-hour day.

TABLE IV

ESTIMATED UNIT TIMES FOR PROCESSING 108 NO. 2 CANS IN PLANT A
(3 pressure cookers)

Operation	Description	Example (Man Minutes)	Your Plant (Man Minutes)
1	Food Preparation	540	
2	Rinsing and Straightening Cans	30	
3	Preheating the Product	45	
4	Filling Cans	60	
5	Exhausting Cans & Adjusting Headspace.	45	
6	Sealing & Coding Cans	54	
7	Processing & Cooling	73	
8	Wiping & Labeling Cans	48	
	Total Man Minutes - 3 Pressure Cookers per Cycle.	895	

When canning plant A is operated commercially 12 persons are required for production and one to serve as plant supervisor. A summary of the total direct

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and indirect labor costs per hour is given in Table V, "Labor Requirements for Plant A Operated Commercially" and annual labor costs in Table VI, "Annual Labor Cost for Plant A Operated Commercially." For calculating annual labor costs it is assumed that the direct labor is retained only for a 6 month canning season. The plant supervisor is employed for the full year. This is the only direct labor plant A employs when it operates commercially because it is assumed that one of the 12 direct labor employees would be trained as a semi-skilled laborer for certain critical operations.

TABLE V

LABOR REQUIREMENTS FOR PLANT A OPERATED COMMERCIALLY

Direct Labor:					
Food Preparation and General	11	$2.60	$28.60	$_____	$_____
Semi-Skilled	1	3.00	3.00	_____	_____
Total Direct Labor	12		$31.60		$_____
Indirect Labor:					
Plant Supervisor	1	$5.95	$5.95	$_____	$_____

TABLE VI

ANNUAL LABOR COST FOR PLANT A OPERATED COMMERCIALLY

	Hours per Year per Person	Plant Hourly Cost	Plant Annual Cost Example	Plant Annual Cost Your Plant
Direct Labor	1008	$31.60	$31,853.00	$_____
Indirect Labor	2016	5.95	12,000.00	_____
Total Annual Labor Cost			$43,853.00	

Capital Requirements

In addition to the capital required to purchase the land, the building, and the equipment, it is necessary that the prospective owner have additional capital to buy raw materials, for payment of wages, etc. This additional capital is known as "working capital." The working capital should be sufficient to operate the plant until it begins to realize a profit. In effect, it is money set aside to insure that the canning operation will have a chance of proving itself.

TABLE VII

CAPITAL REQUIREMENTS FOR PLANT A OPERATED COMMERCIALLY

Item	Example	Your Plant
Fixed Assets:		
Land	$ 1,500.00	$
Building	25,200.00	
Plant Equipment	6,237.00	
Office Furniture and Equipment	1,200.00	
Total Fixed Assets	$34,145.00	$
Working Capital:		
Raw Materials - 1 month	$ 701.00	$
Cans, Cartons, Labels - annual	11,839.00	
Labor:		
Direct - 1 month*	5,309.00	
Indirect - 2 months*	2,000.00	
Other Expenses - 1 month**	617.00	
Inventory of Canned Products***	33,651.00	
Sub-Total of Working Capital	54,117.00	
10% of Working Capital for Contingencies	5,412.00	
Total Working Capital	$59,529.00	$

* See Table VI.

** See Table IX total annual overhead expense less indirect labor.

*** One-half of annual production multiplied by unit cost = See Table X.

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Ownership Costs

Ownership cost includes interest on investment in land, interest and capital retirement on buildings, plant equipment, office furniture and equipment, insurance, property taxes, and interest on one-half of working capital for 6 months. There is more involved in calculating the cost to the owner for the investment in fixed assets than a straight line depreciation. Generally, portable fixed assets have some salvage or sale value, in the magnitude of 10% of the total cost, at the end of the depreciation period, which may be 10, 15, or 20 years. Fixed assets, such as, permanent buildings are usually given a longer depreciation period with little or no remaining salvage value. On the other hand, land on which the buildings are located usually appreciates rather than depreciates, consequently, land is not generally depreciated in determining ownership costs. True ownership costs not only include the cost of depreciation but interest on the amount invested in fixed assets. Therefore, if fixed assets are depreciated over a long period of time, such as,30 years, the interst cost will be greater than if the fixed assets were depreciated for only 15 years. To determine the ownership costs due to depreciation and interest on the investment of fixed assets, the Table I, "Annual Charge for Capital Recovery and Interest for each Dollar of Investment" in Appendix , is used to obtain a calculated mathematical factor for a given number of years at a specified interest rate. This factor from the table is multiplied by the amount of the original investment less its estimated salvage value. The product of this calculation

plus the interest on the salvage value then becomes the annual cost of retiring the investment for a particular fixed asset. Insurance and property taxes are other ownership costs connected with buildings and equipment.

Illustration:

$5,000.00	Purchase Price of Equipment
500.00	Estimated Salvage Value of Equipment at 10% of Cost
$4,500.00	Capital to be Recovered in Plant Operating Costs
0.149	Factor from Table I, Based on 10 Years Depreciation at 8%
$ 670.50	Annual Recovery of both Capital and Interest
40.00	Interest at 8% on the $500.00 Salvage Value
$ 710.50	Total Amount to be Charged to Annual Ownership Costs

Ownership costs are summarized in Table IX, "Annual Ownership Costs for Plant A Operated Commercially."

TABLE VIII

ANNUAL OWNERSHIP COSTS FOR PLANT A OPERATED COMMERCIALLY

	Example	Your Plant
Interest on Land at 8%	$ 120.00	$
Interest and Capital Retirement:		
Building - 30 yr. Depreciation, no Salvage at 8%	2,238.00	
Plant Equipment - 10 yr. Depreciation, 10% Salvage at 8%	882.00	
Office Furniture and Equipment - 16 yr. Depreciation, 10% Salvage at 8%	133.00	
Insurance and Property Taxes	531.00	
Interest on One-half of Working Capital for 6 months at 8%	1,191.00	
Total Ownership Costs	$5,095.00	$

Annual Overhead Expense

Annual overhead expense consists of ownership costs, indirect labor cost, fuel, utilities, factory materials, office supplies and miscellaneous items. These costs are summarized in Table IX, "Annual Overhead Expense for Plant A Operated Commercially."

TABLE IX

ANNUAL OVERHEAD EXPENSE FOR PLANT A OPERATED COMMERCIALLY

	Example	Your Plant
Ownership Costs	$ 5,095.00	$
Labor:		
Indirect	12,000.00	
Fuel	1,174.00	
Utilities	450.00	
Factory Materials - Repairs, Parts, etc	541.00	
Office Supplies and Miscellaneous	150.00	
Total Overhead Expense	$19,410.00	$

Unit Cost for Processing No. 2 Cans

In plant A when operated commercially at full capacity, the cost for manufacturing, selling and distributing No. 2 cans amounts to $0.8543 per can. A breakdown of this cost is given in Table X, "Unit Cost for Processing No. 2 Cans in Plant A operated Commercially."

TABLE X

UNIT COST FOR PROCESSING NO. 2 CANS* IN PLANT A OPERATED COMMERCIALLY

	COST PER CAN	
	Example	Your Plant
Raw Materials	$ 0.0515	$
Cans, Cartons and Labels	0.1450	
Direct Labor	0.3901	
Overhead Costs	0.2377	
Total Plant Unit Costs	$ 0.8243	$
Selling, Distribution, and Administrative Cost	0.0300	
Total Unit Cost	$ 0.8543	$

* Costs are based on an annual production of 81,648 cans.

THE ECONOMICS OF CANNING OPERATIONS OF PLANT A OPERATED COOPERATIVELY

Land Requirements

The land requirements for plant A operated cooperatively are the same as those for plant A operated commercially. The same guidelines should be followed in selecting a suitable site as those followed in selecting one for

a commercial operation. The cost of the land should also be the same as that for a commercial operation - $1,500.00.

Building Requirements

The design for a canning plant building used in a cooperative operation should be the same as that for the commercially operated plant. The size of the processing room, 55.7 square meters (600 sq. ft.) of floor space with a 4 meter (13 ft.) minimum ceiling height, would also be the same. However, the size of the storage and warehouse can be reduced from 118.9 to 65.3 square meters (1280 to 709 square feet) of floor space. This reduction in storage and warehouse space can be made by a cooperative plant because there will be no need to provide storage for canned products since they will be taken from the plant by the patrons as they are processed. Therefore, the building costs for plant A operated as a cooperative is $19,635.00 as compared to $25,200.00 when operated as a commercial enterprise.

Equipment Requirements

The basic production equipment and office furniture and equipment requirements for plant A operated cooperatively are the same as if it was operated on a commercial basis. Production equipment costs are $6,287.00 while the cost of the office furniture and equipment will be $1,200.00. A list and description of the equipment can be found in Table II, "Equipment Requirements for Plant A."

Labor Requirements

The labor requirements for plant A operated cooperatively would be reduced to the plant supervisor on a full time basis and two semi-skilled workers, who would be employed only during the canning season. Two semi-skilled workers

are needed to perform certain critical operations, such as, operating the can sealer and the pressure cookers. Performing these operations properly is very important to prevent outbreaks of deadly food poisoning that can be caused by malfunctioning sealers and improper processing. All other canning operation would be performed by the patrons. The plant supervisor should expect to give individual instruction and assistance to the patrons. To obtain a daily output of 648 No. 2 cans, the plant supervisor will probably need to limit the number of products to one per day. Usually a canning operation can obtain maximum efficiency in canning only one product at a time. In some instances canning two products at the same time may make for better utilization of all the facilities. Labor requirements and annual labor costs for plant A operated cooperatively can be found in Tables XI and XII "Labor Requirements for Plant A Operated Cooperatively" and "Annual Labor Costs for Plant A Operated Cooperatively" respectively. These estimates are based on the assumption that the patrons will perform all daily cleaning tasks, as well as many of the processing tasks.

TABLE XI

LABOR REQUIREMENTS FOR PLANT A OPERATED COOPERATIVELY

		Example		Your Plant	
	No. of Workers	Hourly Rate	Hourly Cost	Hourly Rate	Hourly Cost
Direct Labor:					
Semi-Skilled	2	$2.80	$5.60	$_____	$_____
Indirect Labor:					
Plant Supervisor . .	1	5.95	5.95	$_____	$_____

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TABLE XII

ANNUAL LABOR COST FOR PLANT A OPERATED COOPERATIVELY

	Hours per Year per Person	Plant Hourly Cost	Plant Annual Cost Example	Plant Annual Cost Your Plant
Direct Labor	1008	$5.60	$ 5,645.00	$_____
Indirect Labor	2016	5.95	12,000.00	_____
Total Annual Labor Costs			$17,645.00	$_____

Capital Requirements

Capital requirement needs for plant A operating cooperatively are reduced considerably from those needed if the plant was operated commercially. The reductions are in building, labor, raw materials and inventory of canned goods costs. The capital requirements for this plant are summarized in Table XIII, "Capital Requirements for Plant A Operated Cooperatively." The raw materials shown in this table refer to salt, sugar and other seasonings commonly used in canning operations.

TABLE XIII

CAPITAL REQUIREMENTS FOR PLANT A OPERATED COOPERATIVELY

	Example	Your Plant
Fixed Assets:		
Land	$ 1,500.00	$
Building	19,635.00	
Plant Equipment	6,237.00	
Office Furniture and Equipment	1,208.00	
Total Fixed Assets	$ 28,580.00	$
Working Capital:		
Raw Materials - 1 month	143.00	$
Cans, Cartons & Labels - annual	11,839.00	
Labor:		
Direct - 1 month*	874.00	
Indirect - 2 months*	2,000.00	
Other Expenses - 1 month**	968.00	
Sub-Total of Working Capital	$ 15,824.00	$
10% of Working Capital for Contingencies	1,582.00	
Total Working Capital	$ 17,406.00	$

*See Table XII.
**See Table XV less indirect labor.

Ownership Costs

The ownership costs, which include interest on the investment in land, interest and capital retirement on buildings, plant equipment, and office furniture and equipment, insurance and property taxes, and interest on one-half of working capital for 6 months for plant A operated cooperatively are lower than if the plant was operated commercially. The same explanation of ownership costs that applied to plant A operated commercially will apply to the plant when it is operated as a cooperative. These costs are summarized in Table XIV, "Ownership Costs for Plant A Operated Cooperatively."

TABLE XIV

OWNERSHIP COSTS FOR PLANT A OPERATED COOPERATIVELY

	Example	Your Plant
Interest on Land at 8%	$ 120.00	$
Interest and Capital Retirement:		
Buildings - 30 yr. Depreciation, No Salvage at 8%	1,744.00	
Plant Equipment - 10 yr. Depreciation, 10% Salvage at 8%	882.00	
Office Furniture & Equipment - 16 yr. Depreciation, 10% Salvage at 8%	133.00	
Insurance and Property Taxes	447.00	
Interest on One-half of Working Capital for 6 months at 8%	328.00	
Total Ownership Costs	$ 3,674.00	$

Annual Overhead Expense

Annual overhead expense for plant A operated cooperatively consists of ownership costs, both direct and indirect labor costs, fuel, utilities, factory materials, office supplies and miscellaneous. The overhead expense for a cooperative is higher than for a commercial plant because direct labor becomes an overhead item instead of a unit cost item. The costs making up the annual overhead expense are listed in Table XV, "Annual Overhead Expense for Plant A Operated Cooperatively."

TABLE XV

ANNUAL OVERHEAD EXPENSE FOR PLANT A OPERATED COOPERATIVELY

	Example	Your Plant
Ownership Costs	$ 3,674.00	$
Labor:		
Direct	5,645.00	
Indirect	12,000.00	
Fuel	1,174.00	
Utilities	450.00	
Factory Materials - Parts & Repairs	541.00	
Office Supplies & Miscellaneous	150.00	
Total Overhead Expense	$ 23,634.00	$

Unit Cost for Processing No. 2 Cans

When plant A is operated cooperatively at full capacity, the cost for manufacturing No. 2 cans amounts to $0.4450 per can. In a break down of the costs found in Table XVI, "Unit Cost for Processing No. 2 Cans in Plant A Operated Cooperatively," no direct labor was included because the patrons provided all labor except the semi-skilled and indirect labor, which was taken into consideration in the annual overhead expense.

TABLE XVI

UNIT COST FOR PROCESSING NO. 2 CANS IN PLANT A* OPERATED COOPERATIVELY

	Cost per Can	
	Example	Your Plant
Raw Material	$ 0.0105	$_____
Cans, Cartons and Labels**	0.1450	_____
Overhead Costs	0.2895	_____
Total Unit Costs	$ 0.4450	$_____

* Costs are based on an annual production of 81,648 cans.
** The cost per can could be cut approximately $0.025 by eliminating labels and cartons, which are useful but not essential.

The production of plant A operated either commercially or cooperatively, theoretically can be doubled by operating two 8-hour shifts. However, the production of the second shift will probably not be as high as that of the first shift due to factors such as, the more experienced and efficient workers would rather work during the day than at night, more absenteeism, etc. To

increase production to utilize large supplies of available raw products, operating a second shift may be more feasible than investing a large sum of capital to enlarge the present facilities. Table I, "Comparison of Items of Costs in Sixteen Plant Operations," would be of considerable aid in determining the feasibility of operating a plant on a two shift basis or building new facilities.

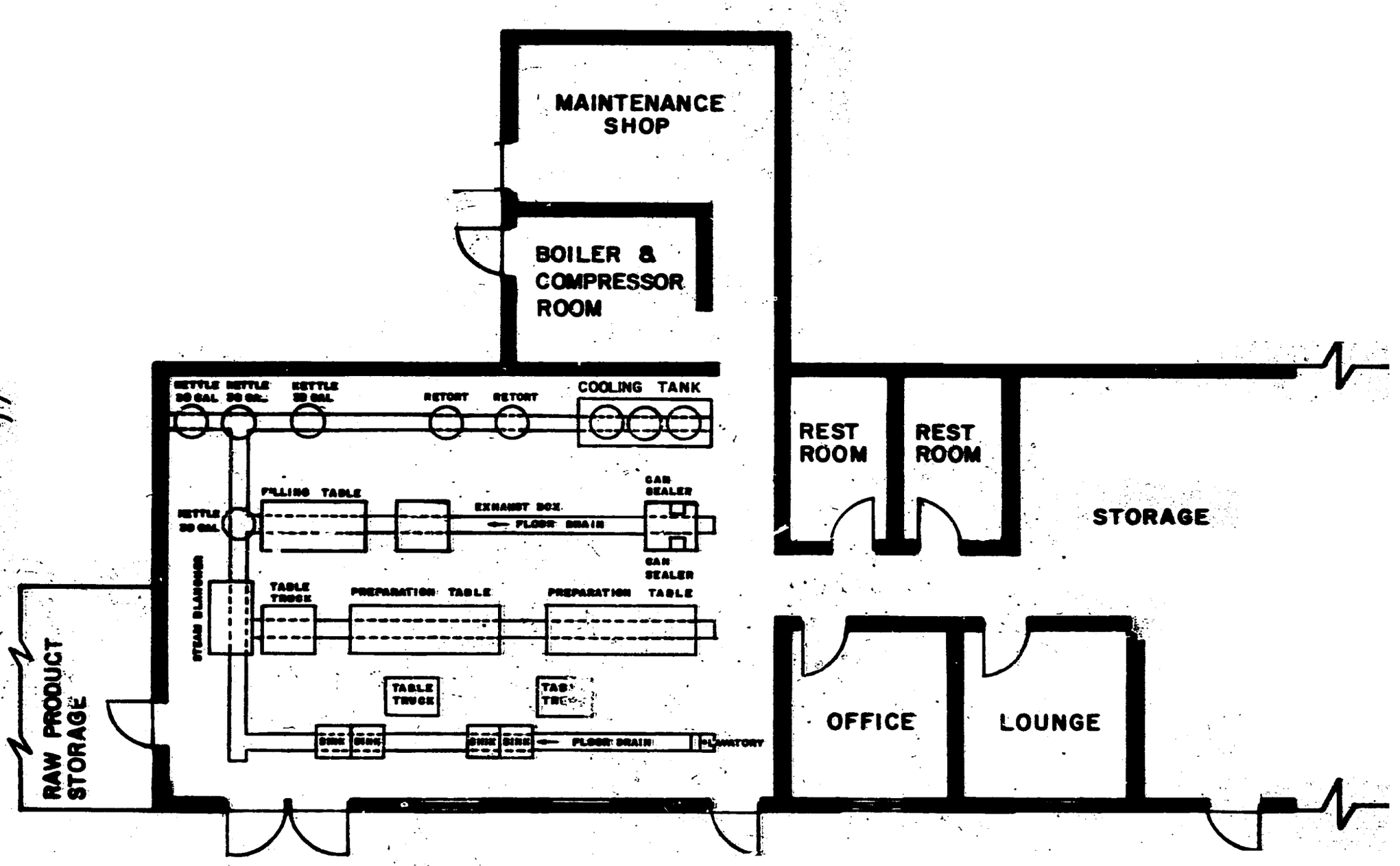

Figure 13. Layout for Plant B

THE ECONOMICS OF OPERATING CANNING PLANT B COMMERCIALLY

It is estimated that plant B using 2 retorts can produce 2,590 No. 2 cans in an 8-hour day. If the plant operates 6 months a year - 126 days; the annual production would be approximately 326,340 No. 2 cans.

Land Requirements

In selecting a site for canning plant B the guideline for selecting building sites as outlined in Chapter 7, "Selection of Plant Site" should be carefully studied. The site selected for this size plant operation should be approximately 1.00 hectares (2.5 acres) or larger. Usually, suitable sites of this size can be found and located on relatively inexpensive land which is not near highly populated areas. This is an important consideration because in the future, it may be necessary to acquire additional land to enlarge or expand the facilities. It is estimated that the land for plant B may be acquired for $3,000.00.

Building Requirements

Careful consideration needs to be given in planning the building for Plant B. Design of the building is important because natural lighting and ventilation should be utilized to the fullest extent for the purpose of conserving energy. See Chapter 10, "Building Construction," for information on constructing the plant building. A one-story masonry type structure having a minimum ceiling of 4 meters (13 ft.) is the most desirable type of building from the standpoint of efficiency in operating, building costs and less hazard from fire. A schematic diagram of a suggested floor plan for plant B is given in Figure 13. Plant B should have at least 104 square meters (1120 sq. ft.) of floor space in the processing room and 231.5 square meters (2492 sq. ft.) of floor area in the storage and warehouse. The recommended

structure can be built in many sections of the United States for approximately $161.50 per square meter (15.00 per sq.ft.) of floor space. This structure would then cost about $54,180. to build.

Equipment Requirements

The basic production equipment and office furniture and equipment necessary to operate plant B are described in Table XVII, "Equipment Requirements for Plant B." The production equipment for this medium sized canning plant costs approximately $42,106.00, which includes installation and 15% of the total cost for overseas shipment, but does not include the cost for crating. A description of specialized equipment is given in Chapter 12, "Equipment Description." Some items of equipment probably can be purchased locally at a saving to the prospective owner.

The office furniture and equipment required in plant B cost approximately $1,322.00. Used equipment and furnishings, when available, can probably be purchased locally at considerable savings.

Labor Requirements

For estimating the labor requirements of plant B, Table XIX, "Estimated Unit Times for Processing 370 No. 2 Cans in Plant B" was used. The times appearing in the table are the average times required for the various operations involved in canning a number of fruits and vegetables. Although the actual times may have varied from product to product, the average times were used for estimating plant B capacity. In using these times, it was estimated that an average of 7 cycles for each of the 2 retorts could be made within an 8-hour day.

TABLE XVII

Equipment Requirements for Canning Plant B

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
1	1	Boiler, 1,035 lbs. steam/hr.(30 hp.), complete with automatic controls, water feed pump, blow-down valve, smoke stack and draft control	$ 8,600.00	$ 8,600.00
2	1	Steam pressure reducing station: 3.8 cm (1½ inch) pressure reducing valve, 3.8 cm (1½ inch) safety relief valve and 3.8 cm (1½ inch) pipe-line strainer	275.00	275.00
3	2	No. 3 Retorts complete with steam cross spreaders, steam pressure regulators, mercury-in-glass thermometers, temperature recorders, pressure gauges, bleeders, pipe-line strainers, safety relief valves, cooling water assemblies, steam, water and air valves	2,034.00	4,068.00
4	2	Extra insert crates for Retort	90.00	180.00
5	20	Jar or Can Dividers, Heavy Duty Plastic Separators	6.00	120.00
6	2	All Purpose Dolly	57.00	114.00
7	2	Model 23 Electric Can Sealers with Power Cords and On/Off Switches	570.00	1,140.00
8	2	Spare Parts Kits	65.00	130.00

TABLE XVII (continued)

Equipment Requirements for Canning Plant B

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
9	2	Exchange Parts for Can Sealer	$ 60.00	$ 120.00
10	1	Continuous Line Exhauster complete with Electric 1 hp. Motor, 100-1 Speed Reducer, Steam Reducing Valve, Pipe-line Strainer and On/Off Valve	2,040.00	2,040.00
Alternate to No. 10	1	Hand Operated Line Exhauster with Steam Reducing Valve, Pipe-Line Strainer, and On/Off Valve	1,151.00	
11	1	Steam Blancher-Cooler without Stainless Steel Trays with 2 Quick Opening Steam and Water Valves and Ready arranged Steam and Water Lines, Spray Nozzle, Steam Reducing Valve, and Pipe-Line Strainer	651.00	651.00
12	4	Stainless Steel Trays for Steam-Blancher-Cooler	11.00	44.00
13	1	1.25 cm ½ inch Steam Pressure Reducing Valves, Range 5-40 PSIG	45.00	45.00
14	1	1.25 cm ½ inch Steam Pipe-Line Strainer	6.00	6.00
15	14.6 meters (48 ft)	12.7 cm 5 inch I-Beam Overhead Track	3.00	144.00

TABLE XVII (Continued)

Equipment Requirements for Canning Plant B

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
16	1	12.7 cm 5 inch I-Beam Overhead Track 90° Curve on 61 cm (24 inch) Radius 3 meters (10 feet) long	$ 140.00	$ 140.00
17	30	0.91 meters (3 ft.) x 1.25 cm (½ in.) Threaded Rod, Brackets for Overhead Track	1.50	45.00
18	1	Trolly for 12.7 cm (5 inch) I-Beam Track	40.00	40.00
19	1	Geared Hand Operated Hoist 0.5 metric ton, (½ Ton) Capacity	250.00	250.00
20	1	114 liters (30 US Gallon) Standard Steam Jacketed Kettle, Trunnion Mounted-Worm, Constructed to ASME Code for 40 PSIG of Type 316 Stainless Steel inside with Stainless Steel Cover, Safety Pop-Off Valve, Trap, Pressure Reducing Valve, Pipe-Line Strainer and Cut-Off Valve	1,370.00	1,370.00
21	2	152 liters (40 US Gallon) Standard Steam Jacketed Kettle, Trunnion Mounted-Worm, Constructed to ASME Code for 40 PSIG of Type 316 Stainless Steel inside with Stainless Steel Cover, Safety Pop-Off Valve, Trap, Pressure Reducing Valve, Pipe-Line Strainer and Cut-Off Valve	1,425.00	2,850.00

TABLE XVII (Continued)

Equipment Requirements for Canning Plant B

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
22	4	Stainless Steel Top Tables, .84 x 3 meters (33 x 117 inches)	$ 540.00	$ 2,160.00
23	2	Stainless Steel Top Table Trucks, .84 x .84 x .86 meters (33 x 33 x 34 inches) high	300.00	600.00
24	3	Two Compartment Stainless Steel Sinks, Each Compartment .61 x .61 x .36 meters (24 x 24 x 14 inches) deep with Splash Back, Legs & Faucets	465.00	1,395.00
25	1	Cooling Tank - 1 x 3 x 1 meters (3 x 10 x 3 ft.) deep with 2.54 cm (1 in.) inlet and 3.8 cm (1½ in.) overflow	450.00	450.00
26	2	External Cooling Spray Assemblies	35.00	70.00
27 Optional	1	Lye Peeler-Scalder with Basket	450.00	
28 Optional	1	Extra Basket for Lye Peeler-Scalder	60.00	
29	1	Air Compressor, Electric	600.00	600.00
30	1	Air Regulating Valve Assembly	50.00	50.00
31	6	Blanching and Utility Baskets, Heavy Duty 16-gauge Expanded Metal, 35.6 cm (14 inches) Diameter, 25.4 cm (10 inches) deep with 15 cm (6 inch) Handles	27.00	162.00

TABLE XVII (Continued)
Equipment Requirements for Canning Plant B

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
32	1	Heavy Duty Portable Platform Scales, 454 kilos (1000 lbs.) with weights	$ 325.00	$ 325.00
33	1	Meat/Food Chopper	700.00	700.00
34	1	Pulper/Finisher with one screen	4,400.00	4,400.00
35	2	Extra Screens	70.00	140.00
36 Optional	1	Can Reformer	2,000.00	
37 Optional	1	AMS Can Flanger with Rolls	2,185.00	
38 Optional	1	Extra Rolls	310.00	
39	1	Hand Flange Reformer Stainless Steel Construction for 307 x 409 Cans	30.00	30.00
40	1	Hand Flange Reformer Stainless Steel Construction for 401 x 411 Cans	30.00	30.00
41	2	38 Liters (10 US Gallon) Aluminum Stock Pots	60.00	120.00
42	2	Aluminum Covers for 38 Liters (10 US Gallon) Stock Pots	11.50	23.00
43	2	19 Liters (5 US Gallon) Aluminum Stock Pots	35.00	70.00

TABLE XVII (Continued)

Equipment Requirements for Canning Plant B

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
44	2	Aluminum Covers for 19 Liter (5 US Gallon) Stock Pots	$ 9.00	$ 18.00
45	4	Aluminum 20 Liter (21 Quart) Dish Pans	40.00	160.00
46	3	Stainless Steel Tilt Buckets - 15 Liter (16 Quarts)	25.00	75.00
47	3	Stainless Steel 1 Liter (1-Quart) Dippers	17.00	51.00
48	3	Stainless Steel 120 ml (1-Pint) Dippers	15.00	45.00
49	3	Boning Knives 15 cm (6-inch) High Carbon Steel	3.00	9.00
50	12	Paring Knives 8¾ cm (3½ inches) Stainless Steel	4.00	48.00
51	12	Stainless Steel Fruit and Vegetable Knives	1.00	12.00
52	4	Stainless Steel Spoons, 38 cm (15 inches)	2.50	10.00
53	4	Solid Stainless Steel Spoons, 46 cm (18 inches)	5.00	20.00
54	3	Utility Forks	6.00	24.00
55	1	Meat Saw, Hand	15.00	15.00
56	4	Hot Lift Tongs for Jars and Cans	5.00	20.00

TABLE XVII (Continued)
Equipment Requirements for Canning Plant B

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
57	2	Heavy Duty Plastic Garbage Cans - Capacity 113.5 Liters (30 US Gallons)	$ 36.00	$ 72.00
58	2	Heavy Duty Plastic Garbage Cans - Capacity 75.7 Liters (20 US Gallons)	12.50	25.00
59	2	Plastic cutting boards 38 x 50.8 x 2.54 cm (15 x 20 x 1 inch)	30.00	60.00
60	3	Stainless Steel Funnels - 15 cm (6 inches) Diameter	9.00	27.00
61	2	Ventilating Fans - 374 Cubic Meters per Minutes (13,200 CFM), Electric	250.00	500.00
62	1	Carborundum Stone	14.00	14.00
63	1	Clock	10.00	10.00
64	1	Labeling Bench	50.00	50.00
65	1	Can Seam Micrometer	50.00	50.00
66	1	Sanitary Can Opener	20.00	20.00
67	1	Pair Nippers - 15 cm (6 inches)	6.00	6.00
68	1	Can opener	22.00	22.00
69	1	Hand Washing Lavatory	250.00	250.00
		TOTAL COST OF PLANT EQUIPMENT		$35,310.00

TABLE XVII (Continued)

Equipment Requirements for Canning Plant B

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		OFFICE EQUIPMENT		
70	1	Desk and Chair	$ 325.00	$ 325.00
71	1	Typist's Desk and Chair	250.00	250.00
72	1	File Cabinet	75.00	75.00
73	1	Typewriter	300.00	300.00
74	1	Calculator	200.00	200.00
		TOTAL COST OF OFFICE EQUIPMENT		$ 1,150.00

TABLE XVII (Continued)

Equipment Requirements for Canning Plant B

Item Number	Quantity	EXPENDABLE EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
75	3	Exhaust Thermometers -18°-104.4° C (0°-220° F)	$ 11.00	$ 33.00
76	2	Water Hose, Heavy Duty - 7.5 meters (25 feet)	50.00	100.00
77	2	Water Hose Nozzles	5.00	10.00
78	4	Extra Blades for Meat Saw	1.50	6.00
79	8	Pot Brushes	2.25	18.00
80	6	Vegetable Brushes	3.00	18.00
81	2	Rubber-Coated Gloves, Gauntlet Style	5.00	10.00
82	4	Rubber Gloves, Thin Canners' Type	2.50	10.00
83	12	Cotton Gloves	3.00	36.00
84	2	Metal Files	5.00	10.00
85	1	First Aid Kit	20.00	20.00
86	2	Brooms	5.00	10.00
87	2	Mops	5.00	10.00
		SUBTOTAL COST OF PLANT EXPENDABLE EQUIPMENT		$291.00

TABLE XVII (Continued)
Equipment Requirements for Canning Plant B

Item Number	Quantity	EXPENDABLE EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		OFFICE		
88		Record Books, Forms and File Folders	$ 275.00	
89		Stationary	50.00	
		SUBTOTAL OF EXPENDABLE SUPPLIES		$ 325.00
		TOTAL COST OF EXPENDABLE EXPENDITURES		$ 616.00

TABLE XVIII

SUMMARY OF EQUIPMENT COSTS FOR PLANT B

CAPITAL		
Plant	$35,310.00	
Plus 15 % for Overseas Freight (Estimated)	5,296.50	
Subtotal		$40,606.50
Office	1,150.00	
Plus 15 % for Overseas Freight (Estimated)	172.50	
Subtotal		1,322.50
TOTAL CAPITAL EXPENDITURE		$41,929.00
EXPENDABLE		
Plant	291.00	
Plus 15 % for Overseas Freight (Estimated)	43.65	
Subtotal		334.65
Office	325.00	
Plus 15 % for Overseas Freight (Estimated)	48.75	
Subtotal		373.75
TOTAL EXPENDABLE EXPENDITURE		$708.40

TABLE XIX

ESTIMATED UNIT TIMES FOR PROCESSING 370 NO. 2 CANS IN PLANT B
(2 Retorts)

Operation	Description	Time (Man Minutes)	Your Plant (Man Minutes)
1	Food Preparation	686	
2	Rinsing and Straightening Cans	62	
3	Preheating Product	106	
4	Filling Cans	92	
5	Exhausting & adjusting Headspace	52	
6	Sealing Cans	52	
7	Processing and Cooling	55	
8	Labeling and Wiping.	220	
	Total Man Minutes per Retort	1,325	

When canning plant B is operated commercially 20 persons are required to form the production work force or direct labor. The indirect labor needed is one each: plant supervisor, clerk and janitor. A summary of the total direct and indirect labor costs per hour is given in Table XX, "Labor Requirements for Plant B Operated Commercially" and the annual labor costs in Table XXI, "Annual Labor Costs for Plant B Operated Commercially." In calculating annual labor costs, it is assumed that the direct labor is retained only for a six month canning season. The plant supervisor, clerk and janitor are employed for the full year.

TABLE XX

LABOR REQUIREMENTS FOR PLANT B OPERATED COMMERCIALLY

	No. of Workers	Example Hourly Rate	Example Hourly Cost	Your Plant Hourly Rate	Your Plant Hourly Cost
Direct Labor:					
Food Preparation and General	18	$2.60	$46.80	$____	$____
Semi-Skilled.	2	3.00	6.00	____	____
Total Direct Labor. . . .	20		$52.80		
Indirect Labor:					
Plant Supervisor.	1	$5.95	$ 5.95	$____	$____
Clerk	1	3.00	3.00	____	____
Janitor	1	2.60	2.60	____	____
Total Indirect Labor	3		$11.55		$____

TABLE XXI

ANNUAL LABOR COSTS FOR PLANT B OPERATED COMMERCIALLY

Item	Hours per Year Per Person	Plant Hourly Cost	Plant Annual Cost Example	Plant Annual Cost Your Plant
Direct Labor.	1,008	$52.80	$ 53,222.00	$_____
Indirect Labor.	2,016	11.55	23,285.00	_____
Total Annual Labor Costs			$ 76,507.00	$_____

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Capital Requirements

In addition to the capital required to purchase the land, the building, and the equipment, it is necessary that the prospective owner have additional capital to buy raw materials, payment of wages, cans, labels, cartons, etc. This additional capital is known as "working capital." The working capital should be sufficient to operate the plant until it begins to realize a profit. In effect, it is money set aside to insure that the canning operation will have a chance of being a success.

The capital requirements for plant B operated commercially are summarized in Table XXII, "Capital Requirements for Plant B Operated Commercially."

TABLE XXII

CAPITAL REQUIREMENTS FOR PLANT B OPERATED COMMERCIALLY

Item	Example	Your Plant
Fixed Assets:		
Land	$ 3,000.00	$
Building	54,180.00	
Plant Equipment	42,106.00	
Office Furniture and Equipment	1.322.00	
Total Fixed Assets	$100,608.00	$
Working Capital:		
Raw Materials - 1 month	$ 2,801.00	$
Cans, Cartons and Labels - annual	47,319.00	
Labor:		
Direct - 1 month*	8,870.00	
Indirect - 2 month**	3,881.00	
Other expenses - 1 month**	1,946.00	
Inventory of Canned Products***	81,998.00	
Sub-Total of Working Capital	$146,815.00	$
10% of Working Capital for Contingencies	$ 14,682.00	$
	$161,497.00	$

* See Table XXI.
** See Table XXIV less indirect labor.
*** One-half of annual production multiplied by unit cost - see Table XXV.

Annual Ownership Costs

Ownership costs include interest on investment in land, interest and capital retirement on buildings, plant equipment, office furniture and equipment, insurance, property taxes, and interest on one-half of working capital for 6 months. There is more involved in calculating cost to the owner for the investment in fixed assets than a straight line depreciation. Generally, portable fixed assets have some salvage or sale value, in the magnitude of 10% of the total cost, at the end of the depreciation period, which may be 10, 15 or 20 years. Fixed assets such as, buildings, are usually given a longer depreciation period with little or no remaining salvage value. On the other hand, land on which the buildings are located usually appreciates rather than depreciates in value, consequently, land is not generally depreciated in determining ownership costs. True ownership costs not only include the cost of depreciation but also the interest on the amount invested in fixed assets. Therefore, if fixed assets are depreciated over a long period of time such as, 30 years, the interest cost will be greater than if the fixed assets were depreciated for only 15 years. To determine the ownership costs due to depreciation and interest on the investment in fixed assets, the Table I, "Annual Change for Capital Recovery and Interest for Each Dollar of Investment" in Appendix , is used to obtain a calculated mathematical factor for a given number of years at a specified interest rate. This factor from the table is multiplied by the amount of the original investment less its salvage value. The product of this calculation plus the interest on the estimated salvage value, insurance, and property taxes then becomes the annual ownership cost of the investment in a particular fixed asset. Illustration:

$ 5,000.00	Purchase cost of equipment
500.00	Estimated Salvage Value of Equipment at 10% of Cost
$ 4,500.00	Capital to be Recovered in Plant Operating Costs
0.149	Factor from Table I based on 10 Years of Depreciation at 8%
$ 670.50	Annual Recovery of Both Capital and Interest
40.00	Interest at 8% on the $ 500.00 Salvage Value
$ 710.50	Total Amount to Be Charged to Annual Ownership Costs

Ownership costs are summarized in Table XXIII, "Annual Ownership Costs for Plant B Operated Commercially."

TABLE XXIII

ANNUAL OWNERSHIP COSTS FOR PLANT B OPERATED COMMERCIALLY

	Example	Your Plant
Interest on Land at 8%	$ 240.00	$
Interest and Capital Retirement:		
Building - 30 yr. Depreciation, no Salvage, at 8%	4,816.00	
Plant Equipment - 10 yr. Depreciation, 10% Salvage, at 8%	5,971.00	
Office Furniture and Equipment - 16 yr. Depreciation 10% Salvage, at 8%	145.00	
Insurance and Property Taxes	1,580.00	
Interest on One-Half of Working Capital for 6 months at 8%	3,230.00	
Total Ownership Costs	$15,982.00	$

Annual Overhead Expense

Annual overhead expense consists of ownership costs, indirect labor costs, fuel, utilities, factory materials, office supplies and miscellaneous. These costs are summarized in Table XXIV, "Annual Overhead Expense for Plant B Operated Commercially."

TABLE XXIV

ANNUAL OVERHEAD EXPENSE FOR PLANT B OPERATED COMMERCIALLY

	Example	Your Plant
Ownership Costs - Table XXIII	$ 15,982.00	$_____
Labor:		
Indirect	23,285.00	_____
Fuel	2,648.00	_____
Utilities	1,000.00	_____
Factory Materials - Parts & Repairs, etc	927.00	_____
Office Supplies and Miscellaneous	2,800.00	_____
Total Overhead Expense	$46,642.00	$_____

Unit Cost for Processing No. 2 Cans

In plant B when operated commercially at full capacity, the cost for manufacturing, selling and distributing No. 2 cans amounts to $0.5325 per can. A breakdown of this cost is given in Table XXV, "Unit Cost for Processing No. 2 Cans in Plant B Operated Commercially."

TABLE XXV

UNIT COST FOR PROCESSING NO. 2 CANS IN PLANT B* OPERATED COMMERCIALLY

	Cost per Can	
	Example	Your Plant
Raw Materials	$ 0.0515	$
Cans, Cartons and Labels	0.1450	
Direct Labor	0.1631	
Overhead Expense	0.1429	
Sub-Total Plant Unit Cost	$ 0.5025	$
Selling, Distribution, and Administrative Costs	0.0300	
Total Unit Cost	$ 0.5325	$

* Costs are based on an annual production of 326,340 No. 2 Cans.

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THE ECONOMICS OF CANNING OPERATIONS IN PLANT B OPERATED COOPERATIVELY

When plant B is operated cooperatively, it should have the same capacity as if it was operated commercially - 2590 No. 2 cans per 8-hour day. If this plant operates for 6 months a year - 126 days -, its annual production should also be approximately 326,340 No. 2 cans.

Land Requirements

The land requirements for plant B operated cooperatively are the same as if it operated commercially. The same guidelines should be followed in selecting a suitable site as those in selecting one for a commercial operation. The cost of the land should be about the same as that for a commercial enterprise - $3,000.00.

Building Requirements

The design for a building to be used as a cooperative canning operation could be the same as that in the commercially operated plant. The size of the processing room, 104 square meters (1,120 sq.ft.) of floor space with a 4 meter (13 ft.) minimum ceiling height, would also be the same. However, the size of the storage and warehouse can be reduced from 231.5 to 195.5 square meters (2492 to 2104 sq.ft.) of floor space. This reduction in storage and warehouse size can be made by a cooperative plant because there will be no need in providing storage for canned products. The patrons will remove the finished products

from the plant at the end of each day of operation. Consequently, the cost of the building for a plant operated cooperatively can be reduced from $54,180.00 to $48,360.00.

Equipment Requirements

The basic production equipment and office furniture and equipment requirements for plant B operated cooperatively are the same as if it was operated as a commercial plant. Therefore, the cost for the production equipment is $42,106.00 and the cost of the office furnishings will be approximately $1,322.00. A list and description of the equipment can be found in Table XVII, "Equipment Requirements for Plant B."

Labor Requirements

The labor requirements for plant B operated as a cooperative will consist of two food preparation supervisors and two semi-skilled workers as direct labor plant supervisor, clerk and janitor as indirect labor. The direct labor will be employed only during the 6-month canning season, while the indirect labor personnel will be employed on a 12-month basis. The two food preparation supervisors will need to give individual instruction and assistance to the patrons. The two semi-skilled workers will be needed to perform certain critical operations such as, operating the can sealer and the retorts. It is very important for specially trained workers to perform these operations properly to minimize the outbreak of deadly food poisoning as well as the incidents of losses due to spoilage that could be caused by malfunctioning can sealers and improper methods of processing and cooling. All other canning operations will be performed by patrons using the facilities.

To obtain a daily output of 2,590 No. 2 cans per day the plant supervisor will probably have to limit the number of products processed in a day to one. Usually, a canning operation can obtain maximum efficiency by canning only one product at a time. However, in some instances canning two products at a time could make for better utilization of all the facilities.

Labor requirements and labor costs for plant B operated cooperatively may be found in Table XXVI, "Labor Requirements for Plant B Operated Cooperatively," and Table XXVII, "Labor Costs for Plant B Operated Cooperatively," respectively. These estimates are based on the assumption that the patrons will perform the daily cleaning tasks and all others except those performed by the two semi-skilled employees.

TABLE XXVI

LABOR REQUIREMENTS FOR PLANT B OPERATED COOPERATIVELY

	No. of Workers	Example Hourly Rate	Example Hourly Cost	Your Plant Hourly Rate	Your Plant Hourly Cost
Direct Labor:					
Food Preparation and General. .	2	$ 2.80	$5.60	$_____	$_____
Semi-skilled.	2	3.00	6.00	_____	_____
Sub-Total Direct Labor			$11.60		
Indirect Labor:					
Plant Supervisor.	1	$ 5.95	$ 5.95	$_____	$_____
Clerk	1	3.00	3.00	_____	_____
Janitor	1	2.60	2.60	_____	_____
Sub-Total Indirect Labor			$11.55		$_____

TABLE XXVII

ANNUAL LABOR COST FOR PLANT B OPERATED COOPERATIVELY

Item	Hours per Year per Person	Plant Hourly Cost	Plant Annual Cost Example	Plant Annual Cost Your Plant
Direct Labor	1,008	$ 5.60	$11,693.00	$_____
Indirect Labor	2,016	11.55	23,285.00	_____
Total Annual Costs			$34,978.00	$_____

Capital Requirements

The capital requirements needs for plant B operating as a cooperative are reduced considerably from those if the plant was operating commercially. The reductions are in building, labor, raw material and inventory of canned goods costs. The capital requirements for this plant are summarized in Table XXVIII, "Capital Requirements for Plant B Operated Cooperatively," The raw materials shown in this table refer to salt, sugar, and other seasonings commonly used in canning operations.

TABLE XXVIII

CAPITAL REQUIREMENTS FOR PLANT B OPERATED COOPERATIVELY

Item	Example	Your Plant
Fixed Assets:		
Land	$ 3,000.00	$
Building - 299.5 sq. meters (3,224 sq.ft.)	48,360.00	
Plant Equipment.	42,106.00	
Office Furniture and Equipment	1,322.00	
Total Fixed Assets.	$ 94,788.00	$
Working Capital:		
Raw Materials - 1 month.	$ 571.00	$
Cans, Cartons, Labels - annual	47,319.00	
Labor:		
Direct - 1 month*.	1,949.00	
Indirect - 2 months*	3,881.00	
Other Expenses - 1 month	2,705.00	
Sub-Total of Working Capital . . .	$ 56,425.00	$
10% of Working Capital for Contingencies	5,642.00	
	$ 62,067.00	$

* See Table ~~XXVII~~ XXVI
** See Table ~~XXIV~~ less indirect labor.

Ownership Costs

The ownership costs, which indlcude interest on the investment in land, interest and capital retirement on other fixed assets, insurance, property taxes, and interest on one-half of working capital for 5 months for plant B operated cooperatively are lower than if the plant was a commercial operation.

The same explanation of ownership costs that was given for plant B operated commercially will apply to the plant when operated cooperatively. These costs are summarized in Table XXIX, "Ownership Costs for Plant B Operated Cooperatively."

TABLE XXIX

OWNERSHIP COSTS FOR PLANT B OPERATED COOPERATIVELY

Item	Example	Your Plant
Interest on Land	$ 240.00	$_____
Interest and Capital Retirement:		
Building - 30 yr. Depreciation, No Salvage, at 8%	4,294.00	_____
Plant Equipment - 10 yr. Depreciation, 10% Salvage, at 8%.	5,971.00	_____
Office Furniture and Equipment - 16 yr. Depreciation, 10% Salvage, at 8%	145.00	_____
Insurance and Property Taxes	1,502.00	_____
Interest on One-half of Working Capital for 6 months	1,241.00	_____
Total Ownership Costs	$13,393.00	$_____

Annual Overhead Expense

Annual overhead expense for plant B operated cooperatively consists of ownership cost, fuel, utilities, factory materials, office supplies and miscellaneous. The overhead expense for a cooperative is higher than for a comparable commercial plant because direct labor becomes an overhead expense

instead of an unit cost item. The costs making up the annual overhead expense are listed in Table XXX, "Annual Overhead Expense for Plant B Operated Cooperatively."

TABLE XXX

ANNUAL OVERHEAD EXPENSE FOR PLANT B OPERATED COOPERATIVELY

Item	Example	Your Plant
Ownership Cost - Table XXIX	$ 13,393.00	$
Labor - Table XXVII		
Direct	11,693.00	
Indirect	23,285.00	
Fuel	2,648.00	
Utilities	1,000.00	
Factory Materials - Parts and Repairs	927.00	
Office Supplies and Miscellaneous	2,800.00	
Total Overhead Expense	$55,746.00	$

Unit Costs for Processing No. 2 Cans

When Plant B is operated cooperatively at full capacity, the cost for manufacturing No. 2 cans amounts to $0.3263 per can. In a breakdown of the costs found in Table XXXI, "Unit Costs for Processing No. 2 Cans in Plant B Operated Cooperatively," no direct labor was included because the patrons provided all labor except the semi-skilled food preparation labor and direct labor, which were taken into consideration in the annual overhead expense.

TABLE XXXI

UNIT COSTS FOR PROCESSING NO. 2 CANS IN PLANT B* OPERATED COOPERATIVELY

Item	Cost per Can	
	Example	Your Plant
Raw Material	$ 0.0105	$_____
Cans, Cartons and Labels**	0.1450	_____
Overhead Expense	0.1708	_____
Total Unit Costs	$ 0.3263	$_____

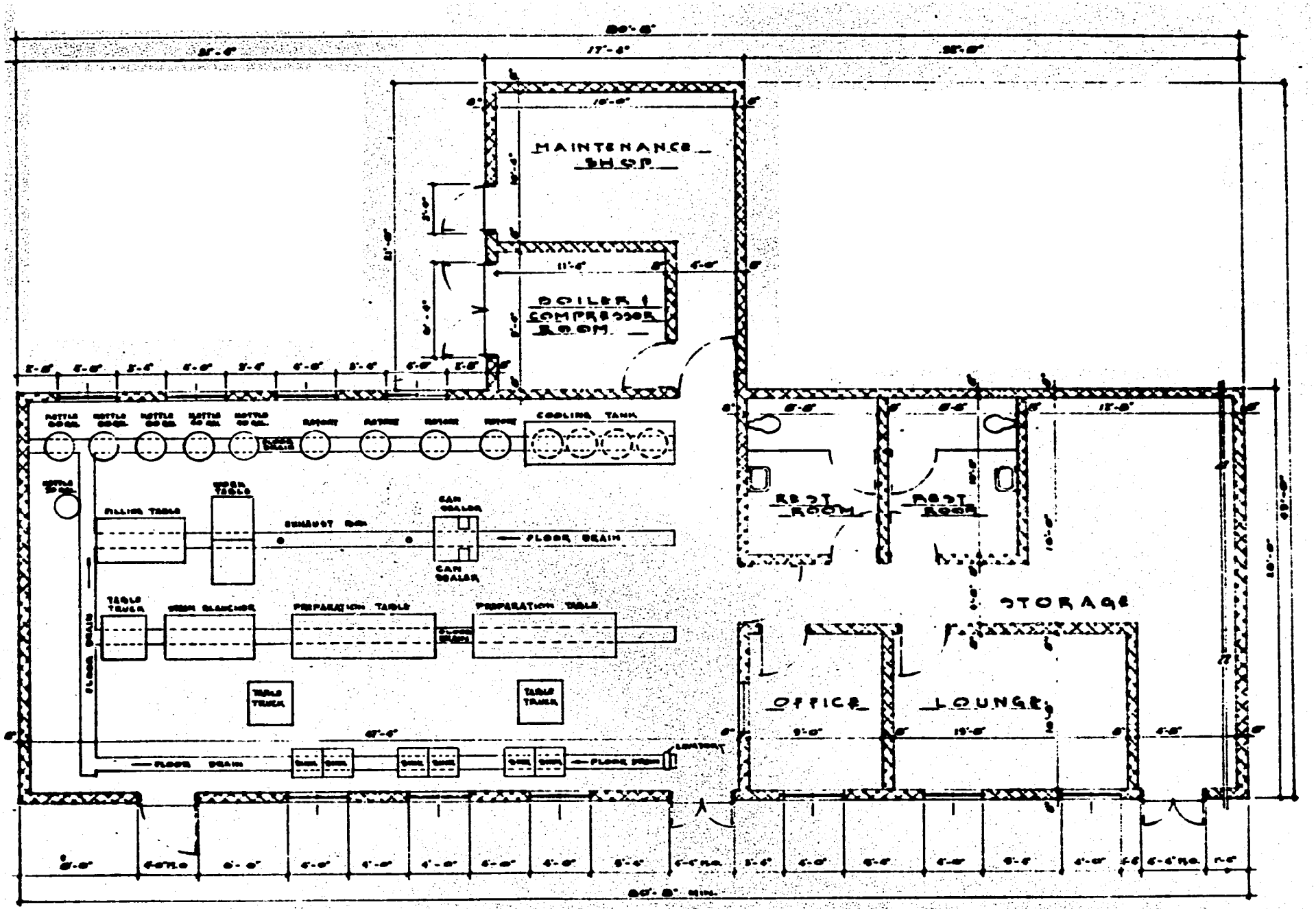
* Costs are based on an annual production of 326,340 No. 2 cans.
** The cost per can could be cut approximately $0.025 by eliminating labels and cartons, which are useful but not essential.

THE ECONOMICS OF OPERATING CANNING PLANT C COMMERCIALLY WITHOUT OPTIONAL EQUIPMENT

Plant C operating commercially utilizing 4 retorts without optional equipment can produce approximately 5,180 No. 2 cans of food in an 8-hour day. If the plant operates 6 months a year - 126 days - the annual production would be about 652,680 No. 2 cans. Operating a canning plant to obtain a production of this number of cans per day or year without the benefit of labor saving optional equipment requires a large number of employees. Working space for the estimated number of workers required in preparing the produce for canning becomes critical in the recommended size building. Management will need to give careful consideration in selecting the type of produce and its quality that will require the least number of workers to prepare it for canning. The delivery of produce should be scheduled to permit an orderly flow of raw materials through the plant unless a holding storage area is provided. The cost of such an area has not been included in the economical analysis of the canning operation of this plant.

Land Requirements

The guidelines as outlined in Chapter 7, "Selection of Plant Site," should be carefully studied in selecting a site for canning plant C. The site selected for plant C should be approximately 2 hectares (5 acres) or larger. Usually, suitable sites of this size can be found and located on relatively inexpensive land which is not near highly populated areas. Consideration should be given to the availability of additional land for enlarging the facilities in the future. It is estimated that the land for plant C can be purchased for about $5,000.00.



FLOOR PLAN

Fig. 14. Layout for Plant C
(Courtesy of G. L. Buckner)

Building Requirements

Much consideration should be given in planning and designing the building for plant C. In planning a building to house as many employees as plant C requires, the prospective owners should make inquiries of the local and national authorities concerning the latest minimum building standards regulations. In the United States, there is a relatively recent building regulation requiring all new buildings to include special features such as, minimum size rest rooms to accommodate the handicapped person, etc. The layout plans in Figure 14 include some of the features required by some of the new regulations. The services of an architect, experienced in designing commercial buildings, would be well worth the expense involved. In designing the building natural lighting and ventilation of the processing room should be utilized to the fullest extent for the purpose of providing the best working conditions as possible for the workers and for conserving energy. It is advisable that the processing room exterior not be flanked on either side with storage areas, which would greatly reduce cross ventilation which is necessary to eliminate the steam vapor laden atmosphere during processing. Chapter 10, "Plant Construction," contains helpful information on constructing the plant building. A one-story masonry type building having a minimum ceiling height of 4 meters (13 ft.) is probably the most desirable type of building from the standpoint of sanitation, efficiency and convenience in operating, low building costs and reduced fire hazards. Plant C should have at least 208 square meters (2240 sq.ft.) in the processing room and 465 square meters (5000 sq.ft.) in the storage and warehouse areas. The recommended type of structure can be built in many sections of the United States for $161.50 per square meter ($15.00 per sq.ft.) of floor space. A building for plant C would probably cost $108,720.00 to build.

1.3

TABLE XXXII

Equipment Requirements for Canning Plant C

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT 626 kilos		
1	1	Boiler, 1,380 lbs. of steam/hour (40 hp.), complete with automatic controls, water feed pump, blow-down valve, smoke stack and draft control	$ 9,401.00	$ 9,401.00
2	1	Steam pressure reducing station: pressure reducing valve, pipe-line strainer and safety relief valve	300.00	300.00
3	4	No. 3 Retorts with side pockets, mercury-in-glass thermometers, pressure gauges, cooling water assemblies, temperature recorders, steam pressure regulators, bleeders, pipe-line strainers, safety relief valves and steam, water and air valves and steam cross spreaders	2,034.00	8,136.00
4	4	Extra retort crates	90.00	360.00
5	4	All-purpose dolly trucks	57.00	228.00
6	3	Electric can sealers set to close one size can	570.00	1,710.00
7	3	Repair parts kits for can sealers	65.00	195.00
8	3	Extra sizes of chucks and base plates for can sealers	60.00	180.00

TABLE XXXII (Continued)

Equipment Requirements for Canning Plant C

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
9	2	Continuous line exhauster, complete with 100-1 speed reducer, steam pressure reducing valves, pipe-line strainers, and steam on/off valve	$ 2,000.00	$ 4,000.00
10	1	Steam blancher-cooler without trays, complete with 2 quick opening steam and water valves, cooling water sprays, pipe-line strainer and steam reducing valve	651.00	651.00
11	6	Stainless steel trays, perforated bottoms for steam cooler-blancher	75.00	450.00
12	14.6 meters (48 ft.)	12.7 cm (5 inch) I-Beam overhead track	3.00	144.00
13	1	Trolly for I-Beam track	40.00	40.00
14	1	12.7 cm (5 inch) I-Beam overhead track curve, 90° on 61 cm (24 inch) radius 3 meters (10 feet) long	140.00	140.00
15	30	Bracket for overhead I-Beam track	1.50	45.00
16	1	Hoist, hand operated, 0.5 metric ton (½ ton) capacity	250.00	250.00

TABLE XXXII (Continued)
Equipment Requirements for Canning Plant C

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
17	1	Steam jacketed kettle, 114 liters (30 US gallons), trunnion mounted-worm, ASME Code for 40 psig of type 316 stainless steel inside with stainless steel cover, safety relief valve, trap, steam reducing valve, pipe-line strainer, and on/off steam valve	$ 1,370.00	$ 1,370.00
18	2	Steam jacketed kettles. 152 liters (40 US gallons), trunnion mounted-worm, ASME Code for 40 psig of type 316 stainless steel inside with stainless steel cover, safety relief valves, traps, steam reducing valves, pipe-line strainers, and on/off steam valves	1,425.00	2,850.00
19	4	Stainless steel top table trucks, .84 x .84 x .86 meters (33 x 33 x 34 inches) high	300.00	1,200.00
20	2	Stainless steel tables .84 x 1.75 meters (33 x 69 inches)	400.00	800.00
21	4	Stainless steel tables .84 x 3 meters (33 x 117 inches)	540.00	2,160.00
22	4	Stainless steel sinks, 2 compartments, .61 x .61 x .36 meters (24 x 24 x 14 inches) deep with swing type faucets and cove corners	465.00	1,860.00
23	1	Water cooling tank, 1 x 3 x 1 meter (3 x 10 x 3 feet) deep with 2.54 cm (1 inch) inlet and 3.8 cm (1½ inch) overflow	400.00	400.00

TABLE XXXII (Continued)
Equipment Requirements for Canning Plant C

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
24	3	External water cooling spray assembly	$ 45.00	$ 135.00
25	1	Hand flange reformer, stainless steel, for 307 x 409 cans	30.00	30.00
26	1	Hand flange reformer, stainless steel, for 401 x 411 cans	30.00	30.00
27	3	Stock pots, 38 liters (10 US gallons), Aluminum with covers	71.50	214.50
28	3	Stock pots, 19 liters (5 US gallons), Aluminum with covers	44.00	132.00
29	8	Dish pans, Aluminum, 20 liters (21 quarts)	40.00	320.00
30	6	Buckets, Stainless steel, 15 liters (16 quarts)	25.00	150.00
31	6	Ladles, stainless steel, .75 liter (12 ounces)	6.00	36.00
32	6	Dippers, stainless steel, 2 liters (2 quarts)	20.00	120.00
33	6	Boning knives, carbon steel blades, 15 cm (6 inches)	3.00	18.00
34	24	Paring knives, stainless steel blades, 8¾ cm (3½ inche	27.00/doz.	54.00
35	12	Fruit and vegetable knives, stainless steel	10.00/doz.	10.00
36	6	Utility forks	6.00	36.00

TABLE XXXII (Continued)

Equipment Requirements for Canning Plant C

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
37	12	Spoons, solid, stainless steel	$ 5.00	$ 60.00
38	6	Spoons, pierced, stainless steel	5.00	30.00
39	1	Hand meat and bone saw	15.00	15.00
40	1	Platform portable scales, 454 kilos (1000 pounds) capacity	325.00	325.00
41	1	All-purpose scales, 27 kilos (60 pounds) capacity	70.00	70.00
42	12	Stools without backs	15.00	180.00
43	6	Hot lift tongs	5.00	30.00
44	2	Garbage cans with covers, heavy duty plastic, 120 liters (32 US gallons)	36.00	72.00
45	2	Garbage cans with covers, heavy duty plastic, 75.7 liters (20 US gallons)	12.00	24.00
46	4	Cutting boards, plastic, 38 x 50.8 x 2.54 cm (15 x 20 x 1 inch) thick	15.00	60.00
47	1	Steam hose 15.2 meters (50 feet) long	150.00	150.00
48	1	Air compressor, electric	600.00	600.00
49	1	Air regulating valve assembly	50.00	50.00

TABLE XXXII (Continued)
Equipment Requirements for Canning Plant C

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		PLANT		
50	20	Jar or can dividers, plastic retort separators, heavy duty	$ 6.00	$ 120.00
51	2	Ventilating fan, 374 Cubic Meters per Minute (13,200 CFM)	250.00	500.00
52	1	Meat and food chopper, Electric	650.00	650.00
53	1	Pulper/finisher, Electric	4,400.00	4,400.00
	2	Extra screens	60.00	120.00
54 Optional	1	Can reformer mandel for 307 x 409 and 401 x 411 cans	2,000.00	
55 Optional	1	Can flanger with rolls for 307 x 409 cans	2,185.00	
Optional	1	Extra rolls for 401 x 422 cans	310.00	
56	3	Funnels, stainless steel, 20 cm (8 inch) diameter	10.00	30.00
57	1	Clock	14.00	14.00
58	2	Carborundum stone	14.00	28.00
59	1	Can Opener	22.00	22.00
60	1	Labeling table, 1 x 6.1 meters (3 x 20 feet)	50.00	50.00
61 Optional	1	Corn cutter with two self-regulating (SR) swing type heads, cut-all device, self-contained motor drive and including kernal size separators	2,600.00	

TABLE XXXII (Continued)

Equipment Requirements for Canning Plant C

Item Number		Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
			PLANT		
62	Optional	1	Double head stand, swing type with cob guide gauge, knife setting ring, main plug, and depth gauge ring	$ 470.00	
63	Optional	1	Spare parts kit for corn cutter	215.00	
64	Optional	1	Knife sharpener, band type, dry wheel, self-contained motor drive	550.00	
65	Optional	1	Silker, high speed, 4 extra screens, stainless steel corn distributor, self-contained motor drive for whole kernel and cream style corn	2,500.00	
66	Optional	1	Lye peeler-scalder complete	450.00	
67	Optional	1	Extra rinse basket	60.00	
68	Optional	1	Pea-Bean huller with 1.27 cm (½ inch) sieve	3,300.00	
69	Optional	1	Extra 0.95 cm (3/8 inch) sieve for huller	150.00	
70	Optional	1	Extra 1.58 cm (5/8 inch) sieve for huller	150.00	
71		1	Can seam micrometer	50.00	$ 50.00
72		1	Sanitary can opener	20.00	20.00
73		1	Pair of nippers, 15 cm (6 inch)	6.00	6.00
74		1	Hand washing lavatory	250.00	250.00
			TOTAL COST OF PLANT EQUIPMENT		46,081.50

TABLE XXXII (Continued)

Equipment Requirements for Canning Plant C

Item Number	Quantity	CAPITAL EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		OFFICE EQUIPMENT		
75	1	Desk and chair	$ 325.00	$ 325.00
76	1	Typist's desk and chair	250.00	250.00
77	2	File cabine	75.00	150.00
78	1	Typewriter	300.00	300.00
79	1	Calculator	100.00	100.00
		TOTAL COST OF OFFICE EQUIPMENT		$ 1,125.00

TABLE XXXII (Continued)

Equipment Requirements for Canning Plant C

Item Number	Quantity	EXPENDABLE EQUIPMENT Description	EXAMPLE COST ONLY Unit	Total
		PLANT		
80	6	Meat and Bone saw blades	$ 1.50	$ 9.00
81	12	Pot brushes	2.25	27.00
82	6	Exhaust test thermometer, -18° - 104.4° C (0 - 220°F)	11.00	66.00
83	2	Water hose, heavy duty, 7.5 meters (25 feet) length	50.00	100.00
84	2	Nozzles for water hoses	5.00	10.00
85	4 pr.	Rubber coated, gauntlet style gloves	5.00	20.00
86	4 pr.	Thin canners' type rubber gloves	2.00	8.00
87	8	Vegetable brushes	3.00	24.00
88	2	Metal files	10.00	20.00
89	1	First Aid Kit	20.00	20.00
90	3	Brooms	5.00	15.00
91	3	Mops	5.00	15.00
92	12 pr.	Cotton gloves	3.00	36.00
		SUBTOTAL COST OF PLANT EXPENDABLE EQUIPMENT		$370.00

TABLE XXXII (Continued)
Equipment Requirements for Canning Plant C

Item umber	Quantity	EXPENDABLE EQUIPMENT Description	EXAMPLE PRICE ONLY Unit	Total
		OFFICE		
93		Record Books, Forms, and File Folders	$ 325.00	$
94		Stationery	75.00	
		SUBTOTAL COST OF EXPENDABLE SUPPLIES		400.00
		TOTAL COST OF EXPENDABLE EQUIPMENT & SUPPLIES		$ 770.00

TABLE III

SUMMARY OF EQUIPMENT COSTS FOR CANNING PLANT C

CAPITAL		
Plant	$46,081.50	
Plus 15 % for Overseas Freight (Estimated)	6,912.23	
Subtotal		$52,993.73
Office	1,125.00	
Plus 15 % for Overseas Freight (Estimated)	168.75	
Subtotal		1,293.75
TOTAL COST OF CAPITAL EXPENDITURE		$54,287.48
EXPENDABLE		
Plant	$ 370.00	
Plus 15 % for Overseas Freight (Estimated)	55.00	
Subtotal		$ 425.50
Office	400.00	
Plus 15 % for Overseas Freight (Estimated)	60.00	
Subtotal		$ 460.00
TOTAL COST OF EXPENDABLE EXPENDITURE		$ 885.50

Equipment Requirements

The basic production equipment and office furniture and equipment necessary to operate plant C are listed in Table XXXII, "Equipment Requirements for Plant C." The production equipment for this size canning plant costs approximately $54,994.00, which includes installation and 15% of the total cost for overseas shipment, but does not include the cost of crating for shipment. A description of specialized equipment is given in Chapter 12, "Equipment Description." Some items of equipment can probably be purchased locally at a saving to the prospective owner.

The office furniture and equipment required for plant C is estimated to cost approximately $1,322.00. Used equipment and furnishings, when available, can probably be purchased locally at considerable savings.

Labor Requirements

For estimating the labor requirements of plant C, Table XXXIV. "Estimated Unit Times for Processing 740 No. 2 Cans in Plant C," was used. The times appearing in the table are the average times required for the various operations involved in canning a number of different fruits and vegetables. Although the actual times may have varied from product to product, the average times were used for estimating plant C capacity. In using these times, it was estimated that an average of 7 cycles for each of the 4 retorts could be made within an 8-hour day giving a production of 5,180 No. 2 cans per day.

TABLE XXXIV

ESTIMATED UNIT TIMES FOR PROCESSING 740 NO. 2 CANS IN PLANT C

WITHOUT OPTIONAL EQUIPMENT

Operation	Description	Time (Man Minutes)	Your Plant (Man Minutes)
1	Food Preparation	1372	_____
2	Rinsing and Straightening Cans	124	_____
3	Preheating Product	212	_____
4	Filling Cans	184	_____
5	Exhausting and Adjusting Headspace . .	104	_____
6	Sealing Cans	104	_____
7	Processing and Cooling	55	_____
8	Labeling and Wiping Cans	440	_____
	Total Man Minutes per Retort Cycle.	2595	_____

When canning plant C is operated commercially 36 non-skilled and 2 semi-skilled workers are required to form the production work force or direct labor. The indirect labor needed consists of plant supervisor, clerk and janitor. A summary of the total direct and indirect labor and the cost per hour is given in Table XXXV, "Labor Requirements for Plant C Operated Commercially," and the annual labor costs in Table XXXVI,"Annual Labor Costs for Plant C Operated Commercially." In calculating annual labor costs, it is assumed that the direct labor is retained only for a six-month canning season. The plant supervisor and the others comprising the indirect labor personnel are employed on a twelve-month basis.

TABLE XXXV

LABOR REQUIREMENTS FOR PLANT C OPERATED COMMERCIALLY WITHOUT OPTIONAL EQUIPMENT

	No. of Workers	Example Hourly Rate	Example Hourly Cost	Your Plant Hourly Rate	Your Plant Hourly Cost
Direct Labor:					
Food Preparation and General	36	$2.60	$93.60	$_____	$_____
Semi-Skilled	2	3.00	6.00	_____	_____
Total Direct Labor	38		$99.00		$_____
Indirect Labor:					
Plant Supervisor	1	5.95	5.95	_____	_____
Clerk	1	3.00	3.00	_____	_____
Janitor	1	2.60	2.60	_____	_____
Total Indirect Labor	3		$11.55		$_____

TABLE XXXVI

ANNUAL LABOR COSTS FOR PLANT C OPERATED COMMERCIALLY WITHOUT OPTIONAL EQUIPMENT

Item	Hours per Year per Person	Plant Hourly Cost	Plant Annual Costs Example	Plant Annual Costs Your Plant
Direct Labor	1,008	$99.60	$100,397.00	$_____
Indirect Labor	2,016	11.55	23,285.00	_____
Total Annual Labor Costs			$123,682.00	$_____

Capital Requirements

In addition to the capital required to purchase the land, building and equipment, it is also necessary that the prospective owner have additional

capital to buy raw materials, payments of wages, cans, labels, cartons, etc. This additional capital is known as "working capital." The working capital should be sufficient to operate the plant until it begins to realize a profit. In effect, it is the money set aside to insure the canning operations will have an opportunity to be a success.

The capital requirements for plant C operated as a commercial enterprise are summarized in Table XXXVII, "Capital Requirements for Plant C Operated Commercially. Without Optional Equipment."

TABLE XXXVII

CAPITAL REQUIREMENTS FOR PLANT C OPERATED COMMERCIALLY

WITHOUT OPTIONAL EQUIPMENT

Item	Example	Your Plant
Fixed Assets:		
Land	$ 5,000.00	$
Building	108,720.00	
Plant Equipment	54,994.00	
Office Furniture and Equipment	1,322.00	
Total Fixed Assets	$ 170,036.00	$
Working Capital:		
Raw Materials - 1 month	$ 5,602.00	$
Cans, Cartons and Labels - annual	94,639.00	
Labor:		
Direct - 1 month*	15,725.00	
Indirect - 2 months*	3,881.00	
Other Expenses - 1 month**	3,211.00	
Inventory of Canned Products***	144,189.00	
Sub-Total of Working Capital	$268,247.00	$
10% of Working Capital for Contingencies	26,825.00	
Total Working Capital	$295,072.00	$

* See Table XXXVI.
** See Table XXXIX less indirect labor.
*** One-half of annual production multiplied by unit cost - see Table XL.

Ownership Costs

Ownership costs includes interest on investment in land, interest and capital retirement on buildings, plant equipment, office furniture and equipment, insurance, property taxes, and interest on one-half of working capital for 6 months. There is more involved in calculating cost to the owner for the investment in fixed assets than a straight line depreciation. Generally, portable fixed assets have some salvage or sale value, in the magnitude of 10% of the total cost, at the end of the depreciation period, which may be 10, 15, or 20 years. Fixed assets such as, buildings, are usually given a longer depreciati period with little or no salvage value. On the other hand, land on which the buildings are located usually appreciates rather than depreciates in value, consequently, land is not generally depreciated in determining ownership costs. True ownership costs not only include the cost of depreciation but also the interest on the amount invested in fixed assets. Therefore, if fixed assets are depreciated over a long period of time such as, 30 years, the interest will be greater than if the fixed assets were depreciated for only 15 years. To determine the ownership costs due to depreciation and interest on the investment in fixed assets, the Table I, "Annual Charge for Capital Recovery and Interest for Each Dollar of Investment" in Appendix ____, is used to obtain a calculated mathematical factor for a given number of years of depreciation at a specified rate of interest. This factor from the table is multiplied by the amount of the original investment, less its salvage value. The product of this calculation plus the interest on the estimated salvage value, insurance, and property taxes becomes the annual ownership cost of the investment in a particular fixed asset.

- Illustration:

$5,000.00	Purchased cost of equipment
500.00	Estimated salvage value of equipment at 10% of cost
$4,500.00	Capital to be recovered in plant costs
0.149	Factor from Table I based on 10 years of depreciation at 8%
$ 670.50	Annual recovery of both capital and interest
40.00	Interest at 8% on the $500.00 salvage value
$ 710.50	Total amount to be charged to Annual Ownership Costs

TABLE XXXVIII

OWNERSHIP COSTS FOR PLANT C OPERATED COMMERCIALLY

WITHOUT OPTIONAL EQUIPMENT

Item	Example	Your Plant
Interest on Land at 8%	$ 400.00	$
Interest and Capital Retirement:		
Building - 30 yr. Depreciation, no Salvage at 8%	9,654.00	
Plant Equipment - 10 yr. Depreciation, 10% Salvage, at 8%.	7,798.00	
Office Furniture & Equipment - 16 yr. Depreciation, 10% Salvage at 8%.	145.00	
Insurance and Property Taxes	2,660.00	
Interest on One-Half of Working Capital for 6 months.	5,901.00	
Total Ownership Costs	$ 26,558.00	$

Annual Overhead Expense

Annual overhead expense consists of ownership costs, indirect labor costs, fuel, utilities, factory materials, office supplies and miscellaneous. These costs are summarized in Table XXXIX, "Annual Overhead Expense for Plant C Operated Commercially Without Optional Equipment."

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TABLE XXXIX

ANNUAL OVERHEAD EXPENSE FOR PLANT C OPERATED COMMERCIALLY WITHOUT OPTIONAL EQUIPMENT

Item	Example	Your Plant
Ownership Costs	$ 26,558.00	$
Labor:		
Indirect	23,285.00	
Fuel	6,683.00	
Utilities	1,590.00	
Factory Materials - Parts and Repairs	1,766.00	
Office Supplies and Miscellaneous	1,875.00	
Total Annual Overhead Expense	$ 61,757.00	$

Unit Cost for Processing No. 2 Cans

In plant C operating commercially at full capacity, the cost for manufacturing, selling and distributing No. 2 cans amounts to $0.4749 per can. A breakdown of these costs is given in Table XL, "Unit Cost for Processing No. 2 Cans in Plant C Operated Commercially Without Optional Equipment."

TABLE XL

UNIT COST FOR PROCESSING NO. 2 CANS IN PLANT C OPERATED COMMERCIALLY*
WITHOUT OPTIONAL EQUIPMENT

Item	Cost per Can Example	Cost per Can Your Plant
Raw Materials	$ 0.0515	$
Cans, Cartons and Labels	0.1450	
Direct Labor	0.1538	
Overhead Expense	0.0946	
Sub-total Plant Unit Cost	$ 0.4449	
Selling, Distribution	0.0300	
Total Unit Cost	$ 0.4749	$

*Costs are based on an annual production of 652,680 No. 2 cans.

THE ECONOMICS OF OPERATING CANNING PLANT C COMMERCIALLY WITH OPTIONAL EQUIPMENT

Operating plant C with optional labor saving equipment as a commercial enterprise is more efficient than operating a plant that uses hand labor in all preparation operations. While the initial investment in plant equipment is approximately 25% greater, the direct labor requirements have been reduced by approximately 35% annually. This annual saving in operating costs over a period of a few years will be substantial.

Land Requirements

The land requirements for plant C operated commercially with optional equipment will be the same as a plant without the optional equipment.

Building Requirements

The building requirements will also be the same as a plant without the optional equipment.

Equipment Requirements

The additional cost of the labor saving optional equipment will be approximately $13,555.00. The optional equipment is listed along with the other plant production equipment in Table XXXII "Equipment Requirements for Canning Plant C."

Labor Requirements

The annual direct labor costs for plant C operated commercially with optional equipment was $74,189.00 as compared to $100,379.00 for direct labor for plant C with the optional equipment - a $26,190.00 reduction. The reductions in labor requirements and annual labor costs can be seen by compar-

ing the values in Table XXXIII, "Unit Time for Processing 740 No. 2 Cans in Plant C, Without Optional Equipment," Table XXXIV, "Labor Requirements for Plant C, Without Optional Equipment" and Table XXXV, "Annual Labor Costs for Plant C, Without Optional Equipment" with those values found in the Tables XL, XLI, XLII for plant C without optional equipment.

TABLE XLI

ESTIMATED UNIT TIMES FOR PROCESSING 740 NO. 2 CANS IN PLANT C
WITH OPTIONAL EQUIPMENT
(4 Retorts)

Operation	Description	Time (Man Minutes)	Your Plant (Man Minutes)
1	Food Preparation	648	____
2	Rinsing and Straightening Cans	124	____
3	Preheating Product	212	____
4	Filling Cans.	184	____
5	Exhausting and Adjusting Headspace . . .	104	____
6	Sealing Cans.	104	____
7	Processing and Cooling	55	____
8	Labeling and Wiping Cans	440	____
	Total Man Minutes per Retort Cycle	1,871	____

With the use of labor saving optional equipment plant C would only need 26 employees plus 2 semi-skilled workers to form the production work force or direct labor. The indirect labor would be a plant supervisor, clerk and janitor. A summary of the total direct and indirect labor and the cost per hour is given in Table XLII, "Labor Requirements for Operating Plant C Commercially with Optional Equipment" and the annual labor cost in Table XLIII, "Annual Labor Costs for Operating Plant C Commercially with Optional Equipment." The direct labor would be retained only for the six-month canning season while the indirect labor would be employed for 12 month periods.

TABLE XLII

LABOR REQUIREMENTS FOR OPERATING PLANT C COMMERCIALLY WITH OPTIONAL EQUIPMENT

	No. of Workers	Example Hourly Rate	Example Hourly Cost	Your Plant Hourly Rate	Your Plant Hourly Cost
Direct Labor:					
Food Preparation and General	26	$ 2.60	$ 67.60	$_____	$_____
Semi-Skilled	2	3.00	6.00	_____	_____
Total Direct Labor	28		$ 73.60		$_____
Indirect Labor:					
Plant Supervisor	1	$ 5.95	$ 5.95	$_____	$_____
Clerk	1	3.00	3.00	_____	_____
Janitor	1	2.60	2.60	_____	_____
Total Indirect Labor	3		$ 11.55		$_____

TABLE XLIII

ANNUAL LABOR COSTS FOR OPERATING PLANT C COMMERCIALLY WITH OPTIONAL EQUIPMENT

Item	Hours per Year per Person	Plant Hourly Cost	Plant Annual Costs Example	Plant Annual Costs Your Plant
Direct Labor	1008	$ 73.60	$74,189.00	$_____
Indirect Labor	2016	11.55	23,285.00	_____
Total Annual Labor Costs			$97,474.00	$_____

Capital Requirements

The annual operating cost for plant C with optional equipment operating as a commercial enterprise amounts to approximately $ 278,120.00 which is $16,952.00 less than if the plant operated without the optional equipment.

Capital requirements for plant C operating commercially with the optional equipmen are set forth in Table XLIV, "Capital Requirements for Operating Plant C Commercially with Optional Equipment."

TABLE XLIV

CAPITAL REQUIREMENTS FOR OPERATING PLANT C COMMERCIALLY WITH OPTIONAL EQUIPMENT

Item	Example	Your Plant
Fixed Assets:		
Land	$ 5,000.00	$_____
Building	100,720.00	_____
Plant Equipment	68,549.00	_____
Office Furniture and Equipment	1,322.00	_____
Total Fixed Assets	$ 183,591.00	$_____
Working Capital:		
Raw Materials - 1 month	$ 5,602.00	$_____
Cans, Cartons and Labels - annual	94,639.00	_____
Labor:		
Direct - 1 month*	12,365.00	_____
Indirect - 2 months*	3,881.00	_____
Other Expenses - 1 month**	2,713.00	_____
Inventory of Canned Products***	133,636.00	_____
Sub-total of Working Capital	$ 252,836.00	$_____
10% of Working Capital for Contingencies	25,284.00	_____
Total Working Capital	$ 278,120.00	$_____

* See Table XLIII
** See Table XLVI less indirect labor.
*** One-half of annual production multiplied by unit cost - see Table XLVII.

Ownership Costs

The annual ownership costs for plant C with the optional equipment amount to $29,401.00 which is greater by $2,843.00 than for plant C operating without

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the optional equipment. This increase is due mainly to the interest and capital retirement on the extra cost of the investment in the labor saving equipment and the extra cost in insurance and taxes. The annual ownership costs are summarized in Table XLV, "Annual Ownership Costs for Operating Plant C Commercially with Optional Equipment."

TABLE XLV

OWNERSHIP COSTS FOR OPERATING PLANT C COMMERCIALLY WITH OPTIONAL EQUIPMENT

Item	Example	Your Plant
Interest on Land at 8%	$ 400.00	$_____
Interest and Capital Retirement:		
Building - 30 yr. Depreciation, no salvage, at 8%	9,654.00	_____
Plant Equipment - 10 yr.Depreciation, 10% Salvage, at 8%	10,756.00	_____
Office Furniture & Equipment - 16 yr.Depreciation, 10% Salvage, at 8%	145.00	_____
Insurance and Property Taxes	2,884.00	_____
Interest on One-half of Working Capital for 6 Mo.. .	5,562.00	_____
Total Ownership Costs	$29,401.00	$_____

Annual Overhead Expense

The annual overhead expense for plant C with optional equipment increased by $2,843.00 over the plant that was operated without the optional equipment to $64,600.00. The items listed in the overhead expense are listed in Table XLVI, "Annual Overhead Expense for Operating Plant C. Commercially with Optional Equipment."

TABLE XLVI

ANNUAL OVERHEAD EXPENSE FOR OPERATING PLANT C COMMERCIALLY WITH OPTIONAL EQUIPMENT

Item	Example	Your Plant
Ownership Costs	$ 29,401.00	$
Labor:		
Indirect	23,285.00	
Fuel	6,683.00	
Utilities	1,500.00	
Factory Materials - Parts & Repairs	1,766.00	
Office Supplies & Miscellaneous	1,875.00	
Total Overhead Expense	$64,600.00	$

Unit Cost for Processing No. 2 Cans

The unit cost for processing No. 2 cans in plant C with optional equipment dropped $0.0355 per can as compared to the unit cost processed in plant C without optional equipment. An annual production of 652,680 No. 2 cans in a plant with optional equipment would save $23,105.00 over a plant without the optional equipment. A breakdown of these costs is given in Table XLVII, "Unit Cost for Processing No. 2 Cans Commercially in Plant C with Optional Equipment."

TABLE XLVII

UNIT COST FOR PROCESSING NO. 2 CANS COMMERCIALLY IN PLANT C*
WITH OPTIONAL EQUIPMENT

Item	Example	Your Plant
Raw Materials	$ 0.0515	$
Cans, Cartons and Labels	0.1450	
Direct Labor	0.1140	
Overhead Expense	0.0990	
Sub-total Plant Unit Cost	$ 0.4095	$
Selling, Distribution and Administration	$ 0.0300	
Total Unit Cost	$ 0.4395	$

* Costs are based on an annual production of 652,680 No. 2 Cans.

THE ECONOMICS OF OPERATING CANNING PLANT C COOPERATIVELY WITHOUT OPTIONAL EQUIPMENT

When plant C is operated as a cooperative it has the same potential capacity as if it was operated on a commercial basis - 5,180 No. 2 cans per 8-hour day or 652,680 per 126 day canning season. These estimates may be high for most plants of this size operating as cooperatives because management does not have the degree of control over the production personnel, except the two semi-skilled employees, as it would have in a commercial operation. However, operating costs in this analysis have been estimated on the assumption that production would be the same as that of a commercial operation because it would be very difficult to predict production at any other level.

Land Requirements

The land requirements for plant C operated cooperatively are the same as if it were operated as a commercial enterprise. The same guidelines need to be followed in selecting a suitable site as were used in selecting a site for a commercial plant C. The cost of the site would probably be the same also - $ 5,000.00.

Building Requirements

The building for cooperative plant C would be smaller because of the elimination of warehouse space to store the canned products, which will be removed by the patrons as they come from the processing lines. The storage area should have 356.7 square meters (3,840 sq.ft.) for storage of empty containers, etc. The processing room should have 208 square meters (2240 sq.ft.) of floor space with a minimum of 4 meters (13 ft.) ceiling height. The building should be a

one-story masonry type structure. The services of an architect, experienced in designing commercial buildings of this type, would be well worth the expense involved. In designing the building, natural lighting and ventilation of the processing room should be utilized to the fullest extent in an effort to provide the best working conditions possible for the workers and to conserve energy. It is advisable that the exterior of the processing room not be flanked on either side with storage areas, which would greatly reduce the effectiveness of cross ventilation, which is necessary in eliminating the steam vapor laden atmosphere from the room during processing. Chapter 10, "Building Construction," contains helpful information on constructing the plant building.

The recommended type of structure can be built in many sections of the United States for $161.50 per square meter ($15.00 per sq. ft.) of floor space. A building for plant C operated cooperatively would probably cost $91,200.00 in the United States.

Equipment Requirements

The basic production equipment and office furniture and equipment to operate plant C are listed in Table XXXII "Equipment Requirements for Plant C." The production equipment for plant C costs approximately $54,994.00, which includes installation and 15% of the total cost for overseas shipment, but does not include the cost of crating for shipment. A description of specialized equipment is given in Chapter 12.

The office furniture and equipment required for plant C is estimated to cost approximately $1,322.00. When available, used office furnishings should be purchased locally at considerable savings.

Labor Requirements

The labor requirements for plant C operated cooperatively would consist of two semi-skilled workers and two food preparation supervisors as direct labor, and a plant supervisor, clerk and a janitor as indirect labor. The semi-skilled employees and food preparation supervisors work only during the 6-month canning season. These workers are needed to perform certain critical operations such as, sealing cans and operating retorts. All the other operations will be performed by the patrons using the facilities. The food preparation supervisors will need to give individual instruction and assistance to the patrons.

Labor requirements and labor costs for plant C when operated as a cooperative may be found in Table XLVIII, "Labor Requirements for Plant C Operated Cooperatively" and Table XLIV, "Labor Cost for Plant C Operated Cooperatively," respectively. These estimates are based on the assumption that the patrons will perform the daily cleaning tasks and all others except those performed by the semi-skilled employees.

TABLE XLVIII

LABOR REQUIREMENTS FOR PLANT C OPERATED COOPERATIVELY, WITHOUT OPTIONAL EQUIPMENT

	No. of Workers	Example Hourly Rate	Example Hourly Cost	Your Plant Hourly Rate	Your Plant Hourly Cost
Direct Labor:					
Food Preparation and General	2	$ 2.80	$ 5.60	$_____	$_____
Semi-Skilled	2	3.00	6.00	_____	_____
Total Direct Labor			$11.60		$_____
Indirect Labor:					
Plant Supervisor	1	$ 5.95	$ 5.95	$_____	$_____
Clerk	1	3.00	3.00	_____	_____
Janitor	1	2.60	2.60	_____	_____
Total Indirect Labor			$11.55		$_____

TABLE XLIX

ANNUAL LABOR COSTS FOR PLANT C OPERATED COOPERATIVELY, WITHOUT OPTIONAL EQUIPMENT

Item	Hours per Year per Person	Plant Hourly Cost	Plant Annual Cost Example	Plant Annual Cost Your Plant
Direct Labor	1,008	$11.60	$11,693.00	$_____
Indirect Labor	2,016	11.55	23,285.00	_____
Total Annual Labor Cost			$34,978.00	$_____

Capital Requirements

The capital requirements for plant C operating as a cooperative are reduced considerably from those if the plant was operating commercially. The reductions

are in building, labor, raw materials and inventory of canned goods costs. The capital requirements for plant C operated as a cooperative are summarized in Table L, "Capital Requirements for Plant C Operated Cooperatively. The raw materials shown in this table refer to salt, sugar, and other seasoning agents commonly used in canning operations.

TABLE L

CAPITAL REQUIREMENTS FOR PLANT C OPERATED COOPERATIVELY
WITHOUT OPTIONAL EQUIPMENT

Item	Example	Your Plant
Fixed Assets:		
Land	$ 5,000.00	$
Building	91,200.00	
Plant Equipment	54,994.00	
Office Furniture & Equipment	1,322.00	
Total Fixed Assets	$152,516.00	$
Working Capital:		
Raw Materials - 1 month	$ 1,142.00	$
Cans, Cartons and Labels - annual	94,639.00	
Labor:		
Direct - 1 month*	1,949.00	
Indirect - 2 months*	3,881.00	
Other expenses - 1 month**	3,728.00	
Sub-total of Working Capital	$105,340.00	$
10% of Working Capital for Contingencies	10,534.00	
Total Working Capital	$ 115,874.00	$

*See Table XLIX
**See Table LII less indirect labor.

Ownership Costs

The ownership costs, which include interest on the investment in land, interest and capital retirement on other fixed assets, insurance, property taxes, and interest on one-half of the working capital for 6 months are lower for plant C when it is operated cooperatively than if it is operated commercially. The same explanation in determining ownership costs that is given for plant C operated commercially will apply to the plant when it is operated as a cooperative. These costs are summarized in Table LI, "Ownership Costs for Plant C Operated Cooperatively."

TABLE LI

OWNERSHIP COSTS FOR PLANT C OPERATED COOPERATIVELY
WITHOUT OPTIONAL EQUIPMENT

Item	Example	Your Plant
Interest on Land	$ 400.00	$
Interest and Capital Retirement:		
Building - 30 yr. Depreciation, No Salvage, at 8%	8,099.00	
Plant Equipment - 10 yr. Depreciation, 10% Salvage, at 8%	7,798.00	
Office Furniture & Equipment - 16 yr. Depreciation, 10% Salvage, at 8%	145.00	
Insurance and Property Taxes	2,397.00	
Interest on One-half of Working Capital for 6 months	2,317.00	
Total Ownership Costs	$21,156.00	$

Annual Overhead Expense

The annual overhead expense for plant C operated as a cooperative consists of ownership costs, both direct and indirect labor costs, fuel, utilities, factory materials, office supplies and miscellaneous. The overhead expense for a cooperative is higher than it is for a comparable commercial plant because direct labor is an overhead expense. Other costs making up the annual overhead expense are listed in Table LII, "Annual Overhead Expense for Plant C Operated Cooperatively."

TABLE LII

ANNUAL OVERHEAD EXPENSE FOR PLANT C OPERATED COOPERATIVELY
WITHOUT OPTIONAL EQUIPMENT

Item	Example	Your Plant
Ownership Costs	$ 21,156.00	$_____
Labor:		
Direct	11,693.00	_____
Indirect	23,285.00	_____
Fuel	6,683.00	_____
Utilities	1,590.00	_____
Factory Materials - Parts & Repairs	1,766.00	_____
Office Supplies & Miscellaneous	1,875.00	_____
Total Overhead Expense	$ 68,048.00	$_____

Unit Costs for Processing No. 2 Cans

When plant C is operated cooperatively at full capacity, the cost for manufacturing No. 2 cans amounts to $0.2598 per can. In a breakdown of the costs found in Table LIII, "Unit Costs for Processing No. 2 Cans in Plant C Operated

Cooperatively" no direct labor was included because the patrons provided all labor except the semi-skilled labor, food preparation supervisors and direct labor, which were taken into consideration in the annual overhead expense.

TABLE LIII

UNIT COSTS FOR PROCESSING NO. 2 CANS IN PLANT C OPERATED COOPERATIVELY* WITHOUT OPTIONAL EQUIPMENT

Item	Cost per Can Example	Cost per Can Your Plant
Raw Material	$ 0.0105	$_____
Cans, Cartons and Labels**	0.1450	_____
Overhead Expenses	0.1043	_____
Total Unit Costs	$ 0.2598	$_____

* Costs are based on an annual production of 652,680 No. 2 Cans.
**The cost per can could be cut approximately $0.025 by eliminating labels and cartons, which are useful but not essential.

THE ECONOMICS OF OPERATING CANNING PLANT C COOPERATIVELY WITH OPTIONAL EQUIPMENT

A cooperative, the size of plant C, should seriously consider the feasibility of investing $13,555.00 in labor saving optional equipment because the unit cost of operating plant C with the optional equipment is only $0.00465 per No. 2 can more than for a plant without the equipment. The production of 5,180 cans per day or 652,680 No. 2 cans per year can be obtained with only 26 patrons in a plant with the optional equipment as compared to 36 patrons in the same type of plant without the labor saving equipment.

The labor requirements and labor costs for operating plant C either with or without the optional equipment are the same. The capital requirements for plant C with the labor saving equipment is only $282.00 more than for the plant without

it. The ownership costs for a plant with the optional equipment is greater by $3,086.00 than the plant without it. The annual overhead expense for plant C with the extra equipment increased by $3,036.00 over the plant without it. This increase in the annual overhead expense caused the unit cost for the plant with the optional equipment to rise $0.00465 per No. 2 can above that for a plant operating without the equipment. The unit cost per No. 2 can processed by plant C with the labor saving optional equipment is estimated to be $0.2644.

CHAPTER SEVEN

SELECTION OF PLANT SITE

General Considerations - A canning plant should not be located at a particular site merely because the land can be obtained cheaply. Rather, many factors should be considered and carefully evaluated before the ideal site is selected. Any local ordinances pertaining to the operation of industrial plants should be known. An adequate supply of raw materials of acceptable quality and an adequate and dependable supply of water should be available at the proposed canning plant site. Sufficient labor must also be obtainable from the area surrounding the canning plant. Good transportation facilities and sewage and waste disposal facilities are essential. Also required is an adequate fuel and power supply. Finally, it is recommended that the site for the proposed canning plant have adequate land available for future expansion purposes.

Raw Materials.- In selecting the site for a proposed canning plant, an adequate and dependable supply of raw materials should be available in the immediate vicinity. The supply should be sufficient to keep the plant operating for at least half of the time. If the district under consideration is not capable of producing the volume of raw materials needed, expenditures for a building and equipment are not justified.

It should be determined whether the quality of the raw materials is suitable for canning purposes. Some fruits and vegetables, although acceptable for fresh market, are not suitable for canning.

The success of a canning plant depends as much on continuous operations as on the maximum capacity. This is necessary in order to decrease the cost of operating the plant per unit of produce canned. Figure 1 in Appendix shows the

approximate harvesting season for a number of fruits and vegetables grown in the United States in the state of California. A chart similar to this one could be used as a guide in selecting the raw products to be canned.

Especially when fruits and vegetables are canned, there is no question as to the advantages of being located near the raw materials. Advantages of being located adjacent to the source of raw products are as follows:

1. The fruits and vegetables can be harvested at the best time in order to assure a quality product.

2. There is a decrease in the injury from handling of the product and in the deterioration changes after harvesting the product.

3. Transportation costs of the raw materials are reduced.

4. Cleaning, sanitizing, and recycling of containers used in harvesting and transporting produce to the canning plant can be programmed on shorter schedules, thereby reducing the need for a large investment for such containers as well as reducing spoilage.

When the source of raw materials is adjacent to the cannery, the producer very often makes frequent delivery of products. This results not only in better quality products but also in a much closer relationship between the canner and producer. Under such conditions, the canner is better able to explain his requirements for raw materials, and the producer is more likely to understand them.

In many instances, the canning plant contracts with the grower for his season's crop. Sometimes the canner even furnishes the seeds. In other instances, the canner buys raw materials from the grower on a batch basis.

Labor Supply - An important factor to consider in selecting a site for a proposed canning plant is the availability of an adequate supply of labor. Unlike many types of businesses, canning plant labor demands fluctuate with the season. To attract and to hold satisfactory labor can be exceedingly difficult. Small towns and rural communities where there are no large industries often provide a good source of seasonal labor. If sufficient labor cannot be obtained otherwise, it may be necessary to bring in outside help and to provide living accommodations. If suitable dwellings have to be erected by the canning plant, an additional item is added to the capital requirements of the new plant.

During the busy canning season, a fixed work day is often impractical for commercial plants. The raw material may be brought to the plant at more or less irregular intervals and, since it is extremely perishable, it must be processed as soon as possible.

As a rule, key personnel such as plant superintendent and clerk are retained for a full twelve month work year. Cooperative canning plants in the United States are often managed by teachers who instruct high school classes in agriculture or home economics during the inactive canning seasons.

Transportation Facilities - The proposed site for a canning plant should be located close to good transportation facilities. The types of transportation which will be needed, e. g., rail, water, and public highways, should be carefully considered. For many canned products, freight rates may be the determining factor as to whether an item can be packaged and marketed profitably.

Many small canning plants make the mistake of not considering transportation facilities for future expansion. As the canning plant grows, the

importance of transportation becomes greater. For this reason, transportation facilities should be considered very carefully in selecting the site for a canning plant.

Fuel and Power Supplies - Fuel and power supplies should be available at a reasonable rate. If gas is used in the plant, the supply should be large enough to meet the present and future needs.

Electric power is very essential in operating a successful canning plant. A careful check should be made to see that adequate power is available at all times. Capacity of the power lines for future expansion of the plant facilities should also be considered. If electric power is not dependable, a standby electric generator should be available.

It is suggested that local representatives of the utility companies be contacted to determine whether the services are adequate.

Water Supply - In selecting a site for a canning plant, the availability of water should be considered after the availability of raw products has been determined. This is true because large quantities of water are needed in the canning operations. The most important uses of water are listed below:

1. Cooling of processed cans
2. Steam generation
3. Preparation of brine, syrups, etc.
4. Blanching
5. Cleaning and preparation of raw materials
6. Cleaning of equipment, floors, walls, etc.

In general, fruit and vegetable canning plants will require more water than meat or fish canning plants. Approximately 1-1/2 to 2-1/2 gallons of water are required for each No. 2 can of peas packed in the United States today.

All water used around a canning plant should be of good drinking quality, free from any possibility of sewage contamination, and low in mineral salts,

especially sulfates and iron salts. "Hard" water containing appreciable quantities of calcium and magnesium salts also should be avoided, not only because of any possible effects on the product but also because of the damage to the boiler tubes. If the water available at the canning site does not meet these requirements, it can possibly be made fit for use by the installation of a water softener. Experienced engineers should be consulted on this problem.

Water for a canning plant may be obtained from wells or municipal water supplies. In many instances, well water requires no purification whatsoever. Municipal water supplies can be of any quality, depending on their source and the treatment used by the municipality. They are almost always free of bacterial impurities. In all cases, a competent bacteriologist should analyze the water supply to determine what purification is necessary.

Land Available for Expansion - In selecting a site for a canning plant, sufficient land should be available for future expansion. Although a small site of probably half an acre is sufficient for a start, availability of adjoining property to expand to seven or eight acres should be considered.

Sewage and Waste Disposal - The sewage and waste disposal facilities of a proposed canning site should be evaluated carefully. As a rule the canning plant should be located on level land or land that can be reshaped by grading so that there will be ample provision for drainage facilities. The immediate area around the building or buildings should be firm with sufficient slope for good drainage. Provision for sewage from toilets must be made for it to enter an underground septic tank with adequate drainage fields or a municipal sewage disposal system. Ideally, a municipal disposal system is the best method of disposing of liquid waste from the processing operation. If municipal waste

disposal systems are not available, a consultant on sewage and waste disposal should be engaged to develop the most practical system. There are three possibilities for disposing of liquid waste from the plant operations that a consultant may consider: 1) septic tank with a large drainage field, 2) absorption ponds or storage lagoons, and 3) spray irrigation. To install either of these three systems will require a competent consultant engineer who has a good knowledge of soil types best suited for each of the three systems.

Plant Grounds - It must be remembered that the grounds about the canning plant will need to be kept free from conditions which may result in the contamination of food including the following: 1) improperly stored equipment, litter, refuse, and uncut weeds or grass within the immediate vicinity of the plant building that may constitute an attractant, breeding place or harbor for rodents, insects, and other pests; 2) excessively dusty roads, yards or parking lots that may constitute a source of contamination in areas where food is exposed; 3) inadequately drained areas that may contribute contamination to food products through seepage or foot-borne filth and by providing a breeding place for insects or microorganisms.

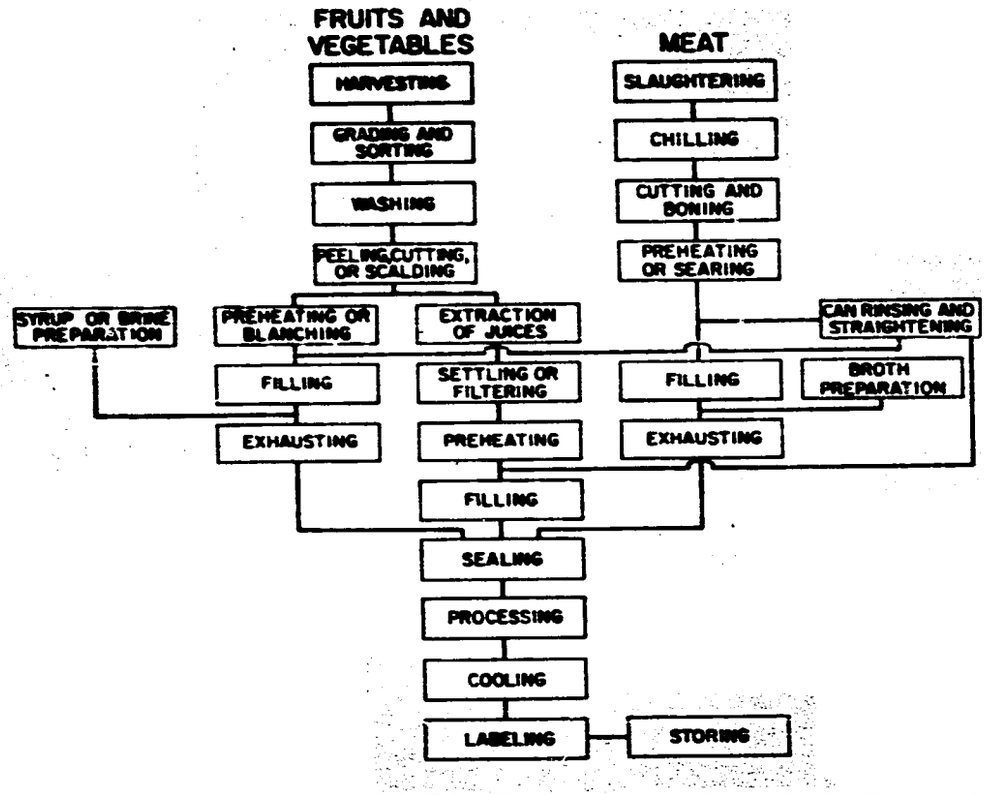

Figure 15 Flow Diagram for Canning Fruits, Vegetables, Juices and Meats

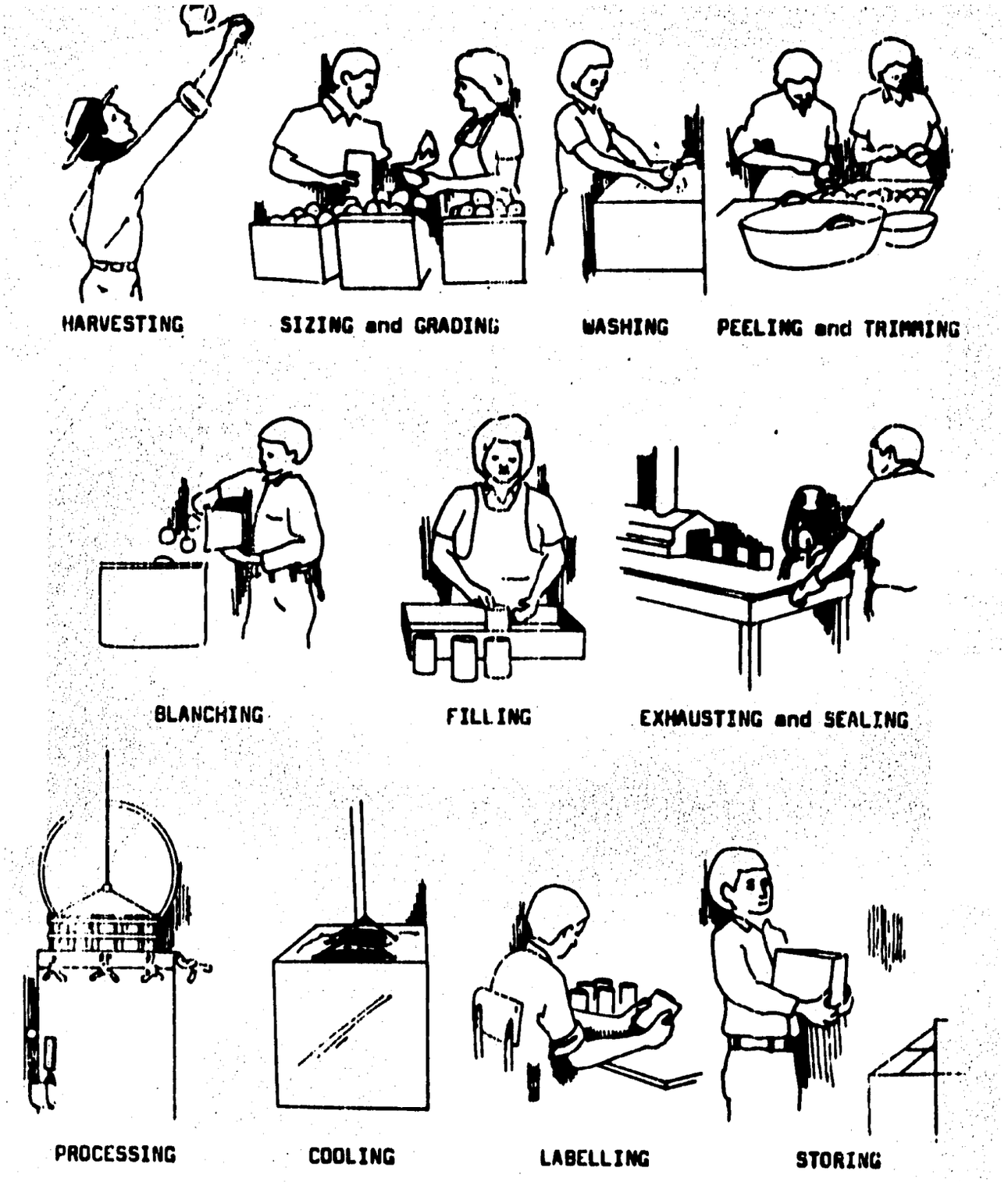

Figure 16. Simplied Pictorial Flow Diagram for Canning Fruits and Vegetables

CHAPTER EIGHT
CANNING PLANT OPERATIONS

General Considerations:

In processing food, strict quality control as well as careful attention to sanitation is necessary to insure an attractive and palatable product. A flow chart showing the various operations involved in canning fruits, vegetables, meats and juices is shown in Figure 15. A simplified pictorial flow chart of the operations involved in canning fruits and vegetables appears in Figure 16.

1. Harvesting: Caution should be taken in preventing the produce from being damaged in harvesting and delivery to the canning plant. Most fruits should be harvested in the firm ripe stage of maturity to prevent excessive damage due to bruising during harvesting and delivery. Some preparation hazards to avoid include: loss of soluble sugars and acids, which will cause poor flavor, in washings of the peeled and cut fruit; break-down of the halves or slices while being processed; and unattractiveness. Most vegetables are harvested at the optimum stage of maturity for fresh consumption. Since changes take place rapidly in harvested produce, it is important that it be delivered to the canning plant and processed promptly. Best results are obtained if the produce is canned within 24 hours after harvesting.

2. Washing: Washing, whether done by hand or mechanically, removes dirt and a large percentage of surface microorganisms. Thorough washing is important because the removal of microorganisms reduces the amount of heating required to sterilize the canned food and therefore, lessens the chance of some organisms surviving and spoiling the product. Care must be taken in the washing operation so that the produce will not become bruised or cut causing the loss of valuable juices. Washing of small lots of produce can be successfully carried out in pans of water, but sprays of potable running water will make the

washing operation more convenient and thorough. If large quantities of produce need to be washed, a mechanical rotary rod washer should be considered.

3. Grading and Sorting: Quality and uniformity in the finished product are maintained by grading and sorting the produce. Produce that is too green, over-ripe, or even spoiled or shows serious insect damage should be discarded. Large, choice fruits and vegetables should be sorted from the small ones and canned separately. Small fruit, if sound and fully ripe, can be utilized by making it into jelly, jam, nectar or juice. Small vegetables can be used in making hash, stews, soups, etc. In some cases, it may be desirable to can two or more different grades of produce. Of course, these comments as to size do not apply to material that is to be cut into pieces.

4. Preparation: Methods of preparation of produce for canning must be chosen according to the type of produce and style of canning desired. Food is ordinarily prepared for canning in the same manner that fresh food is prepared for the table. Peeling is accomplished by scalding, steaming, with a caustic soda solution, or by a mechanical peeler. Shelling of peas and some beans by hand is a slow and tedious operation; and in large operations, it is always done mechanically. The same is true of cutting corn off the cob. However, in small operations, and where labor costs are low, it may be more economical to do these operations by hand.

It is often desirable to can large fruits and vegetables whole or in pieces as large as can be conveniently packed into the can. From an aesthetic standpoint, it is necessary to make the pieces uniform in size and shape and to preserve the natural appearance of the fresh food insofar as is possible.

Most vegetables and some fruits, such as, apples, are blanched before being packed in the cans. Blanching — exposing fruit or vegetables to live steam or boiling water — expels the intracellular gases, further cleans it of dirt or spoilage organisms, eliminates it of earthy flavors, and fixes some of the color in the food. In some cases, particularly in the canning of meats, food is actually cooked before it is placed into the cans. Generally, however, care is taken in the peeling and blanching steps to avoid completely cooking the food since such cooking may harm the flavor, appearance and texture of the food.

Some acid foods are not blanched but are cold-packed. However, it is difficult to obtain full cans without blanching because of shrinkage during processing. Care must be taken to preserve the color of cold-packed foods. Salt, sugar, ascorbic acids or a combination of ascorbic and citric acids are used frequently in the canning medium to prevent discoloration, and cans lined with an acid-resistant enamel are used.

5. Filling: When filling cans, the food is generally placed in the cans, and the liquid medium, brine or syrup, is poured over it. Vegetables may be packed with a salt tablet and covered with water. When packing, it is important to arrange the food in such a way as to leave a minimum of void space in the container. This is one of the reasons for wilting the product by blanching. Such arrangement of the blanched food, insures full weight and, in the case of foods canned in glass, an attractive appearance. Attention to this point is particularly necessary in canning large fruit such as peaches.

6. Exhausting: Exhausting consists of heating filled cans with live steam in an exhaust tunnel or in a boiling water bath until a specifieed

temperature at the center of the can is reached. This insures that a large portion of the intercellular and intracellular gasses is expelled and that the headspace in the container is filled with steam rather than with air. Intracellular and intracellular gases have approximately the same composition as air. Therefore, they contain about 20 percent oxygen. Containers sealed hot will have a partial vacuum when cooled. It is particularly important to eliminate oxygen from the container since food exposed to oxygen discolors and loses flavor. Excessive gas sealed in the can will create excessive pressures within the can and may cause permanent distortion of the can which could lead to spoilage.

Foods that are precooked need not be exhausted provided they are still hot while the containers are filled and sealed. Foods packaged in glass jars with a two piece lid are generally filled hot or are covered with boiling brine or syrup and do not require exhausting since gases escape from the jars during thermal processing.

7. Sealing: Cans are sealed as soon as the center can temperature reaches the specified value for the food being canned. A perfect seal is vitally important because an imperfect one will permit spoilage. Tin cans are sealed by means of a sealing machine, which may be hand-operated or motor-driven. Can sealers must be kept in good repair, properly adjusted and inspected frequently to prevent improper functioning.

Glass jars with self-sealing lids are sealed by placing the tops on the jars and screwing the ring down firmly, but not too tightly. Screwing the ring down too tightly may break the sealing compound on the lid or prevent the jars from exhausting properly during processing. Although the self-sealing lid is the simplest and the most practical, several other types of lids are available and fairly widely used.

8. Processing: Processing consists of exposing the sealed cans or jars to saturated steam under pressure or to boiling water. Acid foods may be safely processed in boiling water since most heat-resistant spores are not able to grow in an acid medium. However, low-acid foods, which include most vegetables, meats, poultry, and sea foods must be processed at temperatures higher than that of boiling water 100 C (212 F) in order to kill the bacterial spores. Steam under pressure at 115 C (240 F) or higher is used for processing low acid foods. To process at temperatures above that of boiling water pressure cookers or retorts, which are pressure vessels especially designed to withstand the pressures involved, are employed. These vessels vary in size, from small pressure cookers used on surface burner units and holding a few cans, to large retorts capable of processing several thousand cans at a time.

From the stand point of food safety, it is vitally important that processing times and temperatures used are sufficient to sterilize the canned product. However, from the stand point of quality control, it is equally important that the food is not overcooked since overcooking will probably destroy the flavor, appearance and nutritional value of the food. For this reason, the temperatures and times given in a schedule for each product and each size container should be accurately measured and carefully controlled.

9. Cooling: Rapid cooling is very important to prevent food spoilage by the heat resistant bacteria, thermophiles, and overcooking. Tin cans are usually cooled by submerging them in cold running water 15.5 to 21 C (60 to 70 F) until they are cooled down to 38 C (100 F). Because glass breaks under

thermal shock, food processed in glass jars needs to be cooled slowly either in air or in fine mist spray of water. A fine mist of spray water is the most desirable from the stand point of food safety and quality of product because this method is much quicker than air. Cooling by this method can best be accomplished by cooling in a retort especially installed for cooling glass jars following the thermal process.

10. Labeling: Labeling serves to identify the product, net contents, ingredients used and the manufacturer's name and address as well as to help protect the can from rust. In small canning plants labeling is done by hand since even the small labeling machines are expensive and have very large capacity. Labels should be attractively designed to appeal to the customers. Although most labels are printed on paper and the paper label is glued on the can, it is possible in some areas to purchase cans with a lithographical label - one that is printed directly on the metal of the can.

11. Storing: Storage areas must be provided for the finished cans. A cool, dry place is not only desirable but necessary because both microbial and chemical spoilage are greatly accelerated in warm atmospheres. For storing glass jars a dark place is recommended because light is likely to cause discoloration of the product. A dry storage is necessary to prevent rust from forming on the metal cans and to prevent cases from coming apart.

CHAPTER NINE

PLANT LAYOU

General Considerations: When designing an efficient food processing plant, major considerations should be given to the location of equipment so that the raw products enter the plant and flow through the processing lines quickly and with a minimum of lost motion and delay due to high capacity in one part of the plant and low capacity or *bottle-necks* in another part.

Receiving Area: The receiving area or raw product storage should be conveniently located with reference to road and/or rail transport and the raw product preparation area in the processing room.

Preparation Line (see Figures 13 and 14): The preparation line area should be large enough to permit the arrangement of the wash sinks or washer units and preparation tables to the best advantage so that the quality and quantity of the output will not be hindered. Scales should be located either in the preparation or raw product storage area to weigh the raw products as they are received into the plant. The sinks should be located close to the front outside wall over drains so the water from the sinks and any spillage can drain into the floor drains. Tables on casters are convenient for moving the produce from the sinks where it has been washed to the preparation tables located over floor drains, for sorting into different size and grade classifications to assist in making decisions for optimum utilization.

Precook Line: In the precook line the blancher-cooler should be located over a floor drain in-line with and between the preparation and filling tables. It would be convenient to have a steam kettle located near the end of the precook line and at the beginning of the exhaust and can sealing line over a

floor drain. A table on casters could be utilized for moving the filled containers from the filling table by the kettle, from which is added either hot brine or syrup to the containers, onto the exhauster.

Exhaust and Can Sealing Line: In the exhaust and can sealing line, the exhauster is placed over a floor drain and the sealers are either mounted on casters or a table with casters which can be moved about the plant when and where needed.

Cook Line: In the cook line, the steam jacketed kettles and retorts are located at least 0.75 meters (2.5 ft.) from the back wall of the plant over floor drains. If the kettles are the tilting type, they should be so placed that when they are tilted their contents should pour directly into the drain. The kettles are usually located on the end of the line close to the exhaust and can sealing line. The retorts are placed in line over the drain with a track overhead for a trolly and chain hoist to lower into and lift crates of canned products from the retorts and transport the crates to the cooling line.

Cooling Line: The cooling line may consist of a cooling tank of cold running water large enough to hold four retort crates, or it may be an opened end walled area 1 meter (3.3 ft.) wide, 1 meter (3.3 ft.) high and 4 meters (13 ft.) long in which external water sprays, shown in Figure 55, are installed for cooling processed cans of product. The cooling tank or walled area is located over floor drains into which the waste cooling water can flow.

Labeling and Casing Area: This area is usually located in the storage area just beyond the lounge and quality control laboratory away from the heat given off by the retorts and moisture from the cooling line. The retort

crates of processed product, as they come off the cooling line, may be transported to the labeling area in the storage on all purpose dolly trucks shown in Figure 50. A sturdy, large table is needed for labeling and casing if these two operations are to be performed manually.

In designing a canning plant for a particular product, undoubtedly several possible floor plans will need to be made showing in detail the placement of all equipment and the continuity of expected operations. Figure 15, flow chart, should help to provide some guidance in selecting the proper placement of equipment. Since the sequence of operations varies somewhat with different products, the floor plans should be checked to determine which one would best accommodate the particular foods to be canned.

Canning Plant Layouts: Figures 12, 13 and 14 give plant layouts for canning plants A, B, and C.

Plant A utilizes only elementary utensils and equipment similar to equipment commonly used for home canning. This plant is only suitable for a low cost cooperative type of operation having a very low output. It would not be feasible to utilize it in a commercial enterprise.

Plants B and C are very similar. The only difference is in size and equipment. Both are equipped with a boiler and steam-heated retorts which hold 126 No. 2½ (401x411) cans or 222 No. 303 (303x406) cans, steam-heated atmospheric cookers, exhauster and blancher. The cost of small retorts is about the same as that of the larger size recommended and has only one-third the capacity. Direct-fired retorts, batch exhauster and blancher are dangerous hazards to workers and relatively inefficient in the use of energy. Therefore,

they are not being recommended for either of the plants. Plant C has more mechanized equipment to increase efficiency and help standardize the quality of the finished canned product.

These plants were designed as all-purpose units. It may be desirable to limit the type of products to be canned in some plants. Also, the need for mechanized equipment will be determined by the cost of labor, the amount of a given product to be canned, etc. The capacity of the three types of plants can be varied within wide limits.

CHAPTER TEN

PLANT CONSTRUCTION

General Considerations - After the site for the canning plant has been selected, the type of building to be constructed should be considered. This is influenced somewhat by the variety of products to be canned. Ideally, a building should not be erected and then adapted for canning purposes. Rather, prior to beginning of construction, planning for arrangement of space as related to installation of utilities for optimum efficient operation, is of utmost importance.

Building - A single-story building is most practical for a small canning plant. The single floor facilitates the work of the superintendent because it is possible for him to have the entire canning plant under direct observation at all times. The use of a single floor also facilitates the handling of material from one operation to the next.

The actual size of the building should be determined by the amount of produce to be canned and the type and amount of equipment to be used. Considerations should be given to future expansion of the plant. A rectangular building, having a processing room, office, lounge, toilets, quality control laboratory and storage space, is the most desirable because its floor space can be used to best advantage in arranging space and equipment.

The building should be suitable in size, construction, and design to facilitate maintenance and sanitary operations for food-processing and storage purposes.

1. The facilities should provide sufficient space for such placement of equipment and storage of materials as is necessary for sanitary operations and production of safe food. The floors, walls and ceilings in the plant should be of such construction as to be adequately cleanable. Masonry

construction is probably the most satisfactory type because of its resistance to fire, rodents, and deterioration due to the humid conditions caused by the release of steam during processing and water used in frequent wash-down of floors, walls and equipment following processing periods. Light and other fixtures and pipes should not be so suspended over work space that drip and/or condensate may contaminate foods, raw materials or food contact surfaces. Aisles or working spaces between equipment and between walls and equipment should be unobstructed and of sufficient width to permit workers in the plant to perform their duties without contaminating the food or food-contact surfaces with personal contact or clothing.

2. Adequate provision by location, partition or other means should be made for those operations within the plant which may cause contamination of food products with undesirable microorganisms, chemicals, filth and other extrageneous material.

3. Adequate lighting needs to be provided to toilets, hand-washing areas, and other areas where food or food ingredients are examined, processed, or stored and where equipment and utensils are cleaned. Food should be protected from contamination by the breakage of light bulbs, fixtures, skylights, etc.

4. Adequate ventilation needs to be provided for the removal of steam vapors and noxious odors from the processing area. The type of ventilation employed should not create conditions that may contribute to the contamination of food by air borne contaminants. A cupola type of ventilator (Figures 17 & 18) has proven satisfactory under a variety of conditions. It requires no source of energy for operation and creates no annoying noise.

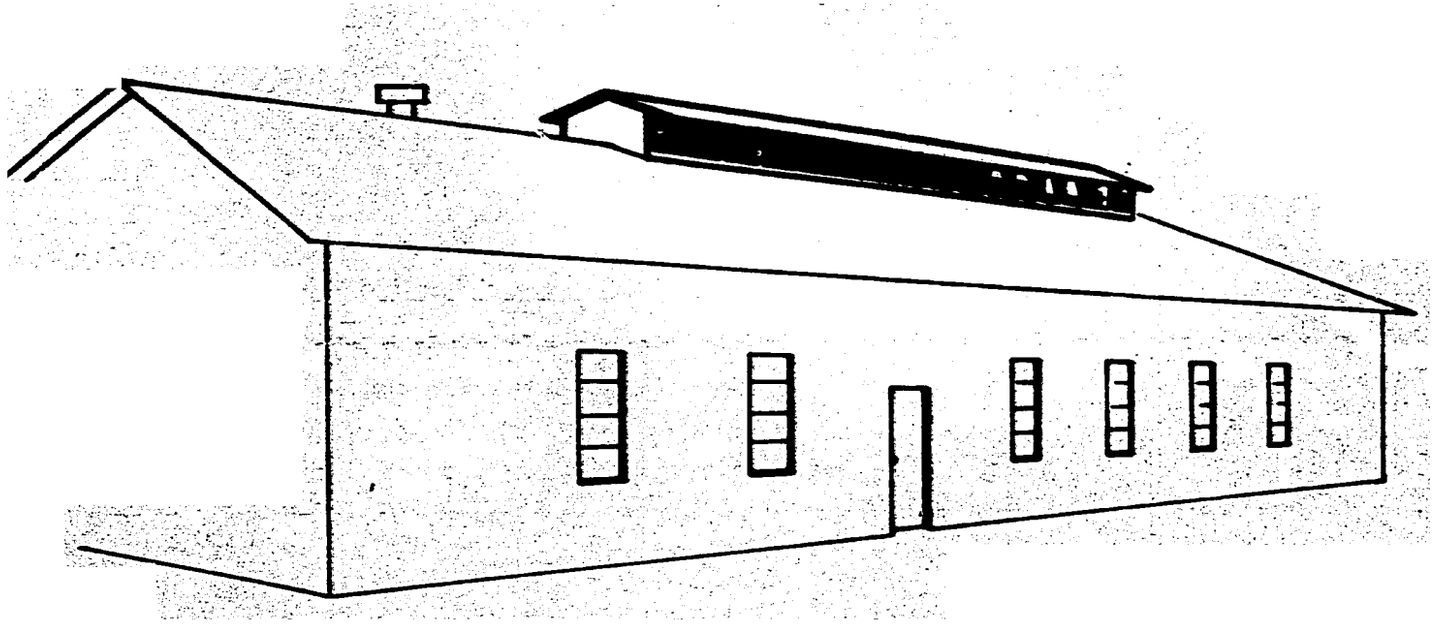

Figure 17. Cupola Type of Ventilator Located over Processing Room in a Canning Plant

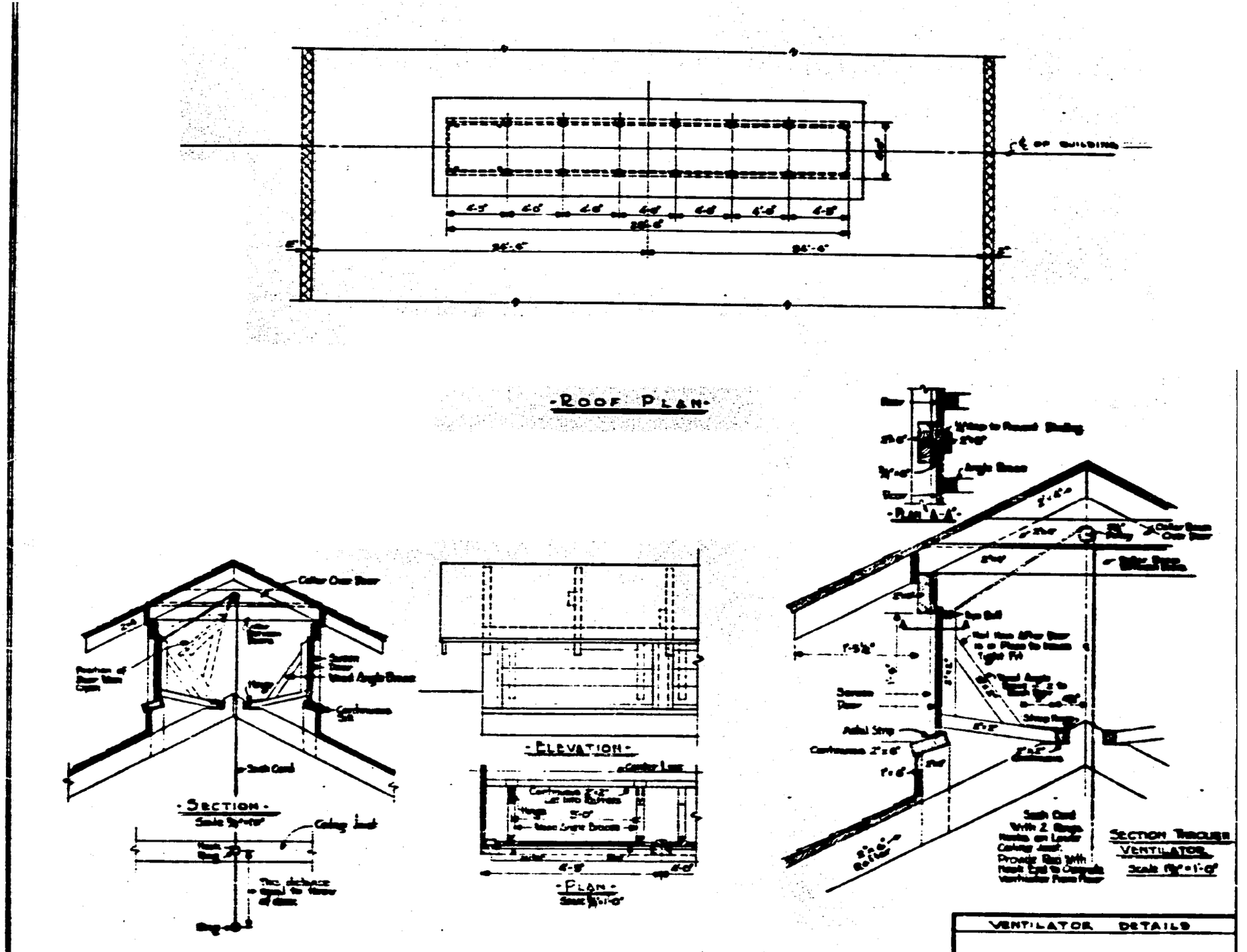

Figure 18. Detail Plans for a Cupola Type of Ventilator

5. Effective screening or other protection against birds, animals and vermine including insects, rodents, etc. should be provided.

Sanitary Facilities - The plant should have an adequate sanitary system including such as:

1. Water Supply - The water supply should be sufficient for the operations intended and should come from safe sources. Water used in the preparation of food and cleaning of food-contact surfaces should be safe and of adequate sanitary quality. Running water at a suitable temperature and under pressure as needed should be provided in all areas where it is required for the processing of food, the cleaning of equipment, utensils, or containers or employee sanitary facilities.

2. Sewage Disposal - The disposal of sewage should be made into an adequate sewerage system.

3. Plumbing - Plumbing should be of adequate size and design and properly installed to: (a) carry sufficient quantities of water to all locations throughout the plant; (b) properly convey sewage and liquid disposal waste from the plant; (c) not constitute a source of contamination to foods, food products or ingredients, water supplies, equipment, or utensils or create unsanitary conditions; (d) provide adequate drainage in all areas.

4. Toilet Facilities - Adequate toilets and associated hand-washing facilities should be provided within the plant building. Doors to toilet rooms should not open directly into areas where food is exposed to airborne contamination.

5. Hand-washing Facilities - Adequate and convenient facilities for washing hands should be provided at each location in the canning plant where good sanitary practices require workers to wash or sanitize and dry their hands.

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These hand-washing facilities should be furnished with running water at a suitable temperature for effective hand-cleaning.

Walls and Ceilings - The foundations for the walls and partitions should be carried to firm natural soil below the frost line. Every precaution should be taken to avoid poor soil conditions that could result in building failure. Concrete for the foundation or footings should be composed of a 1:2½:3 mix - 8½ bags - 352.5 kg. (776 lb.) of an approved brand of portland cement, 0.4 m^3 (14.3 $ft.^3$) of washed sand and 0.6 m^3 (20 $ft.^3$) of stone-max. 2.53 cm (1 in.) in size giving a yield of one cubic meter (33.3 $ft.^3$ or 1¼ $yds.^3$). The concrete footing should be reinforced with steel deformed bars of intermediate grade and 1.27 cm (½ in.) in size. The footing width should be at least twice that of the wall and at least 30.5 cm (12 in.) thick depending upon soil conditions.

The walls of the plant should be constructed to a height that will provide a ceiling height of at least 4 meters (13 ft.) to allow for clearances necessary where a track and hoist are used over retorts in the processing room and where the space over the office, lounge, toilets, and quality control laboratory is used for storage of empty containers. Generally ceiling heights of at least 5 meters (16.4 ft.) are recommended. (Ceiling height as used in this publication refers to the distance from the top of the finished floor to the bottom of the finished ceiling.) The walls should be constructed of 25.4 cm (10 in.) lightweight block that meet American Society for Testing Materials Specifications C-90. Materials used in the blocks should be free from iron or other substances that will stain paint. The mortar should be composed of one part portland cement, one-half part lime paste, and four to six parts of washed, sharp sand by volume. The blocks should be kept dry before being laid and should be laid in a full bed of mortar, and all joints, both vertical and horizontal, should be completely filled with mortar before another course is laid on top. The

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mortar joints should be tooled and pointed to give a smooth and even surface. No blocks should be laid into the walls which are cracked or have chipped corners. Reinforced lightweight lintels of proper capacity should be used ove openings in the walls.

No ceiling material should be placed on the overhead joists or trusses in the processing room to form an attic, as good ventilation is essential in orde to maintain a reasonably cool, steam vapor-free and odor-free atmosphere.

Windows - Sufficient windows should be provided in the processing room so that the need for artificial lighting during daylight hours will be minimized. The windows should also be arranged to take advantage of the prevailing winds in order to provide good cross ventilation. The windows may be either casement or double hung type. For good lighting and ventilation in the processing room the window area should not be less than 25 per cent of the total floor area. In the office, lounge, toilets, quality control laboratory and empty-can storage area, the window area should not be less than 20 percent of the total floor area in each room. For the maximum lighting and ventilating effect in the processing room, the sills of the windows adjacent to the preparation area should be located 1 meter (3.3 ft.) above the floor; and the sills of windows adjacent to the retorts and steam jacketed kettles should be 2 meters (6.6 ft.) from the floor. Such an arrangement of windows would facilitate the movement of air across the preparation area to provide some degree of comfort to the workers in that part of the processing room. This window arrangement would also provide for the removal of steam vapors and heat from the area where the retorts and kettles are located. Screens must be provided for all windows in the office, lounge,

toilets, quality control laboratory and storage room, as well as for the windows in the processing room. If windows are placed in the warehouse for finished canned products, they too must be screened, unless the warehouse is physically separated from the canning plant.

Doors - The number of doors provided for the canning plant storage areas must comply with any local code regulating the number of doors required for a public building. Doors must be provided between the processing room and the boiler room, and between all the other adjacent areas. One double door at least 1.35 x 2.25 meters (4.5 x 7.5 ft.) should be placed in the outside front wall close to one end of the processing room to permit moving equipment in and out of the room. Another door, 0.9 x 2.1 meter (3' 0" x 7' 0"), should be placed in the other end of the front wall to the processing room. Each external door of the canning plant should be hinged to meet the local code in such a way that self-closing screen doors also can be hung.

Roof - The roof for the entire building should be self-supporting. Supporting posts in the processing, storage and warehouse areas are objectionable. Roof supports over retorts and overhead tracks should be designed to support the tracks and a concentrated load on the hoists of 227 kg (500 lbs.). The roof is usually supported by clear-span wood trusses. These may be light-truss rafters spaced approximately on 0.6 meters (2 ft.) centers with roof sheathing or decking nailed directly on them or of heavier built-up trusses with light beams between to carry the roof decking. The latter is more expensive and must have light beams between trusses to carry the track over the retorts. It has, however, few exposed members to collect dust and retard air circulation. It is recommended that all timber used in the

roof, which is exposed to moisture from steam condensate, should be treated (preferably pressure treated) with a wood preservative. Because of poor air circulation and poor drying conditions, it is especially important to treat with wood preservative the wood plates on top of the masonry walls on which the rafters rest.

Lighting - Good lighting is essential in the preparation area of the processing room. To obtain the maximum benefit from natural daylight, a plant should be built in an east to west direction. Sufficient artificial lighting should be installed to operate the plant at night and on those dark and cloudy days when daylight intensity has been reduced by 50 per cent. The artificial lighting should be arranged so that each operation will be properly lighted. The intensity of light required varies in different parts of the canning plant. In the food preparation and steam kettle cooking areas, an illumination intensity of 100 foot-candles is recommended, while a 50 foot-candle intensity is recommended for the retort and cooling areas and 30 foot-candles is recommended in the storage and warehouse areas. Flourescent lighting should be used where possible rather than incandescent, since it will deliver more light per kilowatt hour (kw). The flourescent tubes should be of the natural, soft or warm white type which do not distort the natural color of food products; thereby, producing less eyestrain and making it easier to detect blemishes and defects that need to be removed from the produce. Light fixtures suspended over exposed food in any step of preparation need to be of the safety type or protected to prevent food contamination in case of breakage.

Separate, independent lighting circuits and switches should be installed to localize lighting in work areas so that only those areas needing artificial

lighting need to be lighted. The extra cost of several circuits will soon be overcome by the savings in electric power costs. In some parts of the world where it may be necessary to conserve electricity, skylights should be considered. While there will be some extra cost in installing skylights, it will result in considerable saving over a short period of time. This would be particularly true in the warehouse which would not have windows and some light must be provided during daylight hours. With the proper number and placement of skylights, the need for artificial lighting during daylight hours would be negligible. However, unless windows or skylights are used, some artificial lighting in the warehouse will be needed for those periods when daylight is not available.

Floors - The floors in all areas of the plant should be constructed of concrete and laid in a single piece and not in sections, as it is customary for side walks and other similar construction. Hand trucks with metal wheels would otherwise soon cause the floor to crack and disintegrate at the points between various sections. The floors should have a 100 mm (4 inch) gravel sub-base over-laid with 4 mil polyethylene vapor barrier covering. The polyethylene covering will prevent the migration of moisture from the ground up through the floor. In cold climates 50.8 mm (2 inch) styrofoam is recommended to be laid over the gravel sub-base and then lay the polyethylene covering over the styrofoam panels. A *dense mix* of 100 mm (4 inch) concrete reinforced with wire or 9.5 mm (3/8 inch) rod should then be poured on the polyethylene covering. A *dense mix*, 1:2:2½ proportion, would contain 10 ft.^{3} (427 kg.) of portland cement, 0.5 m^3 (2/3 yd.^{3}) of damp sand, and 0.6 m^3 (4/5 yd.^{3}) stone (20 mm. (3/4 inch) max. size of stone) and should yield approximately 1 m^3 (1 1/3 yd.^{3}) of concrete. Several coats of a silicate type filler should be brushed onto the finished floor to seal the pores and to give an effect of *case-hardening* the floor surface to a depth of 6 mm (¼ inch)

thus making the surface more impermeable to fruit and vegetable acids.

The floors should be troweled to a smooth, level finish with great care to prevent any uneven areas that will pool liquids. To facilitate good drainage, the floors in the processing room should have as a minimum from 3 to 6 mm (1/8 to 1/4 inch) slope or pitch per 30 cm (1 foot) and all parts of the floor should be within 6 meters (20 feet) of floor drains. Floors in all other areas of plant and warehouse should be level.

Floor Drains - Drains in the floor of the processing room should be of the open or trough type with round bottoms to get a better flow when a small amount of water is being moved. The round bottom construction will also provide a smooth surface without corners that will be easy to clean and maintain in a sanitary condition. The slope of the drain should be from 3 to 6 mm. (1/8 to 1/4 inch) to provide good drainage. To carry drain covers, it is recommended that a shelf made of angle iron be placed at the top edge of the trough as shown in Fig. 19 on

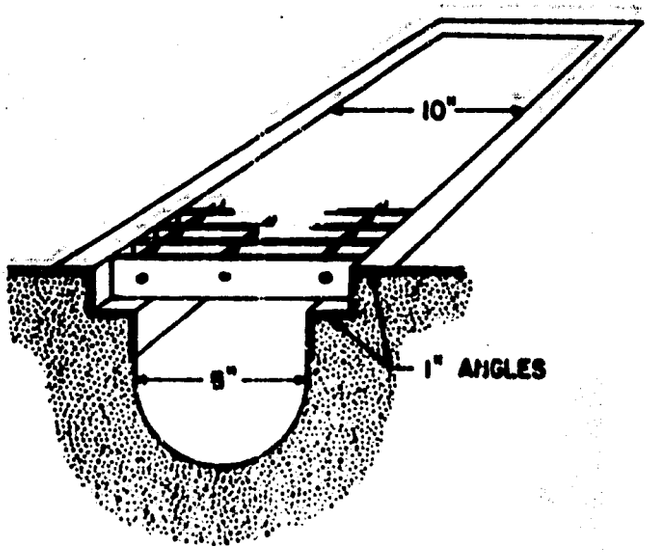

Figure 19 Floor Drains with Sidewalk-Type Metal Covering

which the drain covers may rest so that their tops will be at floor level. To prevent seepage of liquid waste in between joints of angle iron, it is suggested that the joints be welded before the angle iron is positioned in the troughs. The angle iron drain edging or shelf would be securely fastened in the drains with 100 mm (4 in.) bolts that are imbedded into the concrete before the concrete sets up.

Drain covers are generally constructed of metal sidewalk-type of grating consisting of metal strips standing on edge and welded across the top with appropriate size rods as shown in Fig. 19. The openings in between the vertical metal strips should be approximately 16 mm. (3/4 inch) to permit pieces of waste product to be washed into the drain. The grating covers should be constructed in 1 and 2 meter lengths for easy removal to facilitate cleaning and washing the drains.

It is recommended that a water outlet be installed at the ends of the floor drains to provide additional flow of water when necessary to help move the waste material in the drain out into the waste disposal system. Just before the waste from the drain enters into the disposal system, a screen having a mesh of 25.4 mm. (1 inch) should be installed to prohibit large waste particles from passing into the sewage disposal system and perhaps causing a clogging of the pipes in the system.

Auxiliary Space - Office, Lounge, Lavatories, and Quality Control Laboratory - These facilities are usually located between the processing room and the storage and warehouse as shown in Figures 13 and 14. They should be so arranged that a 1.2 meter (4 foot) corridor leading from the

processing room will serve as an entrance to it and to the storage area. The office and lounge are generally located on the front side of the plant and the lavatories and quality control laboratory in the rear with the corridor between. The office should be adjacent to the processing room with a sliding window 0.9 x 1.2 meters (36 x 48 in.) between the two rooms and large enough to provide space for the plant manager and the necessary secretary assistants. The lounge should be large enough to accommodate all the workers during their break periods. The lavatories are usually 1.8 x 3 meters (6 x 10 ft.) in size. The quality control laboratory, if needed, should be large enough to accommodate laboratory benches and instruments necessary to conduct the tests required as outlined in the quality control procedures. The partitions or walls between those five areas should be of masonry - not hollow wooden construction, which could become a harbor for rodents and insects. The walls should be constructed on footings or foundations of the same specifications as the footings in the outside walls. The blocks should meet the American Society for Testing Materials Specifications C-90 and of a size that will permit the walls to become load-bearing in type to support a storage area above. A lightweight 20.3 cm (8 inch) block is suggested. The mortar should be composed of one part portland cement, one-half part lime paste and four to six parts of washed, sharp sand by volume. The blocks should be kept dry before being laid and should be laid in a full bed of mortar, and all joints, both vertical and horizontal, should be completely filled with mortar before another course is laid on top. The mortar joints should be tooled and pointed to a smooth and even surface. No blocks should be laid into the walls which are cracked or have chipped corners. Reinforced

lightweight lintels of proper capacity should be used over all openings in the walls.

The ceiling joists should be 5 x 30.5 cm (2 x 12 in.) size spaced on 30.5 cm (12 inch) centers to provide adequate support for a storage room above. The ceilings in these areas should be finished with gypsum board. A joint cement suitable for gypsum board should be used in the joints and sanded to a smooth finish. The use of a high grade latex paint of appropriate colors on the walls and ceilings would help to provide working conditions that would be conducive to good productivity.

Storage

1. The storage area for empty containers and other supplies should be large enough to store at least 25 percent of the annual requirements or a minimum size shipment, which may be a larger quantity than the annual need. The minimum order for some containers is usually in the magnitude of 100,000 units, which requires approximately 180 m^3 (6,000 $ft.^3$). This storage must be kept dry at all times to prevent rust from forming on metal containers and disintegration of paperboard cases. The area over the auxiliary space could be used to provide most of this storage. If a can reformer, seamer, and reflanger are needed, they should be located in the storage area for convenience and efficiency.

2. The condiment storage should be constructed to prohibit the entrance of insects and rodents as well as moisture, off-odors and flavors that may affect the quality and flavor of sugar, salt, spices and other condiments.

Raw Product Storage - A raw product storage should be provided that will be of sufficient size to store large enough quantities of raw products for at least one day of operation. Its location should be close and convenient to the

preparation area in the processing room. It may or may not be connected to the processing room. If it is connected to or adjacent to the processing room, the concrete floors should have the same slope and the floor drains be of the same type as those in the processing room. The drains should be so designed that the waste water will drain into the processing room floor drains. The concrete mix should also be the same as that used in the floors of the processing room. The raw product storage should have a roof to protect the produce from sun, rain and other elements. It may be necessar to protect the produce with walls. If walls are desirable, provision should be made to provide adequate cross ventilation. The walls should also be of the same type of construction as the other walls of the plant.

Warehouse - The warehouse for storing the finished canned products may or may not be attached to the canning plant and storage building depending upon the terrain of the plant site. Its location should be close and convenient to the canning operation to minimize the labor required to store the canned product. Its walls, floor and roof construction should be of the same type and specifications as those of the canning plant (a polyethylene vapor barrier is most important) - except the concrete mix for the floors may be a 1:2½:3 proportion mix. This mix of 8¼ bags (352½ kg.) of cement, 0.4 m^3 (½ $yd.^3$) of damp sand and 0.6 m^3 (3/4 $yd.^3$) of stone with a maxi. size of 2.54 cm (1 in.) should yield approximately 1 m^3 (1¼ $yds.^3$) of concrete. The concrete floors should be troweled to a smooth and level finish. The block walls should be at least 4.2 meters (14 ft.) in height to permit enough space above the stored canned products so that the heat given off by the canned products can be absorbed into the large volume of air and drawn out with exhaust fans having relatively low capacity. Both

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the walls and roof should be insulated to help maintain interior temperature from 11 to 29 C (50 to 85 F). The hollow block wall may be insulated by using a loose fill type of insulation and pouring it into hollow block as it is being built. The wall should be treated inside and outside with a moistur proofing compound to form a vapor seal to protect the insulation, if the insulation is of the type that will absorb moisture. Exhaust fans with shutters should be installed in the walls near the roof to give the storage area a change of air approximately every 3 minutes. Few, if any, windows should be placed in the warehouse. Flourescent lighting having an intensity of 20 foot-candles should be sufficient. The number and size of doors should be determined by the size of operation. If a fork-lift truck is used, the doors must be of a width and height that will permit the fork-lift fully loaded to pass through. Pallets should be provided for the canned products to be stacked upon. Canned goods should never be stacked directly upon concrete floors to prevent deterioration of the paperboard cases and rust formation on the metal cans by moisture from the floor. The pallets will also permit movement of air under the stacks of canned products.

With respect to warehouse storage space, it is generally felt that enough space should be provided to store approximately 50 percent of the anticipated annual capacity of the canning plant and that portion of the annual supply of empty containers that cannot be stored in the storage area adjacent to the lounge and quality control laboratory in the plant building.

While the warehouse may be constructed of a wide variety of materials, such as, wood, brick, concrete, and metal sheeting on steel frames - light-weight hollow blocks and concrete floors are recommended. This type of construction has several advantages. It has a relatively low construction

cost, a long useful life expectancy, low maintenance cost, and a relatively uniform temperature is easy to maintain. Wood is not recommended because of a great fire hazard and high maintenance cost. While metal sheeting on metal frames has a low initial cost, it has a comparatively short usable life and great maintenance cost. Unless a metal building is extremely well insulated, a uniform inside temperature is very difficult to maintain.

Boiler Room - The boiler room should be placed to the rear of the canning plant adjacent to the wall directly behind the retorts to reduce the distance steam will need to be piped from the boiler to the retorts. The room should be large enough to house the boiler, hot water tank, (water softener and water chlorinator, if needed) and air compressor. The ceiling height should be from 3 to 4 meters (10 to 13 ft.) depending upon whether the boiler is horizontal or vertical in style. The floor of the boiler room should be of concrete having a 1:2½:3 mix which should contain 8½ bags (352½ kg.) of portland cement, 0.4 m^3 (½ $yd.^3$) of damp sand, and 0.6 m^3 (3/4 $yd.^3$) of stone having a maximum size of 2.54 cm (1 inch) giving an approximate yield of 1 m^3 (1½ $yd.^3$) of concrete. The floor should be troweled to a smooth and even finish. The walls should be of lightweight block that will meet the American Society of Testing Materials Specifications C-90. The roof should be designed and constructed of material that will be as fire resistant as feasible. Ample ventilation must be provided at all times to furnish the necessary air for complete combustion of the fuel needed to fire the boiler. To insure complete combustion, an automatic wall shutter, that will open or close on demand by the boiler burner - of the size for the quantity of outside air required - is recommended. A double door 1.8 meters wide and 2.25 meters high (6' 0" x 7' 6") should be placed in an outside wall

to permit passage of the boiler into the room. A 0.9 meter x 2 meters (3' 0" x 7' 0") fire-door should be placed in the wall adjacent to the corridor leading from the boiler room into the processing room to permit quick and easy access to the boiler. One window should be sufficient for a room of this size.

Maintenance Shop - A maintenance shop with 17½ m^2 (190 $ft.^2$) located directly behind and adjoining the boiler room is recommended. The shop should be served by the corridor from the processing and boiler rooms. An outside door to the shop is recommended. The floor, walls and roof should be constructed to the same specifications as those for the boiler room. The window area should be approximately 20 percent of the total floor area and the windows arranged to provide adequate cross ventilation. Flourescent lighting having an intensity of 50 foot-candles should be provided.

Sanitary Facilities - In addition to the two lavatories mentioned under Auxiliary Space, a hand wash basin with foot valves and a soap dispenser, in the processing room has been recommended for Plants B and C. The hot and cold water valves on the type recommended are operated with the foot of the person using the wash basin. This type of valve will prevent a person from contaminating his hands after washing by using his feet rather than his clean hands to close the valves which became contaminated when they were opened by his soiled hands to wash. The lavatories should contain an adequate number of toilets and wash basins to accommodate the number of people working in the plant. The lavatories and fixtures should be given a thorough cleaning each day and more often if necessary. Each person working in the processing room must be encouraged to wash his hands after using the lavatories and use the wash basin to wash his hands each time he returns to the processing room to

prepare food for processing.

Utilities Lines - The water, steam and air main lines should be installed close to the ceiling and outside walls in the processing room. A distribution line to each piece of equipment requiring a particular utility service can then be taken from off the main line and run over and dropped straight down to the equipment. Such an arrangement permits free access to each piece of equipment while operating and cleaning it. The location of the utility lines near the ceiling and outside walls will help to reduce the number of areas where condensate could drip onto exposed food, equipment and personnel. A considerable degree of flexibility in arranging and rearranging equipment for the most efficient layout is possible with this location of the utility service lines. Similar installation of electric main service lines with service drops to the equipment should be incorporated in the construction plans.

Safety - It is absolutely necessary to comply with all the building, plumbing and electrical safety codes applicable to the building site. The following additional points must also be considered in providing safety to the personnel working in the plant:

1. See that stairways and entries are well lighted.

2. Equip platforms and stairs on which people walk or work with hand rails that are securely fastened at a height for convenient use.

3. Locate electrical receptacles close to equipment.

4. Place fire extinguishers at convenient locations in the plant and check them regularly to see that they are properly charged.

5. Place a first-aid kit in a centralized location in the plant.

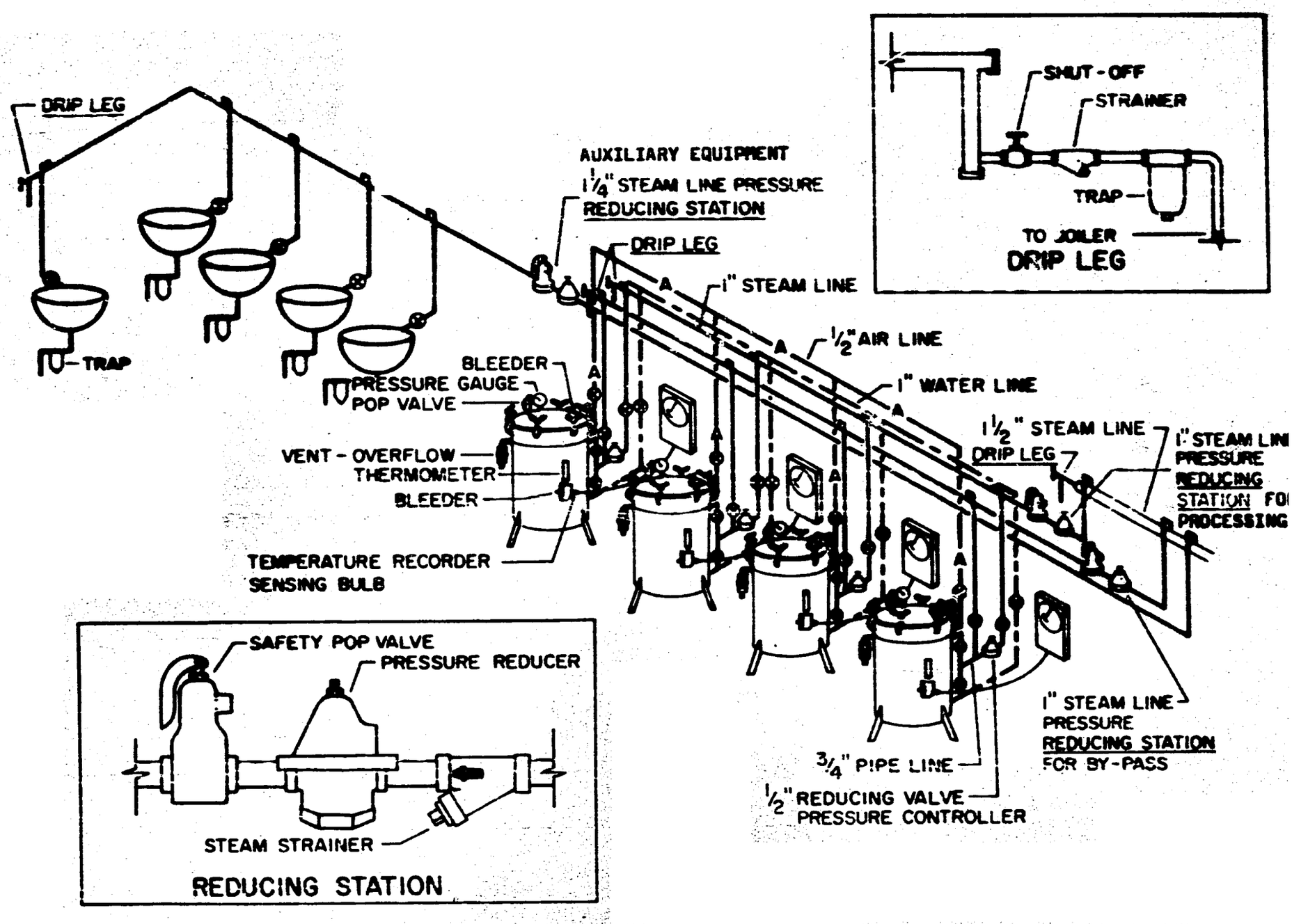

Figure 20 Suggested Layout for Steam, Water and Air Supply Lines in the Processing Room of a Canning Plant

CHAPTER ELEVEN

INSTALLATION OF STEAM, WATER AND AIR SUPPLY LINES TO PROCESSING EQUIPMENT

In planning a canning plant much consideration should be given in designing the steam, water and air supply lines to the equipment requiring these utilities. The proper sizing and location of the distribution lines are very important. If lines are undersized, the equipment will not function properly. It is particularly important that adequate sized steam, water and air lines be installed for retorts. There is no way that health safety of the canned product can be traded for alleged economies. Perhaps in other businesses compromises can be made in the interest of economics, but not in processing canned foods. The dangers of food poisoning are too great to take a chance in making cuts for economical reasons in the installation of retorts. A person skilled in plumbing techniques does not necessarily qualify that person to install retorts unless he has a thorough knowledge of retort operations. Helpful guidelines for installing retorts can be obtained from the manufacturers of retorts and the National Canners Association, Washington, D.C. 2000_. These guidelines should be followed very closely to insure proper operation of the retorts. A suggested design for installing retorts and steam jacketed kettles is given in Figure 20.

It should be noted in the design in Figure 20 that the distribution lines are not located in or on the floors or walls. Pipe lines located in or on the floors and walls would prevent adequate cleaning of these surface areas as well as reduce the flexibility and ease in relocating existing and installing additional equipment.

The boiler should be located in a room adjacent to the processing room as near the retorts as possible. The main steam, water and air supply lines should originate in the boiler room and enter the processing room near the ceiling.

Lateral lines running from main supply lines should have drop lines to each individual piece of equipment requiring the utility. This design will permit complete accessibility all around each piece of equipment without the interference of cross-over lines. The distribution and lateral lines are supported with hangers from the ceiling away out from the walls, but not directly over the retorts, kettle container cooling equipment, or food preparation areas. During the installation of the utility pipe lines provision should be made to place additional pipe fittings (T-ees) in the lines other than those just required to pipe the utilities to the equipment at the time of the installation. This provision will make the installation of new or relocation of existing equipment relatively quick and easy with a minimum of inconvenience and interruption of service.

All steam and water pipe lines should be insulated. Steam lines need to be insulated to minimize the loss of heat (energy) and reduce the incidents of severe burns by those working around steam operated equipment. Water lines must be insulated to reduce condensation, which could drip into food being prepared for canning thus causing contamination.

It is recommended that the retorts, steam jacketed kettles, exhaust boxes or lines and blanching equipment be located directly over or near floor drains into which waste, rinse water and other liquids from these pieces of equipment can flow directly. Wash sinks should also be placed so the waste water can drain directly into the floor drains. Every effort should be made to keep waste products and liquids off the floor and confined to the drains. Wet floors, particularly when grease and/or oil is involved, may become very slippery and hazardous to walk upon.

Steam Supply Pipe Lines

Main steam Supply Line. The main steam supply line from the steam outlet of the boiler should be the same size as that of the outlet, which usually is approximately 38.1 millimeters (1½ inches) in diameter for the size boiler generally

used in the canning plants described in this manual. However, boilers in larger canning plants will have steam outlets that are usually larger. It is very necessary to have a safety pop-off valve, which has the capacity to handle the maximum hourly out-put of steam that the boiler can generate at its maximum operating pressure, installed in the main steam line, preceded by a pipe line strainer, as close to the boiler as possible. The discharge from the safety pop-off valve must be piped to the outside of the building.

The main steam supply line from the boiler should enter the processing room close to the retorts as possible just a few centimeters or inches below the ceiling of the processing room. Three distribution steam lines are then tapped into the main after entry into the processing room. One of the distribution lines will carry steam to the retorts for thermo processing only; the second line to the retorts will carry steam only for venting and for bringing retort temperatures up to the scheduled processing range; the third line, which would be larger, would pipe steam to the auxiliary steam operated canning equipment and to the steam and water mixing faucets used in clean-up operations. It should be noted in Figure 20 that the three distribution lines are tapped into the main line in such a manner that the steam is taken from off of the top of the main instead of its bottom. This method of piping steam from the main will minimize the amount of condensate from the main line that could enter the distribution lines. It is recommended that this method of tapping a steam line always be followed in piping steam. In Figure 20 a "drip-leg" is shown at the end of the main and all other steam lines. See the blown-up illustration of a "drip-leg" in this Figure. The purpose of a drip-leg is to keep the steam lines drained of condensate and return it to the boiler for recycling. The cost of piping for the return of the condensate to the boiler will be paid for many times over again in savings made in

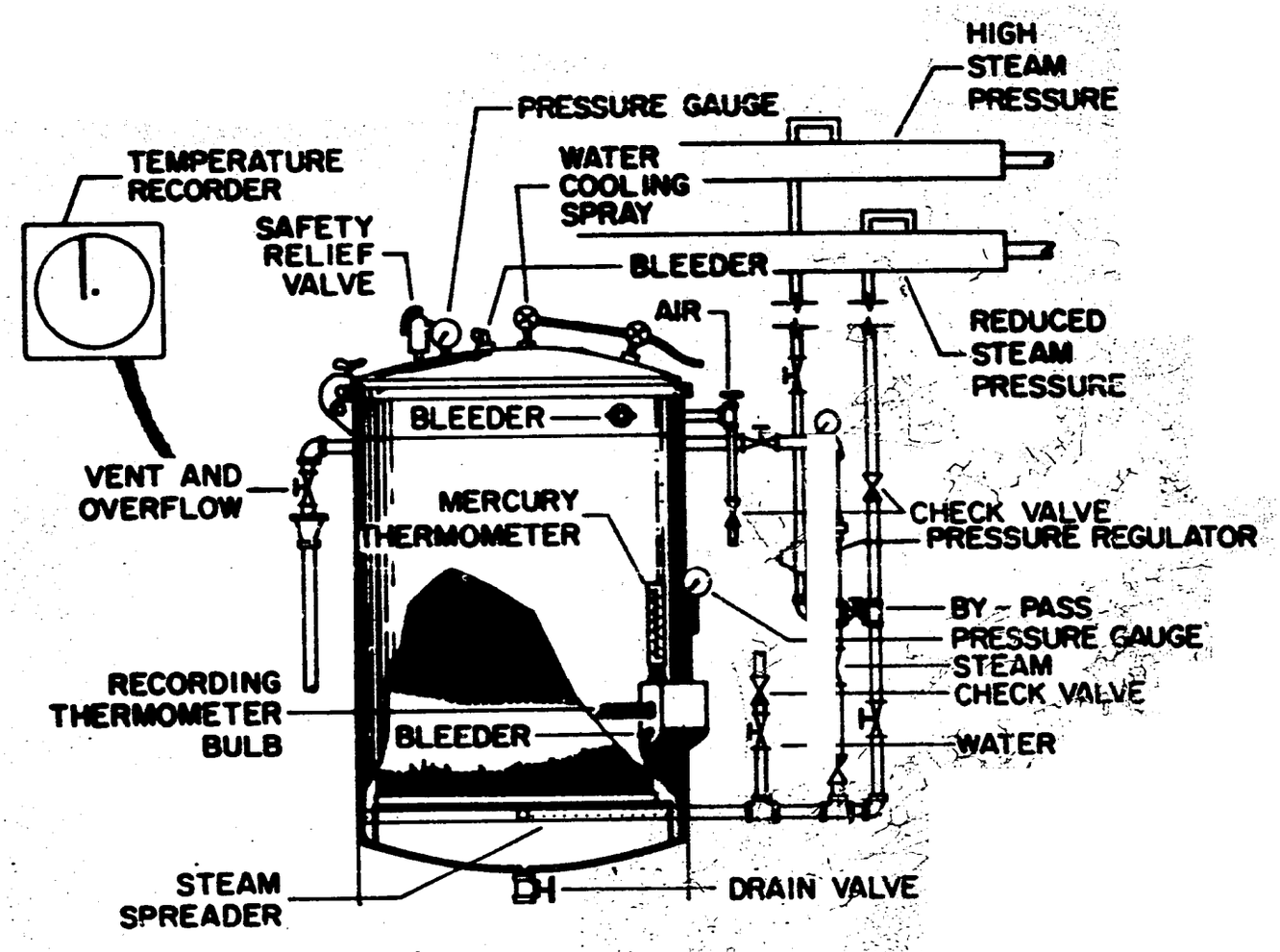

Figure 21. Suggested Method for Installing a Vertical Still Retort with Steam Inlet at the Bottom and Vented at the Top Through the Overflow Valve. The Suggested Installation Makes It Possible for Cooling Containers 1/ in Air or in Retort with Water without Pressure, 2/ in Retort Under Pressure with Compressed Air and Water, or 3/ in Retort Under Pressure with Steam and Water.

fuel to operate the boiler and in chemicals used in treating the water for hardness. It must be remembered that the operating pressure of the steam trap in the drip leg must be equal to or greater than the pressure in the steam line on which it is installed.

Retort Processing Steam Supply Line

The retort processing steam supply line should be sufficiently large to carry the steam that is required by all retorts operating simultaneously when thermo processing. Although it is not shown in Figure 20, it is recommended that a pressure switch be installed in this distribution line between the main steam supply line and the first lateral line leading to a retort. The purpose of the pressure switch is to activate an audible alarm and solenoid valves on all other steam distribution lines when the steam pressure in this line falls below the pressure required at that altitude to maintain 116 C (240 F), or more than 3.5 kpag (0.5 psig) below the processing pressure in use. The activated solenoid valves will close off the steam supply in the other steam distribution lines, thereby automatically increasing the quantity of steam flow to the operating retorts. Figure 21 illustrates a suggested method of hooking-up steam lines to retorts.

Retort Venting Steam Supply Line

The retort venting steam supply line is used only for venting and bringing the retorts up to processing temperatures during the come-up time. While it is the usual practice to use steam for both venting and processing from the same steam supply line, a separate line is being suggested for use in venting for the size canning operations described in this manual. The purpose for making this suggestion is to insure an adequate supply of steam to the retorts during the processing phase of the retort operation cycle without having a large investment in a boiler with enough excess capacity to meet occasional short peaks of demand

for steam. It must be remembered that the peak of demand for steam in a canning operation usually occurs during the come-up time when venting retorts. If exhaust boxes, steam blanchers and a number of steam kettles are in operation while several retorts are processing and another is being vented, the demand for steam may be greater than the boiler capacity. To avoid a temperature drop in those retorts that are in the processing phase of the retorting cycle under such conditions, a separate steam supply line fitted with a solenoid valve is suggested for venting and bringing the retort up to processing temperature. The solenoid valve would automatically cut off the steam in the venting steam supply line until sufficient quantity of steam becomes available for venting without jeopardizing the integrity of the thermo process of those retorts in the processing phase.

A pressure reducing station, shown in the blown-up illustration in Figure 20, should be included in the design of the retort venting steam supply line as well as a drip leg and a solenoid valve. The purpose of the pressure reducing station is to reduce the quantity of steam entering the retort during venting to within the capacity of the safety pop-off valve installed on the retort. The capacity of the retort safety pop-off valves should be sufficient to permit venting the retorts at temperatures ranging from 104 to 110 C (220 to 230 F).

Auxiliary Canning Equipment Steam Supply Line

The auxiliary canning equipment steam supply line should be of sufficient size to carry the quantity of steam that is required to operate such auxiliary equipment as exhaust lines or boxes, steam kettles, blanchers, etc. It is also important to place a pressure reducing station, a solenoid valve and drip leg in this distribution line. Figure 20 will show the proper location for the pressure reducing station and drip leg. The solenoid valve should be placed

between the main supply line and the pressure reducing station. As in the retort venting steam line, the solenoid valve would cut off the steam in this line automatically if the steam pressure drops below that required at that altitude to maintain 116 C (240 F), or more than 3.5 kpag (0.5 psig) below the processing pressure in use. The steam reducing valve in the pressure reducing station should be adjusted to allow the maximum working pressure the safety pop-off valves on the equipment will permit. Most safety pop-off valves on steam kettles are set to relieve excess steam pressures at 275.8 kpag (40.0 psig).

Steam Supply Line to the Steam Jacketed Kettles

The steam supply line to the kettles should be installed in a manner similar to that shown in Figure 20. A steam trap must be installed on each kettle and the condensate from the traps should be returned to the boiler. A pressure gauge and globe type valve should be placed in each of the lateral steam supply lines to the kettles. The globe valve is used to cut on/off and regulate steam flow into the kettle.

Steam Supply Lines to the Continuous Line or Box Exhauster and Blancher

These steam supply lines should be run from locations on the low pressure side of the auxiliary canning equipment steam supply that are the most convenient to the auxiliary equipment using the steam from them. It would not be feasible to place steam traps on a continuous line exhauster or blancher. However, a steam trap must be installed on the discharge side of the steam heating coil in an exhaust box and the condensate returned to the boiler.

CHAPTER TWELVE
EQUIPMENT DESCRIPTION

A substantial part of the equipment used in canning plants is more or less specialized. Most of the equipment recommended for Plants A, B, and C are described and illustrated in this section of the manual. The approximate 1976 prices of the equipment will be found with the individual plant descriptions in Tables II, XVII, and XXXII of this manual. In installing and operating this equipment, the recommendations of the manufacturer should be followed closely.

Boiler:

A boiler is used in both Plant B and Plant C. The boiler is one of the most basic and expensive pieces of equipment in a canning plant. Therefore, selecting the proper type and size boiler is very critical. It would be much better to select a boiler having a steam generating capacity greater than the total requirements than to choose one just matching the requirements. There are two important reasons for selecting an oversize boiler. 1/ Most boilers, after having been in operation for a time, begin losing their efficiency depending upon the care given them. This loss may range from 5 to 10 percent, therefore, a plant with 10 to 20 percent oversized

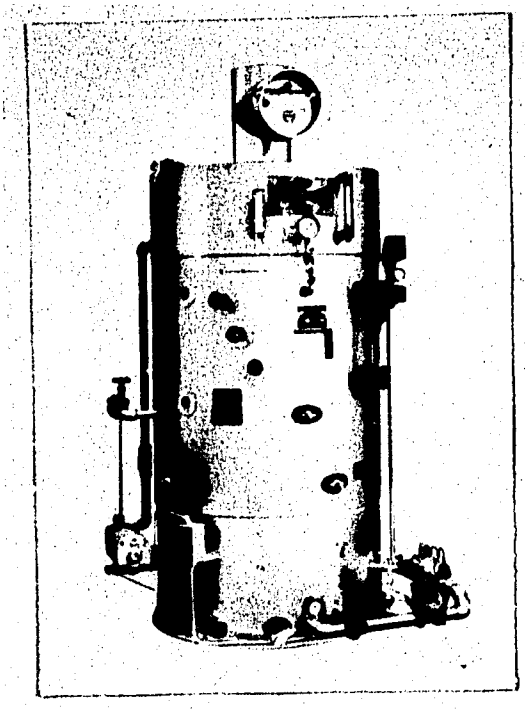

Figure 22. Automatic Gas-Fired Boiler
(Courtesy of Eclipse Lookout Company)

boiler would not need to curtail its maximum output after having been in operation a few years. 2/ An oversized boiler would also allow for a modest increase in expansion of operations without purchasing an additional boiler or replacing the present one with one having greater capacity.

The boiler should have automatic controls to assure a constant supply of steam at the minimum requirement of fuel. The boiler should have capabilities of generating steam at pressures ranging from 861.75 to 1034.1 kpag (125 to 150 lbs psig) in the quantities needed.

In determining the size or capacity of the boiler needed for a canning plant, prime consideration must be given to the peak demand of various operations with respect to the number and frequency of occurance of the peak demands. Steam consumption values for most of the steam consuming equipment are given in Table LII, "Steam Requirements for Various Unit Operations."

TABLE LII

STEAM REQUIREMENTS FOR VARIOUS UNIT OPERATIONS

	Peak Demand Kilos (lb.) per Hour	Operating Demand Kilos (lb.) per Hour	Ave. Kilos (lb.) of Steam Used per Case
Retort - 24 inch diam. x 30 inch deep Venting & Come-up Time - 10 minutes 115.5 or 121.1 C (240 or 250 F) - 30 min.	143 (315)	24 (52)	4.5 (10)
Blancher - Steam	32 (70)	32 (70)	1.6 (3.5)
Exhaust Line - Steam	157 (345)	157 (345)	8.3 (18.4)
Heating Brine or Syrup	.....	.....	1.1 (2.5)
Open Process Cooker - 24 inch diam. x 30 inch deep - 60 min. 100 C (212 F)	79 (375)	9-14 (20-30)	1-2.2 (2-5)
Open Kettle Concentration Tomato Puree - 1.045	157 (345)	130 (285)	16.8 (37)

Knowledge of demands, both peak and operating for each individual piece of equipment is essential in estimating steam requirements for a canning plant. The heaviest demand usually occurs during the starting-up of a retort operation while the exhaust line is in operation. The number of retorts starting-up at one time should be limited to 1 (one) to keep the peak demand low. After peak demands have been determined, a complete analysis of the canning operation with respect to the occurency and timing of the demands should be made. After this information becomes available, one should then sum up all the peak and operating demands which may occur at a given time. The highest estimate figure will become the maximum demand for the canning operation. If the highest total demand is 386 kilos (850 lb.) of steam per hour, a boiler capable of generating 470 kilos (1035 lb.) per hour (30 hp) is recommended. If the total had come to 522 kilos (1150 lb.) per hour then a 627 kilos (1380 lb.) of steam per hour (40 h boiler would be required.

Horsepower (hp) has been frequently used in describing a boiler or steam generator capacity. A horsepower value (745.7 Watts) is defined in terms of ability of the unit to change 15.7 kilos (34.5 lb.) of water at 100 C (212 F) to steam. Most boilers manufactured today are rated on the basis of the number of kilos (pounds) steam per hour the boiler is capable of producing under a specified set of conditions.

Table LIII "Boiler Rating," shows the relationship of boiler horsepower and kilos (pounds) of steam per hour output.

TABLE LIII

BOILER RATING

Horsepower Output	5	10	15	20	30	40
Kilos (lbs.) of Steam per Hour Output	78.3(172.5)	157(345)	235(517.5)	313.2(690)	470(1035)	626.5(1

Steam Properties:

Steam produced for a canning plant should have certain qualities for a good canning operation. 1/ It should be dry saturated steam, which 0.454 kilo (1 lb.) by weight at atmospheric pressure occupies 0.8 cubic meters (26.79 cu. ft.) and its latent heat of vaporization is 1,023,350 Joules (970 British Thermal Units (BTU)). If dry saturated steam cools slightly it will become wet, and is then known as wet steam. When dry saturated steam is piped for some distance, it cools enough to form droplets of water or films of water thus becoming wet steam. Most of the steam in a canning plant is wet steam having varying content of water. The total heat of wet steam is determined by the quantity of water present. If it contains 4 percent water by weight, it has only 96 percent of the number of BTUs as that of dry saturated steam, an efficiency loss of 4 per cent. For this reason the boiler should be located as close to the equipment that uses large quantities of steam as possible.

2/ Boilers should have the capability of producing steam pressures ranging from 861.75 to 1034.1 kpag (125 to 150 psig) which are adequate if the steam lines are properly sized to furnish the quantity of steam required to each unit in the plant. In a canning plant attempts should not be made to operate a boiler at pressures substantially below these figures. If attempts are made to operate the boiler below 861.75 kpag (125 lb. psig), inefficiencies and questionable practices will result. The retorting operation is very vulnerable, since it is practically impossible to adequately vent a retort properly with pressures at the retort under 488.9 kpag (70 psig) - unless exceptionally large, cumbersome and expensive steam lines to the retorts are installed.

3/ Steam should be pure and free from air, excess condensate and entrained soluables, such as salts or minerals from hard water or boiler compounds. Some of the soluable compounds carried from the boiler through the steam lines may

be quite corrosive causing corrosion in automatic control valves on plant equipment and subsequently causing these control valves to malfunction, containers to corrode and rust, and discoloration and off flavors to products blanched with steam.

Boiler Maintenance:

The importance of having a reliable source of steam for a canning plant makes a scheduled boiler maintenance program mandatory. The manufacturer's instructions for daily, weekly, monthly and yearly maintenance should be strictly followed. Certain minerals, if present in the water used in the boiler to generate steam, can be considerably troublesome by causing build-up of scale on the inside of the boiler thus reducing its efficiency and by causing corrosion of the internal boiler parts which will bring about early failures. Samples of water should be analyzed to determine what minerals and in what quantity they are present. Water having high mineral content should be treated before it is allowed to enter the boiler.

Fuel Requirements:

The availability of the most economical fuel should be given prime consideration in selecting a boiler. Boilers are built to utilize a particular type of fuel. Most boilers manufactured today are fired either by natural or liquid propane gas or No. 2 fuel oil. If a gas fired boiler is chosen, the quantity of gas required to operate it can be estimated on the basis that the gas flow into the burners should be equal to 45,000 BTUs per 15.7 kilos (34.5 lb.) of steam per hour (1 hp) of boiler rating. A boiler having a steam generating capacity of 470 kilos (1035 lb.) of steam per hour (30 hp) requires a 1,350,000 BTU correct input. Natural gas is rated as producing 1000 BTUs per 0.03 cu. m. (cu. ft.), therefore, 40.5 cu. m. (1,350 cu. ft.) of gas is required for each unit the boiler operates. If the same size boiler uses No. 2 fuel oil as a source of fuel, it would require 45.8

liters (12 gallons) for each unit it operates based on 3.8 liters of No. 2 fuel oil producing 112,000 BTUs at 80 percent efficiency. Under normal operating conditions, a boiler in a canning plant will operate from 80 to 90 percent of the time the plant is open for processing.

Retorts:

The vertical retort that has been suggested in this manual to be used in the small canning plant, should be approximately 61 cm (23 in.) in diameter and 91 cm (36 in.) in depth or within 25 percent of this size. The retort design should include features that will permit the processing of either glass jars or cans in pure saturated steam (free from air). The design should also have features that will permit the cooling of glass jars and large size cans with air or under steam pressure, as explained under Pressure Processing of Low Acid Foods.

Each retort should have the following equipment:

Steam Header: A steam header is the steam supply line that should be large enough to provide sufficient steam to the greatest number of retorts that may be brought to retort temperature simultaneously. For 2 to 3 retorts of the size suggested in this manual, the steam supply line should be 3.8 cm (1½ in.) in diameter; for 4 to 6 retorts, the pipe size should be 4.1 cm (2 in.) in diameter.

Figure 23. Retort
(Courtesy of Dixie Canner Equipment Company)

Steam Controller: Each retort should have a separate automatic steam controller to accurately maintain the specified retort temperature within ± 0.5 C (1 F). Under no circumstances should attempts be made to operate two or more retorts with one steam controller. If one controller for several retorts should happen to malfunction, all of the retorts' steam supply would be affected and they would have to cease operation. A steam controller may be a self-actuated or air-actuated (air-to-open) type. If the controller is smaller than the steam inlet pipe, the use of a by-pass would become necessary during the come-up period.

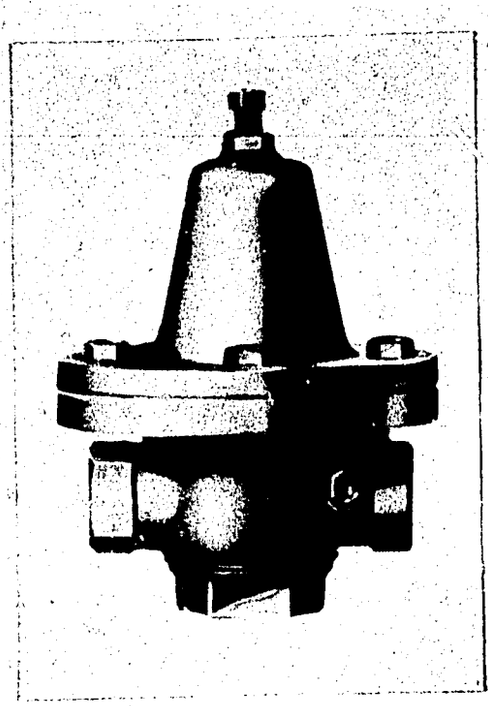

Figure 24. Steam Controller
(Courtesy of Watts Regulator Company)

Steam By-Pass: A steam by-pass for the control valve is desirable to make hand operation of the retort steam supply possible in the event of a failure of the control valve. In most installations, the steam by-pass valve is used regularly during the come-up period when the steam demand is greater than the control valve can provide. THE FLOW OF STEAM THROUGH THE BY-PASS LINE SHOULD NOT EXCEED THAT OF THE SAFETY VALVE (POP-OFF VALVE). THE RETORT OPERATOR SHOULD NOT LEAVE THE RETORT WHILE THE BY-PASS VALVE IS OPEN. The size of the by-pass line should be restricted to permit only the maximum flow of steam into the retort that the safety valve can handle without a build-up of excess pressure within the retort.

Steam Inlets: Each steam inlet should be 1.9 cm (3/4 in.) in diameter for the size retort suggested in this manual. One of the inlets should be placed in the side of the retort near the bottom below the crate supports, and the other in the side near the top. Having these two inlets so placed will make it possible for the steam to enter either at the top or bottom. HOWEVER, THE INLETS MUST BE SO PLACED SO THE STEAM WILL ENTER THE PORTION OF THE RETORT THAT IS OPPOSITE THE VENT. It is recommended that the steam enter the bottom for maximum distribution and efficiency in the venting period.

Steam Spreaders: The steam spreader is a continuation of the steam line inside the retort. Although it is not absolutely required, it is highly recommended, particularly, if glass jars are processed in the retort. The steam spreader should be constructed of 1.9 cm (3/4 in.) perforated pipe in the form of a cross located just below the crate supports. The perforations should be in a straight line along the side of the pipes making-up the spreader cross. To insure good distribution of steam, the number of perforations in the spreader should be such that the total cross-section area of the perforations is equal to 1½ to 2 times the cross-sectional area of the steam inlet line. The number of perforations needed in a 1.9 cm (3/4 in.) diameter steam spreader is determined by the diameters of the spreader and the perforations. For a

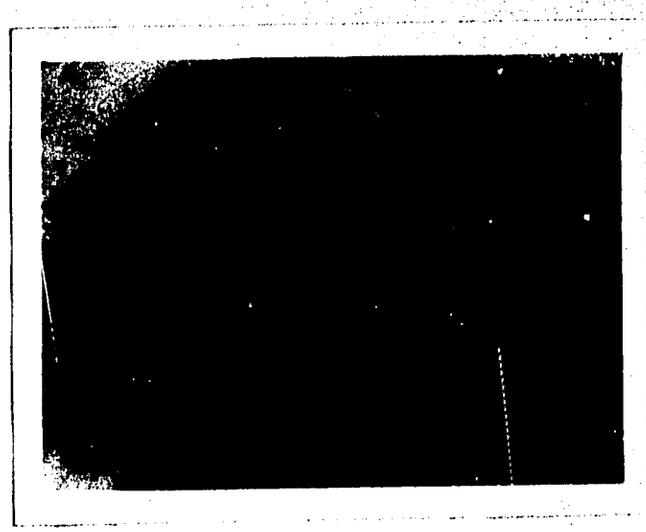

Figure 25:
Steam Spreader

1.9 cm (3/4 in.) diameter spreader, the number of perforations needed will be found in Table LIV, Number of Perforations in Steam Spreaders.

TABLE LIV

NUMBER OF PERFORATIONS IN STEAM SPREADERS

Hole Size (millimeters)	19mm(3/4 in.) pipe	25.4mm(1 in.) pipe	31.7mm(1¼ in.) pipe	38.1mm(1½ in.) pipe
4.76(3/16 in.)	29-39	47-63	82-109	111-148
5.56(7/32 in.)	22-29	35-46	60-80	82-109
6.35(1/4 in.)	17-22	27-36	46-61	63-83
7.94(5/16 in.)	11-14	17-23	30-40	40-54

Vent: Vents are large valve-controlled openings in retorts, used for the elimination of air during the venting period. They should be installed in such a way that all the air can be removed from the retort before timing of the process is started. Vents must be controlled by gate or plug cock type valves which must be fully open to permit rapid discharge of air from the retort during the venting period. The vent line or pipe leading from the retort should be short and as free as possible from bends and other conditions which might retard rapid discharge of air. Such lines should discharge to the atmosphere as close to the retort as possible. THEY MUST NOT BE CONNECTED DIRECTLY TO A CLOSED DRAIN SYSTEM. If the retort overflow is used as a vent, there must be an atmospheric break in the line before it connects to the closed drain. This is required to prevent back pressure during venting and to meet plumbing codes. THE VENT MUST BE LOCATED IN THE OPPOSITE PORTION OF THE RETORT FROM WHICH THE STEAM IS ADMITTED.

Bleeders: Bleeders should not be confused with vents. Bleeders are small petcock type valves used to remove the small amount of air entering the retort with steam and to provide circulation of steam in the retort. Bleeders MUST be open and emit steam continuously and freely during the entire process, including the come-up time. A 1.53 mm (1/16 in.) or larger valve opening should be used to bleed wells for mercury-in-glass thermometers and temperature recorder bulbs. Bleeders are required on all external wells. all other bleeders should be 3.18 mm (1/8 in.) or larger.

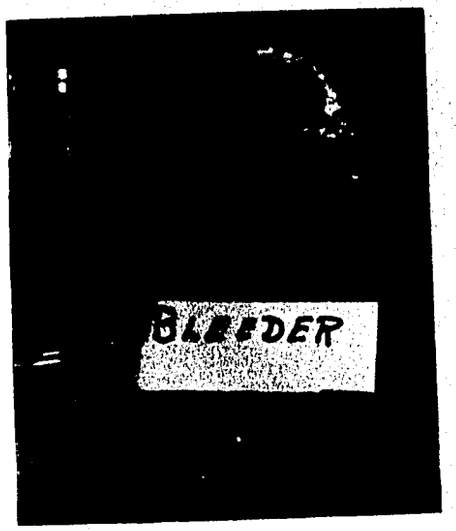

Figure 26. Bleeder

All bleeders should be arranged in such a way that the operator can observe that steam is escaping during the process. In retorts utilizing top steam inlets and bottom venting, an adequately sized bleeder must be installed in the bottom of the retort to indicate and assist in complete and continuous removal of condensate. Its discharge should be at a height or located in a position to enable observation of its operation. Bleeders may be installed in any retort to remove condensate.

Mufflers or Noise Suppressors: Bleeders and vents may be equipped with mufflers or noise suppressors to reduce the noise level in the retort area. If such devices are used, they must be properly designed and maintained to assure that they do not restrict the flow of air and steam.

Drain: The drain should be large enough to permit rapid removal of water after cooling. Only when steam is admitted at the top should the drain be used as a vent. In this case the drain line must be open to the atmosphere.

Water Line: If containers are to be cooled in the retort, the line pressure and pipe size of the water supply line and inlet should be adequate to allow for rapid filling of the retort. Water valves should have replaceable seals and should be maintained in good condition to assure that water does not leak into the retort during processing. Water leakage into the retort during processing may result in under-sterilization of the containers of food.

Water inlets at both top and bottom of the retort may be desirable to provide a means for the most efficient cooling procedure. The top inlet on the vertical retorts should discharge water through a spray ring or several small openings around the shell.

Overflow Line: The overflow line should be located near the top of the retort above the top layer of cans. A gate or plug cock type valve should be used to permit unrestricted flow.

Vacuum Breaker: Retorts equipped to cool with water should have installed an adequately sized vacuum breaker to prevent the rapid formation of a vacuum in the retort which may result in retort and can damage. This condition can occur if water is admitted rapidly to the top of a retort while it is still under steam pressure and the steam inlet valve has been closed.

Air Line: If retorts are equipped with air for pressure cooling, the air valves should have replaceable seals and should be maintained in good condition. Air leakage into the retort during processing must be prevented since steam-air mixture will reduce the effectiveness of the process and may result in under-sterilization of the containers of food.

Crate Supports: Vertical retorts must be equipped with bottom crate supports.

Baffle Plates: BAFFLE PLATES MUST NOT BE USED IN THE BOTTOM OF RETORTS BECAUSE THEY TEND TO DIRECT THE FLOW OF STEAM AROUND THE BASKET OR CRATE OF CONTAINERS RATHER THAN UP THROUGH THE CONTAINERS. Therefore, the use of baffle plates in retorts may cause underprocessing by creating cold spots or pockets of steam-air mixture due to the poor circulation of steam.

Safety Valve: Safety valves must have large enough capacity to relieve all potential excess pressure in retorts. The maximum amount of steam entering a retort at any given time is not determined by a given adjustment on the steam controller, but by the steam flow through the controller when adjusted to permit the maximum unrestricted flow at the maximum pressure of the steam flow in the retort steam supply line. Table LV, "Steam Flow - kilos (pounds) per hour," gives the number of kilos (pounds) of steam per hour that will flow through various sizes of orifices at different pressures.

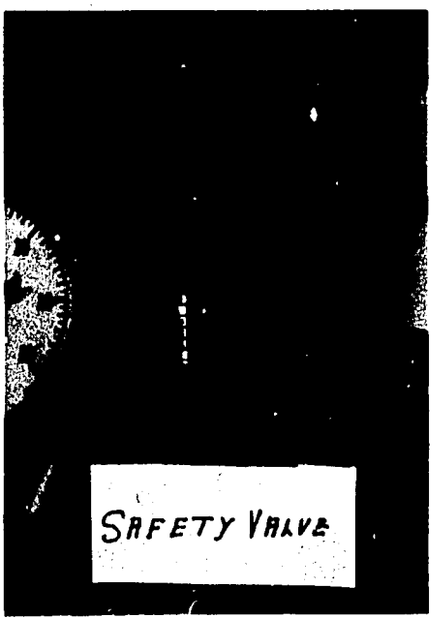

Figure 27.
Safety "Pop-Off" Valve
Courtesy of Manning, Maxwell and Moore, Inc.

TABLE LV

STEAM FLOW - kilos (pounds) per hour

AT DIFFERENT PRESSURES THROUGH ORIFICES OF VARIOUS SIZES

Steam Pressure		Size of Orifices							
		9.5mm (3/8 in.)		12.7 mm (1/2 in.)		19.1 mm (3/4 in.)		25.4 mm (1 in.)	
Kpag	(PSIG)	Kilos	(Pounds)	Kilos	(Pounds)	Kilos	(Pounds)	Kilos	(Pounds)
34.5	(5)	36.3	(80)	65.8	(145)	143.0	(315)	263.3	(580)
68.9	(10)	54.5	(120)	98.1	(216)	217.9	(480)	385.9	(850)
137.9	(20)	79.5	(175)	143.5	(316)	313.3	(690)	558.4	(1230)
206.8	(30)	97.6	(215)	174.3	(384)	381.4	(840)	685.5	(1510)
275.8	(40)	118.0	(260)	204.3	(450)	444.9	(980)	808.1	(1780)
344.7	(50)	136.2	(300)	236.1	(520)	510.8	(1125)	930.7	(2050)
413.7	(60)	156.6	(345)	267.9	(590)	576.6	(1270)	1057.8	(2330)
482.6	(70)	177.1	(390)	299.6	(660)	642.4	(1415)	1180.4	(2600)
551.6	(80)	195.2	(430)	331.4	(730)	708.2	(1560)	1271.2	(2800)
620.5	(90)	215.7	(475)	363.2	(800)	771.8	(1700)	1439.2	(3170)
689.5	(100)	236.1	(520)	394.9	(870)	839.9	(1850)	1566.3	(3450)

An estimate may be made for the number of kilos (pounds) of steam per hour that can enter a retort by using Table LV . A safety valve should be selected that will have the capacity to relieve this estimated quantity of steam entering the retort. If a retort is equipped with a safety valve, its capacity should be checked to see if it is great enough to handle the amount of steam that can enter the retort through the system used in piping the steam into the retort. If the capacity of the safety valve is not sufficient, either it should be replaced with one of adequate capacity or install an additional one with enough capacity so that the combined capacities of the two will be sufficient.

Steam safety valves should comply with local codes or the A.S.M.E. code for unfired pressure vessels. Since the relieving capacity of a given size safety valve varies with different manufacturers, no specifications as to the required size can be given in this publication. Such specifications should be obtained from the manufacturer for the specific operating conditions.

Indicating Mercury-in-glass Thermometer: Each retort must be equipped

with at least one mercury-in-glass thermometer having a scale with no more than 10 C. (17 F.) per 2.54 cm (1 in.) and graduated in no more than 1 C. (2 F.) divisions. The temperature range should adequately encompass the scheduled retort temperatures to be used.

Bulbs of indicating thermometers may be installed within the retort shell or in external wells attached to the retort. External wells or pipes should be connected to the retort through at least a 1.9 cm (3/4 in.) diameter opening, and be equipped with 0.16 cm (1/16 in.) or larger bleeders so located as to provide a full flow of steam past the entire length of the thermometer sensing bulb. Thermometers with separable wells or sleeves should not be used. The bleeder must emit steam continuously and freely during the entire processing period.

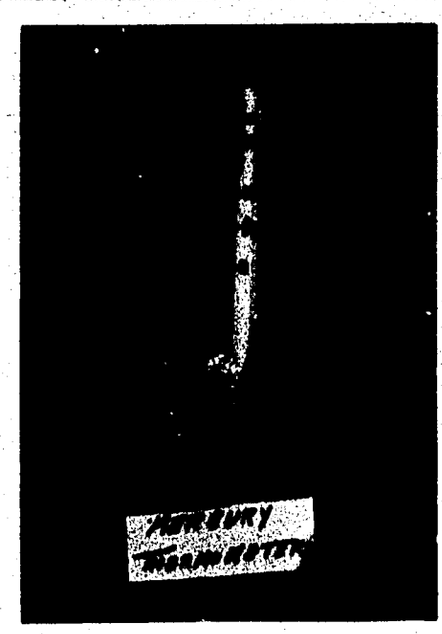

Figure 28. Retort Mercury - in - Glass Thermometer Courtesy of Taylor Instrument Company

Thermometers should not be installed in the lid or door of a retort as an abrupt jar may cause the mercury column to divide. A thermometer with a broken or divided mercury column should be replaced immediately.

Thermometers must be tested for accuracy against a known accurate standard thermometer upon installation and at least once a year thereafter or any time their accuracy is questioned. Records of these tests should be maintained.

THE MERCURY THERMOMETER, NOT THE RECORDER CHART, MUST BE THE OFFICIAL INSTRUMENT FOR INDICATING THE PROCESSING TEMPERATURE.

Recording Thermometer: Each retort must be equipped with a recording thermometer to provide a permanent record of the time and temperature of each retort processed. The chart graduations shall not exceed -17 C (2 F) within a range of -12 C (10 F) of the processing temperature. Each chart shall have a working scale of not more t 13 C (55 F) per 2.54 cm (1 in) within a range -7 C (20 F) of the processing temperature. A means of preventing unauthorized changes in adjustment shall be provided. A means can be provided by either a lock or a suitably worded sign prominently displayed at or near the reco er.

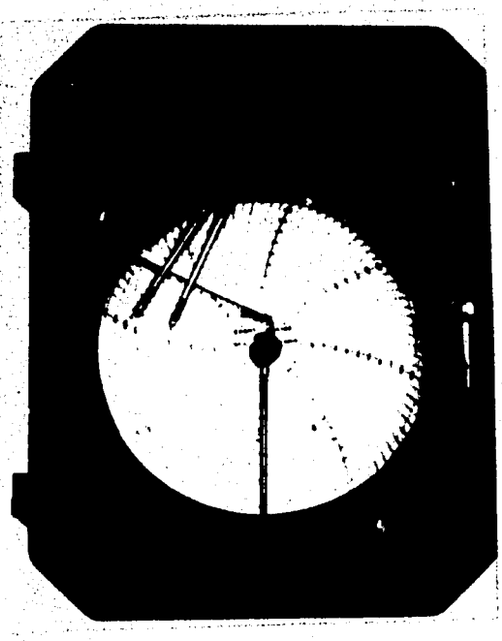

Figure 29. Recording Thermometer
(Courtesy of Taylor Instrument Company)

The sensing bulb may be installed within the retort shell or in an external well connec to the retort through at least a 1.9 cm (3/4 i opening. The well must have a 0.16 mm (1/16 i or larger bleeder which is open at all times during the processing period. The recording thermometer must be checked and adjuste to agree as closely as possible with an accurate mercury-in-glass thermometer at the processing temperature.

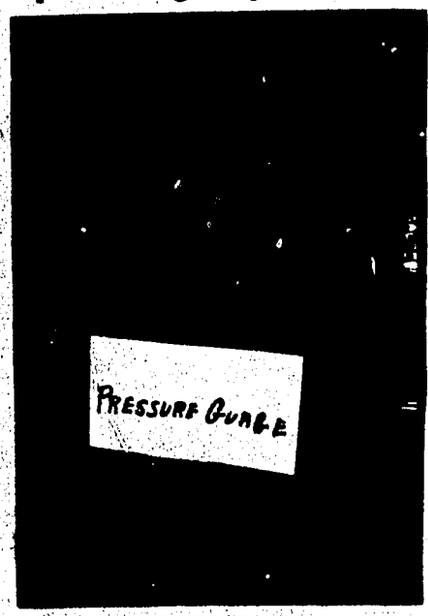

Figure 30. Pressure Gauge
(Courtesy of Manning, Maxwell & Moore, Inc)

Pressure Gauge: A retort should be equipped with an easy to read pressure gauge. The gauge should have range of 0 to 206.8 kpa (30 psig) and be graduated in divisions of 1 kilo (2 psig) or less.

Crates and Baskets: The containers used to hold the cans in the retort should be made of scrap iron or adequately perforated sheet metal. The perforations should be 2.54 cm (1 in) on 5 cm (2 in) centers or the equivalent 1.27 cm (½ in) on 2.54 cm (1 in) centers or 19.1 cm (3/4 in) on 3.8 cm (1½ in) centers in both the sides and bottom. The perforations are necessary to assure adequate circulation of steam around the containers.

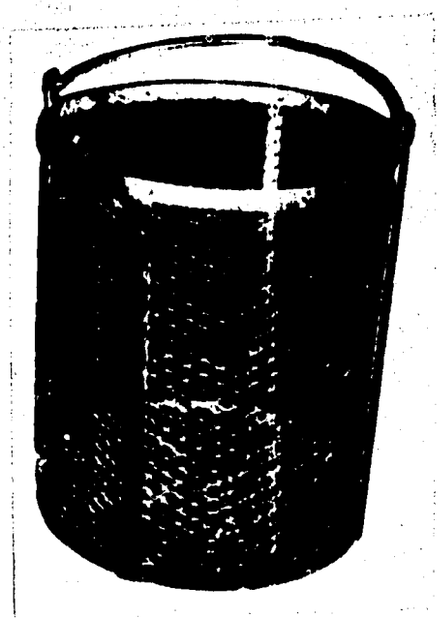

Figure 31. Retort Basket or Crate
(Courtesy of Dixie Canner Equipment Co.)

Dividers: Retort loading systems employing divider plates between layers of containers generally require increased venting schedules. The divider plates should have the same perforations as the crates' bottoms or their equivalent.

Process Timing Equipment: A large, easily read clock or accurate timing device should be installed where it can be observed readily by the retort operator for accurate process timing.

Pressure Cookers

A pressure cooker is a pressure vessel designed to receive its pressure from the application of heat from a direct source, such as a gas burner or an electrical unit of a hot plate or range. The pressure cookers recommended in this manual for Plant A have the capacity to process 36 Number 2 (307 x 409) cans or 16 Mason type quart glass jars.

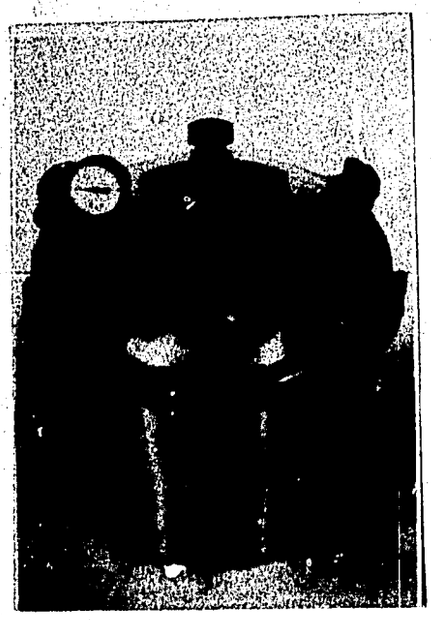

Figure 32. Pressure Cooker (Courtesy of Dixie Canner Equipment Company)

Each pressure cooker must be equipped with a short stem mercury-in-glass thermometer having a scale graduated in no more than 1 C or 2 F divisions. The temperature range should adequately encompass the scheduled retort temperatures to be used. The short stem thermometers may be installed in the top or lid of the pressure cooker. Its location should be close to the bleeder or petcock. Each pressure cooker should also be equipped with a bleeder petcock, safety valve, safety plug and wire rack to hold containers of food during processing

Atmospheric Cookers:

An atmospheric cooker is a relatively large vessel in which containers of food are thermally processed in boiling water at atmospheric pressure. In using an atmospheric cooker it will be important to remember that the time recommended in scheduled processes is based on 100 C (212 F), the temperature at which water boils at sea level. For every 330 meters (1100 ft.) above sea level, the boiling point of water is lower by approximately 1.1 C (2 F). A cannery located above sea level will need to process food in an atmospheric cooker longer than the recommended time of 100 C (212 F), depending upon the elevation.

Two types of atmospheric cookers are commonly used in processing acid canned foods. The one illustrated in Figure 33 consists of a 33.25 liter

(35 quart) container with sufficient depth to maintain at least 3.75 cm (1½ in.) of water over the tops of the containers of food during the processing period. A metal rack is usually used to hold the containers so they can be easily lowered into the cooker and removed from the hot water bath. This size atmospheric cooker will hold 30 No. 2 cans.

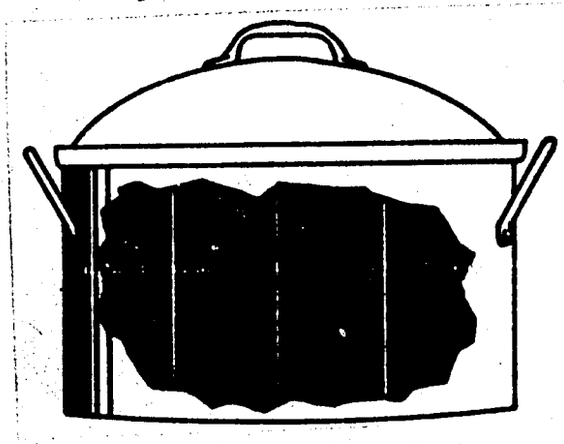

Figure 33. Hot Water-Bath Atmospheric Cooker

If steam is available, it can be used for atmospheric cooking instead of boiling water. Specially designed equipment such as illustrated in Figure 34 can be used for this purpose. This type of cooker is not too difficult to fabricate locally. It is important for the water line to be high enough up on the wall of the cover to form a good water-seal thus making it possible to produce an atmospheric condition with a temperature inside the hood comparable to boiling water when sufficient steam is entering. This being an atmospheric cooker,

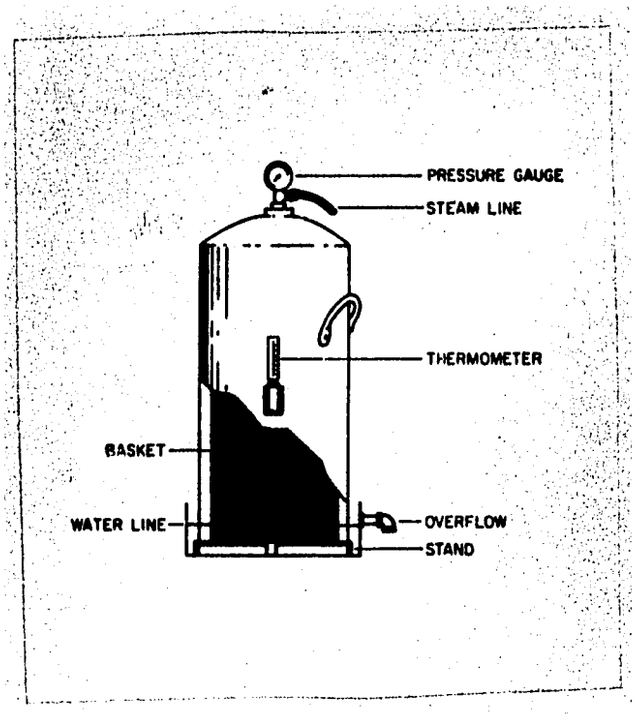

Figure 34. Steam Atmospheric Cooker

it is important to remember that the maximum temperature on the inside of the cooker is 100 C. (212 F.) at sea level. If this type of cooker is operated above sea level, additional time will be required to process acid foods, depending upon the elevation.

- NO LOW ACID FOODS SHOULD BE PROCESSED IN EITHER OF THE TWO TYPES OF ATMOSPHERIC COOKERS. A partial list of low acid foods can be found in Figure 1.

Can Reformer

When cans are purchased in collapsed form, it is necessary that equipment be available for reforming the cylindrical shapes of the cans. This is done by a can reformer. The hand-operated can reformer will reform approximately seven cans per minute; the power operated can reformer - Figure 35 - will reform approximately 10 to 14 cans per minute. Specify can sizes in preparing purchase order.

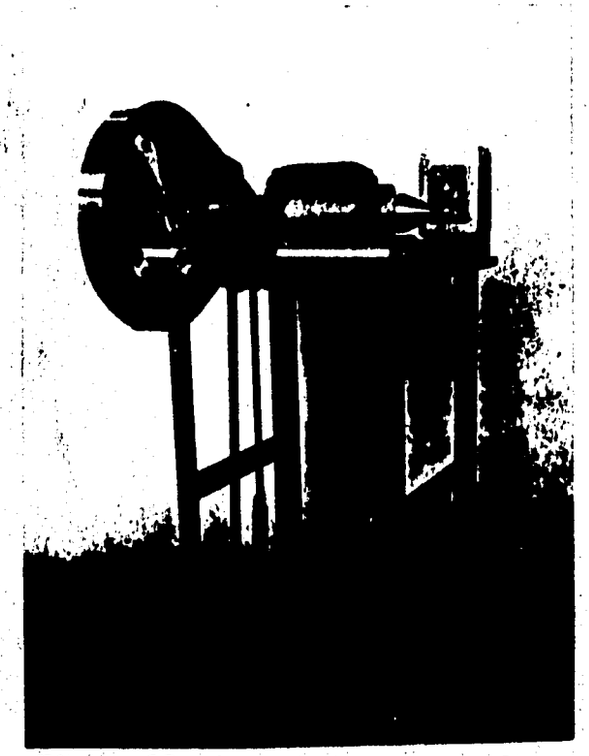

Figure 35. Motor Driven Can Reformer (Courtesy of the Callaham Ams Machine Company)

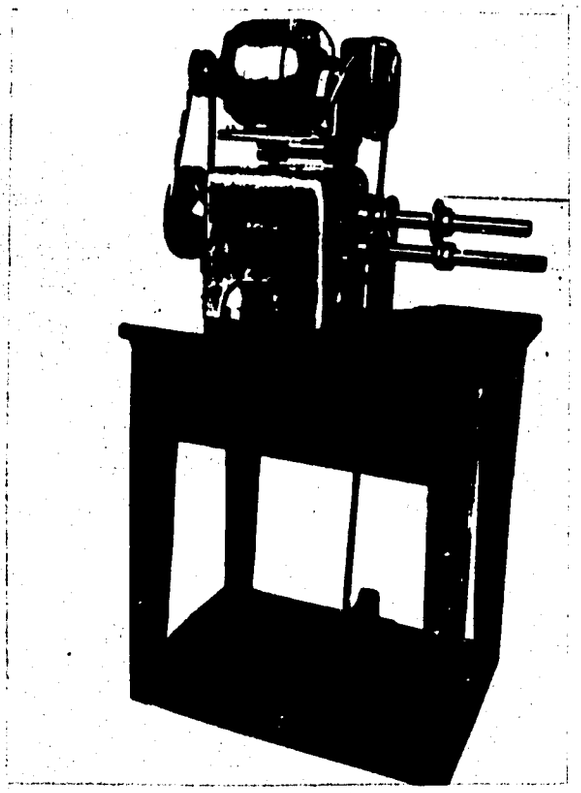

Figure 36. Motor Driven Can Flanger (Courtesy of the Callaham Ams Machine Company)

Can Flanger

After the collapsed cans have been reformed, it is then necessary that flangers be placed on the ends of the cans. This is done by equipment known as can flangers. The hand-operated equipment will flange approximately seven cans per minute; the power operated equipment shown in Figure 36 will flange approximately 10 to 14 cans per minute. Specify can sizes in preparing purchase order.

Flange Reformer

It is recommended that a can reformer - Figure 37 - be available in a canning plant for each diameter size can that is used. The hand flange reformer is used to reform the flange of cans that have become bent and would otherwise be unusuable in which to can food. No other instrument such as, hand pliers, etc., should be used to reform a bent flange because such instruments could easily damage the lining of the can. Specify can sizes in preparing purchase orders.

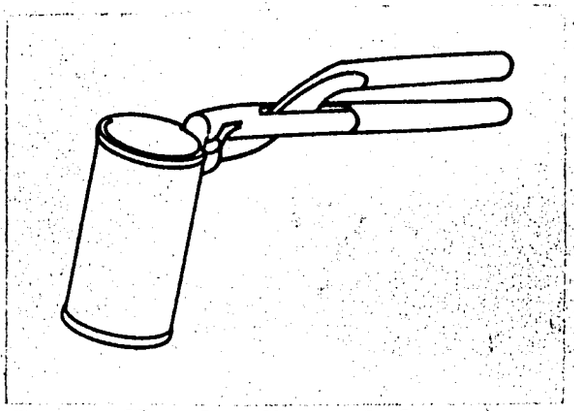

Figure 37. Can Flange Reformer
(Courtesy of Dixie Canner Equipment Company)

Hand-Operated Can Sealer

A hand-operated can sealer - Figure 38 will close any standard size can up to and including No. 3 diameter cans. The hand sealer can close from 2 to 3 cans per minute depending upon the can size and the proficiency of the operator. In ordering a sealer, specify the can sizes that will

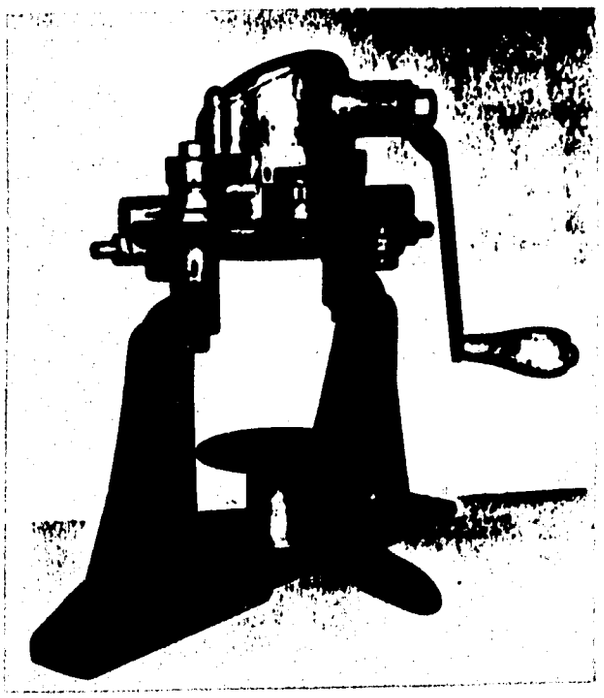

Figure 38. Hand-Operated Can Sealer
(Courtesy of Dixie Canner Equipment Co.)

be closed on the sealer. Repair kits should also be included in the order. This sealer can also be used to secure the ends on reformed and flanged cans.

Power-Operated Can Sealer

A power-operated can sealer - Figure 39 will close any standard size can up to and including No. 3 diameter size cans. To close a No. 10 size can requires a larger machine. A power-operated sealer will close from three to six cans per minute depending upon the size of the cans and the proficiency of the operator. In ordering a sealer, specify the can sizes that will be closed on the sealer. Repair kits should also be included in the order. This sealer can also be used to secure the ends on reformed and flanged cans.

Figure 39. Power-Operated Can Sealer
(Courtesy of Dixie Canner Equipment Company)

Steam-Blancher-Cooler

In using a steam blancher-cooler - Figure 40 - the product is spread evenly without bruising or crushing in smooth flat bed perforated stainless steel trays for uniform steam blanching. The 60.96 cm (24 inch) x 60.96 cm (24 inch) x 7.62 cm (3 inch) filled

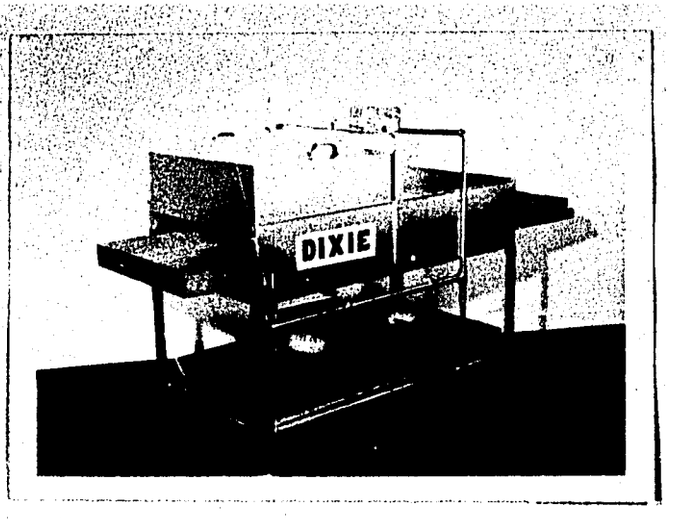

Figure 40. Steam Blancher-Cooler
(Courtesy of Dixie Canner Equipment Company)

trays are placed in the blanching compartment and passed to the cooling compartment automatically when the next tray is placed in the blanching compartment. In most canning plants, for continuous blanching, six stainless steel trays would be needed.

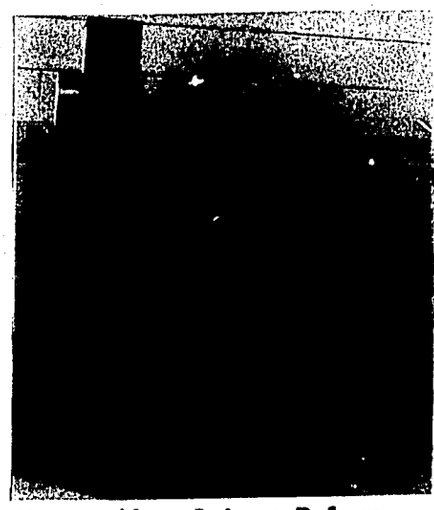

Figure 41. Juicer-Pulper
(Courtesy of F. H. Langsenkamp Company)

Juicer-Pulper

A hand-operated juicer-pulper would be recommended for plant A. A power-operated juicer-pulper - Figure 41 - is recommended for plants B and C. Extra screens need to be ordered with the juicer for juicing, pureeing and finishing the various products. The capacity of this juicer-pulper ranges up to 1362 kilos (3000 lbs.) per hour.

Batch-Type Exhauster

A batch-type exhauster - Fig. 42 can either be fabricated out of stainless steel or purchased locally. The water in this type of exhauster is heated with steam from a boiler piped through coils in the exhauster. The exhausting of food in metal containers can be accomplished in large water atmospheric cookers in plant A where no steam is available.

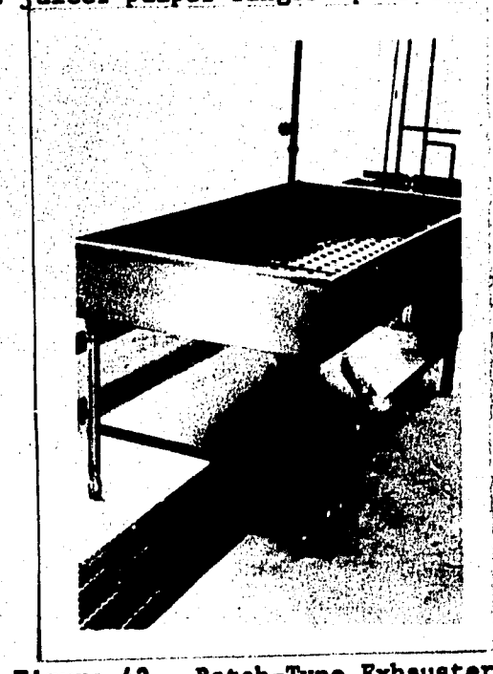

Figure 42. Batch-Type Exhauster

Continuous, Power-Operated Exhauster

The continuous, power-operated exhauster - Figure 43 - "Continuous, Power-Operated Exhauster," is equipped with a filling and sealing table. The cans of standard sizes ranging from No. 1 through No. 10 are conveyed through a 3.66 meter (12 ft.) enclosed steam tunnel on a chain conveyor. At the slowest speed each can remains in the exhauster for 5½ minutes, for the fastest speed, 2½ minutes.

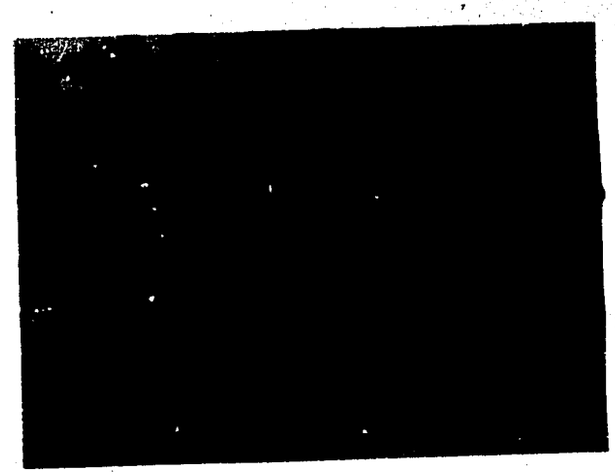

Figure 43. Continuous, Power-Operated Line Exhauster (Courtesy of Dixie Canner Equipment Co.)

Stainless Steel Tables

Stainless steel table tops are recommended for all canning plants because they are easy to keep clean and to sanitize in addition to being resistant to rust and corrosive reactions when coming into contact with acids in foods. Sinks with two small compartments may be placed on racks and mounted on one end or both ends of a table - Figure 44 - "Stainless Steel Table," The disadvantage of having sinks mounted on tables is in making the tables less functional in that they become permanently located.

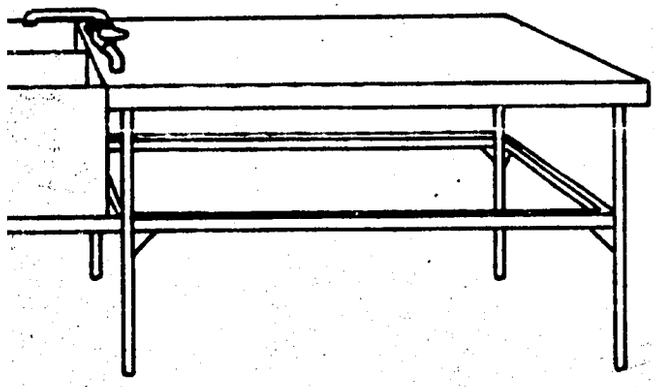

Figure 44. Stainless Steel Table with Double Compartment Sink

Stainless Steel Top Table Truck

Stainless steel top table trucks having a work surface area of 83.8 cm (33 in.) x 83.8 cm (33 in.) are very convenient to use in moving prepared products from place to place in the canning plant. Every canning plant should consider having two or three table trucks.

Stainless Steel Double Compartment Sinks

Stainless steel double sinks, see Figure 45, should have each compartment measuring 60.96 cm (24 in.) x 60.96 cm (24 in.) x 35.56 cm (14 in.) deep to be large enough in which to wash and clean the large pots and pans used in the canning operations. Both hot and cold water should be accessable to the sinks. The sinks should be so constructed to have 0.32 cm (1/8 in.) cove corners which help to make the sinks easier to clean and to keep clean.

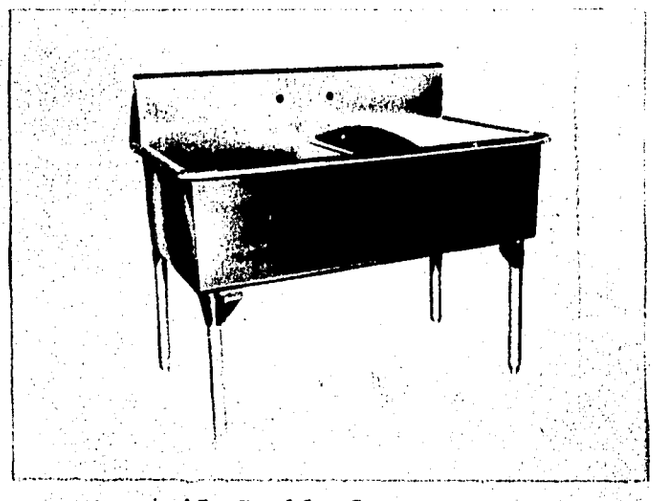

Figure 45. Double Compartment Stainless Steel Sink

Stainless Steel Lavatory

The stainless steel lavatory is a small 40.6 cm (16 in.) x 48.3 cm (19 in.) x 25.4 cm (10 in.) deep hand wash basin that is free standing and has foot operated pedals for hot and cold water valves. See Figure 46. This lavatory should be located inside the processing room where it is convenient for all personnel working in the room to wash their hands after entering the process-

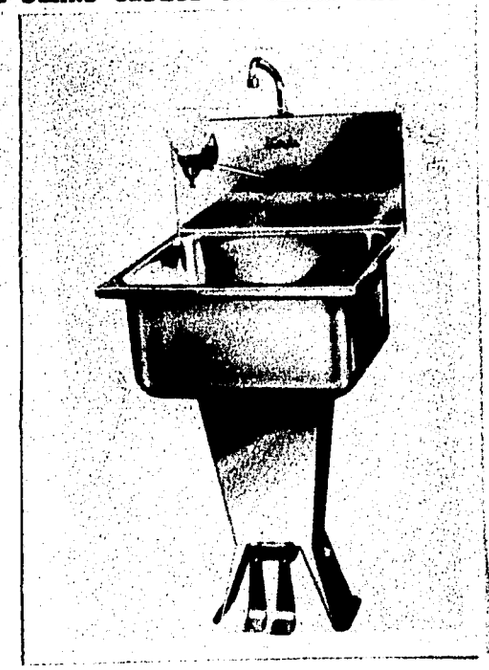

Figure 46. Stainless Steel Lavatory with Foot-Operated Hot and Cold Water Valves.

(Courtesy of Koch Supplies, Inc)

ing area and before they start working with food products.

Chain Hoist

Both plants B and C will require a 454 kilo (1000 lb.) hoist to lower and remove retort crates of canned food into and out of the retorts and placed into water cooling tanks or areas. The hoist - Figure 47 - is hung from a trolly mounted on a track that is suspended from the ceiling directly over the retorts and runs from the retorts to the cooling tank or cooling area.

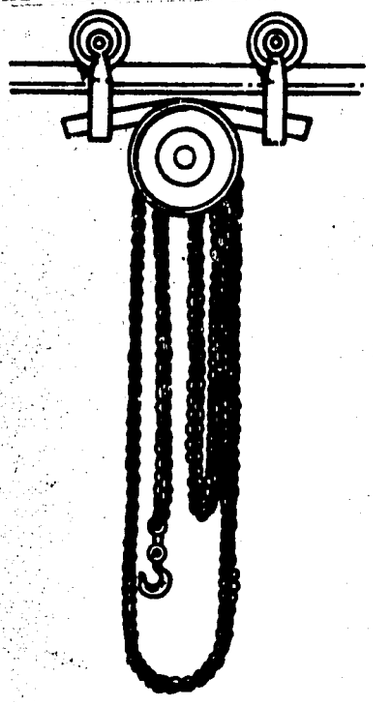

Figure 47. Hand-Operated Chain Hoist

Water Cooling Tank

The water cooling tank 0.91 meters (3 ft.) wide x 3 meters (10 ft.) long and .91 meters (3 ft.) deep is usually made from mild steel boiler plate .32 cm (1/8 in.) thick. Water enters near the bottom of the tank and overflows near the top. Water should run continuously in and out of the tank at a rate to provide adequate cooling for cans of hot foods which have just

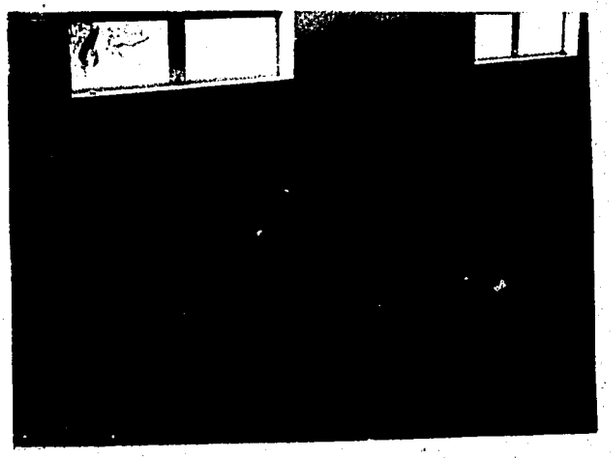

Figure 48. Water Cooling Tank

been removed from the retorts or atmospheric cookers. The water should be drained each day and replaced with fresh potable water. The water cooling tank is shown in Figure 48 .

Trunnion Mounted Steam Jacketed Tilt Kettle

Trunnion mounted steam jacketed tilt kettles, constructed of stainless steel, of at least two sizes are recommended for plants B and C in which steam is available.. See Figure 49 .

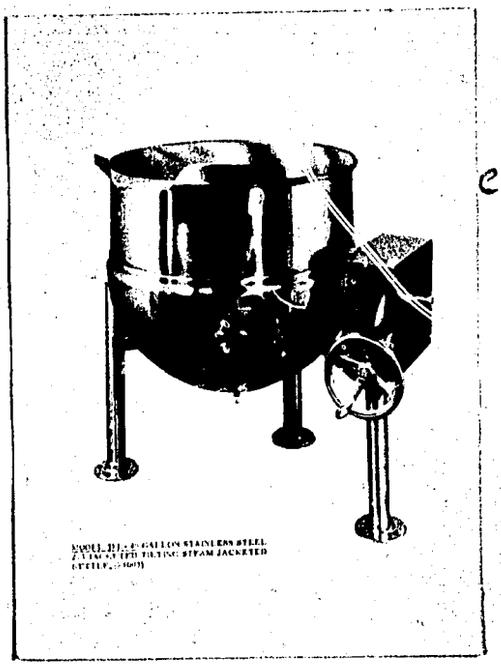

Figure 49. Steam Jacketed Trunnion Mounted-Worm Tilt Kettle
(Courtesy of Goren Division, Dover Corporation)

A trunion mounted tilt kettle is recommended instead of the stationary type because of the elimination of an expensive valve that will need to be replaced from time to time. The elimination of the valve also eliminates a source of food contamination. Unless the valve is taken apart and cleaned thoroughly after each use, it will soon become a source of contamination. One hundred fourteen liters (30 gal.), 152 liters, (40 gal.) and 190 liters (50 gal.) kettle sizes are recommended for plants B and C. The steam line to the kettles should have a steam pressure reducing station to reduce the steam pressure in the manifold serving the kettles to 275.8 kpag (40 psig). Each kettle must have a steam trap fitted on the steam discharge line to conserve steam.

All-Purpose Dolly Truck

An all-purpose dolly truck, see Figure 50, is useful in moving heavy retort crates of canned food from place to place in the canning plant. The dollys are usually constructed of hardwood frames mounted on swivel casters.

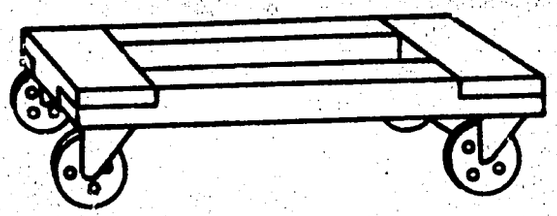

Figure 50. All-Purpose Dolly Truck

Hot Lift Tongs

Hot lift tongs - Figure 51 - are designed to grasp cans and jars of hot food firmly and should be available in all canning plants.

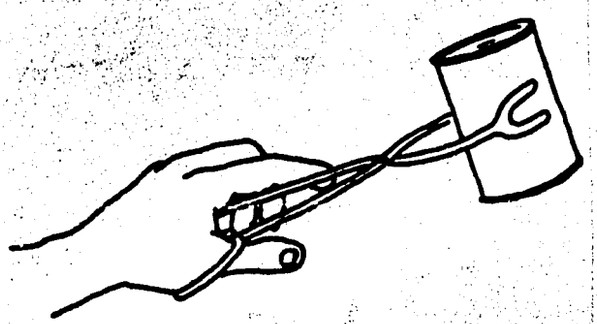

Figure 51. Hot Lift Tongs

Stock Pots

Aluminum stock pots - Figure 52 - of various capacities are useful in canning plants for handling, storing and precooking foods of all types. They usually come in varying sizes from 19 liters (5 gal.), 38 liters (10 gal.) to 57 liters (15 gal.)

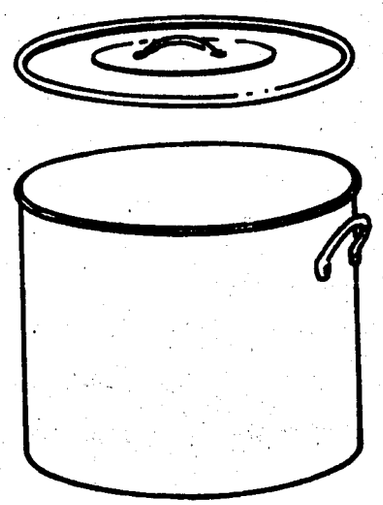

Figure 52. Stock Pot

All-Purpose Scales

All-purpose scales are necessary in canning plants for weighing various products such as those canned by weight. See Figure 53, "All-Purpose Scales," They should have a capacity of at least 18 kilos (40 lbs.) with direct indicating having 10 grams or 0.1 lb. divisions. Over and under scales are necessary in all commercial plants to monitor the filled weight and net weight of canned foods. This type of scale should have a capacity of 5 kilos and a beam with 5 grams division or 10 pounds capacity with a beam having 1/8 ounce divisions. Weights of 100, 200 and 500 grams or 1/2 ounce, 1 and 5 pounds are necessary to give the over and under scales varying weighing capabilities for the various sizes of cans and jars. Platform scales, which are portable, Fig. 54, "Platform Scales," are used to weigh heavy quantities of produce. They usually have a capacity of 500 kilos or 1000 pounds.

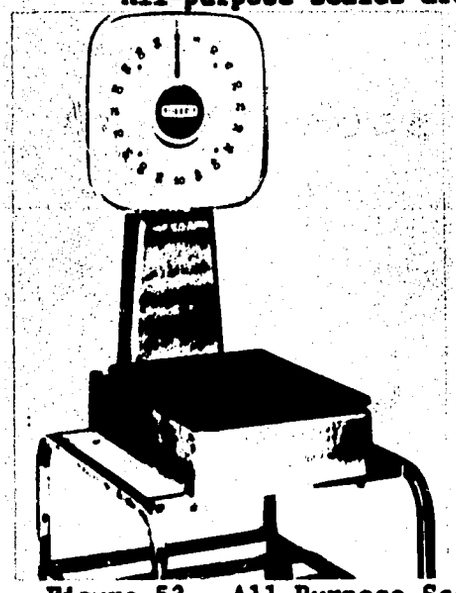

Figure 53. All Purpose Scales (Courtesy of Toledo Scale Division, Reliance Electric Company)

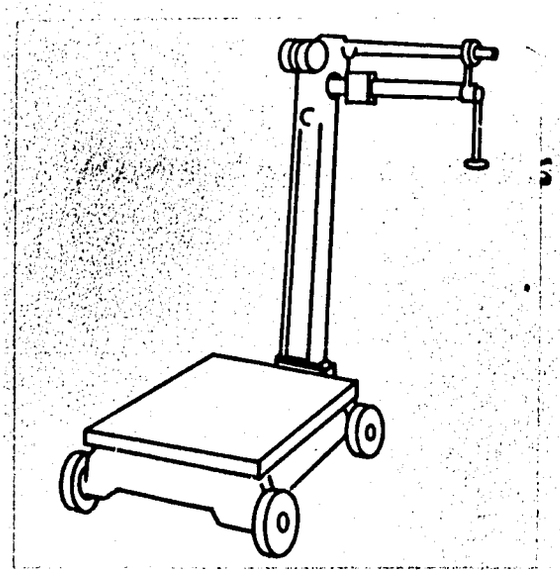

Figure 54. Platform Scales

External Water Cooling Spray

An external water cooling spray is used for cooling glass jars and cans removed from pressure cookers, retorts and atmospheric cookers. It is important to cool processed foods down to

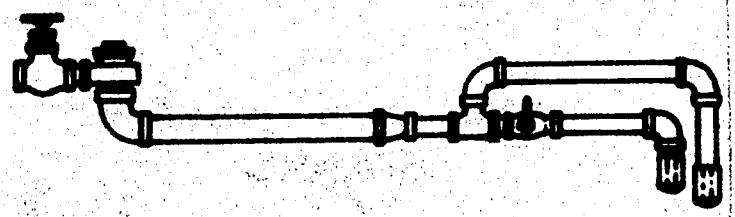

Figure 55. Water Cooling Spray

38 C. (100 F.) as quickly as possible to avoid the possibility of frequent spoilage by heat resistant bacteria. See Figure 55, Water Cooling Spray.

Lye Peeler-Scalder

The lye peeler-scalder is useful for lye peeling peaches, pears, potatoes, carrots, sweet potatoes and tomatoes. The lye peeler-scalder, see Figure 56, "Lye Peeler-Scalder," has a swing basket in a heated lye compartment 45.7 cm (18 in.) x 68.6 cm (24 in.). This compartment is equipped with a steam heated coil and quick opening drain valve. The produce in the lye, caustic soda, compartment is transferred to the rinse compartment by lifting the swing basket. When the basket is filled sufficiently, the produce tumbles into the rinse section. The rinse compartment is the same size as the lye compartment and is equipped with a rinse basket and cool running water. The lye peeler-scalder has a capacity of 17.6 liters (1/2 bu.).

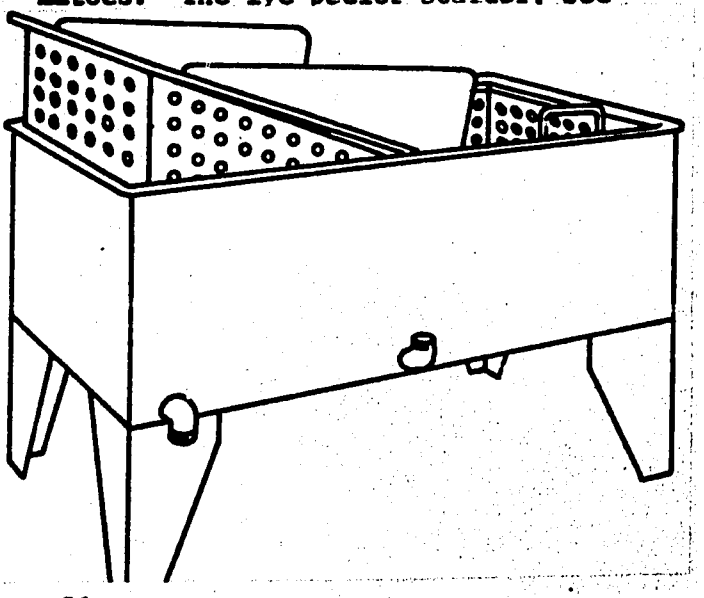

Figure 56. Lye Peeler-Scalder

Pea and Bean Huller

The pea and bean huller - Figure 57 - has a capacity of 211 to 352 liters (6 to 10 bu.) of unhulled product per hour. It is operated with an

one-half horse power motor. Special features of this equip ment are the hopper-type top for convenience in feeding the raw materials to the machine, a variable speed drive for adjusting the speed of the machi to the type and variety of produce or degree of maturity, and an adjustable conveyor bel which separates the peas or beans from broken pieces of po The metal sides lift off the machine completely and the top may be removed by simply loosening four bolt nuts. Thus, all parts are accessible for quick and easy cleanin

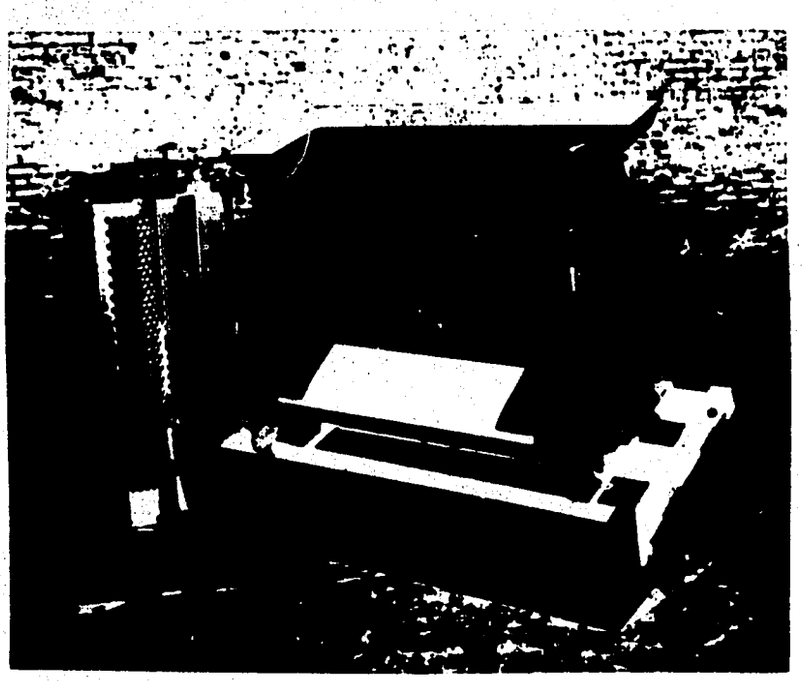

Figure 57. Pea and Bean Huller
(Courtesy of the Dixie Canner Equipment Company)

Corn Cutter and Accessories

The corn cutter - Figure 58 - has a capacity from 20 to 40 ears per minute. The cutting knives are easily and quickly adjustable to the size of the ear and depth of cut. It also has an attachment for preparing cream-style corn. Accessories, knife sharpener and cutting head adjustment stand, are necessary to maintain sharp knives and properly adjusted knives. An accurate adjustment is absolutely necessary and is assured if the sharpen and adjustment stand are properly used.

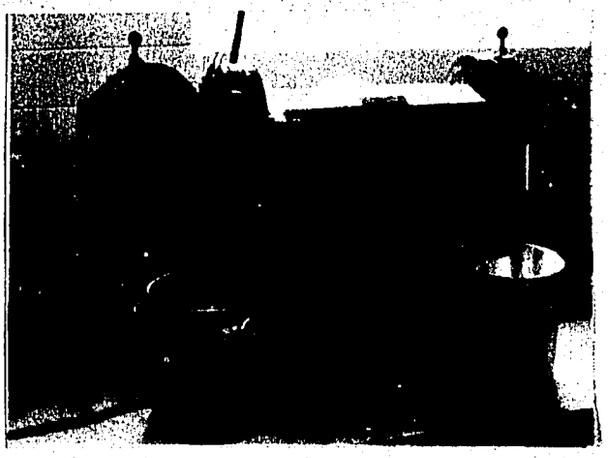

Figure 58. Corn Cutter
(Courtesy of The United Company)

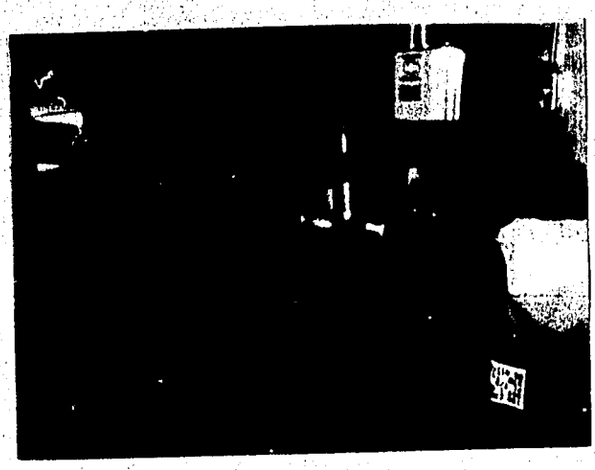

Figure 59. Food Chopper

Food Chopper

A hand-operated food chopper is recommended for plant A. However, a power-operated chopper is recommended for plants B and C. See Figure 59, Food Chopper. The power-operated table model chopper has a capacity of 272 kilos (600 lbs.) per hour.

Rotary Fruit and Vegetable Washer

A rotary fruit and vegetable washer is used for cleaning and washing shelled peas, corn, and other produce which need washing before further preparation steps. The products needing cleaning are fed into a feeding hopper which delivers the products directly into a rotating cylinder. The products pass under a full length high pressure water spray, while being agitated by the rotating cylinder and are discharged into a container or onto a conveyor. The washer has a capacity of 2725 kilos or 6,000 pounds per hour. See Figure 60, Fruit and Vegetable Washer.

Figure 60. Fruit and Vegetable Washer
(Courtesy of Dixie Canner Equipment Company)

Air Compressor

A heavy duty air compressor with an actual delivery rate of at least $0.15m^3$ (5.25 cu.ft.) per minute at 1034.25 kpag (150 psig) is essential for canning plants B and C. The tank capacity should be 228 liters (60 gal.). See Figure 61, Air Compressor.

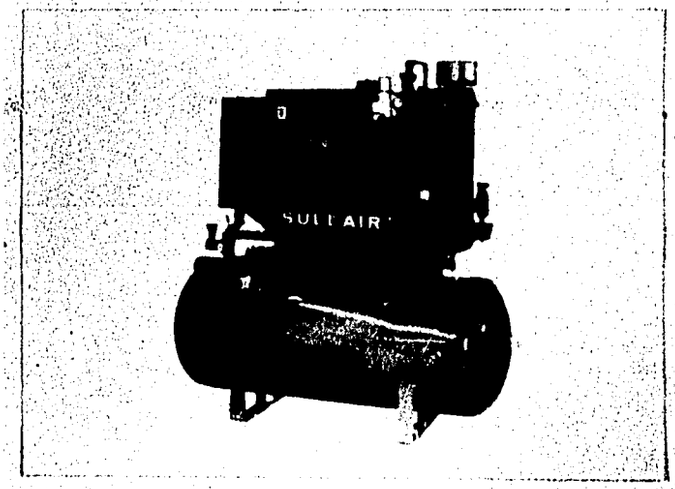

Figure 61. Air Compressor
(Courtesy of DeVilbiss)

Over and Under Scale

An over and under scale is essential in commercial canning operations for checking the fill weight of containers. When used properly, the cost will be negligible when the amount of product saved in overfilling and the risk involved of underprocessing are taken into consideration. The capacity of this type of scale may range up to 9 kilograms (20 pounds).

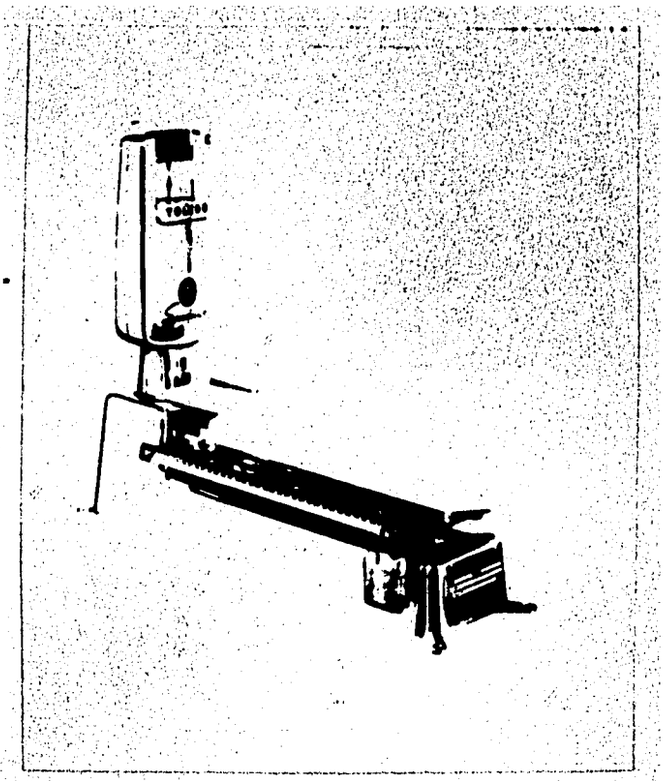

Figure 62. Over and Under Scale
(Courtesy of Toledo Scale Division, Reliance Electric Company)

CHAPTER THIRTEEN

MAINTENANCE

General Clean-Up

A high standard of cleanliness must be maintained in each of the canning operations since the quality of the finished product is affected by the condition under which it is handled. The processing time and temperature may not be adequate to insure a safe and wholesome canned product if general cleanliness is not maintained hourly in a canning plant. Posters telling what is expected of the workers in respect to keeping the plant equipment and building clean and sanitary are valuable aids in reminding the workers what to do to maintain high standards.

Cleaning supplies and equipment must be at hand for the daily clean-up inside and outside the plant. In plants where water is limited, clean-up of the plant and equipment may be performed in part with recovered water from cooling sprays and cooling tanks. Using water from such sources must be chlorinated and then used only for preliminary washing. Only fresh potable water should be used for the final washing.

In general, it is highly desirable to have employees on the job who are constantly doing as much tidying as possible. In cooperative plants, especially the smallest ones, most of the work of cleaning should be performed by the patrons. As soon as the processing is completed each day, the clean-up crew washes floors and equipment, and then treats them with an approved disinfectant. All equipment such as blanchers, cookers, brine and syrup tanks, funnels, tables, pans, steam kettles, pots and buckets used in food processing must be thoroughly scoured

and washed with detergent solution and rinsed with fresh potable water. (See Chapter 14, "The Basics of Cleaning and Sanitizing" for tips and suggestions for the type of cleaning agent to use in cleaning and sanitizing plant and equipment.) This is one of the most important operations of a general clean-up. It is excellent insurance against possible spoilage of the canned products. All garbage containers must be emptied and washed thoroughly each day. They should be left opened until time for use again. Leaving the tops off will permit dampness, or water left from washing, a chance to dry out on the inside. This will prevent rusting and will help to create conditions unfavorable for the build-up of large numbers of spoilage microorganisms and insects. If the area immediately outside the plant is creating a dust problem within the plant, some control measure should be employed. Oil should be avoided, if possible, because workers walking through it could deposit quantities of it on the floors presenting problems during clean-ups.

Building

Cupboards, Shelves and Drawers

Cupboards, shelves and drawers should be kept in good order and thoroughly cleaned at frequent intervals - 2 months.

Floors

Floors must be kept free from litter and excess water. They should be scrubbed and washed down at the end of each day of operation. During shutdown periods or at meal times they should be flushed with water.

Steam Pipes

Steam pipes should be located overhead and drained of condensate if steam lines are not equipped with drip legs. The overhead pipes must be dusted and cleaned weekly to prevent contamination from condensate drip into food.

Walls, Windows and Screens

Walls, windows and screens should be kept clean at all times. The walls need to be washed down daily and scrubbed, if necessary, to remove any food particles that may have accumulated during the day. Windows need frequent washing to remove dust and grease that accumulate in the steamy atmosphere. Screens must be washed to keep them free of dust and grease. All screens that have rusted or have holes in them must be replaced immediately after detection.

Exposed Roof Support Trusses

Exposed trusses most always collect considerable dust. These should be dusted weekly to prevent dust and spores of spoilage organisms from dropping or falling into food being prepared for canning. Painting of the trusses is not recommended because frequently the high humidity in the ceiling area of a canning plant will cause the paint to flake off and drop into the prepared food.

Toilets

Toilets must be cleaned thoroughly with appropriate cleaning agents and equipment. The cleaning should be done at the end of each day.

Building Repair

The building should be kept in a state of good repair at all times. The roof should be checked semi-annually for need of repair to prevent the elements,

rodents, birds, insects and other vermin from entering the plant. The doors, screen doors and windows must be kept in repair to prevent the entrance of vermin. Walls should be painted with a non-flaking paint. A paint employing an epoxy system has been found to be satisfactory, when properly applied, for the walls in the processing room which are exposed to high humidity conditions.

EQUIPMENT

General Discussion

Special attention must be given to the care of canning equipment since spoilage of canned food can often be traced to contamination through carelessness in cleaning the equipment. The manufacturer's instructions should be followed closely in the care of mechanical equipment. As a general rule, all equipment should be cleaned at the end of each day's operation. The equipment should be dismantled, scrubbed and steamed down where practical. The equipment should then be left dismantled until the beginning of the next day's operation and should be well flushed with clean cold water before using. During that period of the year when the plant is closed down, all equipment should be gone over thoroughly and any repairs should be made that are necessary to place the equipment in a high state of repair so that it can be expected to operate without breakdowns through out the next season.

Tables

All tables in the preparation area of the processing room should be washed with hot detergent water and hosed down with clean water.

Sinks and Lavatories

Sinks and lavatories must be cleaned daily to prevent the build-up of dirt deposits. A good sanitizing agent is recommended to be added to the rinse wate

after a thorough cleaning and washing.

Boiler

The boiler is one of the most expensive pieces of equipment in a canning plant, and its proper performance is very necessary for a successful canning operation. Boiler operation will be dependable and consistant as long as a careful maintenance schedule is followed. A maintenance schedule should be established and strictly adhered to throughout the year. Suggested below is a regular schedule of maintenance. Certain maintenance duties, more often than this schedule suggests, may be required because of local conditions. However, this schedule is applicable for average conditions and will be a good basis for setting up a regular maintenance schedule in your locale.

Daily Maintenance Schedule for Boiler

1. Blow down the boiler regularly according to requirements. The blow down schedule should be determined by a qualified water treatment chemist depending on local conditions. Follow the manufacturer's instructions closely to perform the various steps in their proper sequence. This is very important!

2. Scum on water surface should be blown out daily by surface blow down (if units are equipped to do so).

3. Blow down the water column twice a day, or at least one time per day, by opening the water column for about four seconds. This will keep the control free of sludge and sediment which can cause a control failure. Blowing down the low water control with burner operating on low fire will test its operation.

4. KEEP THE BOILER ROOM CLEAN. Dust, lint and grit are causes of improper operation of the boiler controls.

5. When starting the boiler in the mornings, make sure it goes through its correct starting cycle.

Monthly Maintenance Schedule for Boiler - Do the following things each month.

1. Clean electrical controls and check starter contacts. Make sure the main switch is pulled before attempting this work. Always keep control cabinet door closed when not servicing the electrical controls.

2. Clean fuel oil strainer (if oil unit) and more often than monthly, if conditions require. Be sure when closing the fuel strainer body, the gasket is fitting properly and is not torn.

3. Clean water strainer.

4. Check water pump packing, or seal for leaks.

5. Check the hold down bolts on all motors and pumps.

6. (If oil unit) Remove the nozzle assembly by taking it from the burner head to inspect and clean the nozzles and screens by soaking them in a good solvent.

7. Inspect ignition electrodes to see that the spark gap is set properly and that the assembly is clean.

8. Check the condition of all steam traps in the condensate return system. Leaking traps not only waste steam but make the condensate excessively hot, tending to vapor lock the pump. Another cause of pump vapor lock is a leaking check valve between pump and boiler.

9. Remove plugs from cross connection below water level control and clean any sediment out of the water leg and float chamber. This can be done only when the boiler is cold.

10. Clean air intake screen on blower, check blower fan wheel and clean vanes, if necessary (more often than monthly, if required).

11. Check and clean air hole in gas regulator.

12. If barometric draft control is used, check to see that it is operating freely.

13. Check front breeching - rear cover plate -rear door and burner mounting flange for tightness. Allowing high temperature flue products to leak at these points can cause serious damage.

14. Check all burner linkage to be sure adjustments are locked in place and are operating freely.

Quarterly Maintenance Schedule for Boiler

Check water side of boiler. Allow boiler to cool - drain it completely of water (only after allowing a minimum of four hours to cool). Remove handhole and manhole plates and flush out the boiler with a high pressure hose, playing the hose through the top and bottom openings to make sure all loose scale and sediment are washed out of shell. Remove plug from the cross section, clean line to boiler and level control.

After washing out the boiler, the heating surface should be closely examined for signs of corrosion, pitting or scaling. Signs of these conditions indicate better boiler water treatment is needed.

New manhole and handhole gaskets should be installed at this time. First clean off all traces of the old gasket seats on both shell and plates.

To put the boiler back in operation, refill to proper water level, warm up slowly and tighten up on all handhole plates with a wrench while the boiler

is warming up. Do not over-tighten handhole plates. Tighten only enough to stop leak.

Six Month Maintenance Schedule for Boiler

For boilers that have fire tubes, the tubes should be cleaned. The boiler efficiency depends greatly on a clean fire tube. Soot acts as an insulator and prevents absorption of heat from the tube to surrounding water. Tubes must be cleaned every six months or whenever high stack temperature or low steam production indicates the need of tube cleaning.

Cover all motors and exposed controls to keep them free from dust. The tubes should then be brushed out with a tooth brush. Before closing the rear cover, check refractory for possible cracks. If any cracks are found, reseal with a high-temperature mortar.

Lubricate the motor (when equipped with grease or oil fittings). Do not over-lubricate as this will cause bearings to run hot.

Check burner combustion block (if supplied). These cracks are normal but any sign of wide cracks or refractory falling out should be checked immediately and repaired or the block replaced.

Never operate a boiler without water. The heat will loosen the tubes and the boiler will leak. This would seem too obvious to require explanation, but frequency with which this mistake is made is surprising. Great care should be exercised to see that the boiler never runs dry of water while in operation.

Blancher-Cooler

The cover of the blancher-cooler, which lowers over the product during blanching to form a water seal with the water in the bottom of the blanching

compartment, needs to be removed and thoroughly cleaned inside of all food particles at least once a week. If the food particles are allowed to build up, the temperature within the cover becomes ideal for the thermophilic spoilage microorganisms (see page 11, Chapter 1) to multiply in large numbers and become a source of contamination for all food that is blanched. Do not paint the inside of the cover or hood with a paint that will not withstand the high temperature and humidity that the steam creates and cause the paint to flake off into the food as it is being blanched. A high grade epoxy paint properly applied would probably be satisfactory and would make the inside of the hood more easily cleaned.

The stainless steel trays should be thoroughly cleaned after each use and inspected for any food particles that may be stuck in the perforations and corners, and cleaned if any are found.

Steam Kettles

1. Steam kettles should be cleaned thoroughly after each use inside and outside. If food which has been burnt or scorched on the inside or outside is not removed within a few hours and is allowed to accumulate, cleaning becomes very difficult and time consuming. See Chapter 14, "The Basics of Cleaning and Sanitizing." If the kettles are equipped with drain valves in the bottom, the valves should be taken apart and the parts thoroughly cleaned at the end of each day's operation.

2. Should the canning plant be closed down for more than a week or ten days, the kettles should be covered with either heavy plastic sheets or heavy

paper to protect the kettles from dust and other foreign material that may accumulate during the period when they are not in use.

3. The pressure gauges should be checked periodically for accuracy against one of known accuracy.

4. The relief valve should be checked for proper functioning. This may be checked by opening the steam valve and allowing steam pressure to build up between 275.8 kpag (40 psig) and 310.3 kpag (45 psig) but not to exceed 310.3 kpag (45 psig). If the safety valve opens before reaching the minimum pressure or fails to open before reaching the maximum pressure of this range, it should be replaced. Any kettle that can not operate up to 275.8 kpag (40 psig) is not performing at its full potential. Most steam jacketed kettles are not constructed to operate with steam pressures exceeding 275.8 kpag (40 psig). Continued operations in excess of rated capacity could cause a bubble to form in the interior bottom of the kettle. The sudden formation of the bubble will probably cause the hot boiling liquid to blow out onto anyone standing nearby, burning them severely. The formation of the bubble usually makes the kettle unusable without extensive and costly repairs.

Retorts

1. Retorts, like other pressure vessels are subjected to failure after being exposed to high pressures for long periods of time. Therefore, a periodic hydrostatic test of all retorts should be made to detect the presence of any defects due to rust and wear. These faults may be corrected or the retort replaced. The hydrostatic test is simple and can be easily made,

either by maintenance personnel or under the supervision of the plant supervisor. For the test, the regular retort pressure gauge is replaced with a gauge tester. With the lid fully secured, all valves on lines hooked to the retort, except the water line valve, are fully closed. Water, under at least 310.3 kpag (45 psig), is added until the required testing pressure is obtained. This pressure is maintained for a time sufficient to allow a visual inspection for leaks. Standard retorts are constructed for a maximum operating pressure of 103.4 kpag (15 psig) and should be tested to 206.8 kpag (30 psig).

2. All manually-operated valves on steam, water and air lines hooked to the retorts should be carefully checked and repaired or replaced when found to be faulty or tend to stick in any position which may cause improper functioning of the retort. Improperly packed or leaking valve stems are very annoying and dangerous to the operator. They should be repaired or replaced immediately.

3. At the end of each work day, the retorts should be thoroughly drained and permitted to dry to prevent rust and stale odors from forming. Occasionally, the retorts, especially when canning meats or products containing meats, should be filled with water and sufficient detergent and brought to a temperature of 93°C (200°F) by admitting steam and allowing to stand for an hour or so to remove grease or other foreign matter.

4. The retort thermometers should be removed and tested with a United States National Bureau of Standards certified thermometer or with one having equivalent accuracy. Any of the retort thermometers test properly at 100°C (212°F). Any at 115.6°C (240°F) and 121.1°C (250°F) should be destroyed and

replaced.

5. Pressure gauges which do not register zero (0) before steam is admitted into the retort or do not register correct pressure at various retort temperatures after compensating for altitude, should be replaced. See Table II, "Gauge Pressure $\frac{\text{kpa}}{(\text{psi})}$ Corresponding to Specified Temperatures at Various Altitudes" in Appendix for the correct gauge pressure at the various temperatures check are to be made. Be sure that the pressure is checked at the proper altitude in the table.

6. The spray nozzles in the lids of retorts equipped with cooling water spray nozzle assemblies should be checked for proper spray patterns. If the nozzles become clogged, remove the entire ring before taking the nozzles apart so that they can be worked on conveniently. To clean the nozzle, unscrew the end and remove the core with tweezers. Do not attempt to remove the core by pushing a sharp instrument through the small hole of the nozzle as this may severely damage the core and enlarge the hole in the nozzle. Wash the core carefully to remove rust or sediment which may be present. When encrusted from the use of hard water, remove deposits with dilute (5%) hydrochloric acid. Wash the end of the nozzle, then replace the core to see if the desired spray pattern is obtained. The pattern should always be a mist, not ever a stream. If a stream or large drops of cold water hit a hot glass jar, they will cause the jar to crack. The small droplets of water in a mist will warm up enough before touching the glass so that any thermoshock produced will not be great enough to cause the glass to crack or break.

Pressure Cookers

In general, the maintenance of a pressure cooker is similar to that of a retort discussed earlier. There are some additional maintenance suggestions for steam pressure cookers such as:

1. Check the accuracy of the thermometer as described under retorts. If the thermometer is not correct there would be no way to check the accuracy of the pressure gauge. Every pressure cooker should be equipped with a short stem mercury-in-glass thermometer with a 12.7 centimeter (5 in.) scale with no more than 10°C (17°F) per 2.54 centimeters (1 in.), graduated in no more than 1°C (2°F) divisions, and having an indicating range from 76.7 - 132.2°C (170°- 270°F).

2. The pressure gauge should be tested every three months by the same procedure as outlined for testing pressure gauges under retorts.

3. The safety valves should be checked and kept clean and free of any foreign matter that may cause them not to function properly. If the safety valves contain a spring, check it out for proper tension and replace it with a new one as frequently as necessary.

4. Wash pressure cookers after every use to remove grease and other soil. The lids with the thermometers, pressure gauges and safety valves should not be immersed in water, but should be washed with a brush or cloth and hot water.

5. Leave the lids ajar when the pressure cookers are not in use to prevent the formation of mildew and offensive odors.

Can Sealers

The can sealer is an important piece of equipment in the canning operation. It is machined and built to perform the can sealing operation with very close tolerances, therefore, the sealer should be maintained and treated with the same care as any precision equipment. It will not perform as it was designed if it

is neglected or abused.

1. Care of the sealer. With good care the sealer should give many years of good service and be free from troubles if the following rules are observed:

a. Keep the sealer in proper adjustment at all times.

b. Replace worn parts as needed.

c. Clean thoroughly, particularly the two seaming rolls, after each daily use - DO NOT WAIT UNTIL THE NEXT DAY. Following the cleaning, apply a few drops of machine oil to all moving parts and in all places marked "oil." Machine oil should also be applied to all moving parts after every two hours of continuous operation. Only approved grades of oil and grease for food processing equipment should be used.

d. Periodically remove housing covers and grease bevel gears. The frequency depends upon the number of cans sealed - 20,000 to 30,000.

e. If the sealer is used seasonally or is to be inactive for more than 30 days, special attention should be given to servicing it for storage and again prior to active use.

f. Follow closely the manufacturer's operating and maintenance instruction manual.

Juicer-Pulper

The juicer-pulper should be taken apart and each part that has come in contact with food should be carefully cleaned after each use. At the end of

a day's operation, the contact parts should be cleaned and left disassembled to dry. Follow the manufacturer's operation and instruction manual closely.

Food Choppers or Meat Grinders

Food choppers, and particularly meat grinders, can become a source of contamination by spoilage organisms if great care is not exercised in cleaning these two pieces of equipment. After each use they should be disassembled, cleaned and washed in detergent water to remove all food particle residues. If pork or chicken is ground, do not grind any other meat until the grinder is thoroughly cleaned and SANITIZED. These two types of meat may contain the organisms, Trichinella spiralis often found in pork and Salmonella frequently found in poultry, which require longer cooking times to destroy than organisms found in other meats. Therefore, contamination of other meats should be avoided by cleaning and sanitizing the grinder after it has been used in grinding either pork or chicken.

Exhaust Tunnels, Boxes and Steam Blanchers

The temperatures inside of exhaust tunnels, exhaust boxes and steam blanchers are almost ideal for the build-up of large numbers of very troublesome high temperature resistant thermophilic spoilage organisms. Because some species of this group of heat resistant organisms are so resistant to heat that often they are not destroyed during a recommended time and temperature process, therefore, causing spoilage of canned foods if not stored in warehouses having temperatures lower than 48.8°C (120°F). Special care should be given these pieces of equipment to see that they are carefully cleaned inside of food particles to prevent the development of large numbers of these types of spoilage organisms to become a source of contamination.

Air Compressor

To keep an air compressor in good working condition, clean the air filter once a week. At the time drain the storage tank of condensate. It is also important to drain the tank at the end of the canning season to avoid possible damage by freezing. For care of the motor or compressor, follow the manufacturer's instructions.

CHAPTER FOURTEEN

THE BASICS OF CLEANING AND SANITIZING

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Introduction

Sound sanitary management is essential to the operation of a successful canning operation. The level and type of microorganisms in the cannery's environment on the equipment and on the unprocessed food will greatly affect the keeping quality and/or safety of the canned foods. Sanitation is a safeguard to health; furthermore, good sanitation provides a healthful, pleasant atmosphere in which to work; and it contributes to the overall success of the cannery organization.

Some people might tend to play down strict sanitation in a canning plant, because of the sterilizing effects of heat processing. Scientifically speaking, heat from a retort cannot compensate for inadequate sanitation, because poor sanitation leads to higher bacterial levels in the product which require more processing time than the product with lower bacterial levels. High bacterial counts may result from several common sources:

1. Deteriorating, unwholesome raw products
2. Unclean equipment
3. Raw products with high bacterial levels from unsanitary conditions
4. Poor practices or faulty techniques prior, during and after processing

Remember, the processing of food by heat preservation does not improve food quality. It does not make a bad food *good* even though it may prevent it from becoming less good or even *bad*.

Sanitation is for the good of the cannery and everyone concerned. Good management and supervision are required to meet all the objectives of a sanitation program as set forth in this chapter. Systematic and methodical steps are necessary to control dirt, dust, soil, and bacteria (especially spore-forming bacteria). The term *sanitation* is extremely broad and involves more than general housekeeping, including cleaning and sanitizing all surfaces. Each area of sanitation must be considered separately.

Good Housekeeping

Housekeeping is the basis for good sanitation. It is a term used to designate those conditions which display the orderliness and tidiness of an operation. Housekeeping entails putting materials in their place. It is generally recognized by competent supervisors that the attitude of workers or patrons is contagious. Therefore, a concern for neatness and orderliness perpetuates a similar feeling in the performance of other duties. Here are the game rules: Start clean and orderly; work clean; be clean; and remain safe.

Cleaning and Sanitizing

The supervisor should be responsible for the total sanitation program and should have the authority to stop all operations if the conditions established are not met.

The supervisor should conduct the following duties:

1. Establish and outline the cleaning procedure including the methods to be used and the control of chemicals, cleaners, and equipment.
2. Prepare the schedules for cleaning equipment, utensils, and contact-surfaces during working hours.

3. Train all personnel in their duties and responsibilities.
4. Provide adequate equipment, supplies and time to do the job properly.
5. Constantly check on general housekeeping and specifically areas known to be *problem spots*.
6. Provide cleaning instruction in printed form to be posted in areas where they are available to all concerned.

It is normal to refer to a piece of equipment or an area as being *dirty* when we think it is unclean, unsanitary, or otherwise unsatisfactory for use with foods. In the world of the *cleaning chemist* the term *soil* is used to describe all material which must be removed so the equipment, or surfaces, may become referred to as *clean*. The soil may be an *earthy* substance commonly referred to as *dirt*, or it may be any undesirable material between A (apple peel) to Z (Zuccini pulp). Other examples of soil are: meat fragments, grease, or hard water mineral deposits.

Systematic and methodical steps are necessary to assure that all soil is removed in the cleaning process. Thorough cleaning is a prerequisite to any sanitizing operation for food contact surfaces.

For good cleaning operations, soils must be classified. The supervisors should be aware of the type of soil. In cannery operations soils are generally in two categories, namely:

1. Soils that water will dissolve; these are the water-soluble soils, juices, jelly, salt, sugar, and many food residues.
2. Soils that water will not dissolve; these are the water insoluble soils and are our most common forms of dirt. Examples are grease, oil, dust, food particles, and other solid matter, usually in various combinations.

knowledge of the type of soil can be very helpful in selecting the proper detergent or cleanser. Further discussion of detergents will be made in a later section of this chapter.

Exactly when a surface is clean or dirty is not always clear. To most people a surface is clean when it is visually free of *soils*. To an astute supervisor, a surface is clean only when it is *microbiologically clean*. This type of cleanliness is a must for food processing because *visually clean* is not enough; since living microbes may be transferred to the food product.

To achieve *microbiologically clean* a supervisor must use procedures to destroy or remove microbes and, thus, accomplish *sanitation*. The subject of *sanitizers* will be discussed in detail in a later section of this chapter.

Operational. The *rules of operation* call first, for the dry removal of organic materials, either by scraping or soaking. Secondly, we employ a hot water pre-rinse (60°C) to remove food residues. Next, the use of detergents in hot water (49-60°C) softens particles and residue and permits their removal with proper force. (For cleaning there is no substitute for a stiff brush and *elbow grease* after 10 to 15 minutes of soaking.) After washing, a hot water rinse (around 60°C) is needed to remove detergent residue. Sanitizing is effective only when it follows good cleaning. Remember, cleaning with detergents and hot water only achieves *visually clean* but sanitizing achieves the ultimate in cleanliness, *microbiologically clean*.

Detergent. Modern chemistry has provided some ideal compounds to aid in cleaning operations. One class of such compounds is the detergents

Most supervisors are not chemists, therefore, they must become aware of the properties of the detergents and some of the advantages as well as the limitations to their use. The technical representatives of certain chemical companies are often referred to as *soap salesmen* and they are generally qualified to assist in selection of the proper cleaning compound for each specific job. Caution: Once a cleaning program is established with a given brand of cleaning compounds, do not change to another supplier unless the whole program is reviewed--not all formulated cleaners are interchangeable.

The cleaning compound is a complex mixture and has many properties and functions ranging from softening the water to emulsifying a fat. It most likely contains a detergent of some kind. As to why detergents are used, Table 2 helps to explain the many properties and functions of an ideal detergent.

In tabular form, the steps in cleaning and sanitizing food contact surfaces are presented below:

Table 1. Operational Procedures for Cleaning and Sanitizing

Steps	Purpose	Condition
1. Scraping and dry cleaning	Removal of organic matter to help: (a) prevent clogged drains and lines, and (b) to ease the disposal handling and reduce load for sewage treatment	Put waste and scraps in trash cans with plastic liners
2. Pre-rinse	Removes water soluble residues and prepares surface for detergent	Use hot water 60°C
3. Water & detergent (49-60°C)	Softens and dissolves all types of food residues	Soaking after application (10-15 min.); Scrubbing usually needed

Table 1. Operational Procedures for Cleaning and Sanitizing - Continuing

Steps	Purpose	Condition
4. Rinse	Removes detergent residue	60°C
5. Sanitize	Kills microorganisms and allows their removal; helps to eliminate and prevent odors	Application of chlorines, iodophors or quaternary ammonium chlorides
6. Final rinse	Certain chemical sanitizers require final rinse, such as iodophors and quaternary ammonium chlorides	Cold water
7. Air drying	Excess moisture removed by air drying	May require several hours

Table 2. Properties of an Ideal Detergent

Type of Property	Functional Qualities
Physical	Wetting and penetrating Dispersion and suspending Rinsibility Non-corrosive to the plant Non-irritating to people
Chemical	Saponifing, emulsifying and dissolving of fats or other materials

Detergents are chemical compounds that can be formulated for specific applications. In a food processing situation, perhaps one compound will not handle all cleaning jobs. Table 3 presents examples of several types of cleaning situations and categories of application.

Table 3. Detergent Application and Uses

Application	Actual Situations
Manual	Hand scrubbing with brush
Clean-in-place	Pipeline or tank flushing
Clean with high pressure jets	Hand operated nozzles or stationary jets
Clean with foam or slurry	Hand operated nozzle or stationary equipment, walls, or floors

In most canneries, the clean-in-place application is not practical and is seldom employed. In the last two categories, small portable units are commercially available and have excellent application in a cannery situation.

Sanitizers. These are chemical compounds that act to reduce surface contamination to help achieve the goal of *microbiologically clean*. The act of sanitizing will be wasted, if *soil* is not removed first. Organic material, such as food particles, bind and inactivate sanitizers, thus preventing destruction of contaminating microbes. Before applying sanitizers all detergent residue should be removed by thorough rinsing, because of possible incompatibility of ingredients. The use of sanitizers requires knowledge of many factors and interactions. The performance of a sanitizer depends on the following:

1. Toxicity to microbes
2. Non-toxicity to humans
3. Solubility
4. Noncorrosiveness
5. Freedom from odor
6. Capacity to avoid combination with organic materials
7. Homogenity
8. Capacity to penetrate
9. Deodorizing capacity
10. Detergent capacity
11. Cost and availability

No single approved chemical sanitizer will satisfy all of the above criteria. There are a large number of other factors (non-inherent) which affect performance and germicidal activity.

1. Selectivity - the broadness of kill.
2. Concentration - the proper use level.
3. Time of expose - the contact time.
4. Number of microbes - higher levels may require more contact time or higher concentration.
5. Characteristics of the organism - spore growth is harder to kill than vegetative growth.

6. Temperature - sanitizer effectiveness may be altered.
7. pH - the acidic or basic nature of the sanitizer solution.
8. Incompatible materials - certain materials may bind or form complexes to adversely affect efficiency.
9. Organic matter - may reduce germicidal efficiency.
10. Mineral deposit - hard waters tend to neutralize sanitizers and to form films.
11. Surface tension - affects penetration and spot-free drying.

Numerous chemical agents for sanitization are available on the market. The following types are the most common:

1. Chlorine releasing compounds
2. Quaternary ammonium compounds
3. Iodophors (iodine compounds)

Each type of compound has its particular advantages and disadvantages. Tables 4, 5, and 6 give the comparative advantages and disadvantages.

Table 4. Chlorine Releasing Compounds

ADVANTAGE	DISADVANTAGE
1. Fast to moderately fast germicical action	Corrosive action. Misuse can cause rusting, pitting and corrosion
2. Non-selective against organisms (wide spectrum)	Rapidly inactivated by organic matter
3. Deodorizing property	Tends to be irritating to workers--to nose, skin, and eyes
4. Safe at prescribed dilution levels (non-toxic)	Hard water (high alkalinity) may reduce germicidal activity.
5. No residues--chlorine dissipates after use	Storage problems--need protected environment for stability
6. Economical	No residue for bacteriostatic effect

Table 5. Quaternary Ammonium Compounds

ADVANTAGE	DISADVANTAGE
1. Non-corrosive	Germicidal efficiency varied; tends to be selective and bacteriostatic.
2. No objectionable odor	Residual on food-contact surfaces may be objectionable. Slow to dissipate.
3. Very mild to skin, eyes, and clothing	Incompatability with certain detergent components.
4. Deodorizing effect--outstanding ability	Adverse effects on rubber on prolonged exposure at normal use level
5. Easy to handle and store, very stable under wide range of conditions	Higher costs compared to other sanitizers.
6. Can be formulated into a *germicidal detergent.*	
7. Residual bacteriostatic film which may be desirable.	

Table 6. Iodophors

ADVANTAGE	DISADVANTAGE
1. Fast germicidal action, rapid kill	Less effective against bacterial spores and viruses than hypochlorit
2. Non-selective, effective over wide range	Loss of strength in solutions above 43°C also odor and staining problem when hot.
3. Intensity of amber color serves as color indicator of strength of solution	Corrosive to several metals commonly used in food plants.
4. Fairly easy on skin tissue	Comparatively high in cost
5. Useful in *germicidal detergent* for selected light soil application	Possible residual problem
6. Stable under normal storage conditions	Germicidal efficiency reduced by organic matter, by highly alkaline water or *carryover* of highly alkaline detergents.
7. Acid nature helps prevent film formation	

For sanitizers to be effective, sanitizers have to be used according to the type of job and condition of the situation. Sanitizers are many and varied and are formulated for a given set of conditions. If a sanitizer is worth using, it is worth using right. A lot of time and money can be wasted if conditions are not right.

Cleaning directions from the supervisor. Effective cleaning and sanitizing procedures must be written out as specific instructions and posted on the wall. Supervisors or other key personnel are responsible for providing these. Everyone involved in cleaning should be instructed in the following areas:

1) the use of special equipment and utilities for cleaning
2) the proper use of cleaners and sanitizers

One cannot overemphasize proper procedures as prescribed by suppliers and manufacturers. The old rule does not apply here: "if a little is good, a whole lot is better." Overuse is wasteful, waste costs time and money. Measuring devices should be provided for preparing solutions exactly as prescribed on the label.

Employees and patrons should also be instructed in the care of cleaning equipment and utensils after use.

Scheduling. Timing or scheduling of cleaning is of tremendous importance, because the prompt removal of food build-up facilitates cleaning and helps eliminate bacterial build-up. When possible, a piece of equipment or utensil should be cleaned immediately after use. If an operational piece of equipment, such as a meat grinder or slicer, is left unattended, bacterial numbers will build up and become a source of contamination for the next

batch of meat being prepared. Especially important is the elimination of contamination to foods already prepared and ready to eat.

Heat, in the form of live steam or hot water, is recognized by some as an effective sanitizer. This manual does not question the use of steam or hot water as cleaning aids, especially for the removal of fats and grease. However, for use as sanitizers hot water and steam are not recommended for practical consideration in food canneries. We cannot rely on steam to be germicidal unless it is applied in a closed system, such as pipelines and bulk tanks. Live steams on open food contact surfaces loses too much heat through condensation upon contact with metal equipment. Live steam or hot water would have to raise the temperature of contact surfaces to 89°C and hold it for at least five minutes to be germicidal and even that exposure might not destroy the sporeformers which could ultimately cause spoilage to our canned foods. Thus, this manual does not recommend hot water or live steam for sanitizing food contact surfaces in a cannery.

Storage of clean equipment and utensils. After washing, sanitizing, and drying equipment and utensils; they should be stored in clean areas free from contamination and away from dust. Small equipment and utensils should be stored on racks away from the floor. Fixed equipment should be protected by suitable methods to prevent dust and contamination.

CHAPTER FIFTEEN

MATERIALS

Raw Materials

Produce: The quality of canned foods will be no better than that of the raw materials. For this reason the plant supervisor should endeavor to procure products in prime condition for canning. A canning operation should never attempt to operate on the basis of salvaging that portion of the crop that could not be sold on the fresh market. For a processor to be competitive, he needs a dependable source of high quality produce that is produced specially for canning at a price that will make his canned products competitive in the retail market. A very low percentage of the produce suitable for fresh marketing is suitable also for canning a quality product. Therefore, it would be advisable for the plant to make special arrangements with the growers of produce for planting, growing, harvesting and delivering crops of fruit and vegetables.

While it is important to grow special varieties of produce for canning, it is equally important to harvest the crops at the optimum stage of maturity/ripeness for canning, which is usually considerably different from harvesting these crops for the fresh markets. The plant supervisor or procurement supervisor should also specify what herbicides, insecticides and fungicides would be acceptable for using on crops for canning and the timing of the applications of these materials. The types of containers used in harvesting and transporting the produce should be of a design that will permit the circulation of air and give protection to the produce without cutting, puncturing or bruising. There should also be an understanding between the procurement supervisor and

the growers that only clean containers free from decayed produce or parts thereof should be used for harvesting, storing and transporting.

Grade standards should be established for all produce. The standards would be used in determining the value of the produce and as a basis for the canning business to pay the producers. Grades, if properly used, can insure equitable settlement to the producers for delivering produce to the canning plant in accordance to the contract or agreement and they can be used by the canning operation, through incentives, to encourage the producers to deliver high quality produce.

In order for the canning business to operate for a significant period of time during the year, it would probably be advisable to can a variety of foods. The season for certain produce for canning can sometimes be extended several weeks with early and late maturing varieties or by transporting produce from early and late producing areas due to either geographical location or altitude of the production area. Figure 1 in Appendix shows the approximate harvesting periods for a number of fruits and vegetables grown in the state of California in the United States. It is recommended that a canning plant in a particular area prepare a similar chart in order to provide information on which commodities will be abailable at a particular time. Thus, the plant may be able to extend its canning season over a long period of time during a year.

Sugar, Salt, Pepper and Other Condiments:

Cane or beet sugar is used for the preparation of syrup to be used in canning most fruits. Sugar from either cane or beets is identical in chemical composition, and contains more than 99 percent sucrose. Corn syrup contains

about 43 percent dextrose and may be used to replace 15 - 30 percent of sucrose in canning some fruits, vegetables and preserves.

Small quantities of salt, pepper, spices, vinegar and other condiments are used to give canned foods good and acceptable flavor.

Most condiments can be a source of contamination for canned foods in which they are used. All condiments should be purchased on rigid specifications setting forth in detail microbiological standards such as those suggested by the National Canners Association for thermophilic spore contamination for sugar and starch, tolerance of ZERO for vermin and animal filth, and other foreign material.

Containers

General: The container is an important factor in preserving by canning. It must protect the food while it is being subjected to rigorous conditions during sterilization, cooling and handling in storing, transporting and marketing. It must maintain the food inside under sterile conditions from the time it is processed by the canning plant until it is ultimately consumed by the consumer. It is most important that the container closure is properly applied to form a strong hermetic seal to secure against the entry of microorganisms that would cause spoilage. Thus, the seams and closures should adhere closely to the container manufacturer's recommendations on tolerances on can seam dimensions. If canning in glass, one must follow closely the manufacturer' recommendations in applying the covers to produce a satisfactory seal.

The number of different sizes and types of containers used in a canning

operation should be kept to a minimum, however, the proper container should always be used for the product being canned.

Tin Cans: Canning in tin, especially for commercial operations, has several advantages over canning in glass.

1. The initial cost is less.
2. Tin cans are easy to handle because there is less danger of damaging the container.
3. There is no loss of liquid from tin cans during processing because they are tightly sealed before being processed.
4. The processing period is shorter.
5. The containers can be cooled quickly by submerging them in water permitting better control of cooking time thus reducing over-cooking.

Cans and lids should be handled with great care to prevent damage to the flange of the can and the sealing compound in the lids. Cans should be washed thoroughly, rinsed and drained as they are needed. If cans are left over from one day's operation to another, rust will form unless thoroughly dried. It will not be necessary to wash lids unless they are separated from their original shipping containers.

Cans may be purchased preformed or collapsed. Preformed cans are manufactured in all standard sizes in the United States. Overseas freight charges on preformed cans are prohibitive. For this reason, preformed cans are seldom shipped overseas in any large volume from the United States. Since shipping the fully preformed cans (particularly in the large sizes) involves a prohibitive ocean freight rate, can manufacturers have perfected what is known as collapsed cans. Collapsed cans are regular round can bodies, which are formed, soldered, and then flattened. A collapsed can is shown in Figure 63, "Collapsed Can," The can lids are usually packed in paperboard tubes. A full

tube usually contains 250 lids. The reduction in the cubic measurement of the space required for collapsed cans is approximately 75 percent. Collapsed cans are less likely to be damaged in handling than preformed ones. Not all can sizes are available in the collapsed form.

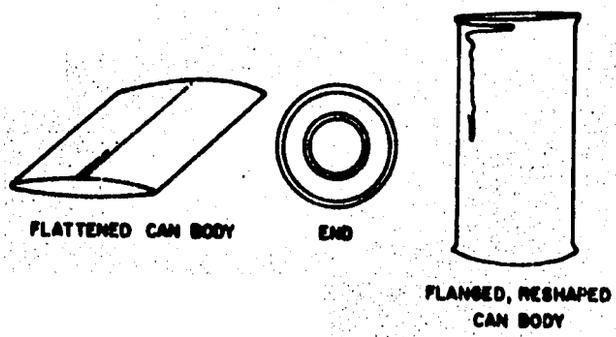

Figure 63. Collapsed Tin Can

Generally, can manufacturers will not ship orders in quantities less than 100,000 of a given size and type. Canning plants having small volumes or packs may have to pool their orders.

Special equipment is required at the canning plant to reform and flange the collapsed cans. However, it is estimated that for a single shipment of 150,000 collapsed cans, the savings in the overseas freight cost will be sufficient to offset the cost of the special reforming equipment.

Tin cans are made in a number of sizes. In Table LVI, "Some Common Can Sizes," are listed 13 different can sizes along with the trade name, dimensions, canner's designation, approximate net weight, net contents (liquid product), number of cans per case and some products for which they are ordinarily used. The canning industry in the United States derives its can designation (303 x 406) from the nominal dimensions of the can. The first digit represents inches, the next two the extra fraction expressed as sixteenths of an inch. The diameter is cited first followed by height. Example: 307 x 406 means

TABLE LVI

SOME COMMON CAN SIZES

Can Trade Name[1]	Dimensions[2] Diameter	Dimensions[2] Height	Canner's Designation[3]	Approx. Net.Wt.[4]	Net Contents Liq. Prod.[5]	No. of Cans per Case	Some Products for Which Ordinarily Used
6Z.....	54.0mm (2 1/8")	88.9mm (3 1/2")	202 x 308	170.2 g (6 oz)	155.3 ml (5 1/4 oz)	24, 48, 100	Tomato paste, tomato sauce
8Z Short ..	68.3mm (2 11/16")	76.2mm (3")	211 x 300	219.7 g (7 3/4 oz)	207.0 ml (7 oz)	24,36,48,96	Tomato sauce, specialties
No.1 Picnic	68.3mm (2 11/16")	101.6mm (4")	211 x 400	297.7 g (10 1/2 oz)	280.6 ml (9 1/2 oz)	24, 48	Vegetables, meat & fish products, soups, specialties
No. 300 ...	76.2mm (3")	112.7mm (4 7/16")	300 x 407	411.1 g. (14 1/2 oz)	399.2 ml (13 1/2 oz)	24, 36, 48	Vegetables, fruits, soups, meat & fish products
No. 300 Cyl.	76.2mm (3")	141.3mm (5 9/16")	300 x 509	458.9 g (19 oz)	502.7 ml (17 oz)	24	Vegetable soup, pork and beans, specialties
No. 303 ...	81.0mm (3 3/16")	111.1mm (4 6/16")	303 x 406	454.0 g (16 oz)	413.6 ml (15 oz)	12, 24, 36	Vegetables, some fruits,and juices, soups, specialties
Kitchenette	87.3mm (3 7/16")	73.0mm (2 14/16")	307 x 214	340.2 g (12 oz)	325.3 ml (11 oz)	24, 36	Pork and beans
No. 2	88.3mm (3 7/16")	115.9mm (4 9/16")	307 x 409	567.0 g (20 oz)	532.3 ml (18 oz)	12, 24	Fruits, vegetables, juices, soups, specialties
No. 1½	103.2mm (4 1/16")	62.7mm (2 15/16")	401 x 207.5	411.1 g (14 1/2 oz)	369.7 ml (12 1/2 oz)	36, 48	Pineapple
No. 2½.....	103.2mm (4 1/16")	119.1mm (4 11/16")	401 x 411	822.1 g (29 oz)	768.9 ml (26 oz)	12, 24	Fruits, vegetables, juices, meat products
No. 3 Vac..	107.9mm (4 4/16")	87.3mm (3 7/16")	404 x 307	652.0 g (23 oz)	621.0 ml (21 oz)	24	Vegetables, meat products
No. 3 Cyl..	107.9mm (4 4/16")	177.8mm (7")	404 x 700	1417.5 g (50 oz)	1360.4 ml (46 oz)	12	Vegetables, fruit and juices
No. 10	157.2mm (6 3/16")	177.8mm (7")	603 x 700	3005.0 g (106 oz)	2839.1 ml (96 oz)	6	Vegetables, fruits, juices. meat & fish products, soups

1 Names used by the canning trade.
2 Nominal over-all dimensions
3 The can size designation used in the industry is derived from the nominal dimensions.
4 The net weights cited are for foods of average density.
5 The volume figures cited are average commercial fills.

3 7/16" (inches) in diameter x (by) 4 6/16 (3/8)" high. The canning industry has not yet moved towards using the metric system in can designation.

Cans are manufactured with several different types of linings depending upon the kind of product that will be packed in the can.

1/ Plain tin lining cans are used for those foods which do not have a significant interaction with the tin lining. Often foods are canned in plain tin cans for the beneficiary bleaching action the tin has on the food. The tin helps to keep applesauce and peaches bright which would otherwise turn dark in enamel lined cans. On the other hand the bleaching action of tin will reduce the red color in cherries and beets, a process not generally desirable.

2/ "R" Enamel: "R" enamel is also known as "Fruit Enamel" because it has good barrier resistance between acid products and the metal in the can. It is used for highly colored fruits such as, cherries and berries and vegetables such as, beets to prevent the fading of the color which occurs when these foods come in contact with plain tin plate as has been mentioned previously. Of course the "R" enamel lining is not limited to just the fruits and vegetable mentioned. This enamel is perhaps more widely used than any other type. It is not advisable to use it in canning produce containing sulfur such as peas, beans and corn, or with high acid foods such as, apple juice, lemon juice and rhubarb, or with foods containing any animal fat. All of these foods have a very short "shelf-life" in cans with "R" enamel. This type of enamel will soon disintegrate after thermo-processing and begin to flake off into the canned product.

3/ "C" Enamel: "C" enamel was first known as "corn enamel" because it was first used in canning corn to prevent the formation of "black sulfide" discoloration. "C" enamel contains about 15% zinc oxide which is added for its chemical reactivity. The sulfides that form in the presence of zinc oxide during thermo-processing of protein-containing foods high in sulfur-containing amino acids are zinc sulfides, which are either white or nearly colorless. If the zinc oxide was not present the sulfur in the foods would react with the metal in the tin plate to form iron sulfide, a black compound or precipitate. While iron sulfide is not harmful to eat it does cause the can product to turn dark causing the food to lose its "eye appeal."

4/ Phenolic Enamel: Phenolic enamels are used in cans in which seafoods, certain meat products and other products are canned. They are used for these products because of their impermeability and resistance to chemical reactions. They do have minimum flexibility and a tendency to impart a flavor and odor to some foods. They are not softened by animal fats as many other enamels are.

There are many other enamels available for use in canning specific products. When placing orders with a manufacturer, tell the manufacturer the kind of produce that will be used in the cans. No satisfactory "all purpose" enamel has yet been developed. Therefore, it is important to give the can manufacturer the information on the kinds of products for which the can will be used.

Care should be exercised to see that lids or ends of cans have the same type of enamel as that of the bottom and side of the cans on which the lids

will be sealed. Lids should be inspected to see that there is a continuous band of sealing compound properly placed in the "cut edge" and "seaming panel", the outer ring of the lids. If there is a skip in the band, the lid should be discarded since it will not permit the lid to produce an effective hermetic seal.

Special care should be given in providing a clean dry storage for cans and lids. Preformed cans and the lids should be stored in the shipping containers to protect them from dust and light. If several different sizes and types are stored, each size and type should be separated out and neatly arranged and stacked with their size and type clearly marked on the containers. This will make for quick and easy identification when they are being withdrawn from storage during the rush of the canning season. Only a day or two supply of collapsed cans should be reformed at a time. The remaining collapsed cans should be kept in their cartons for protection until used. The lids for collapsed cans should be kept in their shipping cartons also.

Glass Jars: Glass jars suitable for canning should be designed so that they can form a hermetic seal and properly tempered to withstand the heat and pressure to which they will be subjected in the canning operation. If this type of glass jar is available, it may be safely used for canning products.

Glass jars have several advantages over tin cans.

1. Glass jars may be used as long as they are not damaged.
2. Well prepared foods packaged in glass jars are attractive since the product can be seen and is not exposed to light for long periods of time.
3. Highly corrosive products such as, rhubarb, sauerkraut and strawberries, may react with tin, unless it is enameled, and will tend to lose their color and flavor. These products can be canned safely in glass.

Glass jars also have several disadvantages.

1. Glass jars weigh significantly more than tin cans.
2. Glass jars are fragile and subject to breakage.
3. Glass jars require a relatively long time to process because they have slow heat penetration, and they cannot be cooled rapidly.
4. Products canned in glass jars must be stored in dark places as the light will cause discoloration of the canned product.

When glass jars are used for canning, a number of precautions should be observed:

1. Jars with chipped rim tops should not be used since they cannot form a hermetic seal.
2. Quart size jars are the largest size that should be used for canning low acid foods.
3. Jars should be sterilized if used for canning acid foods.
4. A large head space is needed in glass jars to permit exhausting of air and intracellular gases from the jar and food during processing without disturbing the seal.
5. Much care needs to be exercised in cooling after completing the processing cycle to prevent breakage and loss of liquid from the jars due to too rapid cooling.

Where glass jars are not manufactured specifically for canning, special attention should be given to glass jars to be sure that they are not cracked or chipped or that they do not have uneven sealing surfaces, rough edges or rims, or rims that are not perfectly round. Even the smallest defect in the top of the rims or jars may cause a poor seal. In an inspection one should

feel the tops of the jars with his fingers for chips, unevenness and roughness and then look through the jars while holding them up to the light to detect cracks.

Glass jars are not generally exported from the United States for use in canning plants in other countries. The canning plants must determine whether a supply of glass jars is available. Because of weight and the hazard of breakage, storage space for large quantities of glass jars are not usually available in the canning plant. If a supply of glass jars becomes available locally, the quality control supervisor must determine if the jars meet the necessary requirements for canning purposes.

The mason type jar with the two piece lid, band and center, is the most satisfactory glass jar for use in a cooperative plant where the patrons bring in produce to can and return home with it for personal use. Under such circumstances the glass jars can be used several times, through the years, making the container cost relatively low. The mason jar would not be economical to use in a commercial operation. It could not be recycled unless deposits would be made by the purchaser at the time the purchases are made and the deposits returned to the purchaser when the jars are returned to the retailer. This type of arrangement would be difficult to administer.

Figure 64. Capping Bottles

Glass bottles with crown caps can be used as containers for juices, Figure 64, "Capping Bottles," shows a closure being placed on a

bottle with a hand operated capping machine.

Labels

Attractive and informative labels are necessary if the products are to be sold. It is the label which must tell the customer why that particular product should be selected. A label must carry a statement of the identity of the food. It shall be stated as the common or usual name of the food, such as "peaches" or "corn". A label must also carry a statement of the name and address of the manufacturer, packer, or distributor. A label must declare in a statement the net quantity of the contents which may be expressed in volume or weight or both. The label should make a statement of the net contents of a serving. The label must also give a statement listing the ingredients by their common name in decreasing order of predominance. Many labels have been found to be appealing to customers when they have included information about how to use the food, providing recipes, the number and size of servings, etc.

There are some advantages in using paper labels which wrap-around the cans such as, the cans are made attractive and salable, the product is easily identified, some protection is given the can against rust, and it gives the canning plant publicity.

In small canning operations the labels are usually applied on the cans by hand. Automatic labeling machines are not recommended for use in any of the canning plants discussed in this publication because even the smallest labeling machines have a capacity much greater than required, and they are rather expensive.

Glue, casein preparations, dextrin, mucilage, or other adhesives can be used to paste the labels on the cans.

Shipping Cases

Generally, shipping cases are not shipped with containers unless the purchase order specifies that the shipping cases are to be included. In purchasing shipping cases, standard specification should be written into the order because poor quality shipping cases are expensive at any price. Recently, most of the shipping cases are constructed of either solid fiber board or corrugated board. Wooden boxes may still be used for special expor or other extra ordinary shipments.

Cases for tin should fit to hold the cans snugly. They should be so constructed that the interior depth of the cases be exactly the height of the cans or tiers of cans, and only enough wider and longer to permit easy filling. An excess of 3 mm (1/8 in.) in width and 5 mm (1/4 in.) in length should be ample. Close packing is advantageous both in the lessening of damage to cases and contents as well as in the conserving of shipping space.

The following table gives the can size, number of cans packed in a case and the average inside dimensions of the carton.

TABLE LVII

INTERIOR DIMENSIONS OF SHIPPING CASES FOR 7 CAN SIZES

Can Name	Can Measurements Millimeters (Inches) Diameter	Height	No. of Cans per Case	Average Interior Case Dimension Length x Width x Depth Millimeters (Inches)
6Z	54mm (2 1/8")	88.9 mm (3 1/2")	48	330 mm x 219 mm x 177.8 mm (13) x (8 5/8) x (7)
8Z Short	68.3 mm (2 11/16")	76.2 mm (3")	24	278 mm x 208 mm x 152.4 mm (11) x (8 1/8) x (6)
No.300	76.2 mm (3")	112.7 mm (4 7/16")	24	310 mm x 235 mm x 225.4 mm (12 1/4) x (9 1/4) x (8 7/8)
No.303	81 mm (3 3/16")	111.1 mm (4 3/8")	24	329 mm x 246 mm x 222.2 mm (13) x (9 5/8) x (8 3/4)
No. 2	88.3 mm (3 7/16")	115.9 mm (4 9/16")	24	358 mm x 268 mm x 231.8 mm (14) x (10 1/2) x(9 1/8)
No. 2½	103.2 mm (4 1/16")	119.1 mm (4 11/16")	24	418 mm x 313 mm x 238.2 mm (16 1/2)x(12 5/16) x (9 3/8)
No. 10	157.2 mm (6 3/16")	177.8 mm (7")	6	476 mm x 317 mm x 177.8 mm (18 3/4) x (12 1/2) x (7)

CHAPTER SIXTEEN

PERSONNEL

General Considerations

The number of people to be employed in a canning plant depends upon the size, plant capacity, and the degree to which the plant operations are mechanized. Regardless of the number of people employed, however, a high standard of performance on the part of each employee is essential for the business to become successful. It will be important for each worker in the sizes and types of plants that will be discussed in this publication to realize that while he/she may be trained to perform duties in certain specific areas, he/she must be willing to work in the plant whenever and wherever his/her services are needed.

Work plans should be prepared for each job. Usually the preparation of work plans are the responsibility of the plant supervisor. These plans should be simple and specific in order for the workers to easily understand them. Assignment of jobs should be made in relationship to the ability of each individual worker.

JOB DESCRIPTION PLANT A

Plant Supervisor

Responsible to: The plant supervisor is responsible to management.

Duties: The plant supervisor's functions are many and varied in Plant A because he may at times be performing many different operations in the plant. He is responsible for hiring and assigning duties to all plant workers, training workers in the correct methods, establishing and maintaining a quality control program, performing or supervising all office tasks, maintaining high standards of health and safety in the plant, and overseeing all plant operations. In addition, he checks and adjusts all can sealers. He is responsible for all

quality control. He also checks and tests thermometers and pressure gauges. During the period the plant is closed down, he inspects all equipment and makes repairs as required. He is also responsible for the purchase of produce, containers and other supplies.

Education: The plant supervisor should have an adequate training course in the field of food technology and should be qualified to perform any operation in the plan

Experience: The plant supervisor should be familiar with all operations in the plant. His experience should indicate sound business ability and personal integrity and the ability to motivate and supervise people.

Food Preparation Operator

Responsible to: The preparation operator is responsible to the plant supervisor.

Duties: The food preparation operator prepares all produce, including sizing, grading, washing, peeling/shelling, trimming away or removing defects, preheating the prepared produce, cleaning and filling containers, exhausting and sealing the containers of prepared food. In addition, he must clean, if necessary, label, and case the containers and place them in storage, straighten bent cans, and clean all areas and equipment used in the preparation operation.

Ability and Experience: The food preparation operator need not have had previous experience, but must be capable of following instructions. The people working in this capacity should have the ability to read and write although it is not absolutely necessary.

Pressure Cooker Operator

Responsible to: The pressure cooker operator is responsible to the plant supervisor.

Duties: The pressure cooker operator codes the containers, operates the pressure cookers, cools the containers and washes them, if necessary, to remove any food or grease that may be present on the containers. He must keep records on come-up and processing times on each cooker.

Ability and Experience: The pressure cooker operator must either have had previous experience or be thoroughly trained by the plant supervisor. He should be able to follow instructions carefully and must be able to read and write.

JOB DESCRIPTIONS PLANT B and PLANT C

Plant Supervisor

Responsible to: The plant supervisor is responsible to management.

Duties: The plant supervisor's functions are many and varied. He is responsible for hiring and assigning duties to all plant production workers, training workers in correct methods including retort operation, can seam evaluation and can sealer maintenance, establishing and maintaining a quality control program in small plants, performing or supervising all office tasks, maintaining high standards of health and safety in the plant, and overseeing all plant operations. In addition he checks daily the sealers for proper functioning, thermometers and temperature recorders for agreement and periodically checks thermometers and pressure gauges for accuracy. During periods when the plant is closed down, he inspects all equipment and either makes or has repairs made as required. He is also responsible for the contracting and purchasing of all produce, containers and other supplies.

Education: The plant supervisor should have an adequate training course in the field of food technology and should be qualified to perform any operation in the plant.

Experience: The plant supervisor should have previous experience or receive thorough training to become familiar with all operations in the plant. His experience should indicate sound business ability, personal integrity and the ability to supervise and motivate people.

Food Preparation Operator

Responsible to: The food preparation operator is responsible to the plant supervisor.

Duties: The food preparation operator prepares all produce including sizing, grading, washing, peeling/shelling, slicing, trimming or removing defects, preheating the prepared produce, cleaning and filling containers, and exhausting the containers of food. In addition, he must clean, if necessary, label, and case the containers and place them in storage, straighten bent cans, and clean all areas and equipment used in the preparation operation.

Ability and Experience: The food preparation operator need not have had previous experience, but must be able to follow instructions closely. The people working in this capacity should have the ability to read and write although it is not required.

Can Sealer Operator

Responsible to: The can sealer operator is responsible to the plant supervisor.

Duties: The can sealer operator operates, adjusts, cleans and maintains all of the can sealers. He must make periodic can seam inspections throughout the day of operation, record the seam parts measurements at the time of inspection and the corrected measurements if an adjustment is made on the sealer. He must see that a daily record is made and kept on file for each machine. He must also maintain and clean the exhauster and assist with the storing of the cased canned products in the warehouse.

Ability and Experience: The can sealer operator must have had previous experience or received training in the operation, care, adjusting and maintenance of the sealers. He must be able to evaluate a can seam externally and internally, including tearing down the seam to make the evaluation. He must be able to read, write and follow instructions carefully.

Retort Operators

Responsible to: The retort operator is responsible to the plant supervisor.

Duties: It is the responsibility of the retort operator to operate the retorts according to Part 128b -- GOOD MANUFACTURING PRACTICES REGULATIONS of the United States Federal Food and Drug Administration as they apply to the retorts to which he is assigned. He must keep records of the come-up time, processing time, temperature for each cook in each retort. He is also responsible for the maintenance of thermometers, pressure gauges, valves, regulators, and temperature recorders. He must adjust the temperature recorder so it will be in agreement with the tested and accurate thermometer on the retort. He will be responsible for the proper operation and maintenance of the boiler to assure

that an adequate steam supply is available at all times during a process. He will also be responsible for properly cooling the canned product after it has been thermally processed. He must have knowledge of the temperature of the coldest container of food in the retort when a retort is started for a process or cook.

Ability and Experience: The retort operator must have had previous experience that would enable him to qualify for a certificate to operate a retort in accordance with Part 128b - GOOD MANUFACTURING PRACTICES REGULATIONS or receive enough training that would enable him to qualify. He must be able to read, write and follow processing instructions for each product being processed.

Labeler

Responsible to: The labeler is responsible to the plant supervisor.

Duties: The labeler wipes the cans after they have cooled, places a label on them, puts them in cases and places the cases in storage.

Ability and Experience: The labeler need not have had previous experience. He must be able to read, write and follow instructions.

Quality Control Supervisor

Responsible to: The quality control supervisor must be directly responsible to management.

Duties: The quality control supervisor must prepare or up-date an over-all plant operating manual for the purpose of providing operation procedures that will permit the canning plant to produce a standardized end product of the quality

that management has specified. The manual will include specifications for all supplies, such as, raw products, critical ingredients as sugar, salt, spices, and containers - plus product specifications, such as, drained weight, headspace, unit count, consistency and syrup cutout concentration. The manual should also include all canning operations such as segregating raw products into various quality grades, peeling and trimming specifications, blanching schedules for various products, fill-in weights, syrup and brine concentrations, exhausting schedules, closing temperatures, processing times and temperatures, cooling schedules, and storage conditions for the canned products. The quality control supervisor will be responsible for inspecting each operation in the canning plant frequently to determine if the quality standards, set forth in the quality control manual, are being met and work with the plant supervisor to take what steps that are necessary for the plant to produce the quality of product that is expected by management. It is the quality control supervisor's responsibility to see that the canning operations are carried out under conditions that provide a canned product that is safe and wholesome for human consumption. He is responsible for checking on the health of each plant employee, sanitary conditions of toilets, plant sanitation, and proper thermal processing techniques.

Ability and Experience: The quality control supervisor need not be a college-graduate food technologist, although highly desirable. However, a person who has a technical background and real interest in this type of vocation can perform satisfactorily in this position if he is experienced in the details of the plant operations and is trained especially for the work he is to perform. Because of the great responsibility he has to assume in preventing possible hazards from occurring that would cause food spoilage, he

must be a person who will speak and act with authority and firmness. Should a hazardous condition develop along the canning operation line and the plant supervisor fail to make appropriate corrections, the quality control supervisor must be of a character that he will not hesitate to close down the production line until the hazardous condition is eliminated.

Sales Supervisor

Responsible to: The sales supervisor must be directly responsible to management.

Duties: The sales supervisor is responsible for finding sale for all canned products at a price that will return a profit to the owners of the plant. He must be able to predict marketing conditions for the plant's canned products six months in advance of sales to advise management within ±5% of the quality, size, style and selling price of the canned pack for each commodity that the market will absorb. He must also be able to advise management which commodities and styles of pack that should be discontinued for lack of future demand and those that should be added.

Ability and Experience: The sales supervisor holds an important position. His performance could be the difference between the plant's being successful or unsuccessful financially. He should have considerable experience in marketing, be familiar with the markets in which the canned products will be sold, and have a good knowledge of the products he is responsible for selling.

Clerk

Responsible to: The clerk is responsible to management

Duties: The clerk is responsible for preparing acquisitions for materials, handling all correspondence pertaining to the plant business, keeping inventory

records, preparing financial statements, preparing employee payrolls and relieving the plant supervisor of routine office jobs.

Education: The clerk should have a general clerical education or training in the field.

Experience: The clerk should have experience in the operation of an office.

CHAPTER SEVENTEEN

GENERAL CANNING OPERATIONS AND PROCEDURES

Purchasing

For a canning plant to run smoothly and efficiently, it is necessary that the canning plant have available in sufficient quantities a variety of commodities of good canning quality throughout the year. Large plants probably should have a procurement supervisor to contact growers that will produce the quality and quantity of each commodity the canning plant will need. It is advisable to contract with the producers for at least 75% of the plant's total needs for each commodity. It is hoped that the remaining 25% can be purchased on the open market or from the contract gorwers should they have a surplus. This type of an arrangement will give the plant greater assurance of having sufficient raw materials of the type and quantity required for canning. The procurement supervisor should spend a significant portion of his time in the field supervising the production of the crops under contract to advise the growers' planting, insect and disease control, irrigating, harvesting and transporting the produce to the plant.

Written contracts between the plant and the growers should specify the variety, cultural practices, pesticide program, agreed upon price and grade standards that will be used in determining the value of each delivery in order to avoid misunderstanding and to help in the settlement of any disputes that might arise.

Receiving

Post-harvest deterioration of fruits and vegetables prior to canning cannot be stopped, but it can be slowed down if the products are properly handled and if little decay develops between the harvesting and the canning operations. When possible the products should be harvested and transported during the cooler portions of the day, and possibly at night. Some produce receives less damage

if harvested into large bins or boxes having the approximate size 1 x 1 x 1 meter in depth (36 x 36 x 36 inches deep) and transported to the canning plant. However, forklift type of equipment must be available to load these large bins onto the transporting vehicle in the field or grove and to unload them at the canning plant. Special equipment is also needed to dump the produce from the bins onto the processing equipment in the plant. Bulk handling has been found to reduce incidents of bruising, skin puncturing, and other external injuries. Small batch size containers are usually handled with much less care than large bulk ones. Rough handling of the full small container causes considerable damage to its contents. Regardless of the size of the containers, special care should be exercised to maintain the containers in a state of good repair and free from dirt and moldy produce. The containers should be emptied of produce before it starts decaying.

Produce should be received at the canning plant only during those hours scheduled by the plant supervisor. It is imperative that there is a good cooperative working relationship between the plant supervisor and the procurement supervisor. As soon as products arrive at the plant, a representative random sample should be drawn from the load of produce and graded by an impartial produce inspector to determine its grade and suitability for canning, to produce the quality of finished product that management has specified. If the quality of the raw produce is so poor that considerable labor will be required to remove the undesirable portion of the produce, it may be that that load of produce should be rejected. Low yield of prepared product plus the extra labor and low output of finished product would make it uneconomical to accept and process some lots of produce delivered at any price. When available, government *grade standards* for produce for processing should be followed by the inspectors.

Grading and Sorting

Grading and sorting of fruits, vegetables and meats before canning gives greater uniformity to the finished product and helps to standardize certain steps in the canning process. Grading vegetables for size is important in peeling and removal from the inedible portions. Grading to standardize maturity is very important if lye peeling is practiced.

In some canning operations two or three grades of canned products should be considered for maximizing on the utilization of the raw products and for capitalizing on the demands of different markets. Some markets may have a greater demand for a *fancy grade* pack than other markets that cater to a segment of the population that can afford only a product of lesser quality. While the best grade is that which represents the quality most desired by the consumer, the lower grade represents products which are not as desirable, but may have equal food value. Appearance and flavor are the primary factors influencing grades. The grading system for grading and sorting raw products in the plant should completely eliminate all culls or unacceptable produce.

The condition of meats and fish is determined by a number of factors. These factors are discussed in special chapters: Chapter 20, "Fish Canning" and Chapter 19, "Meat Microbiology and Canning."

Upon arrival at the canning plant, fruits and vegetables are graded according to quality and size. For small-scale operations, these two operations are usually done by hand. In larger plants, the sizing and grading may be done mechanically by vibrating screens, rotating cylinders, weighing devices, or various conveying devices depending upon the type of produce being canned.

Sorting and inspecting the produce do not end in the receiving room, but continue throughout the preparation period. Produce must be sorted again after it has been prepared according to maturity, grade, size, and freedom from defects. All bruised, decayed, shriveled, and discolored portions should be

removed. Questionable portions of any product should be discarded rather than risk spoilage at a later stage. Foreign material such as dirt, rocks, stems, leaves, or other matter must be removed to decrease the workload of the washing operation. If the produce has been held in preliminary storage for several hours, it should be carefully inspected for results of overheating such as, sliminess, sweating and overmaturity as well as decay.

Preliminary Storage

Before the raw materials are processed at the canning plant, delays may occur necessitating preliminary storage of the materials. Every effort should be made to process meats, vegetables, and most fruits on the day harvested. However, delays in processing may occur due to the following:

1. Sufficient quantities of raw materials must be accumulated to keep the plant in operation after it starts operating.

2. Raw materials must sometimes be stored over weekends and holidays. It is usually better to hold fruits and vegetables over in the field rather than in the canning plant.

3. The raw materials may be delivered faster than the plant can process them. To minimize the storage of raw produce, scheduling should be utilized to match the quantities delivered with the plant's capacity

4. Certain raw materials are sometimes accumulated to extend the canning operations beyond the normal period of harvest.

5. Transporting produce from great distances.

6. Breakdown of processing equipment and lack of labor.

Even though the various products are stored prior to canning, they continue to ripen. The loss of water due to respiration is of major concern. Respiration

continues on inside the produce after it is harvested. Punctured skins, decay and other chemical and physical breakdown cause losses of moisture from the produce.

Besides the loss of water during respiration, other losses occur such as sugar. The loss of sugar detracts from flavor, sweetness and general excellence of certain fruits and vegetables. The respiration process generates heat which causes self-heating in the harvested produce that will cause the development of slime due to mold growth and decay. During storage, especially at high temperatures and humidities, all fruit and vegetables are susceptible to molds and other diseases unless dipped in a fungicide. Some vegetables become tough.

Certain precautions should be observed to reduce the degradation of raw materials during preliminary storage. The storage area should be well ventilated in order to readily dissipate the heat generated in the food product. Shade, water baths, precooling or even refrigerated storage when available should be used. Moldy or dirty containers should never be employed for storage. Before being reused, field boxes should be sterilized by dipping them in hypochlorite solution followed by a fungicide dip.

Caps

Preparation

Fruits and Vegetables

Washing: Washing of the raw materials is one of the most important steps in the preparation of raw materials for canning. Washing reduces the mucilaginous coating and dirt which are the main materials that contribute to the bacterial load. Washing also removes any spray residue that has been left on the product. For the washing operation, a potable water supply should be available. If the produce is washed in pans or tanks, the water must be changed often enough to insure that the product is thoroughly cleaned.

Sealing

After the containers have been exhausted, they must be hermetically sealed. This hermetic seal must be maintained from the time the container is sealed until it is opened by a consumer. During this period of time the sealed container will have been subjected to considerable stress and strain during thermal processing followed by rapid cooling in water and finally handling durin warehousing and shipping.

Hermetic is defined as perfectly closed and airtight. A hermetic seal on a container of food is very necessary to maintain safe, wholesome and appealing food. The hermetic seal performs these three functions by forming an effective barrier against the entrance of microscopic organisms and maintains a partial vacuum to prevent oxidation of essential nutrients and natural color components of the food product.

A hermetic seal on a glass jar is formed by the heat expansion of the contents and expulsion of gases during processing followed by cooling which causes the steam vapor to condense and the contents to contract thus creating a vacuum. The vacuum pulls the metal center of the two piece jar lid down tightly against the jar rim. The sealing compound on the metal center forms the seal with the smooth jar rim. An adequate vacuum in the jar maintains the metal center of the lid in place without the assistance of the metal band, which should be removed after the center has pulled down forming a concave surface. Glass jars may be tested for an adequate vacuum by tapping the center of the lid with a light metal instrument like a spoon. A clear ringing sound indicates a good seal with an adequate vacuum. A dull

note often means a poor seal and insufficient vacuum. However, a dull sound does not always indicate a poor seal but could be caused by some of the jar contents being in contact with the metal center; if the lid does not lift off easily, place that jar aside and watch for signs of spoilage within a few days.

The hermetic seal on cans is formed during the sealing operation. Conditions for creating a vacuum must be formed such as filling the can with hot food, exhausting, etc., before the top is sealed on the can. To be hermetic, the seal must be mechanically sound and any voids within the seam must be properly filled with appropriate sealing compound in the metal lid seaming panel as shown in Figure 67.

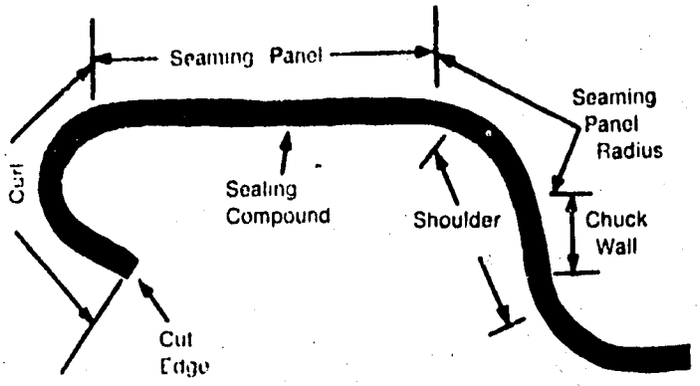

Figure 67. Can End or Can Cover Profile Section.
Courtesy of W. R. Grace Company, Dewey and Almy Chemical Division

Double Seam The seams formed in sealing the top and bottom on a can are known as double seams. A double seam is formed by mechanically interlocking and ironing the curl of the end, which may be either the top or bottom, and the flange of the can body. The double seam formation is formed mechanically by a double seamer, which is also known as a closing or sealing machine, Figure 39. The can double seam is usually formed in two operations; thus the name "double seam". Each can sealer has a base plate, Figure 68, a seaming chuck, Figure 69, a first operation seaming roll, Figure 70, and a second operation seaming roll, Figure 71.

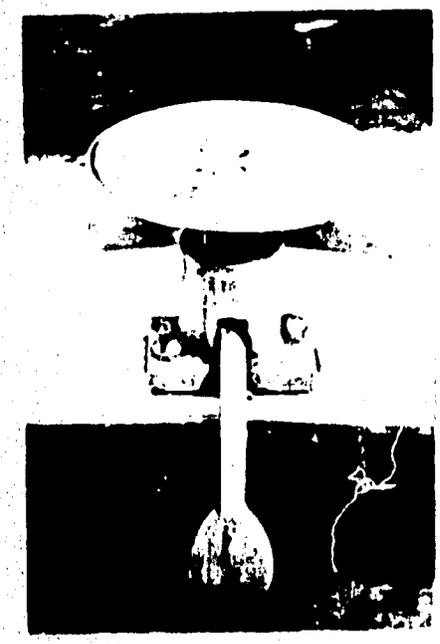

Figure 68. Can Sealer Base Plate
Courtesy of Dixie Canner Equipment Company

Figure 69 Can Sealer Seaming Chuck (Courtesy of Dixie Canner Equipment Company)

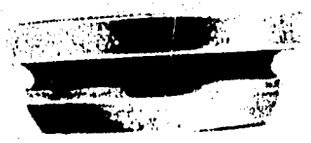

Figure 70 Can Sealer 1st Operation Seaming Roll (Courtesy of Dixie Canner Equipment Company)

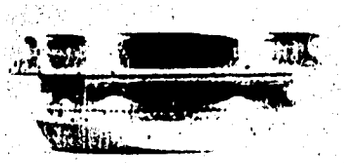

Figure 71 Can Sealer 2nd Operation Seaming Roll (Dixie Canner Equipment Company)

The base plate supports the can body and the seaming chuck holds the can end on the can body, Figure 72. In the first seaming operation, the curl of the can end is interlocked (folded, clinched or engaged) with the flange of the can body, Figure 73. The actual interlocking is performed by the specially contoured first operation seaming roll, shown in Figure 70.

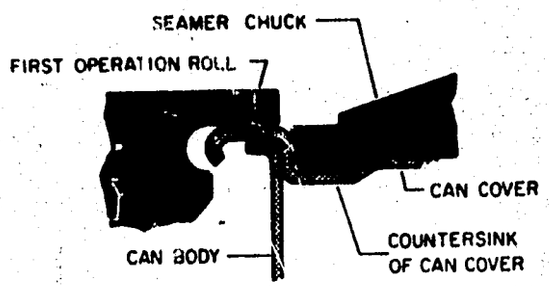

Figure 72. Position of Can and Cover in Relation to Seaming Chuck and 1st Operation Seaming Roll

Since there is no way to compensate for or correct a faulty first operation seam, it is absolutely essential that the first operation seam be properly formed. An acceptable first operation seam has the body hook and the cover hook parallel to each other, Figure 73, the edge of the flange, the body hook, well tucked down into the cover hook radius, and the curl of the end adjacent to, if not actually touching the body wall of the can.

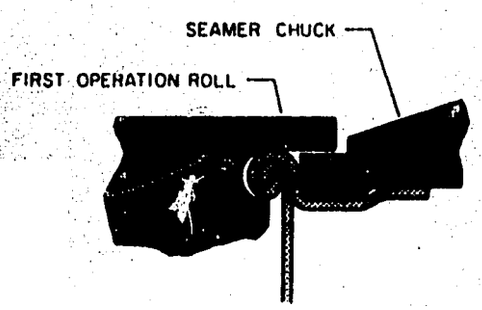

Figure 73. Innermost Position of 1st Operation Seaming Roll in Relation to Chuck for Forming 1st Operation Seam

The first operation seam should be neither too loose nor too tight; either of these defects will impair the quality of the finished seam. The first operation seam will usually be made properly if the following are observed:

1. The proper distance between the lip of the seaming chuck and the top surface of the base plate. This distance is determined by the height of the can.

2. The proper base plate pressure.

3. The correct alignment of seaming roll to the seaming chuck.

4. The correct adjustment of the first operation seaming roll.

Following the completion of the first operation seam, the first operation seaming roll retracts and will no longer make contact with the can end. As the first operation seaming roll retracts the second operation seaming roll, which is specially contoured, moves in and compresses the layers of tinplate in the seam as shown in Figure 74. Notice the difference in the contours of the first and second operation seaming rolls, Figure 75. The tightness or thickness of the double seam is a function of the adjustment of the second operation seaming roll, its contour and its operating condition. If the profile is incorrect or the roll damaged or excessively worn, a desired seam structure and tightness cannot be obtained.

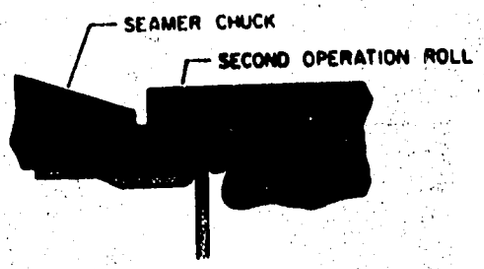

Figure 74. Innermost Position of the 2nd Seaming Roll in Relation to Chuck for Forming 2nd Operation Seam

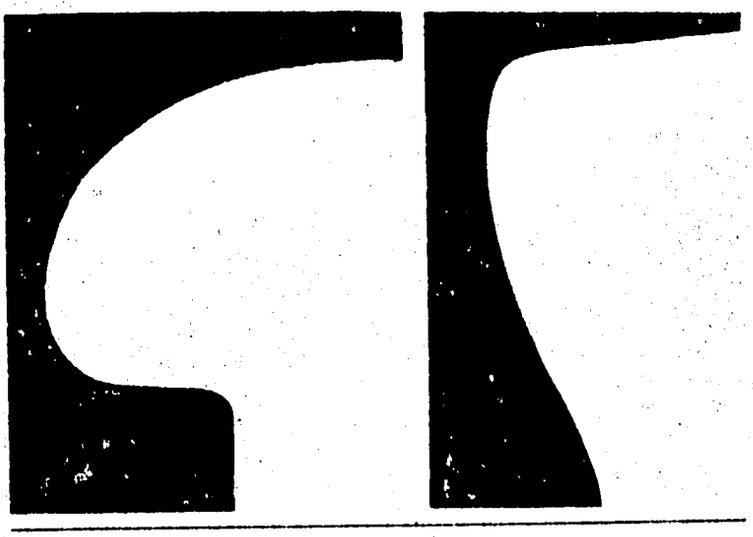

Figure 75. Profile of 1st and 2nd Operation Seaming Rolls
Courtesy of W. R. Grace Company, Dewey and Almy Chemical Company

If the base plate pressure is adequate and the first and second operation seaming rolls are properly adjusted, considerable amount of pressure is exerted while forming the seam. This pressure generates enough heat for the sealing compound in the shoulder-flat-curl portion of the can end to flow and fill all voids in the seam thereby forming a hermetic seal. During the double seaming operation the sealing compound should be completely enclosed within the seam.

It must be remembered that the mechanically interlocked can body and can end and the sealing compound work together to produce a hermetic seal. The sealing compound, not withstanding its resilience and ability to fill voids in the double seam, cannot compensate for a malformed seam. Conversely, a well-formed seal cannot compensate for the incorrect sealing compound and improperly applied compound during the manufacturing of the can ends.

Can ends or covers should be inspected for the proper application of the sealing compound. Can seams should be inspected frequently and evaluated. It has been found through many years of experience that a double seam must be judged in its entirety and not by its dimensions alone. For a seam to withstand the stress and strain during the processing and cooling operations and the abuse of commercial handling conditions, it must be a tight, well-hooked seam, but one that is not too tight.

THE SEQUENCE OF STEPS IN EVALUATING A DOUBLE SEAM:

1. Visual external observations.
2. External measurements of seam sections.
3. A complete tear down and measurement of internal seam sections.

Based on these observations and measurements coupled with the knowledge of the interrelationship of these factors, a judgment for the soundness of a double seam can be made.

Visual External Observations:

Cut-Over

A cut-over is a sharp fin in the can cover at the sealing panel radius Figure 76. Cut-overs occur during the seaming operations when the metal in the cover is forced over the top of the seaming chuck. This condition often occurs at the can body lap or side seam. Cut-overs are detected by running a finger

around the inside of the seam, however, if the cut-over is severe, a fracture is likely to occur resulting in a cut through cut-over and thus a leaking can seam. Corrections should be made immediately.

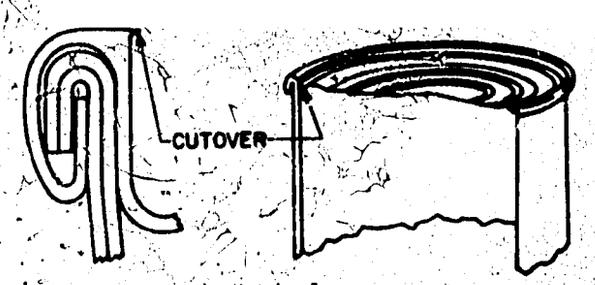

Figure 76 Cut-Over

Probable Causes of Cut-Overs.

1. Excessively long body hook caused by too much pressure on the base plate. The long body hook forces too much metal into the seam.
2. First and second operation rolls set too tight.
3. The vertical alignment of the first operation roll to the seaming chuck is incorrect. The first operation roll grove and the seaming chuck should be set to maintain from .025 to .051 mm (.001 - .002 inches) vertical running clearance between the lead-in angle of seaming roll grove and top of the chuck.
4. Worn seaming chuck flange.
5. Worn first and/or second operation rolls groves.
6. Vertical play of first operation roll in excess of 0.051 (.002 inch).
7. Solid or semi-solid product trapped in the seam during the seaming operation.

Droops

Droops are smooth projections of the double seam below the bottom of a normal seam. This malformation of a double seam is usually found at the side seam but not limited to the side seam area. If the droop is severe, the cover hook

will be shorter than normal or not exist at all. Therefore, the droop should not project below the bottom of the seam more than 1/2 the length of the cover hook.

Probable Causes of Droops:

1. Insufficient and sometimes no overlap of the cover hook with the body hook. Then the cover hook metal may protrude below the seam at the cover hook radius in one or more places. Either of these two conditions could be caused by first operation roll being too loose producing loose first operation seams and worn first operation roll grove.

2. Body hook too long - too much base pressure.

3. Product trapped in the seam during the seaming operation.

Lips, Spurs or Vees

Lips, spurs or vees in a seam are irregularities showing as a sharp "V" projection below the normal seam, Figure 77. When this type of irregularity is found during a routine check the cause should be determined and proper corrections made.

Probable Causes for Lips, Spurs or Vees

See causes under Droops

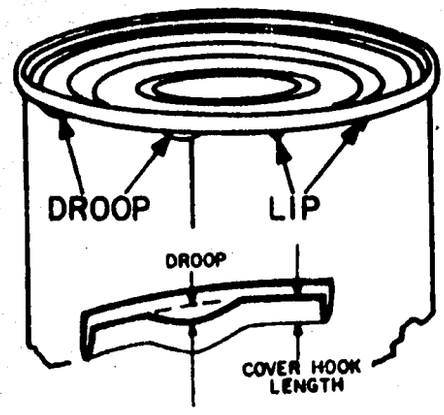

Figure 77. Droops, and Lips, Spurs or Vees.

Dead-Heads

A dead-head is an incompletely rolled seam caused by the chuck spinning in the countersink during the can seaming operation. When a dead-head is first detected, corrections must be made immediately.

Probable Causes of Dead-Heads:

1. Excessively worn seaming chuck.
2. Too little base plate pressure.
3. Excessive vertical play of seaming chuck spindle.
4. Binding of the seaming rolls.
5. Grease or oil on the seaming chuck.
6. Chuck set too high in relation to base plate, when in the raised position.

False Seams

A false seam is a seam or a portion of a seam in which the cover and body hooks are not engaged or overlapped, Figure 78. This is a serious defect which is not always detectable in an external examination. When false seams are discovered, measures must be taken immediately to correct the problem.

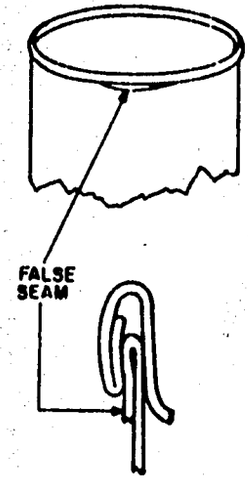

Figure 78 False Seam

Probable Causes of False Seams:

1. Cans improperly filled. Product extending over and beyond the can flange.
2. Missassembly of can cover and can.
3. Bent can flange.
4. Malalignment of can at assembly.
5. Mushroomed can flange.
6. Bent or damaged can cover curl.

SEAM MEASUREMENTS

Visual inspection of the external seam formation should be made frequently,

every 30 minutes, since little time is lost in an examination. External and internal seam measurements should be made at least every four hours of operation. A complete examination of the seam should be made on start-up, after a prolonged shut down, after a severe sealing machine jam and after a change in can size or body or end material.

In evaluating a double seam, measurements should be made at least three places around the circumference of the seam and at least 12.7 mm (0.500") away from the side seam. The highest and lowest reading should be recorded. Do not record average dimension readings from two or more individual readings.

Can Seam Micrometer

To make external and internal seam measurements a can seam micrometer, Figure 79 is needed. The can seam micrometer is a precision instrument and if properly used and cared for will be a useful and accurate piece of test equipment. It consists of an anvil, a spindle, a barrel and a rotatable thimble. Most can seam micrometers also have a pointed shaft, which can be made to protrude from the anvil end of the micrometer.

Figure 79 Can Seam Micrometer
(Courtesy of the L. S. Starrett Company)

The can seam micrometer should be checked periodically for its accuracy or for a correct zero setting. Before checking the zero setting be sure the surfaces of both the spindle and anvil are cleaned with cloth or paper, but not with any abrasive materials. Turn the thimble down, counter clock wise, until the spindle makes contact with the anvil under light pressure. If the zero horizontal line of the thimble does not align with the long vertical line on the barrel at the zero horizontal line of the barrel, an adjustment needs to be made to bring the three points into agreement. While holding the micrometer frame with

one hand, insert the spanner wrench, supplied with the micrometer, into the hole in the barrel sleeve and turn the barrel sleeve until the parallel line aligns with the zero line on the thimble. Can seam micrometers may be calibrated either in Metric units or English units.

A. Metric System:

The barrel of a metric system can seam micrometer is divided in half millimeter increments, 0.5 mm, from zero to thirteen millimeters - 0 - 13 mm. Only the zero, 5, and 10 millimeter horizontal lines on the barrel are numbered, with nine intermediate horizontal lines in 0.5 mm increments between each of the numbered lines. The thimble, which rotates, has fifty graduations around it from 0 to 49. Each of the graduations has a value of one hundredth millimeter. Every fifth graduation on the thimble is numbered. Each complete revolution of the thimble is equivalent to 0.5 mm.

When using the metric micrometer, for measurements ranging from 0 to 0.5 mm readings are made directly from the thimble -- the vertical line which comes the closest to aligning with the long vertical line on the barrel. When measurements are greater than 0.5 mm, the readings on the thimble are added to the readings on the barrel. In making a measurement and a reading is taken at the second line past zero on the barrel and the thirty-ninth (39th) graduation on the thimble aligns with the long vertical line on the barrel, the measurement would read 1.39 mm, 0.5 + 0.5 + .39.

B. English System:

The barrel of the English system can seam micrometer is divided in tenths of an inch increments, 0.1", from zero to one-half inch, 0 to 0.5". Between each of the numbered horizontal lines there are three intermediate lines at 0.025", 0.050" and 0.075". The thimble which rotates has twenty-four (24) numbered graduations around it from 0 to 24. Each of the graduations has a val-

ue of one thousandth of an inch, 0.001". Each revolution of the thimble is equivalent to 0.025".

The values for measurements between 0 and 0.025" are read directly from the thimble -- the vertical line on the thimble which comes the closest to aligning with the long vertical line on the barrel. When measurements are greater than 0.025", the readings on the thimble are added to the readings on the barrel. In making a measurement and a reading is taken at the second horizontal line past zero on the barrel and the third graduation on the thimble aligns the closest with the long vertical line on the barrel, the measurement would read 0.053", 0.025 + 0.025 + 0.003.

Sequence of Steps in Making External Seam Measurements:

1. The countersink depth
2. The seam thickness
3. The seam length - height, width

The Countersink Depth:

The countersink depth measurement is extremely important to help determine the strength of the double seam. A countersink depth that is too great will result in a short cover hook which will not permit sufficient overlap with the body hook to insure a strong seam; a countersink that is too shallow will prevent the seaming chuck from reinforcing the can end and can body during the double seaming operation thus causing a poor quality and weak seam. The depth of a countersink is usually from 0.13 - 0.20 mm (0.005 - 0.008") greater than height of the seaming chuck lip or it is 0.13 - 0.20 mm (0.005 - 0.008") deeper than the double seam is long (wide or high).

A countersink gauge, Figure 80, is the most frequently used instrument in measuring the countersink depth. This gauge is calibrated in tenths (0.1),

hundredths (0.01) and thousandth (0.001) of an inch.

In making countersink depth measurement, the bar of the gauge is placed on top of the double seam in such a manner that it straddles the center of the can cover. The point or foot of gauge that protrudes through and below the bar is lowered unto the chuck wall and measurements are taken at three equidistant points around the circumference of the can.

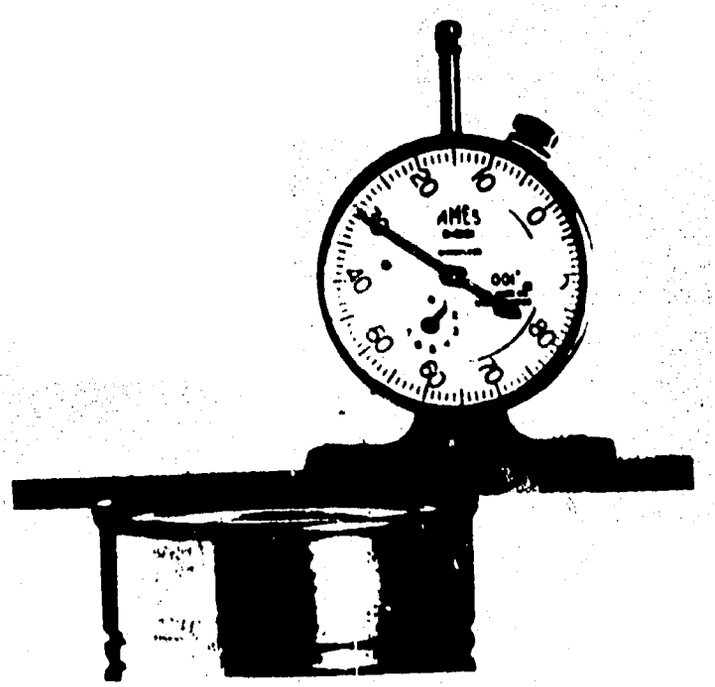

Figure 80 Countersink Depth Gauge

The countersink gauge in Figure 80 has two dials, each having an indicator - a small one on a 0 to 7 small inner scale indicating tenths - 0.1 of an inch, and a larger indicator on a 0 to 99 large outer scale indicating hundredths - 0.01, and thousandths - 0.001 of an inch. Three readings are taken and the minimum and maximum readings are recorded. None of the readings should be taken within 0.5 inch of the side seam. The bar should never be allowed to rest on the high point of the double seam at the side seam when a measurement is being made.

While it is more difficult to obtain an accurate measurement, a can seam micrometer equipped with a pointed shaft protruding from the barrel of the micrometer can be used satisfactorily, if the countersink depth measurement is carefully made.

The micrometer is held lengthwise in an upright position with the flat base surface of the anvil end resting squarely on the top of the can seam with the

pointed shaft protruding just below the micrometer base and just inside the can seam. With the base of the micrometer resting squarely on the seam top, and the pointed shaft protruding approximately 2.54 mm (0.100") below micrometer base, turn the thimble clockwise until the point of the shaft lightly touches the top of the can end or cover. Observe and record the readings taken at three points equidistant around the circumference of the seam. These readings are not the countersink depth. The countersink depth is obtained by subtracting the readings from 5.00 mm. (0.200"), which is the maximum distance the pointed shaft can protrude beyond the base of the micrometer.

In making a countersink depth measurement with a metric calibrated can seam micrometer and a reading is taken at the third horizontal line past zero on the barrel and the 35th graduation on the thimble aligns the closest with the long vertical line on the barrel, the measurement would read 1.85 mm., 0.5 + 0.5 + 0.5 + 0.35. The countersink depth is then computed by subtraction: 5.00 - 1.85 mm. = 3.15 mm.

In making a countersink depth measurement with a micrometer calibrated in English units and a reading is taken at the second horizontal line past zero (0) on the barrel and the 23rd graduation on the thimble aligns the closest with the long vertical line on the barrel, the measurement would read 0.073 inch, 0.025 + 0.025 + 0.023 inch. The countersink depth is then computed by subtraction: 0.200 - 0.073 = 0.127 inch.

<u>The Probable Causes of Countersink Too Deep</u>

1. Worn first or second operation seaming roll interlock
2. Worn seaming chuck interlock flange
3. Chuck set too low
4. Too much vertical play in seaming head causing rolls to raise and lower from chuck.

The Probable Causes of Countersink Too Shallow

1. Chuck flange worn
2. Rolls and chuck out of alignment
3. Insufficient base plate pressure

Seam Thickness

The measurement of seam thickness is an indication of the tightness of the double seam. In making this measurement, balance the micrometer with the index finger above the seam until the anvil assumes the same angle as the taper of the countersink, Figure 81. For the three readings at points equidistant around the circumference of the seam, the thickness should not vary more than 0.008 mm (0.003 in). Seam thickness will vary with the thickness of the tinplate and the size of the can. In making a seam thickness measurement with a can seam micrometer and a reading is taken at the second line up from zero on the barrel and the 35th graduation on the thimble aligns the closest with the long vertical line on the barrel, the measurement would read 1.35 mm -- 0.5 + 0.5 + 0.35. In making the measurement with an English unit micrometer and a reading is taken at the second line up from zero on the barrel and the third graduation on the thimble aligns the closest with the long vertical line on the barrel, the measurement would read 0.053 in. -- 0.025 + 0.025 + 0.003.

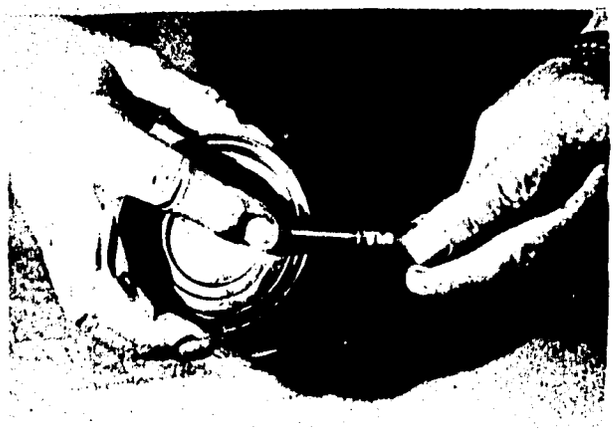

Figure 81 Measuring Thickness of Double Seam

Seam Width, Height or Length

The measurement of the width of a seam is measuring the maximum dimension of the seam parallel to the folds of the seam, Figure 82. This measurement is also

another indication of tightness -- the longer the seam the tighter the seam except in the case of a false seam, giving an extra long seam. Seam width will vary with the thickness of the tinplate, size of container and the contour of the second operation seaming roll. In making a seam width measurement and a reading is taken at the fifth horizontal line up from zero on the barrel and the 32nd graduation on the thimble aligns the closest with the long vertical line on the barrel, the measurement would read 2.82 mm -- 0.5 + 0.5 + 0.5 + 0.5 + 0.5 + 0.32.

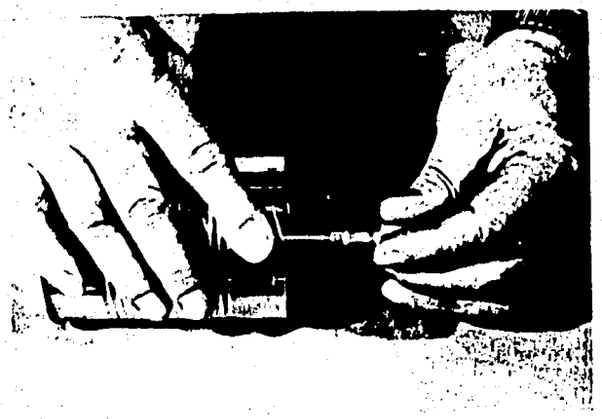

Figure 82 Measuring the Width, Height or Length of Seam

In making this measurement with an English unit micrometer and the reading is taken at the fourth horizontal line up from zero on the barrel and the 11th graduation on the thimble aligns the closest with the long vertical line on the barrel, the measurement would read 0.111 in. -- 0.025 + 0.025 + 0.025 + 0.025 + 0.011.

Evaluating the Internal Seam Formation

Internal seam formation should be evaluated at a minimum of after every three to four hours of continuous operation as well as after prolonged shut-downs, after major jams, and after changes in can and cover size and body.

Figure 83 Notch in Can to Provide a Profile or Cross Section of Seam.

Internal Examination of 1st Operation Seam

In making an internal evalua-

tion of the 1st operation seam, prepare a first operation seam with the can sealer by placing the 2nd operation seaming roll in the "no seam" position or release all adjustment tension or pressure on this seaming roll. A view of the profile or cross section of the 1st operation seam formation is provided by filing at right angles to the seam a notch, Figure 83, using a flat file, Figure 84, having a safe edge. The file should be held so the safe edge is against the proposed cross section, Figure 85. A small magnifying glass will aid in the evaluation.

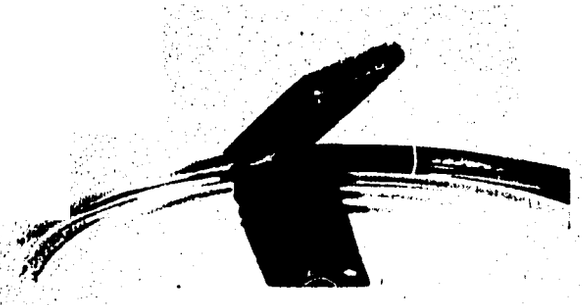

Figure 84 Flat File with Safe Edge

Figure 85 Filing a Notch in a Double Seam Using a Flat File with a Safe Edge.

First Operation Seam

Figure 86A illustrates the configuration of a first operation seam showing the various parts of the seam: Countersink, thickness, width, cover hook, and body hook.

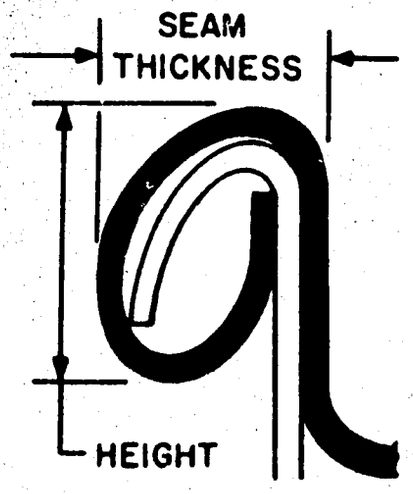

Figure 86A First Operation (Courtesy of American Can Company)

The illustration shows that the cover hook curves around against the side of the can body and the body hook is in contact with the cover hook. The cover hook should be rounded at the bottom and in contact with the can body. Figure 86B illustrates a correct first operation seam at the crossover or side seam. It should be noticed that due to the extra two layers of tinplate in the seam at the crossover or lap, the seam has a different configuration. The cover hook is slightly flat instead of being round at the bottom. The seam at the crossover is the weakest part of a well formed seam. If the sealer is not properly adjusted to form a correct seam at the crossover, it could be that the seam would be weak enough to leak under normal stress and strain during processing and subsequent routine handling in warehousing, shipping and retailing.

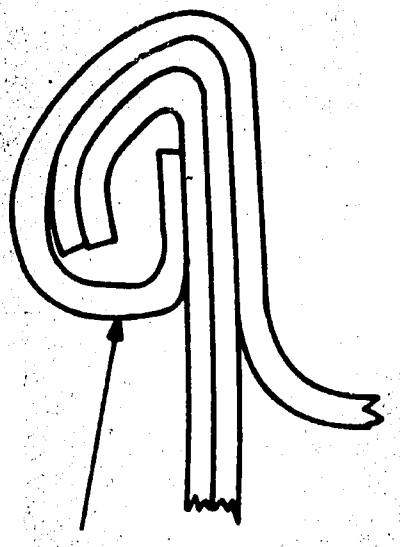

Figure 86B A Correct First Operation Seam at Crossover. (Courtesy of the American Can Co.)

Incorrect First Operation Seam

Figure 86C illustrates a tight first operation seam which appears slightly flatter at the bottom. In a first operation seam, which is too tight, most of the sealing compound will be pushed near the end of the cover hook thus not forming as good a seal as if the sealing compound was evenly spread over the entire area on the inside of the cover hood.

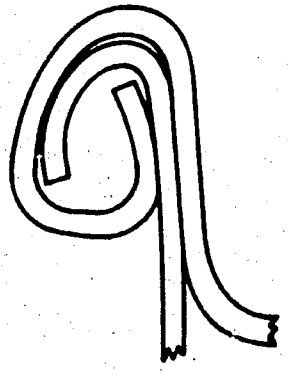

Figure 86C A Tight First Operation Seam. (Courtesy of the American Can Company)

Figure 86D illustrates a loose first operation seam, in which the cover hook does not come in contact with the can body. Such a seam usually results in a short cover hook producing a weak seam.

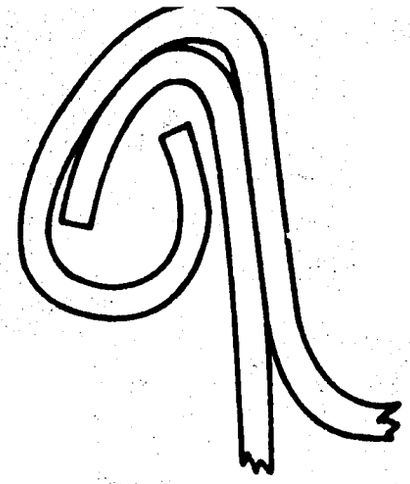

Figure 86D A Loose First Operation Seam (Courtesy of the American Can Company)

Second Operation Seam Formation

The contour of the second operation roll flattens the seam and presses the folds tightly together. See Figure 87 for a correct second operation seam formation and the parts of a seam. The heat generated in this part of the double seaming operation causes the sealing compound to flow into the parts of the seam not occupied by the metal.

Excessive pressure due to too tight adjustment of the second operation roll should be avoided. The excessive pressure could pro-

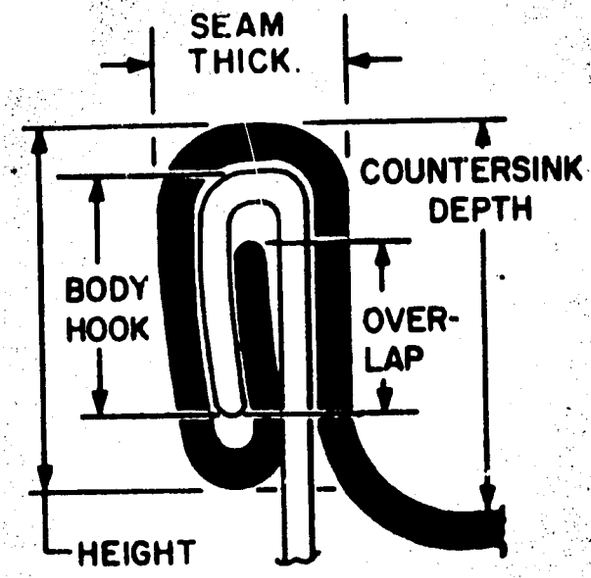

Figure 87 A Correct Second Operation Seam Showing the Various Parts of a Seam.
(Courtesy of the American Can Company)

duce slippage between the cover hook and the body hook causing the hooks to become disengaged. When this happens the measurement of the seam width or length is usually greater than it should be indicating little or no overlap of the cover hook and body hook. Therefore, a second operation seam which has been formed too tightly will more likely leak than one formed with normal pressure. It should also be pointed out that the degree of interlock of the cover hook and body hook is affected by the second operation roll as well as the first operation roll and base plate pressure.

Using too little pressure in rolling the second operation seam will cause the seam to be too loose setting up conditions that would produce leaks during processing and cooling as well as during normal handling in warehousing and shipping.

Tearing down the Double Seam for Internal Evaluations.

The usual method of separating the cover hook and body hook of a finished seam is:

1. Use sanitary can opener, Figure 88, to remove the center panel of the cover. The point of the can opener is used to puncture the can cover as near the center as possible. The opener is lowered to nearly a parallel position with the cover while adjusting the cutting blade to cut the metal center between 6 and 9 mm (1/4 & 3/8 in) from the double seam, Figure 89. Do not force the blade too deeply

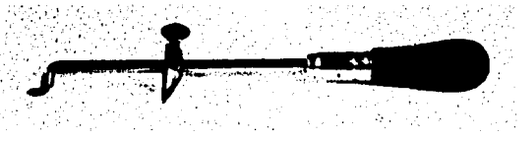

Figure 88 Sanitary Can Opener
(Courtesy of Wilkens-Anderson Company)

into the cover because greater torque would be required to operate the opener and the metal would fold under making it difficult to grasp with nippers in subsequent operations. Probably the easiest way to cut the center panel out would be to cut approximately a third of the way around the can, lift up the blade, skip from 6 to 13 mm (¼ to ½ in.), and reinsert the blade into the cover and continue cutting to the starting point. The cut portion of the center panel can be lifted up, before removing the point of the opener, and broken free from the can.

Figure 89 Removing Center Panel of Cover.

2. Cut across the remaining 6 to 13 mm (½ to ½ in.) portion of cover to the seam with the hand nippers, Figure 90. After turning up a corner of the remaining portion of the cover, grasp the corner with the nippers not so tight as to cut through the tinplate but just tight enough to start tearing the metal cover along the top and circumference of the double seam. Using the face of the nippers as a lever with the double seam as a fulcrum in a rocker-like fashion while holding the nippers at a slight outward angle, Figure 91, the remaining portion of the cover can be removed relatively

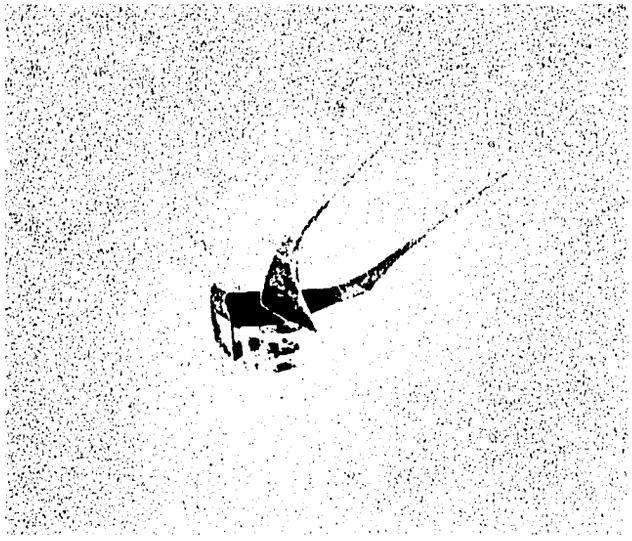

Figure 90 End Nippers (15.25 cm (6 in) Size)
(Courtesy of Western Auto Associate Store)

easy after some experience. Be sure to tear the metal upward, outward and as close as possible to the top of the seam. After completing the removal of the cover examine the raw edge of the metal to see that none of the metal is bent over the top of the seam.

Figure 91 Removing the Outer Can End Section

3. Approximately 25.4 mm (1 in.) from the side seam make a perpendicular cut through the remainder of the seam with the nippers. Next, starting at the cut and using the flat side of the nippers jaws, tap the raw metal edge of the cover until the cover hook begins dropping or disengaging from the body hook. See illustration in Figure 92. Continue tapping gently around the circumference of the can until the cover hook completely becomes disengaged from the body hook. Do not tap hard enough to distort the body hook.

Figure 92 Disengaging the Cover and Body Hooks.

The internal parts of the double seam are now exposed for further examination and evaluation.

Internal Seam Measurements

Sequence of Steps in Making Internal Seam Measurements:

1. Body hook length
2. Cover hook length
3. Wrinkle or waves rating

Body Hook Length

The can seam micrometer is used in making measurements at a minimum of three equidistant points around the can starting at least 13 mm (½ in.) from the side seam. Record the range in the measurements from the minimum to the maximum to the nearest 0.01 mm (0.001 in.). To make this measurement the micrometer is used and held in the same manner it was in taking the length or width of the external seam - hold the micrometer along the body wall of the can, Figure 93, with the body hook enclosed bewteen the spindle and the anvil.

In making a body hook length measurement and a reading is taken at the third horizontal line up from zero on the barrel and the 48th graduation on the thimble aligns the closest with the long vertical line on the barrel, the measurement would read 1.98 mm -- 0.5 + 0.5 + 0.5 + 0.48. If the measurement is made with an English unit micrometer and a reading is taken at the third horizontal line up from zero on the barrel, and the 3rd graduation on the thimble aligns the closest with the long vertical line on the barrel, the measurement would read 0.078 inch -- 0.025 + 0.025 + 0.025 + 0.003. Body hooks may vary from 1.83 to 2.24 mm (0.072 to 0.088 in.) with the ideal range being 1.93 to 2.13 mm (o.076 to 0.084 in.). Any body hook having a measurement beyond this range would indicate an improper balance and soundness of the double seam.

Figure 93 Measuring the Body Hook

A long body hook, Figure 94, could be caused by:

1. Excessive base plate pressure.
2. Mushroomed can flange.

A short body hook, Figure 95, could be caused by:

1. Insufficient base plate pressure.
2. Can flange improperly formed.
3. First operation seaming roll adjusted too tightly.
4. Second operation seaming roll too loosely adjusted.

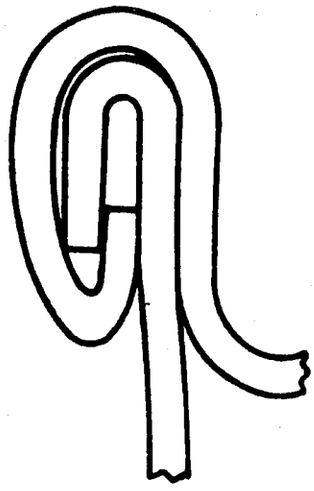

Figure 94 A Long Body Hook (Courtesy of the American Can Company)

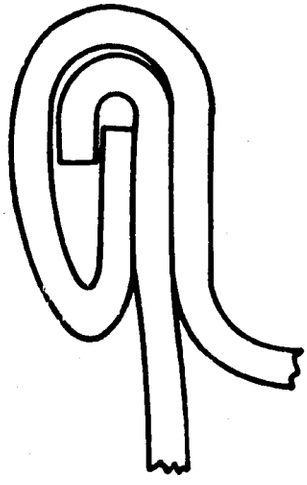

Figure 95 A Short Body Hook (Courtesy of the American Can Company)

Cover Hook Length

With the can seam micrometer make a minimum of three measurements at points equidistant around the circumference of the cover hook portion of the seam. This is one of the more difficult measurements to make because of the cumbersomeness of holding the cover hook parallel to the axis of the micrometer. Record the range in the measurements from minimum to the maximum to the near-

est 0.01 mm or 0.001 inch. To make this difficult measurement the cover hook, usually the shortest and smoothest of the two parts of the hook, is held between the micrometer spindle and the anvil with the smooth edge of the cover hook at the anvil and the cover hook radius at the spindle. It is important for the cover hook to be parallel to the main axis of the micrometer to obtain an accurate, undistorted measurement.

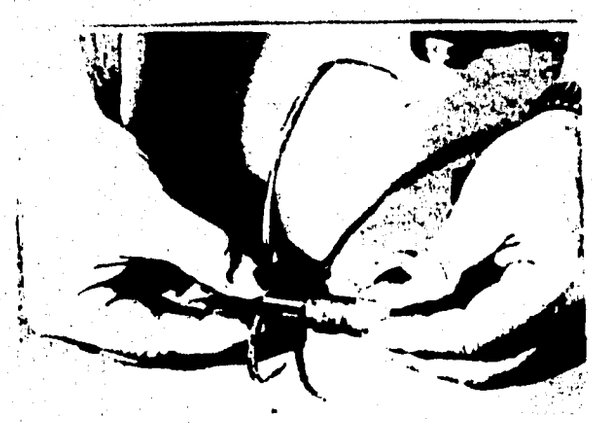

Figure 96 Measuring the Cover Hook

In making a cover hook length measurement and a reading is taken at the third line up from zero on the barrel and the 48th graduation on the thimble aligns the closest with the long vertical line along the barrel, the measurement would read 1.98 mm -- 0.5 + 0.5 + 0.5 + 0.48. If the measurement is made with an English unit micrometer and the reading is taken at the third horizontal line up from zero on the barrel and the 33rd graduation on the thimble aligns the closest with the long vertical line on the barrel, the measurement would read 0.078 in -- 0.025 + 0.025 + 0.025 + 0.003. Cover hook lengths may vary from 1.78 to 2.18 mm (0.070 to 0.086 in) with the ideal range being 1.88 to 2.08 mm (0.074 to 0.082 in). Any cover hook having a measurement beyond this range would indicate an improper balance and soundness of the double seam.

A long cover hook, Figure 97, may be caused by:

1. The first operation seaming roll adjusted too tightly.

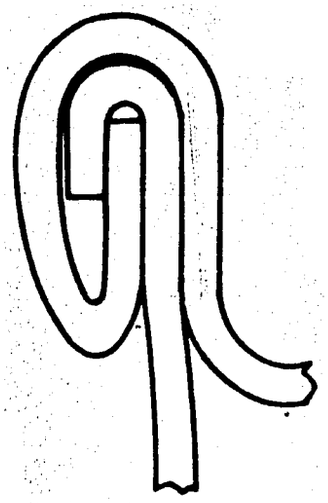

Figure 97 A Long Cover Hook (Courtesy of the American Can Company)

A short cover hook, Figure 98, may be caused by:

1. Too great a countersink depth.
2. Excessive base plate pressure.
3. First operation seaming roll adjusted too loosely
4. Worm groove in the first operation seaming roll.

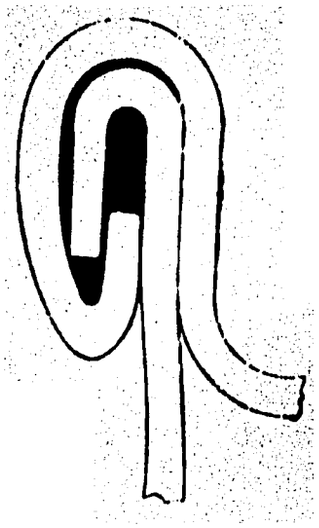

Figure 98 A Short Cover Hook (Courtesy of American Can Company)

Wrinkle or Wave Rating

During the formation of the first operation, seam wrinkles or waves are developed on the inside surface of the cover hook extending from the smooth cut edge downward to the radius of the cover hook. See Illustration in Figure 98. While forming the second operation seam, the second operation seaming roll iron-out or smooth-out the wrinkles.-- the degree depends upon the tightness of the adjustment of the second operation seaming roll. Therefore, the degree of wrinkle is an indication of seam tightness. The tightness of the seam helps to determine whether the sealing compound in the cover is being held under sufficient hydraulic pressure to insure sealing efficiency. In so doing, the compound flows to fill all voids not being occupied by metal.

The diameter size of a can determines the amount of wrinkle -- smaller the can more the wrinkle. Cans having a diameter of 101.6 mm (4 inches) and smaller should have a trace of wrinkle. This trace is desirable so that the seam will not be too tight which indicates that the can seam can absorb abuse without rupturing the seam. Cans over 101.6 mm (4 inches) should have no trace of wrinkle.

Figure 99 Examining Wrinkle in Cover Hook

Several methods or scales have been developed in expressing wrinkle rating. For the purpose of discussing wrinkle rating in this manual, the method or scale developed by American Can Company and the Continental Group will be used. Figure 100 gives the wrinkle rating, tightness, in terms of percent. It should be noted that wrinkle rating is made on the basis of the deepest wrinkle around the circumference of the cover hook. The frequency and the average depth of the wrinkle are not considered in this method of wrinkle rating. The rating is based only on the depth of the wrinkle, for it is at this point or in this area that the seam is most vulnerable to abuse, leakage, or entrance of spoilage microorganisms.

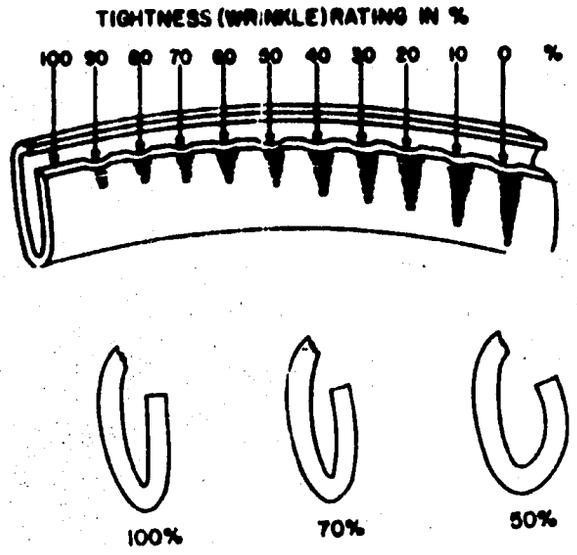

Figure 100 Cover Hook Wrinkle Scale
(Courtesy of the American Can Company)

Before examining a cover hook for its wrinkle rating, it should be first cleaned using a brush or cloth with a solvent to remove any grease, dirt, or sealing compound that may have filled the wrinkles thus resulting in an erroneous tightness rating.

Any cover hook found having a rating under 70 percent would be unacceptable and steps should be taken immediately to correct the cause of this seam malformation.

A low seam rating may be caused by:

1. Second operation seaming roll adjustment is too loose.
2. Worn second operation seaming roll.

Jumpover

A jumpover or jumped seam occurs when that portion of the double seam adjacent to the lap or cross over is not rolled tight enough. This malfunction is caused by the jumping of the seaming roll after passing over the lap or cross over. This defect is found by examining very carefully the portion of the cover hook immediately adjacent to either side of the cross over, Figure 101. Any evidence of jumpover requires immediate corrective action. A jumpover is a critical defect in the seam from the standpoint of leakage resulting in spoiling.

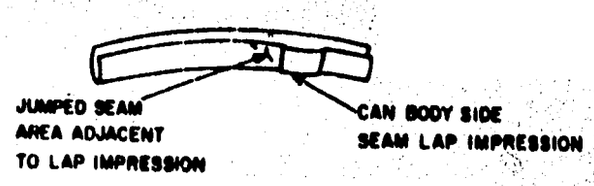

Figure 101 Jumpover
(Courtesy of American Can Company)

A jumpover may be caused by:

1. Broken cushion spring in second operation seaming roll assembly.
2. Slow acting second operation seaming roll cushion spring.
3. Second operation seaming roll cushion spring too weak.

Crossover Droops

The two extra layers of tinplate cause extra thickness of the lap of the side seam. There will be a slight deformation of the cover hook at this point If the length of the droop exceeds one-half the length of the cover hook, Figure

102, corrective action should be taken immediately. When excessive droop is in evidence, insufficient overlap of cover hook and body hook is maintained at side seams. This condition could lead to leakage thus resulting in spoilage.

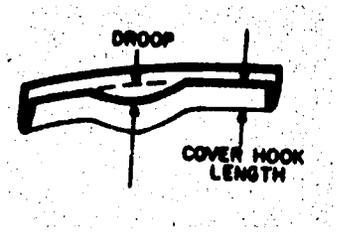

Figure 102 Crossover Droop
(Courtesy of American Can Company)

Cross Over Droops may be caused by:

1. Insufficient and sometimes no overlap of the cover hook and body hook. Then the cover hook metal may protrude below the seam at the cover hook radius. Either of these two conditions could be caused by the adjustment of the first operation seaming roll being too loose or worn first operation seaming roll.
2. Body hook too long due to excessive base plate pressure.
3. Product trapped in the seam during the seaming operation.

Pressure Ridge

The pressure ridge is an impression that is formed on the inside of the can body in the lower portion of the double seam area as the result of the pressure applied by the seaming rolls during the double seaming operation, see Figure 103. The pressure ridge should be clearly impressed around the complete

inside periphery of that portion of the can body which is exposed when the cover countersink wall is removed during the tear down of the seam. While an excessively deep body wall impression should be avoided in an enameled can, it should be present and clearly visible.

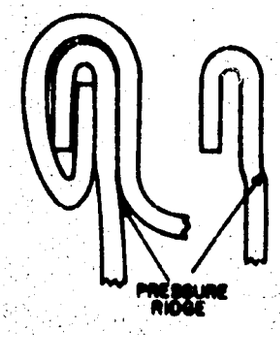

Figure 103 Pressure Ridge
(Courtesy of the American Can Company)

Recording Double Seam Evaluation Results

Visual checks of top double seam on cans from sealing machines should be made at frequent intervals between seam measurement checks. These checks when properly performed often detect in advance probable failures thus preventing sudden failure of vital parts in the seaming mechanism. Failure to detect, as early as possible, malfunctioning of the seaming mechanism can result in substantial losses in time and product. Because it is normal for sealing machines to form correct seams over relatively long periods of time, the trained seam inspectors should not relax their vigilance.

At a regularly scheduled seam measurement check, be sure to carefully inspect seams for external visual defects before tearing down the double seam for exposing the internal components. Record the three measurements of each seam component on chart, RECORD OF TOP DOUBLE SEAM MEASUREMENT, Figure 104, for comparison with the measurement for each size can found in table, TOP DOUBLE SEAM DIMENSIONS FOR ROUND METAL CANS, Tables LVIII and LIX.

TABLE LVIII

TOP DOUBLE SEAM DIMENSIONS FOR ROUND METAL CANS

Fruits, Vegetables, Poultry, and Meats

Metric Units - Millimeters

	Thickness			Width			Countersink Depth See Note (1)			Body Hook Length			Cover Hook Length		
Can Dia.	Min.	Ideal Range	Max.	Min.	Ideal Range	Max.	Min.	Ideal Range	Max.	Min.	Ideal Range	Max.	Min.	Ideal Range	Max.
53.98	1.12	1.17 1.24	1.29	1.77	2.79 2.90	2.97	3.12	3.18 3.28	3.33	1.79	1.88 2.08	2.23	1.68	1.78 1.98	2.18
63.50	1.12	1.17 1.24	1.29	2.79	2.84 2.95	3.02	3.18	3.23 3.33	3.38	1.79	1.88 2.08	2.23	1.68	1.78 1.98	2.18
68.26	1.12	1.17 1.24	1.29	2.79	2.84 2.95	3.02	3.18	3.23 3.33	3.38	1.83	1.93 2.13	2.29	1.68	1.78 1.98	2.18
76.20	1.22	1.27 1.35	1.40	2.79	2.84 2.95	3.02	3.18	3.23 3.33	3.38	1.83	1.93 2.13	2.29	1.68	1.78 1.98	2.18
77.79	1.22	1.27 1.35	1.40	2.79	2.84 2.95	3.02	3.18	3.23 3.33	3.38	1.83	1.93 2.13	2.29	1.68	1.78 1.98	2.18
80.96	1.24	1.29 1.37	1.42	2.84	2.90 3.00	3.07	3.18	3.23 3.33	3.38	1.83	1.93 2.13	2.29	1.73	1.83 2.03	2.23
87.31	1.29	1.35 1.42	1.47	2.92	2.97 3.07	3.15	3.18	3.23 3.33	3.38	1.83	1.93 2.13	2.29	1.78	1.88 2.08	2.29
103.19	1.35	1.40 1.47	1.52	2.92	2.97 3.07	3.15	3.18	3.23 3.33	3.38	1.79	1.96 2.13	2.29	1.78	1.88 2.08	2.29
107.95	1.40	1.45 1.52	1.57	2.92	2.97 3.07	3.15	3.18	3.23 3.33	3.38	1.79	1.96 2.13	2.29	1.78	1.88 2.08	2.29
106.36	1.57	1.63 1.70	1.75	3.00	3.05 3.15	3.23	3.18	3.23 3.33	3.38	1.83	1.98 2.18	2.34	1.78	1.88 2.08	2.29

(1) Countersink dimensions are based on standard chuck flange thickness of .125".

TABLE LIX

TOP DOUBLE SEAM DIMENSIONS FOR ROUND METAL CANS

Fruits, Vegetables, Poultry, and Meats

English Units - Inches

	Thickness			Width			Countersink Depth See Note (1)			Body Hook Length			Cover Hook Length		
Can Dia.	Min.	Ideal Range	Max.	Min.	Ideal Range	Max.	Min.	Ideal Range	Max.	Min.	Ideal Range	Max.	Min.	Ideal Range	Max.
202	.044	.046 .049	.051	.109	.110 .114	.117	.123	.125 .129	.131	.070	.074 .082	.088	.066	.070 .078	.086
208	.044	.046 .049	.051	.110	.112 .116	.119	.125	.127 .131	.133	.070	.074 .082	.088	.066	.070 .078	.086
211	.044	.046 .049	.051	.110	.112 .116	.119	.125	.127 .131	.133	.072	.076 .084	.090	.066	.070 .078	.086
300	.048	.050 .053	.055	.110	.112 .116	.119	.125	.127 .131	.133	.072	.076 .084	.090	.066	.070 .078	.086
301	.048	.050 .053	.055	.110	.112 .116	.119	.125	.127 .131	.133	.072	.076 .084	.090	.066	.070 .078	.086
303	.049	.051 .054	.056	.112	.114 .118	.121	.125	.127 .131	.133	.072	.076 .084	.090	.068	.072 .080	.088
307	.052	.053 .056	.058	.115	.117 .121	.124	.125	.127 .131	.133	.072	.076 .084	.090	.070	.074 .082	.090
401	.053	.055 .058	.060	.115	.117 .121	.124	.125	.127 .131	.133	.070	.076 .084	.090	.070	.074 .082	.090
404	.055	.057 .060	.062	.115	.117 .121	.124	.125	.127 .131	.133	.070	.076 .084	.090	.070	.074 .082	.090
603	.062	.064 .067	.069	.118	.120 .124	.127	.125	.127 .131	.133	.072	.078 .086	.092	.070	.074 .082	.090

(1) Countersink dimensions are based on standard chuck flange thickness of .125".

RECORDING TOP DOUBLE SEAM MEASUREMENTS

Plant_____

Can Size: _____

Date	Time	Seal. Mach. No.	Thickness		Width		Countersink Depth		Body Hook Length		Cover Hook Length		Wrinkle Rating	Pressure Ridge See Legend	REMARKS
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.			
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LEGEND - N - No
G - Good
S - Severe

NOTE: Under remarks indicate all abnormal seam conditions which are observed such as Jumped Seams, Cut overs, Cut seams, Droops, Lips, etc. When adjustments are made duplicate measurements of seam components should be recorded for the closing machine involved. Duplicate measurements should be shown in a color different from the original recording. Indicate under remarks when measurements are recorded after an adjustment has been made to the closing machine.

Figure 104. Record of Top Double Seam Measurements
Courtesy of the American Can Company

After each seam adjustment or maintenance work on a sealing machine, be sure to check the double seam on at least one can before the machine is placed back in operation. After checking cans during a scheduled seam measurement check and the seaming machine is found to be in need of adjustment, duplicate measurements of seam components should be recorded following the final adjustment. Record the duplicate measurements in a different color ink or lead from the original recording. Indicate under remarks when measurements are recorded after an adjustment has been made on a sealing machine.

In adjusting a seaming machine every effort must be made to form a seam within the ideal range. In routine checking of seams, occasional seam dimensions falling outside of the ideal range but within the minimum and maximum range will be acceptable. The average of the measurements should, however, fall within the ideal range. Therefore, seam adjustments become necessary when the average seam component dimension on cans are outside of the ideal range or when any component is beyond the minimum and maximum range.

Washing Sealed Containers

It is particularly important that the exterior of containers be clean and bright. Otherwise, the containers will present an unattractive appearance. More important, however, the presence of food particles or other contaminants on the outside of the containers, particularly cans, tends to induce corrosion. For this reason, the sealed containers are washed at some stage in the operation. Ideally, washing should take place both before and after processing. However, it has been found in most circumstances that it is sufficient to clean the containers thoroughly prior to processing. Washing at this point avoids

contamination of the retort or pressure cooker with undesirable materials accumulated on the outside of the containers during filling and sealing. It also prevents some of these materials from being baked on the cans during processing and thus being carried to the cooling tanks and thereby contaminating the cooling water.

Washing containers of fruits and vegetables does not normally present any great difficulty since traces of syrup and brine are easily removed. Much more difficulty is encountered, however, in washing containers in which meat, poultry and fish are packed. The oil and broth used as a canning medium for such products are sometimes quite difficult to remove from the outside of the containers.

For small operations, the containers may be wiped with a cloth after they have been sealed. A mild alkali or detergent should be used in cleaning containers especially when grease is found on the outside of the container.

A convenient arrangement for washing consists of two locally fabricated narrow tanks of sheet metal, one containing water with detergent and the other with rinsing water. The water should be maintained at a temperature of 52 C (125 F) for greater efficiency in cleaning and at the same time slowing the rate of heat loss from the containers' contents.

The washing operation should be performed as quickly as possible in order that the average temperature of the product in the can does not cool below the minimum initial temperature shown in the processing temperature and time schedule for a particular product.

Marking and Coding

After the containers have been sealed and washed, they should be coded or marked to identify the product. Marking and coding should be done as rapidly as possible so that there will be no delay in the process. The identification

of containers is desirable in commercial canning plants so that the canner can check back on his output and test the quality of the various lots. In cooperative plants where more than one patron's products or more than one type food may be processed simultaneously, coding is necessary in order to avoid confusion. In some plants it is necessary to mark the lids before sealing the containers. In such cases, care should be taken to avoid contamination of the lid. Many different systems can be used to mark and code the canned products. The canning plant supervisor can establish his own system of coding. The code must identify the product, the date of the canning and the lot in which the container was processed. The code itself may consist of a series of letters and numerals marked on the end of the containers.

For small-scale operations, marking may be done with a soft lead pencil. The eraser of the pencil can be used to roughen or remove the protective oil coating on the surface of one of the ends so that the can cover can be marked in this manner. The code may also be applied by means of a rubber stamp using an ink specially formulated to withstand steam during processing. If this is done, care must be taken to be sure that the ink does not contaminate the food. It is advisable to avoid using phenolic base inks.

Large-scale operations may mark the can covers by employing an embossing operation. The embossing is performed by an embossing mechanism attached to the can closing machine. Care must be exercised in adjusting the embossing mechanism to avoid producing sharp imprints that may fracture the tin or enamel lining. Should the lining be damaged corrosion would be promoted which could become a serious matter for canned acid products such as fruits.

PROCESSING

Processing or sterilizing is one of the most important operations in canning. Processing not only renders harmless those microorganisms likely to cause

spoilage but also provides a product properly cooked, i.e., desirable texture, flavor and appearance. The processing should be sufficient to deactivate all the mesophilic microorganisms but not to overcook the food. There are many factors that influence the process: 1/ the types of organisms to be destroyed; 2/ the rate of heat penetration to the slowest heating point. 3/ the initial temperature of the food; 4/ the size and type of container used; 5/ the temperature at which the processing is carried out; 6/ the time or length of the process; 7/ and the pH of the product. Processing schedules and procedures are determined by qualified food processing laboratories after developing considerable quantity of research data for each product in different types and sizes of containers. The canning plant processing operator must follow the prescribed instructions very closely to obtain a safe and attractive product. If any deviations from the recommended processing conditions are desired, a qualified research laboratory connected with food canning industry should be consulted. Also, such a laboratory must be consulted if products are to be canned which are not included in this manual.

The processing operation involves exposing the container of food to hot or boiling water or to saturated steam under pressure for a prescribed length of time. In general, the processing conditions depends on the type of food being canned. Fruit juices are pasteurized at the temperature of boiling water or less. All other products can be divided into two classes; those which can be processed at 100 C (212 F), the temperature of boiling water at sea level at atmospheric pressure and those which require a temperature in excess of 100 C (212 F). The deviation is based upon the degree of acidity of the food product. The acidity of various foods or food products, referred to as the pH factor, can be found in Figure 1 in this manual.

The acid foods, those with pH values below 4.6, include most fruits and certain vegetables. Ordinarily, these foods can be canned by heating them in sealed containers until a center temperature of 88 C (190 F) is reached in the container. Under these conditions microorganisms capable of causing spoilage of an acid product are deactivated.

The other class of canned products consists of those foods with pH values higher than 4.6. This class includes low-acid vegetables, soups, meats and meat products, fish and poultry. These products require processing under pressure for adequate sterilization. Attempts to sterilize low-acid products at the atmospheric boiling point of water are not safe and must not be attempted. In processing low-acid, it is sometimes not practical to kill all the microorganisms, such as heat resistant thermophiles, as a long process time would change the product so that it would not be salable. However, the processing must be sufficient to destroy all mesophilic organisms that grow at temperatures less than 38 C (100 F).

At one time, acidified brines were added to low-acid foods to lower the pH value to a level that would permit processing at atmospheric pressure. This practice is not recommended except under guidance of a qualified research laboratory connected with the food canning industry.

Heat Penetration

For proper processing of canned goods, the slowest heating point of the contents in the container must reach a temperature sufficient to kill the spoilage organisms. Processing temperatures and times are based in part on the rate at this heat is transferred to the slowest heating point. As mentioned

earlier in this manual on page 17, heat is transferred in containers by convection, conduction or a combination of the two. The rate of heat transfer depends on the type of product, the viscosity of the canning medium, the method by which it is packed, the size and type of container and the processing temperature.

Proper heat transfer depends upon two important factors -- temperature and time, which must be carefully controlled. Temperature must be controlled within ± 0.5 C (1 F). In specifying processing temperature it is essential that the time also be indicated. This is important because bacterial spore destruction at 121 C (250 F) is approximately 100 times faster than at 100 C (212 F). It is worth noting that an error in either time or temperature in a short, high temperature process will have a much greater effect on the total sterilizing value of the process than a like error in a longer process at a lower temperature.

Several factors tend to reduce the rate of heat penetration for a given process. Over blanching and overfilling of containers may retard the heat penetration and therefore may result in underprocessing. Overripe fruit sometimes softens and forms a compact mass in the container and retards heat penetration.

Stacking Containers in Cooker Crates or Baskets

Research tests have shown that crates or baskets constructed from the use of expanded metal, strap iron or heavy gauge wire are excellent for holding metal containers and glass jars because these types of materials permit the free flow of steam or water among the containers. In the use of steam for processing, the flow of steam sweeps out the air trapped among the containers. The use of

perforated crates are often found to be unsatisfactory because frequently containers may be placed directly over the perforations thus blocking or interfering with circulation. To minimize the interference of the circulation of steam the perforations in a crate should be at least 25.4 mm (1 in.) in diameter on 37.5 mm (1½ in.) centers.

Containers should be stacked in the crates or baskets in such a manner as to permit the free circulation of the heating medium. In vertical retorts, containers are usually stacked several layers deep. Under such conditions the containers should be staggered so that they do not rest directly over one another. While the jumble method of loading retort crates is most desirable for most products except products which are stratified such as spinach and asparagus, it can cause considerable denting in metal containers larger than No. 2 (307 x 409). The jumble method of stacking also reduces the retort capacity by 20 percent. In retorts having more than one crate or basket the containers should not be stacked in a manner that they would project above the rim of the crates or baskets. Containers projecting above the rims would interfere with the circulation of the steam and the containers in the lower crate could be severely damaged by weight of the top crate resting upon them.

Rough handling of the containers during stacking in the baskets must be avoided to prevent considerable spoilage due to weakened seams caused by the rough handling. Care must be exercised in handling baskets so that they are not dropped or allowed to crash into one another or that cans are not haphazardly dropped or pushed into the crate in filling it.

Dividers of the type shown in Figure 105 are recommended between layers of glass jars and between different lots of metal containers. In selecting dividers, it must be remembered that they must be of the type that will not interfere with the circulation of steam. Heavy gauge wire or expanded metal dividers are satisfactory, but sheet metal, cloth and sacks should never be used as these types will restrict the circulation of the heating medium.

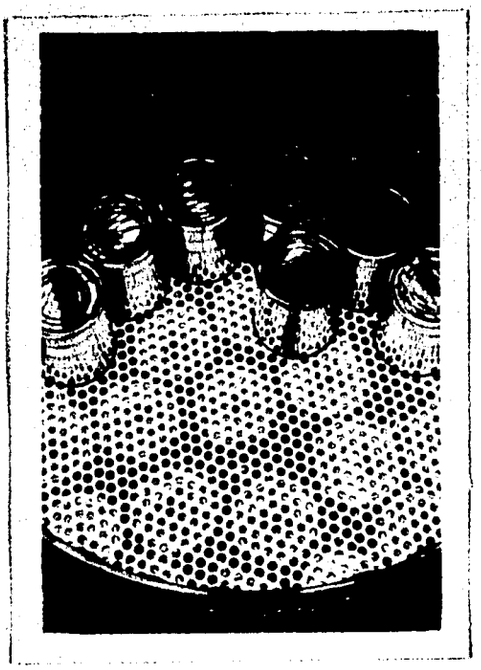

Figure 105 Retort Crate Divider (Courtesy of Dixie Canner Equipment Company)

PROCESSING AT ATMOSPHERIC PRESSURE

Acid products are usually processed at atmospheric pressure of a temperature of 100 C (212 F) at sea level. It must be remembered that the temperature of an atmospheric process is lowered by approximately 1.1 C (2 F) for every 330 meters (1,100 ft.) of elevation. The lowering of processing temperatures at various altitudes above sea level necessitates increasing the processing time by 10 percent for each 330 meters (1,100 ft.) in elevation. A processing time of 40 minutes for an acid product at 100 C (212 F) will need to be increased to 48 minutes if a canning plant is located in an area that is 630 meters (2,100 ft.) above sea level.

There are two methods that can be used for atmospheric processing: 1/ boiling water and 2/ steam. Boiling water is used by those

canning plants that do not have a source of steam. Water is brought to boiling and maintained in a relatively large vessel over an external source of heat such as a gas or electric surface unit. Boiling water is also used in large canning plants which use steam to heat the water. Steam may be used by those plants having a source of steam to process in a steam atmospheric cooker.

PROCESSING IN ATMOSPHERIC PRESSURE WITH BOILING WATER - ACID FOODS

A boiling water bath can be very successfully used to process acid foods because the temperature 100 C (212 F) is sufficient to kill all non-spore forming microorganisms contained in such foods and the acidity prevents the development and growth of heat resistant microorganisms. The time required to process acid foods in the boiling water bath differs with the product, type and size of container, and altitude.

Any type of boiling water bath may be used to process acid foods provided it is operated properly. The water in the bath must be kept at a level that is at least 63.5 mm (2½ in.) above the tops of containers of food. Open retorts and open process cookers, similar in size to the retorts, are used in canning plants with a steam source to heat the water. Regardless of the type of vessel used the containers must not rest on the bottom of the vessel. If the vessel does not have a basket that will prevent the containers from resting on the bottom, a perforated false bottom should be placed in the bottom of the vessel. The water must be boiling before containers are placed in the bath, it must be brought back to boiling before the timing of the process is begun. It is important that the water be boiling vigorously and not simmering or just rolling throughout the processing time. Rolling is a false boiling and will occur at a temperature considerably below the boiling point. Food

processed in water at the temperature of a slow roll may be seriously underprocessed. Upon completion of the processing cycle the containers must be cooled immediately either with cold, potable water or in air. If the cooling water is not potable, it must be chlorinated.

PROCESSING IN ATMOSPHERIC PRESSURE WITH STEAM - ACID FOODS

Atmospheric cookers, utilizing steam at atmospheric pressure, are more efficient and require less time than a boiling water bath. A steam atmospheric cooker requires only a few seconds to reach processing temperature while considerable more time is required to bring the large volume of water in a boiling water bath to boiling point, processing temperature.

The steam atmospheric cooker consists of a base, an insert rack and crate, and a cover, Figure 34. The containers to be processed are placed in a crate, and the crate is placed on the insert rack which is placed in the base and the cover is lowered over the crate in such a manner that the bottom of the cover is sealed by the water. To form the water seal, the covers should extend from 3.8 to 5.1 cm (1½ to 2 in.) below the surface of the water. Steam at atmospheric pressure is then admitted into the cover through a hose, specially manufactured for steam, and the temperature is allowed to rise to the required value. The temperature is measured by a mercury-in-glass thermometer in the side pocket of the cover. The steam enters at the top of the cover, forcing the air downward and out through the water seal. The steam in the cooker during processing is actually about 0.345 kilopascals (0.05 lbs. per sq. in.) above atmospheric pressure. After the processing time has elapsed, the steam is turned off, and almost immediately the cooker can be unloaded and containers cooled with potable cold water or air. If the water is not potable, it must be chlorinated.

PROCESSING UNDER SATURATED STEAM PRESSURE -LOW ACID FOODS

All low-acid food products require processing at high temperatures,

generally 116 C (240 F) or higher, in order to destroy the spoilage micro-organisms associated with these foods within a reasonable length of time. The most practical means at this time for obtaining a temperature of 116 C (240 F) is by the use of steam under pressure. The steam may be produced either in closed vessels in which water has been placed and heat applied externally or in boilers and piped into a closed vessel.

The temperature of steam is directly related to its pressure. By regulating the pressure of the steam its temperature is easily regulated. However, as with boiling water, the temperature of steam changes with changes in elevation. At sea level, steam at 71.0 kilopascals (10.3 psig) pressure has a temperature of 115.6 C (240 F), and at 104.1 kilopascals (15.1 psig) it has a temperature of 121.1 C (250 F). At altitudes higher than sea levels it is necessary to increase the pressure approximately 3.447 kilopascals (0.50 psig) for each 305 meters (1,000 ft.) in elevation to attain the required temperature for the process. Pressures corresponding to changes in altitude may be found in Table II, of the appendix in this manual. While steam pressure is directly related to the temperature of steam, it is not recommended to use pressure as an indication of temperature inside of a retort because of two reasons: 1/ pressure gauges are not reliable, 2/ errors are likely to occur in compensating for changes in elevations. Inside temperature of retorts should be measured only with an accurate mercury-in-glass thermometer.

If the temperature drops during a process, the process must be modified. For every 0.5 C (1.0 F) the temperature is subnormal, two minutes must be added to the specified processing time. However, if the drop is greater than 2.8 C (5.0 F) below that specified, or if the temperature is subnormal for more than 5 minutes, the process must be begun again by

bringing the temperature back to the specified processing temperature and then begin the timing of the process for the full length of time specified in processing schedule.

Only pure steam free from air should be employed for processing because heat transfer from an air-steam mixture is much less than that from pure saturated steam. The process instructions contained in this manual are based on an atmosphere of pure saturated steam. If air is present in the retort, containers could be encased in a thin film of air and thus become partially insulated preventing steam and conducted heat from reaching the containers. Air in the retort also results in slower heating because it is a much less efficient heating medium than steam. IT IS NECESSARY, THEREFORE, TO FOLLOW THE PROCEDURES AS OUTLINED IN THIS MANUAL UNDER PRESSURE COOKER AND RETORT OPERATION IN ORDER TO REMOVE ALL AIR FROM THE COOKERS BEFORE STARTING TO TIME THE PROCESS.

Scheduled processes and venting procedures to be used for each product and container size being packed must be either posted in a conspicuous place near the processing equipment or shall be made readily available to the pressure cooker or retort operator.

A daily process record must be kept for each retort by the pressure cooker or retort operator. Figure 106 is an example of a record sheet that has been found to be adequate for most small canning plants. The data in each column should be entered at the time specified. Temperature charts from the recording thermometers and the daily process record sheets should be filed together for future reference after being carefully examined for any deviations from recommended processes and procedures. If any deviations are found, they should be brought to the attention of the pressure cooker or retort operator.

DAILY PROCESS RECORD FORM FOR STILL RETORTS

Canning Plant Name _____ Plant Location _____ Date _____

Product Code	Scheduled Process I.T.	Scheduled Process Time	Scheduled Process Temp.	Retort and Recorder Number	Container Size	Container Approx. No.	Actual I.T. °C(°F)	Time Steam On	Vent Closed Time and	Vent Closed Temp. °C(°F)	Time Temp. Up	Estimated Time Steam Off	Actual Time Steam Off	Actual Process Time (min.)	Temperature Mercury	Temperature Recorder

Note: Allow headings for critical factors, such as maximum drained weight and minimum net weight etc. where applicable to scheduled process.

Signed (or initialed) by

Operator or Designated Person _____

Reveiwed by _____ Date _____

Figure 106 Daily Process Record Form For Still Retorts

Courtesy of National Canners Association

The retort or pressure cooker operator should have the initial temperature of the contents of the containers to be processed determined with sufficient frequency to insure that the temperature of the product is no lower than the minimum initial temperature specified in the process schedule.

All retort baskets or other containers of unprocessed food must be clearly identified in some manner so that the retort or pressure cooker operator can easily detect whether or not the containers of food have been retorted.

Timing devices used in recording thermal processing time information must be accurate to the extent needed to insure that the processing time specified in the process schedule is achieved. A 30 to 35 cm (12 to 14 in.) diameter accurate and dependable wall time piece is recommended to be placed in the processing area where it can be easily seen by the retort or pressure cooker operator. Pocket or wrist watches are not recommended timing devices.

Processing is divided into three stages: 1/ "come-up time" or time required to vent the air from the cooker and raise the temperature of the retort or pressure cooker and the contents to the processing temperature, 2/ holding time or time the cooker is maintained at the processing temperature, and 3/ cooling time. The come-up time should be as short as possible, but long enough to remove all air from the cooker. The temperature and pressure inside the cookers should be checked to see that they correspond to normal values for pure steam. Correspondence between the gauges is in general a reliable indication that all air has been removed.

PROCESSING IN PRESSURE COOKERS

Pressure cookers with thermometers are used in small canning plants in which the production is not sufficient to support a steam generating unit. Only a well trained pressure cooker operator who has a thorough knowledge and

understanding of the various phases of pressure cooker operation should operate pressure cookers in a canning plant. The operator should not have other responsibilities that would prevent the operator from full attention to this most important operation during thermal processing periods. The pressure cooker operator should observe the following steps in their proper sequence:

Loading the Pressure Cooker

1. Place enough water in the cooker to cover the bottom to a depth ranging from 5 to 7.5 cm. (2 to 3 in.)
2. Arrange the sealed containers in the cooker basket so that the steam can circulate around them.
3. Place the basket of containers in the cooker.
4. Place the cover on the cooker and fasten it securely so that no steam will escape except through the petcock or weighted gauge opening.

Coming-up-Time - (Venting)

1. Open petcock or weighted gauge opening.
2. Place cooker on heating unit and turn on the source of heat to generate steam.
3. Allow steam to flow vigorously from the petcock or gauge opening for at least ten minutes to insure all air has been removed from the cooker. Record the time and temperature during venting.
4. Close petcock or place weighted gauge on the gauge opening. Record the time.
5. Allow temperature inside of cooker to rise to scheduled processing temperature.

Holding Time - Processing Time

1. Start timing the process. Record the time and temperature.
2. Adjust the source of heat to maintain processing temperature with-

in ± 0.5 C (1 F).

3. At the end of the processing time remove the cooker from the source of heat. Record the time.

Cooling

1a. If the containers are metal and are smaller than No. 2 1/2 (401 x 411), open the petcock immediately to allow the pressure to drop to zero (0). If the containers are No. 2 1/2 and larger the pressure should be allowed to drop to zero (0) before opening the petcock to permit the internal pressure in the containers to fall to a level that would not cause distortion of the containers.

1b. If the containers are glass, allow the pressure to drop to zero (0) before opening the petcock. A sudden drop of pressure in the retort would cause the internal pressure in the jars to push the liquid in the jars out through the jar opening and the closure possibly preventing the closures from forming a proper seal as well as resulting in a significant loss of canning medium.

2. Only after the pressure has dropped to zero (0) remove the cooker cover carefully holding the cover in a manner that will deflect the steam vapors away from the operator's face, hands and body.

3. Remove containers from the cooker. Metal containers should be either placed in cold, potable water bath or under a cold, potable water spray for rapid cooling to 38 C (100 F). Care must be exercised in cooling glass jars with water because they are susceptible to thermal shock, causing breakage. In cooling with water, place the jars under very, very fine spray mist. After the removal of the initial heat the quantity of cold water may be increased gradually to allow rapid cooling to 38 C (100 F). The shorter the cooling period, the better the quality of the canned product. If the water used in cooling is not potable, it must be chlorinated.

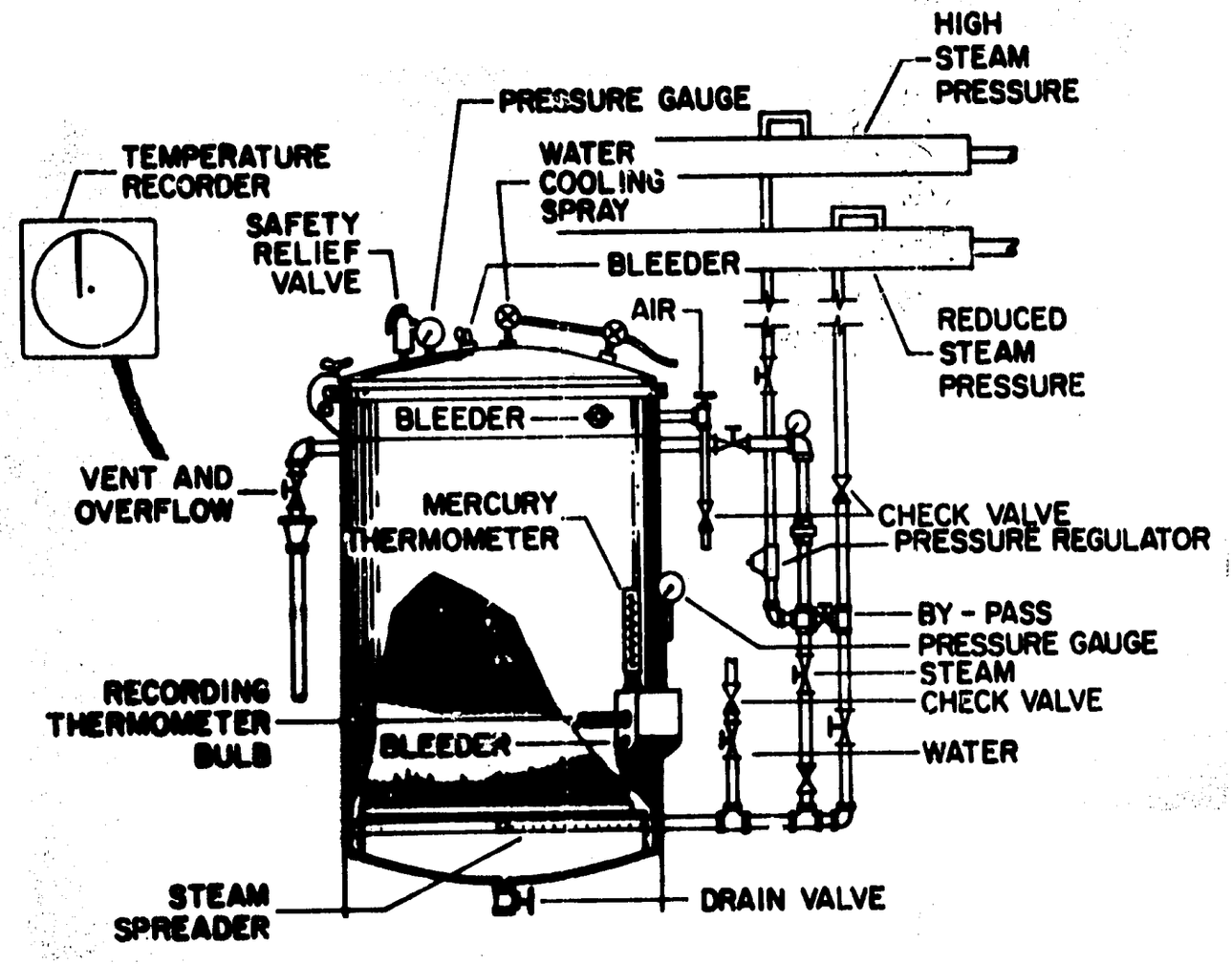

Figure 107. Vertical Still Retort Installation for Cooling in Air or with Water in Retort, Canal, Tank or Under Spray, In Retort Under Pressure with Compress Air and Water, or in Retort Under Pressure with Steam and Water.

PROCESSING IN RETORTS

For a successful process that will insure a properly sterilized canned product an adequately equipped retort, installed properly, and operated by a well-trained operator with a thorough knowldege of the various phases of retort operation are of vital importance. Figure 107 shows a suggested method for installing an adequately equipped vertical still retort that will make possible for the operator to use several alternate methods of cooling containers of processed food following processing. The suggested installation will also permit the retort to be used as an atmospheric cooker.

Should a well trained retort operator fail to use his knowledge due to indifference or be burdened with too many other responsibilities, he should either be removed from the job or his activities be reduced so he can give the operation the attention it requires. A careful analysis should be made of the retort operation frequently and indicate what adjustments should be made to improve efficiency. Besides specified instructions for each type of operation, the more important steps or phases require detailed discussion. These steps should be studied carefully to insure complete understanding as to just what is accomplished by each step and why the step is important.

Loading the Retort, Figure 108

1. The retort crates of canned food should be examined carefully by the retort operator to see that stacking of the containers, dividers, sides and bottoms of crates will not obstruct the flow of steam

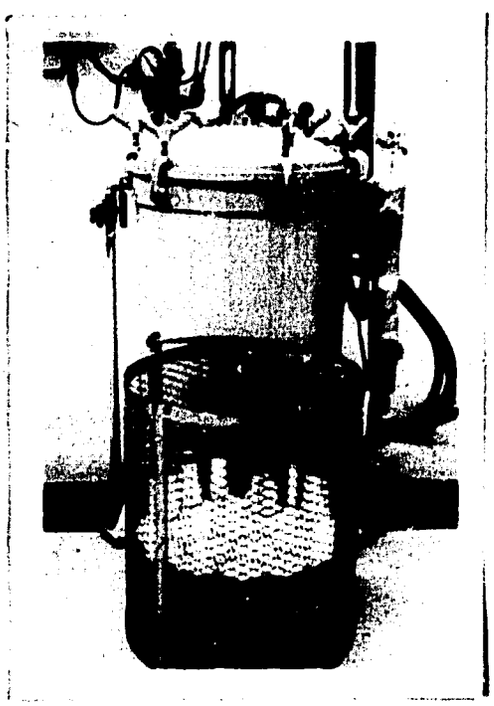

Figure 108. Proper Loading of Retort Crate

through the cans.

2. Record on the Daily Processing Record the product, code, temperature chart number, retort number, size of containers, number of containers, scheduled process, and actual initial temperature. See Figure 106.

3. Lower the retort crate or crates into the retort. See Figure 109.

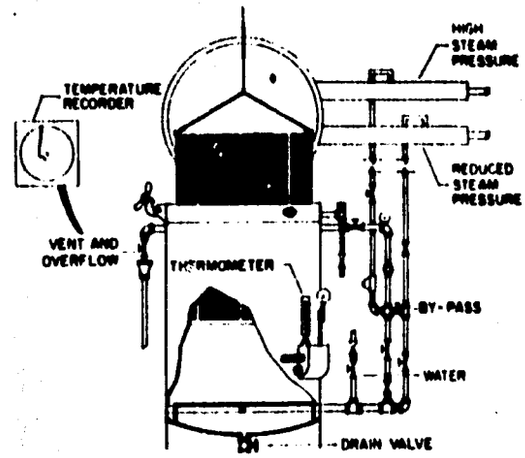

Figure 109. Lowering a Crate of Canned Food into Retort.

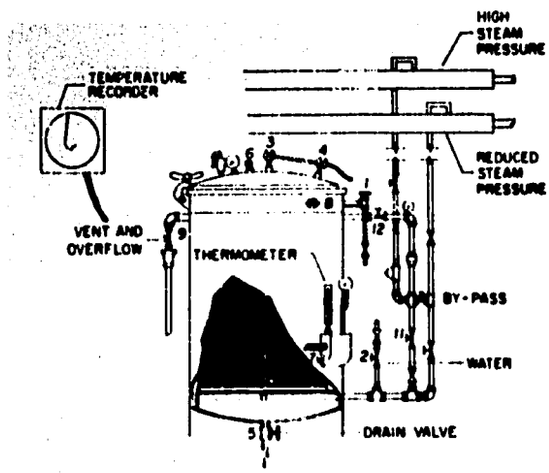

Figure 110. Preparing Retort for Steam-On.

<u>Preparing the Retort for Steam-On, Figure 110.</u>

1. Lower and secure the top of retort.

2. Close <u>completely</u> compressed air valve <u>1</u>, top steam inlet valve <u>12</u>, water inlet valves 2, <u>3</u>, and <u>4</u>, and bleeder valve <u>8</u>.

3. Open drain valve <u>5</u>, bleeder valves <u>6</u> and <u>7</u>, bottom steam inlet valve <u>11</u> and vent/overflow valve <u>9</u>.

Come-Up-Time (Venting), Figure 111.

1. Open steam supply line valve 13 and record the time it was opened.

2. Close drain valve 5 after the accumulated steam condensate has drained from the retort.

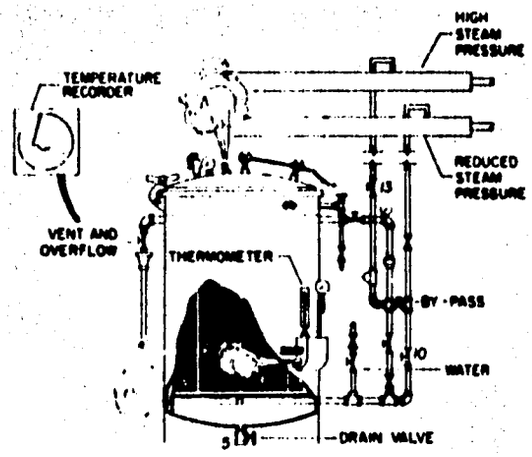

Figure 111. Come-Up-Time (Venting)

3. If necessary, open and adjust steam-by-pass valve 10 to increase the flow of steam into the retort to obtain and maintain scheduled venting temperature during the venting phase of the come-up-time.

4. Record venting temperature.

Bringing Retort up To Processing Temperature, Figure 112.

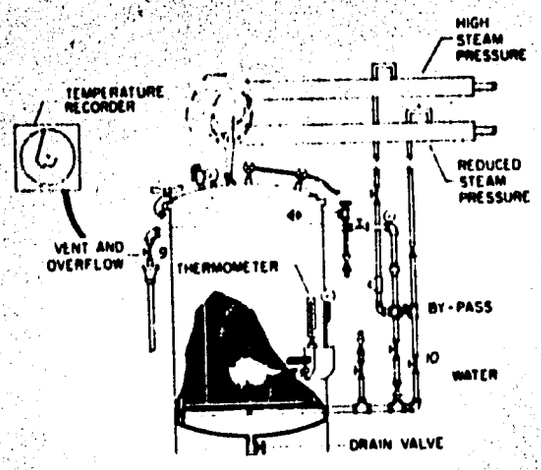

Figure 112. Bring Retort up to Processing Temperature.

1. At the end of the scheduled venting time close vent/overflow valve 9.

2. Immediately start closing steam-by-pass valve 10 slowly. Start closing steam-by-pass valve 10 immediately and slowly after closing vent/overflow valve 9 is essential to prevent excessive buildup of steam pressure within the retort. It is

essential to close the steam-by-pass valve 10 slowly to avoid a sudden drop in pressure within the retort.

3. Record the time vent/overflow valve was closed.

Holding or Processing Time

1. Record the time that the scheduled processing temperature on the mercury-in-glass thermometer was reached and start timing the process.

2. Check to see that steam is flowing through bleeders 6 and 7.

3. Check the temperatures indicated on the mercury thermometer and the recording thermometer chart. The National Canners Association advises that it is not serious if the recording thermometer chart indicates a temperature a degree or two lower than the mercury thermometer, but it must never be higher.

4. Record the processing temperature and any deviation from the scheduled temperature. Should there be a deviation, the process must be modified according to the procedures outlined in the third paragraph under Pressure Processing (Low-Acid Products with pH above 4.6).

COOLING

Cooling is a very important and critical phase of thermal procesing in a still retort. When this operation is properly carried out, the quality and safety of the canned product should be just as good at the end of the phase as it was in the beginning. Both the safety and quality of a canned product can be subjected to questioning if proper care is not exercised. The cooling water should have a temperature no higher than 21 C (70 F) and be free from any contaminants such as spoilage microorganisms, toxic substances, etc. Procedures for cooling each size and type of container must be followed closely in the proper sequence or serious damage may result to both the canned food and equipment.

Cooling No. 2 (307 x 409) Size Metal Containers or Smaller:

Cooling in Air or Water in Canal, Tank or Under Spray. See Figure 113.

1. Close steam supply line valve 13 at the end of the scheduled processing time.

2. Open vent/overflow valve 9.

3. Open drain valve 5.

4. After retort pressure has dropped to zero (0) open retort top.

5. Remove the crates of processed food from the retort and cool rapidly under cold water spray, in tank of cold running water or in air until the temperature of the containers' contents is lowered to 38 C (100 F).

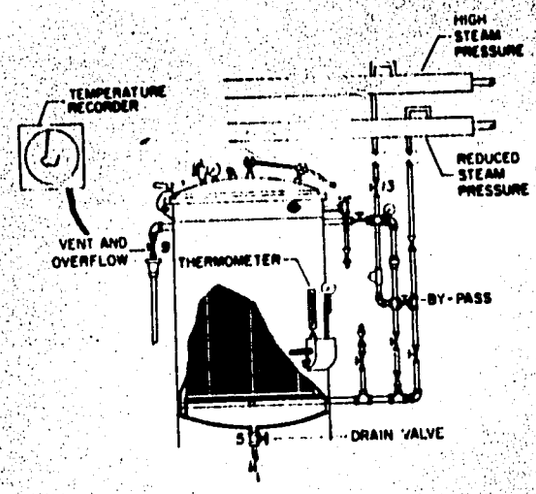

Figure 113. Cooling in Retort

Cooling Metal Containers Larger than No. 2 (307 x 409) and Glass Jars.

Cooling Large Metal Containers Under Air Pressure and Water, Figure 114.

1. Close bleeder valves 6 and 7.

2. Open and adjust compressed air inlet valve 1 so that the retort pressure may be maintained at 13.8 kpag (2 psig) above processing pressure.

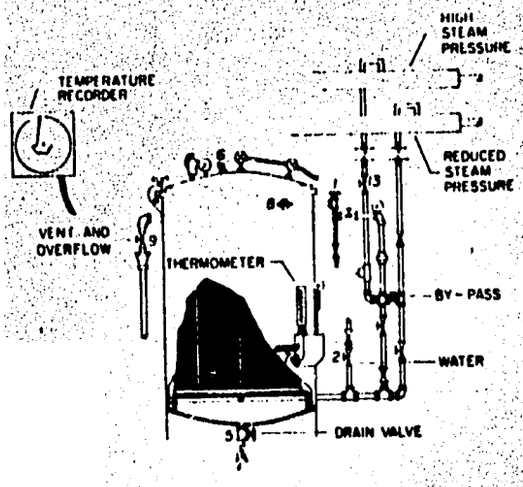

Figure 114. Cooling Large Metal Containers Under Air Pressure and Water.

3. Close steam supply line valve 13.

4. Open water inlet valve 2 gradually wide open to admit water into bottom of retort while holding elevated pressure in retort constant by adjusting compressed air valve 1.

5. Open petcock 8 after retort is about half-full of water while holding elevated pressure constant in the retort.

6. When the water level in the retort rises high enough to flow from bleeder 8 watch for a sudden build-up in pressure.

7. Close compressed air valve 1.

8. Maintain constant pressure by adjusting the flow of water into the retort with vent/overflow valve 9 until the containers cool sufficiently to reduce the internal pressure in the containers below 34.5 kpag (5 psig).

9. Continue cooling with water until the temperature of contents in the containers is reduced to 38 C (100 F) with vent/overflow valve 9 wide open or remove the containers after the internal pressure has been reduced below 34.5 kpag (5 psig) and continue to cool either with water in canal, tank or under spray or in air.

10. Close water inlet valve 2.

11. Open drain valve 5.

12. After retort pressure has been reduced to zero (0) open retort and remove the crate of processed containers of food for further cooling and drying.

Cooling Glass Jars Under Air Pressure and Water, Figure 115.

1. Close bleeder valves 6 and 7.

2. Open and adjust compressed air valve 1 so that the retort pressure may be maintained at 13.5 kpag (2 psig) above processing pressure.

3. Close steam supply line valve 13.

4. Open water spray inlet valve 3 while maintaining retort pressure 13.8 kpag (2 psig above processing pressure by adjusting compressed air valve 1.

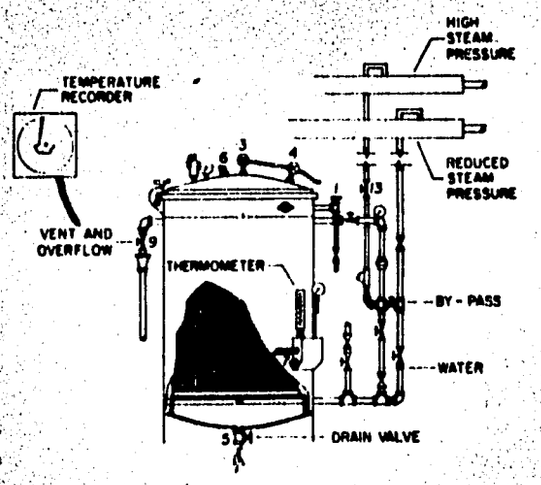

Figure 115. Cooling Glass Jars Under Air Pressure and Water.

5. After retort temperature has been reduced to 100 C (212 F), open water spray valve 4.

6. Continue to cool under pressure for at least ten minutes or longer, depending upon the temperature of cooling water, after the retort temperature is reduced to 77 C (170 F). By that time the internal pressure in the glass jars should be low enough to prevent the jar's liquid contents from being forced out when the retort pressure is reduced to zero (0).

7. Close compressed air valve 1.

8. Close water spray inlet valves 3 and 4.

9. Open vent/overflow falve 9 and drain valve 5.

10. After retort pressure has dropped to zero (0), open retort lid and remove the crate of processed jars of food.

11. Place jars of food under a very fine mist of water for fast cooling or in an open air area for further cooling to 38 C (100 F).

Cooling in Retort Under Steam Pressure and Water (This method may be applicable to both metal and glass containers when properly performed.) See Figure 116.

In cooling under steam pressure and water, steam is admitted in at the top of the retort to increase the retort pressure 13.8 kilopascals (2 psig) above the processing pressure. Steam is prevented from condensing when cold water is added by admitting the cooling water in at the bottom of the retort under a layer of hot water. The layer of hot water is formed by heating the water with steam as it enters the retort. Particular care must be exercised in this operation while cooling glass containers to avoid letting cold water into the retort faster than it can be heated by steam. Should the cold water come in contact with the hot glass jars thermoshock will result, causing the glass containers to break.

1. Close Bleeder Valves 6 and 7.
2. Open top steam inlet valve 12.
3. Gradually open steam valve 14 to raise and maintain retort pressure 13.8 kilopascals (2 psig) above processing pressure throughout the cooling phase.
4. Open by-pass valve 10 to heat the water as it enters the retort.

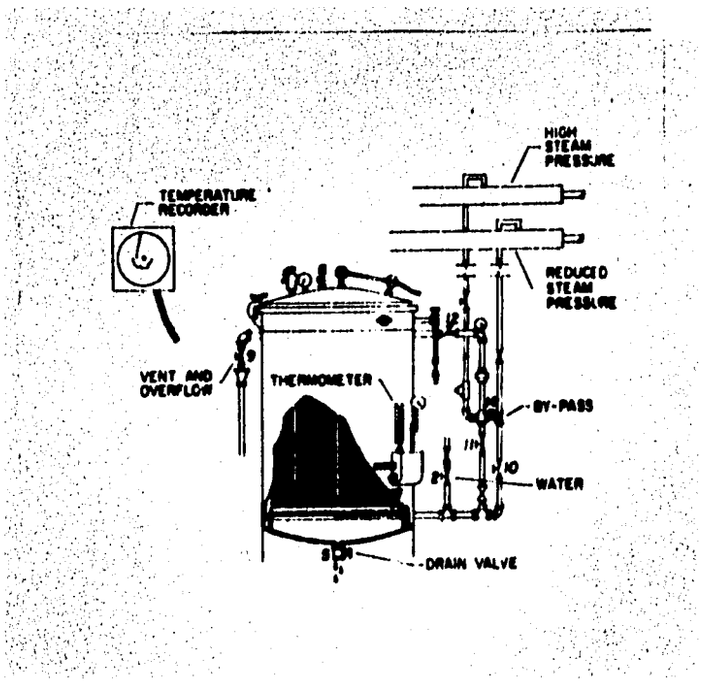

Figure 116. Cooling Large Metal Containers and Glass Jars Under Steam Pressure and Water

5. Open slowly water inlet valve 2. Caution! Do not permit water to enter retort at a rate faster than it can be heated to 100 C (212 F) when cooling glass containers. Continue to heat the water with steam until the retort is about one-fourth full of hot water - 100 C (212 F).

Cooling Metal Containers Under Steam Pressure and Water, Figure 116.

6a. Close bottom steam inlet valve 11.

7a. Increase the opening of water inlet valve 2 to allow cooling water to enter at a faster rate while maintaining retort pressure 13.8 kilopascals (2 psig) above processing pressure by adjusting top steam inlet valve 12.

Cooling Glass Jars Under Steam Pressure and Water, Figure 115.

6b. Reduce the flow of steam gradually through steam by-pass valve 10 to temper the cooling water as it enters the retort.

7b. Increase the flow of cooling water gradually by opening water inlet valve 2.

8. Gradually close top steam inlet valve 12 as the pressure inside retort builds up by the inward flow of the cooling water. Do not allow the retort pressure to exceed 13.8 kilopascals (2 psig) above the processing pressure.

9. When the retort pressure begins to exceed 13.8 kilopascals (2 psig) above the processing pressure gradually open vent/overflow valve 9 to maintain constant pressure.

10. Continue to cool under pressure until the temperature of the containers' contents is reduced to 93 C (200 F).

11. Close water inlet valve 2.

12. Open drain valve 5.

13. After retort pressure has dropped to zero (0), open retort top and remove the crates of processed containers of food.

14. Continue cooling the containers of food with a cold water spray or in air until the temperature of the contents falls to 38 C (100 F).

STORAGE

It is frequently necessary for the canning plant to store canned goods because of the heavy production schedule during the normal canning season. For this reason, properly designed warehouse facilities must be available.

The condition of storage, particularly the storage temperature, have a pronounced effect upon the quality of the canned material.

As the temperature rises, the flavor, color, nutritional value and texture of the canned products deteriorates because of the continuation of chemical reactions. The chemical reactions between chemical compounds, which make up the foods, are accelerated as the temperature rises. In addition, as the temperature rises, the vacuum within the containers decreases, and hydrogen springers and swells may be produced. Finally, the thermophylic, heat resistant, microorganisms, not destroyed during processing, may start developing when storage temperature exceeds 40.5 C (105 F). Because of these actions, the temperature of the storage must be carefully controlled. Canned foods should be stored in a cool place having a temperature ranging between 10 and 20 C (50 and 68 F) in order to prevent deterioration and spoilage.

Chimneys, steam pipes, stoves and boilers should be located in the canning plant so that they will not in any way contribute heat to the storage or warehouse areas.

The humidity in the storage or warehouse area must be kept as low as possible to prevent rusting of containers and to prevent the growth of mold. Rusting can be prevented by keeping the humidity low and preventing frequent and wide variations in temperature fluctuations. If the air temperature in a warehouse is allowed to fluctuate widely, cans that are colder than the surrounding warm, moist atmosphere will become coated with condensed water droplets creating conditions for rusting,

which could gradually corrode through the metal containers. See Figure 2 in Appendix. Should containers of food be stored under ground level, they should not be placed directly on the floor but a few centimeters (inches) above it to permit circulation of air under the containers. Freezing does not normally affect the wholesomeness of the canned products, but it does injure the texture, appearance and the flavor of some foods.

Foods that have been canned in glass should be stored where they are protected from light. Light causes some foods to lose quality, particularly loss of flavor and color.

Canned foods should be stored systematically to conserve space and to permit ready identification and location. In large warehouses, the blocks of canned goods should be easily available for inspection because the ease of access has an important bearing on the reduction of loss from spoilage because canned goods in storage should be inspected at frequent intervals. Inspections are made to detect springers, bulging of the ends of cans, rusting and broken seals. Containers with broken seals which allow the contents to spill out are likely to ruin other containers on which the contents are spilled.

Properly canned and stored canned food should remain satisfactory for relatively long periods of time. Low acid foods have a longer storage-life than acid foods. However, the canning plant should not attempt to hold the goods in storage for long periods of time - in excess of two years. Long time storage of goods also represents unproductive capital.

TESTING AND EXAMINATION OF THE FINISHED PACK

Careful monitoring by quality control should take place throughout the food preparation and processing. However, to determine whether the finished pack

meets the quality standards of management and whether or not there is a tendency for spoilage to occur or the shelf-life to become shortened due to any one or a number of factors further testing is necessary. The testing should be thorough and systematic. Samples should be drawn at random from each lot before storing. If a sample is found to be faulty, the particular lot and possibly even the retort load from which the faulty container or product was obtained should be examined. The code or marking adopted by the canning plant along with the warehousing records should make it possible to locate the questionable lot of containers in the warehouse relatively easy and quickly.

PHYSICAL AND CHEMICAL EXAMINATION

The physical and chemical examination should provide information on the following:

1. Mechanical soundness of the container.

   Special attention should be given to the ends and body of the container. Dents in metal containers and cracks and chips in glass containers should be noted. The condition of the label if present should also be noted. The container should be tested for leaks, and the seals and seams inspected carefully to see that they meet specifications set by management.

2. Vacuum within the container.

   In taking vacuum of a container its lid is punctured with a vacuum gauge which will give the vacuum in millimeters (inches) of mercury. Care should be exercised to puncture the lid close to the edge of the container rather than the center to avoid deformation of the lid by the pressure required to penetrate it. Do not make vacuum tests on severely dented cans which will be lower than readings on

normal cans. Vacuum test should be made only on those containers whose contents are 20 C (68 F) ± 2.75 C (5 F) because a warm can will have a lower vacuum and a cold can will have a higher vacuum than they would have at 20 C (68 F) room temperature. For most food, it is recommended to have vacuums between 250.4 and 500.8 millimeters (10 and 20 inches) of mercury (Hg). However, for some foods it is desirable to have 660.4 millimeters (26 inches) Hg.

3. Headspace

The gross headspace and net headspace should be determined. The gross headspace may be obtained by measuring the vertical distance with a measuring rod in the center of an opened container from the bottom side of a small square bar lying across the top of the container to the surface of the container contents. The measurements are usually made in 0.001 mm or 1/32 of an inch. Should any solid portion extend above the liquid it must be held down with a depressor while the measurement is being taken. The net headspace of a metal container with a double seam may be estimated by subtracting from the gross headspace measurement 4.75 mm (6/32 in.), which is the average width or length of a double seam. The net headspace of a container without a double seam, such as a glass jar, is the same as the gross headspace.

4. Fill of Container

A uniform fill of container is important in commercial packs. Every effort should be made to obtain a uniform fill during the filling operation, however, it is important to check each lot to determine if the

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desired fill has been obtained before shipping the pack into retail markets. A properly filled container is one that is filled to not less than 90% of its total capacity, which is considered the standard fill of container. A filled container that meets the standard of fill of container will have a headspace not greater than 10% of its capacity. The percent fill may be computed by two methods:

Cans

1/ Percent Fill = 100 - (Net Headspace) X C

where C = Percent Can Capacity per 0.031 mm. (1/32 in.) Headspace

The percent can capacity per 0.031 mm. (1/32 in.) headspace is obtained from a prepared table.

2/ Percent Fill = $\frac{\text{Inside Height of Can - Net Headspace}}{\text{Inside Height of Can}}$ X 100

The inside height of a can is obtained by subtracting 0.375 mm. (12/32 in.) from total height of the can (0.375 mm. (12/32 in.) is the average total width or height of both the top and bottom double seams.) Dents, distorted ends and panels in a can will cause the above calculated percent fill to be inaccurate because the calculations are based on a can of uniform cross section area throughout its height. Therefore, in determining the percent fill do not use distorted containers.

Glass Containers

A different method must be used in determining the fill of containers for glass jars because the inside diameter of jars are not exactly the same from bottom to top. Therefore, the measurement of the weight of water that is required to fill

the jar to the actual headspace that is left must be made. This weight of water to actual headspace is divided by the weight of the overflow capacity of the jar, which is obtained by weighing the quantity of water required to fill the jar to overflow capacity.

$$\text{Percent Fill (Jars)} = \frac{\text{Weight of Water to Actual Headspace}}{\text{Weight of Overflow Capacity}} \times 1$$

5. Drained Weight

Every canning plant should establish a minimum drained weight standard for each product and each size container that is packed. This is important in building consumer confidence, which normally leads to increased demand and sales. Drained weight is usually directly related to the raw product fill-weight. However, the maturity of the raw product and the concentration of the canning medium affects drained weight. If the raw product is soft, it will usually disintegrate during thermo processing thereby causing a lighter drained weight. If a heavy syrup is used as a canning medium, the drained weight is generally higher because of the migration of the heavy syrup into the solid portions of the canned products.

Drained weight is determined by separating the liquid portion of the container contents from the solids by emptying the container's contents onto a circular tared sieve allowing exactly two minutes for the free liquid to drain into a receiving tray of the same diameter as the sieve. The difference in the weight of the tared sieve with solid portions and the tared weight of sieve gives the drained weight of the canned product. An 8-mesh sieve with 2.46 mm. (0.097 in.) square openings is used for all products except tomatoes which use a 2-mesh sieve

having 11.33 mm. (0.0446 in.) openings with a wire 1.37 mm. (0.054 in.) in diameter. Containers with contents less than 1.42 liters (48 fluid ounces) require a 203.2 mm. (8 in.) diameter sieve while those containers having a capacity greater than 1.42 liters (48 fluid ounces) require a sieve with a diameter that is 304.8 mm. (12 in.).

All products with the exception of spinach are spread over the entire surface area of the sieve. Fruit halves with cups that would hold liquid should be turned with the cavity down. The screen is tilted so that one side is approximately 50.8 mm. (2 in.) lower than the other for all products except spinach. Spinach is drained by inverting the opened container from which the lid has been removed, on to the sieve, after which the container is raised carefully leaving the spinach in a mound. The spinach is not disturbed during the draining period of two minutes nor is the sieve tilted.

6. Cut-Out Brix

Cut-Out Brix is the quantity of soluble solids in the liquid portion of canned fruit in terms of percent by weight of sugar. It should be noted that practically all of these solids are sugars. The other solids are in such minute quantity that for all practical purposes they are considered as sugars in making the determination. The sugars in the liquid medium is a combination of the sugar in the canning medium (syrup) and the sugar dissolved out of the fruit. Therefore, the Cut-Out Brix depends upon the fill-weight of the fruit, the percent sugar in the fruit, the weight of syrup, and percent sugar of the syrup added to the container. By properly balancing these four factors the Cut-Out Brix can be fairly accurately predicted thus resulting in a uniform

Cut-Out Brix for a pack. Cut-Out Brix should not be determined until the sugars in the fruit and syrup have equalized or equilibrated, which usually requires about eight weeks following canning.

The Cut-Out Brix may be determined by a couple drops of the syrup in a refractometer having a sugar scale showing the Brix direct or with a Saccharometer (a Brix hydrometer) using from 150 to 175 milliliter of syrup in a 200 milliliter glass measuring cylinder. In determining the Cut-Out Brix by either method it is important that the syrup have a temperature of 20 C (68 F) $\pm$ 1 C (2 F).

7. Flavor.

It is most important to have a flavor evaluation of the canned products to determine if the flavor is normal and if any off or undesirable flavors have developed.

8. Color

Color is important for a number of products. Color should be evaluated for its acceptability to the trade.

9. Net Weight

Net weight can usually be obtained while determining the drained weight by subtracting the weight of the dried empty container from the weight of the full container.

10. pH Measurement.

This determination is usually made with a small amount of the canning medium, brine, syrup or broth, using a glass electrode pH meter.

11. Total Acidity

Total acidity is determined by taking three 10 gram samples from the entire contents of the container after the contents have been blended. The samples are usually titrated using 0.1 N Sodium Hydroxide solution to an end point of 8.1 with an electrode pH meter. The results are expressed as percent of anhydrous citric acid for most products except grape products as tartaric acid; catsup and some hot sauces as acetic acid: fermented products such as sauerkraut as lactic acid; and apple and apple products as malic acid.

BACTERIOLOGICAL TESTING

Bacteriological examinations of the finished product are carried out to determine the effectiveness of the heat process, the types and quantity of micro-organisms remaining in the container after processing and cooling, and the cause of spoilage if any. Such examination should be done occasionally unless spoilage occurs frequently. In general, bacteriological examination requires the use of specialized techniques and equipment, which most canning plants do not have. Therefore, this type of examination should be performed by a competent canned food laboratory. However, a canning plant should set aside containers of canned food from each lot for observation. After holding for weeks at 20 C (68 F) temperature these cans should be examined for signs of spoilage such as swells, leaks and for flat-sour spoilage.

CHAPTER EIGHTEEN

INSTRUCTIONS FOR CANNING SPECIFIC PRODUCTS

General Discussion

The instructions and data included in this manual for preparing and processing the various foods should be followed if a safe, wholesome, nutritious and attractive product is to be produced. There should be no deviations from these instructions unless recommended by a laboratory associated with the food canning industry. The processing times for acid products included in the manual are based on boiling water temperature 100 C (212 F) at sea level. Canning plants operating in altitudes higher than sea level must correct their processing times according to the instructions given with each commodity. All low acid products must be processed under pressure at temperatures in excess of 100 C (212 F). Temperatures for processing have been specified in lieu of pressure because: 1/ pressure will vary with altitudes; 2/ pressure gauges are too unreliable for measuring pressure accurately; 3/ pressure inside of a pressure vessel may be due in part to a mixture of steam and air of which the latent heat is considerable less than that of saturated steam.

If products are to be processed which are not found in these instructions, the processing data should be obtained from a reliable laboratory associated with the canning industry.

Acid Foods

Acid foods such as most fruits, tomatoes, rhubarb, sauerkraut, pickle, etc. are processed in boiling water at 100 C (212 F). The time for processing at 100 C (212 F) recommended in these instructions is sufficient to kill the actively growing organisms which cause spoilage. The acid in the food will prohibit the germination of spores and development of bacterial microorganisms.

The canning medium added to the particular product being processed should always be prepared in advance of the time it is to be used. Syrups are prepared by boiling the proper amount of sugar and water together for five minutes to dissolve the sugar and remove air from the syrup. The amount of sugar required for a particular syrup may be determined in Table V in the appendix of this manual. The syrup or other medium is reheated to the boiling point before the cans are filled. It should be noted that sugar is not necessary to preserve fruit and fruit juices from spoilage. However, the use of sugar helps to retain the color, texture, and flavor of fruit.

1. **Apple Slices**

Container: Use plain electrolytic tinplate body and inside enameled electrolytic tinplate ends metal containers or glass jars.

Quality of Product: Use single variety of apple for canning slices. Select varieties that have a firm texture when firm ripe, sugar content from 11 to 14 percent and relatively tart. The fruit should have a good flavor, firm ripe, uniform shape, at least 64 mm (2½ inch) in diameter, free from decay, and worms. Tree run apples should be separated into two to four size classifications with 64 mm (2½ inch) the minimum size and each size classification have a 6 mm (1/4 inch) diameter size differential. Under and overripe fruit should be eliminated.

Preparation: The apples should be washed thoroughly to remove all foreign material and spray residue. Apples may be peeled and cored by hand or machine depending upon the volume. After the removal of the peel and core the fruit should be trimmed with a stainless steel bladed knife to remove any defects that were not removed during the peeling and coring operation. After the removal of the peel, apples should not be allowed to come in contact with iron or copper pieces of equipment as these types of metal will cause undesirable discoloration. After being trimmed of any peel or defect the fruit is sliced into slices of uniform thickness. The slices should fall or be placed into a 2 percent brine as they are sliced to help prevent discoloration due to oxidation. The slices should not remain in the brine for more than ten minutes. If they are allowed to remain longer, they will lose considerable quantities of their water soluble sugars and acids that will adversely affect the flavor of the finished product.

Apple tissue contains considerable quantities of gases that have approximately the same composition as air - 20 percent oxygen. Unless these gases are removed the oxygen in them will react with the metal in the containers causing internal corrosion which could result in forming pin holes in the body of the containers. The oxygen will also cause brown discoloration of the slices. The oxygen can be removed by steam blanching the slices for 4 to 5 minutes or until the slices become translucent in appearance. If steam is not available the slices may be dropped in boiling 15 percent syrup for a few minutes until they become translucent in appearance; the syrup then can be used as the canning medium. The apple flavor that is leached from the slices into the syrup during the blanching is then not entirely lost. If this method of removing the gases is used, only enough syrup should be used to cover the slices. Do not hold the slices in the hot syrup any longer than is necessary to drive out the gases. If left longer they will become soft and mushy.

Filling: Pack the slices to within 6 mm (1/4 inch) of the top of metal containers and to within 13 mm (1/2 inch) of the top of glass jars. Complete the filling of metal containers and fill glass jars to within 6 mm (1/4 inch) of the top with a hot 25 percent syrup.

Exhausting and Sealing: If apple slices and canning medium are filled into the containers at temperatures exceeding 85 C (185 F) there will be no need to exhaust; however, if the temperature falls below that it will be necessary to exhaust to a center temperature 85 C (185 F). The containers must be sealed immediately after a temperature of 85 C (185 F) is reached whether filled hot or exhausted. Do not allow the temperature of the filled containers to cool below the minimum initial temperature shown in the Processing Temperatures and Times Schedule.

Processing:

Processing Temperatures and Times for Apple Slices

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing time by 10 percent
No. 303 can (303x406)	71	(160)	20
No. 2 can (307x409)	71	(160)	20
No. 2½ can (401x411)	71	(160)	20
No. 10 can (603x700)	71	(160)	35
473 mL glass jars (pint)	71	(160)	20
946 mL glass jars (quart)	71	(160)	25

Cooling: Begin cooling immediately after the processing time has elapsed. Cool containers rapidly in cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers of apples until they are completely cool and dry.

2. Applesauce

Container: Use plain electrolytic tinplate body and inside enameled electrolytic tinplate ends metal containers or glass jars.

Quality of Product: A blend of two or more varieties with a mixture of firm and soft varieties produces the flavor, color, tartness and texture that is most desired in applesauce. The fruit should be firm, free from decay and worms and have a diameter that is at least 64 mm (2½ in.). Apples smaller than 64 mm (2½ in.) will have too great a loss in peel and core waste. The use of excessive green (immature) apples will produce salve-like greenish colored sauce which will require large quantities of sugar for proper sweetness. Overripe apples will produce a bland flavored watery sauce. Only a small portion, 15 percent, of the blend should contain either or both green or overripe fruit.

Preparation: The apples should be washed thoroughly to remove dirt and spray material. The fruit should be peeled either by hand with stainless steel bladed knives or machine depending upon the volume of apples being prepared. A properly adjusted machine will save enormous amounts of labor and considerable quantity of apple flesh. All red peeling must be removed by hand if the mechanical peeler failed to do so. The anthocyanin in the red peel will frequently react with the tin in the body of the container to form an undesirable muddy purple color. The anthocyanins in the red peel will also act as a catalyst in the corrosion of tin containers eventually causing hydrogen swells, the formation of hydrogen gas, and pin holing of the tinplate in the container body. Any bruised or corky tissue, decay and calax that was not removed during the peeling and coring operations must be removed by hand trimming.

The peeled, cored and trimmed fruit is washed thoroughly before being sliced or chopped into small pieces for cooking. Care should be exercised that the fruit is not permitted to become brown due to oxidation, which may be prevented for short periods of time by dropping the fruit into a 2 percent brine.

The sliced or chopped apples are steamed in a blancher, cooked in a kettle or specially designed applesauce cooker just long enough to soften the apple tissue. Over-cooking will cause the final product to have a cooked flavor and turn dark. During the cooking process the temperature of the apples has been elevated to approximately 100 C (212 F). The hot fruit should be handled very quickly to minimize any cooling from the time it has finished cooking until it is sealed in the containers. If the product does not cool below 88 C (190 F) it will not be necessary to process it after filling and sealing. The softened fruit is put through a pulper with screens having 3.2 mm (1/8 in.) perforations. This size perforation generally produces the graininess in the finished product that is most desired.

Granulated sugar, sucrose, is added to the apples while they are being heated to 96 to 100 C (205-213 F) for softening the tissue in quantities that will give the finished product from 18 to 22 percent soluble solids as determined by a refractometer. The amount of sugar will vary with the tartness of the fruit being used. The quantity to add can be determined reasonably close by first determining the percent soluble solids for a given weight of prepared apples. The difference in the percent soluble solids of the prepared fruit and that what is desired in the canned product multiplied by the weight of prepared fruit will give the weight of sugar needed

to be added. The quantity will vary according to the method used in heating the apples and the quantity of water used in adjusting the consistency. It is recommended that the sugar be added prior to or during the cooking process. This will afford the opportunity for the sugar to become well mixed with the fruit and to be heated also. The sauce will cool down considerably if the sugar is incorporated after the finishing operation just before filling it into the containers. It is very important that the temperature be maintained from 91-93 C (195-200 F) until the cans are filled and sealed to avoid processing. Processing will cause the sauce to darken.

Filling and Exhausting: Filling the hot pulp from the pulper into clean washed containers may be accomplished by hand or by a plunger type filling machine that places the precise quantity of sauce that should go into each container. Careful attention should be given in the filling to see that the containers are filled to the proper level. Metal containers should be filled to the top and glass containers to a level that will leave 6 mm (1/4 inch) head space. Temperature of the pulp must be checked frequently to see that it does not fall below 88 C (190 F) before sealing. After the containers have been sealed, turn the filled containers upside down for a period of time of at least 5 minutes. This operation gives the hot applesauce enough time to sterilize the top of the container which has not come in contact with the hot pulp. If this operation is not carried out spoilage may occur due to yeast or molds. If the sauce is filled into the containers at a temperature higher than 88 C (190 F) there would be no need to exhaust. Applesauce may be kept hot to a temperature 88 C (190 F) in a kettle but must be continuously stirred during the time it is being kept.

3. **Apricots**

Container: Use plain tin cans or glass jars.

Quality of Product: Apricots that are to be canned should be firm yet fully ripe. Care must be taken to avoid bruising the fruit in handling or in transportation. Use only good canning varieties in commercial packs.

Preparation: Sort the produce, remove green, overripe, bruised or defective fruit and wash the fruit to be canned thoroughly. Separate apricots that are overripe and use this fruit for preparing as a sauce. Fruit of different ripeness should not be canned in the same container. The fruit may be canned either as pitted halves peeled, whole unpeeled, or whole peeled. It is not necessary to peel apricots because their skin is so tender. If peeling is desired, however, dip the apricots in boiling water for about one minute, then plunge them into cold water and peel.

Filling: Pack apricots to within 6 mm (1/4 inch) of the top of metal containers or within 13 mm (1/2 inch) of the top of glass jars. Add boiling 40% syrup to completely fill the metal containers and to within 6 mm (1/4 inch) of top of glass jars.

Exhausting and Sealing: Exhaust the filled containers to a center can temperature of 71 C (160 F) and seal immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 71 C (160 F) and seal the containers immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

After the raw product and boiling medium are added to glass jars adjust the li

Processing:

Processing Temperatures and Times for Apricots

Container Size	Minimum Initial Temperature °C (°F)	Minutes at Boiling Water Temperature 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase the processing time by 10%)
No. 303 can (303x406)	71 (160)	20
No. 2 can (307x409)	71 (160)	25
No. 2½ can (401x411)	71 (160)	30
No. 10 can (603x700)	71 (160)	45
437 mL glass jar (pint)	71 (160)	27
946 mL glass jar (quart)	71 (160)	32

Cooling: Begin cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

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4. **Blackberries, Boysenberries, Loganberries and Raspberries**

Container: Use R-enamel metal containers or glass jars. The color of the fruit tends to bleach rapidly if plain tin containers are used.

Quality of Product: Can berries as soon as possible after they are harvested. In order to reduce spoilage due to bruising, transport harvested berries in shallow boxes. The fruit should be ripe, firm, and free from mold and other signs of spoilage when received at the canning plant. Berries cannot be sorted or held long without high loss of the fruit.

Preparation: Sort and pick over berries in order to remove unripe, overripe, and defective fruit, and foreign materials such as leaves and stems.

Wash the berries gently in a small-mesh wire basket which may be dipped up and down in the cleaning water. Gentle sprays may also be used for washing. Wash berries in very cold or ice water in order to give a firmness to the relatively soft fruit. Only a few berries should be washed at a time. Do not let any berries stand in the water for more than a few minutes. Red raspberries are sometimes not washed as they are very tender and break apart readily. After washing the berries carefully, lift them out of the washing water. Remove caps and stems.

Filling: Pack the berries into the containers by hand to within 6 mm (1/4 inch) of the top of containers and to within 13 mm (1/2 inch) of the top of glass jars. Pack the berries as close as possible without crushing the fruit. The container itself may be used as a scoop in filling with berries that are firm and are not easily crushed.

Fill metal containers completely and glass jars to within 6 mm (1/4 inch) of the top with a hot canning medium. Use a canning medium of boiling water

or hot 20, 30, or 40 percent syrup.

Exhausting and Sealing: Exhaust the filled containers to a center temperature of 77 C (170 F) and seal them immediately. Where exhaust facilities are not available, heat product in kettle to 79 C (175 F), fill into containers and seal the containers immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Blackberries, Boysenberries, Loganberries and Raspberries

Container Size	Minimum Initial Temperature °C (°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing time by 10%)			
		Water Pack	20% Syrup	30% Syrup	40% Syrup
No. 303 can (303x406)	77 (170)	15	25	30	35
No. 2 can (307x409)	77 (170)	17	27	32	37
No. 2½ can (401x411)	77 (170)	20	30	35	40
No. 10 can (603x700)	77 (170)	25	35	40	45
473 mL glass jar (pint)	77 (170)	17	27	32	37
946 mL glass jar (quart)	77 (170)	22	32	37	42

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool containers rapidly to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

5. Cherries

Container: Use R-enamel containers or glass jars for sour and sweet cherries.

Quality of Product: Use cherries that are fully ripe and firm for canning. Sour cherries are generally picked without the stems and for this reason should be canned immediately to prevent loss due to contamination or mold. Discard fruit that shows bruises, blemishes, signs of rot or that is worm-eaten.

Preparation: Sort cherries and discard worm-eaten, overripe, underripe, and defective fruit. Remove foreign material from the fruit such as stems, leaves, etc. Wash the fruit thoroughly to remove dirt and spray residue. If the fruit is to be pitted for canning, chill it in cold or iced water so that it does not lose juice during the pitting operation, and so that it is easier to pit. Discard fruit that floats for it is usually defective or worm-eaten. Pitting may be accomplished either by hand or by machine. One method of hand pitting consists of inserting a u-shaped wire through the stem scar and lifting out the pit. Cherries pitted in this manner remain whole with no loss of juice.

Filling: Pack cherries to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling water or hot syrup to fill containers completely and to within 6 mm (1/4 inch) of top of glass jars. Use a canning medium of boiling water or hot 20, 30, 40 or 50 percent syrup.

Exhausting and Sealing: Cherries are highly acid and for this reason should be thoroughly exhausted. All air should be removed from the fruit and from the container by the exhaust or, in the case of glass jars, by agitating the jar or by inserting a knife and stirring the contents.

Exhaust the filled containers to a center can temperature of 77 C (170 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 77 C (170 F) and seal the containers immediately. Do not allow the contents to cool below temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Cherries

Container Size	Minimum Initial Temperature °C (°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing time by 10%)				
		Water Pack	20% Syrup	30% Syrup	40% Syrup	50% Syrup
No. 303 can (303x406)	77 (170)	12	20	24	28	32
No. 2 can (307x409)	77 (170)	14	22	26	30	34
No. 2½ can (401x411)	77 (170)	17	25	29	33	37
No. 10 can (603x700)	77 (170)	25	33	37	41	45
437 mL glass jar (pint)	77 (170)	15	23	27	31	35
946 mL glass jar (quart)	77 (170)	20	28	32	36	40

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

6. <u>Cranberries</u>

Container: Use R-enamel tin containers or glass jars.

Quality of Product: The fruit should show no bruises or signs of rot and should not be worm-eaten.

Preparation: Discard bruised, overripe, decayed or inferior fruit. Remove foreign material such as leaves and stems. Wash the fruit thoroughly.

Whole Cranberry Sauce. Add the clean prepared berries to just enough water in a steam jacketed kettle or another suitable utensil to prevent the berries from sticking or scorching during an eight to ten minute cook. The quantity of water used will be governed by the consistency desired and should be kept to a minimum quantity to avoid the necessity to evaporate off the excess. Sugar is usually added after the berries have cooked up and are beginning to show signs of breaking apart. The quantity of sugar added depends upon the level of sweetness desired. A suggested quantity would be to add the same quantity of sugar as there is berries by weight. This amount can be adjusted up or down according to taste. Whole cranberry sauce is usually cooked until it reaches a temperature of 102 C (216 F.). It has been found by cooking equal weights of berries, water and sugar gives a very satisfactory finished product if cooked to a temperature of 102 C (216 F.) or 43% solids content (40% sugar) as measured by a refractometer. Care should be exercised to avoid overcooking whole cranberry sauce to a point where it begins to set as a jell. This type of cranberry sauce should flow slowly when spooned into a dish. Excessive vigorous stirring should be avoided to prevent further crushing and disintergration of the berries.

Strained Cranberry Sauce. Cleaned prepared cranberries are run into a steam jacketed kettle or another suitable utensil containing just enough water to equal the weight of the berries. The berries are cooked from eight to ten minutes and then run through the juicer-pulper which is equipped with a screen having openings from .8 to 1 mm (.03 to .04 in.). This size opening in the screen should remove most if not all the seeds. The pulp from the juicer-pulper is placed back into a steam jacketed kettle and the same weight of sugar as that of the raw berries is added and stirred into the pulp. The mixture is cooked to a temperature of 102 C (216 F) or 43% solids as determined by a refractometer or to a desired consistency when the jel point is reached. Care should be exercised to avoid adding more water than is necessary to prevent prolonged cooking to evaporate off the excess water.

Filling: Pack the cooked and strained sauce or jelly while hot to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars.

Exhausting and Sealing: There is no necessity for exhausting when the containers are filled hot. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Cranberries

Container Size		Minimum Initial Temperature °C	(°F)	(For each 305 meters (1000 ft.) in altitude increase processing time by 10%
No. 303 can	(303x406)	93	(200)	10
No. 2 can	(307x409)	93	(200)	10
No. 2½ can	(401x411)	93	(200)	10
No. 10 can	(603x700)	93	(200)	25
473 mL glass jar (pint)		93	(200)	15
946 mL glass jar (quart)		93	(200)	20

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

7. Figs

Container: Use plain tin containers or glass jars.

Quality of Product: Figs for canning should be ripe but firm, free from blemishes and mold and other signs of spoilage. If the figs are too green, the finished product will have an unsatisfactory flavor. If they are too ripe, they will break up badly during canning and present a poor appearance. Avoid the use of bruised and crushed figs.

Preparation: Sort the figs in order to remove overripe, green, or defective fruit. Wash the fruit thoroughly. The fruit is generally left unpeeled but requires blanching in hot water. Blanch the fruit until it is pliable.

Filling: Pack the figs by hand to within 6 mm (1/4 inch) of the top of tin containers and to within 13 mm (1/2 inch) of the top of glass jars. Fill the containers with water and exhaust for 30 minutes at 93 C (200 F). Then drain the water from the containers. This operation removes the milk from the skins and makes the skins translucent. Add two teaspoons of lemon juice to No. 303 can and two and one-half teaspoons to No. 2 can, one tablespoon of lemon juice to each No. 2-1/2 container.* Fill container completely and jars to within 6 mm (1/4 inch) of the top with a boiling 40% syrup or 55% syrup.

Sealing: Seal containers immediately after the hot syrup is added. Do not permit the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing: Process in boiling water 100 C (212 F.). For each 305 meters (1,000 ft.) in altitude add 10% more processing time to the time specified for each size and type of container.

Processing:

Processing Temperatures and Times for Figs

Container Size	Minimum Initial Temperature °C (°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing time by 10%)
Figs acidified with lemon juice or citric acid to pH 4.9		
No. 303 can (303x406)	93 (200)	15
No. 2 can (307x409)	93 (200)	17
No. 2½ can (401x411)	93 (200)	25
473 mL glass jar (pint)	93 (200)	17
946 mL glass jar (quart)	93 (200)	25
Figs that have been precooked for 1 hour and filled hot		
No. 303 can (303x406)	82 (180)	12
No. 2 can (307x409)	82 (180)	12
No. 2½ can (401x411)	82 (180)	12
473 mL glass jar (pint)	82 (180)	12
946 mL glass jar (quart)	82 (180)	13

Cooling: Begin cooling operation immediately after the processing time has elapsed. Cool containers rapidly with water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store containers until they are completely cool and dry.

NOTE: Figs are frequently preferred in a heavier syrup than is usual for canning. For this reason the fruit is prepared as preserves rather than as described above. Fruit that is sound but overripe or that is damaged may also be cooked in syrup and packed as preserves. Sprinkle 237 mL (1 cup) of soda over 5.7 L (6 quarts) of firm, sound figs and add a gallon of boiling water. Let the figs stand in this soda solution for approximately 5 minutes, drain and rinse thoroughly. Add the figs to a boiling 40% syrup, and boil the fruit for approximately one hour. Pack the fruit and syrup hot into the containers, leaving 13 mm (1/2 inch) head space in jars and 6 mm (1/4 inch) head space in cans. Cover the fruit with boiling syrup and seal containers or adjust jar lids immediately. No. 2 and 2-1/2 tin containers and pint and quart jars are all processed in a boiling water bath for approximately five minutes, after which they are cooled as described.

*NOTE: U.S. Std. of Identity requires acidification with lemon juice or citric acid to pH 4.9 or less. (Needed for safety).

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8. Grapefruit

Container: Use plain tin containers or glass jars.

Quality of Product: Canning of grapefruit does not result in a very satisfactory product. If grapefruit is to be canned, however, it should be free from blemishes and signs of decay. Grapefruit may be stored approximately one week before processing if the fruit is kept in a well ventilated storage area. Decay is promoted if fruit is moved from cold storage into humid and warm areas.

Preparation: Peel grapefruit, cut into sections and pack in the containers. For small operations grapefruit is usually peeled by hand. Cut off both ends of the grapefruit to the depth of the peel but not deep enough to cut the fruit. Slit the peel parallel with the center at several points and tear off the peel removing as much of the white membrane as possible. Remove the remaining white membrane since it imparts a bitter flavor to the grapefruit. For larger operations, grapefruit are lye peeled. It is recommended that lye peeling be used only when slightly underripe grapefruit is canned. In lye peeling, place the whole fruit in boiling water for approximately 35 minutes in order to loosen the outer yellow peel from the inner layer. Remove the outer layer as in hand peeling. This leaves the fruit with a covering of the inner membrane. Remove this membrane by passing the fruit through a boiling 2-1/2 per cent lye solution. The time of submersion is around 25 to 35 seconds. Remove the fruit from the lye bath and wash in cold water. Remove the membrane. If sprays are used for washing, the membrane can be removed by impact of the water.

After peeling, divide the fruit into its natural segments.

Filling: Pack grapefruit to within 6 mm (1/4 inch) of the top of tin containers and to within 13 mm (1/2 inch) of the top of glass jars. Add boiling 55% syrup to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 71 C (160 F) and seal them immediately. Where exhaust facilities are not available, precook the fruit, add it to the containers at 71 C (160 F) and seal the containers immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Grapefruit

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Water Temperature - 82 C (180 F) (For each 305 meters (1000 ft.) in altitude increase processing time by 10%
No. 303 can	(303x406)	71	(160)	40
No. 2 can	(307x409)	71	(160)	40
No. 2½ can	(401x411)	71	(160)	40
No. 10 can	(603x700)	71	(160)	60
473 mL glass jar (pint)		71	(160)	40
946 mL glass jar (quart)		71	(160)	40

Cooling: Begin cooling operation immediately after the processing time has elapsed. Cool the containers with cold water rapidly to 38 C (100 F). Drain and wipe the excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

Storage: Canned grapefruit should not be stored at temperatures higher than 10-16 C (50-60 F), otherwise the segments will crumble and develop a bitter taste within a few months.

9. Grapes

Container: Use R-enamel containers or glass jars.

Preparation: Wash grapes thoroughly in order to remove dirt, dust, and spray residue. Remove the stems from the fruit by hand and discard defective berries.

Filling: Pack grapes to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling 25% syrup to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Exhausting and Sealing: Exhaust the filled tin containers to a center can temperature of 77 C (170 F) and seal them immediately. When exhaust facilities are not available, precook the food, add it to the containers at 77 C (170 F) and seal the cans immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Grapes

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing time by 10%)
No. 303 can	(303x406)	77	(170)	15
No. 2 can	(307x409)	77	(170)	15
No. 2½ can	(401x411)	77	(170)	15
No. 10 can	(603x700)	77	(170)	20
473 mL glass jar (pint)		77	(170)	15
946 mL glass jar (quart)		77	(170)	15

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers with cold rapidly to 38 C (100 F). Drain and wipe the excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

Container: Use plain tin containers or glass jars.

Preparation: Prepare only fully matured guavas for canning. Wash and remove the stem and blossom end. Peel the guava; scoop out the seeds, and precook the shell two to three minutes in 40% syrup.

In preparing guava sauce, wash and trim the fruit, and run the prepared fruit through a sieve to remove the seeds. Precook until thickened and add sugar to desired sweetness. Cook the sauce rapidly for ten minutes.

Filling: Pack hot guava - 93 C (200 F) - to within 6 mm (1/4 inch) of the top of the containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling syrup to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Fill containers as completely as possible with hot guava sauce - 99 C (210 F).

Exhausting and Sealing: If shells and sauce are hot when added to the containers, exhausting is not necessary. Seal tin containers immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Guava

Container Size		Minimum Initial Temperature °C (°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing time by 10%)
No. 303 can	(303x406)	88 (190)	20
No. 2 can	(307x409)	88 (190)	20
No. 2½ can	(401x411)	88 (190)	20
No. 10 can	(603x700)	88 (190)	25
473 mL glass jar (pint)		88 (190)	20
946 mL glass jar (quart)		88 (190)	20

Processing Temperatures and Times for Guava Sauce

Container Size		Minimum Initial Temperature °C (°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing time by 10%)
No. 303 can	(303x406)	93 (200)	10
No. 2 can	(307x409)	93 (200)	10
No. 2½ can	(401x411)	93 (200)	10
No. 10 can	(603x700)	93 (200)	20
473 mL glass jar (pint)		93 (200)	10
946 mL glass jar (quart)		93 (200)	10

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (212 F). Drain and wipe the excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

11. **Loquat**

Container: Use plain tin containers or glass jars.

Preparation: Remove the stem and blossom end of the loquats and peel them. Seeds may be either left in or removed. Precook the fruit for two to four minutes in a 40% syrup.

In preparing loquat sauce, remove the seeds but leave the skins on. Run the fruit through a sieve or food chopper with a medium blade. Add water and precook until tender, then add sugar for the desired level. Cook an additional five minutes.

Filling: Pack the loquats to within 6 mm (1/4 inch) of the top of tin containers and to within 13 mm (1/2 inch) of the top of glass jars. Add the boiling syrup to completely fill tin containers and to fill glass jars to within 6 mm (1/4 inch) of the top. In canning loquat sauce, fill containers as full as possible.

Exhausting and Sealing: No exhaust is necessary if the fruit or sauce is added boiling hot to the container. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Loquat

Container Size	Minimum Initial Temperature °C (°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing time by 10%)
No. 303 can (303x406)	88 (190)	15
No. 2 can (307x409)	88 (190)	15
No. 2½ can (401x411)	88 (190)	20
No. 10 can (603x700)	88 (190)	25
473 mL glass jar (pint)	88 (190)	15
946 mL glass jar (quart)	88 (190)	20

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe the excess water from the containers. Do not stack or store the container until they are completely cool and dry.

12. **Mango**

Container: Use plain tin containers or glass jars.

Preparation: Peel the fruit from stem end to blossom end, slice, and allow to stand in a hot 25% or 40% medium syrup for approximately two minutes.

Filling: Pack mangoes to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling syrup to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Use a canning medium of hot 25% syrup.

Exhausting and Sealing: Exhaust the filled tin containers to a center can temperature of 77 C (170 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 77 C (170 F) and seal the containers immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Mangoes

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing time by 10%)
No. 303 can (303x406)	77	(170)	15
No. 2 can (307x409)	77	(170)	15
No. 2½ can (401x411)	77	(170)	20
No. 10 can (603x700)	77	(170)	30
473 mL glass jar (pint)	77	(170)	15
946 mL glass jar (quart)	77	(170)	20

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

13. **Mayhaws**

Container: Use plain tin containers or glass jars.

Preparation: Mayhaws are prepared as a sauce. For canning, gather the fruit when the first color shows. The fruit should be used as soon as it is gathered. Wash, add water and precook the mayhaws until they are soft. Put the fruit through a sieve in order to remove seeds and add sugar to desired level to the pulp. Cook the mayhaw pulp, stirring constantly, until the desired consistency has been reached.

Filling: Pour the pulp into clean containers while hot. Fill the containers as completely as possible.

Exhausting and Sealing: No exhaust is necessary if the pulp is poured into the containers while boiling hot. Seal tin containers immediately after the hot product is added. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Mayhaw Sauce

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing time by 10%)
No. 303 can	(303x406)	82	(180)	10
No. 2 can	(307x409)	82	(180)	10
No. 2½ can	(401x411)	82	(180)	10
No. 10 can	(603x700)	82	(180)	20
473 mL glass jar (pint)		82	(180)	10
946 mL glass jar (quart)		82	(180)	10

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

14. Orange

Container: Use plain tin containers or glass jars.

Quality of Product: Canning of orange segments produces a relatively poor product, but they may be satisfactorily made into a marmalade or conserve. If they must be canned, they should be in the optimum stage of ripeness. The fruit should neither be underripe nor overripe for such fruit imparts a disagreeable flavor to the finished product.

Preparation: Oranges are prepared for canning in a manner similar to that used for preparing grapefruit. Cut the skin into segments parallel to the stem. The skin is then easily removed without breaking the fruit. Break the fruit into segments and remove the remaining portions of the inner white layer. Wash the unbroken segments and heat them in a 55% syrup for several minutes at 79-86 C (175-185 F).

Filling: Pack oranges to within 6 mm (1/4 inch) of the top of metal containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling 55% syrup to completely fill metal containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Exhausting and Sealing: The containers do not need to be exhausted if the product is added to the containers at 86 C (185 F). Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Oranges

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Water Temperature - 85 C (185 F) (For each 305 meters (1000 ft) in altitude increase processing time by 10%)
No. 303 can	(303x406)	82	(180)	10
No. 2 can	(307x409)	82	(180)	10
No. 2½ can	(401x411)	82	(180)	10
No. 10 can	(603x700)	82	(180)	10
473 mL glass jar (pint)		82	(180)	10
946 mL glass jar (quart)		82	(180)	10

Cooling: Begin cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

15. Papaya

Container: Use F (Fruit) enameled cans or glass jars.

Quality of Product: Use only firm fully ripe papayas.

Preparation: Wash the fruit thoroughly. Remove the peel and seeds from the fruit. Dice the fruit into 19 mm (3/4 in.) or 25.4 mm (1 in.) cubes.

Filling: Fill the papaya cubes in the containers to the maximum fill weight specified in the Processing Temperature and Time Schedule under Processing. Add 99 C (210 F) 40% syrup containing 0.75 percent citric acid. The addition of citric acid is necessary to lower the pH of the canned product sufficiently for it to be commercially sterile at the temperature and time recommended in the processing schedule. The syrup should be filled within 6 mm (1/4 in.) of the top of metal containers and within 13 mm (1/2 in.) of t top of glass containers.

Exhaust and Sealing: Exhaust the containers to a center temperature of 71 C (160 F) and seal immediately. Do not allow the contents to cool below the minimum initial temperature shown in the Processing Temperature and Times Schedule.

Processing:

Processing Temperatures and Times for Papayas

Container Size		Maximum Fill Weight grams (oz.)	Minimum Initial Temperature °C (°F)	Minutes at Boiling Water Temperature 100 C (212 F) (For each 305 meters (1000 ft) in altitude increase the processing time by 10
No. 303	(303x406)	312 (11)	71 (160)	12
No. 2	(307x409)	383 (13.5)	71 (160)	14
No. 2½	(401x411)	567 (20)	71 (160)	16
No. 10	(603x700)	2070 (73)	71 (160)	26
473 mL glass jar (pint)		340 (12)	71 (160)	15
946 mL glass jar (quart)		680 (24)	71 (160)	20

Cooling: Begin cooling operations immediately after the processing time has elapsed. Cool all containers rapidly with water to 38 C (100 F). Drain and wipe the excess water from the containers. Do not stack or store the containers until they are thoroughly cool and dry.

16. Peaches

Containers: Use plain tin cans or glass jars. Plain tin cans will help to give the canned product a bright yellow color due to the bleaching action of the tin in the can. However, a fruit, "R", enamel would be satisfactory if a little darker product is not objectionable.

Quality of Product: Varieties that have heavy pigmentation, anthocyanins, around the pit cavity area and those in which the pigments are found in the flesh should be avoided. While the coloration around the pit cavity and through the flesh may be attractive while the peach is in a fresh state, frequently the attractive red color turns a dull brown or even purple during processing. Peaches should be firm ripe, showing a yellow ground color in all surface areas. The fruit should not be green or soft ripe. Do not use bruised, decayed or wormy fruit.

Preparation: Size and sort fruit into different size and ripeness classifications. Can only firm ripe fruit of one uniform size. If there are more than one size of firm ripe peaches can each size separately so the finished canned product will be uniform in appearance.

Peeling may be accomplished by hand with paring knives (stainless steel bladed, only), by scalding or by lye. If peaches are peeled by scalding place fully firm ripe peaches in a blanching basket and dip into boiling water for about one minute or until the skin slips easily. Care should be taken not to put the peaches in water cooler than boiling temperature, 100 C (212 F), since this tends to cook the fruit rather than loosen the skins. Remove the fruit from the boiling water and dip it into cold water to crack

the skins and to stop cooking action. The peaches should not stand in the cold water. After scalding the skins are removed with the aid of a knife.

Peel large quantities of peaches by the lye bath method. Peel peaches by immersing in a hot, 100 C (212 F), lye solution having a concentration of 2 percent until the skins are loose. Immersion times range from 30 to 60 seconds. If the solution is too strong, too much of the flesh is removed, while if it is too weak, the operation requires too much time. Care should be taken not to allow the fruit to remain in the hot solution for periods longer than those designated, as the peaches will absorb the solution causing an impairment of flavor in the finished product. The lye solution does not remove the peel; it only softens it to be washed off with a spray. The peaches should be placed immediately in a rather large volume of cold water after being removed from the lye solution. Spraying to remove the disintegrated peel should start immediately. Properly peeled fruit should be very smooth and difficult to handle. For this reason it is suggested to split the peach into halves and remove the pit before peeling. Pitting spoons are useful in this operation.

After the peaches are peeled remove all blemishes that were not removed during the peeling operation. During the trimming operation varieties that are subjected to browning should be placed in a 0.1 percent ascorbic acid solution until placed in cans with syrup. Peaches may be sliced or left to be canned as halves.

Filling: Pack the peaches to within 6 mm (1/4 in.) of the top of the metal container or within 13 mm (1/2 in.) of the top of glass jars. Add hot 40 to 45 percent syrup to completely fill the metal container or fill glass jars to within 6 mm (1/4 in.) of the top.

Exhausting and Sealing: Exhaust the filled metal containers to a center temperature of 71 C (160 F) and seal immediately. Do not allow the contents to cool below the minimum initial temperature shown in the Processing Temperature and Time Schedule.

Processing:

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase the processing time by 10 percent)
No. 303 can (303x406)	71	(160)	17
No. 2 can (307x409)	71	(160)	17
No. 2½ can (401x411)	71	(160)	25
No. 10 can (603x700)	71	(160)	35
473 mL glass jar (pint)	71	(160)	30
946 mL glass jar (quart)	71	(160)	35

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool all containers rapidly to 38 C (100 F) with cold water. Do not stack or store the containers until they are completely cool and dry.

17. **Pears**

Container: Use plain tin containers or glass jars.

Quality of Product: Pears develop a better flavor and finer texture if they are taken from the tree when somewhat underripe and held in containers for 5 to 10 days for ripening.

Preparation: Sort the fruit and remove bruised, rotted, worm-eaten, and inferior fruit. Because of the irregular shape of pears and the ease with which they may become bruised and discolored, their preparation requires a great deal of hand work. Peel the fruit by hand. Expert labor is required if the fruit is to be peeled well and uniformly. After peeling, cut the pear in half, remove the core with a loop pear corer or coring hook, and cut out the remainder of the core with a paring knife. Trim away blemishes as the fruit is pared. Dip the fruit in a 1½% brine solution to prevent discoloration.

Small quantities of pears may also be satisfactorily peeled by scalding them in boiling water for two to three minutes. This water should not be below the boiling point as it will tend to cook the fruit rather than loosen the skin. After scalding, dip the fruit in cold water to stop the cooking action and loosen and crack the skin. After peeling and slicing, dip the fruit into a 1½% brine solution to prevent discoloration.

If large quantities of pears are to be canned, they may be peeled whole with lye, similar to peaches (p. 404), with the exception that pears require two or three times longer for peeling. Subsequent coring and handling should be done by hand.

Blanch the pears for one minute in 10% boiling syrup.

Filling: Pack pears to within 6 mm (1/4 inch) of the top of metal containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling syrup to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Use a canning medium of a 25% or 40% syrup.

Exhausting and Sealing: Exhaust the filled metal containers to a center container temperature of 71 C (160 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 71 C (160 F) and seal the containers immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Pears

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing time by 10%)
No. 303 can	(303x406)	71	(160)	20
No. 2 can	(307x409)	71	(160)	20
No. 2½ can	(401x411)	71	(160)	30
No. 10 can	(603x700)	71	(160)	45
473 mL glass jar (pint)		71	(160)	30
946 mL glass jar (quart)		71	(160)	35

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

18. **Pineapple**

Container: Use plain tin containers or glass jars.

Quality of Product: The pineapple should be fully mature since green fruit lacks the desired flavor. Overripe fruit ferments rapidly and should not be used for canning.

Preparation: Wash the fruit thoroughly. Cut off the butt end of the pineapple with a sharp knife and twist off the top. The fruit may be prepared by either peeling and cutting to about half the depth of the eye, then slicing to remove the rest of the eye and core, or by placing the pineapple on its side and slicing crosswise and paring each slice. If the latter method is employed, cut out the core with an instrument similar to a biscuit cutter. For large-scale operations, peeling and coring of the pineapple is performed by machine. These machines are entirely automatic and perform the operations of cutting, sizing, coring, and removing the outer shell. Pineapples can be canned as slices or as chunks or fingersize pieces or it may be brushed and grated.

Filling: Pack pineapple to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling 25-40% syrup depending upon the desired level of sweetness to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 71 C (160 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers

at 71 C (160 F) and seal the containers immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Pineapples

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing times by 10%)
No. 303 can	(303x406)	71	(160)	20
No. 2 can	(307x409)	71	(160)	20
No. 2½ can	(401x411)	71	(160)	30
No. 10 can	(603x700)	71	(160)	45
473 mL glass jar (pint)		71	(160)	30
946 mL glass jar (quart)		71	(160)	35

Cooling: Begin cooling immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe the excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

19. **Plums**

Container: Use R-enamel containers or glass jars.

Quality of Product: Plums for canning should be ripe, yet firm. Underripe plums lack flavor and are sour, while overripe plums disintegrate in the process.

Preparation: Sort the plums andrremove any soft and defective fruit. Wash the fruit thoroughly to remove dust and spray residue. If plums are canned with the skins, remove the stems, wash, and grade for size. Prick the skins with a needle to prevent bursting during the processing. Blanch the fruit for about 15 seconds in boiling medium syrup in order to insure a firm pack.

If the fruit is to be packed without skins, remove the skin from the plum by plunging it into boiling water for one minute and then into cold water. If the skins are removed immediately, the plums will be green or yellowish, but if allowed to stand they become reddish from contact with the skin. If they stand too long they become brown.

Filling: Pack plums to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling medium syrup to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 82 C (180 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers

at 82 C (180 F) and seal the containers immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Plums

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing times by 10%)
No. 303 can	(303x406)	82	(180)	15
No. 2 can	(307x409)	82	(180)	15
No. 2½ can	(401x411)	82	(180)	20
No. 10 can	(603x700)	82	(180)	35
473 mL glass jar (pint)		82	(180)	20
946 mL glass jar (quart)		82	(180)	25

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

20. Quince

Container: Use R-enamel tin containers or glass jars.

Quality of Product: Quinces, like oranges, produce poor canned product because of their woody texture and bitter flavor, but are excellent if prepared as preserves. If they must be canned, however, use ripe quinces free from blemishes.

Preparation: Wash the fruit thoroughly, peel and cut in segments similar to pears. Precook the fruit in boiling heavy syrup until almost tender.

Filling: Pack quince hot to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling heavy syrup to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Exhausting and Sealing: No exhaust is necessary if the product is packed hot. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Quince

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing times by 10%
No. 303 can	(303x406)	88	(190)	18
No. 2 can	(307x409)	88	(190)	18
No. 2½ can	(401x411)	88	(190)	20
473 mL glass jar (pint)		88	(190)	20
946 mL glass jar (quart)		88	(190)	25

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or sto the containers until they are completely cool and dry.

21. **Rhubarb**

Container: Use R-enamel tin containers or glass jars. Because of the high acidity of rhubarb, glass jars are recommended in preference to the tin containers.

Preparation: Wash and cut the rhubarb into even lengths without removing the skins. Add sugar to the rhubarb and cook in boiling water.

Filling: Fill the containers with hot rhubarb. Fill tin containers within 6 mm (1/4 inch) of the top and glass jars to within 13 mm (1/2 inch) of the top. Fill tin containers completely with the cooking juice and glass jars to within 6 mm (1/4 inch) of the top.

Exhausting and Sealing: No exhaust is necessary if the product is packed hot. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Rhubarb

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing times by 10%)
No. 303 can	(303x406)	88	(190)	14
No. 2 can	(307x409)	88	(190)	14
No. 2½ can	(401x411)	88	(190)	14
No. 10 can	(603x700)	88	(190)	20
473 mL glass jar (pint)		88	(190)	14
946 mL glass jar (quart)		88	(190)	14

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

22. **Roselle**

Container: Use plain tin containers or glass jars.

Quality of Product: Use full grown calyces for canning.

Preparation: Prepare roselle as a sauce. Remove the stem and the seed and, using equal amounts of calyces and water, cook slowly until tender. Run the pulp through a sieve. Add sugar and bring to a boil. Cook to the desired consistency.

Filling: Pack the hot pulp into containers as close to the top of tin containers as possible and within 6 mm (1/4 inch) of the top of glass jars.

Exhausting and Se ing: Metal containers filled with hot roselle pulp need not be exhausted if the container is sealed immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Roselle

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing times by 10%)
No. 303 can	(303x406)	77	(170)	8
No. 2 can	(307x409)	77	(170)	8
No. 2½ can	(401x411)	77	(170)	12
No. 10 can	(603x700)	77	(170)	20
473 mL glass jar (pint)		77	(170)	8
946 mL glass jar (quart)		77	(170)	12

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Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

23. Sauerkraut

Container: Use R-enamel containers or glass jars.

Quality of Product: Sauerkraut is cabbage which has been subjected to a fermentation process to convert the natural sugar, lactose, in the cabbage to lactic acid. Late summer or fall cabbage is usually best for kraut. The cabbage head should be solid, free from decay and discoloration or damage from freezing.

Preparation: Wash the cabbages to free them from dirt and dust. Trim the heads to remove the defective leaves and bruised spots, and remove the outer green leaves. Core and shred the cabbage. Shredding is accomplished by cutting the cabbage in slices. Slaw cutters or hand-operated shredding machines may be used. The shreds should be cut approximately 1 mm (1/32 inch) thick and as long as possible.

Use tanks, barrels or small stone jars for curing sauerkraut. The containers should be water tight to insure against loss from leakage. Place the cut cabbage in the container and salt at the rate of about 1-1/2 kilos (2 to 2-1/2 pounds) of salt per hundred pounds of cabbage. Sauerkraut will soften if less than 2 percent salt is used and will become pink if greater than 2-1/2 percent salt is used. Spread the salt over thin layers of cabbage in alternate layers. Mix the layers to give an even distribution of the salt throughout the cabbage. Press the cabbage firmly into the containers using a weight if necessary to pack it closely. Brine is formed as the salt draws juice from the cabbage.

After the container is filled, cover it with a clean cloth and a clean wooden cover. Weight down the cover to sink the sauerkraut about 25.4 mm (one inch) beneath the surface of the brine which forms. Allow the cabbage to ferment for about three to four weeks at a temperature of approximately 18 C (65 F). Remove any scum which forms during the fermentation process once or twice each week. The fermentation process is complete when the cabbage develops a translucent appearance and when bubbles no longer rise at the sides of the container. When the fermentation process is complete, remove the cabbage for canning. Discard any discolored or dark sauerkraut.

Heat the well-fermented crisp sauerkraut to approximately 71 C (160 F) before packing into the containers. Do not boil, as this causes the kraut to darken.

Filling: Pack sauerkraut to within 6 mm (1/4 inch) of the top of metal containers and to within 13 mm (1/2 inch) of the top of glass jars. Add boiling brine to completely fill metal containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Exhausting and Sealing: Exhaust the filled metal containers to a center container temperature of 71 C (160 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 71 C (160 F) and seal the containers immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Sauerkraut

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing times by 10%)
No. 303 can (303x406)	71	(160)	20
No. 2 can (307x409)	71	(160)	20
No. 2½ can (401x411)	71	(160)	25
No. 10 can (603x700)	71	(160)	40
473 mL glass jar (pint)	71	(160)	20
946 mL glass jar (quart)	71	(160)	25

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

24. Strawberries

Container: Use R-enamel containers or glass jars.

Quality of Product: Strawberries, like quinces or orange, make excellent preserves, but are unsuited for canning. Canned strawberries are very soft, pale in color, and lack flavor. If they must be canned, however, use strawberries which have firm texture, good color and flavor, and are large. The flesh should be pink to red with no white centers.

Preparation: Pick over and remove faulty or green strawberries. Hull by removing the caps, wash, and drain.

Filling: Pack strawberries to within 6 mm (1/4 inch) of the top of metal containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling 55% syrup to completely fill metal containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Exhausting and Sealing: Exhaust the filled metal containers to a center container temperature of 77 C (170 F) and seal them immediately. Where exhaust facilities are not available, precook the food in a 55% syrup, add it to the containers at 77 C (170 F) and seal the containers immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing Temperatures and Times for Strawberries

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperatures - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing times by 10%)
No. 303 can	(303x406)	77	(170)	8
No. 2 can	(307x409)	77	(170)	8
No. 2½ can	(401x411)	77	(170)	8
No. 10 can	(603x700)	77	(170)	10
473 mL glass jar (pint)		77	(170)	10
946 mL glass jar (quart)		77	(170)	10

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with water to 38 C (100 F). Drain and wipe the excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

25. <u>Tomatoes</u>

Container: Use plain tin or R-enamel containers or glass jars.

Quality of Product: Tomatoes for canning should be red and fully ripened but firm. The tomatoes should be free of green areas around the stem end but not soft overripe. Vine ripened tomatoes give the best flavor and color. Smooth and regularly shaped fruit is preferred since it is more easily prepared than irregularly shaped fruit.

Preparation: Sort tomatoes to remove green, rotton, or undesirable fruit before washing. After sorting, wash the tomatoes thoroughly to remove dirt, mold, or rot that has adhered to the skin due to contact with faulty products. Sprays are usually preferable for washing tomatoes since they are less likely to break or bruise the product.

Peel tomatoes by scalding them for 30 to 45 seconds in boiling water or under steam for about 30 seconds. This scalding loosens the skin on ripened tomatoes and facilitates peeling. The temperature of water should not be below 100 C (212 F) as cooler water tends to cook the tomatoes without loosening the skins. Immediately after scalding the tomatoes, dip them in cold water or under cold sprays in order to cool them for convenient handling and to crack the skins.

First remove the entire core and core particles taking care not to cut too deep as to penetrate into the seed cell. The core must be removed since it is hard and tends to retard heat penetration and thus may cause spoilage. Remove the skins by slipping off or by twisting the tomatoes in the hand, or by using special spoon-shaped knives. Strip off the entire skin and remove the black tip at the blossom end of the fruit. Cut the tomato into conveniently sized pieces if desired.

Filling: Pack tomatoes to within 6 mm (1/4 inch) of the top of metal containers or to within 13 mm (1/2 inch) of the top of glass jars. If packing cut, fully ripe tomatoes, enough juice will be released during packing to cover the pieces. Excess juice in the preparation container should be poured over the product to completely fill tin containers and fill glass jars to within 6 mm (1/4 inch) of the top. If packing whole tomatoes, pour tomato juice over the whole tomatoes within 6 mm (1/4 inch) of top of can and 13 mm (1/2 inch) of glass jar. Add 2.5 mL (1/2 teaspoon) salt to No. 303, No. 2 cans and 473 mL (pt.) glass jars. Add 5 mL (1 teaspoon) salt to No. 2½ cans and 946 mL (qt.) glass jars.

Exhausting and Sealing: Exhaust the filled tin containers for raw pack to a center container temperature of 60 C (140 F) and seal them immediately. Where exhaust facilities are not available, precook the raw food, add it to the containers at 60 C (140 F) and seal the cans immediately. Do not allow the contents to cool below initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

Processing Temperatures and Times for Tomatoes

Container Size	Minimum Initial Temperature °C (°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing times by 10%)	
		Cooled with Water	Cooled in Air
No. 303 can (303x406)	60 (140)	40	35
No. 2 can (307x409)	60 (140)	45	35
No. 2½ can (401x411)	60 (140)	55	45
No. 10 can (603x700)	60 (140)	95	80
473 mL glass jar (pint)	60 (140)	45	35
946 mL glass jar (quart)	60 (140)	55	45

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

APPLE BUTTER

Containers

Glass containers are recommended. If metal containers are used, they should be made from 100-25 electrolytic, fully enameled inside, with inside seam strip of enamel.

Quality of Product:

Select firm ripe fruit of several varieties, free from decay and worms. A blend of several varieties produces a butter of better flavor and quality than a single variety. At least one of the varieties in the blend should be tart.

Preparation:

Wash the apples thoroughly to remove all dirt, spray residue and any other foreign material that may be present. Remove all decay, bruises and other blemishes that will affect the quality of the finished product. Apples may or may not be peeled and cored. If the apples are not peeled, they should be cut into quarters or sections and remove the blossom and stem ends. If the fruit is peeled and cored, it should be chopped into small pieces to increase the cooking speed.

The unpeeled and cored apples will need to be precooked with just enough water to prevent scorching. After the fruit has become soft it must be put through a pulper to remove the peel and core tissue and seeds. The pulp is then returned to the kettle to finish cooking.

In removing peels, cores, stem and blossom ends and defects a yield of approximately 75 to 80 per cent can be expected of good quality apples. If

apples are quartered and only the defects, stem and blossom ends are removed prior to precooking a yield of approximately 80 to 85 per cent can be expected after running them through a pulper to remove the peels and cores.

Cooking:

The cooking of apple butter usually takes place in a stainless steel steam jacketed kettle. During the cooking process several things are accomplished such as: 1/ removal of moisture from the apple tissue and other juices that may be added for seasoning and coloring thus concentrating the ingredients to a higher soluble solids (sugar) content; 2/ carmelizations of sugars for desired flavor and color; and 3/ the desired texture and consistency are obtained.

The ingredients used in making apple butter contributes to the flavor and color of the finished product. Various combinations of spices are used with cinnamon being the primary basic spice flavor and cloves giving the secondary flavor. All-spice and nutmeg will also be found in some recipes depending upon individual preferences. Boiled cider and highly colored concentrated fruit juices such as, raspberry, elderberry and grape are added for their additional acidity and color. Single strength or unpasteurized apple cider is used instead of boiled cider, that has been concentrated to twenty-five per cent of its original volume, if peeled and cored apples are used. It is better to use boiled cider with the mash from precooked unpeeled and uncored apples because less cooking time would be required to remove the moisture. The water in the mash of unpeeled and uncored fruit should be sufficient to prevent sticking and scorching in the initial cooking stage whereas the moisture in single strength apple cider prevents sticking and scorching when peeled and cored apples are used. Just at the end of the cook the addition of a small amount of vinegar in addition to the citric acid is recommended for lowering the pH, improving the

flavor and aroma. Lowering the pH will give the apple butter a longer shelf life after a container is opened for use.

A typical recipe or formula is suggested for apple butter which may be subject to a wide variation:

Apples:		
Chopped peeled and cored apples	21.75 kilos	(48 pounds)
or		
Precooked apple mash	23.6 kilos	(52 pounds)
Apple cider or juice for:		
Chopped peeled and cored apples use single strength	1.9 liters	(2 quarts)
or		
Precooked apple mash use boiled cider concentrated to ¼ of its original volume	500 milliliters	(1 pint)
White sugar (cane or beet)	2.7 kilos	(6 pounds)
Brown sugar (cane or beet)	2.7 kilos	(6 pounds)
Cinnamon, ground	68.0 grams	(2.4 ounces)
Cloves	6.8 grams	(0.24 ounces)
Citric acid, USP or equivalent	27.2 grams	(1.0 ounce)
Vinegar, apple cider	30 milliliters	(2 tablespoonsful

The above recipe or formula will yield approximately 16.7 kilos (36.75 pounds) or 14 liters (3 gallons and 3 quarts).

In cooking apple butter made from chopped peeled and cored apples, the single strength apple juice should be added to the kettle first followed by one-half of the apples if the kettle will not hold all the fruit. Add the remainder of the fruit as the apples cook down from the loss of moisture. If precooked apples are used, add as much of the mash as the kettle will hold

conveniently allowing enough space for proper stirring. Add the remainder of the mash as the fruit cooks down and space becomes available. The boiled cider may be added as space permits.

It is necessary to stir constantly while cooking continues to remove the moisture until the soluble solids reach 43% as determined by a refractometer. A hydrometer or a Brix spindle will not be accurate for a product of apple butter consistency. About half way through the cooking period to reach this point, the sugar is added to give it sufficient time for carmelization thus contributing favorable color and flavor to the apple butter.

After the cooking operation, as set forth, has reached this point, the spices, fruit juices and vinegar are added and the cooking and stirring continues until they are thoroughly mixed into the apple butter, which should not require more than 10 to 15 minutes. If cooked for a longer period, considerable quantities of the volative flavors from the spices and juices will evaporate off into the atmosphere and will become lost.

Filling:

Filling of the containers should begin immediately after the cooking operation has ended. The containers should be filled with the hot apple butter with a temperature of at least 85 C (185 F) to within 3 mm (1/8 inch) of the top and sealed immediately. Upon sealing the containers they should be turned upside down or onto their tops to permit the hot apple butter to sterilize the lids. Should the filling temperature fall below 85 C (185 F) a short process of 15 minutes in boiling water, 100 C (212 F) is recommended to avoid unnecessary spoilage.

Cooling:

Cool the containers immediately with cold water to 38 C (100 F). The containers should be wiped clean and dried before placing them in cases and storage.

D. Juices

The canning or preservation of fresh juices is frequently desirable. When properly canned, the juices provide a tasty and high-vitamin addition to the diet. However, the juices of many fruits and vegetables are not satisfactory for canning. The canned juice must retain its fresh flavor and color throughout its shelf life. With some juices freezing is the only commercial method of preservation capable of keeping the quality of the juice comparable with the fresh food.

The juices normally prepared and canned are of sufficient acidity that they may be processed at or below the temperature of boiling water. In order to prevent producing a product that has a cooked or burned flavor, the temperature of processing is usually less than that of boiling water. Flash pasteurization is highly recommended for sterilizing juices such as apple and citrus juices. This method of processing renders the juice safe for consumption in a minimum of time. The equipment needed for flash pasteurization is comparatively complex and expensive. Consequently it will not be discussed in this manual. However, research laboratories associated with the canning industries should be consulted regarding flash pasteurization and other information if relatively large scale juice preservation is to be undertaken.

In preparing juices for canning, the same general procedures hold that apply to the canning of fruits and vegetables. The same precautions regarding cleanliness and care in performing the various operations should be observed. In particular, the preparation steps must be carried out as

rapidly as possible. Juices are particularly susceptible to oxidation with resultant discoloration and change in flavor and taste. Citrus juices, for example, lose flavor and color very rapidly due to oxidation, and at the same time they lose their nutritive value.

Certain metal utensils and containers should not be used in preparing products for making juices. Copper, iron, or steel implements, utensils, etc., are likely to cause darkening of some juices whereas some metals impart an unfavorable flavor to the juice. For example, zinc or galvanized containers render certain juices poisonous. Glass, agate ware, tin coated, aluminum, or stainless steel utensils and containers are recommended for use in the preparation of the various fruit or highly acid juices.

The flavor of all juices is retained for a longer period of time if the juices are deaerated immediately after preparing and before filling the containers. However, the use of deaerating equipment will not be discussed in this manual. It will be considered that deaeration need not be performed if the juice is flash pasteurized. If the prospective canning plant operator intends to can relatively large amounts of juices that require deaerating, he should consult with laboratories associated with the canning industry for use as such equipment.

1. **Apple Juice**

Container: Metal containers made from double-coated enameled electrolytic tinplate and inside side seam of enamel and glass containers are recommended for their resistance to the corrosive action of apple juice.

Quality of Product: Only sound firm ripe apples should be used to obtain the best quality juice. Immature and overripe apples lack sufficient flavor to produce a good quality juice. Usually, small apples not suitable for fresh market are used for making juice, however, large apples will give a better yield. Generally, the best quality juice is made from a blend of several varieties instead of a single variety. Apples that have dropped and lain on the ground for several days often develop musty off-flavors that are imparted in the juice. Drops should be avoided.

Preparation: The apples must be thoroughly washed to remove spray residue and all other foreign material. Apples soaked in tanks with constant running water and washed under heavy sprays of water will generally free them from dirt and spray residue. All fruit showing signs of decay and worms must be removed before grinding or crushing. The fruit should be ground or crushed with equipment having stainless steel contact parts. This equipment must be kept clean by daily cleaning practices. The crushed apple pulp is pressed with either a manually operated screw type press or by a rack and cloth hydraulic press to extract the juice. The juice is strained through a stainless steel wire mesh or a cloth mesh as it flows from the press to remove the large particles of apple pulp. The strained juice is then placed in large suitable plastic or stainless steel tanks for producing either a cloudy or clarified

juice. A cloudy juice is produced by letting the juice stand for several hours to permit settling of suspended solids. The juice is then siphoned from the sediment and given a heat treatment followed by cooling. This preliminary heat treatment permits removal of substances that may coagulate by subsequent heat treatment during sterilization of the juice. If the volume of juice is large it would pay to run it through a centrifuge. Perhaps the most satisfactory method of clarifying juice is the use of the enzyme, pectinase. This enzyme breaks down the pectin in the juice, precipitating part of it and rendering part of it soluble. Instructions from the supplier of the enzyme should be followed closely to give the best results. Following the enzyme treatment the juice is allowed to set for several hours and is then either siphoned from the sediment or is passed through a filter.

Filling and Sealing: Heat the juice to 88 C (190 F) and completely fill the containers with the juice being careful not to allow the temperature to fall below 88 C (190 F) before sealing. If coding dies are used in the closing machine be sure coding dies are adjusted in such a manner that will not give too sharp an impression. Fracturing the enamel on the inside of the tops can cause early perforations.

Processing: No processing is necessary when the apple juice is filled and sealed into the container at a temperature of 88 C (190 F). Invert or lay the containers on their sides for at least 5 minutes to provide enough time for the hot juice to sterilize the tops before cooling.

Cooling: Begin the cooling operation immediately after the holding period has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

2. **Berry Juices**

Containers: Use R-enameled body and ends metal containers or glass containers.

Quality of Product: Any good-flavored variety of berry such as blackberry, raspberry, loganberry, strawberry, may be used in preparing juices provided they are not underripe and are free of mold, rot and fermented fruit.

Preparation: Wash the berries thoroughly and remove all underripe, overripe, bruised, moldy and decayed fruit. Heat the berries in a kettle to 71 C (160 F). Press and strain juice from the hot berries to remove the pulp. Add sugar if desired. Reheat the juice to 93 C (200 F).

Filling: Fill containers completely with hot 91 C (195 F) juice.

Sealing: Seal the containers immediately. Do not allow the juice to cool before sealing. Invert or turn the filled, sealed containers over on their sides and hold 5 minutes for the hot juice to sterilize the tops.

Processing: Processing will not be necessary if the containers are sealed while the juice has a temperature of at least 88 C (190 F). Should the temperature fall below 88 C (190 F) it will be necessary to give the containers of juice a short process in boiling water: 10 minutes for No. 2 cans and smaller; 15 minutes for No. 2½ cans and glass jars; and 20 minutes for No. 10 cans.

Cooling: Begin the cooling operation immediately after the holding period or processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Do not stack or store the containers until they are completely cool and dry.

3. Grape Juice

Container: Use R-enameled body and ends metal containers or glass containers.

Quality of Product: Any good-flavored juicy grape or muscadine that is free from rot may be used in preparing juice.

Preparation: Wash and stem the grapes. Crush them and heat to between 60 C (140 F) and 63 C (145 F) and press while hot to extract the juice. Strain the juice and add sugar if desired. Pasteurize the grape juice in one-or-two gallon containers at 74 C (165 F) for 40 minutes. Seal the containers and allow them to stand for three to six months to allow the undesirable cream of tartar to separate. After this time, the juice can be used or canned in smaller containers.

Filling: Heat the juice to 93 C (200 F) and pour into the containers to fill them as completely as possible.

Sealing: Seal the containers immediately after the hot product has been added. Invert or turn the container on their sides and hold 5 minutes for the hot juice to sterilize the tops.

Processing: Processing will not be necessary if the containers are sealed while the juice has a temperature of at least 88 C (190 F). Should the temperature fall below 88 C (190 F) it will be necessary to give the containers of juice a short process in boiling water: 10 minutes for No. 2 cans and smaller; 15 minutes for No. 2½ cans and glass containers; and 20 minutes for No. 10 cans.

Cooling: Begin the cooling operation immediately after the

holding period or processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they completely cool and dry.

4. **Grapefruit Juice**

Container: Use plain tin containers or glass container.

Quality of Product: The grapefruit for producing juice for canning should be well ripened yet free from spoilage.

Preparation: Wash the grapefruit thoroughly. Cut the fruit in half and ream the fruit juice from the halves by hand or by machine. Filter or strain the juice to remove seeds and pulp. Heat the juice to 88 C (190 F).

Filling: Fill containers as completely as possible with the hot juice.

Sealing: Seal containers immediately after the hot juice has been added. Invert or turn containers on their sides and hold 5 minutes for the hot juice to sterilize the tops.

Processing: Processing will not be necessary if the containers are sealed while the juice has a temperature of at least 88 C (190 F). Should the temperature fall below 88 C (190 F) it will be necessary to give the containers of juice a short process in boiling water: 10 minutes for No. 2 cans and smaller; 15 minutes for No. 2½ cans and all glass containers; and 20 minutes for No. 10 cans.

Cooling: Begin the cooling operation immediately after the holding period or processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

5. **Orange Juice**

Since a successful method has not been developed for processing orange juice other than flash pasteurization, it is recommended that this juice not be canned unless it is mixed with higher acid juices such as grapefruit juice. If such a mixture is made, the juice will retain its flavor for a longer period of time than pure orange juice. The pasteurizing times for such mixtures are dependent upon the acidity and upon the size of the containers. Research laboratories connected with the canning industry should be contacted for specific instructions if orange juice is to be canned.

6. <u>Pineapple Juice</u>

Container: Use plain tin containers or glass container.

Quality of Product: Field ripened pineapple should be used in preparing pineapple juice. Pineapple juice is usually a by-product from a canning plant, after the choice sections have been canned.

Preparation: Wash the pineapple thoroughly. Peel, slice, core, and grind the pineapple to a pulp. Press the pulp to extract the juice. Strain the juice and heat to 91 C (195 F).

Filling: Fill the containers as completely as possible with the hot juice.

Sealing: Seal the containers immediately after the hot juice has been added. Invert or turn the containers on their sides and hold 5 minutes for the hot juice to sterilize the tops.

Processing: Processing will not be necessary if the containers are sealed while the juice has a temperature of at least 88 C (190 F). Should the temperature fall below 88 C (190 F) it will be necessary to give the containers of juice a short process in boiling water: 10 minutes for No. 2 cans and smaller; 15 minutes for No. 2½ cans and all glass containers; and 20 minutes for No. 10 cans.

Cooling: Begin the cooling operation immediately after the holding period or processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

7. **Prune Juice**

Container: Use R-enameled body and ends metal containers or glass containers.

Preparation: Soak dried prunes in hot water for one to four hours at 93 C (200 F) to remove the soluble substances. The length of soaking time depends on the toughness of the prunes. Repeat the soakings to fully extract the soluble substances. Filter the juice and bring to the desired concentration by boiling or by diluting with water. Heat the juice to 88 C (190 F).

Filling: Completely fill the containers with the hot juice.

Sealing: Seal the containers immediately after the hot juice has been added.

Processing:

Processing Temperatures and Times for Prune Juice

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Water Temperature - 88 C (190 F) (For each 305 meters (1000 ft.) in altitude increase processing times by 10%.)
No. 303 can (303x406)	82	(180)	18
No. 2 can (307x409)	82	(180)	20
No. 2½ can (401x411)	82	(180)	35
No. 10 can (603x700)	82	(180)	60
473 ml glass jar (pint)	82	(180)	25
946 ml glass jar (quart)	82	(180)	35

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

8. **Tomato Juice**

Container: Use plain tin containers or glass jars.

Quality of Product: Use tomatoes which were harvested when fully red ripe. The tomatoes should have developed full color and flavor.

Preparation: Sort tomatoes in order to remove green, overripe, or otherwise undesirable product. Wash the tomatoes thoroughly to remove dirt, mold, or rot. Cut up the tomatoes and place in steam-jacketed kettles or in stock pots and heat in their own juice to 60 C (140 F). (They may also be treated in the steam blancher for two to three minutes.) Take care to prevent excess aeration during these operations.

After preheating the tomatoes, extract the juice. This may be done in one of several ways. The hot pulp may be passed through the juicer puree attachment of the meat grinder. The tomatoes may also be run through a juice extractor or pulper. Heat the extracted juice to between 82 C (180 F) and 85 C (185 F).

Filling: The containers should be filled immediately with the hot juice. Fill tin containers as full as possible. Glass jars should be filled to within 6mm (1/4 inch) of the top. Salt may be added at this time if desired.

Sealing: Seal containers immediately after the hot juice has been added.

Processing:

Processing Temperatures and Times for Tomato Juice

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Boiling Water Temperature - 100 C (212 F) (For each 305 meters (1000 ft.) in altitude increase processing times by 10%)
No. 303 can (303x406)	82	(180)	38
No. 2 can (307x409)	82	(180)	40
No. 2½ can (401x411)	82	(180)	45
No. 10 can (603x700)	82	(180)	80
473 ml glass jar (pint)	82	(180)	40
946 ml glass jar (quart)	82	(180)	45

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

LOW ACID FOODS

Low acid foods require processing at temperatures in excess of 100 C (212 F). The relatively high temperatures are required to kill the spores of mesophilic microorganisms found in these foods.

Brine is the usual canning medium normally added to low acid vegetables. However, a nutritional sweetening agent may also be added to some vegetables. Brine and sweetening agents are added to help mask the raw vegetable flavor some people find objectionable and make the canned product more palatable. The brine, usually a two per cent salt solution, may be made and added in one of several ways. The salt solution may be made prior to canning by adding the specified amount of salt to potable, soft water. Salt may also be added to the individual containers in granulated or in tablet form. The required amount of salt is placed on the product, following filling, in the containers, and the product is covered with boiling water. The quantity of salt to be added in either tablet or granulated form can be found in Table IV in the Appendix of this manual.

1. **Asparagus**

Container: Use plain tin containers or glass jars.

Quality of Product: Use young, tender stalks for canning. Hard or deformed stalks and stalks showing evidence of rust (a reddish fungus) should not be packed.

Asparagus wilts rapidly after it is harvested, and for this reason it should be brought to the processing plant as quickly as possible after cutting. If it is necessary to hold asparagus from one day to the next, it should be refrigerated at about 2 C (36 F).

Preparation: Wash the asparagus, trim off scales and tough ends. Make certain that washing has been thorough; the tips and leaflets should be examined carefully for sand. Washing is accomplished more satisfactorily under sprays than by dipping. Floating the stalks in warm water facilitates cleaning exceptionally dirty asparagus. The top portion, the length of the can, or only portions of the stalk should be canned. Cut the stalks either into container-length pieces or into one-inch pieces. The container-length pieces should be about 6 mm (1/4 inch) less than the height of the container. Tender portions cut from the stalk or trimmings from the container-length pieces may be used as asparagus cuts.

Blanch the cut and washed asparagus in steam or hot water from two to four minutes, depending on the size of the stalks. Blanching removes the mucous material from the stalk and reduces the bitter flavor. At the same time, blanching softens the stalk and thus allows the container to be filled more completely. Cool the blanched asparagus quickly under water

sprays or by dipping in cold water to facilitate packing. Do not allow the asparagus to remain in the cooling water for more than a few seconds.

Filling: Before filling the asparagus into the containers, sort it into grades according to both color and uniformity of size. If the asparagus is to be packed whole, gather sufficient stalks in a bundle. Work the bundle of stalks into the container with the cut ends down. Settle the stalks by tapping the container on the table. The pack should be firm in order to insure that the stalks will not break in subsequent handling. Leave a space of 6 mm (1/4 inch) at the top of tin containers and 13 mm (1/2 inch) at the top of glass jars. Use boiling water or brine to fill tin containers completely or just cover the product in glass jars. Where brine is not used add salt as specified in Table IV in the appendix of this manual.

If asparagus cuts are packed, fill the containers by scooping the sections up and pouring them into metal containers to within 6 mm (1/4 inch) of the top or to within 13 mm (1/2 inch) of the top of glass jars. Brine or boiling water is added as above.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 77 C (170 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 77 C (170 F) and seal the containers immediately. Do not allow the contents to cool below the minimum initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

PROCESSING TIMES & TEMPERATURES

White or Green ASPARAGUS CUTS, Including Soup Cuts, In Brine

Container Size	Maximum Fill Weight Grams	(Ounces)	Minimum Initial Temperatures °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	120 C (248 F)
8Z Tall Can (211x304)	179	6.3	21	(70)	32	23
			49	(120)	30	21
No. 211 Cyl. Can (211x400)	224	7.9	21	(70)	32	23
			49	(120)	30	21
No. 300 Can (300x407)	312	11.0	21	(70)	32	23
			49	(120)	30	21
No. 10 Can (603x700)	2126	75.0	21	(70)	38	29
			49	(120)	36	27

ASPARAGUS SPEARS, Tips Down, In Brine

Container Size	Minimum Initial Temperatures °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	120 C (248 F)
No. 2 Can (307x409) and smaller	21	(70)	29	22
	49	(120)	28	20
No. 10 Can (603x700)	21	(70)	34	24
	49	(120)	32	22

ASPARAGUS SPEARS, Tips Up, In Brine

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	120 C (248 F)
No. 2 Can (307x409) and smaller	21	(70)	32	24
	49	(120)	30	23
No. 10 Can (603x700)	21	(70)	37	28
	49	(120)	35	26

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool tin containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

2. **Artichokes**

Pressure processing of artichokes and artichoke hearts produces a product that is of poor quality. For this reason, this product is usually preserved by acidifying it with vinegar. The acidification permits safe processing in boiling water at 100 C (212 F) which does not reduce the quality of the product. Care should be taken in all steps of the operations. For this reason, a research laboratory must be consulted if the product is to be canned. Spices may be added to artichokes if they are to be prepared as pickles.

3. BEANS - DRIED, White Beans, Navy Beans, Red Kidney Beans and Peas in Brine or Sauce

Container: Use C enamel containers or glass jars.

Preparation: Inspect beans or peas and remove all foreign matter such as small pebbles, stones, clods of dirt and defective beans or peas. Soak beans or peas in tanks, stainless steel or fiber glass, in water with a total hardness not exceeding 205 mg per liter (12 grains per gallon) from 10 to 15 hours depending upon the moisture content of the dried beans. The moisture content of dried beans may range from 9 to 18 percent. The lower the moisture content the longer the time required for soaking. Hardness of the water also affects the soaking time. Harder the water the longer the time required for soaking. The addition of 0.2 percent sodium hexametaphosphate to water having a hardness from 428 to 479 mg per liter (25 to 28 grains per gallon) has been found to improve the texture of the bean and skins in the finished product. Frequent changes of the soaking water helps to prevent the souring of the beans. In tropical countries sprouting often occurs during long periods of soaking. Under such conditions the soak time should be shortened as much as possible by adjusting the hardness of the water and selecting beans or peas with high moisture contents. Conditions and procedural methods should be avoided that will cause the beans or peas to soften and their skins to split and peel off. Over soaking, particularly in soft water with a hardness under 68.5 mg per liter (4 grains per gallon), will cause splitting and matting of the beans in the containers. Soaking water with a temperature in excess of 38 C (100 F) will contribute to softening and skin splitting. When beans are soaked properly, 25 kilos (55 lb.) of dry peas or beans should produce approximately 46 to 48 kilos (101 to 106 lb.) after an 8 to 10 hour soak.

Beans and peas are blanched after soaking from 3 to 8 minutes in water at 82 to 93 C (180 to 200 F). Avoid over blanching which will contribute to splitting of the skins. Longer blanch from 10 to 30 minutes may be substituted for long soaks. However, trial packs must be made if short soaks followed by long blanches are employed to make accurate adjustments in filling weights and in water content of the sauce if sauce is used as a canning medium.

Various sauces may be prepared for baked beans and pork and beans. Plain sauce can be prepared from molasses, sugar, salt, water and spices. Tomato sauce may be made from the same ingredients with the addition of tomato puree. If the beans are to be canned with pork, place a piece of pork in each container before filling with beans and adding the sauce.

The following recipes have been found to be acceptable and could be used as a basis for formulating one that would be more suitable for a particular market or one's taste.

MOLASSES SAUCE

Molasses	2.40 kilos	(5.28 lbs.)
Brown Sugar	3.00 kilos	(6.60 lbs.)
White Sugar	3.60 kilos	(7.90 lbs.)
Salt	2.38 kilos	(5.25 lbs.)
Starch	0.84 kilos	(1.85 lbs.)
Pepper	25.52 grams	(0.90 ozs.)
Mustard	59.54 grams	(2.10 ozs.)
Garlic Powder	7.09 grams	(0.25 ozs.)
Onion Powder	36.86 grams	(1.30 ozs.)
Water, Sufficient Quantity to Make	100.00 liters	(26.5 gals.)

TOMATO SAUCE

Tomato Sauce, 1.045 specific gravity	14.65 kilos	(32.25 lbs.)
Salt	2.40 kilos	(5.30 lbs.)
White Sugar	6.00 kilos	(13.20 lbs.)
Starch	0.85 kilos	(1.85 lbs.)
Corn Syrup	2.40 kilos	(5.30 lbs.)
Vinegar, 5.00 per cent acetic acid	0.50 liter	(1.06 pt.)
Mustard	59.50 grams	(2.10 ozs.)
Mace	7.10 grams	(0.25 ozs.)
Cloves	5.70 grams	(0.20 ozs.)
Paprika	7.10 grams	(0.25 ozs.)
Pepper	26.90 grams	(0.95 ozs.)
Cinnamon	5.70 grams	(0.20 ozs.)
Garlic Powder	7.10 grams	(0.25 ozs.)
Onion Powder	29.80 grams	(1.05 ozs.)
Water, Sufficient Quantity to Make	100.00 liters	(26.5 gals.)

Filling: Fill hot beans into the metal containers to a prescribed fill weight and add the hot sauce or 2 percent brine to completely fill the metal container and to within 6 mm (1/4 inch) of the top of glass jars. The fill weight will vary according to the moisture content of the beans after soaking and blanching. Generally, beans will continue to absorb moisture from the sauce or brine for some time after the beans have been canned. Properly filled containers should contain just enough sauce to cover the beans after canning and storage for several weeks. After establishing soak and blanching times that will be used for the type of beans available, several packs should be made to determine the proper fill weight. The following are some suggested fill weights for several different size containers.

These fill weights are based on the conventional soak time using water with a hardness of 68.5 to 154.1 mg per liter (4 to 9 grains per gallon).

FILL WEIGHT

Container Size		Fill Weight grams	Fill Weight ozs
8Z Short	(211x300)	106 to 120	(3 3/4 to 4 1/4)
No. 300	(300x407)	198 to 227	(7 to 8)
No. 303	(303x406)	212 to 248	(7 1/2 to 8 3/4)
No. 2	(307x409)	269 to 326	(9 1/2 to 11 1/2)
No. 2½	(401x411)	283 to 468	(13 1/2 to 16 1/2)
No. 10	(603x700)	1446 to 1729	(51 to 61)
473 mL glass jar	(pint)	220 to 248	(7 3/4 to 8 3/4)
946 mL glass jar	(quart)	439 to 496	(15 1/2 to 17 1/2)

Exhausting and Sealing: No exhausting is necessary for beans when they are filled at a temperature of 88 C (190 F) and the sauce or brine is added at that temperature.

Seal the containers immediately after the hot product has been added. Do not allow the contents to cool below the minimum initial temperature specified in the Processing Temperatures and Times Schedule for Soaked Dried Beans or Peas in Brine before processing.

Processing:

Processing Temperatures and Times for Soaked Dried Beans or Peas in Brine

(No starch added)

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 2½ can and Smaller	(401x411)	38	(100)	40	27	19
		60	(140)	38	25	17
No. 10 can	(603x700)	38	(100)	59	42	30
		60	(140)	54	37	26
473 mL glass jar (pint)		60	(140)	40	30	20
946 mL glass jar (quart)		60	(140)	45	35	25

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Processing Temperatures and Times for Soaked Dried Beans or Peas in Sauce With or Without Pork

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
8Z Short can	(211x300)	38	(100)	86	73	65
		60	(140)	80	68	60
		82	(180)	71	59	52
No. 300 can	(300x407)	38	(100)	107	90	80
		60	(140)	97	83	74
		82	(180)	84	72	64
No. 303 can	(303x406)	38	(100)	112	97	87
		60	(140)	102	89	79
		82	(180)	90	77	68
No. 2 can	(307x409)	38	(100)	127	112	102
		60	(140)	117	102	89
		82	(180)	102	86	76
No. 2½ can	(401x411)	38	(100)	153	138	128
		60	(140)	143	128	113
		82	(180)	123	108	98
No. 10 can	(603x700)	38	(100)	275	255	240
		71	(160)	225	210	195
473 mL glass jar (pint)		82	(180)	110	98	85
946 mL glass jar (quart)		82	(180)	120	110	100

Cooling: Begin cooling operations immediately after the processing time has elapsed with cold water and cool rapidly to 38 C (100 F). Cool under pressure all glass containers and metal containers larger than No. 2 (307x409). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

4. **Beans, Snap (Green or Wax)**

Container: Use plain tin containers or glass jars.

Quality of Product: Snap or green beans for canning should be harvested while tender and before the seed tends to separate from the pod during the processing. When the individual beans leave the pods during cooking, they are too mature to have good flavor and texture for canning use. The bean pods should be as free as possible from strings or fiber and from blemishes and rot. Beans, if held in storage for too long a time after harvesting, become wilted, darkened, and tough.

Preparation: Remove the ends of the beans and the strings, and break or cut the beans into pieces approximately one to one and one-half inches long. Discard overmature, bruised or otherwise undesirable beans during the snapping operation. If large quantities of beans are to be canned, a mechanical *snipper* can be used to remove the ends.

Blanch the beans in steam blanch-cooler or hot water at approximately 91 C (195 F). The length of blanching depends upon the type and maturity of the beans and is usually less than five minutes. The beans should become pliable in the blanching process, but should not become slimy. Sliminess is an indication that the product has been over-blanched.

After blanching, dip the beans quickly into cold water or under water sprays to stop the blanching process and make the product easy to handle. Do not allow the beans to remain in the cooling water more than a few seconds.

Filling: Pack beans to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add

boiling water or brine to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 74 C (165 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 74 C (165 F) and seal immediately. Do not allow the contents to cool below the minimum initial temperature shown in Processing Temperature and Time Schedule before processing.

Processing:

PROCESSING TEMPERATURES AND TIMES FOR GREEN OR WAX BEANS IN BRINE

Asparagus Style

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 2 Can (307x409)	21	(70)	29	23	19
and Smaller	49	(120)	27	21	17

Whole or Cut, With Soaked Dried Shelled Type Beans, In Brine
No Starch Added

Can Size	Maximum Fill Weight Grams	(Ounces)	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 Can (303x406)	326	11.5	21	(70)	37	26	19
			49	(120)	35	24	17
No. 2½ Can (401x411)	567	20.0	21	(70)	37	26	19
			49	(120)	35	24	17
No. 10 Can (603x700)	1985	70.0	21	(70)	47	34	26
			49	(120)	44	31	23

Whole or Cut

Container Size	Maximum Drained Fill Weight Grams	(Ounces)	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
8Z Tall Can (211x304)	147	(5.2)	21	(70)	23	18	14
8Z Tall Can (211x304)	181	(6.4)	21	(70)	24	18	15
No. 303 Can (303x406)	284	(10.0)	49	(120)	22	16	13
No. 303 Can (303x406)	354	(12.5)	49	(120)	23	17	14
No. 2 Can (307x409)	363	(12.8)	21	(70)	23	17	14
			49	(120)	21	15	13
No. 2½ Can (401x411)	539	(19.0)	21	(70)	24	18	14
			49	(120)	22	16	13
No. 3 Cyl Can (404x700)	794	(28.0)	21	(70)	26	20	16
			49	(120)	25	19	15
No. 10 Can (603x700)	1,985	(70.0)	21	(70)	30	23	18
			49	(120)	28	18	16
473 mL Glass Jars (pint)			74	(165)	25	23	20
946 mL Glass Jars (quarts)			74	(165)	30	28	25

Sliced Lengthwise or French Style

Container Size		Maximum Drained Fill Weight Grams	(ounces)	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
8Z Tall Can	(211x304)	159	(5.6)	21	(70)	29	23	19
8Z Tall Can	(211x304)	173	(6.1)	21	(70)	38	31	27
8Z Tall Can	(211x304)	190	(6.7)	21	(70)	52	44	39
8Z Tall Can	(211x304)	204	(7.2)	21	(70)	71	63	57
No. 303 Can	(303x406)	312	(11.0)	49	(120)	27	21	17
No. 303 Can	(303x406)	340	(12.0)	49	(120)	35	28	24
No. 303 Can	(303x406)	369	(13.0)	49	(120)	47	39	34
No. 303 Can	(303x406)	397	(14.0)	49	(120)	65	57	52
No. 10 Can	(603x700)	2,098	(74.0	21	(70)	43	33	27
				49	(120)	37	28	22

Cooling: Begin the cooling operation immediately after the processing time has elapsed with cold water and cool rapidly to 38 C (100 F). Cool under pressure all glass containers and metal containers larger than No. 2 (307x409). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

5. **Beans, Green Lima**

Container: Use plain tin containers or glass jars.

Quality of Product: Lima beans should be harvested when the bean reaches mature size but before it loses its green color. The best time for harvesting lima beans is when the pods are still green yet the beans shell out well. Only young, tender lima beans should be canned. The older beans with high starch content are undesirable for canning but may be preserved by drying. Lima beans should be handled in small quantities and as rapidly as possible in the smaller operations so that spoilage will not occur.

Preparation: Lima beans must be shelled during preparation if they are not separated from the hull by vining machines during harvesting. Lima beans can be shelled either by hand or with the mechanical pea sheller with the proper accessories. Pea or bean shellers are highly recommended where large quantities of beans are to be prepared. If these machines are used, the product must be handled rapidly to avoid spoilage. After shelling, wash the beans thoroughly in running water or under cold water sprays. Do not store beans for further operations after they are washed since they discolor and spoil within a few hours. If they must be held, hold them in shallow trays where air can circulate through them to prevent spoiling, and do not wash them until just prior to the blanching operation.

Sort the beans in order to remove old, discolored, or dried beans. Blanch the sorted and washed beans at approximately 91 C (195 F). Blanching may

take place either in hot water or in a steam blancher. The blanching time will vary with the maturity of the beans. Small beans may be blanched in less than three minutes whereas the older beans will require a longer time. Drain the beans at once.

Filling: Pack beans to within 12.5 mm (1/2 in.) of top of metal containers or to within 25.4 mm (1 in. of the top of glass jars. Add boiling 2% brine or boiling water to completely fill the metal containers or to fill glass jars to within 12.5 mm (1/2 in.) of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 60 C (140 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 60 C (140 F) and seal the containers immediately.

Processing:

Processing Temperatures and Time for Lima Beans

Green Lima Beans, In Brine

Container Size	Minimum Initial Temperature °C (°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 2 Can (307x409) and Smaller	21 (70)	40	27	19
	49 (120)	38	25	17
No. 3 Can (404x700)	21 (70)	46	31	22
	49 (120)	44	29	21
No. 10 Can (603x700)	21 (70)	57	41	31
	49 (120)	53	[illegible]	27
473 mL Glass Jar (pints)	60 (140)	45	35	25
946 mL Glass Jar (quarts)	60 (140)	50	40	30

Cooling: Begin the cooling operation immediately after the processing time has elapsed with cold water and cool rapidly to 38 C (100 F). Cool under pressure all glass containers and metal containers larger than No. 2 (307x409). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

6. **Beets**

Container: Use R-enamel containers or glass jars.

Quality of Product: Beets for canning should be tender and young, and should be canned as soon after harvesting as possible. Beets that must be stored for any length of time develop a bitter flavor. The beets most desirable for canning are of a uniform dark red color, not light-colored. Beets that have developed in dry weather usually have fibrous and woody portions and should not be used in canning.

Preparation: In general, beets of approximately two inches in diameter are canned whole, whereas beets of larger sizes may be sliced or quartered. First remove the tops or leafy portions of the beets. The tender tops are often canned as greens. Leave about one inch of both root and leaf stalk on the beet to prevent bleeding during the steaming operation. Wash the beets thoroughly to remove adhering dirt. A strong water spray is desirable for this purpose, particularly if considerable dirt is present. In some cases, it may be necessary to soak the beets in order to remove the adhering dirt. Use vegetable brushes in washing if necessary but take care not to break the skin of the vegetable.

Grade the beets roughly into two sizes, smaller than two inches and larger than two inches in diameter. This grading gives a uniformity to the finished product and simplifies the subsequent preparation steps.

To permit peeling, steam the washed and trimmed beets at about 107 C (225 F) for about 15 to 25 minutes, the time depending upon the size of the beet. Boiling water may be used instead of steam to loosen the skins

but it removes considerable sugar and other soluble compounds from the beets. Steaming is accomplished in the retort at the required pressure or in specialized apparatus. Chill the steamed beets in water to stop the cooking action and to crack the skins. After steaming and cooling the beets, grasp them firmly with both hands, and twist in opposite directions with the hands. This removes the peeling except around the stem and the small root at the tip of the beet. Trim to remove all traces of the skin and root tip. Do not allow the beets to remain in the cold water for more than a few seconds before peeling begins. Prompt handling is then necessary or the skin may be difficult to remove.

Quarter, slice, or dice large beets. Slices are usually about 9.5 mm (3/8 of an inch) thick.

Filling: Pack beets to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling water or brine to completely fill tin containers or completely cover the product in glass jars.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 71 C (160 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 71 C (160 F) and seal the cans immediately. Do not allow the contents to cool below the minimum initial temperature before processing.

Processing:

Processing Temperatures and Times for Beets
Whole, Cut, Quartered or Sliced

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 2½ Can (401x411) and Smaller	21	(70)	37	30	25
	60	(140)	33	26	21
No. 10 Can (603x700) not sliced	21	(70)	51	42	35
	60	(140)	42	36	29
No. 10 Can (603x700) sliced	21	(70)	54	45	39
	60	(140)	49	40	34
473 mL Glass Jar (pint)	71	(160)	35	27	20
946 mL Glass Jar (quart)	71	(160)	40	33	25

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool metal containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

7. **Broccoli**

Container: Use C-enamel containers or glass jars.

Quality of Product: Use only fresh broccoli with the florettes and buds tight and not in flower. Do not use thick stems unless they are tender.

Preparation: Wash the broccoli thoroughly to remove dirt and foreign material. Cut the broccoli to a length of about 13 mm (1/2 inch) less than the height of the container. The larger stalks should be halved or quartered. Blanch the product at about 91 C (195 F) for approximately 3 minutes, depending on the thickness of the stalks. Dip the blanched product in the cold water to stop the cooking action and to allow ease in handling.

Filling: Pack broccoli with heads up to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling brine or water to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 66 C (150 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 66 C (150 F) and seal the containers immediately. Do not allow the contents to cool below the minimum initial temperature before processing.

Processing

Processing Temperatures and Times for Broccoli, In Brine

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 2 can	(307x409)	66	(150)	30	28	25
No. 2½ can	(401x411)	66	(150)	30	28	25
No. 10 can	(603x700)	66	(150)	40	35	30
473 mL Glass Jar (pints)		66	(150)	35	26	20
946 mL Glass Jar (quarts)		66	(150)	40	31	25

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool tin containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

8. **Brussels Sprouts**

Container: Use plain tin containers or glass jars.

Quality of Product: Brussels sprouts used for canning should be matured and free of insect injury. The florettes should not be shriveled, bruised or discolored.

Preparation: Break sprouts from the heads, wash, sort and blanch with steam for about four minutes. Chill the sprouts thoroughly in cold water to prevent matting in the container.

Filling: Pack brussels sprouts to within 6 mm (1/4 inch) of the top of tin containers and to within 13 mm (1/2 inch) of the top of glass jars. Add boiling 1½% brine to completely fill the tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 66 C (150 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 66 C (150 F) and seal the containers immediately. Do not allow the contents to cool below minimum initial temperature before processing.

Processing:

Processing Temperatures and Times
Brussels Sprouts in Brine

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 2 cans	(307x409)	21	(70)	42	33	27
		60	(140)	37	28	22
No. 2½ cans	(401x411)	21	(70)	47	38	32
		60	(140)	42	33	27
No. 10 cans	(603x700)	21	(70)	67	52	40
		60	(140)	62	47	35
473 mL Glass Jars (pints)		60	(140)	37	30	25
946 mL Glass Jars (quarts)		60	(140)	42	35	30

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool tin containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the continers until they are completely cool and dry.

9. **Cabbage**

Container: Use plain tin containers or glass jars.

Quality of Product: Cabbage used for canning is usually small and very firm. The heads should not be shriveled, bruised or discolored, and should be free of insect damage.

Preparation: Wash the cabbage thoroughly to remove dirt and foreign material. Trim the head, cut into sections and steam blanch until tender, usually 5 to 6 minutes. Steaming is preferable to blanching in water as less of the soluble food elements are lost.

Filling: Pack cabbage to within 6 mm (1/4 inch) of the top of tin containers and to within 13 mm (1/2 inch) of the top of glass jars. Add boiling 1½ percent brine to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the containers.

Exhausting and Sealing: If cans are filled with hot cabbage and brine, it will not be necessary to exhaust.

Processing:

Processing Temperatures and Times for Cabbage Wedges in Brine

Container Size		Maximum Filled Weight Grams	(Ounces)	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperatu 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 2 can	(307x409)	340	(12)	21	(70)	40	31	25
				60	(140)	35	26	20
No. 2½ can	(401x411)	482	(17)	21	(70)	45	36	30
				60	(140)	40	31	25
No. 10 can	(603x700)	1758	(62)	21	(70)	65	51	40
				60	(140)	60	46	35
Glass Jar 473 mL (pint)				66	(150)	35	29	25
Glass Jar 946 mL (quart)				66	(150)	40	34	30

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool tin containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

10. **Carrots**

Container: Use R-enameled containers or glass jars.

Quality of Product: A well shaped, deep orange-colored carrot is most desirable for canning. The carrots should be crisp and tender, and only fully matured ones should be used. Dispose of any root that has become fibrous or woody.

Preparation: Remove the leaves from the carrot, leaving about 38 to 51 mm (1-1/2 to 2 inches) of the stalk at the top (the tops can be removed from the carrots before delivery at the cannery to eliminate the waste disposal problem). Soak the carrots in water to loosen dirt before washing. Scrub the carrots with a stiff brush until they are clean. If large quantities of carrots are to be handled, sprays expedite washing.

Peel carrots after they are washed. Carrots may be peeled either by hand or by lye. In peeling by hand, use the stub of the carrot stalk to hold them with while removing the thin peel from the carrot with a sharp peeling knife. Remove the top remainder after the peeling is complete. If carrots are to be lye peeled, trim them, removing tops and small root tip from the point of the carrot. Carrots that have been freshly dug are lye peeled with a very short treatment of about one and one-half minutes. Carrots that have been shipped or held in storage for up to ten days require about two and one-half minutes or more. The skins should slip off freely and leave the carrots smooth and clean after this time. After lye peeling, practically no trimming is necessary. A 4-1/2 percent lye solution is required for peeling

carrots. Wash the carrots thoroughly in cold water after the lye treatment. If the skin still remains on the carrot, it should be removed by holding the carrot underwater and brushing with a vegetable brush.

Cut the carrot into the desired size. Can small carrots whole if desired. Cut or slice larger carrots for canning.

Filling: Pack carrots to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add 2% brine to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 66 C (150 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 66 C (150 F) and seal the containers immediately. Do not allow the contents to cool below the minimum initial temperature shown in the Processing Temperatures and Times for Processing before processing.

Processing:

Processing Temperature and Times for Whole, Cut, Quartered, Sliced or Diced Carrots

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 2½ Can	(401x411)	21	(70)	36	29	25
	and Smaller	60	(140)	33	26	22
No.10 Can	(603x700)	21	(70)	44	35	30
	not sliced	60	(140)	39	31	25
No. 10 Can	(603x700)	21	(70)	52	43	38
	sliced	60	(140)	47	38	33
Glass Jars 473 mL (pints)		66	(150)	35	26	20
Glass Jars 948 mL (quarts)		66	(150)	40	31	25

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool tin containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

11. <u>Cauliflower</u>:

Container: Use C-enamel containers or glass jars.

Quality of Product: The heads of cauliflower should be mature, but not showing any greenness or discoloration. They should be free of insects and insect damage.

Preparation: Cut the head into convenient-size pieces to fit the containers, wash, sort, and blanch for approximately four minutes. It is advised that the cauliflower be blanched in boiling 1 per cent citric acid 08 grams (1-1/3) per 3.785 liter (1 gallon) solution) to prevent greying in the containers. After blanching, chill the cauliflower thoroughly in cold water to prevent matting in the container.

Filling: Pack cauliflower to within 6 mm (1/4 inch) of the top of tin containers and to within 13 mm (1/2 inch) of the top of glass jars. Add 1½% brine to completely fill tin containers or fill glass jars to within 6 mm (1/4 inch) of the top.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 66 C (150 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 66 C (150 F) and seal the containers immediately. Do not allow the contents to cool below the minimum initial temperature specified in the Processing Temperatures and Times Schedule before processing.

Processing:

Processing Temperatures and Times for

Broken Heads of Cauliflower in Brine

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)
No. 303 (303x406) Can	21	(70)	22
	60	(140)	21
No. 2 (307x409) Can	21	(70)	22
	60	(140)	21
No. 2½ (401x411) Can	21	(70)	22
	60	(140)	21
No. 10 (603x700) Can	21	(70)	42
	60	(140)	40
473 mL Glass Jars (pints)	66	(150)	35
946 mL Glass Jars (quarts)	66	(150)	40

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool tin containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

12. Celery

Container: Use plain tin containers or glass jars.

Quality of Product: Celery stalks used for canning should be well developed but not over mature.

Preparation: Separate the large stalks and use the hearts whole. Wash carefully, cut into one-to-two-inch lengths, and precook approximately two minutes.

Filling: Pack hot celery to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling brine or water to fill tin containers completely or to fill glass jars to within 6 mm (1/4 inch) of the top.

Exhausting and Sealing: No exhaust is necessary if celery is precooked and packed immediately into the containers. Do not allow contents to cool below the minimum initial temperature shown in Processing Temperatures and Times Schedule before processing.

Processing:

Processing Temperatures and Times for Celery Cuts

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 can	(303x406)	21	(70)	28	25	23
		60	(140)	26	23	21
No. 2 can	(307x409)	21	(70)	28	25	23
		60	(140)	26	23	21
No. 2½ can	(401x411)	21	(70)	33	27	23
		60	(140)	30	24	20
473 mL Glass Jar (pints)		66	(150)	30	24	20
946 mL Glass Jar (quarts)		66	(150)	35	32	30

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool tin containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

13. **Corn - Whole Grain**

Container: Use C-enameled metal containers or glass jars.

Quality of Product: The maturity and quality of corn for canning is determined by a test of the kernels. The kernels should be fully developed but tender. Whole grain style corn is usually packed from the less mature ears and cream style corn is made from the more mature ones. Each ear is usually tested to determine its classification for the two styles of packs. The test used to classify the stage of maturity is known as the *thumb-nail test*. The young or less mature kernels when punctured with the thumb nail gives off a relative thin milky juice and that ear is classified as being in the *milk stage*, suitable for whole grain packs. The more mature kernels giving off a little thicker or more viscous creamy juice are classified as being in the *cream stage*, suitable for cream style packs. When the maturity of corn passes through the *cream stage* into the *dough stage* it becomes too old for canning high quality products. The variety of corn used in canning has a significant effect upon not only quality of the canned product but how long or the number of days corn will remain in the *milk and cream stages* after reaching optimum maturity for canning. This is important to a canning operation. Many varieties have just one or two days of optimum maturity while a select few have three or four days.

Preparation: Corn must be processed as soon as possible after it has been harvested or picked. Picked corn undergoes very rapid changes due to enzymatic reactions which convert the sugar in corn to starch that causes considerable loss of quality. Keeping the corn cool or chilling it with cold water

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or ice after picking until it can be processed will slow the rate of conversion from sugar to starch thus maintaining quality at a relative high level. The husk is removed either by hand or machine from the ear and the remaining silk is removed with either a stiff brush by hand or a mechanical corn silker. Mechanical aids are used in these two operations when the quantity is sufficient to justify the expense. The ears are inspected for blemishes and undesirable portions, which are removed by trimming. Following trimming, the corn is washed thoroughly with clean cold potable water. The kernels may be cut from the cob with a sharp knife by hand or a mechanical corn cutter, which, if in proper adjustment, will produce a very uniform whole grain product with a higher yield than by hand cutting. If cut by hand, a sharp bladed knife must be used to cut only two rows at a time. If too many rows are cut at one time, portions of the cob may be unintentionally included. Normally, about three-fourths (3/4) of the total depth of the kernel is cut during the one stroke. Do not scrape the cob in preparing whole grain corn.

Whole grain corn must be washed before putting it into containers to obtain a pack free from spoilage. In many instances putrefactive spoilage has been traced to highly contaminated equipment through or over which the kernels of corn had passed. While strict procedures should be followed in frequent cleaning of such equipment, the washing of the kernels with cold potable water prior to filling gives added assurance of a spoil free pack. Washing not only helps to remove contaminating spoilage organisms, it removes a considerable portion of the *fines* and helps to give the product a clear liquid instead of a milky appearing one. The removal of the *fines* permits a much faster heat penetration to the coldest point in the container than if they were left in the pack. The processing temperatures and times given in the whole grain corn are based on the pack being free from *fines*. The washed corn must be thoroughly

drained of water before packing it into containers.

Filling: In filling containers great care must be exercised to prevent overfilling, which makes the containers of corn more difficult to sterilize thus causing spoilage due to under processing. The fill of whole grain corn is based upon its maturity. The more mature the corn, the less should be the fill.

In general, fill corn to within 13 mm (1/2 inch) of the top of the tin container or to within approximately 25 mm (1 inch) of the top of glass jars. Add hot 2 percent brine to within 6 mm (1/4 inch) of the top of the containers. Where brine is not used granulated salt or salt tablets are placed on top of the corn before filling the containers with boiling water within the same tolerances as described in the use of brine as a canning medium.

Exhausting and Sealing: Exhaust the filled containers to a center temperature of 82 C (180 F) and seal them immediately. Where exhaust facilities are not available, the corn is heated to a temperature of 82 C (180 F) before filling it into containers. Do not allow the containers of corn to cool below the minimum initial temperature stated in the processing schedule before processing.

Processing:

Processing Temperatures and Times for Whole Grain Corn in Brine The Processes Also Apply to Succotash Prepared from Whole Kernel Corn and Beans

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
8Z Tall	(211x304)	21	(70)	51	35	25
		38	(100)	49	33	24
		60	(140)	46	31	22
No. 303 Can	(303x406)	21	(70)	51	35	25
		38	(100)	49	33	24
		60	(140)	46	31	22
No. 2 Can	(307x409)	21	(70)	51	35	25
		38	(100)	49	33	24
		60	(140)	46	31	22
No. 2½ Can	(404x411)	60	(140)	65	45	33
No. 10 Can	(603x700)	It is not recommended to can corn in this large a container.				
473 mL Glass Jar (pint)		82	(180)	60	42	30
946 mL Glass Jar (quart)		82	(180)	70	49	35

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool all containers rapidly to 38 C (100 F). Cool No. 2½ metal containers and glass jars under pressure. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

14. Corn - Cream Style

Container: Use C-enameled containers or glass jars.

Quality of Product: The maturity and quality of corn for canning is determined by a test of the kernels. The kernels should be fully developed but tender. Whole grain style corn is usually packed from the less mature ears and cream style corn is made from the more mature ones. Each ear is usually tested to determine its classification for the two styles of packs. The test used to classify the stage of maturity is known as the *thumb-nail test*. The young or less mature kernels when punctured with the thumb nail gives off a relative thin milky juice and that ear is classified as being in the *milk stage*, suitable for whole grain packs. The more mature kernels giving off a little thicker or more viscous creamy juice are classified as being in the *cream stage*, suitable for cream style packs. When the maturity of corn passes through the *cream stage* into the *dough stage* it comes too old for canning high quality product. The variety of corn used in canning has a significant effect upon not only quality of the canned product but how long or the number of days corn will remain in the *milk and cream stages* after reaching optimum maturity for canning. This is important to a canning operation. Many varieties have just one or two days of optimum maturity while a select few have three or four days.

Preparation: Corn must be processed as soon as possible after it has been harvested or picked. Picked corn undergoes very rapid changes due to enzymatic reactions which convert the sugar in corn to starch that causes considerable loss in quality of the canned product. Keeping the

corn cool or chilling it with cold water or ice after picking until it can be processed will slow down the rate of conversion from sugar to starch. The husk is removed either by hand or machine from the ear and the remaining silk is removed with either a stiff brush by hand or a mechanical corn silker. Mechanical aids are used in these two operations when the volume of produce is sufficient to justify the expense. After removal of husk and silk the ears are inspected for blemishes and undesirable portions, which are removed by hand trimming. The kernels may be cut from the ears by hand with a knife, or a mechanical corn cutter. The mechanical corn cutter cuts and scrapes the cob in one continuous operation. The depth of cut is easily and quickly regulated, which helps to avoid the removal of chaff from the cob. By cutting and scraping at the same time it gives a pulp, which when mixed with the grain, produces a creamy consistency that is associated with a high quality cream style corn. The corn cutter can cut the kernels and scrape just as fast as it can be fed into the machine. In cutting kernels from the cob by hand two cuts are made for each two rows. The first cut removes the major portion of the kernels from the cob; the second cut scrapes off the exposed pulp that remains on the ear. The first cut should cut as thin a slice as possible. The knife is then turned over and its back is used to scrape the exposed pulp. Care should be taken not to scrape too deeply or portions of the cob may be added which would give an undesirable flavor to the finished product. Where a rapid hand production is practiced, it is desirable for one person to make the initial cut and another person to scrape the remaining portion from the cob.

Blend the cream style corn thoroughly with the necessary water and seasoning before filling the containers. Salt and sweeten to taste and add water to establish the desired consistency. The following is recommended in order to

produce an acceptable consistency. Add 946 mL (1 quart) of water to each 3.8 liters (1 gallon) of corn, and add salt and sugar to taste. For larger quantities, 3.8 liters (1 gallon) of water is added for each 11.4 liters (3 gallons) of cut corn, 240 mL (1 cup) of sugar, and 60 mL (4 tablespoons) of salt. The quantity of sugar and salt varies with individual's taste.

Blend the corn in a steam-jacketed kettle or stock pot by bringing the temperature of the contents up slowly to between 88 C (190 F) and 93 C (200 F). Stir the corn constantly to prevent sticking. Add additional water when necessary. Since cream style corn thickens during processing, the consistency during blending should not be too great. Prepared syrups may be used in blending corn. Prepare this syrup by adding sugar and salt in the desired proportions to boiling water prior to the time the blending operation is begun. Reduce the time between cutting, blending, and processing to a minimum to reduce the tendency of the finished product to spoil.

Filling: Add the hot cream style corn to the containers at the blending temperature, 88-93 C (190-200 F) leaving 6 mm (1/4 inch) head space in metal containers and 13 mm (1/2 inch) head space in glass jars.

Exhausting and Sealing: No exhaust is needed when the corn is added to the containers immediately after the blending operation. The cans must be sealed immediately after exhausting. The contents of the sealed cans must not be allowed to cool below the minimum initial temperature stated in the Processing Temperature and Time Schedule.

Processing:

Processing Temperatures and Times Schedules for Cream Style Corn

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
8Z Tall Can	(211x304)	60	(140)	71	60	53
		71	(160)	68	57	50
		82	(180)	64	53	46
No. 1 Picnic	(211x400)	60	(140)	75	64	56
		71	(160)	72	60	53
		82	(180)	67	56	49
No. 303 Can	(303x406)	60	(140)	96	82	73
		71	(160)	90	77	69
		82	(180)	83	71	63
No. 2 Can	(307x409)	60	(140)	106	91	82
		71	(160)	101	86	77
		82	(180)	91	79	70

It is not recommended to can cream style corn in larger cans or glass jars.

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool all containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

15. **Egg Plant**

Container: Use plain tin containers or glass jars.

Quality of Product: Egg plant should be fresh and sound for canning. Only freshly harvested egg plant should be used.

Preparation: Remove green and defective sections of the egg plants. Wash, peel, and cube. Soak the cubed egg plant in a three percent salt solution for about one hour and then drain.

Filling: Pack egg plant to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling 2 percent brine or water to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 71 C (160 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 71 C (160 F) and seal the containers immediately. Do not allow the contents to cool below the minimum initial temperature in the Processing Temperatures and Times Schedule.

Processing:

Processing Temperatures and Times for Egg Plant Packed in Brine

Container Size	Minimum Initial Temperature °C (°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 can (303x406)	71 (160)	33	28	23
No. 2 can (307x409)	71 (160)	35	30	25
No. 2½ can (401x411)	71 (160)	40	35	30
No. 10 can (603x700)	71 (160)	60	53	45
473 mL glass jar (pint)	71 (160)	35	28	20
946 mL glass jar (quart)	71 (160)	40	33	25

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool under pressure all glass and metal containers larger than No. 2 (307x409). Cool tin containers rapidly to 38 C (100 F) with cold water. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

16. Greens

Container: Use C-enameled containers with enameled bodies and ends.

Quality of Product: Greens for canning should be young and tender. They should be crisp and free from stems of tough woody texture. Tough stems give rise to slow heat penetration, and possible spoilage.

Preparation: Green leafy vegetables such as spinach, mustard, beet tops, turnips, kale, collards, and dandelions can be canned. Only the young tender leaves may be picked or the entire plant may be pulled. Trim the roots from the stalks if necessary and remove yellow or discolored leaves and foreign material. This sorting and preparing should be performed before the greens are wet, since wet leaves mat and are not easy to handle. Shake sand and loose dirt from the leaves before wetting them. Wash the greens thoroughly to remove all soil. Usually, several washings are required. Use a large volume of water during the washing process. Wire baskets may be used for washing the greens. Partially fill the basket and dip it up and down in the washing water. Rotary-drum washers or heavy sprays of water are particularly desirable for washing greens. Sprays tend to cut soil from the leaves.

After washing the greens, blanch them in steam or hot water. The blanching operation removes the air from the greens and fixes the color of the leaf. Care should be taken that the hot water or steam comes in contact with each leaf during the blanching operation. This may require that the greens be blanched in relatively thin layers. Blanch the greens by placing them in

blanching baskets about one-third to one-half full and immersing for approximately three minutes in water at a temperature of rolling boil. Blanching time is complete when the leaves and particularly the stems become limber; they should not be blanched so long that the stems become mushy. The leaves will have a bright green color. Drain the greens to remove the excess water before filling the containers. Do not allow the greens to drain for too long a time as they will mat and become difficult to pack. Hard water should be avoided in blanching and making brine.

Filling: Pack greens into the containers rather loosely with forks. Thus, they may be handled quite hot. The amount placed in the containers should be regulated in order to insure proper heat penetration during the process. This is normally accomplished by packing to a particular drained weight. Check the weight of the first several filled containers and then check containers often enough to indicate the general average of the fill. Fill 473 mL (pint) jars or No. 2 containers to approximately 369 grams (13 ounces), 946 mL (quart) jars to approximately 595 grams (1 pound 5 ounces) and No. 10 containers to approximately 1700 grams (3 and 3/4 pounds). Do not exceed the suggested weights or else the processing will not be complete. After filling the containers with the greens, add boiling water or brine to completely fill tin containers and to fill glass jars to within 6 mm (1/4 inch) of the top. In order to obtain a good fill of brine, agitate the greens or cut them with a sharp stick or knife to permit the hot brine or water to penetrate throughout the containers. Where brine is not used, granulated salt or salt tablets may be placed on top of the contents and covered with boiling water.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 77 C (170 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 77 C (170 F) and seal the containers immediately. Do not allow the contents to cool below minimum initial temperature specified in Processing Temperatures and Times Schedule before processing.

Processing:

Processing Temperatures and Times for Cut Leafy Greens in Brine

Container Size		Maximum Drained Weight grams (ozs.)	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	122 C (252 F)
No. 303 can	(303x406)	366 (12.9)	38	(100)	83	64
			60	(140)	77	58
No. 2 can	(307x409)	369 (13.0)	38	(100)	90	70
			60	(140)	85	65
No. 2½ can	(401x411)	666 (23.5)	38	(100)	115	90
			60	(140)	105	81
No. 10 can	(603x700)	1871 (66.0)	38	(100)	140	110
			60	(140)	125	100
473 ml glass jar (pint)		369 (13.0)	60	(140)	90	70
946 ml glass jar (quart)		595 (21.0)	60	(140)	100	80

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool under pressure all glass jars and metal containers larger than No. 2 (307x409). Cool tin containers rapidly to 38 C (100 F) with water. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

17. Hominy

Container: Use C-enamel containers or glass jars.

Quality of Product: Use flat, fully ripened corn for making hominy.

Preparation: Soak shelled corn in a 1-1/2 percent lye solution and boil rapidly for 25 to 30 minutes. After the corn is boiled in the lye solution, drain it and wash in cold water. The water should run over the lye-treated corn for three to four hours to remove all traces of the lye. After washing, remove the seed coats of the corn kernels by rubbing the corn on a washboard with the hands. Then pick the hulls off by hand. It is also possible to hull the corn with a mechanical hulling machine or a barrel churn.

Filling: Pack hominy to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling water or brine to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled metal containers to a center container temperature of 71 C (160 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 71 C (160 F) and seal the containers immediately. Do not allow the contents to cool below the minimum initial temperature in the Processing Temperatures and Times Schedule.

Processing:

Processing Temperatures and Times for Lye Hulled Hominy in Brine

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 2 can and Smaller	(307x409)	21	(70)	46	29	20
		60	(140)	43	27	18
No. 2½ can	(401x411)	21	(70)	47	30	21
		60	(140)	45	28	19
No. 10 can	(603x700)	21	(70)	63	43	30
		60	(140)	57	37	25
475 mL glass jar (pint)		71	(160)	75	50	35
946 mL glass jar (quart)		71	(160)	90	60	40

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool under pressure all glass jars and metal containers larger than No. 2 (307x409), rapidly to 38 C (100 F) with water. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

18. Mushrooms

Container: Use plain tin containers or glass jars

Quality of Product: Any edible fungus especially *Agaricus campestris* may be canned. Not all mushrooms are edible, however, and some are deadly poisonous. If the wild or uncultivated variety of mushroom is picked for canning, make certain that it belongs to one of the edible varieties. Mushrooms for canning should be fresh.

Preparation: Do not remove the stems of small mushrooms. Remove the stems of large mushrooms and can the buttons and stems separately. Wash the mushrooms thoroughly and peel the large caps. In order to prevent discoloration after peeling, drop the peeled mushroom into water containing a 1/2 percent vinegar solution. Blanch with hot water or steam the mushrooms for three to four minutes. Steam blanching produces a more uniform color. In hot water, stir them continuously or use containers that will allow them to be completely immersed.

Filling: Pack mushrooms to maximum fill weight for each size container shown in Processing Temperature and Times Schedule. Add boiling water or 2 percent brine to completely fill tin containers and to fill glass jars to within 6 mm (1/4 inch) of the top.

Where prepared 2 percent brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 66 C (150 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the

containers at 66 C (150 F) and seal the containers immediately. Do not allow the contents to cool below the minimum initial temperature in Processing Temperatures and Times Schedule for Mushrooms in Brine.

Processing:

Processing Temperatures and Times for Mushrooms in Brine
Buttons or Small Whole

Container Size		Method of Fill	Maximum Fill Weight grams	(ozs)	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 121 C (250 F)
4Z Mushroom can	(211x212)	Hand	136	(4.8)	21	(70)	25
					38	(100)	24
					60	(140)	22
8Z Mushroom can	(300x400)	Hand	255	(9.0)	21	(70)	28
					38	(100)	27
					60	(140)	25
473 mL glass jar	(pint)	Hand	340	(12.0)	66	(150)	30
946 mL glass jar	(quart)	Hand	680	(24.0)	66	(150)	35

Processing Temperature and Times for Mushrooms in Brine
Sliced or Stems and Pieces

Container Size		Method of Fill	Maximum Fill Weight grams (ozs.)	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 121 C (250 F)
4Z Mushroom can	(211x212)	Hand or Tumble	153 (5.4)	21	(70)	28
				38	(100)	27
				60	(140)	24
8Z Mushroom can	(300x400)	Hand or Tumble	255 (9.0)	21	(70)	40
				38	(100)	38
				60	(140)	34
No. 10 can	(603x700)	Hand	2551 (90.0)	21	(70)	53
				38	(100)	49
				60	(140)	45
No. 10 can	(603x700)	Tumble	2410 (85.0)	21	(70)	74
				38	(100)	67
				60	(140)	56
473 mL glass jar	(pint)	Hand	380 (13.4)	66	(150)	54
946 mL glass jar	(quart)	Hand	763 (26.9)	66	(150)	63

Cooling: Begin the cooling operation immediately after the process time has elapsed. Cool under pressure all glass jars and metal containers, larger than No. 2 (307x409), rapidly to 38 C (100 F) with water. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

19. Okra

Container: Use plain tin containers or glass jars.

Quality of Product: Okra for canning should be harvested when tender and about half grown. Harvest the pods every two or three days in order to insure that the product at the canning plant is tender. Old okra is tough and should not be canned.

Preparation: Sort the product to remove tough, off-color or damaged pods. Inspect it and trim the stem and tip ends. Do not use iron knives or utensils for trimming okra since these cause it to turn black; stainless steel knives are recommended. Wash the okra thoroughly with water free of any iron. Do not allow the okra to stand in the water. After washing the okra, blanch it for three to four minutes in water at 88 C (190 F). This time for blanching should produce the bright green color desired for the product. After blanching, dip the okra in cold water free of iron to stop the cooking action and to facilitate handling. Drain the blanched and cooled okra. Cut the okra into 25.4 to 38.1 mm (1 to 1-1/2 inch) pieces or pack whole in separate containers. After cutting the okra, handle it as rapidly as possible in the following operations.

Filling: Pack okra to maximum fill weight for each size container specified in the Processing Temperatures and Times Schedule. Add boiling water or 2% brine to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Exhausting and Sealing: Exhaust the filled metal containers to a center container temperature of 77 C (170 F) and seal them immediately Where exhaust facilities are not available, precook the food, add it to the containers at 77 C (170 F) and seal containers immediately. Do not allow the contents to cool before processing below the minimum initial temperature in the Processing Temperatures and Times Schedule.

Processing:

Processing Temperatures and Times for Unfermented Okra in Brine

Container Size		Maximum Fill Weight grams (ozs.)	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 1 Picnic	(211x400)	187 (6.6)	21	(70)	36	29	24
			60	(140)	31	24	20
No. 303 can	(303x406)	286 (10.1)	21	(70)	36	29	24
			60	(140)	31	24	20
No. 2 can	(307x409)	349 (12.3)	21	(70)	36	29	24
			60	(140)	31	24	20
No. 2½ can	(401x411)	510 (18.0)	21	(70)	48	39	33
			60	(140)	40	32	28
No. 10 can	(603x700)	1871 (66.0)	21	(70)	56	48	42
			60	(140)	49	41	36
473 mL glass jar (pint)		306 (10.8)	77	(170)	32	25	20
946 mL glass jar (quart)		612 (21.6)	77	(170)	43	36	31

Cooling: Begin the cooling operation after the processing time has elapsed with cold running water in the retort. Cool under pressure all glass jars and metal containers larger than No. 2 (307x409) rapidly to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

20. **Onions, Scallions, Leeks.**

Processing onions, scallions, and leeks at the temperature required for adequate sterilization renders them mushy and unacceptable. For this reason, if this product is to be canned it must be processed in an acid medium in order that it may be processed in boiling water. Since careful supervision of all details are essential when acidification is necessary, a research laboratory associated with the canning industry should be consulted if this product is to be canned.

21. Parsnips

Containers: Use metal containers made of electrolytic tinplate with plain bodies and enameled ends or glass jars.

Quality of Product: Parsnips for canning should be fully mature, crisp and tender. Under-developed parsnips lack flavor and those that have developed in dry weather or in poor soil are frequently tough and woody; they should not be used for canning.

Preparation: Sort the parsnips to remove those of poor quality. Remove the tops, but leave 38 to 51 mm (1½ to 2 in.) of the stalk to facilitate peeling. Wash thoroughly to remove adhering soil. It is frequently necessary to soak the parsnips before they may be cleaned thoroughly. Scrub the product with a stiff brush until clean. After washing cut or slice them into sections for canning. The sections are usually about 38 mm (1½ in.) in length.

Filling: Pack the cut pieces or slices to within 6 mm (1/4 in.) of the top of metal containers and to within 13 mm (1/2 in.) of the top of glass jars. Add 2 percent brine or hot water to completely fill the metal containers and to within 6 mm (1/4 in.) of the top of glass jars.

When prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled containers to a center can temperature of 66 C (150 F) and seal them immediately. Where exhaust facilities are not available, precook the food, and add it to the cans at

66 C (150 F) and seal immediately. Do not allow the contents to cool below the minimum initial temperature shown in the Processing Temperatures and Times schedule before processing.

Processing:

Processing Temperatures and Times for Parsnips Slices or Cut Pieces in Brine

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 2 can (307x409) and Smaller	66	(150)	30	24	20
No. 2½ can (401x411)	66	(150)	30	27	25
No. 10 can (603x700)	66	(150)	50	44	40
473 mL glass jar (pint)	66	(150)	35	29	25
946 mL glass jar (quart)	66	(150)	40	34	30

Cooling: Begin the cooling operation immediately after the processing time has elapsed with cold running water. Cool all glass and metal containers larger than No. 2 (307x409) under pressure rapidly to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

22. Peas, Field (Blackeyed, Crowder, Etc.)

Container: Use C-enamel containers or glass jars.

Quality of Product: Peas for canning should be at a stage where the product retains its fresh green flavor, while the hull is sufficiently mature for fairly easy shelling. Although the yield of shelled out peas increases with the maturity and ease of shelling, the flavor and appearance of the product decreases.

Preparation: Sort peas in order to separate overmature, bruised, slimy or otherwise undesirable pods. Shell the peas either by hand or with mechanical pea shellers. Where large quantities are to be processed, the mechanical sheller is highly recommended. If these machines are used, the product must be handled rapidly to avoid spoilage. After the peas are shelled, wash them thoroughly. If for any reason they must be held for several hours or more, they should not be washed until just before subsequent operations are undertaken. During the washing, remove faulty peas and foreign materials by hand.

After the peas are thoroughly washed, blanch or give them a preliminary cook. The time for blanching is dependent upon the maturity of the peas. Where they are fairly mature, a blanch of approximately five minutes in steam or boiling water is necessary. If the peas are picked for flavor and greenness, approximately three minutes is sufficient.

Filling: Pack peas to within 25.4 mm (1 inch) of the top of tin containers or to within 32 mm (1-1/4 inch) of the top of glass jars. Add boiling water or 2 percent brine to completely fill tin containers or to

fill glass jars to within 13 mm (1/2 inch) of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 71 C (160 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 71 C (160 F) and seal the containers immediately. Do not allow the contents to cool below the minimum initial temperature shown in the Processing Temperatures and Times Schedule before processing.

Processing:

Processing Temperatures and Times for Field Peas - Blackeyed, Crowder Etc. in Brine

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 can	(303x406)	71	(160)	45	36	30
No. 2 can	(307x409)	71	(160)	45	36	30
No. 2½ can	(401x411)	71	(160)	50	41	35
No. 10 can	(603x700)	71	(160)	70	58	50
473 mL glass jar	(pint)	71	(160)	45	36	30
946 mL glass jar	(quart)	71	(160)	55	46	40

Cooling: Begin the cooling operation immediately after the processing time has elapsed and continue to cool with water to 38 C (100 F). Cool under pressure all glass containers and metal containers larger than No. 2 (307x409). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

23. Peas, Green (Garden)

Container: Use electrolytic tinplate containers with enameled bodies and ends or glass jars.

Quality of Product: Only young tender peas should be canned. They should be canned immediately after harvesting. The small ones are usually preferable because of their high sugar content and deep green color. The larger peas have a high starch content and are less desirable from the standpoint of both the flavor and color.

Preparation: Shell peas either by hand or by mechanical shelling machines. Where large quantities are to be processed, the mechanical shellers are recommended. If hand shelling is to be accomplished, it may be quickened by placing the peas in a blanching basket, dipping for a few minutes in boiling water and then plunging quickly into cold water. After shelling, sort the peas to remove broken, overripe or otherwise undesirable peas. Wash the peas thoroughly. If for any reason the product must be held for more than 3 hours, do not wash until just prior to undertaking subsequent operations. Normally, the peas are washed just prior to blanching.

After washing, blanch the peas either in hot water or in steam. Blanching serves to remove the mucilaginous material from the peas as well as fixing the color, improving the flavor, and permitting placing a greater weight of peas in the container. The length of blanching varies with the maturity of the peas and may be as short as 1/2 minute or as long as 30 minutes. The longer blanching times are usually required for large starch peas. Wash or rinse peas thoroughly after blanching in cold water.

Filling: Pack peas to the maximum fill weight shown in the Processing Temperatures and Times Schedule. Add boiling water or 2 percent brine to completely fill tin containers or to fill glass jars to within 6mm (1/4 inch) of the top.

When prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled metal containers to a center temperature of 60 C (140 F) and seal immediately. Where exhausting facilities are not available, precook, add it to the container at 60 C (140 F) and seal immediately. Do not allow the contents to cool below the minimum initial temperature shown in the Processing Temperatures and Times Schedule before processing.

Processing:

Processing Temperatures and Times for Green (Garden) Peas or Green (Garden) Peas and Carrots

Container Size		Maximum Drained Fill Weight grams	(ozs.)	Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
8Z Tall Can	(211x304)	167	(5.9)	21	(70)	32	21	14
				60	(140)	29	19	13
8Z Tall Can	(211x304)	181	(6.4)	21	(70)	35	23	17
				60	(140)	31	21	14
No. 303 Can	(303x406)	326	(11.5)	21	(70)	45	33	25
				60	(140)	40	27	20
No. 303 Can	(303x406)	383	(13.5)	21	(70)	66	52	44
				60	(140)	57	44	36
No. 2 Can	(307x409)	397	(14.0)	21	(70)	50	38	30
				60	(140)	45	32	25
No. 2½ Can	(401x411)	575	(20.0)	21	(70)	55	43	35
				60	(140)	50	38	30
No. 10 Can	(603x700)	2,041	(72.0)	21	(70)	59	42	30
				60	(140)	50	34	23
473 mL Glass Jar (pint)		337	(11.9)	60	(140)	45	33	25
946 mL Glass Jar (quart)		674	(23.4)	60	(140)	59	38	30

Cooling: Begin the cooling operation immediately after the processing time has elapsed and continue cooling using cold water to a temperature of 38 C (100 F). Drain and wipe the excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

24. **Peppers, Green**

Pressure cooking necessary to safely sterilize green peppers results in an undesirable product. For this reason, acidification is necessary to permit processing in boiling water. Acidification must be carefully controlled and the prospective canner should consult a research laboratory connected with the canning industry for details of processing.

25. **Pimientos**

Acidification of pimientos is desirable to prevent spoilage. Since acidification must be carefully controlled, the prospective canner of pimientos should consult a research laboratory connected with the canning industry. For this reason, no further information is included on the processing of pimientos.

26. Potato, Sweet

Container: Use electrolytic tinplate containers with enameled body and ends or glass jars. Plain tin was recommended when heavier tin coatings were available at a reasonable cost. The thinner coating does not give the protection that is necessary to prevent internal corrosion to the degree that iron in the tinplate will not become exposed and cause dark discoloration of the canned product.

Quality of Product: Freshly dug - not over 96 hours - roots produce the highest quality whole canned product. If a longer period of time elapses between the time the roots are dug and canned the canned product often breaks down and becomes mushy. This is due to enzymatic action by alpha and beta enzymes. Cured potatoes make a more desirable solid pack than freshly dug ones. If cured roots are used they should be used as soon as possible after curing. Old roots become shriveled and are difficult to peel satisfactorily, however, they may have more sugar and flavor. DO NOT USE SWEET POTATOES THAT HAVE RECEIVED CHILL INJURY DUE TO FROST OR BEEN EXPOSED TO TEMPERATURES BELOW 9 C (48.2 F).

Preparation: Wash the potatoes thoroughly to remove all dirt. A strong water spray is desirable. Soaking may be necessary to completely remove all adhering soil. After cleaning, peel the potatoes. They may be peeled by hand or more efficiently either by steam or by lye. Before peeling by either of these latter methods, however, grade the potatoes for size to give uniform results in the peeling operation.

If the potatoes are to be steam peeled, place them in retort crates or wire baskets and steam in retorts until the skin may be slipped from the potato by hand. This requires approximately 9 to 12 minutes at 116 C (240 F). The time of heating depends on the size and age of the potatoes. After steaming, place the potatoes under sprays or in water vats to cool for handling. It is preferable, however, not to cool the potatoes before peeling, but to handle them with heavy canvas gloves. Cooling before processing must be avoided because the rate of heat penetration with sweet potatoes is so slow that any cooling increases the processing time appreciably.

If the potatoes are to be lye peeled, immerse them in the lye solution and stir slowly. Keep them in a 10 percent solution of lye for from 4-1/2 to 8-1/2 minutes. Remove them from the lye when the skins begin to come off and wash. Washing is preferable performed under strong cold water sprays. Trim any remaining skin off by hand. Also, remove the stem end or deep pits.

Small potatoes may be canned whole. Cut large potatoes into pieces as desired. In order to prevent discoloration of cut potatoes, place them in a mild salt or one percent citric acid solution. Sweet potatoes may also be precooked and canned as mashed potatoes or as puree. Puree is made by adding enough water to the screened, mashed potatoes to make them soupy.

Filling: Pack sweet potatoes as hot as possible to within 6mm (1/4 inch) of the top of tin containers and to within 13mm (1/2 inch) of the top of glass jars. The potatoes may be either packed with syrup or packed in the solid pack fashion. For potatoes in 25% syrup, pack the potatoes as closely as possible without mashing them. It is preferable not to pack sliced potatoes together with the whole ones. Add boiling light syrup to completely fill tin containers and to fill glass jars to within 13mm (1/2 inch) of the top.

For the solid pack potatoes again pack the cut or mashed sweet potatoes as hot as possible into the containers. Mash the cut potatoes into the containers to fill the containers thoroughly or completely. Do not leave air spaces in the contents.

Exhausting and Sealing: Exhaust sweet potatoes to a center container temperature of 68 C (155 F) for solid packor higher and 77 C (170 F) or higher for those packed in syrup.

Processing:

Processing Temperatures and Times for Sweet Potato Solid Pack

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	121 C (250 F)
No. 1 Picnic can	(211x400)	49	(120)	73	
		66	(150)	68	
		82	(180)	61	
No. 2 can	(307x409)	49	(120)	105	
		66	(150)	100	
		82	(180)	85	
No. 2½ can	(401x411)	49	(120)	130	
		66	(150)	120	
		82	(180)	105	
No. 10 can	(603x700)	68	(155)	225	200
473 ml glass jar	(pint)	68	(155)	95	80
946 ml glass jar	(quart)	68	(155)	115	110

Processing Temperatures and Times for Whole Sweet Potatoes in 40% or less Syrup

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	121 C (250 F)
No. 303 can	(303x406)	49	(120)	39	24
		60	(140)	37	22
		71	(160)	35	20
No. 2½ can	(401x411)	49	(120)	52	34
		60	(140)	49	31
		71	(160)	45	28
No. 3 Vacuum can	(404x307)	49	(120)	52	34
		60	(140)	49	31
		71	(160)	45	28
No. 10 can	(603x700)	49	(120)	66	39
		60	(140)	59	36
		71	(160)	53	32
473 ml glass jar (pint)		77	(170)	55	40
946 ml glass jar (quart)		77	(170)	65	50

Cooling: Begin the cooling operation immediately with cold water and cool to 38 C (100 F). Cool under pressure all glass containers and all metal containers larger than No. 2 (307x409). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

27. Potatoes, White

Container: Use electrolytic tinplate containers with enameled bodies and ends or glass jars.

Quality of Product: Use only small, freshly dug potatoes. Old potatoes and potatoes that have been held in storage are too mealy for processing.

Preparation: Wash the potatoes thoroughly and peel. Peeling of potatoes may be accomplished either by hand, by steaming, or with lye (see sweet potatoes). If the potatoes are to be peeled by steaming, immerse them for a short time in boiling water or steam until the skins may be slipped off. After steaming, cool the potatoes to facilitate handling. Do not expose peeled potatoes to the air as they will darken. In order to prevent discoloration, dip the peeled potatoes into a mild salt solution, a one percent citric acid solution, or cover them with cold water until they are packed.

Filling: Pack potatoes to within 6 mm (1/4 inch) of the top of tin containers or to within 6 mm (1/4 inch) of the top of glass jars. Add boiling water or 2 percent brine to completely fill tin containers or to completely cover the potatoes in glass jars. The addition of $CaNa_2$ EDTA (calcium sodium ethylenediamine tetra-acetic acid) up to 100 ppm (parts per million) to control greying discoloration which is caused by iron sulfides and approximately 0.06% calcium to control sloughing to the brine are recommended. The calcium treatment is not usually recommended for potatoes having a specific gravity less than 1.075. Probably, the most satisfactory method of adding $CaNa_2$ EDTA with/without calcium would be to use tablets containing 1.4 to 1.7% $CaNa_2$ EDTA with/without 20% calcium chloride.

Where prepared brine is not utilized, salt in granulated or tablet

form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 71 C (160 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 71 C (160 F) and seal the containers immediately. Do not allow the contents to cool below the minimum initial temperature found in the Processing Temperatures and Times Schedule for White Potatoes in Brine.

Processing:

Processing Temperatures and Times for Whole White Potatoes in Brine

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 can	(303x406)	21	(70)	36	29	24
		60	(140)	33	26	21
		71	(160)	32	25	19
No. 2 can	(307x409)	21	(70)	37	30	25
		60	(140)	34	27	22
		71	(160)	33	26	20
No. 2½ can	(401x411)	21	(70)	44	37	32
		60	(140)	41	34	29
		71	(160)	40	33	27
No. 10 can	(603x700)	21	(70)	61	49	41
		60	(140)	52	41	34
		71	(160)	49	38	32
473 mL glass jar (pint)		71	(160)	40	34	30
946 mL glass jar (quart)		71	(160)	45	39	35

Cooling: Begin the cooling operation immediately after the processing time has elapsed with cold water and cool rapidly to 38 C (100 F). Cool under pressure all glass jars and metal containers larger than No. 2 (307x409). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

28. Pumpkin and Winter Squash

Container: Use R-enamel tin containers or glass jars.

Quality of Product: Use pumpkin varieties which are hard and sweet and evenly ripened. The flesh should be of good texture but not watery. Do not use frosted pumpkin.

Preparation: Wash pumpkin thoroughly, cut open and remove seeds and fiber. Discard pumpkin which show evidence of rot. Cut the pumpkin into pieces approximately one inch in size. Steam the pieces at 116 C (240 F) for approximately 20 minutes. (If steam is not available, the pieces may be cooked in boiling water until tender). Separate the pulp from the skin and tough fiber with a pulper or siever. Drain off excess water. Evaporate the product further by placing the pulp in a steam-jacketed kettle or stock pot and heat at about 100 C (212 F) until the desired consistency is obtained.

Filling: Pack pumpkin to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. The pumpkin should be filled as rapidly as possible to avoid the temperature of the product from falling below 85 C (185 F).

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 85 C (185 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 85 C (185 F) and seal the containers immediately. Do not allow the contents to cool below the minimum initial temperature found in the Processing Temperatures and Times Schedule for Pumpkin and Winter Squash before processing.

Processing:

Processing Temperatures and Times for Pumpkin or Winter Squash

Container Size		Minimum Initial Temperature °C (°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 300 can	(300x407)	60 (140)	72	65	59
		71 (160)	67	60	55
		82 (180)	61	55	50
No. 303 can	(303x406)	60 (140)	78	70	65
		71 (160)	73	66	60
		82 (180)	66	59	54
No. 2 can	(307x409)	60 (140)	88	79	73
		71 (160)	82	73	67
		82 (180)	74	66	61
No. 2½ can	(401x411)	60 (140)	117	107	97
		71 (160)	107	97	89
		82 (180)	97	86	79
No. 10 can	(603x700)	60 (140)	217	202	192
		71 (160)	197	187	177
		82 (180)	172	162	152
473 mL glass jar (pint)		82 (180)	85	77	72
946 mL glass jar (quart)		82 (180)	125	114	107

Cooling: Begin the cooling operation immediately after the processing time has elapsed with cold water and cool rapidly to 38 C (100 F). Cool under pressure all glass and metal containers larger than No. 2 (307x409). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

29. Squash, Summer

Container: Use R-enamel tin containers or glass jars.

Quality of Product: Only young, tender squash should be used.

Preparation: Wash the squash thoroughly, remove the stems and cut into slices approximately 13 to 20 mm (1/2 to 3/4 inch) thick.

Filling: Pack squash to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling water or 2% brine to completely fill tin containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled tin containers to a center container temperature of 66 C (150 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 66 C (150 F) and seal the containers immediately. Do not allow the contents to cool below the minimum initial temperature shown in Processing Temperatures and Times Schedule for Summer Squash.

Processing

Processing Temperatures and Times for Summer Squash in Brine

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 can	(303x406)	66	(150)	35	29	25
No. 2 can	(307x409)	66	(150)	35	29	25
No. 2½ can	(401x411)	66	(150)	45	36	30
473 mL glass jar	(pint)	66	(150)	35	32	30
946 mL glass jar	(quart)	66	(150)	45	42	40

Cooling: Begin the cooling operation immediately after the processing time has elapsed with cold water and cool rapidly to 38 C (100 F). Cool under pressure all glass containers and metal containers larger than No. 2 (307x409). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

30. **Squash, Winter**

For canning winter squash use the instructions and processing data used for pumpkin.

31. **Mixed Vegetables**

In general, mixtures vary in composition and in canning procedure. For this reason, it is considered advisable to consult with a research laboratory connected with the canning industry when mixtures other than whole grain corn, green beans, cut asparagus, cut celery, lima beans, peas, and diced carrots and white potatoes are to be canned. The vegetables can be canned in any desired combination.

Container: Use electrolytic tinplate containers with enameled body and ends or glass jars.

Quality of Product: The same quality is required for canning mixed vegetables that is required in canning the vegetables separately. Defective and otherwise undesirable vegetables should not be canned.

Preparation: Prepare each vegetable as if canning alone. Mix the vegetables in the desired proportions.

Filling: Pack vegetable and soup mixtures to within 6 mm (1/4 inch) of the top of tin containers or to within 13 mm (1/2 inch) of the top of glass jars. Add boiling water or 2 percent brine to completely fill metal containers or to fill glass jars to within 6 mm (1/4 inch) of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

Exhausting and Sealing: Exhaust the filled metal containers to

a center container temperature of 71 C (160 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 71 C (160 F) and seal the containers immediately. Do not allow the contents to cool below minimum initial temperature shown in Processing Temperatures and Times for Mixed Vegetables in Brine.

Processing:

Processing Temperatures and Times for Mixed Vegetables in Brine

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 1 Tall can (301x411)	66	(150)	36	33	31
No. 303 can (303x406)	66	(150)	38	35	33
No. 2 can (307x409)	66	(150)	41	38	36
No. 2½ can (401x411)	66	(150)	46	43	41
No. 10 can (603x700)	66	(150)	75	69	65
473 mL glass jar (pint)	66	(150)	45	38	35
946 mL glass jar (quart)	66	(150)	50	43	40

Cooling: Begin the cooling operation immediately after the processing time has elapsed with cold water and cool rapidly to 38 C (100 F) Cool under pressure all glass containers and metal containers larger than No. 2 (307x409). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

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CHAPTER NINETEEN

MEAT MICROBIOLOGY IN CANNING

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The Microbiological Flora of Meats

The microflora of fresh meat may consist of bacteria, molds, and yeasts. The chief cause of problems in the canning industry is generally bacterial growth. Fresh raw meats, such as beef, pork, lamb or chicken, have an established microflora which results from a composite of many natural conditions, the live animal itself, the dust, the air, and the water. On carcass meat the contamination flora arises from contact of the knife with the animal's hide, hair, and feet. Improper use of equipment or exposure to unclean implements may expose the carcass to organisms from the intestinal tract. The following factors in tabular form are known to affect the bacterial load on fresh meats:

1. Bacterial flora of the animal, including the intestinal load. Healthy animals, withheld from feed 24-36 hours, are recommended.
2. Method of slaughter and degree of bleeding. The slaughtering method should not excite the animal and should permit good bleeding.
3. Degree of sanitation during killing and opening the carcass to prevent contact of meat with fecal material, hide, hoofs, hair; sanitation during scalding and skinning operations. Strict observance of critical contamination areas is essential.
4. Rate of cooling the carcass. Rapid cooling is the greatest weapon for immediate control of bacterial populations.

5. Degree of sanitation in cutting of meat to avoid possible contacts with diseased meat and other contaminated surfaces. These are very critical areas of control.

Other factors which affect contamination levels within the meat processing plant are among the following:

1. General sanitary condition of the meat plant
2. Freedom from rodents and insects
3. Health, working habits, and personal hygiene of workers
4. Competency of supervision

The microflora of fresh meats, poultry and flesh type foods, is important because it contributed to flavor, odor, color, stability, and safety. There are usually many kinds of microorganisms present in raw meats. Prior to processing certain of these microbes may grow and produce undesirable appearance, odor, and taste which results in spoilage. Others may grow to produce a food-borne illness, if handled under improper conditions. Spore-forming bacteria may be present to produce spores. Spores of many species are heat resistant and are able to survive thermo-processing to later cause spoilage if growth conditions become conducive in the canned product.

Fresh meats, including red meats and poultry, being the most perishable of all important food groups, are very susceptible to microbial deterioration. Thus, raw meats must be handled in a sanitary manner under proper refrigeration. The reasons why fresh meats are so perishable are several:

1. Meats contain an abundance of most nutrients required for microbial growth.
2. Fresh meats have pH values within the growth range of most microbes.

3. Moisture contents of meat are near the optimum level for most microbes.
4. Meats can support the oxygen requirements for a wide array of bacterial activity from the strict aerobe (growing on the surface) to the strict anaerobe (growing deeply within the tissue).
5. Fresh meats do not possess antimicrobial constituents.

Thus, fresh meats provide conditions suitable for a wide array of bacterial growth. In order to prevent microbial growth prior to processing, one must consider temperature of storage (incubation temperature) to be of utmost importance. It is imperative that fresh meats be chilled immediately after slaughter and be held at temperatures close to freezing until the meat is processed to go into the canning tin. Such precautions will help avoid undesirable organoleptic changes and, thus, help to insure a high quality canned meat product.

As a point of interest, chilling of meats does not prevent all microbial activity. Low temperature spoilage can occur after extended storage as a result of psychrotrophs growth. Psychrotrophs grow below 10°C (50°F) presenting a problem in refrigerated meats. Many bacteria in this group will grow best at warmer temperatures 20-25°C (68 -77°F); however, their activity continues at low temperatures. For psychrotrophs the lower the temperature, the longer the lag phase before growth begins and the slower the growth rate once the "rapid growth" phase has been reached as depicted in Figure 117, "Bacterial Growth Curve."

Figure 117 represents the general growth curve of a bacterial population under a given set of conditions. Growth occurs in the form of cell reproduction

At the end of the lag phase, bacteria start multiplying and very soon thereafter the increase in cells is directly related to time. This is the "rapid growth" or logarithmic growth phase when the increase is at its maximum. The slope of the "rapid growth" phase tells the rate of growth. The steeper the curve the faster the growth.

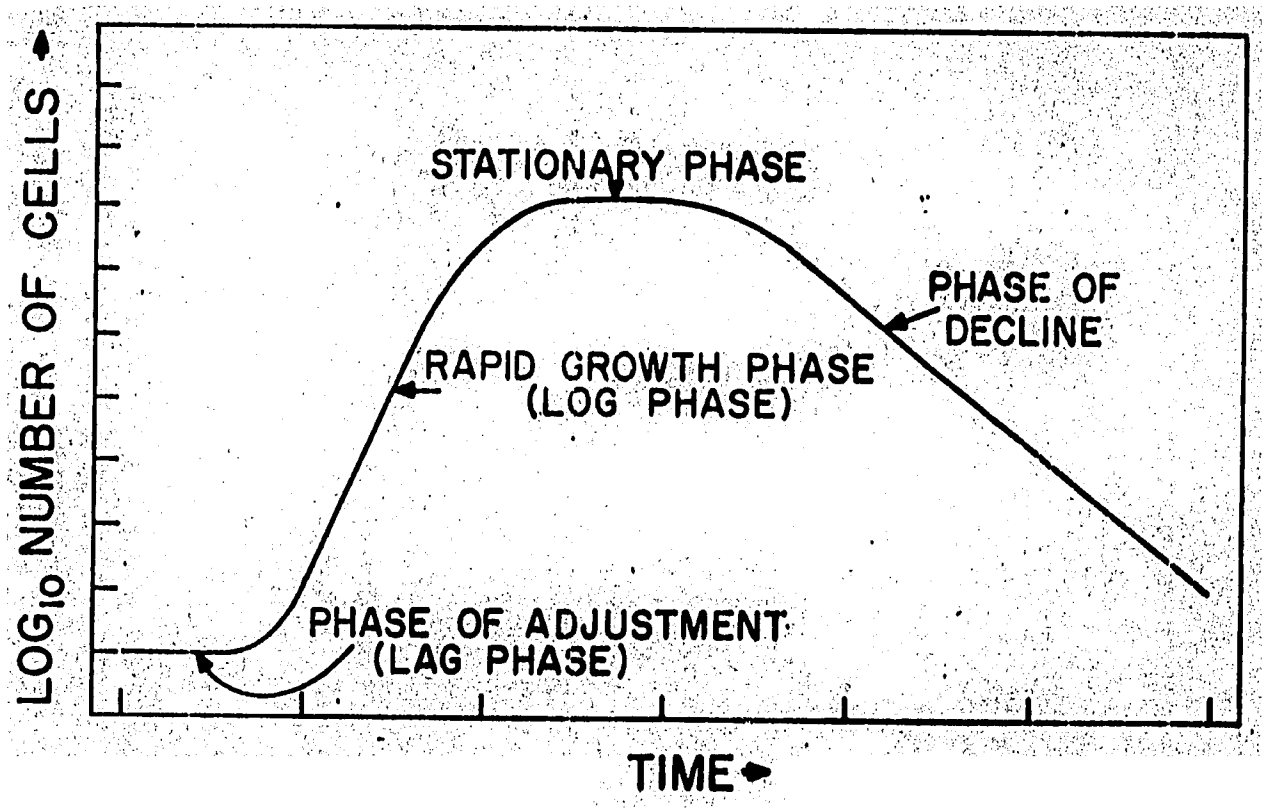

Figure 117. Bacterial Growth Curve

To insure the storage life of fresh meats many commercial establishments hold their meats just above the freezing point, which is 28-30°F. In meat canning operations, raw meats should be kept as cold as possible and processed

within a few days. The use of frozen meats for canning is a very acceptable practice if meats are rapidly defrosted and are used immediately. Thawed meats are more susceptible to deterioration than fresh raw meats for reasons as follows:

1. Thawed meats have greater available nutrients in a liquid phase as a result of meat "drip" or "weepage".
2. Psychrotrophic bacteria are better adapted to rapid growth in thawed meats.

Problem Areas with Meats from a Microbiological Viewpoint

Many individuals may be lackadaisical about proper handling of canning types of meat, because of the lethal effects of heat in canning. There are many special concerns, even though meats during the canning process will undergo heat treatment sufficient to render the product free of all pathogens (disease producers) and most spoilage types. Certain bacteria which form endospores may survive heating to later cause spoilage. A dreaded sporeformer, Clostridium botulinum, may find its way into meats; if not adequately processed, meats may contain surviving spores which may give rise to vegetative cells, capable of producing toxin which is often fatal. Meats, like other low acid foods, require careful thermo-processing to eliminate all spores of C. botulinum. This category of thermo-processing should not be confused with heat pasteurization as in certain canned meats such as boiled ham, meat loaf, or cooked sausage. These canned products are different because they must rely on refrigeration for storage. Most of these canned products contain sodium or potassium nitrite which offers protection against C. botulinum. The use of nitrite and the production of canned refrigerated meats is not advisable, unless done under a commercial environment with adequate supervision, backed by a high degree of expertise.

When problems occur in the conventional canning of meats, they may often be traced to one of the following:

1. Less than fresh or deteriorating raw meats with high bacterial counts
2. High bacterial spore counts from raw materials or equipment
3. Underprocessing to allow viable C. botulinum.
4. Improper sealing and processing of cans.

Within the cannery, clean fresh meat is only the starting point, proper canning of meats depends on clean equipment, tables, utensils and canning tins or glass. General sanitation will greatly affect the final product. Any unsanitary condition which allows bacterial build-up may serve to provide a direct inoculum to the product.

Meats being held at room temperature awaiting the retort offers potential problems. Prior to the exhausting step, meat must stand unprocessed for a time before it can be heat processed; however, chilled raw meat should not stand for morethan 4 hours, because bacteria will begin to grow. Under optimum growth conditions, many species of microbes can double their number every 20-30 minutes at room temperature. The following table presents the number of bacteria at each time period starting with an initial count of 25 with varying generation times.

Table LX. Numbers of Bacteria vs Different Generation Times

TIME (Hr:Min)	GENERATION TIME 0.5	1.0 hr	4.0 hr
12:00	25	25	25
12:30	50		
1:00	100	50	
1:30	200		
2:00	400	100	
2:30	800		
3:00	1,600	200	50
3:30	3,200		
4:00	6,400	400	
4:30	12,800		
5:00	25,600	800	
5:30	51,200		
6:00	102,400	1,600	
6:30	204,800		
7:00	409,600	3,200	100
7:30	819,200		
8:00	1,638,400	6,400	
8:30	3,276,800		
9:00		12,800	

Generation time = The time required for the population to double its number.

Generation time is another way to look at rate of growth. The temperature of the meat during holding is one of the most important factors governing bacterial growth. Temperature control is one of the greatest weapons against bacterial growth. In addition, the pH of the meat and the moisture conditions of the meat surfaces are two other important factors of growth. The control of microbiological growth in holding fresh meats may hinge on all of the factors.

As shown in Figure117, bacterial growth goes through a lag phase or a period of adjustment. Holding meats at lower temperatures will help keep the bacterial population in its lag phase. The length of the lag phase and the rate at which bacteria multiply in the "rapid growth" phase are under the direct control of temperature. By temperature control alone it is often possible to lengthen the lag phase of bacterial growth sufficiently to permit completion of a processing operation before active growth occurs in the product. It is recommended that we avoid the "rapid growth" phase by holding raw meats under strict temperature control.

The initial bacterial level within the meat will affect the bacterial activity. Generally speaking, the greater the number of bacteria present, the shorter the lag phase of growth and the more rapid the "logarithmic" growth phase by increased multiplication. Hence, every effort should be made to hold down to a minimum the contamination level. In other words, the larger the number of bacteria present at the start, the shorter the time required to reach a particular final population or reach a spoilage level.

Canned meats, like many other low acid foods, are susceptible to spoilage. This condition can occur at any stage after retorting. Generally

speaking, canned meats are not processed to destroy all bacterial spores. The spores of thermophilic (*heat loving*) bacteria, being generally more heat resistant that mesophilic types, may survive heat processing. If total thermal destruction were achieved in canned meats, the products would not be organoleptically acceptable. Thermophilic spoilage in canned meats is controlled by rapid cooling after retorting and subsequent storage under cool to warm temperatures (65-100°F). Very warm storage (100-140°F or 38-60°C) may permit the thermophilic organisms to begin growth.

If a spoilage condition in canned meats is traced to a vegetative bacterial type, (non-sporeformer), mold, or yeast, then there was probably a condition of leakage or under processing.

For spoilage to occur in canned meats, many factors may be involved. The following factors are in tabular form:

1. Numbers of particular organisms surviving the heat process
2. Temperature at which the finished product is held
3. Suitability of the canned meat to support growth of the organism
4. The temperature the finished product is held
5. The pH of the meat in relation to growth of surviving organisms
6. The presence of nitrite or other inhibitors

Successful canning of meat products requires adequate knowledge of microbiology. From a microbiological point of view, meats are unique and must be treated special in order to insure the production of wholesome, safe meat products.

CHAPTER TWENTY

CANNING MEATS AND POULTRY

General Discussion

While meats may be canned throughout the year, certain animals are generally slaughtered at the end of the grass growing season. If this time occurs after the fruit and vegetable season is past, an efficient canning schedule can be employed. Canning in this way prolongs the operating season of the canning plant.

Meats for canning should be from healthy animals of good quality that have been slaughtered and prepared for canning in a sanitary manner. After animals such as cattle and sheep have been slaughtered and dressed, the meat should be allowed to age and become tender. Aging is normally carried out at about 2 C (36 F) for 7 to 20 days depending on the quality of the animal. Meats such as pork and poultry should not be aged but should be prepared and processed or frozen immediately. If the meat such as beef cannot be canned immediately after aging, refrigeration facilities should be available for storing the meat. If it is necessary to hold the meat for two or three days, it should be kept at 1 C (34 F); for long-time storage, it should be frozen until canned. If the meat is frozen, keep it so until canning time since alternate freezing and thawing spoils the meat.

All meats are low acid products and as such must be processed at a minimum of 116 C (240 F) to kill the harmful microorganisms. Thus, the processing of meat must take place under pressure.

The processing instructions for heavy meats such as beef, veal, lamb, mutton, pork, venison, and the meat of other large animals are the same.

The processing instructions for poultry such as chicken, duck, and turkey, and small game such as rabbits are also the same. In general, the canning of mixtures of meats and vegetables is not recommended unless the processing instructions and data are obtained from a research laboratory associated with the canning industry.

1. Roast, Steaks, Stew Meats (Beef, Veal, Pork, Lamb, Mutton, Venison)

Container: Use containers that have electrolytic tinplate with enameled body and ends and are manufactured especially for meat products. Some enamel linings in the containers and sealing compound in the ends may be soluble in the presence of certain fats and oils thus causing the container to lose its seal resulting in the spoilage of the meat. Some brands of tops for glass containers are not recommended for the same reason. The sealing compound in the metal center of the two piece lid has been found to be soluble also in the presence of certain fats and oils. The jars would lose their seal causing spoilage of the meat product. Use only those brands of tops that are resistant to fats and oils.

Quality of Product: For canning in large pieces, use loin, round, chuck, shoulder, or other cuts suitable for roast, steaks or chops. Use the trimmings and the less tender cuts such as brisket, neck and shanks for canning as stew meat.

Preparation: Remove the bone and most of the fat. Too much fat makes the meat difficult to process. Save the bones to make the broth with which the containers are filled. Cut roast across the grain of the meat in lengths that will come approximately 6 mm (1/4 inch) above the top of the container. Cut steaks and chops as for serving fresh and pack in layers to fit the container. Use the meat cut and trimmed from the larger pieces as stew meat, and handle it in the same way as the larger pieces.

Precooking and Filling: Roasts, steaks and stews may be either precooked and packed hot into the containers or packed raw and exhausted in the containers. The method utilized is dependent upon facilities available and the canning schedule. In either case, the meat shrinks during the precooking or exhausting sufficiently to prevent excessive shrinking during processing. Preshrinkage assures a full pack and expels air from the product. Precooking is recommended over packing raw and exhausting in the containers because it makes possible for a more uniform fill weight. Precooking is more efficient use of energy or steam and time than the long exhaust period required by the raw pack method.

If cuts of meat are to be packed hot, place the cuts of meat in covered shallow pans with a very small amount of water. The cover is to prevent steam condensate from dropping into the pans during steam cooking. Stack the pans on top of each other in a retort. Cook in the retort at 116 C (240 F) until the meat turns from a red to pink color at the center of cut - it usually requires from 25 to 30 minutes depending upon the thickness of cuts. Cool the containers or meat to 99 C (210 F) under air pressure to avoid drawing the natural juices from the meat. If air pressure is not available, allow the pressure in retort to drop slowly. Precook stew meats in steam-jacketed kettles and allow to simmer until the meat turns from a red to pink color.

Fill the containers with the hot precooked meat to within 6 mm (1/4 inch) of the top of metal containers and 12.6 mm (1/2 inch) of top of glass containers. Add salt before the meat is placed in the containers. Fill metal containers completely with boiling broth which has been prepared from scraps of meat and bone. Fill glass containers to within 6 mm (1/4 inch) of the top.

If the meat is to be packed raw, fit the pieces tightly into the containers to fill them completely. Add salt by placing it in the containers before the meat is added. Exhaust the containers containing the raw meat to a center container temperature of 77 C (170 F). Exhausting normally requires about 50 minutes depending upon size of container used. When the proper temperature has been reached, press the meat into the containers to obtain the proper head space. Fill with broth if needed as was done in the hot-pack method.

Sealing: Seal immediately. Do not allow the contents of the containers to cool below the minimum initial temperature specified in the Processing Temperatures and Times Schedule for Meats.

Processing:

Processing Temperatures and Times for Roast, Steaks and Stew Meat

(Beef, Veal, Pork, Lamb, Mutton and Venison)

Container Size	Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 can (303x406)	77	(170)	75	65	55
No. 2 can (307x409)	77	(170)	75	65	55
No. 2½ can (401x411)	77	(170)	100	90	80
473 mL glass jar (pint)	77	(170)	90	80	70
946 mL glass jar (quart)	77	(170)	105	95	85

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool under pressure all glass containers and No. 2½ (401x411) and larger cans. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

2. Ground Meat

Container: Use containers that have electrolytic tinplate with enameled body and ends and are manufactured especially for meat products. Some enamel linings in the containers and sealing compound in the ends may be soluble in the presence of certain fats and oils thus causing the container to lose its seal resulting in the spoilage of the meat. Some brands of tops for glass containers are not recommended for the same reason. The sealing compound in the metal center of the two piece lid manufactured by some companies has been found to be soluble also in the presence of certain fats and oils. Containers using these lids would lose their seal causing spoilage of the meat product. Use only those brands of tops that are resistant to fats and oils.

Quality of Product: The quality of meat required for ground meat must be essentially the same as that of meat canned in whole sections. In general, however, the meat may be somewhat coarser or fatter than meat canned whole.

Preparation: Grind the meat for hamburger in a meat chopper or grinder. Add 272 grams (9½ ounces) of salt for each 11.35 kilos (25 pounds) of meat and mix well. Add additional seasoning if desired. If spices are added, it should be noted that their flavor changes during storage.

Precooking and Filling: Ground meat may be packed into the containers raw or as cakes or links which have been precooked. The method utilized is dependent upon the equipment available and the canning schedule.

When packing the meat raw, fill the containers about 19 mm (3/4 inch) above the top. The meat can be packed in bulk or link form.

Exhaust to a center container temperature of 77 C (170 F). Exhausting requires approximately 75 minutes. Once the meat has been exhausted to the proper center container temperature, press it down into the containers. Leave not more than 13 mm (1/2 inch) of space at the top of metal containers. The liquid from the meat should fill the metal containers completely. Add additional medium if necessary.

If precooked, pack ground meat as either cakes or links to within 13 mm (1/2 inch) of the top. Completely fill metal containers with hot broth. Fill glass jars to within 6 mm (1/4 inch) of top with hot broth.

Sealing: Seal the containers immediately. Do not allow the contents of the containers to cool below the minimum initial temperature specified in the Processing Temperatures and Times for Meat Schedule before processing.

Processing:

Processing Temperatures and Times for Ground Meat

(Cakes - Hot)

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 can (303x406)	77	(170)	75	65	55
No. 2 can (307x409)	77	(170)	75	65	55
No. 2½ can (401x411)	77	(170)	100	90	80
473 mL glass jar (pint)	77	(170)	90	80	70
946 mL glass jar (quart)	77	(170)	105	95	85

Processing Temperatures and Times for Ground Meat
(Solid-Raw)

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 can (303x406)	77	(170)	100	85	75
No. 2 can (307x409)	77	(170)	100	85	75
No. 2½ can (401x411)	77	(170)	135	120	110
473 mL glass jar (pint)	77	(170)	100	90	80
946 mL glass jar (quart)	77	(170)	135	125	110

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool under pressure all glass containers and No. 2½ (401x411) and larger cans. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

3. Tongue and Heart (Beef)

Container: Use containers that have electrolytic tinplate with enameled body and ends and are manufactured especially for meat products Some enamel linings in the containers and sealing compound in the ends may be soluble in the presence of certain fats and oils thus causing the container to lose its seal resulting in the spoilage of the meat. Some brands of tops for glass containers are not recommended for the same reason. The sealing compound in the metal center of the two piece lid has been found to be soluble also in the presence of certain fats and oils. The jars would lose their seal causing spoilage of the meat product. Use only those brands of tops that are resistant to fats and oils.

Preparation: Wash the heart thoroughly. Remove the thick connective tissue and cut it into pieces. Place the pieces in a steam-jacketed kettle or stock pot, partially cover with water, and simmer for 25 to 40 minutes or until the pieces show only a slight pink at the center. Wash tongue thoroughly, place it in a steam-jacketed kettle or stock pot and cover with boiling water. Simmer for about 45 minutes or until the skin can be removed. Remove the skin and cut the tongue into pieces.

Filling: Add seasoning to the containers before they are filled. Pack heart and tongue separately. Pack the hot, 82 C (180 F), meat into the containers to within 6 mm (1/2 inch) of the top of the containers. Fill tin containers as completely as possible with boiling broth. Fill glass containers with boiling broth to within 6 mm (1/4 inch) of top.

Exhausting and Sealing: Exhaust, if necessary, to a center container temperature of 77 C (170 F). Seal the containers immediately after filling hot or exhausting. Do not allow the contents to cool below the minimum initial temperature specified in the Processing Temperatures and Times Schedule for Tongue and Heart (Beef) before processing.

Processing:

Processing Temperatures and Times for Tongue and Heart (Beef)

Container Size	Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 can (303x406)	77	(170)	75	65	55
No. 2 can (307x409)	77	(170)	80	70	60
No. 2½ can (401x411)	77	(170)	105	95	85
473 mL glass jar (pint)	77	(170)	90	80	70
946 mL glass jar (quart)	77	(170)	105	95	85

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool under pressure all glass containers and No. 2½ (401x411) and larger cans. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they completely cool and dry.

4. Corned Beef

Container: Use containers that have electrolytic tinplate with enameled body and ends and are manufactured especially for meat products. Some enamel linings in the containers and sealing compound in the ends may be soluble in the presence of certain fats and oils thus causing the container to lose its seal resulting in the spoilage of the meat. Some brands of tops for glass containers are not recommended for the same reason. The sealing compound in the metal center of the two piece lid has been found to be soluble also in the presence of certain fats and oils. The jars would lose their seal causing spoilage of the meat product. Use only those brands of tops that are resistant to fats and oils.

Preparation: Wash the corned beef and cut it into pieces suitable for packing. Remove excess fat from the meat. Cut the meat into large pieces to fit the containers with the grain of meat running lengthwise. Place the cut pieces in a steam-jacketed kettle or stock pot and cover with cold water. Heat the meat to 82 C (180 F).

Filling: Pack the hot, 82 C (180 F), meat into containers to within 13 mm (1/2 inch) of the top. Fill metal containers completely with boiling water. Fill glass jars with boiling broth to within 6 mm (1/4 inch) of top.

Exhausting and Sealing: Exhaust, if necessary, to a center container temperature of 77 C (170 F). Seal the containers immediately after filling hot or exhausting. Do not allow the contents to cool below the minimum initial temperature specified in the Processing Temperatures and Times Schedule for Corned Beef before processing.

Processing:

Processing Temperatures and Times for Corned Beef

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 can	(303x406)	77	(170)	85	70	60
No. 2 can	(307x409)	77	(170)	90	75	65
No. 2½ can	(401x411)	77	(170)	115	105	90
473 mL glass jar (pint)		77	(170)	95	85	75
946 mL glass jar (quart)		77	(170)	120	110	100

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool under pressure all glass containers and No. 2½ (401x411) and larger cans. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they completely cool and dry.

5. Poultry and Small Game (Boned)

Container: Use containers that have electrolytic tinplate with enameled body and ends and are manufactured especially for meat products. Some enamel linings in the containers and sealing compound in the ends may be soluble in the presence of certain fats and oils thus causing the container to lose its seal resulting in the spoilage of the meat. Some brands of tops for glass containers are not recommended for the same reason. The sealing compound in the metal center of the two piece lid has been found to be soluble also in the presence of certain fats and oils. The jars would lose their seal causing spoilage of the meat product. Use only those brands of tops that are resistant to fats and oils.

Quality of Product: Plump fowl or animals should be used for canning boned style. If young birds are canned, the texture and flavor of the meat is not as good as that from more mature birds.

Preparation: Dress the bird or animal for cooking. Take care not to break the gall bladder of poultry since this spoils the meat. Cut the bird or animal into pieces such as breast, thighs, legs, back, neck, etc. and separate the giblets, such as heart, liver, etc. If giblets are kept, they should be canned separately. Remove lumps of fat. Cover the meat with lightly salted cold water and simmer until the meat is tender. Keep the broth for use as a canning medium. Strip the meat from the bones.

Filling: Pack the hot, 82 C (180 F), meat into the containers to within 6 mm (1/4 inch) of the top of metal containers immediately before allowing

it to cool. Fill glass containers to within 12.6 mm (1/2 inch) of top. Add boiling broth to completely fill metal containers and to within 6 mm (1/4 inch) of top of glass containers. Add salt as desired.

Exhausting and Sealing: Exhaust the filled containers to a center container temperature of 82 C (180 F) and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the containers at 82 C (180 F) and seal the containers immediately. Do not allow the contents to cool below the minimum initial temperature specified in the Processing Temperatures and Times Schedule for Poultry and Small Game (boned) before processing.

Processing:

Processing Temperatures and Times for Poultry and Small Game (Boned)

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 can	(303x406)	77	(170)	95	85	75
No. 2 can	(307x409)	77	(170)	100	90	80
No. 2½ can	(401x411)	77	(170)	115	105	95
473 mL glass jar (pint)		77	(170)	90	80	70
946 mL glass jar (quart)		77	(170)	115	105	95

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool under pressure all glass containers and No. 2½ (401x411) and larger cans. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they completely cool and dry.

6. Poultry and Small Game (Not Boned).

Container: Use containers that have electrolytic tinplate with enameled body and ends and are manufactured especially for meat products. Some enamel linings in the containers and sealing compound in the ends may be soluble in the presence of certain fats and oils thus causing the container to lose its seal resulting in the spoilage of the meat. Some brands of tops for glass containers are not recommended for the same reason. The sealing compound in the metal center of the two piece lid has been found to be soluble also in the presence of certain fats and oils. The jars would lose their seal causing spoilage of the meat product. Use only those brands of tops that are resistant to fats and oils.

Quality of Product: The quality of the bird or animal for canning on the bone should be as good as that for canning in the boned style. Only the meaty pieces of the bird or animal should be canned by this method.

Preparation: Dress the bird or animal as for cooking. Cut into pieces such as breast, thighs, legs, etc. Do not utilize bony pieces such as back, wings, neck, etc. Trim fat from the animal.

Precooking and Filling: The meat may then either be precooked before packing or packed raw and exhausted. The method utilized is dependent upon equipment available and the canning schedule.

If the bird or animal is to be precooked and packed hot, place the meaty portions in a steam-jacketed kettle or stock pot and cover with hot water. Precook until the meat is medium done or until it shows a pink color at the center of the pieces.

Pack the hot, 82 C (180 F), precooked meat to within 6 mm (1/4 inch) of the top of metal containers and 12.6 mm (1/2 inch) of top of glass containers.

If meat is to be packed raw, pack to within 6 mm (1/4 inch) of the top of containers. Add boiling broth to completely fill metal containers and to within 6 mm (1/4 inch) of top of glass containers.

Exhausting and Sealing: Exhaust the containers packed with raw meat to a center container temperature of 82 C (180 F). Seal containers immediately after filling hot or exhausting. Do not allow the contents to cool below the minimum initial temperature specified in the Processing Temperatures and Times Schedule for Poultry and Small Game (Not Boned) before processing.

Processing:

Processing Temperatures and Times for Poultry and Small Game (Not Boned)

Container Size		Minimum Initial Temperature °C	(°F)	Minutes at Retort Temperature 116 C (240 F)	118 C (245 F)	121 C (250 F)
No. 303 can	(303x406)	77	(170)	70	65	60
No. 2 can	(307x409)	77	(170)	75	70	65
No. 2½ can	(401x411)	77	(170)	90	85	80
473 mL glass jar	(pint)	77	(170)	85	75	65
946 mL glass jar	(quart)	77	(170)	110	100	90

Cooling: Begin the cooling operation immediately after the processing time has elapsed. Cool under pressure all glass containers and No. 2½ (401x411) and larger cans. Cool the containers rapidly with cold water to 38 C (100 F). Drain and wipe excess water from the containers. Do not stack or store the containers until they completely cool and dry.

Rendering lard is a process of removing the moisture from animal fat by some means of heat, usually in a stainless steel steam jacketed kettle. However, sometimes iron kettles are used if free of rust. Copper and rusty iron kettles are not recommended because of the discoloration that develops in the lard during rendering. Overcooking or rendering at temperatures in excess of 116 C (240 F) increases the free fatty acid content, lowers its keeping quality, develops pronounced off-flavors and odors and darkness in color.

Containers:

Either plain tin cans or glass containers with oil and fat resistant lids are suitable for lard. Use only meat type of enameled cans if plain tin is not available. The fats and oils in lard will soften some types of enamel linings in cans. One of the primary considerations in selecting containers is size. Containers too large will frequently waste lard because it will become rancid before it can be utilized. Containers too small add to the cost of processing. A size should be selected that will provide the quantity of lard needed for a period not exceeding 20 to 30 days. Once a container is opened, the lard will become rancid relatively quick, particularly in warm humid climates. A container should be selected for which a reasonably tight cover can be used to close the container after opening and while in use. The cover will serve to protect the contents from excessive air, dirt, insects and other foreign material.

Quality of Product:

For white, creamy, high quality lard, the fat should be trimmed and rendered from only freshly killed (not over 48 hours) and chilled carcasses. Fat that is several days old produces an unstable lard of relatively poor quality.

Ruffle fat, fat from around the intestines, yields a dark, less desirable product that should be rendered and kept separate from lard made from leaf, back and cutting fat.

Yield of Rendered Lard:

Leaf fat (the layer of fat around the kidneys) yields from 90 to 93 per cent of its weight. It is perhaps the highest quality lard produced from an animal.

Combination of leaf, back and cutting fat yields from 80 to 85 percent of its weight.

Ruffle fat yields only 50 to 60 percent of its weight.

Preparation:

Cut fat into one inch cubes or run through a meat or food chopper. Fat ground or cut into small pieces renders faster and gives larger yield than fat that is cut into large pieces. If cracklings are desired, the fat should be cut into pieces or cubes.

Cooking:

Place a small quantity of water in a steam jacketed kettle and add the cut fat. Apply steam and cook relatively slow, stirring frequently until the lards obtain a temperature of 116 C (240 F). Caution! Do not allow the temperature to exceed 116 C (240 F). Continue cooking and stirring, holding the temperature constant at 116 C (240 F), until the cracklings become amber in color and start settling to the bottom of the kettle. Particular care needs to be exercised to prevent scorching when the cracklings begin settling.

The addition of 1 to 1½ kilos (2 to 3 pounds) of hydrogenated vegetable shortening to every 22.7 kilos (50 pounds) of lard at rendering time just before

settling and separating the cracklings, will improve the quality and shelf-life of the lard. The shortening should be stirred thoroughly into the hot lard. The vegetable oils used in making the vegetable shortening contain Vitamin E (tocopherol), which is an antioxidant. If hydrogenated vegetable shortening is not used, an approved food grade antioxidant is recommended. There are several of these antioxidants that are approved for foods; 1/ BHA (butylated hydroxyanisole), 2/ BHT (butylated hydroxytolulene), 3/ glycine. 4/ propyl gallate, 5/ resin guaiac, and 6/ tocopherols.

The lard can be drawn off when moisture ceases to rise from the lard. The lard should be pressed and strained through clean press cloths, free from any rancidity, and cooled immediately. The longer the lard remains hot the more fatty acids are formed, which cause unstable lard. If lard is allowed to cool without stirring, oils will separate from the stearin causing the development of a grainy texture. When the lard cools to a creamy consistency, it should be stirred or agitated in the sealed containers vigorously and allowed to harden. This will produce a lard with excellent texture.

Storage:

Lard should be stored at 4.5 C (40 F). Warmer storage temperature will contribute to a less stable lard having a short storage-life.

CHAPTER TWENTY-ONE

FISH CANNING

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Introduction

In this chapter, the term canning is used to describe the method of preservation involving the thermal processing of seafood products. Seafood products are also preserved in cans by smoking, pickling, salting, and pasteurization.

Canning in this perspective includes the total unit operations of the process as: product safety; quality control, pretreatment of the fish, preparation of sauces and brines; adequate processing times and temperature; can seam evaluation; and can cooling and storage.

Safety of Seafood Products

1. Bacterial

a. Staphylococcal Poisoning

Canned seafood has been a cause of staphylococcal food poisoning. The cause of the poisoning has been related to contamination during handling combined with inadequate time-temperature handling conditions which have allowed the growth of *Staphylococcus aureus* before heat processing and possibly subsequent inadequate thermal processing. It is important to remember that *S. aureus* enterotoxin is relatively heat-stable and may not be completely destroyed or denatured during thermal processing. When *S. aureus* has been found in canned seafoods, the cans were not swollen nor did the products have abnormal organoleptic properties.

1. Botulinum Poisoning

Botulinum poisoning in seafood is seldom encountered in some countries while relatively common in others. It is noteworthy that type E is almost always involved. This is not unexpected since type E is found in mud samples taken from seafood producing waters. Since the organism is in the mud, it is not surprising that it would be found in the various fish and shellfish. The fish muscle is an excellent growth medium and the organism can grow at refrigerated temperatures as low as 2° C.

Type E poisoning in canned fish products has been related to inadequate thermal processing and post-processing contamination through faulty sealed cans. It should be emphasized that botulism poisoning is not limited exclusively to type E. Other types have been observed to occur in various processed fish products.

2. Naturally Occuring Poisons

a. Tetraodon Toxin

This group includes the puffer-like fishes which is composed of ocean sunfishes, puffers, and porcupine fishes. A characteristic of all puffers is that they can inflate themselves with air or water. The liver, gonads, intestines, and skin of the fish contain tetraodon toxin. A few species seem to carry the toxin in the muscle tissue. The heat stability of tetraodotoxin has been studied. It was found that the usual commercial canning procedure caused a loss in toxicity of cut whole fish, but not enough to allow safe human consumption. Procedures included heating to 100°C for 10 minutes and under pressure to 116°C. These steps did not inactivate the poison completely and cannot be relied upon to destroy

the poison in canned fish. Toxicity differs greatly with species, however, as little as 2 g. of ovary tissue can cause death.

b. Paralytic Shellfish Poisoning

Under ordinary circumstances most molluscs are edible. However, at times they feed on certain dinoflagellates which produce a dangerous toxin. The dinoflagellates are ingested by the molluscs and the toxin is stored in various parts of the shellfish. Some shellfish remain toxic for long periods of time after ingestion of the toxin.

The toxin is relatively heat stable and is not completely destroyed during normal heat processing operations. Canned clam, processed to 115°C in the normal warmer, may still contain 50% or more of the poison. In order to prevent accidental poisoning, shellfish waters are monitored for toxin content by use of the mouse test. The test, however, is not standardized through the world and some countries report the toxin per gram of tissue while others use the toxin per 100 grams of tissue.

Some of the species of shellfish identified in human intoxications are:

California mussel (Mytilus californianus)
Common (black) mussel (Mytilus edulis)
Soft-shell clam (Mya arenaria)
Smooth Washington clam (syn. (Alaska) butterclams)
(Saxidomus giganteus syn. S. nuttali)
Razor clams (Siliqua patula)
White Mussel (Donax serra)
Northern horse mussel (Volsella modiolus)

Solid surf clam (Spisula solidissima)
Atlantic jacknife clam (Ensis directus)
Sea scallop (Pecten grandis)
Common cockle (Cardium edule)
Edible oyster (Ostrea edulis)
Atlantic deep-sea scallop (Placopecten magellanicus)

The U.S. Food and Drug Administration has set the maximum acceptable level of paralytic shellfish poisoning in fresh, frozen, or canned shellfish at no more than 400 mouse units, or about 80 g/100 g of shellfish meat. A mouse unit is defined on the basis of the amount required to kill 50% of a group of mice in a defined period of time.

c. Poisonous Scombroid Fishes

This classification includes tuna, bonito, mackeral, skipjack, etc. These fish may be dangerous when consumed, especially in tropical areas. The poisoning resembles a severe allergy and is caused when histamine in the fish tissues is acted upon by bacteria to produce saurine, a histamine-like substance. The saurine is produced when scombroid fishes are left in the sun or at room temperature for several hours.

Commercially canned tuna have caused scombroid poisoning since the toxin is relatively heat stable. Scombroids should be processed immediately after capture and discarded if left in the sun for more than two hours.

d. Ciguatera-Producing Fishes.

Ciguatera is a type of poisoning produced by a large variety of tropical marine reef or shore fishes. More than 300 different species have been incriminated, to date, but usually only 15 to 20 species are

concerned. Apparently, any marine fish, under the proper circumstances, may become involved with this type of poison since all of the species listed as poisonous are commonly eaten in some localities, and considered as good food fishes. The toxins from the various fish produce similar symptoms; however, it appears that the toxin is actually a mixture of toxins. The fish responsible for ciguatera poisoning are unpredictable since the same species is not uniformly and consistently poisonous. Most of the poisonous fish are harvested near land rather than deep water. For these reasons it is generally believed that the cause of the poisoning is from marine algae that are passed through the food chain. One particular algae Schizothrix Calcicola has been shown to contain toxic water and lipid extracts that produce ciguatera poisoning symptoms.

Representative Species of Ciguatera-Producing Fishes

Surgeonfish
Ladyfish
Jack
Herring
Surmullet (Parupeneus chryserydros)
Surmullet (Upeneus arge)
Seabass, Grouper
Seabass
Trunkfish (Lactoria cornutus)
Trunkfish (Lactophrys trigonus)
Porgie
Squaretail
Porgie (Pagrus pagrus)
Surgeonfish
Filefish
Triggerfish
Jack
Anchovy

Squirrelfish	
Oceanic Bonito	
Wrasse	(Epibulus insidiator)
Wrasse	(Julis gaimardi)
Snapper	(Aprion virescens)
Snapper	(Gnatodentex aureolineatus)
Snapper	(Lethrinus miniatus)
Red Snapper	(Lutjanus bohar)
Red Snapper	(Lutjanus gibbus)
Snapper	(Lutjanus monostigma)
Red Snapper	(Lutjanus vaigiensis)
Snapper	(Monotaxis grandoculis)
Chinaman Fish	
Parrotfish	(Scarus Caeruleus)
Parrotfish	(Scarus Microrhinos)
Seabass, Grouper	
Seabass	(Plectropomus oligacanthus)
Seabass	(Plectropomus truncatus)
Seabass	(Variola Louti)

One cannot detect a poisonous fish by its appearance. Moreover there is no known simple chemical test to detect the poison. The most reliable methods involve the preparation of tissue extracts which are injected intraperitoneally into mice, or feeding samples of viscera and flesh to cats or dogs, and observing the animal for the developments of toxic symptoms. The viscera-liver and intestines of tropical marine fishes should never be eaten. Also, the roe of most marine fishes is potentially dangerous, and in some cases may produce rapid death. Fishes which are unusually large for their size should be eaten with caution. This is particularly true for barracuda (Sphyraena), jacks (Caranx), and grouper (Epinephelus) during their reproductive seasons.

It must be emphasized that ordinary processing procedures may not destroy or significantly weaken the poison. The advice of native people on eating tropical marine fishes is frequently conflicting and erroneous particularly if they have not lived

within a particular region over a period of time. Keep in mind that an edible fish in one region may kill you in another.

e. Other Seafood Toxins

Skates, rays, mullets, and herring have been indicated in seafood poisonings. It is generally believed that the illness is a type of ciguatera poisoning since the symptoms are somewhat similar.

Clams and oysters in Japan and other countires have been reported to contain a poison that is different from the paralytic shellfish poison. This toxic principle is found mostly in the liver or dark gland of the bivalves. The toxin is quite stable to heat and appears to be produced for dinflagellate. The poison can be detected by animal assay.

Fish Canning Procedure

1. Standard Fish Process

Fish may be divided into two broad categories in relation to the amount of preparation necessary prior to filling: (a) packed raw (no pre-cook), (b) a pre-cook prior to filling.

a. No Pre-cook

The whole fish is washed, cleaned, cut to appropriate size, placed in the can and processed. Examples of fish processed in this manner include salmon, shad, and river and sea herring.

b. Pre-cook

This includes fish as sardines, tuna, and anchovies. The fish is pre-cooked prior to can sealing. The pre-cook willvvary from 2 to 12 hours at 100 to 109 C. The pre-cook can be accomplished in the can itself or in a larger specifically designated vessel. The

purpose of the pre-cook is: (1) to cook out some of the natural oils; (2) to loosen the meat on the bones to facilitate the cleaning operation; (3) to obtain proper texture in the final product.

2. Shellfish

The canning of shellfish differs from finfish in that most shellfish are pre-cooked prior to canning; also other treatment may be given; as brining and acidification. In addition additives are added to prevent discoloration or bluing; greening or blackening of shellfish. Additives are also included to prevent inorganic crystal formation. Another difference between canned fish and shellfish is the packing media; fish are usually packed dry or with oil while shellfish are normally packed with brine.

Securing the Raw Material

Canning is not a salvage operation. Only the freshest fish should be used in order to produce a high quality, wholesome product. Fish stored on the boat should be boxed rather than bulk stored. The boxing not only prevents poor appearance but also prevents deterioration of the muscle tissue by the intestinal juices. Once caught the fish should be delivered to the cannery as soon as possible. Thorough icing is recommended to prevent spoilage. This is especially true in warm weather or in tropical climates. Refrigerated sea water (RSW) is also an acceptable method of maintaining product quality on fishing vessels. If the fish cannot be handled within a reasonable time at the cannery, the fish should be refrigerated or packed in ice. If mechanical refrigeration is used, the fish must not be placed in boxes or piles so that several hours or days would be necessary for proper

cooling. In order to reduce the incidence of spoilage, fish are usually stored under refrigeration with thorough icing. Freezing is an acceptable method for achieving long-term storage of fish and once thawed, the fish are acceptable for canning.

It is important to remember that the fish should be handled as little as possible and any carelessness in handling should be absolutely avoided. The use of pitchforks for unloading or moving fish should be prohibited or restricted only to the head of the fish. Stepping, walking, or standing upon, throwing or bruising the fish not only lowers the quality of the raw material but often makes it unusable in products of any grade.

Treatment of the Fish Before Canning

1. Grading

On arrival the fish and shellfish should be graded and sorted into different containers. At the present time, there is no uniform grading system but a number of methods have been developed. In general, grading is dependent on freshness, size and species of fish and other physical characteristics. Careful grading is essential to the preparation of the high quality canned product.

The condition of the fish on arrival may be determined by a number of factors. Table 1 contains some of the factors used in assessing quality.

Table 1	FRESH	REJECT
a. General Appearance: (lustre and bleaching)	Bright, with metallic lustre, very little, if any, bleaching.	Bloom completely gone. Color faded or bleached.

b. Eyes	Bright, translucent, usually full but in some cases may be slightly sunken and somewhat dull.	Dull and sunken May be cloudy, dull, white or opaque.
c. Gills: a. Color	Bright red to slightly pinkish red.	Brownish red to brown or gray. Frequently covered with thick, bacterial mucus.
b. Odor	Fresh odor characteristic of species to faint sour odor.	Medium to strong sour odor.
d. Odor: a. Poke End	Fresh to very faint sour odor.	Medium to strong sour odor.
b. At Neck When Breaking	No odor to very slight odor.	Sour or putrid.
e. Consistency of Fish:	Firm and elastic to the touch. Occasionally may be slightly soft.	Generally soft and flabby.
f. Belly Cavity:	Flesh adheres firmly to rib bones.	Rib bones free or almost free from flesh
g. Vent:	Normal in shape and color.	Protruding and may be discolored.

2. Cleaning and Trimming

In the case of larger fish, the head and intestines are removed. This process can be either performed by hand or through the use of machines. The machines are able to process approximately 180 fish per minute and can remove the head and tail in addition to the evisceration. Attention should be given to insure that the intestines are completely removed.

3. Washing and Scale Removal

Washing is an important operation. Washing removes the surface slime as well as blood which was released during the cleaning and trimming step. Washes may be of three general types: soaking or tank washing, washing by agitation, and spray washing. The tank method may act as a source of contamination rather than a means of cleaning unless the water is changed when slime, blood and fish particles accumulate. In warm climates and with large volume processing, it may be necessary to change the water several times a day. Chlorination may also be used to help reduce the bacterial content in the washing tanks. Soaking or tank washing is effective in removing blood but softens texture if the fish are left over 15 minutes in the tank, unless a salt brine is used. Oversoaking in salt may toughen the texture or make the canned product unpalatable.

Agitation increases the efficiency of washing. The latest development of this type of washes in fisheries is the flume conveyor in which the fish are carried from the cleaning and trimming section to the precooking or preparation stage by a current of rapidly running water. Another simple type of agitation wash is the tank equipped with a propeller. Unless the propeller is guarded by a heavily screened cage or is geared to move slowly, it may bruise the fish. Compressed air is sometimes used to agitate water.

The drum or squirrel-cage is also used. It is composed of a drum of mesh wire with a central axle and equipped with longitudinal baffles. The drum either revolves in a tank of water or has a water spray. Few

fish are bruised and it requires little water and acts as a scaler with fish or herring and shad.

Fish are also washed by jets or sprays of water. Spray washing depends on pressure of the water rather than volume. The scales can be removed by machine, water spray, or hand operation. After hand or machine scaling, the fish should be washed or rinsed.

It is important that all washing water be chlorinated if not obtained from an approved public supply.

4. Brining

Some fish are immersed in salt (Sodium chloride) solution for various lengths of time. Salt is absorbed in the flesh to impart desirable flavor. A salt content of 2% is desirable. The time of holding and the strength of brine used depends largely upon the size and fatness of the fish and the nature of the subsequent canning operations. Brining helps draw blood from the fish tissues, brightens the appearance of the fish, removes any remaining slime, and toughens the skin. When unbrined fish are canned, much of the skin adheres to the can.

Brining is a batch operation. The salt should be pure and free from Divalentions, especially magnesium. A salt containing magnesium chloride increases the chance of struvite formation. Struvite is magnesium ammonia phosphate and resembles glass slivers. It can be distinguished from glass since struvite dissolves in dilute acid solution as vinegar.

The brine concentration should be checked with a salinometer. The salinometer is cheap and easy to use. Brining times vary from 15 to 45 minutes.

Many bacteria are able to grow in brine solutions. The brine should not be used for long periods of time and it should be changed frequently.

After brining, the fish are removed and placed in mesh containers and allowed to drain.

5. Cooking

Some fish are given a cooking or drying process before being packed into cans. This removes excess moisture, toughens the skin so that it will not break or become adhesive to the container during the thermal processing step. For sardines the fish are either: (1) steamed and dried before packing or (2) dried and cooked by frying.

Pre-cooking is a very important process. The fish should be heated sufficiently so that no further water is exuded in retorting. It is a general rule that the water content should be reduced to at least 60% by the pre-cooking process. When 1% dry polyphosphate was added to herring fillets, the exudate was reduced by 20-40 percent.

6. Packing

Most fish products are packed by hand. The cans may be shallow and oval in shape or tall and round. Sizes vary from 2 oz. to 16 oz.

Cans should be washed immediately before filling to remove dirt and dust accumulated during storage.

In filling, the required weight is placed in the can. A headspace of 1/8 to 3/16 inches should be allowed in the top of the cans so that a proper vacuum can be obtained. Most cans are over-filled rather than under-filled. There is a tendency to place more than the stated label weight in a can to insure compliance with food regulatory agencies. It is important to control over-fill to prevent excessive product loss.

Sauces or oils are added hot before or after the fish are placed in cans. In some instances half of the oil or sauce is placed in the can before packing and the reminder after packing.

7. Exhausting

After small cans are filled they can be closed. Large cans must be exhausted before closing. The object of exhausting is to produce a partial vacuum in the headspace of the can which will persist after the can is thermally processed and cooled.

8. Sealing

The sealing operation is also quite critical, especially when oval and rectangular cans are used. The equipment may vary from hand-operated machines to automatic machines operating at speeds of 30 to 60 cans per minute. Because of the inherent danger of improperly sealed cans, a can seam evaluation or control program is necessary. The cans should be checked at least daily or hourly depending on the quantity of cans processed. Usually the sealing is done with the can contents at a temperature of 60°C.

9. Thermal Processing

The purpose of thermal processing is to (1) inactivate enzymes, (2) destroy or inactivate microorganisms and (3) cook the canned product.

Care should be used to prevent over processing which could result in (1) undesirable changes in flavor, texture, odor, and appearance and (2) loss of nutrients.

Many enzymes and bacteria are inactivated at low temperatures; however, some bacteria and enzymes are resistant to high temperature for relatively long periods of time. Consequently, the time and temperature of the process should be sufficient to inactivate the most heat-resistant spores. It is

important to note that canned products are not completely sterilized. The heat treatment applied in canning is sufficient to kill those organisms that are likely to cause spoilage or present a health hazard.

Placing a can of fish in a retort and heating it for several minutes will not provide an adequate process because of the time required for the heat to penetrate the can and heat the center of the can.

It is important to remember that a recommended adequate process will be inadequate if the fish possess an abnormal concentration of flora. The greater the concentration of spoilage organisms, the greater the heat treatment. Thus a stated thermal process, must not be considered as being absolutely adequate in all situations.

As the processing temperature is increased, the processing time decreases. Fish products are usually processed from 110 to 121° C. In order to reach these temperatures it is necessary to use steam under pressure. Consequently, the processing is performed in pressure vessels or retorts.

The correct procedures for retort operation is given in chapter

D. Storage of Canned Fish Products

Canned products should not be shipped as they are obtained from the cannery line. There are several reasons for this practice:

(1) Additives, especially pelletized salt, may take several days before the chemical is equally distributed throughout the can.

(2) Equilibrium between added oils and sauces and natural fish oils may require weeks.

(3) Time may be required for seasoning to be distributed through the product.

(4) Improperly processed cans may be observed before shipping has occurred.

(5) In the event defects in processing are discovered from quality control procedures, a product recall would not be necessary.

Some fish (tuna) are stored up to 3 months before released for sale.

The warehouse the products are stored in should be dry and reasonably cool. Canned fishery products will not be adversely affected by heat or cold for short periods. However, continued heat or alternate freeze and thawing causes severe losses in quality and may result in bacterial spoilage. Storage under moist warm conditions results in rapid deterioration.

If canned fishery products are well stored, quality will be maintained for long periods of time, up to 5 to 12 years. For most fish products, the storage temperature should not exceed 20° C. If storage temperature does exceed 20° C, the physical properties of the canned product will be greatly reduced in quality.

The Canned Product

1. Nutritive Aspects

Thermal processing of seafood causes some undesirable changes with respect to nutritional content. However, the major consideration in any method of preservation is a compromise between food availability and nutritional losses. It is important to remember that the effect of thermal processing on any particular nutrient should be placed in perspective on the importance of the food as a source of the nutrition. For example, although the fact that heat destroys vitamin C, it is unimportant in the processing of seafood products since they do not contain vitamin C. Also the degree of positive and negative effects are also important. While heat processing decreases the nutrient content of vitamins A, B_1, C and E, it also destroys the enzymes (Thyaminases) which bring about the destruction of B_1 (Thiamin) in fish and fish products.

It is important to remember that the variation in mineral content of many raw seafood products will affect the content of vitamins and nutrients in the final product perhaps with as great effects as those of thermal processing itself.

It is also necessary to consider nutrient loss from canning with that of the degree of losses that occur during the home preparation of meals. The home preparation of meals sometimes causes high losses of nutrients in foods, especially when vitamins and minerals are considered. Considering the losses that occur during home preparation, thermally processed foods are generally no worse in nutritional quality.

When seafood products are canned most of the vitamins, with the exception of riboflavin and niacin, undergo decomposition. Some vitamins (as Riboflavin) are also light sensitive and degrade when exposed to light and high temperature. Vitamin losses occur during the storage and distribution of canned foods. It is important to keep storage and distribution temperatures within recommended tolerances.

Proteins in foods become less available physiologically during processing or storage. This loss in utilization is due to chemical reactions that involve free radicals or the presence of carbohydrates. Amino acids may be destroyed during high temperature processing and prolonged storage at room temperature. Browning reactions which occur during the canning operations or storage decreases the availability of amino acids to metabolism.

Carbohydrates may become more digestible by canning. The greatest loss in carbohydrates is in browning reaction which was previously discussed. Fat is not significantly affected by canning.

The main factors responsible for physical and chemical deterioration are:

(1) Discoloration
(2) Perforation & corrosion of tin plate
(3) Foreign tastes
(4) Undesirable textures
(5) Freezing
(6) Rusting
(7) Faulty techniques
(8) Unsuitable products

2. Discolorations and Appearance

a. Color

Considerable research has been devoted to the effect of canning on the pigments in fish. The main pigment involved in discoloration is oxyhemoglobin. This is converted during storage to methemoglobin. During thermal processing both oxyhemoglobin and methemoglobin are converted to hemochromes which cause the color of canned fish.

b. Browning

The white muscle of fish will acquire a brown color on heating. This is due to the maillard reaction involving reducing organs with other compounds in the fish flesh. The greater the heat treatment during processing the greater the browning.

c. Blackening

Blackening of canned seafood contents is found in both fish and shellfish. It occurs most readily where the product has an alkalenic reaction. Sulphur compounds, particularly H_2S in the seafood flesh, unite with iron to form iron sulfide (FSE). The iron is primarily from the iron base of the tin plate but also can come from iron in the flesh or from canning equipment or from the water. The iron sulfide is not injurious to consumers but produces objectionable organoleptic properties. In canned tuna, the blackening is found

more commonly in the solid packs rather than the grated or flaked style.

Some of the factors responsible for blackening are: (1) Incomplete butchering, (2) cold storage prior to canning, (3) shortened time of pre-cooking, (4) delay in canning lines and (5) processing times and temperature.

Blackening can sometimes be prevented by using aluminum or stainless steel cans, type C enamel cans with parchment - paper can liners, the use of small amounts of organic acids, the use of pure water when the muscle tissue contains high levels of iron.

d. Discolorations of Tuna

The pink color of tuna can be retained by either the use of a reduction agent prior to cooking or the exclusion of air.

When frozen tuna is canned a brown pigment is sometimes formed. The discoloration can be reduced if the fish are frozen in water or brine instead of in air.

Sometimes greening in tuna is observed. The nature of the greening has not been completely defined but it is connected to blood and related pigments.

e. Struvite

Struvite is magnesium ammonium phosphate hexahydrate and is frequently found in canned fish and shellfish. Struvite crystals do not adversely affect the product but they resemble glass and therefore cause consumer rejection of the product. Fish canned below a pH of 6.0 eliminates the problem. The pH is important since phosphate is only slightly soluable at a pH of 6.5.

Fish having pH values above 6.0 can be successfully canned by combining fish with high pH values with small pieces of low pH fish. Struvite can be prevented in canned seafood by lowering the pH or canning with citric acid or 0.5% sodium hexametaphosphate or sodium acid pyrophosphate.

f. Stacks Burning

Stacks Burning is a form of over processing. It occurs when hot cans are placed in stacks or boxed before sufficient cooling has occurred.

g. Curd

Curd is coagulated protein found on the top of canned fish which are processed without pre-cooking. The problem is more common when frozen fish are thermally processed.

Curd formation can be prevented by brining thawed fish prior to canning. Usually a 10 minute soaking in 70 percent brine will retard the curd formation. It can also be reduced by using low storage temperature combined with short storage times.

h. Honeycombing

This defect is more common in tuna. Cavities develop in the fish tissue, usually between the layers, after the pre-cooking step. Since the defect is a result of fish decomposition, the product is usually considered unusable for human consumption and discarded. Usually, off-odors accompany the honeycombing.

i. Can Corrosion

See chapter 15.

3. Microbial Spoilage

See chapter 1.

Quality Control

The Canned Fish Inspection Laboratory of the North Carolina Department of Fisheries has determined the following schedule for examination of canned fishery products:

Number of Cases in Lot	Minimum Number of Cases Withdrawn
25	3
26-50	6
51-100	12
101-500	18
501-1000	24
1001-5000	48

All cans should be examined

Chemically	Bacteriologically
Physically	Organoleptically

Pasteurization

Shelf-stable thermally processed seafoods, however, do have several disadvantages. The canning process sometimes causes undesirable changes in texture, flora, odor, and appearance. In order to minimize some of the adverse effects of thermal processing, pasteurization with subsequent refrigeration have been applied to some shellfish species. Pasteurization destroys or inactivates psychrophiles; however, sporeformers and thermoduric organisms survive the process. To prevent microorganism growth subsequent to pasteurization the product must be stored at 2° C or lower. It is important that the temperature not exceed 2° C since Clostridium Botulinum, Type E will be able to grow.

Pasteurization Process Controls

Pasteurization process controls are the same as those for sterilization of other canned products. See chapter 2.

Shellfish for Pasteurization

(A) Preparation. Shellfish for pasteurization should be prepared in compliance with existing state regulations for fresh meat.

(B) Sealing of Containers. The containers of seafood should be sealed as quickly as possible after the meat is picked.

(C) Refrigeration. The containers of seafood should be placed immediately under ice refrigeration.

Pasteurization of Shellfish

(A) Pasteurizing operation. Shellfish for pasteurization should be pasteurized within 24 hours of the time it is picked. The minimum pasteurization specifications shall be the raising of the internal temperature of the container of crab meat to 85° C and holding at that temperature for at least one minute at the geometric center of a suitable container. Each set of pasteurizing equipment shall be standardized so that the above pasteurization treatment can be obtained.

Advisory: This means that temperature-time requirements must be determined for each retort and for other conditions, such as the temperature of the meat, the size of the container and other variables. Alteration of the equipment or in the stacking of containers shall require that the procedure be re-standardized. Plant operators are warned that time-temperature conditions for one retort may not give a satisfactory pasteurization on another retort.

(B) Chilling. The containers of meat must be chilled by cooling to 38° C within 50 minutes to allow refrigerated storage within one hour after processing. The procedure for chilling shall be standardized.

(C) Refrigeration. Refrigerated storage should be provided for the chilled pasteurized crab meat and shall maintain a storage temperature at or below 2° C but above 0° C.

Labeling of Pasteurized Shellfish

(A) Designation of contents. The label used should clearly identify the contents of the container.

(B) Coding. Each container should be permanently and legibly identified with a code indicating the batch and the day of processing.

(C) Refrigeration. The words *Perishable - Keep Under Refrigeration* or their equivalent should be prominently displayed on the label.

Bacteriological Standards for Pasteurized Crab Meat

(A) Fecal coliform bacteria. There shall be no fecal coliform bacteria present in pasteurized crab meat.

(B) Total bacteria count. Samples of pasteurized crab meat, taken within 24 hours of processing, shall not have a standard plate count of more than 3000 bacteria per gram of pasteurized crab meat.

(C) Seizure and contemnation. The presence of fecal coliform bacteria, or a total bacteria count in excess of 25,000 per gram shall be construed as adulteration.

Quality Defects

(A) Blue or gray shellfish. If certain species of shellfish are heated over 88° C for several minutes, the meat may acquire a blue or gray color. While the discoloration may be organoleptically objectionable, the seafood is still suitable for consumption.

A properly processed and stored product can be expected to have a storage time of 3 to 6 months.

Recipes Processed Seafood Products

1. Canned Fish Chowder

   a. Fish Broth

      I. Place 95 kilos (210 pounds) of fillet trimmings and fish heads wrapped in mesh bags in 227 liters (60 gallons) of water.

II. Heat to boil and simmer for 2 hours.

b. Chowder Base

I.

Ingredients	Liters	(Gallons)	Kilos	(Pounds)	Grams	(Oz
Flour			23	50		
Diced Fresh Onions			8	18		
Diced Salt Pork			8	18		
Fish Broth	197	52				
Water	95	25				
Salt			7	16		
Pepper (White)					142	

II. Cut onions and cook at a low temperature until soft in 45 kilos (12 gal) of broth. Add cut salt pork and cook until soft.

III. Mix 11 kilos (25 lb.) of flour with 56 liters (15 gal.) of water until the mixture becomes a smooth slurry. Add 75 liters (20 gal.) of fish broth to the pork-onion mixture and bring to a boil. Stir to prevent scorching. Add the slurry to the broth and bring the contents of the kettle to a second boil.

IV. Prepare a second batch of slurry with 11 kilos (25 lb.) of flour and 38 liters (10 gal.) of water. Next add 75 liters (20 gal.) of broth to the chowder base and heat to a boil. Then add the second batch of slurry and heat to a boil with constant stirring.

V. Add Additional broth to bring the volume to approximately 300 liters (80 gal.).

VI. Add salt, pepper and heat to boiling while stirring.

c. Fish and Potatoes

I. Cut into small cubes 118 kilos (260 lb.) of fillet fish.

II. Cut into small cubes 118 kilos (260 lb.) of white potatoes.

d. Filling of Cans.

I. Add 56.7 grams (2 Oz.) of fish and the same weight of cubed potatoes in a No. 1 picnic can (211x400) with a seafood enamel lining. To prevent discoloration add 0.8-0.9 grams of citric acid.

II. Fill cans with hot broth having a minimum temperature of 85°C. Do not Exhaust Cans.

III. Yield should be approximately 1,980 cans.

e. Processing

I. Process 75 minutes at 116 C (240 F).

II. Water cool immediately after processing.

2. Canned Salmon or Tuna Loaf

a. Ingredients

	Kilos	(Pounds)	Grams	(Oz)
Salt	6.9	(15)		
Prepared lemon powder a/	.8	(1)		
Sodium Nitrite			28	(1)
Boneless or Skinless Salmon or Tuna Fillets	227	(500)		
Precooked Wheat Flour	22.7	(50)		
Chopped Ice	45.4	(100)		

a/ 850 g. (30 oz.) citric acid

128 g. (4½ oz.) processed oil of lemon

3.6 kilo (125 3/4 oz.) corn sugar

b. Procedure

I Mix salt, lemon powder, sodium nitrite, and pepper.

II Chop fillet with one-half of the ice and mix for 5 minutes.

III Add salt, lemon powder, sodium nitrite and pepper mix to remaining ice and chop for 2 minutes.

IV Add flour on the top of the fish slurry and chop for 2 minutes more.

c. Filling

I To prevent the fish from sticking to the inside of the cans, coat the interior of the cans with an edible oil.

II Place the product into either 340 g. (12 oz.) or 1362 g. (3 lb.) oblong cans. Close under 27 in. vacuum.

d. Processing

I. Process 340 g. (12 oz.) oblong cans - 1 hr. 30 min. at 116 C (240 F).

II. Process 1362 g. (3 lb.) oblong cans - 4 hr. 30 min. at 116 C (240 F).

3. Canned Fish Flakes

a. Ingredients

	Kilos	(lb.)	g.	(oz.)
Fresh peeled sliced potatoes	90.8	(200)		
Shredded salt cod	45.4	(100)		
Hydrogenated coconut oil	2.3	(5)		
Pepper (white)			56.7	(2)

b. Process Procedure

I. Soak cod in water for 10 hr. or 1½ hr. if running water is used. Shell cod.

II. Cut potatoes .6 cm (¼ inch) thick.

III. Mix two parts potatoes and one part cod with water and boil for 30 min. in a steam jackated kettle.

IV. Grind through a .3 cm (1/8 inch) plate.

V. Place in a mixer and add oil and pepper and mix for 5 min.

c. Filling

I. Fill into can while 74 C (165 F) or hotter. Exhausting is not necessary.

I. Seal immediately.

d. Processing

I. Process 227 g. (8 oz.) flat cans - 75 min. at 116 C (240 F).

II. Process No. 10 cans (603x700) - 4 hr. at 116 C (240 F).

III. Water cool immediately after thermal process.

4. Canned Clam Chowder

a. Ingredients

	Liters (gal)	Kilo (lb.)	g. (oz.)
Diced White Potatoes		136 (300)	
Chopped Clam Meat		136 (300)	
Fine Cracker Crumbs		29.5 (65)	
Ground Salt Pork		8 (18)	
Diced Onions		8 (18)	
Water	206.6 (55)		
Salt		7.3 (16)	
Pepper (White)			142 (5)
Canned Tomatoes (24 # 10 Cans)			

b. Procedure

I. Cook onions until clear. Add ground salt pork and saute until golden, but not brown.

II. Add 56.3 L (15 gal.) of water and boil.

III. Add 16 kilo (35 lb.) of cracker crumbs in a mixer to 56. 3 l. (15 gal.) of water and mix until smooth. Add contents to 4b (II).

IV. Prepare a second batch of cracker crumbs 13.6 kilos (30 lb.) and add crumbs to 37.5 L (10 gal.) water.

V. Add 56.3 L (15 gal.) water to the kettle. Add 4b (III) and heat to 93-100 C (200-212 F). Now add second batch of cracker crumbs, 4b (IV).

VI. When the mixture returns to a boil, add salt, pepper, and tomatoes.

VII. Dice potatoes and either blanch or place in water to prevent browning.

c. Filling

I. Use C enamel cans.

II. Fill potatoes and clam meat by hand and add clam broth.

III. No. 1 Picnic cans 56.7 g. (2 oz.) - Potatoes

56.7 g. (2 oz.) - Clam Meat

No. 2½ cans (401x411) 170 g. (6 oz.) - Potatoes

170 g. (6 oz.) - Clam Meat

IV. Fill all cans with hot broth and seal immediately.

Yield will be approximately 2350 No. 1 Picnic cans (211x400) or

Yield will be approximately 800 No. 2½ (401x411) cans.

d. Process

I. No. 1 cans - 50 min. at 116 C (240 F).

II. No. 2½ cans - 90 min. at 116 C (240 F).

III. Water cool the canned chowder immediately after processing.

5. Canned Terrapin Stew

a. Ingredients

	Liter	(pt.)	kilo	(lb.)	doz.
Terrapin			11	(24)	
Butter			4.5	(10)	
Hard Boiled Egg Yolk					6
Sherry Wine	5.6	(12)			

b. Procedure

I. Dress the terrapin and cut the fresh meat into ½ cm (¼ inch) cubes.

II. Place the meat in a kettle with the butter and bring mixture to a boil.

III. Mash and cream the egg yolks with the sherry and add to the kettle.

IV. Place the contents into the cans.

c. Processing

I. Process No. 1 can - 50 min. at 121 C (250 F).

6. Canned Snapping Turtle Ste

a. Ingredients

	Liter	(pt.)	kilo	(lb.)	g	(oz.
Snapper Meat			9	(20)		
Minced Onion			½	(1)		
Flour			¼	(½)		
Lard or Olive Oil			¼	(½)		
Bay Leaves					3.5	(1/8
Water	2½	(5)				
Madeira Wine	¼	(½)				
Minced Garlic					3.5	(1/8
Thyme					3.5	(1/8

Salt . . . . . to taste

b. Procedure

I. Cut meat into 2½ cm (1 inch) cubes.

II. Cook onions with oil and garlic until onions are clear.

III. Add flour and stir constantly.

IV. Add meat and allow to brown; add water slowly while stirring.

V. Heat to near boiling and add wine and seasonings.

VI. Place contents into cans while hot.

c. Processing

I. Process No. 1 Picnic - 50 min at 116 C (240 F).

II. Water cool immediately after processing.

Table 2.

Processing Times and Temperatures

PRODUCT	CONTAINER SIZE with/without liner	INITIAL TEMP. °C (°F)	PROCESS Temp. °C(°F)	Time (Min.)
Clams or Clam Chowder[b]				
Crab Meat, Blue or Gulf Hand Picked in Brine	½ Tuna, without liner 307x113[e]	21 C (70 F)	110 C (230 F)	70
			116 C (240 F)	35
			121 C (250 F)	20
	½ Tuna, with one piece liner 307x113[e]	21 C (70 F)	110 C (230 F)	70
			116 C (240 F)	50
			121 C (250 F)	35
Crab Meat, Blue or Gulf Hand Picked, Vacuum Pack[cd]	½ Tuna, without liner 307x113[e]	21 C (70 F)	110 C (230 F)	80
			116 C (240 F)	45
			121 C (250 F)	35
	½ Tuna, without liner 307x208[f]	21 C (70 F)	110 C (230 F)	85
			116 C (240 F)	55
			121 C (250 F)	40
	½ Tuna, one piece liner 307x113[e]	21 C (70 F)	110 C (230 F)	85
			116 C (240 F)	50
			121 C (250 F)	35
	½ Tuna, one piece liner 307x208[f]	21 C (70 F)	110 C (230 F)	95
			116 C (240 F)	60
			121 C (250 F)	45
Crab Meat, Dungeness or King, Vacuum Pack	½ Flat, without liner 307x200.25	21 C (70 F)	110 C (230 F)	85
			116 C (240 F)	55
Fish Flakes[g]	(See Mackerel, In Brine)			
Herring & Herring Roe[g]	(See Mackerel, In Brine)			
Lobster[g]	(See Mackerel, In Brine)			
Mackerel, In Brine	8Z Tall 211x304	21 C (70 F)	116 C (240 F)	75
		21 C (70 F)	121 C (250 F)	60
		54 C (130 F)	116 C (240 F)	70
		54 C (130 F)	121 C (250 F)	50
	No. 300 300x407	21 C (70 F)	116 C (240 F)	90
		21 C (70 F)	121 C (250 F)	75
		54 C (130 F)	116 C (240 F)	80
		54 C (130 F)	121 C (250 F)	55

PRODUCT	CONTAINER SIZE with/without liner	INITIAL TEMP. °C (°F)	PROCESS Temp. °C (°F)	Time (Min.)
Oysters, Cove Atlantic & Gulf Coast	No. 1, Picnic & smaller, 211x400 & smaller	21 C (70 F)	116 C (240 F)	24
		21 C (70 F)	121 C (250 F)	14
		54 C (130 F)	116 C (240 F)	23
		54 C (130 F)	121 C (250 F)	13
	No. 95 & No. 2 307x400 307x409	21 C (70 F)	116 C (240 F)	28
		21 C (70 F)	121 C (250 F)	14
		54 C (130 F)	116 C (240 F)	27
		54 C (130 F)	121 C (250 F)	13
Oysters, Pacific Coast	No. 1 Picnic & smaller, 211x400 & smaller	21 C (70 F)	116 C (240 F)	30
Salmon, Water Cooled[h]	¼ Flat 301x106	2 C (35 F)	116 C (240 F)	50
			118 C (245 F)	40
			121 C (250 F)	35
	½ Tuna 307x113	2 C (35 F)	116 C (240 F)	70
			118 C (245 F)	60
			121 C (250 F)	55
	½ Flat 307x200.25	2 C (35 F)	116 C (240 F)	80
			118 C (245 F)	70
			121 C (250 F)	60
	4 lb. 603x405	2 C (35 F)	116 C (240 F)	230
		2 C (35 F)	118 C (245 F)	215
		2 C (35 F)	121 C (250 F)	200
		16 C (60 F)	116 C (240 F)	220
		16 C (60 F)	118 C (245 F)	205
		16 C (60 F)	121 C (250 F)	190
Salmon, Air Cooled[h]	¼ Flat 301x106	16 C (35 F)	116 C (240 F)	45
			118 C (245 F)	35
			121 C (250 F)	30
	½ Tuna 307x113	16 C (35 F)	116 C (240 F)	65
			118 C (245 F)	55
			121 C (250 F)	50
	½ Flat 307x200.25	16 C (35 F)	116 C (240 F)	75
			118 C (245 F)	65
			121 C (250 F)	55
	No. 1 Tall 301x411	16 C (35 F)	116 C (240 F)	95
			118 C (245 F)	85
			121 C (250 F)	80

PRODUCT	CONTAINER SIZE with/without liner	INITIAL TEMP. °C (°F)	PROCESS Temp. °C(°F)	Time (Min
Sardines[1]				
Sardines, In Mustard Sauce	½ 405x301x014	21 C (70 F)	110 C (230 F)	50
			113 C (235 F)	45
			116 C (240 F)	40
	3/4 412x308x112	21 C (70 F)	110 C (230 F)	70
			113 C (235 F)	60
			116 C (240 F)	55
Sardines, In Oil	½ 405x301x014	21 C (70 F)	110 C (230 F)	75
			113 C (235 F)	60
			116 C (240 F)	50
	3/4 412x308x112	21 C (70 F)	110 C (230 F)	100
			113 C (235 F)	80
			116 C (240 F)	70
Sardines, In Tomato Sauce	½ 405x301x014	21 C (70 F)	110 C (230 F)	65
			113 C (235 F)	50
			116 C (240 F)	45
	3/4 412x308x112	21 C (70 F)	110 C (230 F)	85
			113 C (235 F)	75
			116 C (240 F)	65
Shrimp, Wet Pack	No. 1 Picnic or smaller 211x400 or smaller	21 C (70 F)	116 C (240 F)	26
			121 C (250 F)	14
		32 C (90 F)	116 C (240 F)	25
			121 C (250 F)	13
		49 C (120 F)	116 C (240 F)	24
			121 C (250 F)	12
	No. 95 307x208 307x400	21 C (70 F)	116 C (240 F)	27
			121 C (250 F)	15
		32 C (90 F)	116 C (240 F)	25
			121 C (250 F)	13
		49 C (120 F)	116 C (240 F)	24
			121 C (250 F)	12
	No. 2½ 401x411 No. 5 502x510	21 C (70 F)	116 C (240 F)	30
			121 C (250 F)	19
		32 C (90 F)	116 C (240 F)	27
			121 C (250 F)	16
		49 C (120 F)	116 C (240 F)	26
			121 C (250 F)	15

PRODUCT	CONTAINER SIZE with/without liner	INITIAL TEMP. °C (°F)	PROCESS Temp. °C (°F)	Time (Min.)
Shrimp, Dry Pack	No. 1 Picnic, One Piece liner 211x400	21 C (70 F)	116 C (240 F)	80
			121 C (250 F)	60
	No. 1 Picnic, without liner 211x400 without liner 307x208	21 C (70 F)	116 C (240 F)	70
			121 C (250 F)	50
	No. 95, without liner 307x400	21 C (70 F)	116 C (240 F)	75
			121 C (250 F)	55
Tuna, All Styles	¼ Tuna 211x119	21 C (70 F)	116 C (240 F)	65
			121 C (250 F)	40
	½ Tuna 307x113	21 C (70 F)	116 C (240 F)	75
			121 C (250 F)	55
	9 Oz. Family 303x212	21 C (70 F)	116 C (240 F)	90
			121 C (250 F)	70
	No. 1 Tuna 401x206	21 C (70 F)	116 C (240 F)	95
			121 C (250 F)	80
	4 lb. Tuna Folio, chunk style only 603x408	21 C (70 F)	116 C (240 F)	230
			121 C (250 F)	190

a. For processes for smoked, kippered or specially treated seafoods, consult a laboratory connected with the canning industry.

b. Due to variation in raw product and lack of standardized packing procedure, this product should not be packed without directions from a laboratory connected with the canning industry.

c. Processes for mechanically-picked crab meat should be obtained from a laboratory connected with the canning industry.

d. The processes given for vacuum pack crab meat are dependent on the following factors for maintenance of their intended sterilizing value: (1) The maintenance of at least 26 inches of machine vacuum; (2) the presence of ½ to 1 ounce of free liquid; (3) the use of a fill-in weight which will result in a drained weight not greater than the maximum specified in the applicable footnotes.

e. Process times suggested for maximum drained weight of 5.25 ounces.

f. Process times suggested for maximum drained weight of 7.75 ounces.

g: Due to variation in raw product and style of pack and to lack of standardized packing procedure, this product should not be packed without directions from a laboratory connected with the canning industry.

h: These processes are not adequate for cans that contain frozen fish. The fish must be completely thawed.

i: Processes for other styles and can sizes should be obtained from a laboratory connected with the canning industry.

TABLE 3. CANNING OF FISHERY PRODUCTS, PROCEDURES AND PACKING DATA, CONDENSED.

Product	Season	Cleaning Loss	Pre-treatment	Blanch or pre-cook	Total Loss	Exhaust	Closing Temp
		Percent			Percent		Deg. C.
Salmon							
Chinook	Varies from year to year according to necessity for conservation of supply	30	Wash and cut in container length pieces	None	30	Vac. seal	Rm. temp 16-21
Red		33	do	do	33	do	do
Coho		33	do	do	33	do	do
Pink		35	do	do	35	do	do
Chum		33	do	do	33	do	do
Sardines							
California	Winter	no data	Brine 45 to 90 min.	1. Raw pack 2. Fry-lg. 7 min;sm, 4-6 min. 3. Steam Exhaust, 25-40 min. 4. Steam Exhaust, 20-25 min. then through super-heated steam 115-126°C. 5. Oven cook, steam and gas 20-40 min. 6. Oven cook, gas, 45 min. "Ullman"cooker	50	Vac. seal 12-15 min.sa. Sealed hot do do do	21 66 66 66 66 66
Maine	Spring-Fall	15 (sm. fish)	Salted in boat 280 lb. to hogshead (1200 lb.)	Steam 18-20 min., 100-104° C.	35-41 (sm.fish) 55-60 (lg.fish)	Cold fill no exhaust	18
Mackerel							
Boston	Mid-summer-Fall	30	Brined 1 hour in 100° brine (Salt mackerel-12 hrs in 100° brine)	Raw	50	15 min.at 99°C.	71
California	Mid-summer-Fall	30	Brine 1 hour in 80° - 90° brine	Raw	60	20-45 min. at 99°C.	82

TABLE 3. CANNING OF FISHERY PRODUCTS, PROCEDURES AND PACKING DATA, CONDENSED.

Product	Season	Cleaning Loss	Pre-treatment	Blanch or pre-cook	Total Loss	Exhaust	Closing temp.
		Percent			Percent		Deg. C.
Tuna							
Albacore	Mid-summer (Calif)	No data	Clean and wash	10 to 14 lb. 3-3½ hrs. 102-104°C	60-64	3 min at 99°C	21
	Mid-summer-Fall (Oregon)			18 to 40 lb. 4-4½ do		(Some packs vac. seal)	
Bluefin	Summer-Fall	No data	Clean and wash	8 to 18 lb. 2 hrs. 102-104°C 18 to 50 lb. 3 hrs. do 50 to 60 lb. 4 hrs. do 60-200 lb. 5-9 hrs. do	60-64		
Yellowfin	Year-round (Generally more abundant in summer mos.)	do	do	8 to 18 lb. 2 hrs. do 18 to 50 lb. 3 hrs. do 50 to 60 lb. 4 hrs. do 60 to 200 lb. 5-9 hrs. do	60-64		
Striped	Mid-summer-Fall	do	do	5 to 12 lb. 2-2½ hrs. do	60-64		
Alewife or river herring	Spring	30	Brined 8 to 12 hrs. 100° brine	None	30-35	3 min. 99°C. also filled with hot brine or water	38 (aprx)
Fish flakes (haddock)	Spring or at other times depending on fresh fish market	40	Brined 10 to 14 hrs. 100° brine	Steam 30 min., 116°C.	70	Hot fill	66
Finnan haddie	Fall-Winter	40	Brined 20 to 40 hrs. 100° brine then smoked 10-14 hrs.	Fillets steam 15 min., 115°C. (whole fish 30 min.)	70	Hot fill	66

TABLE 3 . CANNING OF FISHERY PRODUCTS, PROCEDURES AND PACKING DATA, CONDENSED.

Product	Season	Cleaning Loss	Pre-treatment	Blanch or pre-cook	Total Loss	Exhaust	Closing temp.
		Percent			Percent		Deg. C.
Shad	Calif. Spring Columbia River Spring-Mid-summer	25	Wash, cut in container length pieces	Raw fill	35	Vacuum seal	16
Clams							
Razor	Spring	65	Wash	Steam	65	Vacuum seal and hot fill	66
Soft	Fall-Winter and Spring	65	Wash	Steam 20 min. 100°C., 15 min. 109°C.	75	Hot fill	66
Oysters							
Atlantic or Gulf	Winter-Spring	75	Wash	Steam 5 to 8 min., 118°C.	93	Hot fill	66
Pacific	Fall-Spring		Wash	Steam 3.5 to 4 min., 115°C.	80	Hot fill	71
Crab							
Dungeness	Spring-Fall (Alaska closed season during this time) (Year-round Oregon-Washington)	73	Shelled alive, washed.	Boiled 20 min.	75	Vacuum seal	27
King (Japanese)	Spring-Late Summer	no data	Shelled alive, washed.	Boiled 15 to 20 min., 25° brine	no data	Heat exhaust 7 to 10 min., 99°C.	74
Shrimp	Spring-Mid-summer and Late-Summer-Spring	55	Brine soak 30 min., 50°	Wet pack 5 to 7 min. Dry pack 7 to 12 min.	75	Hot fill Vacuum seal	66 29

TABLE 3 . CANNING OF FISHERY PRODUCTS, PROCEDURES AND PACKING DATA, CONDENSED.

Product	Season	Cleaning Loss	Pre-treatment	Blanch or pre-cook	Total Loss	Exhaust	Closing temp.
		Percent			Percent		Deg. C.
Clam chowder	Fall-Winter and Spring	75	Solid ingredients diced	Potato 2 to 3 min.	75	Hot fill	82
Fish chowder	Spring	40 fish, 20 potatoes	Fish brined 10-12 hrs 100° brine. potato peeled, washed, dried.	Potato 2 to 3 min., fish steam 30 min. at 115°C.	70	Hot fill	71
Fish cakes	Late-Summer-Winter	20 potato	Wash and peel potato. Soak salt cod 10 hrs.	200 lb. potato, 100 lb. cod. Boil 30 min. (100°C.)	20	Hot fill	66
Fish roe:							
Alewife (river herring).	Spring	5	Rinse	Raw fill	5	Heat exhaust 3 min., 98°C. and hot fill brine	27
"Deep Sea" (Cod & haddock)	Winter-Spring	None	Ground and mixed with brine.	None	None	15 min. 99°C.	82
Shad	California Spring	10	Wash, skin and slime.	Raw fill	10	8 min. 99°C.	66
	Columbia River Spring-Mid-summer					Some use no exhaust	16-

TABLE 3 . CANNING OF FISHERY PRODUCTS, PROCEDURES AND PACKING DATA, CONDENSED

Product	Brine or Sauce	Fill*		Process		Yield	Remarks
		Weight	Can Size	Time	Temp		
		Ounces		Minutes	Deg. C.		
Salmon:							
Chinook	¼ oz. salt added to each can. No. brine;	16.6	No. 1 tall	90	115-118	1 to 5 fish per case	Col. River chinook only part of pack graded for quality and is mostly hand packed.
		16.2	No. 1 flat	do	do		
		8.0	No. ½ flat	80	do		
Red	do	3.9	No. ¼ flat	70	do	12 to 13 fish per case	This species in demand because of deep red color and excellent flavor. Use of lighter colored species has given rise to rumors that some fish are dyed and sold as salmon which is entirely false. It is not permitted by law and technical difficulties of such a process are practically insurmountable.
		16.0	No. 1 oval	90	do		
		7.9	No. ½ oval	80	do		
		3.9	No. ¼ oval	70	do		
		64.	(602x403)	195	117		
Coho	do					9 to 10 fish per case	It is not very abundant. Forms only 7 percent world's pack canned salmon. More important in fresh, frozen and smoked fish trade.
Pink	do					17 fish per case	Smallest and most numerous of salmon. Forms 41 percent world's pack.
Chum	do					9 to 10 fish per case	Has less color in flesh and lower oil content than either species but is not as popular. Sells at lower price than other species salmon but has very high food value and can be made into palatable and nutritious dishes.
Sardines							
California	2 oz. tomato or mustard sauce to each 1 lb. oval - 1 oz. to each ½ lb. oval or 8 oz. rect.	16	No. 1 tall	75	115	Average of 13 cases of sardines per ton of fish required by Calif. law. Fish in good canning cond. about 20 cases per ton.	Packing of natural and smoked fillets becoming important feature of pack.
		16	No. 1 oval	65	115		
		9	½ rect	50	115		
		8	½ oval				

TABLE 3. CANNING OF FISHERY PRODUCTS, PROCEDURES AND PACKING DATA, CONDENSED

Product	Brine or Sauce	Fill*		Process		Yield	Remarks
		Weight	Can Size	Time	Temp		
		Ounces		Minutes	Deg.C.		
Maine	Cottonseed oil	3½	(quarter oil)	45	115	20 cases per hogshead (large fish); 30 cases per hogshead (small fish).	Maine law requires; use of winterpressed cottonseed oil 4 lb. per case (100 quarter); minimum of 4 fish per can (kaylake), 5 (kayopening).
		11	(3/4 mustard)	60	115		
Mackerel							
Boston	3 percent	14	1 lb. oval	75	115	66 percent	Declared net weight on 1 lb. ovals 12 oz. but fill is always heavier. Mackerel must be firm and not over 24 hrs. old.
		14	1 lb. tall				
		16	No. 2 short				
California	3 percent	17 6/8	No. 1 tall (301x411)	9	115 or	No data	Some mackerel packed raw pack without brining, ¼ oz. salt added to can. Not recommended by canning technologists who urge brining be employed.
				75	121		
		17	No. 1 meat (301x407)	75	121		
		11½	No. 1 standard	75	115 or 121		
			(211x400)	60			
Tuna:							
Albacore	Oil and salt oil 3/4 oz; salt 1/14 oz.	9 1/8	8 oz (211x304)	75	121		Small amounts of tuna packed in glass tumblers, aluminum cans. Number of specialty tuna packs of which "Tonna" is probably most important. Other specialty packs "ventreaca", creamed tuna, garlic flavored tuna. Bonito also packed tuna style but may not be labeled as tuna
		3½	No. ¼ tuna	65	115	76 cases; 48¼s per tpn	
	Oil 1½ oz. salt 1/7-3/14 oz	5½-5 3/4	No. ½ tuna	75	115	47 cases; 48/½s	

TABLE 3. CANNING OF FISHERY PRODUCTS, PROCEDURES AND PACKING DATA, CONDENSED

Product	Brine or Sauce	Fill*		Process		Yield	Remarks
		Weight	Can Size	Time	Temp		
		Ounces		Minutes	Deg. C		
Bluefin Yellowfin Striped	Oil 2; salt 9/14 Oil 9; salt 6/7	11-11½ 46	No. 1 tuna 4 lb. tuna	95 230	115 115	23 cases; 48/1s	yellowtail packed tuna style, but may not be labeled tuna. Some canned tuna imported into U.S. from Europe packed in salt brine without oil must be labeled "Packed without oil and in salt solution."
Alewife or river herring	3 percent	16 26	No. 1 tall No. 2 tall	50 60	118 121	No data	Labeled "fresh river herring" but is of canned salt fish style. Fish wrapped individually in parchment paper and packed in No. 2 tall cans.
Fish flakes (haddock)	None	7½ 12	(211x300) (307x208)	55 75	115 115	66 cans per 100 lbs. (211x300) size; 40 cans (307x208) size per 100 lb.	Fillets sometimes used instead of whole fish. Cod may be mixed with haddock 1 to 3, but is not often packed alone because of its soft texture.
Finnan haddie	None	4 12 16	(211x109) (307x208) (300x307)	65 75 75	115 115 115	About same as fish flakes not definitely determined.	Also packed in "nappy" glass tumblers. Imports from England in 1 lb. oval cans.
Shad	½ oz. salt	16½	No. 1 tall	90	115	75 lb. round-fish per case 48/1s.	Pack resembles salmon but flesh is rather dark and soft. Some kippered shad also canned.
Clams: Razor	Clam juice	5½ 7½ 12½	No. ½ No. 1 picnic No. 2	45 45 60	104 104 104	1 bu.clams=40 No.½ flat cans; = 20 No.1 tall	Sold mostly as "minced sea clams."

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TABLE 3. CANNING OF FISHERY PRODUCTS, PROCEDURES AND PACKING DATA, CONDENSED

Product	Brine or Sauce	Fill*		Process		Yield	Remarks
		Weight	Can Size	Time	Temp		
		Ounces		Minutes	Deg. C.		
Soft	3 percent	6	No. 1 picnic	20	115	48 No. 1 picnic cans per bu.	Darkening is principal difficulty in canning. If this occurs blanch in 1.5 percent citric acid and add 0.5 percent citric acid to pack.
		10	No. 1 tall	20	115		
		11	No. 300	20	115		
		12	No. 2	25	115		
Oysters							
Atlantic or Gulf	4°	3	(211x300)	8	121	20 to 25 No. 1 picnic (211x400) cans per bbl.	1 bbl. = 3 bu. in Miss.; 1 bbl. = 4 bu. in La.; Miss. bu. = 2826 cu.in.; La. bu. =2150 cu.in.; Std. U.S. bu. 2150 cu.in. 9/0 loss = shell, mud, oyster juice (nectar).
		4	(211x304)	do	do		
		5	(211x400)	9	121		
		8	(307x400)	10	121		
		10	(307x409)	do	do		
Pacific	3 percent	7 to 9	No. 1 picnic (211x400)	29	115		Pacific oysters filled by count as well as weight. Certain number oysters must go into can for each grade size. Count per No.1 tall can usually 6 to 7 if oysters are large, 8 to 14 if grade is medium, and 15 to 20 if grade is small.
		10 to 13	No. 1 tall	35	115		
		14 to 16	No. 2	42	115		
Crab							
(Dungeness)	4°	6½	(307x202½)	70	109	20 lb.meat or 4 doz. crabs to case 48/½s.	Dry salt may be used instead of brine. Speedy operations without delay, esp. important in this pack.
		13	(401x211)	80	109		
		17	(307x408)	80	109		
King (Japanese)	See remarks	3½	(211x109)	80	104	No data	2 oz. weak buffer sol. of organic acid (lactic or citric) added when discoloration may occur.
		6½	(307x202½)	90	104		
		13	(401x211)	80	109		
Shrimp	4°	5-3/8	No. 1 picnic and squat.	10	121	190 No.1 picnic cans per bbl. (210 lb.)	Processes for dry pack increase as liner type changes from 3 pc. to 1 pc.
		9-3/4	No. 1½	12	121		
		5-1/8	No. 1 picnic and squat.	70 to 85	115		
		9½	No. 1½	75 to 90	115		

TABLE 3. CANNING OF FISHERY PRODUCTS, PROCEDURES AND PACKING DATA, CONDENSED

Product	Brine or Sauce	Fill*		Process		Yield	Remarks
		Weight	Can Size	Time	Temp		
		Ounces		Minutes	Deg.C.		
Clam chowder	Hot soup added	4 solids) 6 soup) 7.5 clam)	No. 1 picnic	60	115	550 No. 1 picnic to 168 lb. solid ingredients.	Down East clam chowder similar to Manhattan, except D. E. has whole clams, no tomatoes and flour instead of cracker meal.
		7.5 potato) 11 soup)	No. 3	85	115		
Fish chowder	Hot soup added	2 fish) 2 potato) 6 soup)	No. 1 picnic	60	115	550 No. 1 picnic to 168 lb. solids.	Darkening or discoloration principal difficulty to be guarded against.
Fish cakes	Solid pack	10		75	115	460 cans to batch (200 lb. potato, 100 lb. fish).	Green mountain potatoes best variety in fish cakes. Discoloration caused by over-processing.
Fish roe:							
Alewife (river herring)	3 percent (sometimes hot water used)	8	(211x300)	50	115	1 case 48/8 oz. cans per 20 lb. bucket "green" roe.	From 13½ to 15 oz. green roe required as fill in weight to give drained weight 16 oz. Variation depends on condition of roe.
		16	(307x400)	60	115		
"Deep sea" (Cod and Haddock)	3 percent	14	(300x407)	75	115	400 cans to 300 lb. roe.	Fill of cans must be watched carefully. Leave ½ in. headspace in filling.
Shad	¼ oz. salt	7-3/4	½ oval	110	110	26; 6 lb. per case 24/½ ovals.	Roe must be fully developed but not over ripe. If roe is too ripe, is watery and lacks flavor. If too green, is hard and tough.
				55	115		
				90	115		

APPENDIX

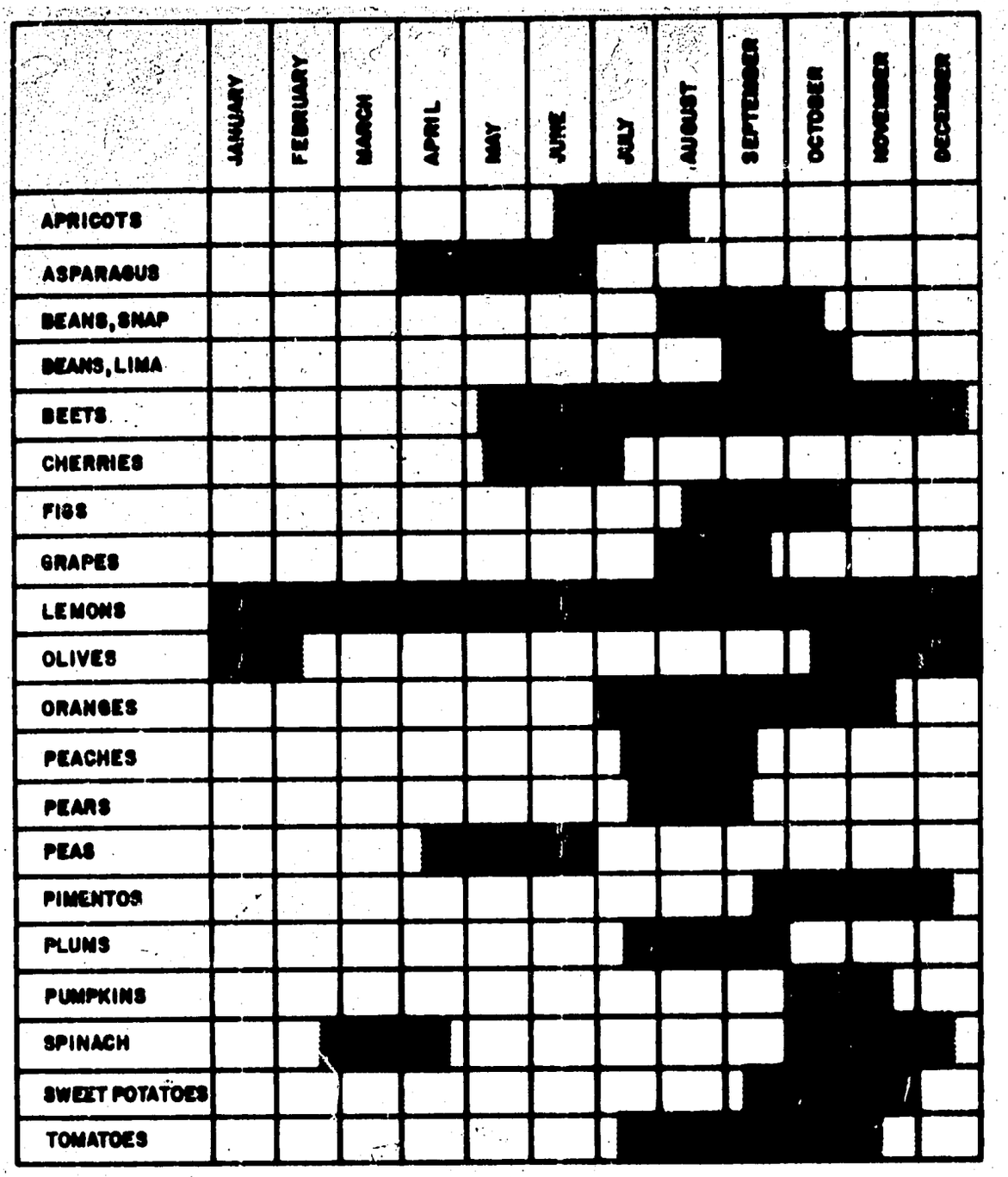

Figure 1. Harvesting Seasons in the State of California, U.S.A.

Permissible room relative humidity without surface condensation, for stored goods in transit from refrigerated to non-refrigerated room conditions.

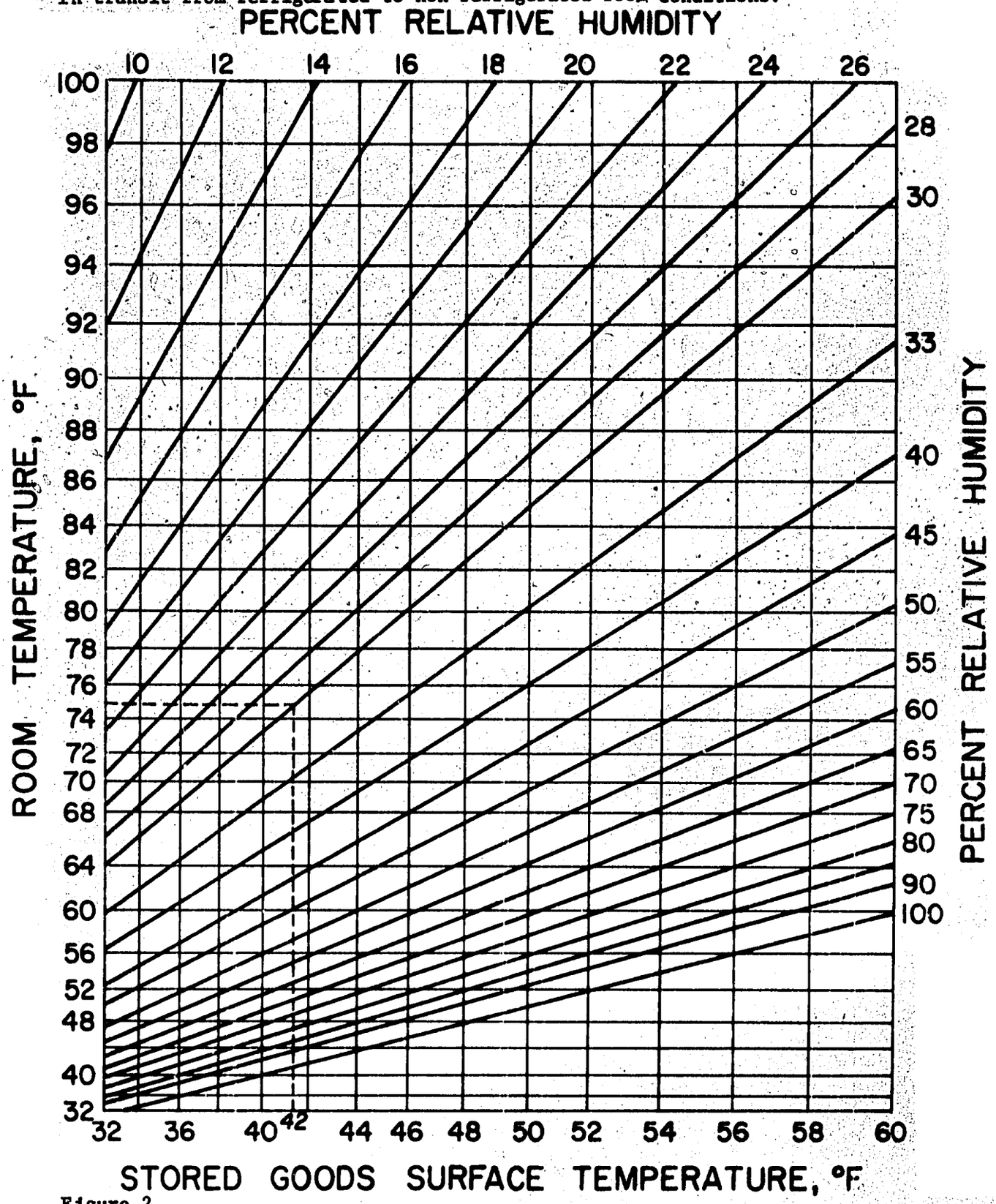

Figure 2

Example: If stored goods are to be moved from a room at 41.5°F, to a room at 75° F., the relative humidity in the 75° F. room must not be over 30 per cent in order to avoid condensation. As surfaces rise in temperature, a higher relative humidity can be tolerated.

TABLE I

Annual Charge for Capital Recovery and Interest for Each Dollar of Investment

Years	5%	6%	7%	8%	10%	12%	15%	Years
1	1.0500	1.0600	1.0700	1.0800	1.1000	1.1200	1.1500	1
2	.5378	.5454	.5531	.5608	.5762	.5917	.6151	2
3	.3672	.3741	.3811	.3880	.4021	.4164	.4380	3
4	.2820	.2886	.2952	.3019	.3155	.3292	.3503	4
5	.2310	.2374	.2439	.2505	.2638	.2774	.2983	5
6	.1970	.2034	.2098	.2163	.2296	.2432	.2642	6
7	.1728	.1791	.1856	.1921	.2054	.2191	.2404	7
8	.1547	.1610	.1675	.1740	.1874	.2013	.2229	8
9	.1407	.1470	.1535	.1601	.1736	.1877	.2096	9
10	.1295	.1359	.1424	.1490	.1627	.1770	.1993	10
11	.1204	.1268	.1334	.1401	.1540	.1684	.1911	11
12	.1128	.1193	.1259	.1327	.1468	.1614	.1845	12
13	.1065	.1130	.1197	.1265	.1408	.1557	.1791	13
14	.1010	.1076	.1143	.1213	.1357	.1509	.1747	14
15	.0963	.1030	.1098	.1168	.1315	.1468	.1710	15
16	.0923	.0990	.1059	.1130	.1278	.1434	.1679	16
17	.0887	.0954	.1024	.1096	.1247	.1405	.1654	17
18	.0855	.0924	.0994	.1067	.1219	.1379	.1632	18
19	.0827	.0896	.0968	.1041	.1195	.1358	.1613	19
20	.0802	.0872	.0944	.1019	.1175	.1339	.1598	20
21	.0780	.0850	.0923	.0998	.1156	.1322	.1584	21
22	.0760	.0830	.0904	.0980	.1140	.1308	.1573	22
23	.0741	.0813	.0887	.0964	.1126	.1296	.1563	23
24	.0725	.0797	.0872	.0950	.1113	.1285	.1554	24
25	.0710	.0782	.0858	.0937	.1102	.1275	.1547	25
26	.0696	.0769	.0846	.0925	.1092	.1267	.1541	26
27	.0683	.0757	.0834	.0914	.1083	.1259	.1535	27
28	.0671	.0746	.0824	.0905	.1075	.1252	.1531	28
29	.0660	.0736	.0814	.0896	.1067	.1247	.1527	29
30	.0651	.0726	.0806	.0888	.1061	.1241	.1523	30
35	.0611	.0690	.0772	.0858	.1037	.1223	.1511	35
40	.0583	.0665	.0750	.0839	.1023	.1213	.1506	40
45	.0563	.0647	.0735	.0826	.1014	.1207	.1503	45
50	.0548	.0634	.0725	.0817	.1009	.1204	.1501	50
55	.0537	.0625	.0717	.0812	.1005			55

TABLE II

GAUGE PRESSURE K.P.A.* (P.S.I.)‡ CORRESPONDING TO SPECIFIED PROCESS TEMPERATURES AT VARIOUS ALTITUDES

Temp. Deg. C.	Sea Level	152m 500ft	305m 1000ft	610m 2000ft	914m 3000ft	1219m 4000ft	1524m 5000ft	1829m 6000ft	Temp. Deg. F.
93.3	•••• ••••	•••• ••••	•••• ••••	•••• ••••	•••• ••••	•••• ••••	•••• ••••	•••• ••••	200
96.1	•••• ••••	•••• ••••	•••• ••••	•••• ••••	•••• ••••	•••• ••••	3.4 (0.5)	6.2 (0.9)	205
98.9	•••• ••••	•••• ••••	•••• ••••	2.8 (0.4)	6.2 (0.9)	9.6 (1.4)	12.4 (1.8)	15.9 (2.3)	210
100.0	0.0 (0.0)	1.4 (0.2)	3.4 (0.5)	6.9 (1.0)	10.3 (1.5)	13.8 (2.0)	16.5 (2.4)	20.0 (2.9)	212
101.7	6.2 (0.9)	7.6 (1.1)	9.6 (1.4)	13.1 (1.9)	16.5 (2.4)	20.0 (2.9)	22.7 (3.3)	26.2 (3.8)	215
104.4	17.2 (2.5)	18.6 (2.7)	20.7 (3.0)	23.4 (3.4)	26.9 (3.9)	30.3 (4.4)	33.8 (4.9)	36.5 (5.3)	220
107.2	29.0 (4.2)	31.0 (4.5)	32.4 (4.7)	35.8 (5.2)	39.3 (5.7)	42.7 (6.2)	45.5 (6.6)	48.9 (7.1)	225
110.2	42.1 (6.1)	43.4 (6.3)	45.5 (6.6)	48.9 (7.1)	52.4 (7.6)	55.2 (8.0)	58.6 (8.5)	62.1 (9.0)	230
112.8	55.8 (8.1)	57.2 (8.3)	59.3 (8.6)	62.7 (9.1)	66.2 (9.6)	68.9 (10.0)	72.4 (10.5)	75.8 (11.0)	235
115.6	71.0 (10.3)	72.4 (10.5)	74.5 (10.8)	77.9 (11.3)	80.7 (11.7)	84.1 (12.2)	87.6 (12.7)	90.3 (13.1)	240
116.7	77.2 (11.2)	78.6 (11.4)	80.7 (11.7)	84.1 (12.2)	87.6 (12.7)	90.3 (13.1)	93.8 (13.6)	97.2 (14.1)	242
118.3	86.9 (12.6)	88.9 (12.9)	90.3 (13.1)	93.8 (13.6)	97.2 (14.1)	100.7 (14.6)	103.4 (15.0)	106.9 (15.5)	245
120.0	97.2 (14.1)	98.6 (14.3)	100.7 (14.6)	104.1 (15.1)	107.6 (15.6)	110.3 (16.0)	113.8 (16.5)	117.2 (17.0)	248
121.1	104.1 (15.1)	106.2 (15.4)	107.6 (15.6)	111.0 (16.1)	114.5 (16.6)	117.9 (17.1)	120.7 (17.5)	124.1 (18.0)	250
122.2	111.7 (16.2)	113.1 (16.4)	115.1 (16.7)	118.6 (17.2)	122.0 (17.7)	124.8 (18.1)	128.2 (18.6)	131.7 (19.1)	252
123.9	122.7 (17.8)	124.8 (18.1)	126.2 (18.3)	129.6 (18.8)	133.1 (19.3)	136.5 (19.8)	139.3 (20.2)	142.7 (20.7)	255
126.7	142.7 (20.7)	144.8 (21.0)	146.2 (21.2)	149.6 (21.7)	153.1 (22.2)	156.5 (22.7)	159.3 (23.1)	162.7 (23.6)	260

* Kilopascal – 6.894 kpa = 1 sq. in. or 6,894 newton/meter^2 = 1 sq. in.

‡ Pounds per square inch.

TABLE III

EQUIVALENTS OF HOUSEHOLD FOOD MEASURES

Quarts	Pints	Standard Cups	Fluid Ounces	Tablespoonsful	Teaspoonsful	Milliliters
1.000	2.000	4.000	32.0	64.00	192.0	946.4
0.500	1.000	2.000	16.0	32.00	96.0	473.2
0.250	0.500	1.000	8.0	16.00	48.0	236.6
0.125	0.250	0.500	4.0	8.00	24.0	118.3
	0.125	0.250	2.0	4.00	12.0	59.2
		0.125	1.0	2.00	6.0	29.6
			0.5	1.00	3.0	14.8
				0.33	1.0	4.9
					0.2	1.0

TABLE IV

AMOUNT OF SALT SUGGESTED FOR CANNING VARIOUS VEGETABLES

Product	Milliliters (Teaspoonsful) or Grams (Ounces)							
	Container Size							
	No. 303 & No. 2 Cans or Pint Jars				No. 2½ Cans or Quart Jars		No. 10 Cans	
	mL.	(t.) or	g.	(oz.)	mL.	(t.) or g. (oz.)	mL.	(t.) or g. (oz.)
Asparagus	3.8	(3/4)	4.9	(0.17)	6.3	(1¼) 8.2 (0.3)	22.2	(4 1/2) 29 (1.0)
Beans, Green	3.1	(2/3)	4.1	(0.14)	4.1	(3/4) 5.4 (0.2)	13.8	(2 3/4) 18 (0.6)
Beans, Lima	3.1	(2/3)	4.1	(0.14)	4.1	(3/4) 5.4 (0.2)	13.8	(2 3/4) 18 (0.6)
Beets	3.1	(2/3)	4.1	(0.14)	4.1	(3/4) 5.4 (0.2)	13.8	(2 3/4) 18 (0.6)
Carrots	3.1	(2/3)	4.1	(0.14)	4.1	(3/4) 5.4 (0.2)	13.8	(2 3/4) 18 (0.6)
Corn, Whole	3.1	(2/3)	4.1	(0.14)	4.1	(3/4) 5.4 (0.2)	13.8	(2 3/4) 18 (0.6)
Greens, Leafy	3.8	(3/4)	4.9	(0.17)	6.3	(1¼) 8.2 (0.3)	22.2	(4 1/2) 29 (1.0)
Okra	3.1	(2/3)	4.1	(0.14)	4.1	(3/4) 5.4 (0.2)	13.8	(2 3/4) 18 (0.6)
Peas, Green	3.1	(2/3)	4.1	(0.14)	4.1	(3/4) 5.4 (0.2)	13.8	(2 3/4) 18 (0.6)
Tomatoes	3.1	(2/3)	4.1	(0.14)	4.9	(1) 6.4 (0.2)	14.7	(3) 19 (0.7)
Squash, Summer	3.1	(2/3)	4.1	(0.14)	4.1	(3/4) 5.4 (0.2)	13.8	(2 3/4) 18 (0.6)
Squash, Winter	3.1	(2/3)	4.1	(0.14)	4.1	(3/4) 5.4 (0.2)	13.8	(2 3/4) 18 (0.6)

TABLE V

AMOUNT OF MATERIAL (sugar, salt, etc.) to ADD TO WATER TO OBTAIN A SOLUTION WITH A SPECIFIED CONCENTRATION

Per Cent Concentration Desired	Grams per Liter[1] of Solution (syrup, brine, etc.)	Ounces (Avoir.) per U. S. Gallon[2] of Solution (syrup, brine, etc.)
1	10.0	1.33
1½	15.0	2.00
2	20.0	2.67
2½	25.0	3.33
3	30.0	4.00
3½	35.0	4.67
4	40.0	5.32
4½	45.0	6.00
5	50.0	6.67
6	60.0	8.00
8	80.0	10.70
10	100.0	13.30
12	120.0	16.00 (1 lb. - 0 oz.)
15	150.0	20.00 (1 lb. - 4 oz.)
20	200.0	26.70 (1 lb. - 10.70 oz.)
25	250.0	33.25 (2 lb. - 1.25 oz.)
30	300.0	40.00 (2 lb. - 8.00 oz.)
35	350.0	46.55 (2 lb. - 14.55 oz.)
40	400.0	53.20 (3 lb. - 5.20 oz.)
45	450.0	59.85 (3 lb. - 11.85 oz.)
50	500.0	66.50 (4 lb. - 2.50 oz.)
55	550.0	73.15 (4 lb. - 9.15 oz.)
60	600.0	80.00 (5 lb. - 0.00 oz.)

1. Add enough water to the material to make up to one liter of solution.
2. Add enough water to the material to make up to one U.S. gallon of solution

TABLE VI

CONVERSIONS FACTORS

To Change	To	Multiplied By
acres	hectares	.4047
atmospheres	cms. of mercury	76
BTU	horsepower-hrs.	.0003931
BTU	kilowatt-hrs.	.0002928
BTU/hr.	watts	.2931
bushels	cubic inches	2150.4
bushels	hectoliters	.3524
centimeters	inches	.3937
centimeters	feet	.03281
cubic feet	cubic meters	.0283
cubic meters	cubic feet	35.3145
cubic meters	cubic yards	1.3079
cubic yards	cubic meters	.7646
feet	meters	.3048
gallons (U.S.)	liters	3.7853
grains	grams	.0648
grams	grains	15.4324
grams	ounces avdp.	.0353
grams	pounds avdp.	.002205
hectares	acres	2.4710
hectoliters	bushels (U.S.)	2.8378
horsepower	watts	745.7
hours	days	.04167
inches	millimeters	25.400
inches	centimeters	2.5400
kilograms	pounds avdp or t	2.2046
kilometers	miles	.6214
Kilowatt	horsepower	1.341
liters	gallon (U.S.)	.2642
liters	pecks	.1135
liters	pints (dry)	1.8162
liters	pints (liquid)	2.1134
liters	quarts (dry)	.9081
liters	quarts (liquid)	1.0567
meters	feet	3.2808
meters	miles	.0006214
meters	yards	1.0936
metric tons	tons (long)	.9842
metric tons	tons (short)	1.1023
miles	feet	5280
miles	kilometers	1.6093
millimeters	inches	.0394
ounces avdp.	grams	28.3495
ounces	pounds	.0625
pecks	liters	8.8096
pints (dry)	liters	.5506
pints (liquid)	liters	.4732
pounds avdp.	grams	453.6
pounds avdp.	kilograms	.4536
pounds	ounces	16
quarts (dry)	liters	1.1012
quarts (liquid)	liters	.9463
square feet	square meters	.0929
square meters	square feet	10.7639
square meters	square yards	1.1960
square yards	square meters	.8361
tons (long)	metric tons	1.1060
tons (short)	metric tons	.9072
tons (long)	pounds	2240
tons (short)	pounds	2000
watts	BTU/hr.	3.4129
watts	horsepower	.001341
yards	meters	.9144

TABLE VII

MEASURES OF LENGTH AND SURFACE

Metric denominations and Values		Equivalent
Length		
1 myriameter	10,000 meters	6.2137 miles
1 kilometer	1,000 meters	0.62137 miles 3,280 feet 10 inches
1 hectometer	100 meters	328 feet 1 inch
1 decameter	10 meters	393.7 inches
1 meter	1 meter	39.37 inches
1 decimeter	1/10 meter	3.937 inches
1 centimeter	1/100 meter	0.3937 inch
1 millimeter	1/1000 meter	0.03937 inch
1 micron	1/1,000,000 meter	1/1,000 millimeter
1 millimicron	1/1,000,000,000 meter	1/1,000 micron
1 Angstrom unit	$1/10^{10}$ meter	1/10,000 micron
Surface		
1 square kilometer	1,000,000 square meters	0.3861 square miles
1 hectare	10,000 square meters	2.472 acres
1 are	100 square meters	119.6 square yards
1 centare	1 square meter	1,550 square inches
1 square decimeter	0.01 square meter	15.50 square inches
1 square centimeter	0.0001 square meter	0.155 square inch
1 square millimeter	0.000001 square meter	0.00155 square inch

TABLE VIII

MEASURES OF CAPACITY AND VOLUME

Metric Denominations and Values		Equivalents		
		Cu. In.	Dry Measure	Liquid Measure
1 kiloliter	1,000 liters	61,025.0	1.308 cubic yards	264.18 gallons
1 hectoliter	100 liters	6,102.50	2.8378 bushels	26.418 gallons
1 decaliter	10 liters	610.25	1.1351 pecks	2.6418 gallons
1 liter	1 liter	61.025	0.9081 quarts	1.0567 quarts
1 deciliter	1/10 liter	6.1025	0.18162 pint	0.21134 pint
1 centiliter	1/100 liter	0.61025	0.61025 cubic inch	0.3381 fluid ounce
1 milliliter	1/1000 liter	0.061025	0.06102 cubic inch	1 cubic centimeter

TABLE IX

THE RELATION BETWEEN RELATIVE HUMIDITY AND VAPOR PRESSURE AT DIFFERENT TEMPERATURE

Temp.		Actual vapor pressure (mm. Hg) at indicated relative humidity										
°C	°F	0	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0	32	0	0.5	0.9	1.4	1.8	2.3	2.8	3.2	3.7	4.1	4.6
5	41	0	0.7	1.3	2.0	2.6	3.3	3.9	4.6	5.2	5.9	6.5
10	50	0	0.9	1.8	2.8	3.7	4.6	5.5	6.5	7.4	8.3	9.2
15	59	0	1.3	2.6	3.8	5.1	6.4	7.7	9.0	10.2	11.5	12.8
20	68	0	1.8	3.5	5.3	7.0	8.8	10.5	12.3	14.0	15.8	17.5
25	77	0	2.4	4.8	7.1	9.5	11.9	14.3	16.6	19.0	21.4	23.8
30	86	0	3.2	6.4	9.6	12.7	15.9	19.1	22.3	25.5	28.6	31.8
35	95	0	4.2	8.4	12.6	16.9	21.1	25.3	29.5	33.7	38.0	42.2
40	104	0	5.5	11.1	16.6	22.1	27.7	33.2	38.7	44.2	49.8	55.3

TABLE X

Equipment Suppliers

For convenience, the equipment discussed in this manual has been classified in the following categories:

A. Food preparation equipment

1. hand-operated
2. power-operated

B. Exhausters

1. batch
2. continuous

C. Sealers

1. hand-operated
2. power-operated

D. Kettles, cookers, and retorts, fillers

E. Materials handling equipment

F. Instruments

G. Steam boilers

H. Labeling equipment

I. Can manufacturing equipment

J. Can reforming equipment

K. Cans

L. Glass jars

An alphabetized list of distributors of canning equipment and the specialized items they handle, as indicated in the above classification, is given in Table X. Mention of the name of these firms is not to be construed as a recommendation or endorsement but merely as a citation that is typical in its field. Commercial directories generally list names of additional companies.

New equipment is constantly being developed in the canning machinery industry. Hence, this listing cannot be considered complete or up to date after the lapse of even a few months.

TABLE X

DISTRIBUTORS OF CANNING EQUIPMENT

Distributor	Equipment Category														
	A-1	A-2	B-1	B-2	C-1	C-2	D	E	F	G	H	I	J	K	L
Aluminum Goods Manufacturing Company Manitowoc, Wisconsin	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
American Can Company American Lane Greenwich, Conn. 06830	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-
Angelus Sanitary Can Machine Company 4900 Pacific Boulevard Los Angeles, California 90058	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Ball Corporation Muncie, Ind. 47302	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
Berlin Chapman Div. of Perfex Corp. Berlin, Wisconsin 54923	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
Bernardin, Inc. Evansville, Ind.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
E. W. Bliss Company 1004 East State St. Hastings, Michigan 49058	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
Callahan-Max Ams Can Machine Company 61 Main Street Proctor, Vermont 05765	-	-	-	-	x	x	-	-	-	-	-	x	-	-	-
Chisholm-Ryder Company, Inc. College & Highland Avenues Niagara Falls, New York 14305	x	x	-	-	-	-	x	x	x	-	x	-	-	-	-

TABLE X (Continued)
DISTRIBUTORS OF CANNING EQUIPMENT

Distributor	Equipment Category														
	A-1	A-2	B-1	B-2	C-1	C-2	D	E	F	G	H	I	J	K	L
Continental Can Company, Inc. Food Division 5745 East River Road Chicago, Ill. 60631	-	-	-	-	-	-	-	x	-	-	-	-	x	-	-
Crosby Steam Gage & Valve Company Wrenthan, Massachusetts	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
Dewey & Almy Chemical Division W. R. Grace & Co. 62 Whittemore Avenue Cambridge, Massachusetts 02140	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
Dixie Canner Equipment Company P.O. Box 1348 Athens, Georgia 30601	x	x	x	x	x	x	x	x	x	x	x	-	-	-	-
Federal Enameling & Stamping Company Box 626 Pittsburgh 30, Pennsylvania	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
First Machinery Corporation, Falcon Mfg. Div. 209 Tenth Street Brooklyn, New York 11215	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
FMC Corporation Canning Machinery Div. 103 East Maple Street Hoopeston, Illinois 60942	x	x	-	x	-	x	x	x	-	-	-	-	-	-	-

TABLE X (Continued)

Distributor	Equipment Category														
	A-1	A-2	B-1	B-2	C-1	C-2	D	E	F	G	H	I	J	K	L
17 Groen Division Dover Corporation 1900 Pratt Boulevard Elk Grove Village, Illinois 60007	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Hamburg Boiler Works, Inc. Hamburg, Pennsylvania	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Hamilton Kettles Div. of Brighton Corporation 11861 Mosteller Road Cincinnati, Ohio 45241	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Hazel-Atlas Glass Division Continental Can Co. Inc. Wheeling, West Virginia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
Kerr Glass Mfg. Corp. Sand Springs Okla 74063	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
Kewanee-Ross Corporation Kewanee, Illinois	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Lakeside Aluminum Company 2633 Southeast Fourth Street Minneapolis, Minnesota	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
F. H. Langsenkamp Company 229 East South Street Indianapolis, Indiana 46225	x	x	-	x	x	x	x	x	x	-	x	-	-	-	-
Lee Metal Products Company, Inc. 432 Pine Street Philipsburg, Pennsylvania 16866	-	-	-	-	-	-	x	x	-	-	-	-	-	-	-

TABLE X (Continued)
DISTRIBUTORS OF CANNING EQUIPMENT

Distributor	Equipment Category														
	A-1	A-2	B-1	B-2	C-1	C-2	D	E	F	G	H	I	J	K	L
Legion Utensils Company 40th Avenue & 21st Street Long Island City 1, New York	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Lookout Boiler & Manufacturing Company Chattanooga, Tennessee	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Manning, Maxwell & Moore, Inc. Stratford, Connecticut	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
Mateer-Burt 436 Devon Park Dr. Box 405 Wayne, PA 19087	-	-	-	-	-	-	x	-	-	-	x	-	-	-	-
Moeller Instrument Company 132nd Street and 89th Avenue Richmond Hill 18 New York, New York	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
National Aluminum Manufacturing Company Peoria, Illinois	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
National Pressure Cooker Company Eau Claire, Wisconsin	-	-	-	-	x	-	x	-	-	-	-	-	-	-	-
Orr & Sembower, Inc. P.O. Box 1138 Reading, Pennsylvania 19603	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-

TABLE X (Continued)
DISTRIBUTORS OF CANNING EQUIPMENT

Distributor	Equipment Category														
	A-1	A-2	B-1	B-2	C-1	C-2	D	E	F	G	H	I	J	K	L
Palmer Instruments, Inc. 2515 Norwood Avenue Cincinnati, Ohio 45212	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
Pressure Cooker Company 388 Broadway Denver, Colorado	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Rietz Manufacturing Company 150 Todd Road Santa Rosa, California 95401	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
A. K. Robins and Company, Inc. 713 East Lombard Street Baltimore, Maryland 21202	x	x	-	x	-	x	x	x	-	-	-	-	-	-	-
R. & S. Machinery Company 19 Howard Street New York 13, New York	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
Ross Machine Works, Inc. 30 Main Street Brooklyn 1, New York	-	-	-	-	-	x	-	-	-	-	-	x	-	-	-
Sinclair-Scott Company 6245 State Road Philadelphia, Pennsylvania 19135	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
Taylor Instrument Companies 95 Ames Street Rochester, New York 14601	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-

TABLE X (Continued)
DISTRIBUTORS OF CANNING EQUIPMENT

Distributor	Equipment Category														
	A-1	A-2	B-1	B-2	C-1	C-2	D	E	F	G	H	I	J	K	L
Vischer Products Company 2815 West Roscoe Street Chicago 18, Illinois	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Vulcan Hart Manufacturing Company 3600 North Point Boulevard Baltimore 22, Maryland	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Wisconsin Aluminum Foundry Company, Inc.	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-

TABLE XI

PRODUCT IDENTIFICATION BY LATIN NOMENCLATURE AND SUITABILITY FOR CANNING

Product	Latin Nomenclature	Suitability For Canning	Suitability For Juices
Apple	Pyrus malus	Excellent	Excellent
Apricot	Prunus armeniaca	Excellent	
Asparagus	Asparagus officinalis	Excellent	
Bean, Snap	Phaseolus Vulgaris	Excellent	
Bean, Lima	Phaseolus lunatus	Excellent	
Beets	Beta Vulgaris	Excellent	
Blackberry	Rubus villosus	Excellent	Excellent
Broccoli		Good	
Brussels Sprouts	Brassica oleracea gemmifera	Good	
Cabbage	Brassica oleracea capitata	Good	
Carrots	Daucus carota	Good	
Cauliflower	Brassica oleracea botrytis	Good	
Celery	Apium gravedens	Fair	
Cherry	Prunes Cerasus avium	Excellent	
Corn	Zea Mays	Excellent	
Cranberry	Oxycocous palustris macrocarpus	Good	
Egg Plant	Solanum melongena	Fair	
Fig	Ficus carica	Good	
Grape	Vitis labrusca vinifera vulpina Muscadinia rotundifolia	Fair	Excellent
Grapefruit	Citrus grandis	Good	Good

PRODUCT IDENTIFICATION BY LATIN NOMENCLATURE AND SUITABILITY FOR CANNING

Product	Latin Nomenclature	Suitability For Canning	Suitability For Juices
Guava	Psidium quajava cattleyanum	Good	
Loquat	Eriobotrya japonica	Good	
Mango	Mangifera indica	Good	
Mayhaw	Crataegus aestivalis	Poor	
Mushroom	Any edible fungus of orders Agaricales, Lycoperdales, especially Agaricus campestris	Excellent	
Okra	Abelmoschus esculentus	Fair	
Orange	Citrus sinensis aurantium bergamia	Poor	Poor
Papaya	Carica papaya	Fair	
Parsnip	Pastinaca sativa	Good	
Peach	Amygdalus persica	Excellent	
Pear	Pyrus serotina communis	Excellent	
Pea, Field	Pisum arvense	Excellent	
Pea, Green	Pisum sativum	Excellent	
Pineapple	Ananas sativa	Excellent	Excellent
Plum	Prunus munsoniana domestica americana	Good	
Potato, White	Solanum tuberosum	Good	
Potato, Sweet	Ipomoea batatas	Excellent	
Pumpkin	Cucurbita pepo	Good	

PRODUCT IDENTIFICATION BY LATIN NOMENCLATURE
AND SUITABILITY FOR CANNING

Product	Latin Nomenclature	Suitability For	
		Canning	Juices
Quince	Cydonia oblonga	Poor	
Raspberry	Rubus strigosus	Good	
Rhubarb	Rheum rhaponticum	Good	
Roselle	Hibiscus sabdariffa	Fair	
Spinach	Spinacea oleracea	Good	
Squash, Summer	Cucurbita pepo	Good	
Squash, Winter	Cucurbita maxima moschata	Good	
Strawberry	Fragaria Virginiana	Poor	
Tomato	Lycopersicum esculentum	Excellent	Excellent

GLOSSARY

ACID FOOD - A food having reached a finished equilibrium with a pH value of 4.6 or lower. In some cases foods having a pH value ranging up to 4.9 are classified as acid foods such as tomatoes, pineapple, pears and figs.

ADULTERANT - Any foreign material in food that will be objectionable esthetically hazardous to health, or indicative of unsanitary handling or manufacturing practices.

AEROBES - Microoganisms that require oxygen or air for growth.

AGING - The process by which foods under controlled conditions are allowed to develop certain qualities, such as beef, mutton and flour, which has been treated with an oxidizing agent.

ANAEROBES - Microorganisms that cannot grow in the presence of oxygen or air. A type of anaerobe known as facultative anaerobe can grow in air or oxygen, but can also grow in the absence of oxygen.

ANTHOCYANINS - Color pigments, red, purple and blue, in many fruits, vegetables flowers and leaves. Being depolarized in electrochemical reactions frequently cause problems in canned foods by accelerating internal corrosion in metal containers.

BACILLUS - A rod shape bacterium, some of which produce spores such as Clostridium botulinum.

BACTERIAL LOAD - The microorganisms associated with a quantity of foodstuff that must be rendered harmless during the canning operation.

BACTERICIDE - A substance, usually in solution, that destroys bacteria in the vegetative stage of development. However, it does not usually destroy spores.

BACTERIOSTATIC - Arresting the growth of bacteria without destroying them.

BASE PLATE PRESSURE - The amount of forces applied to the base plate of a can closing machine holding the can body and end against the chuck during the seaming operation.

BIOLOGICAL OXYGEN DEMAND (BOD) - A term used as a measure of microbial activity in sewage, water, etc.

BLANCHING - Heating in water or in live steam food material to soften tissues, eliminate air from tissues, inactivate enzymes and eliminate some of raw flavors.

BLEEDERS - Valve openings on steam pressure vessels to permit the escape of air that enters the vessel along with the steam and promote the circulation of steam within the vessel.

BODY HOOK - The flange portion of the can body that is turned down and up in forming a double seam.

BOTULISM - A food poisoning resulting from ingesting a toxin produced by *Clostridium botulinum* organism.

BRINE - A water solution containing salt which is a canning medium for vegetables.

BRITISH THERMAL UNIT (BTU) - A British thermal unit - the amount of energy required to raise 453.59 grams (1 pound) of water 0.5555°C (1°F).

BRIX - A measure of specific gravity of a solution containing sucrose at 20°C (68°F).

BUCKLING - The permanent bulging along the double seam of a metal container due to excessive internal pressure. The defect frequently occurs during cooling of large cans when procedures for cooling are not properly followed.

CANNING MEDIUM - The liquid such as brine, syrup, or oil used to improve the flavor and physical properties of canned products and to fill the air spaces reducing discoloration and improving heat penetration.

CONVECTION - Transmitting or conveying heat in a fluid or mass movement of parts of a fluid within the fluid because of differences in the density, temperature, etc. of the parts.

COUNTERSINK DEPTH - The distance from the top edge of a double seam of a can to the cover center panel adjacent to the chuck wall.

COVER - The end piece that is placed on a can by a can closing machine.

COVER HOOK - The curl portion of the can cover that is rolled down in the formation of a double seam.

CRATE - A basket or container into which metal containers or glass jars are stacked for placement in the pressure cooker or retort. Also, boxes or cases made of slats of wood in which harvested produce is stored and transported.

CROSSOVER - The part of a double seam at the side seam or lap of the can body.

CURL - The extreme edge of the can cover which is rolled down and up to form the cover hook of a double seam.

CUT-OVER - A sharp bend or break in the metal of the double seam that occurs at the top of the countersink.

DOUBLE SEAM - A seam or joint formed in attaching a cover to the body of a can in which five thickness of tin plate are interlocked and pressed firmly together.

DROOP - A smooth projection of metal in a double seam below the bottom of a normal seam.

ENAMEL - A vitreous or paint-like lining or coating of a metal container usually baked on to protect the contents or the container from corrosion.

ENDOTOXIN - A toxic substance produced within an organism that is liberated by the disintegration of the bacteria cell.

ENZYME - A proteinlike substance, formed in animal and plant cells that act as organic catalysts in initiating or speeding up specific biochemical reactions and usually become inactive or unstable at high temperatures.

EXHAUST - Heating food in containers just prior to closing the container to eliminate air and create a partial vacuum after the closed container cools following thermal processing.

EXHAUSTER - A piece of equipment used to exhaust containers of foods prior to closing to create a partial vacuum.

EXOTOXIN - A toxic substance excreted by certain types of microorganisms into the medium surrounding them.

FALSE SEAM - A double seam in which the cover hook and body hook do not overlap.

FIRST OPERATION - The first operation in double seaming in which the curl of the can end is rolled under the flange of the can body to form the cover hook and body hook.

FLANGE - The flared top of the can body.

FLAT-SOURS - Food spoilage caused by thermophilic bacteria, facultative anaerobes which ferment carbohydrates to produce acid without the formation of gas. Flat-sour spoiled cans of food do not show any swelling at the can ends.

FLIPPER - A can of food having both ends flat but with insufficient vacuum to maintain this configuration. A sharp rap on one end may cause the can end to bulge out but can be pressed back into its original position.

FOOD ADDITIVE - A chemical substance that is added to the food during processing to improve the quality of the food.

FOOD POISONING - A term used to describe an illness or discomfort due to ingestin food contaminated with microorganisms or toxins produced by certain organisms.

HALOPHILIC - A type of microorganism that has the ability to grow in mediums having relatively high salt concentrations.

HARDSWELL - Cans of food in which the ends are swollen too hard to be depressed back into their original positions by applying thumb pressure.

HEADSPACE, GROSS - Is the vertical distance from the top of the double seam of a metal container and the rim of a glass container down to the top of the surface of the container contents.

HEADSPACE, NET - is the vertical distance between the bottom of the container cover and the top of the surface of the container contents.

HYDROGEN-ION CONCENTRATION - A measurement of dissociated hydrogen-ions in a substance or a measurement of the substance acidity or alkalinity. It is also called pH.

HYDROGEN SWELL - The swelling in cans of food due to hydrogen gas produced by a chemical reaction between the contents and the metal in the can.

HYDROPHILIC - Capable of uniting with or taking up water.

HYGROSCOPIC - Attracting or absorbing moisture from the air.

INCUBATION - Holding cultures of microorganisms in a favorable environment for development.

INHIBITION - Preventing the development and growth of microorganisms or enzyme activity.

INITIAL TEMPERATURE - This is the average temperature of the contents in the coldest container of a batch to be processed at the time thermal process cycle begins.

JUMPED SEAM - A defect in a double seam which was not rolled tightly enough adjacent to the side seam or lap which was caused by jumping of the second operation seaming roll at the side seam.

LAP - Overlap of two pieces of metal bonded together at the end of the side seam in the can body.

LID - Can cover or end.

LIP - A defect in the double seam which occurs at the lap.

LOW ACID FOODS - Foods having a pH value greater than 4.6 except certain foods such as tomatoes, pears, pineapples and figs.

LYE - Caustic soda (sodium hydroxide and/or potassium hydroxide). It is used to make solutions to peel certain fruits and vegetables.

MESOPHILIC BACTERIA - Bacteria that have an optimum growing temperature ranging from 23.9°C (75°F) to 40.5°C (105°F). However, some may grow in temperatures down as low as 10°C (50°F) and as high as 43.3°C (110°F).

MOLDS - A fungi which is more resistant to heat than yeast but much less resistant than bacteria.

OVER LAP - The distance that the body hook and cover hook lap over each other.

PANELING - A permanent inward distortion of metal containers caused by excessive external pressure. This defect frequently occurs during cooling in retorts under pressure when the proper technique is not applied.

PASTEURIZATION - A heat treatment applied to foods in a range from 71°C (160°F) to 100°C (212°F) for a very short period of time to destroy a part but not all microorganisms that could cause spoilage.

pH - A symbol for the degree of acidity or alkalinity of a solution - the logarithm of the reciprocal of the hydrogen ion concentration in gram equivalents per liter of solution: pH7 (.0000001 gram atom of hydrogen ion per liter), the value of pure distilled water which is regarded as neutral; pH values from 0 to 7 indicate acidity and from 7 to 14 indicate alkalinity.

POTABLE - Safe to drink, free from harmful substances.

PRESERVATION - A process by which the decomposition of foods is delayed or prevented.

PRESSURE RIDGE - An impression that is formed on the inside of the can body in lower double seam area as the result of the pressure applied by the seaming rolls during the seaming operation.

PROCESS EFFLUENT - The liquid discharge from a plant which usually consists of water and suspended and soluble solids.

PROCESS SCHEDULE - The processing temperature and time that a processor has selected for a given product that will render that product commercially sterile.

PSYCHROPHILIC BACTERIA - Bacteria that have an optimum growth temperature range from 15.5°C (60°F) to 21°C (70°F). This type of bacteria may grow and develop in temperatures as low as 0°C (32°F) and as high as 30°C (86°F).

PUREE - A thick, moist, smooth-textured form of cooked vegetable, fruit, etc., usually made by pressing the pulp through a sieve or by whipping it in a blender.

PUTREFACTION - The decomposition of organic matter (food) by microorganisms resulting in the formation of foul-smelling products.

RANCIDITY - The deterioration of a food by oxidation producing a characteristic off-odor and flavor.

REFRACTOMETER - An optical instrument for measuring refraction as the bending of a beam of light as it passes through a solution containing soluble solids. It is used to measure the soluble solids in solutions, fruits, etc.

RESPIRATORY GASES - Gases evolved from fruits and vegetables during respiration while in storage.

RETORT - A pressure vessel used for the thermal processing of foods.

SANITIZE - To make sanitary by sterilizing with a chemical, heat, etc.

SEALING COMPOUND - A latex or similar material that is applied in the end curl of a container cover to aid in the formation of a hermetical seal.

SECOND OPERATION - The finishing operation in double-seaming in which the cover hook and body hook rolled tightly together with enough pressure to cause the sealing compound to flow into any voids not filled with metal.

SOFT SWELL - A bulging of the ends of a metal container that can be depressed fairly easily with the thumb.

SOLUBLE SOLIDS - Solids in solution.

SPRINGER - A swollen can with only one end bulging out. When the bulging end is pushed in the other end will bulge out.

STAPHYLOCOCCUS - Any of a genus of spherical, Gram-positive bacteria that generally occur in irregular clusters or short chains. Pathogenic species will cause pus in the formation of boils, abscesses, etc.

SWELL - A container which has either or both ends bulging out due to the formation of internal pressure caused by gases formed as the result of biological activity or chemical reactions.

SYRUP - A sugar and water solution used as a canning medium for most fruits.

THERMOPHILE - A bacterium that is adapted to grow and develop in temperatures in excess of 45°C (113°F).

TIN PLATE - A sheet of metal made from steel with a special formula having a specified temper coated on both sides with a very thin controlled coating of tin.

TOXIN - An organic poisonous compound produced by some microorganisms found in foods.

VEGETATIVE CELL - The active growth stage of an organism.

VENT - An opening in a pressure vessel controlled by a valve through which air may be eliminated during the venting phase of a thermal process cycle.

WRINKLE, COVER HOOK - Waves that occur in the cover hook during the formation of the double seam in the first operation seam. The degree of waves or wrinkle is an indication of the tightness of the seam.

YEAST - Any single-celled ascomycetous fungi which cause the fermentation of products containing sugar breaking the sugars down into carbon dioxide and alcohol.