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Title: DEVELOPMENT OF A SUPERVISOR'S MANUAL FOR EMPLOYEE TRAINING IN SANITARY FOOD PRODUCTION IN THE FROZEN FRUIT AND VEGETABLE INDUSTRY

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This study describes the development and analysis of a manual for management and supervisory personnel involved with employee training programs in sanitary food production in the frozen fruit and vegetable industry. The physical aspects of the plant, microbiology of frozen foods, and employee training are discussed in relationship to the factors revolving around the sanitary production of frozen foods. Consideration of these factors was an integral part of the development of the manual which progressed in four steps: seek opinions of frozen fruit and vegetable industrial professionals, literature search, development of the manual, and analysis.

A ten member expert panel comprised of five industrial personnel and five related and regulatory personnel evaluated the contents of the manual by use of a questionnaire. Panel members expressed their interest in the cleaning, sanitation, and inspection section of

the manual. Responses from the panel indicated that the manual would serve as a useful industrial tool. The Student "t" test was used to determine if significant differences existed between response means of the industrial and related professional expert panel members. No significant differences were found between group members for the two major sections of the manual; the Physical Aspects of the Plant, and Training. A significant difference in response means was noted for the section, Microbiology of Frozen Foods, where industrial personnel rated the section higher than did related personnel. This indicated that industry felt it was more important to include the section than did the related professionals.

The study was concluded by stating recommendations for manual revision received from panel members. Topics for future study were suggested by industry professionals. Industry professionals expressed a need for detailed information on the use and selection of cleaning and sanitizing agents, and the development of training programs for cleaning crew members.

Development of a Supervisor's Manual for Employee Training in Sanitary Food Production in the Frozen Fruit and Vegetable Industry

by

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I extend thanks to the ten expert panel members who evaluated the manual and exhibited concern and interest in the outcome of the study.

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DEVELOPMENT OF A SUPERVISOR'S MANUAL FOR EMPLOYEE TRAINING IN SANITARY FOOD PRODUCTION IN THE FROZEN FRUIT AND VEGETABLE INDUSTRY

I. INTRODUCTION

In today's American society, foods are an important part of life and culture. Changes have occurred in patterns of food consumption and life styles of dynamic Americans. These changes have been especially noted within the last ten years. In our industrial society, there has been a shift from families whose needs are mostly supplied by gardens to those dependent on the purchase of processed foods. The factors contributing to the change are increased mobility, higher income, better education, continuing movement of consumers to eat away from home, and the increased number of working women in the labor force.

As early as 1908, freezing of "cold pack" strawberries and fruit occurred in the northwestern United States. The quick freezing industry had its birth on July 31, 1923, when Clarence Birdseye formed the first freezing company, a fish freezing plant in New York. Birdseye was not the first man to commercially freeze foods but his contributions to the industry were numerous. Mr. Birdseye said, "My contribution was to take Eskimo knowledge and the scientific

theories and adapt them to quantity production" (36).

The frozen food industry had only been operating officially for 18 years when World War II erupted. The World War II economy gave the young industry a boost. The industry responded to the increased demand for processed food during this time of national emergency. By 1943, one-third of all frozen vegetables in the United States were going to the war effort. However, the shortage of labor and equipment necessary to expand production worried packers. The industry had a wartime advantage over the canning industry. The frozen food industry did not require the short-supply metal, tin, that was needed by the canning industry. Frozen food processors could use a variety of materials: plastics, papers, and foils for packaging.

The processed food shortages in the United States resulting from the government's use of canned products for servicemen were quickly replaced by frozen foods. This was a positive factor in the acceptance of the industry. The demand for frozen food increased as the Chief Procurement Officer of the United States Quartermaster Corps asked for seventy million pounds of frozen food in 1943 for the armed forces.

The frozen food industry has experienced tremendous growth. For example, 11% of the Food Service industry's purchases are

frozen commodities. Projections are made that by 1980, 40-45% of the food service industry's purchases will be frozen products (11). This growth is largely a result of the benefits of frozen products provided to the consumers. Benefits include convenience, nutritionally sound products, economy, variety, ease of preparation, high quality, and out-of-season availability.

Consumers observed that the frozen product was more like the fresh product than its canned counterpart. This was an important fac tor relating to the growth of the frozen food industry. The consuming public was excited and pleased by the bright green color of frozen peas. Canned peas were drab, olive green. Currently, frozen vegetables retain more of the favorable characteristics of fresh produce than those processed by any other me ans. Frozen vegetables have color and texture similar to fresh vegetables. In addition to the improved visual condition of the product, a high percentage of nutrients remain in the frozen product (11).

In 1971, the size of the convenience food market was 36 billion dollars. Market analysis indicates that sale of foods with quality and convenience increase at a faster rate than other commodities (5). Recent consumer surveys indicate that the qualities of frozen foods most important to the consumer are convenience and out-of-season availability. In western states consumer surveys

conducted at the time of purchase revealed that convenience outranked our-of-season availability by a margin of two and one-half to one (33).

The consumer's reasons for product acceptance are affected by product quality. Even though an item may possess appealing factors such as convenience and variety, the consumer may reject the product from past experience with less desirable product quality. Besides the production and marketing techniques needed for industrial financial survival, certain product standards should be upheld. Additional objectives of the industry are to make frozen foods available that are chemically and biologically safe, unadulterated, and equal to the representations of the producers.

Frozen food products have achieved wide distribution in America. If any of the products are unsafe to eat, large sections of our population could be affected. This has prompted regulatory programs. For example, products containing low levels of pathogens like Salmonella species can be seized as a violation of the Federal Food, Drug, and Cosmetic Act. This results in economic losses to the companies involved in addition to sales lost from unfavorable publicity.

The production of foods of uniformly high quality requires the implementation and integration of programs aimed at total quality assurance. The production of high quality frozen foods

stimulates sales and growth for producers. However, much work and dedication must be present in a company for high quality production to occur.

Purpose

The purpose of this paper was to examine the factors contributing to the microbiological quality of frozen vegetable and fruit products designed for human consumption. The physical characteristics of the plant, aspects of the food processing operation, and the training programs for employees were discussed in relationship to plant sanitation. This information appeared in the form of a manual.

The purpose of the manual was to document the factors contributing to acceptable in-plant handling methods of food products in the frozen vegetable and fruit processing industry. The guide was designed as a reference to assist management and supervisory personnel. The material would serve as a reference for new management personnel in outlining the basic concepts important in the sanitary production of frozen fruits and vegetables.

The information contained in the manual would serve as the basic information source for many future educational programs by providing managers and employees the principles necessary to maintain a high quality and economically feasible product. This

manual would assist the industry to implement or revise a program of employee training to insure products which are aesthetically pleasing and bacteriologically safe. Through the use of this manual, management would be able to effectively train the greatest number of employees in the shortest period of time with maximum employee comprehension (27). Because of the highly seasonal nature and high turnover rate of most processors, it is economically important that employees are trained as efficiently as possible.

The overall objective of this reference manual was to provide guidelines to management on the production of high quality frozen foods in order that foods for human consumption are produced under conditions and practices that are safe and sanitary. Information was obtained from a variety of sources. Guiding principles of sanitary food production were compiled into a usable form for the industry, considering their unique conditions and special problems.

The manual was composed of two main parts. The first part of the manual briefly covered the following areas: physical characteristics of the plant, aspects of the processing operation, sanitation, and microbiological controls. This information served as a reference for managers new to the field or as a resource to experienced managers when they conduct training sessions. The second part of the manual dealt with employee training and aspects

of management. Qualities desirable for instructors were outlined. The general format of training sessions was discussed. Ideas for employee motivation and employee needs were presented.

The manual can be used as a tool in the frozen fruit and vegetable industry, which in turn would benefit consumers and producers.

II. LITERATURE REVIEW

The review of the literature relative to the needs of employee training programs in the frozen fruit and vegetable industry is limited. There is a scarcity of published information designed for management personnel as guides to the training of employees handling foods. Available literature on the frozen fruit and vegetable industry including processing operations, quality control, waste disposal, microbiology of the product, and the work environment. These areas should be considered because workers are employed in each area. When employees need guidance, managers will have a reference covering many aspects of the industry to aid employees. The areas discussed relate to plant sanitation, sanitary food production, and the overall microbiological quality of products.

Frozen food industries use a large amount of water for their processing and cleaning operations and water quality is an important consideration. Purdom noted that processors must be concerned with the odor, taste, turbidity, color, and bacteriological properties of industrial water. For maximum product quality, these factors must meet or exceed the standards for water quality set by the industry (23).

Olson, Katsuyama, and Rose studied the economic effects of

liquid waste treatment from vegetable and fruit processing plants. They observed that the amount of waste water and its pollution load varied widely among plants. Several factors that influenced the amount and nature of plant waste were product style, processing methods, percentage of the plant facility utilized, and the means used to move the product and solid waste (32).

Blanching is an important step in the freezing process. Slade described blanching as an operation performed on the raw product offering one or more advantages of enzyme destruction, texture improvement, reduced vitamin loss, expulsion of gases from intercellular spaces, and easier product packaging. Slade considered the relationship of microorganisms and blanchers. A temperature of 180° F. for those parts of the blancher contacting the food product was necessary to prevent the buildup of thermophilic bacteria that contaminate the product. A thorough daily cleaning of the blancher parts contacting food products and weekly internal cleaning was desirable to keep the bacterial load controlled (25).

Blanching has been a subject of study to determine the methods evolving the least amount of water waste while giving a satisfactory product. Eheart compared the quality of frozen green vegetables blanched in four concentrations of ammonium carbonate prior to freezing to those same vegetables prepared by the conventional blanching process. The vegetables blanched in ammonium

carbonate had improved color but the texture was adversely affected (6).

Individual Quick Blanching, IQB, has been developed as a blanching process. In 1973, Bomben et. al., reported on the observed where IQB was used as the blanching method in a pilot plant. IQB produced the same degree of enzyme deactivation and product quality as the conventional water and steam processes. IQB had the advantage of less solids in the wastewater than water or steam methods (3).

The importance of microbial investigations should not be overlooked. Bacteria types and levels are indices of the efficacy of plant sanitation practices. Studies indicate that different methods of freezing products do not result in statistically significant changes in the reduction of microbes (15).

In 1973, Splittsloesser examined the microbiology of frozen vegetables by describing how products become contaminated and the predominating organisms of contamination. Equipment was found to be the source of most contamination. Splittsloesser cited methods of control to reduce such contamination as fabric and construction of inpection belts. The most common organisms found on peas, snap beans, and corn were lactic cocci (26).

The production of high quality foods is dependent on the implementattion and application of total quality assurance programs. De Figueiredo gave a brief account of the development of quality

assurance programs. He considered product characteristics, stages of the processing operation, and plant sanitation as parameters of effective quality assurance programs (5).

One goal of the frozen food industry is to produce food acceptable to the consumer. When foods leave the processor, they are subjected to environmental conditions that may alter their quality. Studies on the shelf life of products have progressed very slowly in the frozen food industry due to the high cost of such studies. Foods are generally protected against oxygen and moisture but the time and temperature factors are less easily controlled (15).

Stokes discussed the importance of training employees and the resultant advantages to employees and employers. Employee needs and desires are vital to the effectiveness of training programs. Stokes compared the employee's and manager's views on factors associated with work. The information in the comparison should serve as an example for managers establishing programs to meet the needs of the company and individual.

Stokes described how the Four-step Training Program developed during World War II can be adapted to the food service industry. The Four-step Training Program is one of the most valuable training tools available. The program consists of explaining the procedure to the employee, demonstrating the procedure, letting the employee demonstrate it, and correction and follow-up

of the employee (27). Stokes showed the importance of establishing training goals. Employees learned at a faster rate when provided with standards which they used to evaluate their progress. Attainment of goals gave satisfaction and enthusiasm to employees (27).

Many ideas for conducting training sessions and employee motivation were found in Future Farmers of America publications (1, 24). Personal checklists for supervisors or trainers addressing training groups were outlines. The checklist included factors of personal appearance, voice and method of delivery, and responsiveness to members of the group addressed (24).

Employee motivation is very useful in achieving good results in training sessions. Motivation is the energy trainers use to get trainee action. Motivation has been described by the "5I's": Ingenuity, Imagination, Inspiration, Incentive, and Involvement (1). Thomas viewed the role of motivation in training programs as revolving around four basic wishes people possess. These wishes are; the wishes for security, the wishes for response, the wishes for new experiences, and the wishes for social recognition (27).

Thorpe felt managers should be responsible for making sure all employees understand the legal and factory regulations pertinent to their job. This included personal hygiene and habits. Thorpe outlined basic factors for persons supervising employees

contacting food products. Factors included employee health, adequate hand washing, and the proper use of protective clothing. Methods and materials used for employee hand washing and drying were discussed and compared by Thorpe. Liquid or cream soaps distributed by dispensers are recommended for washing hands. Hot air dryers or paper towels are acceptable methods of hand drying. Acceptable methods are chosen to prevent recontamination of clean hands.

Thorpe described a training program for members of sanitizing crews. He covered topics such as the importance of the crew's job, characteristics of bacteria, how to clean and disinfect efficiently, the use of equipment and materials, and safety. Trainers can use the outline as a guide and modify it where necessary to meet their specific needs (28).

Physical aspects of the processing operation relate to the sanitation of the plant. A well designed and maintained plant is a basic factor of good sanitation. Many items such as wall, ceiling, and floor construction and maintence are found in the book, Applied Foodservice Sanitation. Characteristics and benefits of lighting, ventilation, employee facilities, and pest control are discussed. Cleaning ease and adequacy is dependent on the equipment to be cleaned, skill of the cleaning crew, cleaning equipment and materials. The authors described equipment designed for cleaning(20).

III. METHODOLOGY AND DEVELOPMENT OF THE MANUAL

Methodology

Several methods were used to supply information for the development and content of the manual. The amount of literature dealing with employee training programs in the frozen fruit and vegetable industry is limited, so direct correspondence was sought with the experts in industry.

The first step in the study was to seek the opinion of frozen fruit and vegetable industry professionals and members of national organizations of frozen food processors on the proposed contents of the manual. The comments received served as the focus of the study. The next step was to conduct a search of the literature. The emphasis of the literature search was placed on the areas in which industry and organizations had expressed an interest. Construction of the manual followed the literature search. Comments from industrial professionals, members of national organizations, and information from the literature search were compiled into manual form. The last step was the analysis of the manual. A panel of experts was asked how important they felt was the inclusion of various information sections in the manual. Their comments were used for analysis of the manual.

Seeking Opinions of Frozen Fruit and Vegetable Industry Professionals

Managers in fourteen fruit and vegetable freezing plants in Oregon were contacted by letter at the beginning of the study, (Jan. 8, 1976). Head offices of four national organizations of frozen food processors were also contacted by letter. The industries and organizations chosen were listed in the Thomas Grocery Register, 73rd edition (20).

The letter contained a brief description and introduction to the study which included the development of an educational manual for industrial use. The purpose of the manual and its proposed contents were discussed.

Quality control directors and production managers from industry and officials from national organizations were sent these letters and asked to comment on the contents of the manual. Correspondents were asked to suggest topics they felt should be included or deleted from the manual. They were asked for an opinion of what they felt were industrial needs that could be addressed in the form of a manual. The number of returned responses was small; four industrial managers and one organization director responded. Despite the small number of responses received, the decision was made to

progress with the study because of the broad representation of industries. The Director of Education of the National Frozen Food Association, an organization that represents 331 manufacturing plants through membership, responded to the initial letter of correspondence.

Literature Search

The replies received from the initial correspondence with industrial personnel served as a focus in searching the literature. The difficulties of writing a broad spectrum manual were discussed by correspondents. Individual plants have adopted a variety of special programs to meet their needs. Programs working for one plant may not necessarily work for another plant. Therefore, the literature search was designed to find a cross-section of information and methods to provide industries with new ideas to incorporate into their training programs.

Correspondents showed interest in several areas. Sanitation and cleaning were areas of greatest concern. This information led to a literature search of the factors associated with equipment design, design for cleaning, cleaning schedules, self-inspection, and employee training. The other major concern was the training of seasonal workers. This was addressed in the literature by the

four-step training program first used during World War II. The program effectively trains employees in a short period of time with maximum employee comprehension.

Development of The Manual

The manual was developed around ideas and comments received from the initial correspondence with industrial and organizational professionals. Recommendations from respondents were incorporated into the study to make the manual more useful and relevant to the frozen fruit and vegetable industry. Information contained in the manual was a product of the literature search. Employment and personal observation as a bacteriologist in a processing operation in Oregon aided the writer to better understand some of the needs and characteristics of the industry.

The manual was constructed in small informational sections. This style was chosen so that the information would be quickly available for personnel using the manual.

Analysis

The completed manual was evaluated by ten experts comprising an expert panel. The panel was made of a cross-section of professionals so that a broad input of ideas would be received. The

panel consisted of industrial personnel, regulatory agency personnel, and other related experts. The expert panel members were:

1. National Frozen Food Association, Director of Education (Pennsylvania).
2. Sanitarian (California).
3. University sanitarian and instructor (Oregon).
4. United States Department of Agriculture: Agricultural Commodity Grader (Oregon).
5. United States Department of Agriculture: Processed Food Inspector Supervisor, retired (Oregon).
6. General manager, Frozen food industry (Washington).
7. Industrial relations Director, Frozen food industry (Oregon).
8. Quality assurance supervisor, Frozen food industry (Oregon).
9. Quality control director, Frozen food industry (Oregon).
10. Quality control bacteriologist (Oregon).

The panel members were chosen because of their expressed interest in the study and upon recommendations from industrial management personnel.

Panel members were given a copy of the manual preceded by a letter of introduction. A questionnaire, to be completed after they read the manual, was attached. The questionnaire was a tool to aid

panel members evaluate the manual's content (refer to Appendices I and II).

The questionnaire listed the individual informational sections of the manual. The number, order, and name of the sections listed in the questionnaire were identical to the listing in the table of contents. Section listings were followed by a five-point response scale. Members were asked the question, "To what degree do you feel it is useful to include the following sections in the manual?" The choice of responses were: Agree strongly; Agree; Undecided; Disagree; and Disagree strongly. Space was left below each section for members to express written suggestions such as the addition or deletion of information contained in the section.

An informal, personal interview and discussion time with individual members of the panel followed completion of the questionnaires. The discussion was conducted in person or by telephone. The purpose of the discussion was to gather opinions, ideas, or comments that panel members did not write on the questionnaire form or to clarify existing comments.

Analysis of the questionnaire responses followed. The responses were assigned numerical values for ease of analysis. Each response was given a numerical value of one to five: Strongly agree was a 5 response; Agree was 4; Uncertain was 3; Disagree

was 2; and Disagree strongly was 1. Sections that received a 5 or 4 response were considered positive indicators that the section should be included in the manual. When sections received a 2 or 1 response, it indicated that perhaps the section should not be included in the manual or should be revised to meet industrial professionals' needs. Response 3 was the undecided choice.

The numbers of responses in each category were totaled for the total panel members and for industrial and related experts. The computed mean was used to assess the overall importance of the manual's sections as judged by the expert panel. A student's "t" test was used to determine if significant differences existed between the responses of the industrial experts and related professional expert panel members. A 0.01 significance level was used to test the null and alternate hypotheses.

Ho: There are no significant differences in response mean scores among the selected samples of industrial experts and related professional expert panel members as to the importance of including information sections in the manual.

Ha: There are significant differences in response mean scores among the selected samples of industrial experts and related professional expert panel members as to the importance of including information sections in the manual.

The outcome of the questionnaire's scaled responses and written comments will serve as the basis for future revisions of the manual. The input will be an information source to help direct the manual to meet the needs of the frozen fruit and vegetable industry.

Limitations of the Study

1. One limitation of the study was the small number of plants (14) processing frozen fruits and vegetables in Oregon with personnel that could serve as sources of initial input concerning the proposed contents of the manual. Therefore, the number of potential responses from persons representing industry was small (5).

2. A small number of responses were received from industrial (4) and organizational (1) personnel. However, The National Frozen Food Association that represents 331 manufacturing plants through membership, responded to the initial correspondence.

3. Input into the proposed contents of the manual was received from industrial respondents located in Oregon. The input cannot be said to represent plants located throughout the United States.

4. The expert panel members chosen formed a non-random sample. Inferences derived from the evaluation of the manual by the panel cannot be drawn outside the group.

5. The manual was evaluated by a ten member panel of industrial and related professional experts concerning its content and usefulness to industrial personnel. The evaluation was limited to management and supervisory level personnel and did not include other industrial employees.

6. The manual has been evaluated by questionnaire responses but it has not been evaluated through field testing.

7. Not all of the recommendations offerred by the panel have been incorporated into the manual due to the time limitations of the study. These recommendations form the basis for future revision of the manual.

Construction of the Manual

SUPERVISOR'S MANUAL FOR EMPLOYEE TRAINING IN SANITARY FOOD PRODUCTION IN THE FROZEN FRUIT AND VEGETABLE INDUSTRY

INTRODUCTION

In today's American society, foods are an important part of life and culture. In our industrial society, there has been a shift from families whose needs were mostly supplied by gardens to those dependent on the purchase of processed foods. The frozen food industry has provided a year-round supply of diverse products including many kinds of fruit and vegetables.

As early as 1908, freezing of "cold pack" strawberries and fruit occurred in the northwestern United States. The quick freezing industry had its birth on July 31, 1923 when Clarence Birdseye formed the first freezing company, a fish freezing plant in New York. Birdseye was not the first man to commercially freeze foods but his contributions to the industry were numerous. Mr. Birdseye said, "My contribution was to take Eskimo knowledge and the scientific theories and adapt them to quantity production (3)."

The frozen food industry had only been operating officially for eighteen years when World War II erupted. The World War II economy gave the young industry a boost. The industry responded to the increased demand for processed food during this time of national emergency. By 1943, one-third of all frozen vegetables in the United States were going to the war effort. However, the

shortage of labor and equipment necessary to expand production worried packers. The industry had a wartime advantage over the canning industry. The frozen food industry did not require the short-supply metal, tin, that was needed by the canning industry. Frozen food processors could use a variety of materials; plastics, papers, and foils for packaging.

The processed food shortages resulting from the government's use of canned products for servicemen were quickly replaced by frozen foods. This was a positive factor in the acceptance of the industry. The demand for frozen food increased as the Chief Procurement Officer of the United States Quartermaster Corps asked for 70 million pounds of frozen food in 1943 for the armed forces.

The frozen food industry has experienced tremendous growth. For example, 11% of the Food Service industry's purchases are frozen commodities. It is projected that by 1980, 40-45% of the food service industry's purchases will be frozen products (11). This growth is largely a result of the benefits provided to the consumers. Benefits include convenience, nutritionally sound products, economy, variety, ease of preparation, high quality, and out-of-season availability. Consumers observed that the frozen product was more

like the fresh product than its canned counterpart. This was an important factor relating to the growth of the frozen food industry. The consuming public was excited and pleased by the bright green color of frozen peas. Canned peas were drab, olive brown. Currently, frozen vegetables retain more of the favorable characteristics of fresh produce than those processed by any other means. Frozen vegetables have color and texture similar to fresh vegetables. In addition to the improved visual condition of the product, a high percentage of nutrients remain in the frozen product (11).

Recent consumer surveys indicate that the qualities of frozen foods most important to the consumer are convenience and out-of-season availability. In western states consumer surveys conducted at the time of purchase revealed that convenience outranked out-of-season availability by a margin of two and one-half to one (33).

The consumer's reasons for product acceptance are affected by product quality. Even though an item may possess appealing factors such as convenience and variety, the consumer may reject the products from past experiences with less desirable product quality. Besides the production and marketing techniques needed for industrial financial survival, certain product standards should be upheld. Additional objectives of the industry are to make frozen foods available that are chemically and biologically safe, unadulterated, and equal to the representations of the producers.

PURPOSE

The purpose of this manual is to document the proper in-plant handling methods of food products in the frozen fruit and vegetable processing industry. This guide is designed as a reference to assist management and supervisory personnel as a management tool. The material will serve as a reference for new management personnel in outlining the basic concepts important in the sanitary production of frozen fruits and vegetables.

The information contained in the manual could serve as the basic information source for many future educational programs by providing employees with the principles necessary to maintain a high quality, economically feasible product. The manual will assist the industry in implementing a program of employee training to insure products which are aesthetically pleasing and microbiologically safe. Through the use of this manual, management will be able to effectively train the greatest number of employees in the shortest possible time with maximum employee comprehension (27). Because of the highly seasonal nature and high employee turnover rate of most processors, it is economically important that employees are trained as efficiently as possible.

The overall objective of this reference manual is to provide

guidelines to management on the production of high quality frozen foods in order that foods for human consumption are produced under conditions and practices that are safe and sanitary. Information will be obtained from a variety of sources. Guiding principles of sanitary food production will be compiled into a usable form for the industry, considering their unique conditions and special problems.

METHODS

Several methods were used to obtain information for the development and content of the manual. The amount of literature dealing with the frozen fruit and vegetable industry's training programs is limited so direct correspondence with the industry was sought.

Sour main steps were used to develop and construct the manual.

1. Seek industrial opinion: Fruit and vegetable freezing plants in Oregon, and National organizations of frozen food processors were contacted by letter at the beginning of the study. The professionals in industry were asked to respond and comment on the proposed content of the manual.

2. Literature search: The replies received from the initial letter correspondence served as a focus during the literature search. The literature search was designed to find a cross-section of information and methods to provide industries with new ideas to incorporate into their training programs. Sanitation, cleaning, and the training of workers were industry's major concerns.

3. Development of the manual: The manual was developed around the ideas contained in the initial letter correspondence with industrial personnel. Information contained in the manual was a

product of the professional input and of the literature search. Employment and personal observation in a frozen food processing operation in Oregon aided the writer to better understand some of the needs and characteristics of the industry. The manual was constructed in small sections so information would be easy to find.

4. Analysis: The manual was sent to ten experts comprising an expert panel for evaluation. The panel was made of a cross-section of industrial personnel, regulatory agency personnel, and other related experts so that a broad input of ideas would be received. Panel members were sent a copy of the manual and a reaction questionnaire to complete about the manual. The questionnaire was a tool to aid panel members to evaluate the manual's content. Panel members were asked to rate the importance of including the individual information sections in the manual. Their overall response was used to modify the manual. A personal interview followed the completion of the questionnaire. The input from the expert panel was an information source to help direct the manual to meet the needs of the frozen fruit and vegetable industry.

PHYSICAL ASPECTS OF THE PLANT

A properly designed and maintained plant is basic to good sanitation. Physical factors associated with the plant structure influence the ease and method of microbiological control programs. Water supply and disposal are essential subjects industries must consider. In addition to product safety and quality, the work environment of the employee is considered. Many of these factors of plant construction are related. For example, both the lighting and ventilation of a building reflect upon the worker's environment and control of product contamination.

The following sections are designed to review several plant characteristics that are related to sanitation of the frozen food product. The information presented is background material for management level personnel.

Water Supply

Water quality and quantity are considerations of major economical importance for industries. Water for the frozen fruit or vegetable processing plant may originate from a municipal system or private well. The supply must be continuous and of sufficient volume and quality to meet the demands of the industry.

The quantity of water required by your plant depends on the size of operation and the nature of the processes demanding water. The United States used 3.5×10^{11} gallons per day in 1960. Of this amount industries used 1.55×10^{11} gallons per day. It is evident that water is a major consideration for industry. The amount of water used by an industry is known as in-plant consumption, the difference between plant influent and effluent water. The consumption, based on this definition, is very high in the food industry (23).

The quality of water is important to your industry. As a food processor, you are concerned with the odor, taste, turbidity, hardness, chemical composition, color, and bacteriological properties of the influent or source water. If any of these factors fall below the standards needed for your industry, consider implementing an in-plant or external water treatment step.

Waste Water

Water is used to clean raw foods for human consumption and to keep the plant sanitary at all times. Food processing waste-water cannot be stored for later treatment due to its high organic content making it putrescible. This complicates disposal problems.

A 1974 study dealt with the economic effects of treating liquid waste from fruit and vegetable processing industries (32). They found that the amount of waste water and its relative pollution load varies widely among the industry's plants. Factors contributing to the variety included product sytle, method of processing, percentage of the plant facility being utilized, and the means of moving the product and solid waste.

Product style influences the amount of water used. For example, pulped fruits require less water than non-pulped, and corn-on-the-cob used less water than cream style or kernel corn.

Raw product quality factors such as culls, size, and maturity influence the amount of waste created. Preparation processes

and types of equipment also affect the amount of waste water generated.

An important factor in the economics of pollution control is plant size. For the smaller plants, the relative cost of waste water, treatment, disposal, and in-plant treatment are higher than for the larger plant. Increases in the utilization of the plant's capacity generally results in a decrease in the water per ton of product required for processing. Recycling cooling water to wash raw products can lower plant effluent.

In 1974 it was estimated that about 430 plants would face closure because of the increasing costs of pollution control. These plant closures result in the loss of about 27,000 jobs, 31,000 part-time jobs, loss of service to 14,000 farmers, and result in a loss of $600 to $900 million dollars in local economic activity.

Waste discharge guidelines were set in the 1972 Water Quality Act Amendments. Because of the many factors contributing to the generation of waste water by fruit and vegetable processing plants, The Environmental Protection Agency gives separate consideration to the industries based on those factors discussed.

Water-borne and Solid Waste

The frozen food industry generates three main types of waste products. The first of these is water waste from the processing and clean-up operations. Waste water often creates special disposal problems. Water from processing operations may contain high amounts of organic matter, heat, and chemicals. Removal of these material from the water before disposal is often expensive and difficult. Chemicals may be found in effluent water resulting from the cleaning and sanitizing operations. The reader is referred to the standards and methods of water disposal established by authorities in your area.

The second type of waste common to frozen food processing plants are discarded fruit and vegetable products and by-products of the freezing and packing operation. Refuse such as corn cobs and husks are generated. All material considered as waste is not wasted. Recycling of foodstuffs does occur. Some of the discarded products are sold as silage. Other are used as ingredients in foods for non-human consumption. The remaining material is sent to the disposal site. A study reported in 1974 discussed the use of activated citrus sludge as an ingredient in poultry feeds. The sludge

served as a source of nitrogen, protein, vitamin B_{12}, and energy (31).

The third main type of waste is packaging materials consisting of paper, wood, plastic, and metal.

The collection and disposal of solid fruit and vegetable product and packaging wastes is a management responsibility. It is essential that rules and supervision are established by the management to ensure that this area of responsibility is not overlooked by an untrained employee. Due to the possible public health and aesthetic factors, the following guidelines are suggested for keeping garbage disposal and trash areas in an acceptable condition. Because each branch of the industry has special methods of collection and disposal with their associated problems, the guidelines will be kept general.

1. Keep the collection areas clean and orderly, thus averting problems such as offensive orders and rodent and insect infestation.

2. Confine trash in suitable containers that are water-proof, easy to clean, with tightly fitting lids.

3. Keep containers clean on the outside and wash them out prior to return and reuse.

4. Spilled litter, organic products, grease, and oils in front of dumpsters, incinerators, and other collection and disposal objects should be minimized.

5. Promptly clean up spills to prevent attraction of pests and as a safety precaution against slippage of employees.

6. If the collection site floor surface needs washing down be careful not to leave puddles of wash water. Alleviate the problem by mopping or other suitable practice.

7. Conduct area inspections so that accumulations of debris due to infrequent pickups does not occur.

8. Monitor surrounding areas for garbage accumulations in corners, under stairs, or any area that is not readily accessible.

9. Check for evidence of rodent and insect harborage and nests.

10. Use your senses to help determine if the area is clean. An objectionable odor may indicate a problem.

Lighting

Lighting should sufficiently illuminate the plant and the

employee's work area. Good lighting is essential for proper clean-up activities so that soiled areas can be seen.

Light fixtures should be located and constructed to minimize food contamination from shattered glass or fluorescent bulbs. Bulbs can be shielded with metal globes or sleeves.

Ventilation

Proper ventilation aids the comfort of employees. Ventilation can be a tool for better plant sanitation. A properly designed ventilation system can help provide temperature control, remove airborne bacteria, odor, smoke, dust, toxic fumes, and moisture without producing drafts. Excess moisture tends to condense on walls, ceilings, and equipment favoring the growth of mold and bacteria. Contamination of food products can occur if condensate droplets carrying organisms fall into food products.

Entryways, Exits, Exterior Areas

For safety, the entryways and exits must be clear of extraneous materials. Doors, screens, and screen doors must be tight fitting. Doors and screen doors should be self-closing to

prevent the entrance of flies, insects, and pests. A well designed and properly installed air door effectively keeps out insects in areas where there is continuous in and out traffic.

The environment adjacent to the plant is important when considering insect control. Wet spots, areas with standing water, and tall grass form good breeding grounds for insects, mainly flies and mosquitoes. The areas should be drained and chemicals applied if needed to deter insects. A small bit of conscientious prevention can alleviate severe insect problems. If your building or surrounding trees provide roosting or nesting areas for rats or noxious birds, steps should be taken to discourage them.

Floors

It is important that floor coverings are resistant to wear, grease, water, and cleaning compounds. Cleanability and ease of maintenance are essential. Safety is enhanced by the use of non-skid devices. (Cracks of sufficient size to harbor food products should be resurfaced. Floors should be sloped to the gutters for good drainage.)

Walls and Ceilings

Ease of cleaning and maintenance are priorities when choosing material and designs for walls and ceilings. Painted plaster

or cinder block walls are among the acceptable finishes for dry work areas if sealed with soil resistant, easy-to-wash glossy paints. Do not use toxic paint. Chipping and peeling paint is often a problem in the interior areas of plants. Usually the problem can be limited by proper maintenance. Continuous waterproof walls are needed for wet areas. Properly constructed ceilings can aid the overall work environment by absorbing sound and improving the lighting (20).

Plumbing and Sewage

It is essential that sewage lines, non-potable water, and fresh water lines are separated. Cross-connections between the two systems are caused by faulty installation. Backflow of contaminated water into the water supply may result from cross-connections. Back siphonage takes place when the pressure in the fresh water supply drops. Sewage is a pathogen reservoir. Any cross-connections, backflows, or backsiphonages into the water supply are potentially dangerous. To prevent this, install backflow check valves on all water outlets. Avoid overhead waste water drain lines or pipes in the storage and processing areas to prevent contamination caused by dripping lines.

Pest Control

To prevent a pest problem is easier than to eliminate one

after it gets started. In either case, begin by preventing the entry of animals and insects. Eliminate openings into your plant. Doors, windows, and air intake ducts should be screened. Outside doors should be snug fitting and self-closing. Check and seal all cracks and openings in the foundation and around heating, plumbing, and electrical conduits. Insects can pass through very small spaces, mature rats are able to squeeze through holes one inch wide, and one-half inch is required for the passage of young rats. This is why it is important to check your facility carefully to reduce the chance of invasion by pests.

Employee Facilities

Stress the importance of establishing and maintaining clean facilities for employees. Clean facilities will help their morale and aid them to maintain sanitary habits. Be sure to have adequate numbers of lavatory and wash facilities for the size of your operation. Hand washing and drying procedures may be part of your training programs. Cross-infections and contamination are minimized by the use of soap dispensers rather than bar soap. Hand drying equipment should be adequate to prevent improper drying.

Rooms or areas designated for employee use such as

lunchrooms or rest areas should be clean and orderly. There should be enough tables and chairs to accomodate all workers. Provide adequate garbage disposal to keep the area orderly. If food vending machines are provided for employee use, ensure employee safety by making sure the machines are properly maintained and serviced by the company.

Equipment Design

Equipment design is a large factor in the effectiveness of cleaning methods. Equipment design factors are considered by purchasers as governmental and consumer pressures are forcing plants to improve their sanitation. If your industry is planning to purchase new or different equipment, the presence of easy-to-clean features is an important consideration in your final choice.

Filling and packaging equipment often have hard to reach parts. However, it is advantageous if the machine parts coming in contact with food can be examined, removed, and cleaned.

Only non-toxic material should be contacted by food. Materials should not conduct significant color, odor, or taste to food. Surfaces should be non-absorbent to foods to prevent bacteriological and non-absorbent cleaning compounds to prevent chemical product contamination. Food contact surfaces are smooth, without pits,

crevices, or avoidable ledges to trap food and debris. Inside threads, bolts, and rivet heads should be avoided. Seams are smooth and easily cleaned. Corners and edges are rounded as much as possible to prevent product build-up and aid the ease of cleaning. Packing, sealing, and gasket materials are non-toxic, non-absorbant, and not affected by food or cleaning compounds. If coating materials are used they must be resistant to cracking and chipping.

Desirable equipment features allow the easy removal of waste liquids and condensation to reduce product contamination.

Consider attaching a plate inscribed with cleaning instructions to the equipment. This tool would supplement employee training.

Design for Cleaning and Maintenance

Strive to have all spaces around equipment in the processing areas and in all of the storage places in reach of brooms, brushes, mops, or water sprays. Unreachable areas collect soil and may attract pests. Inaccessible areas can result from poor planning and construction or structural deterioration such as cracks. Install equipment so there is sufficient space under it and between equipment and the walls for cleaning and maintenance.

The use of rounded coving instead of regular flat molding eliminates sharp corners and edges. The curved surface allows

more thorough cleaning, reducing particulate build-up, bacteria, and insect harborage.

Cleaning and Sanitizing

Cleaning and sanitizing are two of the most important aspects of plant operation. The job can be made more efficient and effective if two areas are considered by management: the selection of the proper cleaning and sanitizing agents for specific jobs, and the proper sanitizing and cleaning procedures.

Detergents are agents brought into close contact with the contaminant to be removed. Detergents loosen and remove contaminants while keeping them suspended until they are washed away. A good detergent is safe, efficient, and economical.

The purpose of sanitizing agents including germicides, bactericides, and disinfectants, are to reduce the number of bacteria. Chemical and physical methods are used to sanitize equipment. Chemical agents include chlorine, iodine, and quaternary ammonium compounds. Heat, live steam, and flowing hot water are physical agents that kill organisms by high temperatures.

Cleaning Schedule

Scheduled cleaning is beneficial to a plant. Properly organized

procedures ensure that key areas are regularly cleaned and that employees are organized to efficiently carry out the procedure. Characteristics and benefits of scheduled cleaning follow:

1. Scheduled cleaning is the format for effective management and the efficient use of employee time. Scheduling involves planning ahead so in case of an unexpected event, the company is not short of employees.

2. Scheduling helps distribute the workload. This aids employee morale because employees are deterred from thinking they carry more than their fair share of the work.

3. Organization ensures that necessary work is completed.

4. Careful scheduling eliminates the duplication of work, thus the waste of company time.

5. Scheduling involves specific employee assignments so there is no question of who does what job.

6. Scheduling helps anticipate vacations so substitute workers are provided.

7. Scheduling aids supervisors. They know ther persons doing certain jobs at assigned times.

8. Effective scheduling sets goals for employees (20).

Organization is the key to scheduled cleaning. The person or group of people establishing the schedule surveys the plant and

determines the areas that need cleaning on a regular basis. The scheduler identifies the pieces of equipment and decides how often they need to be cleaned and sanitized. An estimate of the time required to clean the units is made.

An individual schedule can be formulated for identified pieces of equipment. Cleaning instructions are written in such a way that they are clear to old and new employees. The appropriate times for cleaning may be between shifts, at lunch,or at specified hourly intervals. The frequency of cleaning is dependent on the manufacturing operation, equipment and product. Sometimes special conditions such as safety hazards will occur during cleaning and sanitation. An example would be to post signs warning of slippery floors.

Supervision is an integral part of scheduled cleaning. Effective cleaning programs require continual supervision and self-inspection to determine program weaknesses and strengths. Weaknesses indicate the schedule needs modification. Scheduled cleaning is a management tool that produces efficient plant cleaning and sanitation when management supplies adequate supervision.

Self-inspection

Self-inspection is an excellent follow-up to scheduled cleaning. Self-inspection is important for what is seen and not seen in a plant. What is seen by visitors, buyers, and inspectors is a clean, orderly

operation. What is not so obviously seen is the personal hygiene of workers and the cleaning of equipment. Inspectors should undertake continual self-inspection of the facilities and employee practices of the plant. Any unsafe conditions or sanitation problems leading to contamination of the food product can be observed and remedied.

Managers, department supervisors, or foremen are the logical persons to do the self-inspection. The job title of the person inspecting may differ at each plant depending on company size and structure. Written checklists are helpful to the inspector during inspections. Checklists organize the inspection and reduce the chance of missing key points.

During the inspection, employees should not feel "spied on" during the inspection. Employees must feel that their work is important and that their inspector is interested in what they are doing and how they do it. Employees receive helpful ideas from inspectors and give inspectors ideas. The most important point in an inspection is for the inspector to demonstrate a genuine interest in the employee, not the idea that the boss is checking again. An acceptable attitude for self-inspection is that you are continually monitoring the adequacy and completeness of cleaning, supervision, and safety of the area, not primarily preparing for the arrival of an outside inspector.

There are several general areas that are included in most

self-inspections. The number and type of areas to be checked may vary among plants. You must decide which areas are the most vital to your continued production. Some suggested areas are:

product receiving points

raw product holding facilities

processing areas

key time-temperature control points

storage areas

restrooms and employee facilities

employee safeness

employee food handling practices

cleaning and sanitation

garbage and disposal areas

entrys, exits, parking lots

vehicles for finished product transport

Checklists are very useful to the self-inspection process. Characteristics of good checklists follow:

1. Lists are specifically designed for your industry and are applicable to the facilities, company policies, practices, and procedures.

2. Lists are compatable with the regulations that apply to your operation.

3. Lists are divided to permit separate checks of specific areas and procedures (20).

Follow-up should be done after self-inspection if the inspection is to be meaningful and useful to the industry. In follow-up activities you might initiate corrective action of undesirable situations by mentioning the situation in training sessions, on employee bulletins, or posters. Keep a file of reports for management to review. Reports indicate the immediate and long range effectiveness of the self-inspection program. The effectiveness of supervision will be evident from reports. Finally, the promptness and adequacy of action for the correction of undesirable conditions can be assessed.

There are several benefits the plant will realize by conducting self-inspection sessions. Self-inspection efforts recognize problem areas and enlist help to resolve them. The inspection records are evidence of the interest and effectiveness in maintaining the plant. This can be a positive factor when dealing with news media or consumer groups. The copies of reports available to outside inspectors will show your interest in maintaining a good program. Inspection records serve to show your concern for identifying and correcting problems. The continuing program of inspection and follow-up may help protect you from law suits and claims due to your action to reduce or eliminate injury or illness causes (20).

Employee Selection

Safe food handling practices should be considered in the selection, placement, and training of workers. Employees working directly with the food product are generally considered for work by questionnaire job applications and observation. Good personal hygiene habits of prospective employers are characteristics that employees wish to observe. Screen applicants for general health, personal health habits, knowledge, and skill for specific jobs. Good health habits are plus factors in food sanitation. When choosing an employee, the employer may ask himself:

1. Is the prospective employee neatly groomed and dressed?
2. Does he have skin infections?
3. Does he cough or sneeze excessively?
4. Does he have habits that contaminate his hands like scratching his scalp, face, or neck (20)?

The employer should realize that it may be difficult to detect undersirable health conditions or habits of prospective employees. Conditions may arise after the employee begins work. With supervision, training, and medical help if needed, conditions may be corrected or prevented.

Employee Health Guidelines

Supervising employees is a continuing job to maintain sanitary

plant practices. Supervisors may consider the following suggestions for employees contacting foods to guard against and reduce bacterial contamination from human sources:

1. Employees wear clean uniforms or outer garments. Protective clothing and head coverings should not be worn to and from work.

2. Hands and fingernails are clean. Appropriate hair restraints are worn. Rings, watches, and jewelry that hold food, dirt, and are possible sources of product contamination are not worn.

3. Unsafe practices are not allowed on the job: excessive scratching, smoking, eating, coughing, sneezing, or spitting.

4. Wiping cloths are used for perspiration.

5. Employees with bowel disorders, severe colds or respiratory conditions and skin problems such as sties, boils, and carbuncles should be temporarily transferred to work in a non-food product contact area.

6. Employees report to supervisors if they have been in contact with infectious diseases or have any of the above conditions.

7. Employees wash and sanitize hands before work, after breaks and meals, absence from the line, or lavatory stop.

Hand Washing and Drying Procedures

The employee habits of hand washing and drying are difficult to moniter. Meetings with employees to discuss plant hygiene practices may be used to educate employees by demonstrating proper hand washing and drying techniques.

Washing is carried out before work, after breaks, after meals, and after absences from the line. Hands are washed and rinsed in sufficient amounts of warm, running water. Plastic nail brushes with nylon bristles help to clean the nail areas harboring bacteria and dirt particles. Liquid or cream dispenser soaps are preferred to bar soaps. Cross-contamination may occur with bar soaps. Germicidal soaps may be used. Germicidal barrier creams applied after soap may confer longer bacterial protection.

Don't recontaminate hands by improper drying techniques. Paper towels are efficient and acceptable but are expensive and a source of litter. Roller towels and hot air drying, improperly used, may result in recontamination of the hands. Roller towels are subject to mechanical failure, employees may not get a clean section, thus contaminating clean hands. Hot air drying can be slow and inadequate. Employees may be tempted to dry their hands on their uniform or not bother to wash at all.

Employees must avoid the recontamination of their washed and

dried hands. They should not touch their face, hair, or neck since these areas are rich in microorganisms. Wiping the nose with a handkerchief, wiping hands on the uniform, or adjusting head coverings readily contaminate hands. Requiring employees to use germicidal hand dips before returning to processing lines helps eliminate hand contamination. Hand dip solution must be changed periodically because it can become contaminated.

Gloves

Gloves are worn in some areas of the frozen food processing operation. However, even gloves that are frequently disinfected, do not take the place of proper hand washing practices. When a person wears gloves, a microclimate is created that favors rapid bacterial multiplication on the hands. Product contamination may occur unless gloves are impervious or are changed and disinfected regularly (29).

MICROBIOLOGY OF FROZEN FOOD

To protect food products we employ methods of prevention, the action to guard against contamination. Time and temperature controls are used in various ways to reduce progressive contamination (20). The concern with keeping bacterial numbers low may be seen at points along the processing line. These critical points are washing, blanching, cooling, and cutting. The process controls are equipment sanitation and personnel sanitation.

Several processing operations will be discussed in this section. The influence of the processes on the microbiology of the product is considered.

Blanching

Most raw foods have enzymes that continue their action when picked and stored. Lower storage temperatures will result in slower enzymatic action. Some enzymes function at temperatures below freezing. This is why vegetables are blanched before freezing.

Blanching will reduce the total number of microbes but it is not a sterilizing procedure. Bacterial spores can survive. The blanching operation results in one or more advantages such as destruction of enzymes, improving texture, easier packaging, or the

expulsion of gases from intercellular spaces.

Blanching makes vegetables more susceptible to bacterial attack, the growth products are more available after blanching. Products can be recontaminated by equipment. The microbial load of the product as it enters the freezer depends on the duration and temperature of the post-blanching process, amount of handling, and sanitation of the plant.

Blanching is an operation requiring strict time-temperature controls. The amount of chlorophyll of green vegetables lost during blanching is linear with respect to time at a given temperature. The blanch temperature and degree of blanch affect chlorophyll retention in storage within certain limits of enzyme inactivation (33).

The temperature of blancher parts in contact with the product should be greater than 88° C. or 180° F. to prevent the build-up of thermophilic bacteria. A daily cleaning of the blancher is recommended. The cleaning of its internal components can be done on weekends (25), if the plant is in continuous operation during the week.

Freezing

Low temperature preservation, freezing, retards chemical reactions and enzyme activity in foods. Growth and activity of micro-organisms are slowed or stopped. The lower the temperature,

the slower the chemical reactions and microbial growth.

Growth of mold, yeast, and bacteria at sub-freezing temperatures has been reported. Bacteria have been found growing on peas at 10° F., while mold has been noted on vegetables at 18° F and berries at 20° F (9).

Some psychrophilic bacteria grow at below freezing temperatures. These are not dangerous organisms but can cause the deterioration of odor, color, texture, and taste of foods. This can occur in frozen foods unless the storage temperature is low enough to prevent growth.

Psychrophilic and mesophilic bacteria may grow on processing equipment and contaminate the product. Further growth occurs if the product is not immediately frozen.

Freezing does not sterilize products but may reduce the numbers of viable organisms. It is estimated that 50-80% of microbes will be killed if quick freezing methods are used. However, if a product has high microbial count before it is frozen it usually will remain in this condition after frozen storage.

Quick freezing methods usually have a freezing time of 30 minutes or less. Food is in small packages or units. Among quick freezing's advantages over slow freezing is found a more prompt prevention of microbial growth.

Changes in the products may occur during the preparation for

freezing. Microorganisms may grow on the product surface and cause physical and chemical changes. Organisms may cause sliminess, off-colors, and off-flavors. Therefore, it is important to keep the time short between product arrival at the plant until it is frozen.

Spoilage can occur during the freezing process if the product temperature is not reduced rapidly below the minimum growth temperature of microorganisms. The center of large packages may spoil due to an insufficient cooling rate.

In products frozen and stored, the microbial count drops sharply at or near the onset of freezing and drops slowly during storage. The population may level after a few weeks or months. Some species of bacteria die more quickly than others. Some survive for months or years. Usually enough survive so that the product will spoil as fast after thawing as if it had never been frozen. Vegetative cells that can't multiply will eventually die. The survival of mixed populations of spoilage organisms varies with circumstances. Survival is usually between 1-75% in nonacid foods (33). Some bacteria can increase at 25^{o} F storage in frozen green beans, spinach, peas, and cauliflower.

If foods are properly thawed, little trouble should result from microorganisms because the temperature is too low before usage to allow much growth. If foods thaw slowly or stay at room temperature,

organisms can grow well.

Spoilage can be detected by the organoleptic tests of odor, appearance, and taste. Chemical and bacterial tests confirm the spoilage. A detectable loss of product flavor with detectable odor occurs at bacterial levels of 10^4 or 10^5 per gram or cubic centimeter. When the odor of decomposition is noted or surface slime forms, levels are 10^6 to 10^8 bacteria per gram or cubic centimeter (33).

Producing foods that are bacteriologically safe and of uniform quality requires continual monitoring of the parameters affecting the finished product quality. These parameters include ingredients, the manufacturing process, and sanitation.

Frozen products can be of no higher quality than the raw product. Raw fruit and vegetable quality characteristics may be specified according to the United States Raw Product Standards. In choosing produce, industries specify the variety and conditions of maturity. Methods and time of harvest, restrictions for spray residue, and the delay between harvesting and processing are considerations.

The finished product isonly as good as the manufacturing process. Process control is important when the production of many units at a high rate makes quality control by evaluation of the finished product improbable. The parameters of a production

process should be standardized.

Sanitation

Sanitation alone will not guarantee that a produced food is wholesome. Facility sanitation, housekeeping, cleaning practices, and maintenance factors can be used to make sure that pests or contaminated air are not sources of contamination. Condensation, dirt, paint chips, and other materials should not contaminate the product at any step in the processing operation. Also the industry must consider the quality of water used for processing, clean-up, and ensure the proper disposal of waste water and sewage.

Equipment sanitation is important in controlling and preventing microbial contamination of the product. Equipment should be sanitized and cleaned properly. The frequency and adequacy of cleaning and sanitizing can be aided by using bacterial control programs. Equipment swabs and contact plates are methods for measuring the numbers of bacteria present. This is a mesure for determining the efficacy of cleaning programs. Regular maintenance of equipment is desired to reduce accidents and product contamination by foreign material.

The employee personal hygiene factors such as dress, grooming, and food handling practices are important. Good hygiene help

prevent the inoculation of pathogens andother microbial contaminants of the product.

Microbiological controls apply to ingredients, materials in the process, and the products. They are used to determine if a particular processing sequence is operating within acceptable limits.

Microbial growth is largely temperature and time dependent. Different fruit and vegetable products have somewhat different microbial flora and suitabilities for growth.

Some processes like mixing, grinding, slicing, and chopping, make the product more susceptible to contamination. Increases in bacterial numbers may be noted due to the breaking up of clumps of cells.

The cutting, slicing, and dicing procedures increase the possibility of high contamination. There is an increased product surface area for growth. The tissue fluids from cut surfaces are good growth mediums. This combined with the possibility of inoculation from contaminated equipment can lead to severe bacteriological problems that negate the successful controls prior to the point of contamination (7).

Information in Table I, compiled by D. Splittstoesser, illustrates the contamination of products exposed to cutting, slicing, and chopping operations. Numbers of bacteria on products before and

after the operations are listed. Numbers of bacteria on products after they had been chopped, sliced, or cut were 60 to 72 times higher than the number prior to the operation (26).

Table 1. Bacterial Contamination From Processing Equipment.

		Bacteria per gram X 10^3	
Unit	Vegetable	Before	After
Cutter	Corn	180	1300
Slicer	French beans	20	130
Chopper	Spinach	20	120

Proper equipment maintenance is a vital step in controlling bacterial populations. For example, a plant described a product transport belt that had minute cracks and holes on its surface which served as a reservoir of quickly multiplying bacteria. Lima beans passing on the belt were found to have 100 to 200 fold increases in bacterial numbers. Belts that are worn, improperly maintained, or not cleaned and sanitized properly may contribute large numbers of bacteria to the product.

Synthetic rubber or polyvinyl chloride form acceptable surfaces for inspection belts because microorganisms do not generally adhere to the materials. Polyvinyl chloride or synthetic rubber should cover the sides of the belt. Edges should be sealed so wicking does not

occur. Belt fabric such as polyester minimizes the absorption of water (26).

Product contamination from belts can be controlled by spraying the returning belts with chlorinated water. The use of in-plant chlorination reduces the build-up of bacterial populations on equipment. The recommended chlorine residue is 1 to 6 parts per million (33).

Information contained in Table 2, compiled by D. Splittstoesser, shows that belts can contribute to the microbial load of a product. Inspection belts one, two, and three did not greatly increase the bacterial load of the product. However, after the product traveled on belt four, its bacterial load had increased 200 fold (26).

Table 2. Bacterial Contamination of Peas From Inspection Belts.

Sampling position		Bacteria per gram X 10^3
Flume, before belts		4.8
End inspection belt	No. 1	4.7
	No. 2	7.7
	No. 3	9.0
	No. 4	960.0

Indicator Organisms

Indicator organisms are sought during bacteriological testing of products. Members of the coliform group, Escherichia coli and

Streptococcus faecalis, are considered organisms of fecal contamination. Large numbers of these organisms occur in the gut of man and animals. Usually these organisms are harmless but their presence indicates a possible danger due to the pathogenic organisms also present.

The indicator organism, E. coli, is found in soil and may be present on fruits or vegetables that are not heat treated. Therefore, their presence in food is not always evidence of fecal contamination. The source of E. coli, should be determined. It may originate from a contaminated water supply or even an employee.

Some coliforms do not survive frozen storage as well as other bacterial species. E. coli is sensitive to frozen storage so is considered an indicator of recent contamination. The size of coliform populations can be much reduced after frozen storage. Food that has been produced under insanitary conditions may seem to be in good bacteriological condition after storage if quality is judged on the basis of coliform count (33).

Summary

The microbiological quality of frozen foods is no better than the quality of food before freezing. Harmless bacteria are naturally present on fruit and vegetables and may cause the product to spoil. Foods may be further contaminated by equipment and human handlers

during the processing operation.

Freezing can reduce the population size of bacteria but not eliminate them. Freezing slows spoilage. Temperature increases speed up the spoilage process so food will spoil when thawed if not promptly used. When food thaws and stays at room temperature for several hours, bacterial populations grow rapidly. Often the growth of food poisoning or disease producing organisms is suppressed by spoilage bacteria.

Moist, nonacid foods may have the proper growth conditions for Staphylococcus. Staphylococcus growth and toxin production may be prevented by harmless spoilage bacteria. However, if the normal microflora of the product including spoilage organisms is reduced or destroyed, Staphylococcus can grow. Staphylococcus is carried on most humans at some time on skin, scalp, or nasal passages. We expect to occasionally find the organism on frozen foods until advances in technology eliminate the need for human contact of frozen foods. High occurences of Staphylococcus indicate a high or unneeded amount of human contact. In this case, it is wise to seek the source of high contamination.

Clostridium botulinum is an anaerobic organism and cannot grow in an atmosphere containing oxygen. C. botulinum is usually not associated with frozen foods. However, there have been reports of C. botulinum on products. C. botulinum generally is not a hazard

unless frozen foods are mishandled after thawing (33).

The frozen food industry has excellent safety records. It is advisable that the industry examine the microbiology of new and revised packaging and processing techniques to avoid the introduction of microbial hazards to consumers.

Suggested microbial standards for frozen vegetables have been established. It is suggested that peas should have no more than 50,000 bacteria per gram when they enter the freezer. Corn should not exceed 60,000 and string beans 100,000. Most workers feel that the upper limit for frozen vegetables is 100,000 organisms per gram with fruits containing lower numbers than vegetables (9).

TRAINING

Why Train?

Training is an important job in industry that is often overlooked by management. We commonly hear phrases like, "Training doesn't work in our business; training is too costly and time consuming." We find the time to increase profits and productivity so why not invest in training? Training programs are not as difficult as many managers would have us believe. Training employees can achieve dramatic results if programs are carefully planned and management is dedicated to the plan. Training is the change incurred in an individual by adding to or altering the skills he uses.

Training is needed in the frozen food industry because a large number of employees are recruited from an unskilled labor force. Due to the seasonal nature of the industry in some parts of the country there is a large influx of temporary employees. Often homemakers, students, and transient people comprise the large share of the working force. Even if workers come to your plant with experience from another food processing plant, your processes, machines, and procedures may be different enough to warrant training to achieve your goals.

Training is important because employees are working indirectly with the public. If one of your employees makes an error, the

company may lose a customer. Whether the customer is a supermarket shopper or a large government or private institutional order, his loss is damaging.

The value of training is difficult to measure. It is estimated that training can increase employee performance by 25% in some instances. More conservatively, if each one of ten employees increased their efficiency by 10% the equivalence of one extra worker has been added with no additional cost to the company (27).

It does cost money to train but it costs more not to train workers. The potential costs of lost customers or law suits could easily outweigh training costs. The highest costs of training to the employer are wages of the instructor and trainees. Materials are less costly.

Employer Advantages

Training offers several advantages to the employer. The worker learns faster and is more interested in his work. Productivity can be increased and by-products and waste reduced. Accident rates are decreased when the trainee learns about the machines or products he works with. As a result, employee turnover and absenteeism are reduced. Attitudinal atmosphere improvement is a very vital part of good working environments and may be realized if employees' attitudes are positively changed. Training can help maintain good sanitation and good quality standards.

Employee Advantages

Training provides advantages to the employees. Employees may realize an opportunity for increased earning power and advancement through successful completion of instruction. Training enhances self-respect while improving the feelings of security and importance.

Employee Needs

The successful manager should be interested in the feelings and desires of the employees. Consider some of these needs. As an example, employees were asked to rate a list of job factors in order of importance. Restaurant managers were asked to rate the same job factors taking the role of employees. Major discrepancies occurred between the ratings of the two groups. This example shows the different values held by management and employees. A successful manager should realize the potential differences in values between management personnel and employees (see Figure 1).

An interesting view of management-employee relations was written by J. D. Phillips, President of Hillsdale college, Hillsdale, Michigan. His ideas take the form of a letter written from employee to "boss" (see Figure 2).

How employees rate the list		How management rates the list	
1.	Full appreciation of work done	1.	Money
2.	Feeling "in" on things	2.	Job security
3.	Sympathetic help on personal problems	3.	Promotion and growth in company
4.	Job security	4.	Good working conditions
5.	Money	5.	Work that keeps you interested
6.	Work that keeps you interested	6.	Personal loyalty to workers
7.	Promotion and growth in company	7.	Tactful disciplining
8.	Personal loyalty of workers	8.	Full appreciation to work done
9.	Good working conditions	9.	Sympathetic help on personal problems
10.	Tactful disciplining	10.	Feeling "in" on things

Figure 1. Comparison of management-employee values (27).

"Confidentially, Mr. Boss. . . . . .

If you want my loyalty, interest, and best efforts remember that. . .

1. I need a SENSE OF BELONGING. . . a feeling that I am honestly needed for my total self, not just for my hands, nor because I take orders well.

2. I need to have a sense of sharing in planning our objectives. (My need will be satisfied only when I feel that my ideas have had a fair hearing.)

3. I need to feel that the goals and objectives arrived at are within reach and that they make sense to ME.

4. I need to feel that what I'm doing has real purpose, or contributes to human welfare--that its value extends even beyond my personal gain. . . or yours.

5. I need to share in making the rules by which together we shall live and work toward our goals.

6. I need to know in some clear details just what is expected of me not only my detailed job but where I have opportunity to make personal and final decisions.

7. I need to have some responsibilities that challenge, that are within range of my abilities and interest, and that contribute toward reaching my assigned goal and the company's goals.

8. I need to see that progress is being made toward the goals we have set.

9. I need to be kept informed. What I'm not up on, I may be down on. (Keeping me informed is one way to give me status as an individual.)

10. I need to have confidence in my superiors--confidence based upon assurance of consistent fair treatment, of recognition when it is due, and trust that loyalty will bring increased security.

In brief, it really doesn't matter how much sense my part in this organization means to you, Mr. Boss--I must feel that the whole deal makes sense to me!

P.S. Can't help but wonder how you'd rate yourself--then--how those who work for you would rate you.

Cordially

John Doe
(A member of your team who wants to be a team-member.)

Figure 2. "Confidentially, Mr. Boss. . . (23)"

The Trainer

Now that the need for training has been established, the next question is, "Who should do the training?" Usually the supervisor or manager is the person suited to lead the training sessions. The supervisors are familiar with the characteristics of the work area. They are in daily contact with employees. Since they see employees so often, training can continue on an informal, yet personal manner, by observation, suggestions, correction, and praise.

The trainer must realize that employees differ in learning rates and ability. He must be patient when some don't catch on quickly and methodically explain the procedures. He must make sure that they understand the principles and are not overlooked in haste.

The management will determine the number of sessions possible considering the economic and time feasibility factors of the company. Training sessions are more beneficial when spaced over several short periods. Employees can learn more in several short periods than in one longer period. Learning occurs more quickly when trainees are given some type of comparative standard that he can

use to indicate his progress. Standards of accomplishment in the form of written examinations may or may not be applicable to your industrial needs. Adapt the measurement techniques to your particular branch of industry. It may be more effective for the trainee to manually or verbally demonstrate knowledge and skill. Trainers can effectively measure trainee progress by conducting discussion periods after training sessions. Trainers can observe if the students seemed interested in the session and what subjects or questions they raised.

Objectives should be set up so that trainees can reach them gradually. Attainment produces satisfaction and enthusiasm which are great morale and attitude boosters.

Manager's Role and Responsibility

We all realize that only one part of the manager's job is instruction. He does not need to be an excellent public speaker nor an expert on his subject. However, he must be able to address a group of employees in an effective manner. While working with employees, his objective should be to get the points across to the

greatest number of employees in the shortest time. The shortest time may be several training sessions, not just one. If the manager is not an expert on the subject addressed, he should be familiar enough with it to answer questions and give the correct information. He may enlist the help of other professionals. If the manager does not take the role of instructor, he should still be familiar with the concepts presented to select an appropriate person or means of presentation to fill the industry's needs.

Managers are responsible for ensuring that all employees know the company policies regarding safety, clothing, and sanitation. Employees must understand legal regulations and factory policy on personal hygiene and habits. This will be discussed in more detail later. The management is responsible to see that employees are instructed in the meaning and purpose of regulations. Policy enforcement is management's job.

To facilitate the first phase of training, give the newly hired employee or those that have changed departments a company booklet or document clearly stating company policy. Remember that the responsibility of management is not discharged when the rules are handed to the employee or when they sign statements indicating rules have been read and agree to comply. The employee probably will not

remember what he read in his excitement of starting a new job.

Employees may be instructed by notices (posted reminders), informal lectures, discussion, movies, films, or slides. Education is a continual process. The form and extent of training is a matter left to individual companies to fill their specific needs (28).

Managers can follow some general guidelines to aid their training function. First, organization is a must. They must be personally organized and have their training program organized. Managers need to plan, set objectives and standards, and organize efforts to meet these criteria. Continual evaluation and control of the training program are useful in assuring the program stays on the right course and meets the industry's needs. The manager should delegate responsibility, authority, and work to get employees involved and to relieve him of part of his work load (27).

A personal checklist of standards for the manager-trainer is supplied:

1. The Golden Rule of Manager: Employee relationship: Don't do yourself that which you don't want employees to do. Set a good example.
2. Be honest.

3. Be involved in continuing education. Keep current with new developments and techniques in the field.

4. Dress appropriately for the group you address.

5. Develop a pleasant, audible voice. Keep distracting hand movements and gestures to a minimum.

6. Assume a business-like yet friendly manner to put trainees at ease.

7. Be a good listener. Be sincere, courteous, and genuinely interested in employees.

8. Consider individuals and be responsive to questioning.

9. Exert positive leadership and direction.

10. Motivate employees (24).

Motivation

Motivation is the power supply leadership uses to get action. It is the guiding force that can result in excellence for an organization. Motivation sources are simple in form but are well thought out. The "5I" model neatly summarizes the main components of motivation for managers: Ingenuity, Imagination, Inspiration, Incentive, and Involvement.

1. Ingenuity: involves getting things done with the means and methods available. It means utilizing all resources to your

advantage. Use ingenuity to place employees where they will do best, in a job that relates to their interests.

2. Imagination: is looking for new and better ways of doing things. Suggestion boxes and encouraging employee input are ways to receive imaginative input. Keeping current on new developments in the industry can provide you with imaginative ideas.

3. Inspiration: can be catching. Enthusiasm and belief in what you are saying in training sessions are very important. Develop a positive attitude to convince others to believe in you.

4. Incentive: is the reason why the employee's job is important. Incentives can take the form of material awards or personal gain that pushes the person into action.

5. Involvement: is keeping employees interested in their jobs by taking active roles in the industry (1).

Another way to view motivation is by considering the needs and desires we all have. Managers can expand on these personal factors as they set up training programs. Professor W. I. Thomas described motivation using four wishes. These wishes are:

1. Wishes for security: Wishes for security take the negative form of fears for lack of food, shelter, and fear and opposition to change.

2. Wishes for response: This is the desire we have for the

human responses of sympathy, understanding, friendship. A favorable employee comment would be, "I like to work at (name of plant), the people are so friendly there."

3. Wishes for new experiences: Persons have the desire of adventure to depart from their daily routine. Offer a change of pace to employees. You might have them switch jobs or alter break routines.

4. Wishes for social recogniation: We have the desire for approval from those we esteem. Participation in plant activities or direct correspondence with plant officials may serve employees' needs.

The satisfaction of these personal desires involves respect for the dignity of each individual personality (27).

The Presentation

There are three main steps to follow when giving a training presentation. First is the introduction. At this time tell the group what you are going to talk about. Don't leave the group guessing, some may not realize the topic of instruction until the presentation is over, if at all.

Next comes the body of the presentation. Give information at a level appropriate to the trainees. Films, demonstrations, lecture, discussion, and other methods can be used. You might try logic,

stories, or humor, whatever technique is best suited to the material covered and the group addressed.

Finally, keep the conclusion short. Restate the most important points. Leave the group with a statement to think about.

Your voice and personal characteristics are important during the presentation. Your attitude should be positive and challenging. Your voice should be clear, interesting, and audible. Posture says a lot about a person, make sure it says good things about you. Gestures such as facial expressions, body and hand movements, also reflect your whole being. Have the reflection be an asset to you (1).

4-Step Training Program

During World War II it became necessary to train large numbers of workers in relatively short times with maximum comprehension. From this wartime need came the Training Within Industry Program. This basic 4-step program is modified slightly for adaptation to the frozen food industry. The program consists of explaining the procedure to the employee, demonstrating the procedure, letting the employee demonstrate it, and correction and follow-up of the employee.

1. Preparation: Put your trainee at ease so that he can be receptive to the ideas presented. Tell him the importance of

performing his job properly. Arouse his interest in learning.

2. Presentation: Explain and demonstrate the operation for the trainee. Repeat the key steps. Be patient, some people take longer than others to comprehend ideas. Keep your pace slow but interesting. Don't rush through an explanation or demonstration.

3. Performance: Direct the trainee to demonstrate the procedure. Question about key points to make suggestions for improvement if needed. Have him repeat the performance until you are sure he has mastered it.

4. Check-up: Assign a fellow experienced employee or foreman to assist trainee when trainee is on his own. Continue follow-up until the trainee can comfortably perform the task by himself (27).

The 4-step program is quite easy to use and is well suited for training food service employees. It takes much of the guess work out of instructing by providing a framework for presentation. It calls for personal attention for each employee from an experienced person. The program is flexible and can be used in nearly all training session. It provides a time for follow-up of the trainee.

Ideas for Trainers

Ideas and suggestions that may be of assistance to the trainer follow. Numbers one through seven refer to the training session,

eight and nine to employee interests, and ten and eleven to trainer's characteristics.

1. Keep the training sessions running smoothly. Be prepared if you are instructing or you have a guest speaker. Have all audio-visual equipment previously set up so that delays are not likely to occur. Have films rewound, machines focused and in proper operating condition. Preview films, filmstrips, slide shows, and tapes to see that they fit the needs of the industry and the trainees.

2. Utilize all resources available including experts, experienced people within your plant and facilities such as community colleges.

3. Be involved and interested in what you instruct. Your enthusiasm is contagious.

4. Establish and maintain an environment that is conducive to learning. Have the room a comfortable temperature with enough room for all to sit without undue crowding. Have adequate lighting and noise control. You may want to consider serving coffee or punch before the session.

5. Get as many people involved as possible. Have them assist in demonstrations as long as they are not ridiculed nor embarassed. It is advisable to involve the foremen, they can be great sources of help to you.

6. Be sure that personnel are adequately notified of training

sessions. Notices can be posted in lunchrooms, restrooms, or on checks. Use your foremen to remind employees and to act as liasons between employees and management.

7. Carry out follow-up activities on trained personnel.

8. Invite top management to training sessions if it will not hinder responsiveness of employees. Sometimes it is helpful if employees feel that those in charge have an interest in them.

9. Gather and classify plant news. Get employees involved by publishing a small plant newspaper giving new happenings in the industry and news of fellow employees and themselves. It boosts spirits to see one's name in print (24).

10. Set an example for employees by displaying proper conduct and apparel when in production areas.

11. Be responsible for employee conduct. This should not be a problem if employees have been properly trained and informed of plant policy.

Objectives

It may be beneficial to your industry to formulate a set of plant objectives involving the help of the levels of management and employees. First, top level management could design a set of plant objectives. These could be passed to managers and supervisors

for action. Supervisors would then enlist the help of their foremen in making the objectives attainable. Foremen then work with employees. This plan would be instrumental in getting all levels to work together and create a feeling of teamwork among employees. Management and employees are drawn together in a cooperative effort.

One way to visualize the objectives is to set up a chart stating goals on one side and the methods to attain them on the other. This could be used for a variety of objectives. An example follows:

Objectives	Ways and Means
I. Keep bacterial load on hands and/or gloves controlled.	A. Properly wash hands/ gloves
	B. Sanitize hands/gloves before returning to the production line

Figure 3. Objectives: Ways and Means (24).

Awards and Employee Recognition

Awards and recognition are given to employees that meet high standards set by the organization. Awards are used to recognize outstanding achievements or accomplishments of employees. Areas where recognition can be awarded are excellence in safety, production, sanitation, training completion, and most improvement in

any selected area.

Be sure the award presentation is carried out where other employees can witness and take part. Often managers present awards behind the doors of their office. The award's full effect is not recognized in this situation. An important part of awards are the peer respect and praise that goes along with the material award.

Here are several guidelines that can be used in the presentation of awards that can make the affair more beneficial to the company. Explain that it is a privilege to present the award. Outline the reasons why this employee was chosen for the honor. Be sure to give the proper attention to the recipient. Be sincere while talking about and to him. Guide the award winner back to his seat. The award presentation is a happy time that can be used to the company's benefit.

Example: Training the Clean-up Crew

The general principles of effective training that have been discussed can be applied to training clean-up and sanitation crews. An example of topics you might incorporate into your program are noted below.

As you read this section, try to formulate in your mind the three basic parts of presentations: introduction, text, and

conclusion. Also think how you could best apply the 4-step training program that is effective in training a large number of people achieving comprehension in a short time. The steps consist of the explanation, demonstration, trainee demonstration, and follow-up.

Training sessions can be very effective when you remember that they are a time of information and skill sharing benefiting the individual and company.

1. Explain the importance of their work to the clean-up crew.

    a. Discuss the nature of contamination sources and the consequences of a job poorly done.

    b. Stress why it is necessary that they understand the proper ways of using their cleaning and sanitizing compounds. Include mixing, application techniques, and personal safety.

2. Discuss the crew's role in keeping microorganisms under control.

    a. Consider the general characteristics of bacteria and their requirements to live: temperature, water, food.

    b. Explain the reproduction and rate of multiplication of bacteria to show why it is important that cleaning is thorough and on schedule.

    c. Describe how dirt and food products protect microorganisms from the action of disinfectants.

3. Explain how to clean and disinfect efficiently.

   a. Discuss the preparation of cleaning and sanitizing solutions. Include the skill of mixing for the proper strength, possible damage and corrosion to equipment by too great strengths, and personal safety in the mixing and handling of products.

   b. Demonstrate the preparation of equipment for cleaning and the protection of electrical equipment.

   c. Consider the storage of supplies and tools.

   d. Give the correct sequence of cleaning and why it is important.

   e. Discuss the importance and effect of regular disinfection and the maintenance of automatic systems.

4. Train crews how to use specialized equipment and techniques.

5. Discuss the results of bacteria tests.

   a. Explain how the crew and management can use the bacteriological tests to their advantage.

   b. Spot check areas to determine if places are missed in clean-up. Determine which sanitizers to use when the types of organisms and their location and number are known.

6. The following list of materials, equipment, and protective

clothing may be used as a base. Add or delete items to fill your industry's specific needs.

Detergents and sanitizers specifically suited to your plant.

Plastic measuring cups and cylinders.

Sturdy plastic buckets: 1 or 2 gallons for mixing.

Protective coverings for electric motors and switches: heavy plastic bags and sheets work well.

Water hoses with variable nozzle and automatic shut-off fittings.

Narrow and wide hand brushes with bristles of nylon or polypropylene.

Brooms and squeeges.

Ladders.

Inspection lights.

Pressure sprays.

Storage cupboard for cleaning equipment, chemicals, protective clothing: this should be locked.

Water-proof boots.
Water-proof aprons or jackets.
Eye protection when chlorine or quaternary ammonium compounds, (QUATS), are used (29).

IV. PROCEDURES USED FOR ANALYSIS OF MANUAL

The manual was sent for evaluation to ten experts who made up the reactor panel. The panel was made of a cross-section of professionals so that a broad input of ideas would be received. The panel consisted of five industrial personnel and five related professional and regulatory agency personnel A questionnaire served as the evaluative tool for use by the expert panel. The individual informational sections appearing in the manual were listed on the questionnaire, followed by a five-point response scale. The expert panel members were asked to respond to the question, "To what degree do you feel it is useful to include the following sections in the manual?" A sample questionnaire appears in Appendix I.

An example of a questionnaire entry with explanation follows:

Section	Agree strongly	Agree	Uncertain	Disagree	Disagree Strongly	
Sanitation	AS	A	U	D	DS	(verbal response)
	(5)	(4)	(3)	(2)	(1)	(numerical response)

The number of responses in each category of agree strongly, agree, uncertain disagree, and disagree strongly, were totaled for industrial experts, related experts, and total expert respondents.

A narrow distribution of responses was observed. The majority of responses occurred in the agree strongly, and agree categories. The results of the tabulation appear in Table 3. Nine panel members responded to two sections: Microbiology of Frozen Foods and Training. One industrial panel member did not feel qualified to answer the section dealing with the Microbiology of Frozen Foods, and another industrial respondent did not feel qualified to comment on the Training section. Ten responses were received for the Physical Aspects of the Plant section.

In addition to separate means for industrial and related professionals, means were also computed for the total number of panel member responses. Results are listed in Table 4.

The lowest mean for industry respondents was 4.0 (Agree), Employee Selection. Industry professionals commented that employee selection was difficult because management generally was not able to screen applicants prior to employment. The lowest mean for related professionals was 3.4 (between Agree and Undecided), Waste Water. Respondents did not feel it was necessary for employees to understand plant waste water operations. This section was designed to provide information to management personnel. The lowest total mean was 4.0, (Agree) Waste Water.

The highest mean for industry was 5.0 (Agree Strongly), associated with Self-inspection, Blanching, Freezing, Sanitation, and

Table 3. Summary of Expert Panel Member Responses to the Contents of the Manual as Listed on the Questionnaire.

Information Section	Number of Responses					Number of respondents
	AS[1]	A	U	D	DS	
Physical aspects of the plant						
Water supply	T[2] = 5	5	0	0	0	10
	I = 4	1	0	0	0	
	R = 1	4	0	0	0	
Waste water	T = 5	3	0	1	1	10
	I = 3	2	0	0	0	
	R = 2	1	0	1	1	
Water borne and solid waste	T = 6	3	0	1	0	10
	I = 3	2	0	0	0	
	R = 3	1	0	1	0	
Lighting	T = 4	6	0	0	0	10
	I = 2	3	0	0	0	
	R = 2	3	0	0	0	
Ventilation	T = 5	5	0	0	0	10
	I = 2	3	0	0	0	
	R = 3	2	0	0	0	
Entryways, exits, and exterior areas	T = 5	5	0	0	0	10
	I = 2	3	0	0	0	
	R = 3	2	0	0	0	
Floors	T = 4	5	1	0	0	10
	I = 2	2	1	0	0	
	R = 2	3	0	0	0	
Walls and ceilings	T = 4	5	1	0	0	10
	I = 2	3	1	0	0	
	R = 2	3	0	0	0	
Plumbing and sewage	T = 4	5	0	1	0	10
	I = 1	4	0	0	0	
	R = 3	1	0	1	0	
Pest control	T = 6	3	1	0	0	10
	I = 4	1	0	0	0	
	R = 2	2	1	0	0	

Table 3. Continued.

Information Section	Number of Responses					Number of respondents
	AS[1/]	A	U	D	DS	
Employee	T[2/] = 4	6	0	0	0	10
	I = 2	3	0	0	0	
	R = 2	3	0	0	0	
Equipment design	T = 6	3	1	0	0	10
	I = 3	1	1	0	0	
	R = 3	2	0	0	0	
Design for cleaning and maintenance	T = 5	5	0	0	0	10
	I = 2	3	0	0	0	
	R = 3	2	0	0	0	
Cleaning and sanitizing	T = 7	3	0	0	0	10
	I = 4	1	0	0	0	
	R = 3	2	0	0	0	
Cleaning schedule	T = 8	2	0	0	0	10
	I = 4	1	0	0	0	
	R = 4	1	0	0	0	
Self-inspection	T = 8	2	0	0	0	10
	I = 5	0	0	0	0	
	R = 3	2	0	0	0	
Employee selection	T = 4	5	1	0	0	10
	I = 1	3	1	0	0	
	R = 3	2	0	0	0	
Employee health guidelines	T = 7	3	0	0	0	10
	I = 4	1	0	0	0	
	R = 3	2	0	0	0	
Employee hand washing and drying procedures	T = 4	5	1	0	0	10
	I = 3	2	0	0	0	
	R = 1	3	1	0	0	
Gloves	T = 4	4	2	0	0	10
	I = 3	2	0	0	0	
	R = 1	2	2	0	0	

Table 3. Continued.

Information Section	Number of Responses					Number of respondents
	AS[1/]	A	U	D	DS	
Microbiology of frozen foods						
Blanching	T[2/] = 5	4	0	0	0	9
	I = 4	0	0	0	0	
	R = 1	4	0	0	0	
Freezing	T = 5	3	1	0	0	9
	I = 4	0	0	0	0	
	R = 1	3	1	0	0	
Sanitation	T = 5	4	0	0	0	9
	I = 4	0	0	0	0	
	R = 1	4	0	0	0	
Indicator organisms	T = 3	5	1	0	0	9
	I = 2	2	0	0	0	
	R = 1	3	1	0	0	
Summary	T = 3	5	0	0	0	
	I = 2	1	0	0	0	
	R = 1	4	0	0	0	
Training						
Why train?	T = 6	3	0	0	0	9
	I = 3	1	0	0	0	
	R = 3	2	0	0	0	
Employer	T = 4	5	0	0	0	9
	I = 1	3	0	0	0	
	R = 3	2	0	0	0	
Employee	T = 3	6	0	0	0	9
	I = 1	3	0	0	0	
	R = 2	3	0	0	0	
Employee needs	T = 5	4	0	0	0	9
	I = 2	2	0	0	0	
	R = 3	2	0	0	0	

Table 3. Continued.

Information Section	Number of Responses					Number of respondents
	AS[1]	A	U	D	DS	
The trainer	T[2] = 5	4	0	0	0	9
	I = 4	0	0	0	0	
	R = 1	4	0	0	0	
Manager's role and responsibility	T = 5	3	0	1	0	9
	I = 3	1	0	0	0	
	R = 2	2	0	1	0	
Motivation	T = 5	4	0	0	0	9
	I = 3	1	0	0	0	
	R = 2	3	0	0	0	
The presentation	T = 5	4	0	0	0	9
	I = 3	1	0	0	0	
	R = 2	3	0	0	0	
4-step training program	T = 3	6	0	0	0	9
	I = 2	3	0	0	0	
	R = 1	4	0	0	0	
Ideas for trainers	T = 4	5	0	0	0	9
	I = 2	2	0	0	0	
	R = 2	3	0	0	0	
Objectives	T = 4	5	0	0	0	9
	I = 1	3	0	0	0	
	R = 3	2	0	0	0	
Awards and employee recognition	T = 4	4	1	0	0	9
	I = 2	1	1	0	0	
	R = 2	3	0	0	0	
Example: Training the clean-up crew	T = 4	3	0	0	0	7
	I = 2	1	0	0	0	
	R = 2	2	0	0	0	

[1] AS = Agree strongly; A = Agree; U = Uncertain; D = Disagree; DS = Disagree strongly.

[2] T = total responses from all panel members; I = Industrial panel member responses; R = Related professional panel member responses.

Table 4. Questionnaire Response Means of Industrial (I), Related (R), and Total (T) Expert Panel Members.

Information section	Mean[1/] T	Mean I	Mean R
Physical aspects of the plant			
Water supply	4.5	4.8	4.2
Waste water	4.0	4.6	3.4
Water borne and solid waste	4.4	4.6	4.4
Lighting	4.4	4.4	4.4
Ventilation	4.5	4.4	4.6
Entryways, exits, exterior areas	4.5	4.4	4.6
Floors	4.3	4.2	4.4
Walls and ceilings	4.3	4.2	4.4
Plumbing and sewage	4.2	4.2	4.4
Pest control	4.5	4.8	4.2
Employee facilities	4.4	4.4	4.4
Equipment design	4.5	4.4	4.6
Design for cleaning and maintenance	4.5	4.4	4.6
Cleaning and sanitizing	4.7	4.8	4.6
Self-inspection	4.8	5.0	4.6
Employee selection	4.3	4.0	4.6
Employee health guidelines	4.7	4.8	4.6
Employee hand washing and drying procedure	4.3	4.6	4.0
Gloves	4.2	4.6	3.8
Microbiology of frozen foods			
Blanching	4.6	5.0	4.2
Freezing	4.4	5.0	4.0
Sanitation	4.6	5.0	4.2
Indicator organisms	4.2	4.5	4.0
Summary	4.4	4.6	4.2

Table 4. Continued.

Information section	Mean[1/] T	Mean I	Mean R
Training			
Why train?	4.7	4.8	4.6
Employer advantages	4.4	4.3	4.6
Employee advantages	4.3	4.3	4.4
Employee needs	4.6	4.5	4.6
The trainer	4.6	5.0	4.2
Manager's role and responsibility	4.3	4.8	4.0
Motivation	4.6	4.8	4.4
The presentation	4.6	4.8	4.4
4-step training program	4.3	4.5	4.2
Ideas for trainers	4.4	4.5	4.4
Objectives	4.4	4.3	4.6
Awards and employee recognition	4.3	4.3	4.4
Example: Training the cleanup crew	4.6	4.6	4.5

[1/] 5 = Agree Strongly; 4 = Agree; 3 = Undecided; 2 = Disagree; 1 = Strongly Disagree.

Training. The highest mean for related respondents was 4.8, (between Agree Strongly and Agree), Scheduled Cleaning. This high mean reflected the interest and need for properly outlined cleaning operations in a plant. The highest total mean was 4.8, (between Agree Strongly and Agree), associated with Scheduled Cleaning and Self-Inspection. These two categories fit together to form the planning and execution of an efficient and effective cleaning and sanitizing program that could be applied to many operations. Again, the importance and interest in cleaning expressed by the industrial (5.0) and related (4.8) personnel was shown by the high means received.

The Student's "t" test was used to determine if significant differences existed between the responses of Industrial and Related experts in the three sections of the manual, the Physical Aspects of the Plant, Microbiology of Frozen Foods, and Training. The responses were treated as uncorrelated data since they were gathered from different individuals. The mean values of responses were compared. The significance level of choice was 0.01.

Ho: There are no significant differences in response mean scores among the selected samples of industrial experts and related professional expert panel members as to the importance of including information sections in the manual.

Ha: There are significant differences in response mean scores among the selected samples of industrial experts

and related professional expert panel members as to the importance of including information sections in the manual.

The tabular "t" value exceeded the computed "t" value for the Physical Aspects of the Plant, and Training sections. The null hypothesis, Ho, was retained and the alternative hypothesis, Ha, was not rejected. The computed "t" value for the section, Microbiology of Frozen Foods, exceeded the tabular "t" value so the null hypothesis, Ho, was rejected and the alternate hypothesis, Ha, was retained. Therefore, the results of the Student's "t" test indicated that there was a significant difference between the industrial and related panel member response means for the section, Microbiology of Frozen Foods. The industrial panel members consistently rated the microbiology subsections higher than did related experts.[1/] There was no significant difference in industrial and related panel member response means for the sections on the Physical Aspects of the Plant, and Training.

A limitation to the study must be noted. The panel members form a non-random sample. Interpretation of statistical data applies

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[1/] Statistical differences were indicated but practically, a marked difference was absent. Both industrial and related personnel rated the Microbiology of Frozen Foods section between Agree Strongly and Agree. Both groups agreed that the section should be included in the manual.

only to the group serving as expert panel members. No inferences can safely be drawn to persons outside the group.

Table 5. Use of Student's "t" to Determine if There are Significant Differences in Response Means of Industrial and Related Expert Panel Members.

Section	Standard Deviation		Student's "t" computed	"t" value tabular
	Industrial	Related		
Physical aspects of the plant	0.26	0.33	1.46	2.72
Microbiology of frozen food	0.25	0.11	5.75[a/]	3.36
Training	0.25	0.48	0.43	2.80

[a/] Significant difference at 0.01 level.

Expert panel members were asked to answer four questions after completing the scaled response portion of the questionnaire. The questions were designed so that answers given by panel members would provide information for future improvement and revision of the manual. Incorporation of the comments into the manual is outside the scope of the study at this time, but the comments are constructive and may serve as a basis for future study. A summary of the comments given by the expert panel members follow:

1. Which areas do you feel need more emphasis or information?

Industry: One panel member indicated that all sections were

covered but that the importance of a clean and sanitary operation cannot be overemphasized. Another respondent felt that more emphasis should be placed on follow-up activities of the training operation. All training requires follow-up to be effective. The other industrial panel member who commented thought that a section describing types of cleaners and sanitizers and their specific use on different metals, painted surfaces, belts, and other equipment should be included.

Related: A regulatory agency panel member indicated that the section dealing with the physical structures of the plant needed more emphasis and explanation of the associated favorable and unfavorable characteristics of the facility. A related professional thought the information was good as presented.

No response: Two related professionals and two industrial professionals offered no comments to the question.

2. Which sections would you leave out?

Industry: One respondent felt that no sections should be deleted but several should be consolidated. Another panel member indicated that the Employee Awards and Recognition section should be deleted or rewritten with emphasis on the thought, theory, and purpose of awards, not the method of presentation. An industrial respondent thought that the selection of employees was difficult because

applicants complete employment application forms and return to work when notified. Management did not have much opportunity to screen prospective employees. Another panel member questioned the value of including the section on Waste water for the average employee.

Related: A related professional panel member desired more detail in the section on Employee Selection. He felt such information would benefit management.

No response: Four related professional panel members and one industrial respondant did not comment on the question.

3. Did the Training section offer any helpful ideas for employee training programs? If yes, please explain.

Industry: One panel member favored the emphasis that was placed on employee-employer relationships. In his opinion, the type of relationship could determine the success of training programs. A different respondent believed that management should be involved with training programs. He felt that if the training responsibility were delegated to persons with lesser authority, employees might not feel that management cared about the program. A panel member consulted his plant superintendent and he was very much in favor of the information presented in the Training section.

Related: A panel member described the section as excellent.

He viewed the section as very concise and to the point, easy to follow, and easy to implement. Another member thought the Ideas for trainers section should help company training programs.

No response: One related professional and two industrial panel members offered no comment to the question.

4. What would make the manual more useful to the frozen fruit and vegetable industry?

Industry: The industrial panel member thought a more detailed section on clean-up crew training would be helpful.

Related: A panel member responded that to make the manual useful to the industry, it is essential that managers have a knowledge of the information presented in the manual facilitated by a means of access to the manual. The member thought that managers could direct supervisors to effectively use the variety of information presented in the manual. Another member felt that the manual could contain more detailed information on sanitation procedures, what to look for in establishing sanitation programs, means of cleaning, and problem analysis and correction.

No response: Two related professional and four industrial panel members did not comment on the question.

V. SUMMARY AND RECOMMENDATIONS

The purpose of this study was to construct a supervisor's manual for employee training in sanitary food production in the frozen fruit and vegetable industry. The manual was designed as an information source on principles of sanitary food production for industrial management and supervisory personnel. The general factors of the physical aspect of the plant, microbiology of frozen foods, and employee training that contribute to the sanitary production of frozen foods were discussed. Material outlined in the manual was designed to serve as a basic information source for employee training programs to ensure that foods for human consumption were produced under sanitary conditions.

Several methods were employed to supply information for the construction of the manual. First, industries and national organizations of frozen food processors were contacted to determine what they felt were needs of the frozen food industry that could be addressed in the form of a manual. Next, the literature was searched with emphasis placed on the needs expressed by industry. The manual was then constructed around comments received from initial correspondence with industry and information found in the

literature search. Finally, the contents of the manual were evaluated by a ten member panel of experts comprised of five industrial personnel and five related professional and regulatory agency personnel. A questionnaire was the tool the panel used to evaluate the subunits of the three major information sections of the manual revolving around the concepts of sanitary food production: Physical Aspects of the Plant, Microbiology of Frozen Foods, and Training. Panel members were asked to rate the degree of importance of including the individual information sections in the manual. They used a five point graduated response scale progressing from agree strongly to disagree strongly. Questions asking for ways to improve the manual appeared at the end of the questionnaire. After all questionnaires were received, statistical analysis of the responses was initiated.

Examination of the computed means of the expert panel indicated that every information section should be included in the manual. High response means were received by the sections dealing with Scheduled Cleaning, Self-inspection, and Sanitation. This observation parallels the needs expressed by industry in the initial letter correspondence. The planning and execution of effective, efficient cleaning and sanitizing programs are desired by the frozen fruit and vegetable industry.

The Student's "t" test was used to determine if significant differences existed between industrial and related personnel response means for the three major sections of the manual. The results indicated that there was no significant difference between the means on the Physical Aspects of the Plant section and the Training section. However, a significant difference was noted for the Microbiology of Frozen Foods section where industrial panel members rated the subsections continually higher than did related personnel.

The limitation to the study must be considered. The panel members constitute a non-random sample. Interpretation of statistical data applies only to the panel, no inferences can be drawn to persons outside the group.

Comments and suggestions on the manual by expert panel members serve as recommendations for revision of the manual and future studies to meet industrial needs. Incorporation of all of the suggestions is outside the scope of the study at this time. Each expert panel member indicated that the product of the study, the manual, was useful to the frozen fruit and vegetable industry. Panel members provided suggestions for revision of the manual. One panel member from each group suggested that several of the individual information sections be combined to reduce fragmentation of

the manual. Pictures or cartoons could be added to illustrate and clarify selected concepts. Several suggestions offered by the panel are topics of future studies to aid industry. Industrial respondents desired detailed information dealing with the use, safety, and selection of cleaning compounds for various surfaces including equipment, metals, and painted surfaces. Another industrial panel member expressed the frozen fruit and vegetable industry's need for a detailed training program designed for cleaning and sanitation crews with individual information manuals for each crew member. The inclusion of line members and union representatives in addition to industrial management level personnel would be another dimension to the study and aid in analyzing the effectiveness of the manual. The development of these suggestions would provide a useful and much needed service to industry.

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APPENDICES

APPENDIX I

MANUAL ASSESSMENT QUESTIONNAIRE

Name: _____

Professional title: _____

This questionnaire is a tool to determine how important the various sections are in the manual. Your ratings of the sections and any suggestions you offer are much appreciated.

Listed below are the section headings contained in the manual. Please respond to the following question by circling your response:

TO WHAT DEGREE DO YOU FEEL IT IS USEFUL TO INCLUDE THE FOLLOWING SECTIONS IN THE MANUAL?

	Agree strongly	Agree	Uncertain	Disagree	Disagree Strongly
A. Physical aspects of the plant					
Water supply	AS	A	U	D	DS
Waste water	AS	A	U	D	DS
Water borne and solid waste	AS	A	U	D	DS
Lighting	AS	A	U	D	DS
Ventilation	AS	A	U	D	DS
Entryways, exits, exterior areas	AS	A	U	D	DS
Floors	AS	A	U	D	DS
Walls and ceilings	AS	A	U	D	DS

TO WHAT DEGREE DO YOU FEEL IT IS USEFUL TO INCLUDE THE FOLLOWING SECTIONS IN THE MANUAL?

	Agree Strongly	Agree	Uncertain	Disagree	Disagree Strongly
Plumbing and sewage	AS	A	U	D	DS
Pest control	AS	A	U	D	DS
Employee facilities	AS	A	U	D	DS
Equipment design	AS	A	U	D	DS
Design for cleaning and maintenance	AS	A	U	D	DS
Cleaning and sanitizing	AS	A	U	D	DS
Cleaning schedule	AS	A	U	D	DS
Self-inspection	AS	A	U	D	DS
Employee selection	AS	A	U	D	DS
Employee health guidelines	AS	A	U	D	DS
Employee hand washing and drying procedures	AS	A	U	D	DS
Gloves	AS	A	U	D	DS

COMMENTS: _____

_____

_____

B. Microbiology of frozen foods

Blanching	AS	A	U	D	DS
Freezing	AS	A	U	D	DS
Sanitation	AS	A	U	D	DS
Indicator organisms	AS	A	U	D	DS
Summary	AS	A	U	D	DS

COMMENTS: _____

_____

TO WHAT DEGREE DO YOU FEEL IT IS USEFUL TO INCLUDE THE FOLLOWING SECTIONS IN THE MANUAL?

	Agree strongly	Agree	Uncertain	Disagree	Disagree strongly
C. Training					
Why train?	AS	A	U	D	DS
Employer advantages	AS	A	U	D	DS
Employee advantages	AS	A	U	D	DS
Employee needs	AS	A	U	D	DS
The trainer	AS	A	U	D	DS
Manager's role and responsibility	AS	A	U	D	DS
Motivation	AS	A	U	D	DS
The presentation	AS	A	U	D	DS
4-step training program	AS	A	U	D	DS
Ideas for trainers	AS	A	U	D	DS
Objectives	AS	A	U	D	DS
Awards and employee recognition	AS	A	U	D	DS
Example: Training the clean-up crew	AS	A	U	D	DS

COMMENTS: _____

_____

_____

Which areas do you feel need more emphasis or information?

_____

_____

Which sections would you leave out? _____

_____

_____

Did the Training section offer any helpful ideas for Employee training programs and presentations? If yes, please explain _____

_____

_____

What would make the manual more useful to the frozen fruit and vegetable industry? _____

_____

_____

APPENDIX II

March 22, 1976

Dear

Thank you for agreeing to participate as an expert panel member in the development and assessment of the educational manual, the product of my thesis work. Enclosed are the "Supervisor's Manual for Employee Training in Sanitation in the Frozen Fruit and Vegetable Industry" and the Manual Assessment Questionnaire. Please respond to the questionnaire as you read the manual. The questionnaire is a tool to determine the importance of the sections appearing in the manual. The questionnaire is divided into sections for ease of analysis. The sections correspond to the section headings appearing in the manual. Any suggestions you offer such as information addition or deletion may be written on the "Comments" line of the questionnaire. Please feel free to write comments, clarifications, corrections, or questions on the manuscript.

The manual copy you received is still in the formative stage. This manual is not the finished product. Your ratings, comments, and suggestions will help shape the manual into the finished product.

I sincerely appreciate the time and effort you spent reading and responding to the manual. I hope a product will be developed that will be useful to the industry. I would welcome any project questions or inquiries. If you would like a copy of the completed manual, I will send you a copy.

Sincerely,

Victoria Eddy.