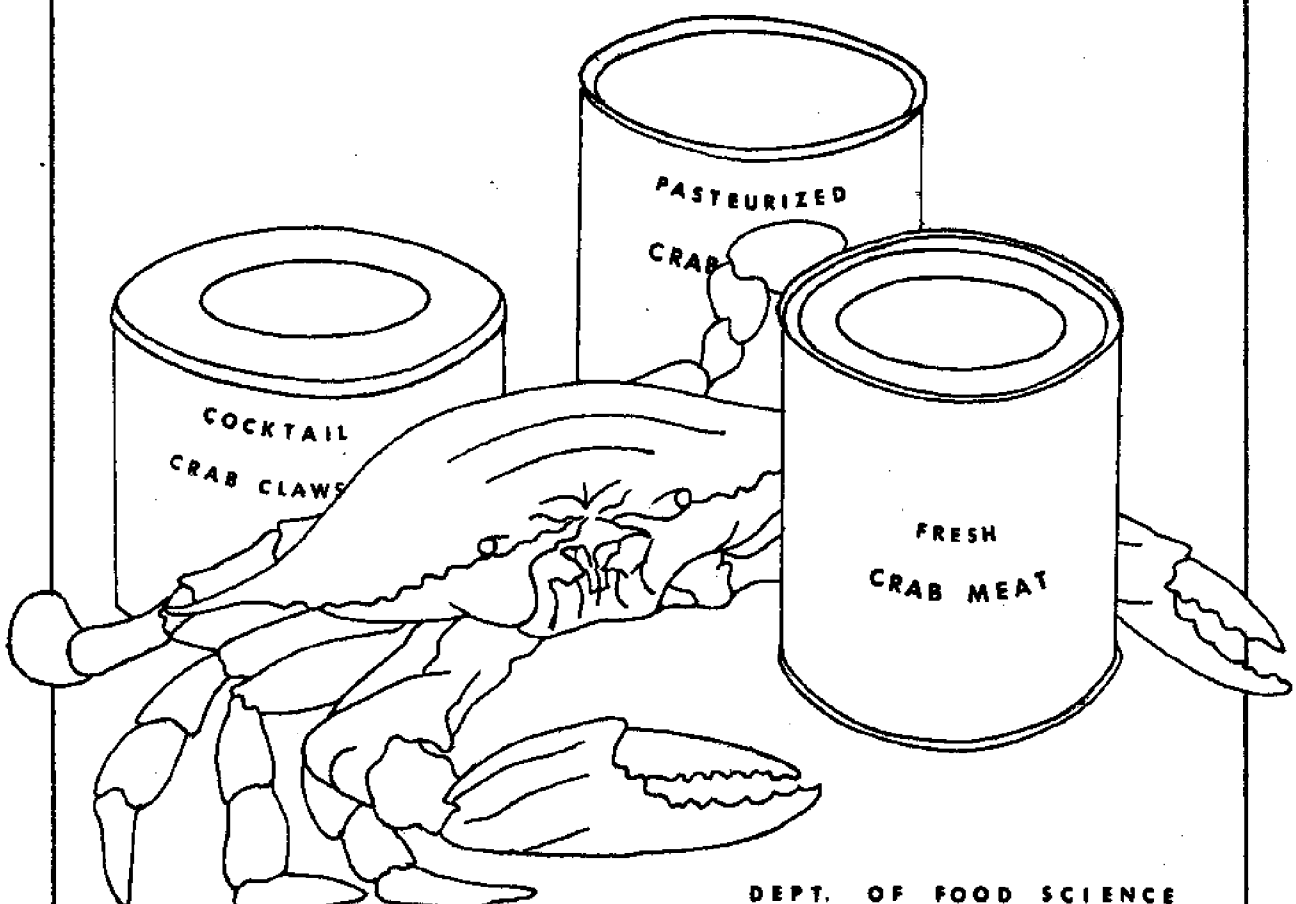
TECHNICAL OPERATIONS MANUAL

FOR THE BLUE CRAB INDUSTRY



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TECHNICAL OPERATIONS MANUAL FOR THE BLUE CRAB INDUSTRY[1,2]

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4. N. C. Division of Marine Fisheries, Special Scientific Report No. 28.

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PREFACE

Thousands recall pleasant days spent crabbing, and ensuing gustatory rewards, leading many to maintain that blue crab is the king (or queen) of seafoods. Such reactions help build a substantial market for commercially prepared crab meat. Those who have feasted on fresh-cooked crabs know how delicious the meat can be, thus providing a challenge for industry to produce meats of equal quality.

The North Carolina blue crab industry has attained a three-fold expansion of output in less than twenty years. This means that demands made by a wider range of customers, farther removed from production centers, are specifying more rigid requirements, and adequate shelf life.

Canned, pasteurized, or fresh crab meats are used interchangeably in prepared dishes, and in salads. It is implicitly understood that crab meats do not require heating before eating. This places the products in the same category as other processed foodstuffs intended for human consumption without cooking, and falling within the purview of the Good Manufacturing Practices (GMP) issued by Food and Drug Administration, May 29, 1969, entitled "Human Foods; Current Good Manufacturing Practice (Sanitation) in Manufacture, Processing, Packing, or Holding." These describe such criteria as sanitation, plant and grounds, equipment and utensils, sanitary facilities and controls, sanitary operations, processes and controls, and personnel which shall apply in determining "WHETHER THE FACILITIES, METHODS, PRACTICES AND CONTROLS USED IN THE MANUFACTURE, PROCESSING, PACKING, OR HOLDING OF FOOD IN CONFORMANCE WITH OR OPERATED OR ADMINISTERED IN CONFORMITY WITH GOOD MANUFACTURING PRACTICES TO ASSURE THAT FOOD FOR HUMAN CONSUMPTION IS SAFE AND HAS BEEN PREPARED, PACKED, AND HELD UNDER SANITARY CONDITIONS".

The above Practices apply generally to the manufacture of all food products. It is reported that a GMP specifically for blue crab plants is "in the mill."

Requirements for producing high quality crab meats apply equally to small and to large plants. The latest requirements for the North Carolina blue crab industry appear in "Laws, Rules, and Regulations Relative to the Sanitation of Crustacea" effective May 22, 1974, prepared by the Department of Human Resources, Division of Health Services, Sanitary Engineering Section.

Present day knowledge of crab meat manufacture is based upon a substantial amount of investigation and research effort as evidenced by an annotated bibliography on the blue crab (Tagatz et al, 1971), covering 742 publications. Basic studies by Puncochar et al. (1954) and Ulmer et al. (1959) dealing with commercial production of crab meat, sanitary requirements, suggested technological improvements, and contamination

vectors including hands of employees, contain many items which are still relevant.

Recent work has focused on problems of controlling bacterial levels. Thomas et al., (1965) investigated bacteriological quality of crab meat in relation to storage characteristics. Ward et al., (1970) proposed a bacteriological method of examining whole crabs. In sampling an important segment of the industry he reported that the percentage of cooked crabs or crab meat samples from the picking table, exceeding total plate count of 100,000 was much higher in 1969 than in the two previous years. Webb et al., (1973) applied supervised sanitation procedures in blue crab plants but did not attain consistent improvement in standard plate counts of the products, thus indicating that numerous links in the protective chain must be applied before consistent improvements can be made.

During 1965-66, some key individuals involved with regulatory, research or production phases of the blue crab industry in Maryland, Virginia and North Carolina began to coordinate their efforts on mutual problems. The Tri-State area has about one-half the total number of blue crab plants in the United States. As a result of this collaboration, the Tri-State Seafood Committee was formed with Mr. W. A. Van Engel, Virginia Institute of Marine Science, as Chairman. The members are as follows:

Virginia:
Dr. George J. Flick, Virginia Polytechnic Institute; Mr. John A. Hope, Supervisor, Virginia Department of Health; Mr. Robert Moberg, Representative, Virginia Seafood Council; Mr. Cloyde W. Wiley, Director, Bureau of Shellfish Sanitation, Virginia Department of Health.

Maryland:
Mr. J. Clayton Brooks, Representative, Chesapeake Bay Seafood Industries Association; Mr. Lewis F. Hobbs, Head, Department of Health; Dr. Mahlon C. Tatro, Director, Seafood Processing Laboratory.

North Carolina:
Mr. John Andrews, Chief, Sanitation Section, State Board of Health; Mr. N. McK. Caldwell, Shellfish Sanitation Consultant, Sanitation Section, State Board of Health; Dr. Frank B. Thomas, Extension Specialist (Seafood), North Carolina State University; Mr. Wilson F. Whorton, President, North Carolina Crab Packers Association.

The Committee issued the "Manual of Good Manufacturing Practices for the Sanitary Control of Blue Crab Meat Production" in December, 1971. This document has exerted much influence on state regulatory attitudes and understandably is the main point of reference in preparing, "Technical Operations Manual for the Blue Crab Industry."

Because of the changing nature of the problem and a desire to constantly arrive at improvements, this manual is offered in looseleaf form to enable substitution or addition of pages. As indicated by Section VIII,

blue crab research will continue to produce new information useful in delineating guidelines for the blue crab industry. Agricultural Extension and Sea Grant Advisory Services will keep the industry informed and assist in applying new ideas at the plant level.

Since this manuscript was started it has been revised on a number of occasions, each time recognizing new trends and concepts. We gratefully acknowledge reviews and advice offered by Mr. Robert Benton, N. C. Division, of Health Services; Mr. James R. Brooker, National Marine Fisheries Service; Mr. Vernon Keyes, Florida State Board of Health; Mr. Howard Lupton, N. C. Division of Health Services; Dr. Ransell Nickelson, II, Texas A & M University; Mr. Fred Phillips, Department of Health, Education, and Welfare, Food and Drug Administration; Dr. Mahlon C. Tatro, Seafood Processing Laboratory (Maryland); Mr. Willard A. Van Engel, Virginia Institute of Marine Science; Mr. L. F. Hobbs, Maryland Department of Health; Mr. Stanley E. Waskeiwicz, The Blue Channel Corporation; Mr. Cloyde W. Wiley, Virginia Department of Health; and Mr. Robert Learson, U.S. Department of Commerce, NMFS-NOAA.

The contributions by the N. C. Agricultural Extension Service, and the specialist staff are gratefully acknowledged. Special thanks are due Mr. David A. Hill and Mrs. Linda S. Burgess of the Seafood Laboratory at Morehead City for their direct involvement in the preparation of this manual.

Cover design by Miss Leslie L. Miller

TECHNICAL OPERATIONS MANUAL FOR THE BLUE CRAB INDUSTRY

I. INTRODUCTION:

This manual has been prepared as a practical guide for processors of blue crabs in order to assist in producing crab meats which are highly acceptable to customers. It is not intended to replace regulatory agency requirements, but rather to describe in practical terms how to meet or to exceed them.

Plant and laboratory studies make it evident that additional surveillance is needed in many parts of the crab meat preparation process. The Seafood Laboratory works with the North Carolina Blue Crab industry on those problems requiring additional research or extension demonstrations, thus helping achieve the desired production efficiency and product quality.

Much in this manual can be attributed to the Tri-State Seafood Committee, to Blue Crab Meetings held by National Marine Fisheries Service and to consultations with Shellfish Sanitation, Division of Health Services. Results of 13 Food and Drug Administration inspections of North Carolina crab plants were analyzed by the Seafood Laboratory to determine frequently reported violations which were as follows:

Violations	% of Plants in Violation
Flies in picking room and on tables	69%
Pickers failed to sanitize hands after handling unsanitized objects	46%
Hand and can sanitizing solutions had improper amount of chlorine, or none	39%
Garbage and trash on ground near plant	31%
Condensate dripping from ceiling surface in cooler room	31%
Flies in packing room	31%
Openings in screens	23%
Cooked claws allowed to remain in cans for prolonged periods at room temperature	23%
Excessive length of time between picking crab meat and taking to packing room	23%
Pickers failed to sanitize hands after wiping noses, faces or hair	23%
Excessive table loads of crabs	23%

The edible blue crab (Callinectes sapidus Rathbun) inhabits estuarine waters from Cape Cod to Mexico. It has an average annual value on the East coast (1967 to 1972) of $ 8.55 million ex-vessel price to crabbers. Other than

shrimp, Blue Crab is the most valuable crustacean in North Carolina waters, with average value of $ 1.4 million between 1967 and 1972. The landings of the fishery relative to other major producing states is shown in Figure 1. As far as is known, the productivity of the North Carolina fishery has not been impaired by man-made factors, but there are appreciable catch variations from year to year, ranging from 13 to 22 million pounds per year.

The major goals in processing crab meat are (1) attainment of maximum yield, (2) production of a high quality product particularly with respect to bacterial population and organoleptic properties, and (3) maintenance of high quality during storage, shipment and distribution within normal shelf life of the product.

In this manual, considerable emphasis is placed on sanitary requirements which should begin at the fishing grounds and extend to the consumer. Raw crabs, and the processing areas in which they are handled, are likely to contain large numbers of microorganisms which, if transferred to the cooked meat may destroy wholesomeness, reduce palatability, and even cause food poisoning. Cooked crabs and extracted meats must be handled under stringent sanitary conditions. This is achieved by avoiding high bacterial counts in those parts of the plant intended for handling the cooked whole crabs or extracted meats. Those workers who are in direct contact with crab meats must avoid hygienic malpractices which can introduce pathogenic organisms capable of affecting the health of hundreds of people.

North Carolina regulations, ("Laws, Rules and Regulations Relative to the Sanitation of Crustacea", effective May 22, 1974) directed at oysters, scallops and clams, also should be kept in mind in handling crabs: "All boats used in taking and handling of shellfish shall be kept in such a state of cleanliness and repair that the shellfish hauled or stored thereon shall not be subject to contamination by bilge water, through leakage of polluted water, or by other means. Docks, holds or bins used for storage on boats shall not be washed with polluted water. Reasonable precautions shall be observed by fishermen while boats are in waters over shellfish grounds to prevent the pollution of such grounds through the discharge of human wastes."

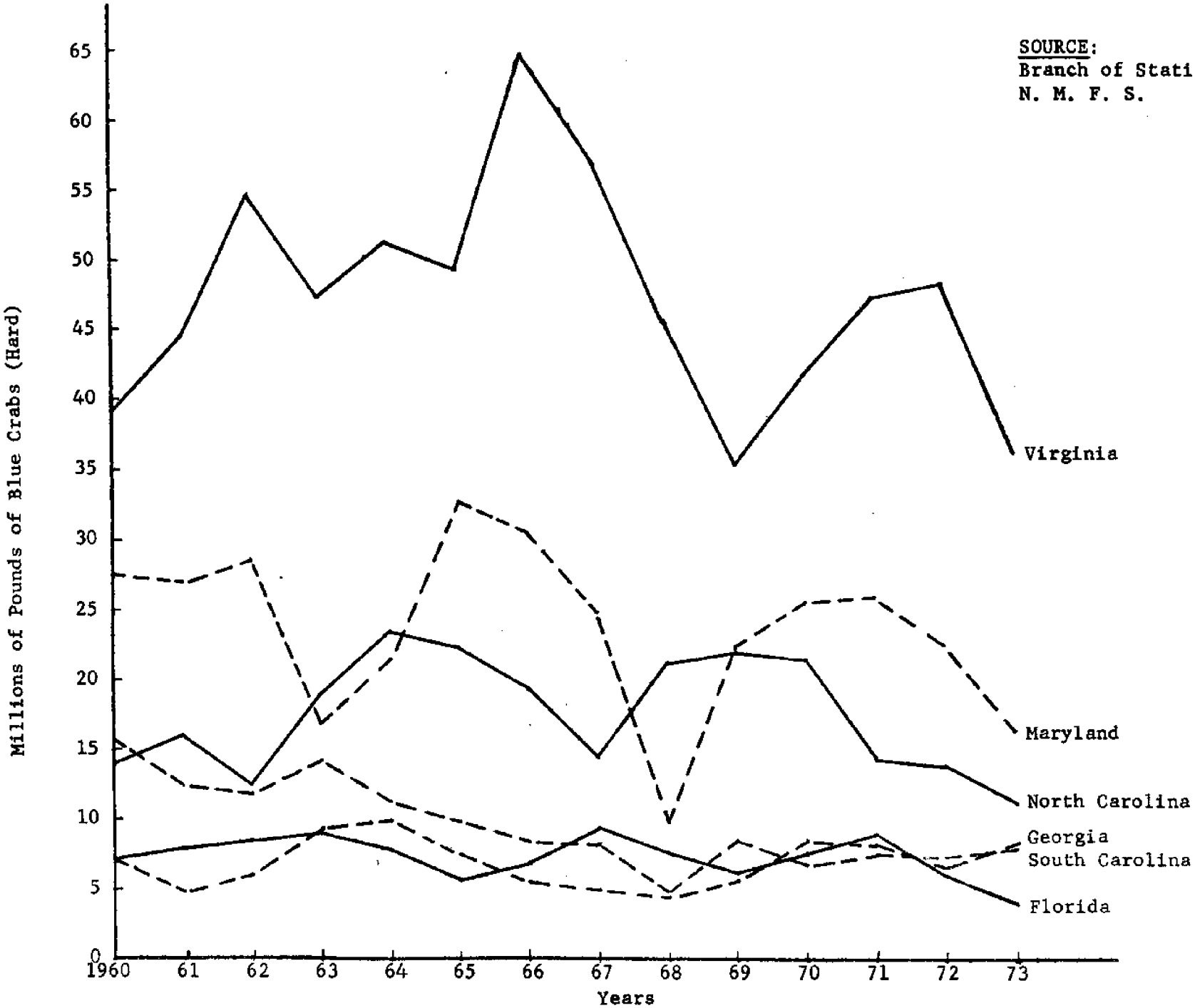
Live crabs arrive at the plants potentially contaminated with pathogenic microorganisms in addition to harmless bacteria normally present. Bacterial counts per gram of raw crabs coming into the plants may range from 2 to 23 million. Therefore, a crucial problem in arriving at adequate plant sanitation is keeping raw crab contamination confined to the receiving and cooking areas.

II. GENERAL CONSIDERATIONS:

A. Harvesting and Handling:

As a means of assuring a steady year round supply, North Carolina plants receive appreciable interstate shipment of live crabs from other Atlantic coast states and the Gulf coast.

Crab catching methods depend on season, regional preferences and state regulations. Crabs are taken by crab pots, trotlines, dredges, scrapes


SOURCE:
Branch of Statistics
N. M. F. S.
Millions of Pounds of Blue Crabs (Hard)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1960
61
62
63
64
65
66
67
68
69
70
71
72
73
Years
Virginia
Maryland
North Carolina
Georgia
South Carolina
Florida

and dip nets. The fishing boats are usually small with exception of some used on the lower Chesapeake Bay, or as occasional enterprise when not trawling for other species. Fishing is usually a one- or two-man operation, employing inexpensive gear. Crab pots may be furnished by the packer, creating an obligation to sell the catch to that processor. However, most crabbers are quite independent in their boat operations. Packers do not usually control the supply, often having to purchase excessive amounts in times of plenty in order to have a source when crabs are scarce.

1. North Carolina Fisheries Regulations for Coastal Waters (1974) Applying to Catching of Hard Crabs:

   The following acts are prohibited:

   a. "Taking, buying, selling, or possessing any hard crabs measuring less than 5 inches from tip of spike to tip of spike, except "peelers" which may be floated in regular crab floats. Crabs shall be culled by the catcher where taken and all crabs less than legal size shall be immediately returned to the waters from which they were taken. Tolerance of not more than 10% of any portion examined shall be allowed. In determining whether the proportion of undersize crabs exceeds the 10% tolerance limit, the Commissioner and his agents are authorized and empowered to grade all, or any portion, or any combination of portions of the entire quantity of crabs being graded, and may require seizure and return to the waters, or other disposition as authorized by law, of the entire quantity being graded, or of any portion thereof, if undersized crabs in excess of the tolerance limit are found."

   b. "Using, for the purpose of taking hard crabs, any crab trawl having a mesh length of less than 3 inches."

   c. "Taking crabs through the use of crab pots between May 1 and November 1 except that the Director, acting upon the advice of the Commissioner, may designate areas and times in which crab pots may be used between May 1 and November 1. An individual may take hard crabs through the use of crab pots at any time for personal consumption, provided that not more than one crab pot is used and no boat is used to aid in the taking."

   d. "Taking crabs by use of dredges between April 1 and November 30."

   e. "Setting crab pots in any marked navigation channel."

   f. "Taking hard crabs by the use of a crab trawl between the hours of 8:00 P.M. on any Saturday and 8:00 P.M. on the following Sunday."

2. Mortality Factors:

   The supply of crabs is undoubtedly affected by such ecological factors as changes in salinity, supply of nutrients and severe winter condi-

tions which kill many crabs.

Every effort should be directed at keeping crabs alive on boats after catching since biological changes occur rapidly, yields drop, and the meats become mushy and unpalatable. Basically, transport of live crabs depends on keeping them cool and moist. If there is excessive lapse in delivery to the plant, then every effort should be made to maintain high humidity with a temperature range of about 50°F - 60°F.

B. Land Transportation:

The temperature and moisture conditions mentioned above are equally important when crabs are transported by land. Trucks, trailers and other conveyances should be cleaned and sanitized before loading to avoid additional contamination. When ice is used as a refrigerant, its cleanliness and method of handling must be in accordance with requirements for food plants and it should not come in direct contact with the crabs.

C. Management:

The owner or manager should personally, or through a designated individual, supervise and accept responsibility for compliance with regulations and guidelines needed to assure high quality standards. In many food plant operations this is the duty of Quality Control personnel.

D. OSHA Requirements:

All items referred to in this manual must be in compliance with the federal Occupational Safety and Health Act of 1970, and with amendments or additions issued thereafter.

III. PLANT FACILITIES:

Crab meat, in common with other foods which may be eaten without further cooking, must meet stringent state and federal requirements. Increasingly, there is the view that an acceptable food plant must encompass bacteriological cleanliness in addition to physical cleanliness. All considerations concerning personnel, buildings, plant layout, and operating guidelines bear directly on how this may be achieved.

A. Construction and Design:

Variability of crab meat plants prevents discussion applying fully to each. However, important concepts pertaining to all plants are shown by means of a Flow Sheet (Figure 2), a drawing of a Prototype Plant (Figure 3) and a Partial Equipment List (Appendix A), for a medium-sized operation capable of producing about 300,000 pounds per year of hand picked crab meat.

III. A. 1. FLOW SHEET

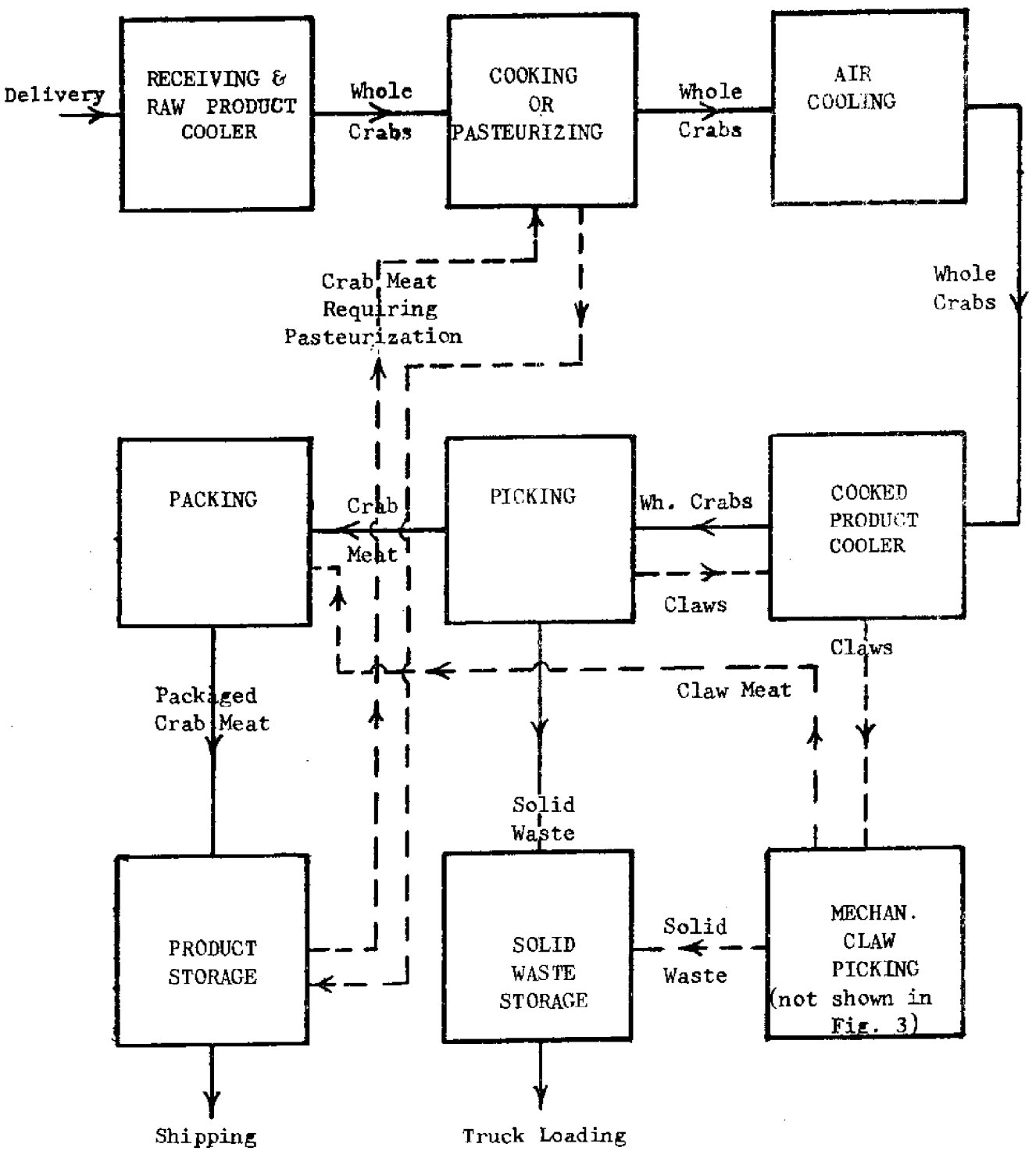
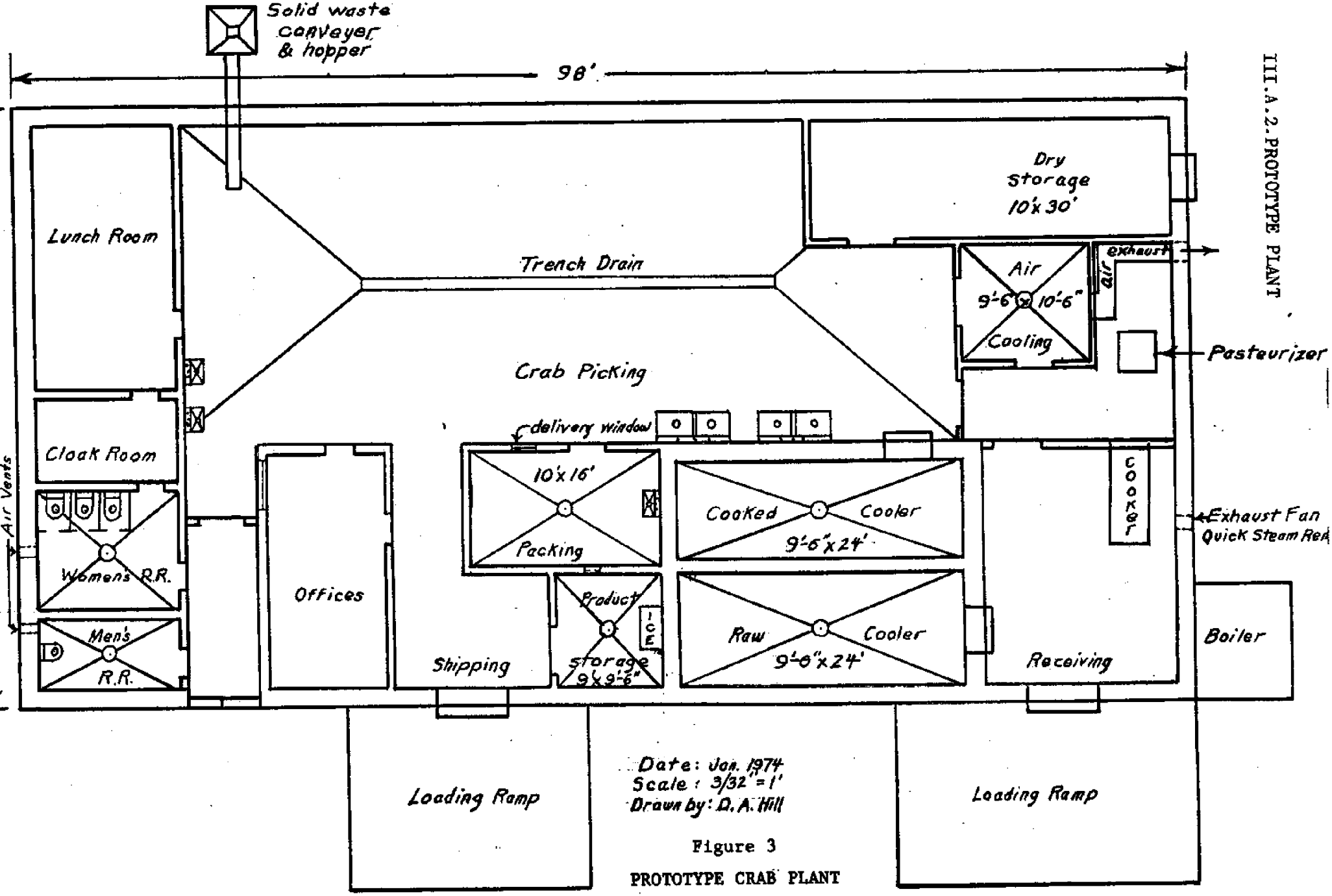


FIGURE 2

Flow Diagram of Crab Processing Stages



Date: Jan. 1974
Scale: 3/32" = 1'
Drawn by: D. A. Hill

Figure 3

PROTOTYPE CRAB PLANT

Weight Raw Crabs Processed Daily, pounds.....17,400
Weight Crab Meat Produced, pounds.....1,740
(based on 10% yield: picking for 8 hours)

Number of Pickers.....48

4.53 lbs./hr. av., based on:
20% of Pickers extract 3-4 lbs./hr.
60% of Pickers extract 4-5 lbs./hr.
20% of Pickers extract 5-6 lbs./hr.

Obviously, the instituting of automation and mechanization would result in a plant with different design and size relationships.

1. Boiler(s):

The boiler should be at least 30 HP for processing 3,400 pounds of raw crabs per hour. The pressure should be sufficient to maintain 45 to 100 psig during cooking. Steam line from boiler to retort should be a minimum of 1¼" I.D. A pressure regulating valve in the 10 to 30 psig range is desirable. If used, it should be located on the steam line and should be 1¼" I.D. if not adjacent to retort, or at least 1" I.D. if adjacent. (All boilers and retorts should conform to the N. C. Department of Labor requirements.)

2. Containers:

All single-service containers (one time use only) should be stored and handled in a sanitary manner. These should be rinsed with a sanitizer and drained completely before using.

3. Conveyor for Solid Waste:

Conveyors used for carrying waste should be designed to meet food handling requirements - easily cleaned and sanitized immediately after each use. The receiving hopper should hold at least the waste from one full day of operations, i.e., about 55% of the weight of raw crabs cooked. The hopper should be enclosed, or covered, adequately drained, equipped with screens for catching solid waste and easily cleanable. The exit opening from the plant should have a drop curtain to prevent the entry of insects. This opening must be tightly sealed when the plant is not in operation.

4. Cooking Room:

This room should be permanently enclosed and located between the raw crab receiving area and the cooling room. It should have an exhaust fan to assure complete removal of steam, such venting also serving to move air away from the cooling room. Movement of air avoids condensate which can contaminate cooked crabs.

A wall and emergency door should separate the raw crab area from the cooked crab area (Figure 3). This is the first line of defense against

contamination of the finished product. Personnel cannot be permitted to move freely between the two areas since foot traffic as well as the pushing of carts will spread bacteria. A chlorinated foot bath may be provided for personnel occasionally going directly from the raw to cooked crab areas. When not practical, footwear must be carefully cleaned to prevent contamination.

The erecting of protective barriers separating raw from cooked product involves difficulties, each plant having to work out its own solution as to how this can be accomplished. The horizontal cooker shown in Figure 3 requires a door on each end so that baskets can be introduced from the raw crab handling side, and removed in the cooked crab area. In plants with circular retorts, the overhead tracks for the moving hoist (the chain should never contact the product) will have to extend from the raw crab handling side, pass over the retorts, and enable basket transfer to the cooked crab handling area.

5. Cooling Rooms:

Adequate protection must be provided during air cooling to protect the cooked crabs from flies, insects, rodents, dust, plant traffic, and the cleaning operation. The air used for cooling the crabs should be drawn from above the roof, passed through a filter, then around the crabs, and finally exhaused by fan through a screened opening at the side of the building. The refrigerated cooked product cooler should open directly into the picking room, or to an enclosed passageway through which the crabs are transported after cooling.

Figure 4 illustrates a relatively inexpensive way to construct an improved cooling room. This is a departure from present crab meat plants which usually locate screened cooling rooms near areas employed in raw crab handling.

6. Electrical Service:

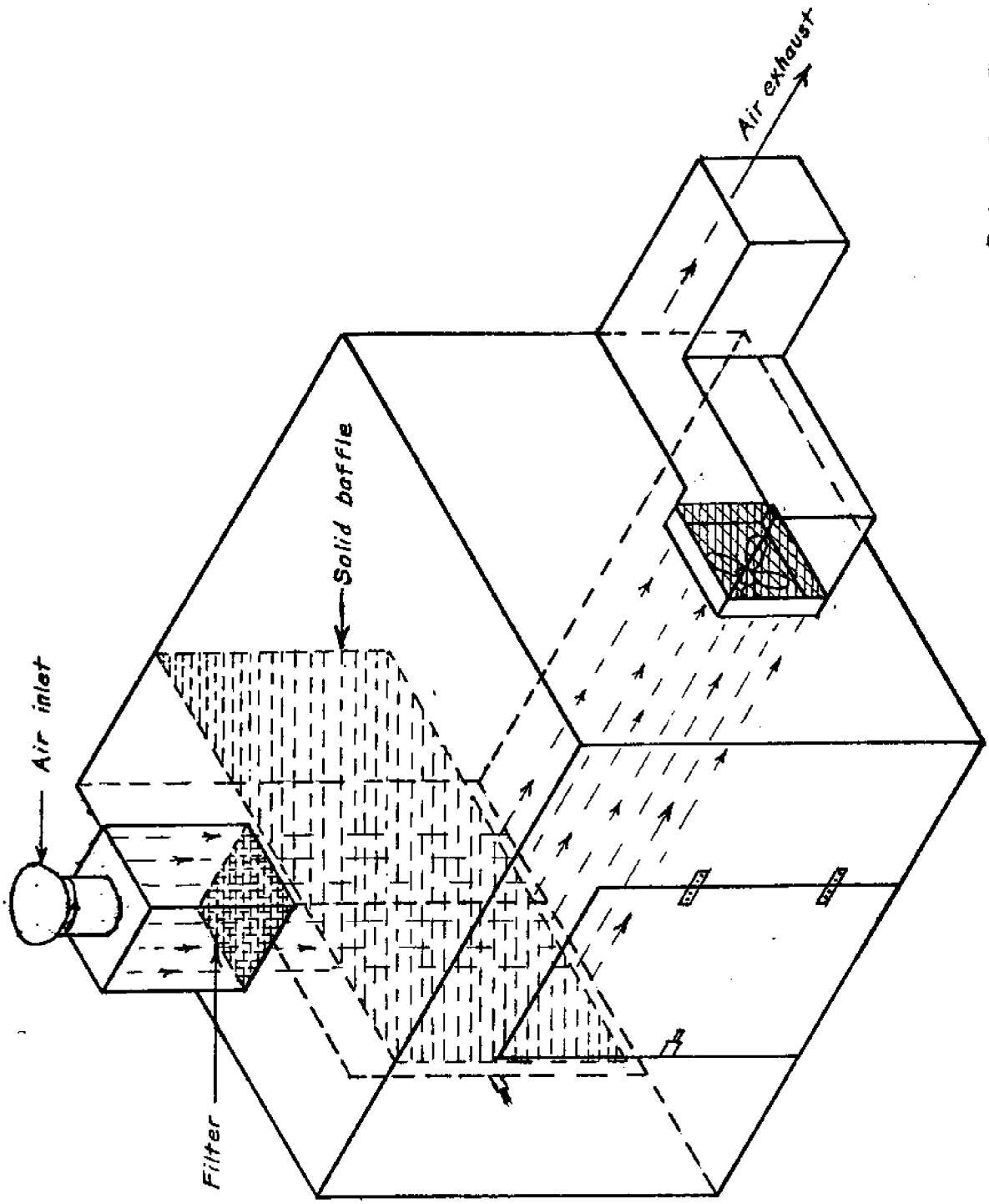
This service must comply with existing codes with switch boxes and exposed wiring outside of processing areas. Wires leading to equipment must be in waterproof ducts and completely grounded for safety of employees.

7. Floors:

Floors throughout the plant should be of smooth, impervious, easily cleanable materials, kept clean and in good repair. Adequate drainage should be provided in all areas where floors are subject to flooding-type cleaning or where normal operations release or discharge water or other liquid waste on the floor. Joints between floors and walls should be coved.

8. Handwashing Facilities and Supplies:

There should be at least one lavatory for every twenty employees among the first 100 employees, and at least one lavatory for each 25 employees



Date: June 7, 1974
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FIGURE 4
Prototype Air Cooling Room

in excess of the first 100. (24 lineal inches of wash sink or 18 inches of a circular basin, when provided with water outlets for such space, will be considered equivalent to one lavatory). Handwashing facilities should be convenient to the work areas, and so located that the person responsible for supervision can readily observe that employees wash hands before beginning work and after each interruption. There should be at least one lavatory in the packing room for use of packing room workers.

The lavatories should be provided with hot water (at least 100°F) either from a controlled temperature source with a maximum temperature of 115°F, or from a hot-and-cold mixing or combination valve. Steam-water mixing or steam-water combination valves are not suitable.

Supplies of soap and single-service towels and protected dispensers should be available near the lavatory. (Other sanitary drying devices if approved by the Division of Health Services* are also acceptable.) Adjacent to the lavatories, a container of suitable construction should be provided for the sole purpose of sanitizing the hands in an approved solution of adequate strength, 100 parts per million of available chlorine or its bactericidal equivalent.

9. Heating, Cooling, and Ventilation:

All rooms and areas should be well-ventilated, by natural or artificial means which are effective under actual work use conditions, and should be heated or air conditioned, if necessary to maintain a comfortable working temperature. The picking room should be kept as cool as personnel can tolerate in order to retard bacterial growth.

Since circulating air may carry sufficient bacteria to contaminate the product, the ventilation system should draw fresh supplies of air from above the building, filtered at a point where it enters the picking and packing rooms, and under slight positive pressure so that air exhausts outward from critical areas.

Toilet rooms and privies should be ventilated by direct opening to outer air, or by a mechanical ventilating system exhausting to outside of building. Exhaust fans, if used, should have a minimum capacity of 2 cubic feet a minute per square foot of floor area. Air vents should have screens, or self-closing louvers.

10. Lighting:

Adequate light should be provided to hand-washing areas, dressing and locker rooms and toilet rooms and all processing and storage areas. Equipment and utensil cleaning areas should be adequately lighted. Safety-type light bulbs, fixtures, skylights, or other glass suspended over working areas employed in handling the meats are necessary to prevent contamination in event of breakage. Work, storage, and toilet areas should have adequate artificial light. Suggested illumination for picking and packing area surfaces is 100 foot candles; and 25 foot

* North Carolina Department of Human Resources

candles for storage rooms (including refrigerated storage rooms), and toilet rooms.

11. Picking and Packing Rooms:

The picking rooms should provide a minimum working space of 4 square feet for each picker. Desirably, six (6) workers should use a 4' x 8' table. The room should provide adequate facilities for the cleaning and sanitizing of utensils and equipment, including for every 30 pickers a 2-compartment sink with hot and cold running water piped to each compartment. Adequate facilities for washing and sanitizing solid crab waste containers should be provided. Figure 3 indicates the size requirement for a picking area to produce approximately 300,000 lbs per year.

The packing room should have a delivery window between picking and packing, equipped with a corrosion resistant shelf of metal or equally smooth non-porous surface, draining toward the picking room. There should be a large stainless steel counter for handling and weighing the finished product. The can sealer must be lubricated with food plant type (non-toxic) lubricants.

12. Plant Layout:

It cannot be overemphasized that a protective barrier around cooked crabs and picked meat is needed to prevent product contamination. Thus, raw crab handling and storage must be completely separated from cooling and picking and cooked meat storage.

Plant design should provide for interrupted flow of raw materials and product. (The flow interrupted by protective barriers). Such flow should be rapid so that perishable materials do not remain outside of refrigerated areas for too long a time. Mechanical processing equipment should be integrated into the total flow pattern.

13. Plant Location:

The area around the plant should be kept completely clean and free from piled materials or trash. Drainage should be away from the building. Grounds and driveways should be free from depressions which foster insect or bacterial growth.

Plants should be located ro prevent flooding by high tides. If plant floors are flooded, processing should be discontinued until waters recede and the facilities can be thoroughly cleaned and sanitized. A minimum plant elevation of at least two feet above mean high water should be provided in new plant construction.

14. Plumbing:

Plumbing should comply with State and local plumbing ordiances, or be equivalent to recommendations contained in the current American Standard National Plumbing Code.

There must be no cross-connections between the approved pressure water supply and water from a non-approved source or waste discharge line, or fixtures or connections through which the approved supply may be contaminated by back siphonage.

15. Refrigeration, Mechanical:

Mechanical refrigeration capacity must be adequate to maintain the air temperature in the (1) raw cooler, (2) cooked cooler and (3) product storage at 33°F - 40°F.

The blower and heat exchanger systems employed in (1) and (2) should be designed to avoid buildup of moisture and consequent dripping on product, an important source of contamination.

16. Refrigeration Rooms:

Refrigeration rooms should be of sanitary construction with an impervious floor graded to drain quickly. Such rooms should be constructed to exclude drainage from other parts of the plant. Floor drains should have an air gap when connected directly to a sanitary sewer.

The product storage room should be equipped with an accurate thermometer (± 1°F), have an impervious lining, an adequate drain, and should be large enough to permit storage of at least one full day's production plus adequate ice.

17. Retorts:

In providing a barrier wall between the raw and cooked crab handling areas, the rectangular retort, as stated above, will require a door on each end. The circular retort must have its top hinged so that baskets can be loaded from the raw crab side, and removed in the direction of the cooling room by means of an overhead track.

The retort should be constructed to permit a working pressure of at least 0-20 psig. Steam inlet and venting should provide a uniform and complete distribution of steam. Venting should be sufficient to permit complete elimination of air from the retort. Drains and vents should be located at least two feet above mean high water.

The retorts should be equipped with:

a. An automatic time-temperature device, mechanical, electrical or combination type, for regulating the cooking process, with a range of 170-270°F for 1-20 minutes. It should be designed to signal when timed cook has begun and signal when timed cook is
c completed.

b. An enclosed indicating thermometer with a range that will include 170°F - 270°F and located with the blub extending into the heat chamber.

c. An operating pressure indicator, at least 3 inches in diameter,

with a 0-30 psig range, and located adjacent to the indicating thermometer.

d. A safety valve operational at 18-30 psig, located in the upper portion of the retort, protected from tampering, and appropriate for operator's personal safety. (N. C. Dept. of Labor)

e. Retort cooking baskets should be of stainless steel or equivalent material, and should be designed to allow for proper steam dispersement yet made with small enough openings to prevent spillage of crabs. Construction should permit ease of handling, dumping, and satisfactory cleaning.

18. Rest Room Facilities:

Conveniently located, separate toilets should be provided for each sex, except that separate facilities need not be required when family operations are carried on and satisfactory toilets are conveniently located, or when there are less than 10 employees. The number of water closets should comply with State laws. The following number of water closets should be provided:

Number of Employees	Number of Water Closets	
	Male	Female
1 to 9	1	1
10 to 24	2	2
25 to 49	3	3
50 to 74	4	4
75 to 100	5	5

One additional fixture is needed for every 30 employees over the first 100. When urinals are provided, one water closet less than that specified may be provided for each urinal installed, except that the number of water closets in such cases should not be reduced to less than 2/3 of the minimum specified. A 24-inch trough will be considered equivalent to one urinal.

The toilet rooms should be kept clean and in good repair, furnished with toilet tissue, and should be fly-tight with self-closing doors that open outward, providing that the doors should not open directly into areas where food is exposed to airborne contamination.

19. Room Requirements Summarized:

To emphasize what is stated elsewhere in this manual, separate rooms or areas should be provided for receiving, washing and cooking crabs. The following processes should be carried out in separate rooms, the dividing walls extending from floor to ceiling, containing only those openings required for circular retorts, conveyors, or doorways:

a. Raw Product Cooler
b. Post Cook Handling Area and Pasteurizing

c. Air Cooler
d. Cooked Product Cooler
e. Picking Area
f. Packing Area
g. Product Storage and Shipping

Separate rooms should be provided for:

h. Container Storage
i. Locker and Lunch Room
j. Rest Rooms
k. Office and Sales
l. Supplies, Chemicals, Maintenance Materials

20. Space Requirements:

Food plant regulations specify that adequate space should be provided for all routine operations to permit sanitary handling and thorough cleaning of equipment.

21. Utensils and Equipment Composition:

Such items should be constructed of materials which are odorless and unaffected by food products and cleaning compounds. Work surfaces should have a finish of corrosion resistant stainless steel, nickel alloy or the equivalent.

Galvanized copper, copper alloys, cadmium, antimony, and/or other deleterious substances should not be used in or on food equipment. Lead must not be used except as a component of solder in an amount not exceeding 5%.

Plastics must be abrasion resistant, heat resistant, shatter proof, and must not contain free phenol, formaldehyde, or other constituent which may contaminate the food product.

Gaskets, packing materials and lubricants must be non-toxic.

22. Walls, Ceilings, Windows, Doors:

All walls and ceilings should be constructed of tile, concrete, cement plaster, concrete blocks, or equivalent material with smooth, light-colored surface which will endure repeated washing and cleaning. Walls should be free from cracks, ledges and shelves. Doors and windows shoul be tightly fitted, screened where necessary, and maintained in good repair.

B. Environmental Considerations:

1. Animal Control Measures:

Pets, as potential carriers of filth, Salmonella and other organisms detrimental to the process, should not be allowed within, or near

the plant.

2. Condensate:

Fixtures, ducts and pipes capable of condensing moisture should not be suspended over working areas. The cooked crab cooler should be designed to minimize condensate and to prevent its dripping on crabs.

3. Ice:

Ice is preferably manufactured in the plant, but in any event should come from an approved source. Packers purchasing crushed ice should secure it from dealers who handle, crush and deliver it in a sanitary manner.

Ice bins should have smooth, impervious surfaces, constructed and located with bottom above the level of the adjacent floor, draining away from unused ice.

Block ice should be properly stored to avoid contact with contaminated surfaces and should be thoroughly washed on an elevated metal stand or grating with a hose provided for this purpose before it is placed in the crushing machine. A corrosion resistant container should be provided to catch crushed ice issuing from the crusher. If the crusher is in a protected portion of the refrigeration room, such container may not be needed.

All facilities and equipment employed in handling and/or preparing ice for use should be used for no other purpose and should be cleaned each day the plant is in operation. Shovels should be hung or stored in a protected manner when not in use.

Where it is necessary to have ice in the packing room, a metal lined container or compartment of sanitary construction should be provided for the sole purpose of storing such ice manufactured in the plant, purchased crushed ice, or block ice that has been crushed in the plant; except that clean barrels or boxes for shipping crabs may be used for this purpose.

4. Rodent and Pest Control:

Effective measures should be taken to keep rodents, flies, and other vermin out of the establishment and to prevent breeding or presence in the premises. All openings to the outside should be effectively protected against entrance of insects and rodents by self-closing doors, closed windows, 16-mesh or finer screening, controlled air currents (air doors), or other effective means.

Rodenticides which are highly toxic to humans must neither be stored in crab meat processing plants nor used except under the supervision of a licensed pest-control operator or qualified specialist. Rodent-

icides with low toxicity for humans should be identified, stored and used in a manner to prevent contamination of product and health hazards to employees.

Only those pesticides which are properly registered with the Federal Government and the State Department of Agriculture, and approved for the purpose by Division of Health Services, can be used. Pesticides should be handled, stored and used to avoid product contamination and hazards to employees.

5. Sewage Disposal:

Sewage should be discharged into public sewers wherever possible.

Private sewage-disposal facilities must be constructed and operated in compliance with State and local requirements. Human excreta must not be accessible to flies or rodents.

All liquid wastes should be disposed of in a manner to avoid nuisance or degraded water quality. With new construction, wastes from hand-wash and utensil-wash sinks cannot be discharged overboard without proper treatment.

6. Waste Handling:

Solid waste should be immediately removed from picking room if a conveyor has been installed. Otherwise, containers for solid waste should be removed from the picking room as soon as filled, placed in suitable protected outside storage for removal at least daily. Waste containers should be made of non-absorbant materials, free of leaks and each day should be thoroughly cleaned and sanitized.

7. Water:

There should be adequate supply for simultaneously conducting processing and adequate washdown as required by the plant. Only potable water should be used, i.e., water approved by Division of Health Services.

Water temperatures which should be provided include (1) for handwashing, at least 100°F either from a controlled temperature source with a maximum temperature of 115°F, or from a hot-and-cold mixing or combination valve, and (2) for the rest of the plant, a temperature of 130°F minimum, for all hours of plant operation.

IV. PROCESSING CRABS AND HANDLING CRAB MEAT:

A. Cooking:

The method of cooking must be approved by the N. C. Division of Health Services. Steam pressure should be applied until the internal temperature of the centermost crab reaches 235°F. Internal temperature can be measured with a maximum registering thermometer having a range of 170-270°F.

The following description is not intended to provide cooking directions, but rather to serve as a working example. Exact schedules to achieve the required internal temperature will vary from one plant to another.

Example: A rectangular basket with inside dimensions of 2'9" x 3' x 7'6" can be loaded with 1700 pounds of crabs and cooked in a rectangular retort. Two circular baskets each with inside dimensions of 3' diam. x 35" high, can be loaded with 1200 pounds of crabs, then put in a circular retort and subjected to the following cooking cycle:

1. Retort preheated before first use.
2. Filled baskets loaded into retort.
3. Retort closed, clamps firmly secured.
4. Steam turned on.
5. Condensate continually removed from bottom, vent adjusted and remains open at top.
6. Pressure should reach 15 psig (250°F) 9 to 10 minutes after steam is turned on.
7. Time cook for 9 minutes with steam valve left open.
8. Turn off steam, slowly release pressure (approximately 10 min.).
9. Open retort, remove baskets.

B. Cooling:

Cooked crabs should be removed immediately from the cooking room and while in the same retort basket, transferred to the cooling room and air cooled to ambient temperature if possible within 30 minutes. Then, with minimum delay, the crabs should be moved to the cooked cooler room having refrigerated air temperature of 33°F to 40°F.

C. Picking and Packing:

Hand or mechanical picking operations should be conducted with all due regard to sanitary requirements, while avoiding conditions which elevate meats to temperatures favoring rapid multiplication of bacteria. Exposure of whole cooked crabs to room temperature should be minimized, a fresh supply from the cooler being delivered to pickers only after the previous supply is exhausted.

Mechanical picking requires that claws or other parts be separated and accumulated before going into the equipment. The handling of such parts requires the same care as is applied to hand picked crab meat, i.e., collecting in sanitized buckets or moved via food handling conveyors, for accumulation under sanitary refrigerated cooler conditions.

Cooked crabs, or portions thereof, intended for meat separation at other locations should be accumulated under conditions indicated above. The means of transfer to another plant, the time schedules involved, and the meat separation methods employed must be outlined and agreed upon by Division of Health Services before the operations are undertaken.

The use of mechanical equipment for extracting crab meats requires careful handling to avoid excessive bacterial buildup. Physical contact between the food, the brine, and the equipment provides ideal conditions for recontamination if there has not been sufficient regard for protecting the crab parts or for frequent cleaning and sanitizing of lines, tanks, conveyors, and everything else involved. The equipment manufacturer can undoubtedly provide directions for producing an acceptable product. Final responsibility for product quality, however, remains with the plant owner.

Repacking of crab meat which has been picked or processed in another plant, or blending of fresh, and/or frozen, and/or pasteurized crab meat is not allowed by the Division of Health Services.

Cans or other containers for packaging cooked crab meat should be provided in clean, sanitized condition, be single service and made of an approved material. Containers must be tightly closed and/or sealed after filling.

With rigid containers, packer's certificate number must be legibly and permanently marked on the sides, except when lids are permanently attached the markings can be on the lids. Location of the name and address of the firm or distributor should follow the same rules. Flexible packages should be clearly and permanently marked with the same information, hand stamping not being acceptable. Containers bearing a certificate number of another plant must not be allowed on the premises. Each container should be permanently and legibly identified with a code showing date of packing.

Only clean master containers for shipping the packaged crab meat should be used.

D. Freezing:

Crab meat intended for freezing should be frozen within 24 hours of picking, and stored at 0°F or lower temperature.

E. Pasteurization:

"Pasteurization" refers to the process of heating every particle of crab meat in an approved hermetically-sealed container to a temperature of at least 185°F and holding it at that temperature or above for at least one minute.

1. Time and Temperature Measuring Equipment:

This equipment should be provided to include (1) indicating thermometer and (2) recording thermometers, equipped with 12 hour charts, 10" diameter, to serve as time-temperature controllers. Accuracy of such thermometers should be checked frequently. The thermometers should be well protected from vibration and impact, protected from moisture. Adjustments or any possible interruption of the recording thermometer should be avoided during processing.

As a double check on the recorder, a well-protected thermometer should be provided, with accuracy and readability ± 1°F in the 160°F - 200°F range. The recording thermometer should have a range of 120°F - 220°F, accurate to ± 1°F between 160°F and 200°F, and the chart scaled at maximum of 2° intervals between 160°F and 200°F. The clock mechanism, equipped with spring or electrically operated clock, should be as reliable as an accurate watch. The rotating chart support should provide reliable means of affixing the chart.

2. Processing Equipment:

A constant flow steam control valve is essential if steam is the source of heat. The water bath should not be overloaded. There will be better distribution of heat if steam is released from the side of the steam discharge spreader pipes, in the base of the water bath, providing tangential release of steam. The containers should be immersed at least 6 inches below the surface of the water, with a minimum of 3 inches clearance from the sides of the water bath and 2 inches clearance from the bottom. The basket cover should be perforated for water circulation. There should be effective circulation to maintain a uniform temperature.

3. Preparation of Crab Meat:

Pasteurized crab meat should meet the same requirements as fresh crab meat, remain under ice until processed, and should be pasteurized within 24 hours after picking.

4. Minimum Requirement for Pasteurization:

Pasteurization should be applied to crab meat within 24 hours of picking. The internal temperature of the container of crab meat must be raised to 185°F and held at that temperature for at least one minute at the geometric center of the container. Temperature-time requirements must be determined for each water bath and for other conditions, such as initial temperature of the meat, size of the container, and for other variables. Alteration of the equipment or in the method of stacking of containers will require that the procedure be restandardized. Time-temperature conditions for one water bath may not give a satisfactory pasteurization in another water bath.

The meats should be cooled upon removal from the water bath, reducing temperature to 100°F within 50 minutes.

5. Recording Chart:

This should comply with regulations of the Division of Health Services in such matters as recording details of each batch processed, noting interruptions due to breakdowns and other causes, changing the chart for each day of operation, recording all relevant information such as date, code of pack, and mechanical or

power failures.

6. Refrigerated Storage:

Refrigerated storage of the pasteurized chilled crab meat must be slightly above 32°F and under 36°F. The label should clearly identify the contents of the container as pasteurized crab meat. Each container must be permanently and legibly identified with a code indicating the batch and the day of processing. The words "Perishable--Keep Under Refrigeration" or an equivalent statement must be prominently displayed on the label. Crab meat should be shipped on a rotating basis, the oldest product first. It is essential that the best available information concerning shelf life be kept in mind. Fresh crab meat is only of optimum quality if it is distributed and delivered to the consumer in a few days. Pasteurization or freezing provides flexibility in avoiding adverse market situations and extended holding before the product is consumed.

V. FURTHER PROCESSING:

This section states some important considerations in producing such products as crab cakes and crab imperial for sale to retail outlets and to institutional users. Applicable requirements listed elsewhere in this manual apply equally well to "further processing", but generally there are additional and more stringent measures to be taken in providing the level of sanitation, minimum exposure to critical temperatures and other needed precautions.

The putting together of food ingredients, weighing, blending, mixing, packaging, cooling, refrigerating or freezing requires keen awareness of how neglectful practices may reduce product quality or permit unacceptable bacterial counts; such threats being minimized through constant attention to specific sanitary practices, and correct training and supervision of personnel.

Food sanitation depends upon complete awareness of how microorganisms must be kept under control in food handling. Disease-producing bacteria may be transmitted through food, or may multiply to cause food poisoning. Control measures may include minimum exposure of perishable ingredients to those conditions which permit multiplication of bacteria, and of course there must be complete cleaning and sanitizing of tables, equipment, utensils, cutting boards, and all surfaces which contact foods.

Potentially hazardous are perishable foods consisting of milk, or milk products, eggs, meat, poultry, fish, shellfish, or other ingredients capable of supporting rapid and progressive growth of infectious or toxigenic organisms.

Bacteria require moisture and warm conditions for growth. The further processed items, to which this section has reference, provide ideal moisture and nutrient combinations for rapid buildup of bacteria. If the combining and handling of the ingredients is delayed in the 45°F - 140°F temperature range,

then there can be rapid multiplication of organisms.

Once the required recipes have been achieved to a point where there is indication of customer satisfaction, then it becomes important to maintain that level of quality. Each ingredient must be selected for its complete suitability, and handled to avoid deterioration or loss of flavor.

The finished product(s) should be regularly sampled and evaluated for flavor, aroma, texture and appearance under conditions used by the consumer, at time of manufacture, and in connection with inventory checks while in storage, to assure uniformly high quality deliveries.

VI. PERSONNEL:

Persons affected with a disease in a communicable form, or while a carrier of such disease, or while afflicted with boils, infected wounds or an acute respiratory infection should be excluded from the plant. The manager should observe employees and do everything possible to detect any sign of illness.

Local health authorities should be informed if an employee is known or is suspected of having a disease in a communicable form.

Employees should wash their hands thoroughly with warm water and soap, then dip them in an approved sanitizing solution before beginning work and prior to returning to work after leaving working areas, or after contact with any unprotected surface or other source of contamination.

Fingernails should be short and clean, and ornate rings should not be worn while picking or packing. Use of cloth wraps or cloth finger cots should not be permitted.

Appropriate handwashing signs should be conspicuously posted in toilets in both packing and picking rooms, and near handwashing lavatories.

Pickers, packers, and handlers of unpicked cooked crabs or picked meat should wear clean outer garments and aprons. Aprons should cover the front and sides of body. Caps or hair nets should cover the hair. Arms should be bare to the elbow or covered with approved type arm guards. Any type of protective clothing employing ruffles and gathering of material as well as scrap plastic, should not be used.

Clean, individual, single-service, hand paper towels should be provided for each picker to use during picking operations.

Employees must not eat food or use tobacco in any form in the picking or packing rooms.

Unauthorized persons should not at any time be allowed in the processing areas of the plant. Sales of crabs or crab meat should not be made from any processing portion of the plant or by any processing personnel.

VII. CLEANING AND SANITIZING:

A. Cleaning:

"Cleaning" is a basic and important part of the operation and the starting point for adequate sanitation practices. Cleaning is the process of removing soil, organic particles, debris, and the vast number of organisms which usually accompany such materials. "Sanitizing", discussed under C., below, can be effective only after cleaning has been correctly accomplished. Basic steps in cleaning are as follows:

1. Remove all solid debris and other items which would interfere with complete cleaning.

2. Rinse walls, floors, equipment, utensils with potable water.

3. Apply a suitable food plant detergent to all surfaces.

4. Rinse with 120-140°F water before applying sanitizing solution. (High pressure hosing devices, some capable of introducing detergents on demand will facilitate application of cleaning agents and adequate rinsing.)

5. Debris should be removed promptly while plant is in operation, and every particle of solid waste should be completely removed at end of operating day. Water connections, hoses, and hose racks assigned to each area should be strategically located for convenient use.

6. Facilities should be provided for the cleaning, draining and sanitizing of utensils, waste containers, and small equipment. For every 30 pickers a two-compartment sink of adequate size with hot and cold running water piped to each compartment, located in the picking room should be provided. Draining racks that enable complete runoff of water before sanitizing should be provided. At the end of operating day, all utensils and equipment should be thoroughly cleaned. It is advisable to institute additional cleaning procedures during lunch hour, including cleaning the picking tables and meat handling surfaces in the packing room.

B. Handwashing Facilities and Supplies:

Supplies of soap and single-service towels and protected dispensers should be available near the lavatory. (Other sanitary drying devices if approved by the Division of Health Services are also acceptable.) Adjacent to the lavatories, a container of suitable construction should be provided for the sole purpose of sanitizing the hands in an approved solution of adequate strength, 100 parts per million of available chlorine or its bactericidal equivalent.

C. Sanitizing:

Sanitizing refers to the effective bactericidal treatment of clean surfaces of equipment and utensils by a process which has been approved by the Divi-

sion of Health Services and is effective in destroying vegetative cells of pathogenic bacteria and in substantially reducing other microorganisms. Such treatment should not adversely affect the product and should be safe for the consumer.

All food-contact surfaces should be treated by one or both of the following methods:

1. Employ clean water at 170°F for 15 minutes, or a steam cabinet, 200°F at coldest point and exposure for 5 minutes.

2. Immersion or exposure for at least 1 minute to a solution maintained at not less than 100 parts per million of free chlorine or its equivalent. All food-contact surfaces must be wetted by the bactericidal solution, and piping so treated must be filled. Bactericidal sprays containing not less than 200 parts per million of free chlorine or its equivalent may be used for large equipment. Bactericidal treatment with chemicals is not effective unless the surface has been thoroughly cleaned.

3. Bactericides approved by the Division of Health Services should be employed in connection with crab plant sanitation.

VIII. QUALITY CONTROL:

This section is concerned with methods of controlling quality and producing highly acceptable products. Effective management must include a definite assignment of responsibility for quality control if crab meats are to meet state, interstate, and consumer requirements.

A. Daily Quality Control Checklist:

The plant manager, or a designated quality control inspector, should employ the following checklist concerning the plant operation, making sure that basic requirements are met each production day:

1. Grounds and Buildings:

   Grounds in good condition ( ), free of debris ( ), and animal, rodent and pest control measures in force ( ). Good housekeeping throughout building ( ).

2. Solid Waste Handling:

   Receptacles emptied frequently ( ), cleaned and sanitized daily ( ); solid waste conveyor clean and in good repair ( ), cleaned and sanitized after each use ( ); exit barrier sealed when not operating ( ); outside storage facilities emptied and cleaned each day ( ).

3. Cleaning and Sanitizing:

   Walls, floors, equipment washed with detergent and rinsed following approved schedules ( ), debris removed while plant in operation ( ),

surfaces sanitized according to correct schedules and levels of sanitizing agents ( ), hoses and other cleaning equipment at correct locations and ready to use ( ).

4. Water and Ice:

Water supply adequate ( ). Ice bins clean and drains working ( ), block ice washed before crushing ( ), containers and shovels cleaned each day and protected from contamination ( ).

5. Personnel:

Only healthy personnel allowed in plant ( ), bandages, rags, or paper on hands, knives or tables not permitted ( ), tobacco and food prohibited in picking and packing areas ( ), suitable clothes, aprons, hairnets or hats ( ), hands washed and sanitized as specified ( ), fingernails short and clean, no ornate rings ( ), single use hand paper towels provided each picker ( ), unauthorized personnel not allowed in processing area ( ). Rest room facilities clean ( ), toilet tissue on hangers ( ), and exhaust fans operating ( ).

6. Unit Operations, Times and Temperatures:

a. Receiving Raw Crabs:

Practically all legal size and alive ( ), placed in clean retort baskets and cooked with minimum delay ( ), or if delay in cooking, held in raw crab cooler @ 50°F - 60°F ( ).

b. Cooking Crabs:

Fan removing steam from room ( ), door between raw and cooked crab handling areas kept closed ( ), foot bath maintained ( ), boiler pressure 45 to 100 psig during cook ( ). Retort: time-temperature device working ( ), indicating thermometer working ( ), safety valve operational ( ), adequate venting top and bottom, remaining open during cook ( ), internal temperature centermost crab reaching 235°F ( ), maximum temperature registering thermometer working ( ), correct pressure maintained ( ), cook accurately timed ( ), pressure indicator working ( ), hoist chain does not contact product ( ).

c. Cooling Cooked Crabs:

Cooked crabs retained in same baskets and moved immediately to air cooling room ( ), protected from contamination ( ), air cooled in 30 minutes or minimum time required to reach ambient temperature ( ), transferred to refrigerated room held at 33°F- 40°F ( ), thermometer checked for accuracy ( ), condensate dripping avoided ( ), holding less than 24 hours before picking ( ).

d. Picking and Packing:

Each picker has adequate work space ( ), all crabs picked before

new supply delivered ( ), crabs remain on table for short time ( ), room as cool as practical ( ), and air being filtered ( ).

Meat fits label description and mostly free of shell ( ), free of foreign matter ( ), weights within tolerances ( ).

Single-service containers stored and handled correctly ( ), sanitized and completely drained before using ( ), correctly marked with name of packer, location, certificate number, and code showing date of manufacture ( ), clean master cartons ( ).

Crab meat packed in ice immediately ( ), cooler temperature 33 °F to 40°F, thermometer checked for accuracy ( ). Freezing: Crab meat frozen within 24 hours after picking ( ).

e. Pasteurizing:

Meat pasteurized within 24 hours of picking ( ), heating schedule achieves internal temperature of at least 185°F for 1 minute ( ), standardization schedule on file ( ).

Constant flow steam control valve operational ( ), water bath not overloaded ( ), containers immersed 6" below surface of water, minimum of 3" clearance on sides and 2" on bottom ( ).

Indicating and time-temperature recording thermometers operating ( ), new chart each day filed at end of day ( ), date, quantity each batch, code of each pack, notations concerning processing interruptions, reading of indicating thermometer and time of reading noted on chart ( ).

Meat chilled to 100°F within 50 minutes of processing ( ), placed under refrigerated storage, temperature maintained at over 32°F, under 36°F ( ).

Code applied to each can to indicate batch and day of processing ( ), and label prominently states, "Perishable--Keep Under Refrigeration ( ).

B. Product Quality - Visual and Organoleptic Examination:

The plant manager, or designated quality control inspector, should routinely pour contents of selected cans into a sanitized tray, making sure that style of crab meat conforms with label, checking for shell or foreign matter (preferably under ultraviolet light) and evaluating for texture, appearance and aroma. Flavor checks should be made at least once per day. Such examinations should be made in order to judge performance of personnel, since carelessness of a single picker may result in rejected shipments.

The following sections, taken from "Proposed United States Standard for Grades of Chilled Cooked Blue Crab Meat" (April 12, 1971), provide guidance in conducting visual and organoleptic examinations:

1. Styles:

   a. Lump and Jumbo Lump - All meat from body portion adjacent to backfin appendage. Lump - 1/15 oz. per portion; Jumbo Lump - 1/7 oz. per portion.

   b. Flake - Meat from body portions normally containing no lumps.

   c. Mixed - Mixture of lumps and flakes, lumps weighing at least 1/15 oz. per portion.

   d. Claw - All meat from claws.

   e. Formed Products - Any comminuted or minced meat, pressed or formed into larger pieces to simulate lump or jumbo lump cannot be graded under this standard.

2. Grades:

   a. "U. S. Grade A" is that quality of chilled cooked blue crab meat that possesses a good flavor and odor and is reasonably free of minor defects in accordance with Table I of the Standard.

   b. "U. S. Grade B" is that quality of chilled cooked blue crab meat that possesses reasonably good flavor and odor and is reasonably free from major defects in accordance with Table I of the Standard.

   c. "Substandard" is that quality of chilled, cooked blue crab meat that meets the product description but fails to meet the requirements of "U. S. Grade B".

3. Determination of the Grade:

   The grade is determined by examining the product in accordance with the schedule of defects (Table I). Blue crab meat with minor defects is acceptable for "Grade A", blue crab meat with major defects for "Grade B", and blue crab meat with severe defects for "Substandard". In addition, blue crab meat with 4 or more "Grade A" minor defects shall be reduced to "Grade B", and blue crab meat with 4 or more "Grade B" defects shall be reduced to "Substandard".

4. Quality Factors:

   a. Appearance of Surface - The surface shall have a pleasing appearance.

   b. Color - Refers to reasonably uniform color characteristic of the species utilized.

      1. Gray Discoloration - Such as that which occurs from exposure of meat to elevated temperatures.

      2. Blue Discoloration - Throughout the meat, blue gray to light

blue.

c. Conformity to Style - Refers to conforming in all respects to indicated style.

d. Normal - Refers to a condition that conforms to the usual, regular, or accepted characteristic of chilled cooked blue crab meat.

e. Significant - Refers to a condition which is noticeable, easily seen, and obvious.

f. Slight - Refers to a condition which is scarcely noticeable, but does not affect the appearance, desirability, and/or eating quality of the blue crab meat.

g. Moderate - Refers to a condition that is conspicuously noticeable but that does not seriously affect the appearance, desirability and/or eating quality of the blue crab meat.

h. Excessive - Refers to a condition that is conspecuously noticeable and that does seriously affect the appearance, desirability, and/or eating quality of the blue crab meat.

i. Texture - Refers to the delicate characteristic texture of properly cooked crab meat.

j. Good Flavor and Odor - (Essential requirements for "Grade A") Means that the product has a typical flavor and odor of the species and is free of bitterness, staleness and off flavors and off odors of any kind.

k. Reasonably Good Flavor and Odor - (Minimum requirements for "Grade B") Means that the product may be lacking in good flavor and odor but is free from objectionalbe off flavors and off odors of any kind.

l. Shell - Refers to any part of the exoskeleton.

m. Cartilage - Refers to a tough, transparent, elastic tissue.

n. Extraneous Material - Refers to pieces or fragments of undesirable material that is not a natural part of the body meat and cartilage or exoskeleton of the blue crab.

PROPOSED UNITED STATES STANDARD FOR GRADES OF CHILLED COOKED BLUE CRAB MEAT
April 12, 1971

BLUE CRAB MEAT TABLE I

Quality Factors	Grade A	Grade B	Substandard
Occurrences	3 or less minor defects	3 or less major defects	1 or more severe defects
Appearance of the surface	Reasonably well packed	Poorly arranged	Excessive slackfill
Discoloration of meat	Significant intensity involving up to 10% of the product	Significant intensity involving more than 10% but less than 50% of product	Significant intensity involving over 50% of the product
Conformity to style	Up to 5% variation from indicated style	Up to 10% variation from indicated style	Over 10% variation from indicated style
Texture	Slight variation from characteristic texture	Stringy, tough, significantly mushy or wet	Excessively soft, mushy, tough, or stringy
Shell and Cartilage fragments	Less than 3 grams	Less than 6 grams	Greater than 6 grams
Extraneous material	Gills (fingers) seaweed, etc. 1 per pound; sand, grit, etc., not noticeable	2 or 3 per pound moderately evident	More than 3 per pound excessively present

Four or more minor defects as listed reduce product to Grade B.
Four or more major defects as listed reduce product to Substandard.

C. Product Quality - Employing Laboratory Methods

Up to this point our discussion of quality control methods has been limited to what can be accomplished with in-plant checks, and visual or organoleptic methods. Such approaches can assist a great deal in achieving uniformly good product quality. However, definitive laboratory support is needed in checking for safety, or the possibility of incipient spoilage. Methods for microbiological examination of foods, applicable to crab meats, include determining plate counts and checking for pathogens and indicator organisms of public health significance. Indirect microbiological methods for estimating bacterial numbers may include methylene blue and resazurin reduction tests. Chemical methods of judging freshness are based on the varied degradation products generated as spoilage progresses. The chemical indices of freshness, indicated below, are often determined as being in the normal range for fresh crab meat even though product quality has not remained at a high level. On the other hand, if such parameters fall outside of normal limits, it can be assumed that the crab meat is definitely suspect.

1. Microbiological Methods:

According to the May, 1974 Regulations issued by the N. C. Division of Health Services, fresh-cooked crab meat should not contain more than 36 E. coli MPN per 100 grams, and/or have a standard plate count of more than 100,000 bacteria per gram. Pasteurized crab meat should contain no E. coli or fecal coliform. Samples of pasteurized crab meat taken within 24 hours of processing should not have a standard plate count of more than 3,000 bacteria per gram. Crab meat should not contain pathogenic organisms (Salmonella, Cl. perfringens, Cl. botulinum, Staphylococcus, Vibrio parahaemolyticus).

2. Indirect Microbiological Method:

Resazurin Test (Seafood Laboratory Modified Method) appears effective in detecting bad crab meat. When applied to fresh crab meats, the results do not always correlate well with total plate counts.

3. Chemical Methods:

Such paramaters as pH, Nessler reaction, total volatile base and level of hydrogen sulfide are useful indicators of spoilage. These and other tests can be employed when raw materials and processing conditions are relatively uniform. Then it is possible to establish normal ranges, based on chemical tests, and detect onset of spoilage as the values begin to change, i.e., increase in pH, ammonia, volatile basic nitrogen compounds, or hydrogen sulfide.

IX. N. C. S. U. BLUE CRAB RESEARCH:

The seafood program of Department of Food Science is conducted jointly by extension and research personnel located on campus in Raleigh, and in the N. C. Division of Commercial and Sports Fisheries Building in Morehead City. Appreciable blue crab research has been conducted by the Department in recent years.

A successful research program depends upon contact with industry as well as effective laboratory personnel. N. C. S. U. Agricultural Extension Service and Sea Grant Advisory Service provide the function of working with industry, at the same time keeping the research staff informed of urgent industry needs.

Major areas of blue crab research, currently under investigation are:

A. Keeping Crustaceans Alive:

Studies have been conducted on lobsters and Jonah Crabs caught at 100 fathom depths, and red crabs caught at 300 fathoms. Such crustaceans, as well as blue crabs, suffer appreciable mortality in handling out of water, even under conditions of temperature and humidity thought to offer the best chance of survival.

A study initiated in 1974 has investigated the chance of survival of blue crabs during over-the-road shipments. The results and recomendations are forthcoming in a November 1974 publication.

B. Proteolytic Activity in Crab Meat:

Crab meat undergoes changes which eventually make it unsuitable for consumption. Bacterial population measurements assist in predicting how long the product will remain acceptable. Certain important changes may result from enzyme systems which occur naturally in crab meat. Enzymatic action contributes to low yields and mushy texture. Proteolytic enzymes occur in the living animal. Activity is reduced by selecting the best processing condition for inactivation. Current research is aimed at measuring activity of certain enzyme systems in crab meats after processing by various methods.

C. Sanitation Studies:

A paper presented by Webb, et al, (1973) was abstracted as follows:

"The seafood industry needs additional effort on the control of microorganisms. During the processing of crab meat, there is a possibility that large numbers of bacteria may be brought into the plant on the raw product and by the workers. Also, a serious increase in bacteria can occur if adequate sanitary practices are not used throughout the plant. This laboratory has previously made studies on the level and types of microorganisms occurring in commercial crab meat. However, a detailed study of in-plant levels needs to be accomplished. Once the levels have been established and problem areas identified, methods of control can be

defined.

This investigation involved the examination of microbial levels and appraisals of in-plant sanitation conditions at various points in the plant throughout the processing cycle. The object of this study was to establish levels of microbial organisms found in the finished product and throughout the processing operation".

D. Crab Meat Shelf Life:

Webb, Thomas, Busta and Kerr(1972) described use of the Resazurin reduction technique as a partial check of meat quality in connection with shucking of scallops. During 1973 the laboratory undertook to refine the method by employing a spectrophotometer as a means of detecting an early color change in the dye, thereby reaching an endpoint in about one-half the time.

The modified method was tried on crab meat samples obtained from a selected group of plants. This determination, along with total plate counts and sensory ratings, was applied to the samples after one (1) and eight (8) days storage at $34^{\circ}F$.

These initial studies indicate the possibility that field equipment for conducting this test can be taken to the crab plants for checking large numbers of production samples within a few hours. It is hoped that this will provide assistance in predicting the shelf life of crab meats which in turn may be related to management compliance with good manufacturing practices.

E. Processing Losses:

These studies were directed at measuring protein and other substances lost from crabs in normal processing. Measuring gallons of effluents coming from the plants together with such parameters as organic loading, BOD, COD, and other values, then makes it possible to assess environmental effects, and pollution control requirements.

The study produced quantitative estimates concerning relationship of solids losses to method of processing and to meat yields. A practical result is that eventual modifications in the cooking cycle may produce economic benefits for the plant operators.

F. Miscellaneous:

Only a limited number of key projects can be conducted each year. Initiation of new ones is based on estimates of importance to the industry. The modified air cooling system for cooked crabs shown in Fig.4 results from concepts of what is needed to eliminate certain important

sources of contamination. A further refinement in this air cooling system may be the spraying of water or steam into the airstream as a means of providing evaporative cooling. Later, injection of chlorine solution into such sprays may be recommended as a means of sanitizing the surfaces of cooked crabs and baskets. The carrying out of studies needed to confirm these ideas must await the building of the first cooling room, constructed as recommended.

In another category, considerable work has involved further processing of crab meat, ie, its use in various products. There is continuing effort directed at improving freezing techniques. The use of crab meat in precooked products which are then frozen in boil-in bags for later use, has produced promising results. Finally, preliminary work has been directed at use of mechanically deboned finfish meats as possible extenders for crab meat. This may make it possible to reduce the cost of the prepared products sold to the consumer and thereby increase the demand and consumption of the crab meat component.

APPENDIX A.

Partial Equipment List for Prototype Plant

	Estimated Costs[a]		
	New		Used or Homemade
Air Conditioning (20,000 cu. ft.) 20-Ton	10,000		
Air Curtains (1) at each access - 4 units		(4)	160
Aprons: White Plastic - 6 dozen @ 1.00	72		
Boiler: Oil Fired 30 HP	4,000		3,000
Cans: (32 Gal.) 36 @ 2.20	79.20		
Conveyor for Solid Waste			600
Dollies: 2' x 6' ea.			150
Fans: Exhaust: Rest rooms (2)		(2)	280
Fan: For Cooked Crab Cooling	1,200		
Heating: (20,000 cu. ft.) 250,000 BTU Oil Fired	2,000		
Heater: Hot Water	100		
Hoist: 1-Ton	350		
Ice Machine: 1-Ton Unit	4,800		
Knives - Crab: 6 doz. @ 1.75	126		
Pasteurizer: 2' x 2' x 3' (2)	3-4,000	(2)	800
Retort: Horizontal: 3'-3" x 3'-9" x 8' internal	5,000		1-2,000
Retort Basket: Horizontal for above (10 required)	8,000	(10)	5,000
Retort: Vertical 41" dia. x 72" height			1,700
Retort: Vertical baskets for above (30 required)			4,500
Refrigeration: Cooling rooms			
(3) 5 HP Com. Units	4,290		
(6) 2½ Ton blowers	5,430		
Scales: 1 lb. x-act weight (2)	(2) 4-600		
1,000 lb. x-act weight	500		
Sealer: Can (Most sealers are furnished by Can Co. on rental basis depending on amount of cans used)	420		
Sealer: Heat	40		
Sink: Double Compartment (2)		(2)	600
Sink: Hand (3)		(3)	120
Shovels: s-steel + aluminum 3 @ 35.00	105		
Water Supply, Well of Approved Type or	2,500		
Water Supply, City, Installation Cost	1,500		

[a]1973 Prices

APPENDIX B.

PLANT EVALUATION CHECKLIST

Page	Section	Subject
5	II. C.	MANAGEMENT: Responsibilities properly supervised ( )
5	II. D.	OSHA: Requirements being met ( )
8	III. A. 1.	BOILER: Correctly sized ( ) Pressure maintained ( ) Correct size steam line ( )
8	III. A. 2.	CONTAINERS, SINGLE SERVICE: Stored correctly ( )
8	III. A. 3.	CONVEYOR FOR SOLID WASTE: Clean and good repair ( ) Exit opening sealed when not operating ( )
8	III. A. 4.	COOKING ROOM: Air vent fan ( ) Raw and cooked crab areas physically separated ( ) Foot bath ( ) Hoist chain doesn't contact product ( )
9	III. A. 5.	COOLING ROOMS: Provides crabs with adequate protection from contamination ( ) Air drawn from above roof through filter ( ) Exhausted at side through screened opening ( ) Refrigerated room equipped to minimize condensate ( )
9	III. A. 6.	ELECTRICAL SERVICE: Complies with existing codes ( ) Switch boxes and exposed wiring outside of processing areas ( )
9	III. A. 7.	FLOORS: Smooth, impervious, easily cleaned ( ) Adequate drainage ( ) Joints coved between floors and walls ( )
9	III. A. 8.	HANDWASHING FACILITIES: Number and location of lavatories complies with state requirements ( )
11	III. A. 9.	HEATING, COOLING AND VENTILATION: Heating and cooling adequate ( ) Air filtered ( ) Slight positive pressure in critical areas ( ) Rest rooms have fans exhausting to outer air ( )
11	III. A. 10.	LIGHTING: Adequate lighting for requirements of specific areas ( )
12	III. A. 11.	PICKING AND PACKING ROOMS: Adequate working space ( ) Adequate facilities for cleaning and sanitizing ( ) Suitable delivery window shelf ( ) Suitable product handling counter ( ) Food plant type lubricant in sealer ( )
12	III. A. 12.	PLANT LAYOUT: Production areas properly separated ( ) and Designed for continuous flow ( )

Page	Section	Subject
12	III. A. 13.	PLANT LOCATION: Surrounding area free of piled materials or trash ( ) Free from depressions ( ) Elevated 2 ft. above mean high water level ( )
12	III. A. 14.	PLUMBING: Complies with State and local ordinances ( ) No connections permitting back siphonage ( )
13	III. A. 15.	REFRIGERATION, MECHANICAL: Mechanical refrigeration capacity adequate ( )
13	III. A. 16.	REFRIGERATION ROOMS: Sanitary construction ( ) Well drained ( ) Adequate product and ice storage ( ) Thermometer ( )
13	III. A. 17.	RETORTS: Time-temperature device ( ) Indicating thermometer ( ) Pressure indicator ( ) Safety valve ( ) Adequate venting ( ) Baskets stainless steel or equivalent ( ) Allow correct steam disbursement ( )
14	III. A. 18.	REST ROOM FACILITIES: Good repair ( ) Comply with State laws ( )
14	III. A. 19.	ROOM REQUIREMENTS SUMMARIZED: Rooms separated as specified in text ( )
15	III. A. 20.	SPACE REQUIREMENTS: Adequate for all routine operations ( ) and for Cleaning and sanitizing ( )
15	III. A. 21.	UTENSILS AND EQUIPMENT COMPOSITION: Working surfaces suitable for food handling ( ) Non-toxic ( )
15	III. A. 22.	WALLS, CEILINGS, WINDOWS, DOORS: Clean, bright and impervious ( ) Well fitted, free from cracks ( ) Screened where necessary ( )
15	III. B. 1.	ANIMAL CONTROL MEASURES: No animals in or near plant ( )
16	III. B. 2.	CONDENSATE: Eliminated from critical areas ( )
16	III. B. 3.	ICE: Sanitary ( ) Bins smooth, impervious, well drained ( ) Containers and shovels sanitary construction, correctly stored ( )
16	III. B. 4.	RODENT AND PEST CONTROL: Breeding places eliminated ( ) No points of entry ( ) Rodenticides stored outside of plant ( ) Only registered pesticides used ( )
17	III. B. 5.	SEWAGE DISPOSAL: Discharge to public sewers ( ) Private facilities comply with State and local requirements ( ) Disposal of liquid wastes avoids nuisance or degraded water quality standards (
17	III. B. 6.	WASTE HANDLING: Adequate transferring and storing equipment provided ( ) Protected from vermin ( )
17	III. B. 7.	WATER: Adequate supply ( ) Maximum and minimum temperatures maintained ( ) Potable ( )

Page	Section	Subject
19	III. C. 4.	PASTEURIZATION: Recording thermometer operational ( ) Indicating thermometer checked for accuracy ( ) Constant flow steam control valve in good condition ( )

APPENDIX C.

TEMPERATURE OF SATURATED STEAM

Gauge Pressure (lbs/in^2)	Temperature (^oF)
0	212.0
1	215.4
2	218.5
3	221.5
4	224.4
5	227.1
6	229.6
7	232.3
8	234.7
9	237.0
10	239.4
11	241.5
12	243.7
13	245.8
14	247.8
15	249.8
16	251.6
17	253.4
18	255.4
19	257.0
20	258.8
21	260.4
22	262.0

Zero gauge pressure corresponds to an absolute pressure of 14.696 pounds per square inch.

SELECTING THERMOMETERS

It has been suggested by a representative of a thermometer manufacturer that instruments containing mercury, as the means of actuation, not be permitted at any point in the process. Equally important is avoiding those instruments actuated by means of other toxic substances. Investigation of what is practical to provide under these limitations, is now underway.

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