

**GENERIC HACCP MODEL
FOR**

**Heat Treated Not Fully Cooked, Not
Shelf-Stable**

**Developed:
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Kansas City, MO**

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Introduction:

Hazard Analysis Critical Control Point (HACCP) is a systematic, scientific approach to process control. It is designed to prevent the occurrence of problems by ensuring that controls are applied at any point in a food production system where hazardous or critical situations could occur. Hazards can include biological, chemical or physical contamination of food products.

The United States Department of Agriculture (USDA) published a final rule in July 1996 mandating that HACCP be implemented as the system of process control in all USDA inspected meat and poultry plants. As part of its effort to assist establishments in the preparation of plant-specific HACCP plans, FSIS determined that a generic model for each process defined in the regulation will be made available for use by the industry.

In May 1996, the U.S. Department of Agriculture (USDA) Food Safety and Inspection Service (FSIS) awarded Contract Number 53-3A94-6-04 to the International Meat and Poultry HACCP Alliance for the development of ten generic HACCP models. The ten models developed were:

1. Not Heat Treated, Shelf-Stable (dried products, those controlled by water activity, pH, freeze dried, dehydrated, etc.)
2. Heat Treated, Shelf-Stable (rendered products, lard, etc.)
3. Heat Treated Not Fully Cooked, Not Shelf-Stable (ready to cook poultry, cold smoked and products smoked for trichinae, partially cooked battered, breaded, char-marked, batter set, and low temperature rendered products, etc.)
4. Products with Secondary Inhibitors, Not Shelf-Stable (products that are fermented, dried, salted, brine treated, etc., but are not shelf-stable)
5. Irradiation (includes all forms of approved irradiation procedures for poultry and pork)
6. Fully Cooked, Not Shelf Stable (products which have received a lethal kill step through a heating process, but must be kept refrigerated. This includes products such as fully cooked hams, cooked beef, roast beef, etc.)
7. Beef Slaughter
8. Pork Slaughter
9. Poultry Slaughter
10. Raw Products - not ground (all raw products which are not ground in their final form. This includes beef trimmings, tenderized cuts, steaks, roasts, chops, poultry parts, etc.)

USDA developed three additional models:

1. Raw, Ground
2. Thermally Processed/Commercially Sterile
3. Mechanically Separated Species/Deboned Poultry

This document contains the generic HACCP model for the process category titled: **Heat Treated Not Fully Cooked, Not Shelf-Stable.**

In order to develop this model, a literature review and an epidemiological assessment of the products selected were performed to present an overview of the microbiological characteristics and profile of the product. This information then was reviewed by a team of industry, academic, public health officials,

and consumer representatives. The team met in a workshop in Kansas City, MO on June 26-28, 1996. Subsequent to the workshop, this generic HACCP model was reviewed by small business establishments for clarity and usability, and it was submitted to an expert peer review panel for technical review.

Generic HACCP plans serve as useful guidelines; however, it is impossible for a generic model for to be developed without it being too general. Therefore, it is incumbent on each plant's HACCP Team to tailor this model to fit products in each plant, based on the knowledge about the process. Several points should be considered when using this model to develop specific HACCP plans.

All plants shall have Sanitation Standard Operating Procedures (SSOPs). Good Manufacturing Practices (GMPs) (FDA, 21 CFR 110; Appendix 1) and Standard Operating Procedures (SOPs) may be in place as the foundation of the HACCP program. Good Manufacturing Practices are minimum sanitary and processing requirements applicable to all companies processing food. Standard Operating Procedures (SOPs) are step-by-step directions for completing important plant procedures. SOPs should specifically describe the method for conducting and controlling the procedure. SOPs should be evaluated regularly (i.e., daily) to confirm proper and consistent application, and modified as necessary to ensure control.

Each generic model can be used as a starting point for the development of your plant-specific plan reflecting your plant environment and the specific processes conducted. The generic model is not intended to be used "as is" for your plant-specific HACCP plans.

The generic models designed for use in developing a plant-specific HACCP plan are defined according to process category. In order to select the model or models that will be most useful for the activities performed in your plant, the following steps should be taken.

If a model for a slaughter operation is required, select the model for the appropriate species. If a model for a processed product or products is required, make a list of all products produced in the plant. Examine the list and group all like products according to common processing steps and equipment used. Compare these to the list of Process Models in Appendix 1. After reviewing and grouping the products produced, you will know the number of models that are needed to assist in developing your plant-specific plans.

If an establishment is a combination plant, i.e. conducting both slaughter and processing activities, the two models can be merged into a plant-specific plan. In this case, over-lapping critical control points (CCPs) can be combined as long as all significant hazards are addressed.

Seven Principles of HACCP:

The following seven principles of HACCP were adopted by the National Advisory Committee on Microbiological Criteria of Foods (NACMCF, 1992):

1. Conduct a hazard analysis. Prepare a list of steps in the process where significant hazards occur and describe the preventive measures.

Three types of hazards:

Biological (B)— primarily concerned with pathogenic bacteria, such as *Salmonella*, *Staphylococcus aureus*, *Campylobacter jejuni*, *Clostridium perfringens*, *Clostridium botulinum*, *Listeria monocytogenes*, and *Escherichia coli* O157:H7; also should consider *Trichinella spiralis*, and other parasites, as well as potential pathological concerns.

Chemical (C)— toxic substances or compounds that may be unsafe for consumption; i.e., cleaners, sanitizers, pesticides, insecticides, rodenticides, paint, lubricants, etc.

Physical (P)— foreign objects which may injure the consumer; i.e., rocks, stones, wood, metal, glass, nuts, bolts, screws, plastic, knife blades, etc.

2. Identify the critical control points (CCPs) in the process. A critical control point is defined as a point, step or procedure at which control can be applied and a food safety hazard can be prevented, eliminated or reduced to an acceptable level.
3. Establish critical limits for preventive measures associated with each identified CCP. A critical limit is defined as a criterion that must be met for each preventive measure associated with a CCP. Each CCP will have one or more preventive measures that must be properly controlled to assure prevention, elimination or reduction of hazards to acceptable levels. Each preventive measure has associated with it critical limits that serve as boundaries of safety for each CCP.
4. Establish CCP monitoring requirements. Establish procedures for using the results of monitoring to adjust the process and maintain control.
5. Establish corrective action(s) to be taken when monitoring indicates that there is a deviation from an established critical limit.
6. Establish effective record-keeping procedures that document the HACCP system.
7. Establish procedures for verification that the HACCP system is working correctly.

Specifics about this Generic Model:

1. Products Included In This Model. This model deals only with the **PROCESS CATEGORY, Heat Treated Not Fully Cooked, Not Shelf-Stable**. This product examples include partially cooked poultry and smoked sausage.
2. Items Addressed. This model does not address certain aspects of product safety, such as Sanitation Standard Operating Procedures (SSOPs). Good Manufacturing Practices (GMPs) and Standard Operating Procedures (SOPs) may be in place as the foundation of HACCP.
3. Critical Control Points. The Critical Control Points in this model were established by the team members of the workshop. Some products or processes may require fewer or more CCPs depending on the individual operation.
4. Product Flow. In the product flow, the general processes were included; however, order of flow varies. The product flow of every HACCP plan should be specific and accurately reflect the processes involved at each plant.
5. Safety vs. Quality. Several parameters have been discussed to ensure a safe product. Only parameters relating to product safety were discussed. Quality issues were not addressed in this model.
6. Critical Limits. Critical limits selected must be based on the best information available to provide a safe product and yet be realistic and attainable. Processors must keep in mind that any product which does not meet a critical limit must have a Corrective Action taken on the product before being released from the plant.
7. Process Authority. Reference may have been made about a “Process Authority” in this model. A Process Authority may be an in-plant employee who has had specialized training, an outside consultant, or other professional.

8. Record-keeping. Record-keeping is an important part of the HACCP plan. Lack of accurate, current records may be cause for withholding or suspending inspection from a plant.
9. Chain of Custody. Chain of custody refers to the point at which a plant gains control of the meat. This is particularly important to know the history of incoming meat products. Requiring a HACCP plan from the supplier will in effect, extend the chain of custody to the supplier.
10. Sampling Procedures. Each plant must establish a sampling plan to verify critical control points (biological, chemical and physical) in the operation. The procedures will be based on prior knowledge about the problem areas and not necessarily on random testing. A Process Authority may help establish these sampling procedures which are most likely to identify a problem if it exists.

USING THIS GENERIC MODEL TO DEVELOP AND IMPLEMENT A HACCP PROGRAM

Getting Started: The plant should establish a HACCP team which includes at least one HACCP trained individual, and then develop a flow chart for each product (or process category). In addition, a training program should be completed for all employees. It is important for all employees to have ownership in the HACCP plan and to participate in its development as appropriate. It also is important that the employees be given the authority to stop production if the process becomes out of control. This empowerment is critical to make the HACCP program a successful one. Once HACCP is established, it must be continually evaluated, upgraded, and modified. Experience in working a HACCP plan will be helpful in continual improvement in the plan. In effect, the HACCP program is a long-term commitment to improving the safety of the product by controlling the process.

The NACMCF has 12 steps (five preliminary steps listed below and the seven principles previously listed) in developing a HACCP plan.

PRELIMINARY STEPS:

- 1) Assemble the HACCP team.
- 2) Describe the food and its method of distribution.
- 3) Identify the intended use and consumers of the food.
- 4) Develop a flow diagram which describes the process.
- 5) Verify the flow diagram.

Then apply the seven principles beginning with conducting a hazard analysis.

The following steps should be considered when developing an effective HACCP system.

Before developing the HACCP system it is important to ensure that an adequate sanitation system (sanitation standard operating procedures - SSOPs) is in place for compliance with FSIS regulation. GMPs and SOPs are also important because they establish basic operational parameters for the production of safe food.

Assembling the HACCP Team: An important step in developing a plan is to gain management commitment and assemble a HACCP team. Top management must be fully committed to product safety through HACCP to make the program effective. After commitment is obtained, the HACCP team should be assembled. The team should consist of individual(s) from all aspects of production and should include at least one HACCP trained individual.

Product Description. The description should include the products within the process, their distribution, intended use, and potential consumers. This step will help ensure that all areas of concern are addressed. If a particular area on the example form is not applicable to your process, then eliminate it from your description. The description for the **Heat Treated Not Fully Cooked, Not Shelf-Stable** is included in this model.

Flow Diagram. The HACCP team should develop and verify a flow diagram for production of the product(s). A simple flow diagram which includes every step of production is necessary. The flow diagram should be verified for accuracy and completeness by physically walking through each step in the diagram on the plant floor. The purpose of the flow diagram is to provide a clear, simple description of the steps in the process which are directly under the control of the facility. This model contains a generic flow diagram for **Heat Treated Not Fully Cooked, Not Shelf-Stable**.

Hazard Analysis. A hazard has been defined as any biological (B), chemical (C) or physical (P) property that may cause a food to be unsafe for human consumption. The hazard analysis is one of the

most critical steps in the development of a HACCP plan. The HACCP team must conduct a hazard analysis and identify steps in the process where significant hazards can occur. The significant hazards must be “of such a nature that their prevention, elimination, reduction or control to acceptable levels is essential to the production of safe food.” (NACMCF, 1992) The team should focus on risk and severity as criteria for determining whether a hazard is significant or not. Risk, as defined by the National Advisory Committee, is “likelihood of occurrence.” “The estimate of risk is usually based on a combination of experience, epidemiological data, and information in the technical literature.” (NACMCF, 1992). Severity is the potential magnitude of the consequences to the consumer if the hazard is not adequately controlled. Hazards that are not significant or not likely to occur will not require further consideration in the HACCP plan.

Appendix 3 provides a list of example food safety hazards as identified in the Pathogen Reduction; Hazard Analysis Critical Control Point (HACCP) Systems regulation (USDA, 1996).

The hazard analysis and identification of associated preventive measures accomplishes the following:

- Identifies hazards of significance and associated preventive measures.
- The analysis can be used to modify a process or product to further assure or improve food safety.
- The analysis provides a basis for determining CCPs, principle 2.

Critical Control Point (CCP): A CCP is any point, step, or procedure at which control can be applied so that a food safety hazard can be prevented, eliminated, reduced, or controlled to acceptable levels. Information developed during the hazard analysis should enable the HACCP team to identify which steps in the process are CCPs. A decision tree, such as the NACMCF Decision Tree (Appendix 4) may be useful in determining if a particular step is a CCP for an identified hazard.

The CCPs discussed in this generic model should be considered as examples. Different facilities preparing the same product can differ in the risk of hazards and the points, steps, or procedures which are considered CCPs. This can be due to differences in each facility layout, equipment, selection of ingredients, or the production process that is being used. Plant-specific HACCP plans may include additional or fewer CCPs than this model based on their individual process.

Critical Limit: A critical limit is a criterion that must be met for each preventive measure associated with a CCP. Therefore, there is a direct relationship between the CCP and its critical limits that serve as boundaries of safety. Critical limits may be derived from sources such as regulatory standards and guidelines, scientific literature, experimental studies, and advice from experts. The HACCP worksheet provided in this model summarizes the critical limits for each CCP. Critical limits must be based on the best information available at the time to provide a safe product and yet must be realistic and attainable. Establishments must keep in mind that any product which does not meet the critical limit must have a Corrective Action taken. Corrective actions may be as simple as re-processing or re-packaging or may require destroying the product.

Monitoring: Monitoring is a planned sequence of observations or measurements to assess whether a CCP is under control and produces an accurate record for future use in verification. Monitoring serves three purposes:

- 1) Monitoring is essential to food safety management in that it tracks the systems operation.
- 2) Monitoring is used to determine when there is a loss of control and a deviation occurs at a CCP, exceeding the critical limit. Corrective action must then be taken.
- 3) Monitoring provides written documentation for use in verifying the HACCP plan.

Because of the potential serious consequences of a critical defect, monitoring procedures must be effective. Continuous monitoring is possible with many types of equipment, and it should be used when possible.

Individuals monitoring CCPs must:

- 1) Be trained in the technique used to monitor each preventive measure;
- 2) Fully understand the purpose and importance of monitoring;
- 3) Have ready access to the monitoring activity;
- 4) Be unbiased in monitoring and reporting; and
- 5) Accurately report the monitoring activity.

All records associated with monitoring must be signed or initialed, dated, and the time recorded by the person conducting the monitoring activity.

Corrective Actions: Corrective actions are procedures to be followed when a deviation occurs. Because of variations in CCPs for different products and the diversity of possible deviations, specific corrective action plans must be developed for each CCP. The actions must demonstrate that the CCP has been brought under control and that the product is handled appropriately.

Record-Keeping: Record keeping is a critical aspect of the HACCP system. Records must be accurate and reflect the process, the deviations, the corrective actions, etc. Lack of accurate, current records may be cause for withholding or suspension of inspection from the plant.

It is also important that all HACCP records dealing with CCPs and corrective actions taken, be reviewed on a daily basis by an individual who did not produce the records and who has completed a course in HACCP, or the responsible establishment official who must sign or initial, date and record the time all records are reviewed. The HACCP plan and associated records must be on file at the meat and/or poultry establishment.

Example forms have been included in this model. It may be beneficial to combine forms as possible to reduce the amount of paperwork.

Verification: Verification consists of the use of methods, procedures or tests in addition to those used in monitoring to determine that the HACCP system is in compliance with the HACCP plan and whether the HACCP plan needs modification. There are three processes involved.

- 1) The scientific or technical process to verify that critical limits at CCPs are satisfactory — review of critical limits to verify that the limits are adequate to control hazards that are likely to occur.
- 2) Process verification to ensure that the facility's HACCP plan is functioning effectively.
- 3) Documented periodic reassessment, independent of quality audits or other verification procedures, that must be performed to ensure the accuracy of the HACCP plan.

Sanitation SOPs: According to USDA's Pathogen Reduction/HACCP regulation (USDA, 1996), effective establishment sanitation is essential for food safety and to successfully implement HACCP. There are direct and substantial links between inadequate sanitation and the contamination of meat and poultry products by pathogenic bacteria. Sanitation SOPs are necessary because they clearly define each establishment's responsibility to consistently follow effective sanitation procedures and substantially minimize the risk of direct product contamination and adulteration.

Microbial testing for indicator organisms can be used to validate CCP effectiveness, and to establish in-plant trend analysis. Microbial testing should be part of a sanitation program in order to validate effectiveness. Microbial testing does not indicate that the product is safe, but it is used to verify that the process was in control.

PROCESS CATEGORY DESCRIPTION

WORKSHOP LOCATION: Kansas City, Missouri

THE FOLLOWING QUESTIONS NEED TO BE ANSWERED WHEN DEVELOPING THE PRODUCT CATEGORY DESCRIPTION:

COMMON NAME: Partially Cooked Poultry

HOW IS IT TO BE USED?

Cook before serving.
Salads, entrees, nuggets, and snack foods

TYPE OF PACKAGE?

Bulk-non vacuum packaged
Vacuum packaged
Gas back flush - N₂, CO₂, O₂

LENGTH OF SHELF LIFE, AT WHAT TEMPERATURE?

Shelf-life will vary depending on type of package, temperature of storage, type of product and initial microbial load. For example: vacuum packaged product at 0°F may have a shelf-life of 3-6 months.

WHERE WILL IT BE SOLD?

Retail
Food Service

LABELING INSTRUCTIONS:

“Keep Frozen”

Cooking Instructions - Must cook to proper end-product temperature for specific product.

Instructions should include cooking temperature and time and/or end-point temperature.

Safe Food Handling Label

“Not Fully Cooked. Cook Before Serving.” statement on label

IS SPECIAL DISTRIBUTION CONTROL NEEDED?

Control temperature per labeling instructions - “Keep Frozen”

LIST PROCESS CATEGORIES AND INGREDIENTS

PRODUCT: Partially Cooked Poultry

WORKSHOP LOCATION: Kansas City, Missouri

MEAT/POULTRY AND BYPRODUCTS	NONMEAT FOOD INGREDIENTS	BINDERS/EXTENDERS
Raw Poultry Mechanically separated poultry Poultry skin	Lactose Dextrose Salt Sugar Corn Syrup Breeding	Milk proteins Non-fat dry milk Gums/Starches/Cereal extenders Whey Gelatin Hydrolyzed milk proteins Hydrolyzed vegetable proteins Soy proteins Textured Vegetable Proteins (TVP)
SPICES/FLAVORINGS	RESTRICTED INGREDIENTS	PRESERVATIVES/ACIDIFIERS
Paprika Spice extracts Liquid smoke Garlic Onion Protein flavors Natural spices	Nitrites/Nitrates Antioxidants Erythorbates/Ascorbates Sodium phosphates	Sodium or Potassium lactate Encapsulated acids citric acid lactic acid propionic acid acetic acid
OTHER	Packaging Materials	
Water/ice	Packaging materials approved for food products	

PROCESS CATEGORY DESCRIPTION

WORKSHOP LOCATION: Kansas City, Missouri

THE FOLLOWING QUESTIONS NEED TO BE ANSWERED WHEN DEVELOPING THE PRODUCT CATEGORY DESCRIPTION:

COMMON NAME: Smoked Sausage

HOW IS IT TO BE USED?

Cook before serving.

Salads, entrees, seasonings, and snack foods

TYPE OF PACKAGE?

Bulk-non vacuum packaged

Vacuum packaged

Gas back-flush (N₂, CO₂, O₂)

LENGTH OF SHELF LIFE, AT WHAT TEMPERATURE?

Shelf-life will vary depending on type of package, temperature of storage, type of product and initial microbial load. For example: vacuum packaged product at refrigeration temperatures ($\leq 40^{\circ}\text{F}$), may have a shelf-life of 15-20 days; vacuum packaged product at frozen storage (0°F) may have a shelf-life of 3-6 months.

WHERE WILL IT BE SOLD?

Retail

Food Service

Wholesale

LABELING INSTRUCTIONS:

“Keep Frozen” or “Keep Refrigerated”

Cooking Instructions - Must cook to proper end-product temperature for specific product.

Instructions should include cooking temperature and time and/or end-point temperature.

Safe Food Handling Label

“Not Fully Cooked. Cook Before Serving.” statement on label

IS SPECIAL DISTRIBUTION CONTROL NEEDED?

Control temperature per labeling instructions - “Keep Frozen” or “Keep Refrigerated.”

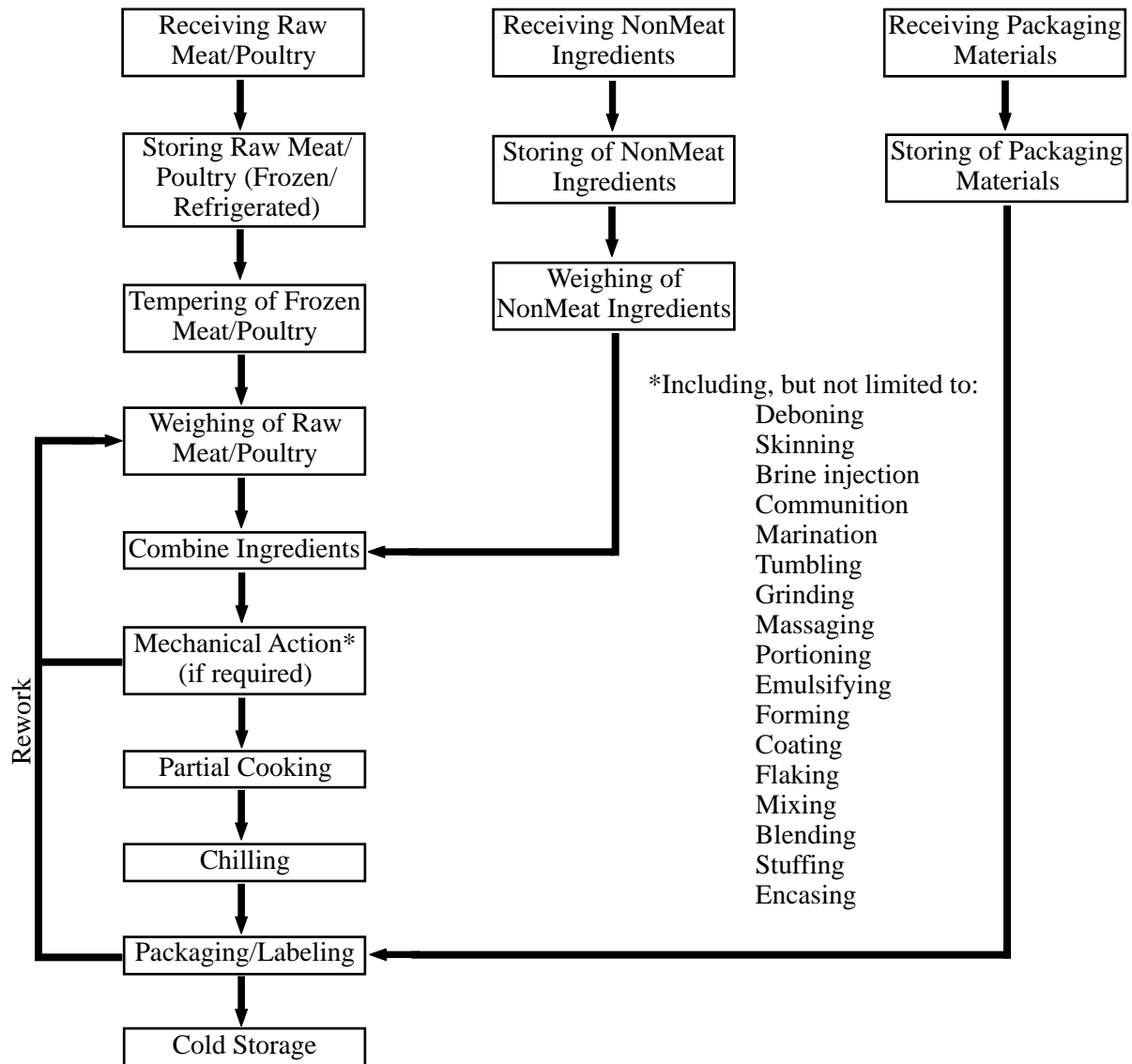
LIST PROCESS CATEGORIES AND INGREDIENTS

PRODUCT : Smoked Sausage

WORKSHOP LOCATION: Kansas City, Missouri

MEAT/POULTRY AND BYPRODUCTS	NONMEAT FOOD INGREDIENTS	BINDERS/EXTENDERS
Raw Meat Species (beef, pork, lamb) Raw Poultry Variety Meats Poultry Skin	Lactose Dextrose Salt Sugar Corn Syrup	Milk proteins Non-fat dry milk Gums/Starches/Cereal extenders Whey Gelatin Soy Protein Textured Vegetable Proteins (TVP) Hydrolyzed milk proteins Hydrolyzed vegetable proteins
SPICES/FLAVORINGS	RESTRICTED INGREDIENTS	PRESERVATIVES/ACIDIFIERS
Paprika Spice extracts Liquid smoke Garlic Onion Protein flavors Natural spices	Nitrites/Nitrates Antioxidants Erythorbates/Ascorbates Sodium phosphates	Sodium or Potassium lactate Encapsulated acids Citric acid Lactic acid Propionic acid Acetic acid
OTHER	PACKAGING MATERIAL	
Water/ice	Approved packaging materials	

Heat Treated Not Fully Cooked, Not Shelf-Stable



Hazard Analysis Worksheet:

The Hazard Analysis Worksheet format used in this model is an example format. The following forms are for the “Heat Treated Not Fully Cooked, Not Shelf-Stable” process. The two products (partially cooked poultry and smoked sausage) are both included in this process. Alternative forms can be used for the hazard analysis.

This worksheet should be used in two steps.

The first step, is to review each process step listed in the Process Flow Diagram and identify all potential hazards that can be introduced or enhanced at this step. Chemical, physical, and biological hazards should all be addressed. It is recommended that you list all potential hazards for each process step before moving to column two.

The second step, is to determine if the potential hazard is significant. The significant hazards must be “of such a nature that their prevention, elimination, reduction, or control to acceptable levels is essential to the production of safe food.” (NACMCF, 1992) The team should focus on risk and severity as criteria for determining whether a hazard is significant or not. Risk, as defined by the National Advisory Committee, is “likelihood of occurrence.” “The estimate of risk is usually based on a combination of experience, epidemiological data, and information in the technical literature.” (NACMCF, 1992). Severity is the potential magnitude of the consequences to the consumer if the hazard is not adequately controlled. Hazards that are not significant or not likely to occur will not require further consideration in the HACCP plan.

It is important that you justify your decision for determining if a hazard is or is not significant. This will help you document your rationale for making decisions and is a useful tool when you re-validate or revise your HACCP plan.

The fifth column, addresses preventive measures. For each significant hazard, identify preventive measures, if they exist. A preventive measure is a physical, chemical, or other means which can be used to control an identified food safety hazard.

It is recommended that you complete columns 1 through 5, before starting on column 6. Column six asks, “Is this step a critical control point (CCP)?” A CCP is any point, step, or procedure at which control can be applied so that a food safety hazard can be prevented, eliminated, reduced, or controlled to acceptable levels. Information developed during the hazard analysis should enable the HACCP team to identify which steps in the process are CCPs. A decision tree, such as the NACMCF Decision Tree (Appendix 4) may be useful in determining if a particular step is a CCP for an identified hazard. The hazards identified during the development of this model were subjected to a decision tree by the team members. CCPs must be carefully developed and documented and must be for product safety only. Different facilities preparing the same product can differ in the risk of hazards and the points, steps, or procedures which are CCPs.

The CCPs identified in this model are for illustrative purposes only. Individual plant process will determine the CCPs identified for plant-specific plans. Remember that Sanitation Standard Operating Procedures are essential prerequisites to HACCP.

HAZARD ANALYSIS

Ingredient/ Process Step	Potential hazard introduced, controlled or enhanced at this step	Is the potential food safety hazard significant? Risk:Severity	Justification for decision	What control measures can be applied to prevent the significant hazards?	Is this step a critical control point (CCP)?
Raw Meat/Poultry Receiving	<p>P: Foreign materials</p> <p>C: Sanitizers, cleaners, etc.</p> <p>B: Microbiological (Pathogens: i.e., <i>Salmonella</i>, <i>Campylobacter jejuni</i>, <i>Listeria monocytogenes</i>, <i>Clostridium perfringens</i>, <i>Clostridium botulinum</i>, <i>Staphylococcus auerus</i>, <i>Escherichia coli O157:H7</i>) parasites</p>	<p>P: No</p> <p>C: No</p> <p>B: Yes <i>Salmonella</i> - <i>Campylobacter</i> <i>E. coli O157:H7</i></p> <p>No - parasites</p>	<p>P: Low risk, unlikely to occur. Supplier's HACCP plan for raw products may also address foreign materials. Recommend implementing an operating system for removal of foreign material if found during the process as part of plant operations. (<i>May want to consider using a metal detector on packaged product later in the process.</i>)</p> <p>C: Unlikely to occur, low/moderate risk. Sanitation Standard Operating Procedures (SSOPs) should clearly address potential contamination control from cleaners/sanitizers, etc.</p> <p>B: Raw meat and poultry are known sources of pathogens. Proper temperature control is needed to reduce risk of growth.</p>	<p>B: Temperature control to reduce potential risk of pathogen growth. Subsequent heating step will help reduce pathogen levels.</p>	<p>No</p>
Storage of Raw Meat/Poultry (refrigerated/ frozen)	<p>P: Foreign material</p> <p>C: Ammonia, lead from paint, cleaners, sanitizers</p> <p>B: Microbiological - pathogens; trichinella spiralis</p>	<p>P: No</p> <p>C: No</p> <p>B: Yes</p>	<p>P: Low risk, unlikely to occur for product to be held at improper storage temperatures. Recommend implementing an operating system for removal of foreign material if found during the process as part of plant operations. (<i>May want to consider using a metal detector on packaged product later in the process.</i>)</p> <p>C: Low risk; Sanitation Standard Operating Procedures (SSOPs) should clearly address potential contamination control from cleaners/sanitizers, etc.</p> <p>B: Potential for pathogen growth if temperature abused. (Pork is a known source of trichinae.)</p>	<p>B: Temperature control to prevent pathogen growth. Recommend establishing plant procedure for storing frozen and fresh meat/poultry. Subsequent heating step will reduce pathogen levels.</p>	<p>No</p> <p><i>**This step may be a CCP if product contains pork and if freezing is being used for trichinae control of the product.</i></p>

Ingredient/Process Step	Potential hazard introduced, controlled or enhanced at this step	Is the potential food safety hazard significant? Risk:Severity	Justification for decision	What control measures can be applied to prevent the significant hazards?	Is this step a critical control point (CCP)?
Tempering of Frozen Meat/Poultry	P: Foreign material C: Sanitizers, cleaners B: Microbiological - bacterial pathogens	P: No C: No B: Yes	P: Low risk, unlikely to occur. Establishment should have procedure for ongoing removal of foreign material as detected. <i>(May want to consider using a metal detector on packaged product later in the process.)</i> C: Low risk, unlikely to occur. Sanitation Standard Operating Procedures (SSOPs) should clearly address potential contamination control from cleaners/sanitizers, etc. B: Low risk; unlikely to occur. Potential for pathogen growth if temperature abused	B: Time /Temperature controls for tempering to prevent potential for pathogen growth. Recommend keeping product temperature at 40°F or below. This can be controlled as part of the plants written operating procedures. Subsequent heating step will reduce pathogen levels.	No
Weighing of Raw Meat/Poultry	P: Foreign material C: Sanitizers, cleaners, etc. B: Microbiological - bacterial pathogens	P: No C: No B: No	P: Low risk, unlikely to occur. Establishment should have procedure for ongoing removal of foreign material as detected. <i>(May want to consider using a metal detector on packaged product later in the process.)</i> C: Low risk, unlikely to occur. Sanitation Standard Operating Procedures (SSOPs) should clearly address potential contamination control from cleaners/sanitizers, etc. B: Potential for cross contamination; Sanitation SOPs should address potential contamination from equipment, like scales.		No
Receive and Storing of Non Meat/Restricted Ingredients and Packaging Materials	P: Foreign material C: Chemical contaminants B: Microbial - spores	P: No C: No B: No	P, C and B: Unlikely to occur, letters of guarantee, certificate of analysis.		No

Ingredient/Process Step	Potential hazard introduced, controlled or enhanced at this step	Is the potential food safety hazard significant? Risk:Severity	Justification for decision	What control measures can be applied to prevent the significant hazards?	Is this step a critical control point (CCP)?
Weighing of Non Meat/Restricted Ingredients	<p>P: Foreign material</p> <p>C: Sanitizers, cleaners, nitrite</p> <p>B: Microbiological - bacterial pathogens</p>	<p>P: No</p> <p>C: Yes</p> <p>B: No</p>	<p>P: Low risk, unlikely to occur. Establishment should have procedure for ongoing removal of foreign material as detected. <i>(May want to consider using a metal detector on packaged product later in the process.)</i></p> <p>C: Excessive amount of nitrite which is a restricted ingredient and potential health risk.</p> <p>B: Potential for cross contamination; Sanitation SOPs should address potential contamination from equipment, like scales.</p>	<p>C: Properly weigh nitrite for appropriate formulation. Appropriately train employees on proper usage and handling of restricted ingredients.</p>	<p>**CCP - 1(C)</p> <p><i>(**If nitrite or other restricted ingredients are not in the product, then this should be omitted.)</i></p>
Combining Ingredients	<p>P: Foreign materials</p> <p>C: Sanitizers, cleaners, lubricants, hydraulic fluid</p> <p>B: Microbiological - bacterial pathogens</p>	<p>P: No</p> <p>C: No</p> <p>B: No</p>	<p>P: Low risk, unlikely to occur. Establishment should have procedure for ongoing removal of foreign material as detected. <i>(May want to consider using a metal detector on packaged product later in the process.)</i></p> <p>C: Low risk, unlikely to occur. Sanitation Standard Operating Procedures (SSOPs) should clearly address potential contamination control from cleaners/sanitizers, etc.</p> <p>B: Potential for cross contamination; Sanitation SOPs should address potential contamination from equipment, like scales.</p>		<p>No</p>

Ingredient/Process Step	Potential hazard introduced, controlled or enhanced at this step	Is the potential food safety hazard significant? Risk:Severity	Justification for decision	What control measures can be applied to prevent the significant hazards?	Is this step a critical control point (CCP)?
Mechanical Process (if required) *See list on flow chart.	P: Foreign materials C: Sanitizers, cleaners, lubricating oils, hydraulic fluid B: Microbiological - bacterial pathogens	P: No C: No B: No	P: Low risk, unlikely to occur. Establishment should have procedure for ongoing removal of foreign material as detected. (<i>May want to consider adding bone eliminator, metal detector, etc. at this point.</i>) C: Low risk, unlikely to occur. Sanitation Standard Operating Procedures (SSOPs) should clearly address potential contamination control from cleaners/sanitizers, etc. B: Potential for cross contamination; Sanitation SOPs should address potential contamination from equipment, like grinders, mixers, etc..		No
Partial Cooking/Smoking	P: Foreign materials C: Sanitizers, cleaners, etc. B: Microbial <i>Staphylococcus aureus</i> ; : <i>trichinella spiralis</i> for pork products	P: No C: No B: Yes	P: Low risk, unlikely to occur. (<i>May want to consider using a metal detector on packaged product later in the process.</i>) C: Low risk, unlikely to occur. Sanitation Standard Operating Procedures (SSOPs) should clearly address potential contamination control from cleaners/sanitizers, etc. B: Moderate risk. Pork is a known source of trichinae. Possible <i>Staphylococcus aureus</i> risk.	B: Proper temperature control for trichinae	**CCP - 2(B) ** <i>This must be a CCP if product contains pork and if this step is being used for trichinae control of the product.</i>

Ingredient/ Process Step	Potential hazard introduced, controlled or enhanced at this step	Is the potential food safety hazard significant? Risk:Severity	Justification for decision	What control measures can be applied to prevent the significant hazards?	Is this step a critical control point (CCP)?
Chilling	<p>P: Foreign materials</p> <p>C: Sanitizers, cleaners, etc.</p> <p>B: Microbiological - bacterial pathogens</p>	<p>P: No</p> <p>C: No</p> <p>B: Yes</p>	<p>P: Low risk, unlikely to occur. <i>(May want to consider using a metal detector on packaged product later in the process.)</i></p> <p>C: Low risk, unlikely to occur. Sanitation Standard Operating Procedures (SSOPs) should clearly address potential contamination control from cleaners/sanitizers, etc.</p> <p>B: Potential for pathogen growth and potential for cross-contamination of product and subsequent pathogen growth.</p>	<p>B: Temperature control to prevent pathogen growth and Sanitation SOP to address potential cross-contamination.</p>	CCP - 3(B)
Packaging and Labeling of Product	<p>P: Foreign materials</p> <p>C: Sanitizers, cleaners, etc.</p> <p>B: Microbiological - bacterial pathogens</p>	<p>P: No</p> <p>C: No</p> <p>B: Yes</p>	<p>P: Low risk, unlikely to occur. Establishment should have procedure for ongoing removal of foreign material as detected throughout the processing system as part of their standard operating procedures. <i>(May want to consider using a metal detector on packaged product and including this step as a CCP.)</i></p> <p>C: Low risk, unlikely to occur. Sanitation Standard Operating Procedures (SSOPs) should clearly address potential contamination control from cleaners/sanitizers, etc.</p> <p>B: Potential for cross-contamination of partially cooked product with raw product and from employee contamination</p>	<p>B: Sanitation SOPs to prevent cross-contamination and plant procedures for controlling product temperature during packaging, and labeling.</p>	No
Cold Storage of Product	<p>P: Foreign materials</p> <p>C: Sanitizers, cleaners, etc.</p> <p>B: Microbiological - bacterial pathogens</p>	<p>P: No</p> <p>C: No</p> <p>B: No</p>	<p>P: Low risk; packaged product.</p> <p>C: Low risk, unlikely to occur. Sanitation Standard Operating Procedures (SSOPs) should clearly address potential contamination control from cleaners/sanitizers, etc.</p> <p>B: Moderate risk; unlikely to have temperature abuse during chilling to allow for potential pathogen growth</p>	<p>B: Proper temperature control to prevent potential pathogen growth. Recommend, storage of product at 40°F or less.</p>	No

Ingredient/ Process Step	Potential hazard introduced, controlled or enhanced at this step	Is the potential food safety hazard significant? Risk:Severity	Justification for decision	What control measures can be applied to prevent the significant hazards?	Is this step a critical control point (CCP)?
Rework	P: Foreign materials C: Sanitizers, cleaners B: Microbiological- bacterial pathogens	P: No C: No B: No	P: Low risk; rework has been through a controlled process and process will continue to be controlled. C: Low risk, Sanitation Standard Operating Procedures (SSOPs) should clearly address potential contamination control from cleaners/sanitizers, etc. B: Low risk, unlikely to occur if process control has been maintained throughout the process. Rework must be handled properly to prevent potential contamination and the plant should have a written operational procedure for using rework.		No

HACCP Worksheet:

The HACCP Worksheet format used in this model is an example format. Alternative forms can be used for the HACCP plan.

The first three columns of the form, identify the process step associated with the CCP, allows for CCP identification (number and type of hazard), and provides a description of the CCP. Columns four through eight are used to indicate the establishment's critical limits, monitoring procedures, corrective actions, recordkeeping methods, and verification procedures for each CCP.

A critical limit is a criterion that must be met for each preventive measure associated with a CCP. Critical limits may be derived from sources such as regulatory standards and guidelines, scientific literature, experimental studies, and advice from experts. Critical limits must be based on the best information available at the time to provide a safe product and yet must be realistic and attainable. Establishments must keep in mind that any product which does not meet the critical limit must have a Corrective Action taken. Corrective actions may be as simple as re-processing or re-packaging or may require destroying the product.

Monitoring procedures should include a planned sequence of observations or measurements to assess whether a CCP is under control and produce an accurate record for future use in verification.

Monitoring serves three purposes:

- 1) Monitoring is essential to food safety management by tracking the systems operation.
- 2) Monitoring is used to determine when there is a loss of control and a deviation occurs at a CCP, exceeding the critical limit. Corrective action must then be taken.
- 3) Monitoring provides written documentation for use in verifying the HACCP plan.

All records associated with monitoring must be signed or initialed, dated, and the time recorded by the person conducting the monitoring activity.

Corrective actions are procedures to be followed when a deviation occurs. Because of variations in CCPs for different products and the diversity of possible deviations, specific corrective action plans must be developed for each CCP. The actions must demonstrate that the CCP has been brought under control and that the product is handled appropriately. Corrective action records must be signed, dated, and the time of action recorded by the individual responsible for taking the action.

Record keeping is a critical aspect of the HACCP system. Records must be accurate and reflect the process, the deviations, the corrective actions, etc. Lack of accurate, current records may be cause for withholding or suspension of inspection from the plant. It is also important that all HACCP records dealing with CCPs and corrective actions taken, be reviewed on a daily basis by an individual, who did not produce the records and who has completed a course in HACCP, or the responsible establishment official who must sign or initial, date, and record the time all records are reviewed. The HACCP plan and associated records must be on file at the meat and/or poultry establishment.

Example recordkeeping forms have been included in this model. It may be beneficial to combine forms as practical to reduce the amount of paperwork.

Verification consists of the use of methods, procedures, or tests in addition to those used in monitoring to determine that the HACCP system is in compliance with the HACCP plan and whether the HACCP plan needs modification. Verification involves:

- 1) The scientific or technical process to verify that critical limits at CCPs are satisfactory — review of critical limits to verify that the limits are adequate to control the hazards and that are likely to occur.
- 2) Process verification to ensure that the facility's HACCP plan is functioning effectively.
- 3) Documented periodic revalidation, independent of quality audits or other verification procedures, that must be performed to ensure the accuracy of the HACCP plan.

INDUSTRY WORKSHOP HACCP MODEL

PRODUCT CATEGORY: Non Shelf Stable, Heat Treated, Not Fully Cooked — Product Examples: Partially cooked poultry, and smoked sausage

WORKSHOP LOCATION: Kansas City, Missouri

Process Step	CCP/ Hazard Number	CCP Description	Critical Limits	Establishment Monitoring	Corrective Action	HACCP Records	HACCP System Verification
<p>**Weighing of Nonmeat/ Restricted Ingredients</p> <p><i>**If no restricted ingredients are used, then omit this step.</i></p>	CCP - 1(C)	Control of restricted substances	Equal to regulatory limit for specific product or as established by Processing Authority	Monitor weight/ formulation on each batch by scale/formulation operator or responsible plant employee.	<p>Adjust to correct weight deviation before it enters the product.</p> <p>Place product on hold, evaluate significance of the deviation and utilize established procedures for product disposition (i.e., rework, condemn, etc.).</p> <p>Identify cause of deviation and take action to prevent reoccurrence and modify the HACCP plan if needed.</p>	<p>Scale/ formulation log</p> <p>Hold log</p> <p>Scale calibration log</p> <p>Deviation/ Corrective Action log</p> <p>Verification log</p>	<p>Calibrate scale periodically, (i.e., daily).</p> <p>Designated plant employee must review HACCP records daily prior to shipping product.</p> <p>Periodic (i.e., daily) observations and/or weight measurement checks to confirm accurate weight of restricted ingredient.</p>

Process Step	CCP/ Hazard Number	CCP Description	Critical Limits	Establishment Monitoring	Corrective Action	HACCP Records	HACCP System Verification
<p>**Partial Cooking/ Smoking</p> <p><i>**This step may be used to control Staphylococcus aureus and/or for trichinae control. Additional limits may be needed to control other pathogens specific to the individual product.</i></p>	CCP - 2(B)	Trichinae control	<p>Time/Temperature control per regulatory requirements for trichinae control.</p> <p>Internal product temperature must reach 120°F within 2 hours to prevent <i>Staphylococcus aureus</i> enterotoxin production (Bryan, 1990) or to meet time/temp. relationship established by Processing Authority to prevent toxin production.</p>	<p>Time-Temperature of product recorded once per batch by designated employee on designated form which includes date, time of recording, etc.</p> <p><i>and/or</i></p> <p>Use demonstrated time-temperature parameters (continuous monitoring by chart recorder) in smokehouse to control trichinae and to prevent <i>Staphylococcus</i> enterotoxin production.</p>	<p>Reheat to reach appropriate endpoint temperature.</p> <p>Identify cause of deviation and take action to prevent reoccurrence and modify the HACCP plan if needed..</p>	<p>Cooking log and or smokehouse time/temp log</p> <p>Hold log</p> <p>Thermometer calibration log</p> <p>Deviation/ Corrective Action log</p> <p>Verification log</p>	<p>Period (i.e., daily) Smokehouse/ product thermometer ($\pm 2^{\circ}\text{F}$) calibration.</p> <p>Periodically (i.e, daily) verify and record internal product temperature.</p> <p>Designated plant employee must review HACCP records daily prior to shipping product.</p>

Process Step	CCP/ Hazard Number	CCP Description	Critical Limits	Establishment Monitoring Procedures	Corrective Action	HACCP Records	HACCP System Verification
Chilling	CCP 3(B)	Temperature control for controlling pathogen growth.	Internal product temperature 70°F within 3 hours and must reach 41°F within an additional 6 hours. (Total chilling time of 9 hours) (Bryan, 1990) <i>Alternative temperatures /times may be established by plant data or from additional references. However, the parameters provided above will limit the growth rates of even psychotrophic spoilage organisms. Therefore, these parameters are more than sufficient to prevent growth of mesophilic enteric bacterial pathogens.</i>	Monitor internal product temperature using a calibrated thermometer; (i.e., check 5 randomly selected products per lot.) <i>and/or</i> Continuously monitor (chart recorder) established refrigeration parameters to meet desired endpoint temperature. Monitoring done by designated plant employee and recorded on appropriate form.	Destroy product or remove from human consumption. Identify cause of deviation and take action to prevent reoccurrence and modify the HACCP plan if needed..	Product chilling log and/or refrigeration parameter log. Hold log Thermometer calibration log Deviation/ Corrective Action log Verification log	Periodically calibrate thermometer ($\pm 2^\circ\text{F}$) (i.e., daily) Designated plant employee must review HACCP records daily prior to shipping product. Periodic temperature checks to confirm internal product temperature. (i.e., weekly)

Example Records

Example: SCALE LOG/FORMULATION SHEET

CCP: ____

Critical Limit: Acceptable level to maintain product safety as established by Quality Control or processing authority.

- Corrective Action(s):
1. Adjust to correct weight deviation before it enters the product.
 2. Place product on hold, evaluate significance and utilize established procedures for product disposition.
 3. Evaluate cause of deviation and take action to prevent reoccurrence.

Date/ Time	Lot ID	Batch Size	Nitrate Weight	Operator Initials	Comments*

Equipment: Scale

Instructions: Record data for nitrate addition per batch made.

*Comment column could allow for recording of deviations and corrective actions that occur at this point.

Reviewed by

Date

Example: HOLD SUMMARY LOG

Hold Number	Date of Hold	Product / Code	Reason for Hold	Number Units Held	“Held by” Operator Initials	Date of Disposition	Final Disposition	Number Released	Number Destroyed	Total Number	Released by Initials

Reviewed by: _____

Date:

Example: CALIBRATION LOG*

CCP(s): _____

Date	ID for Equipment Calibrated	Comments	Operator Initials

*Calibration logs can be used for Scales, pH meter, Thermometer, or other equipment.

Instructions: Record equipment calibrations and comments according to individual equipment calibration SOPS.

Reviewed by:

Date:

Example: SMOKEHOUSE/PRODUCT TEMPERATURE LOG*

DATE: _____

	Smokehouse/Product Temperature					
Smokehouse/ Product:						Operator Initials
TIME:	TEMPERATURE					

*Smokehouse/Product Temperature Log may be used if smokehouse chart is not available.

Reviewed by:

Date:

Example: VERIFICATION LOG*

DATE/TIME	CCP NUMBER/ID	OBSERVATION/MEASUREMENT	COMMENTS	INITIALS

*This log can be used for verification observations and measurements taken for individual CCPs.

Reviewed by:

Date:

APPENDIX 1

This is not an FSIS requirement. The following Good Manufacturing Practices (21 CFR Part 110) codified by the Food and Drug Administration are being provided for reference material to help assist you in developing your plant's manufacturing procedures. The document provides information which may also be useful as part of your Sanitation Standard Operating Procedures.

**FOOD AND DRUG
ADMINISTRATION,
DEPARTMENT OF HEALTH
AND HUMAN SERVICES**

**21 CFR PART 110 - CURRENT
GOOD MANUFACTURING
PRACTICE IN
MANUFACTURING,
PACKING, OR HOLDING
HUMAN FOOD**

Subpart A - General Provisions

Sec. 110.3 Definitions.

Sec. 110.5 Current good manufacturing practice.

Sec. 110.10 Personnel.

Sec. 110.19 Exclusions.

**Subpart B - Buildings and
Facilities**

Sec. 110.20 Plant and grounds.

Sec. 110.35 Sanitary operations.

Sec. 110.37 Sanitary facilities and controls.

Subpart C - Equipment

Sec. 110.40 Equipment and utensils.

Subpart D - [Reserved]

**Subpart E - Production and
Process Controls**

Sec. 110.80 Processes and controls.

Sec. 110.93 Warehousing and distribution.

Subpart F - [Reserved]

**Subpart G - Defect Action
Levels**

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

**SUBPART A - GENERAL
PROVISIONS**

110.3 Definitions.

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

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

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

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

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

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

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

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

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

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

'microbial' instead of using an adjectival phrase containing the word microorganism.

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

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

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

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

(n) "Safe-moisture level" is a level of moisture low enough to prevent the growth of undesirable microorganisms in the finished product under the intended conditions of manufacturing, storage, and distribution. The maximum safe moisture level for a food is based on its water activity (a (INFERIOR w)). An a (INFERIOR w) will be considered safe for a food if adequate data are available that demonstrate that the food at or below the given a (INFERIOR w) will not support the growth of undesirable microorganisms.

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

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

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

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

110.5 Current good manufacturing practice.

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

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

110.10 Personnel.

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

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

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

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

(2) Maintaining adequate personal cleanliness.

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

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

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

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

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

(8) Confining the following to areas other than where food may be exposed or where equipment or

utensils are washed: eating food, chewing gum, drinking beverages, or using tobacco.

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

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

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

110.19 Exclusions.

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

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

SUBPART B - BUILDING AND FACILITIES

110.20 Plant and grounds.

(a) *Grounds.* The grounds about a food plant under the control of the operator shall be kept in a

condition that will protect against the contamination of food. The methods for adequate maintenance of grounds include, but are not limited to:

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

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

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

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

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

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

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

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

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

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

(i) Using protective coverings.

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

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

(iv) Skimming the fermentation vessels, as necessary.

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

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

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

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

110.35 Sanitary operations.

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

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

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

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

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

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

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

(c) *Pest control.* No pests shall be allowed in any area of a food

plant. Guard or guide dogs may be allowed in some areas of a plant if the presence of the dogs is unlikely to result in contamination of food, food-contact surfaces, or food-packaging materials. Effective measures shall be taken to exclude pests from the processing areas and to protect against the contamination of food on the premises by pests. The use of insecticides or rodenticides is permitted only under precautions and restrictions that will protect against the contamination of food, food-contact surfaces, and food-packaging materials.

(d) *Sanitation of food-contact surfaces.* All food-contact surfaces, including utensils and food-contact surfaces of equipment, shall be cleaned as frequently as necessary to protect against contamination of food.

(1) Food-contact surfaces used for manufacturing or holding low-moisture food shall be in a dry, sanitary condition at the time of use. When the surfaces are wet-cleaned, they shall, when necessary, be sanitized and thoroughly dried before subsequent use.

(2) In wet processing, when cleaning is necessary to protect against the introduction of microorganisms into food, all food-contact surfaces shall be cleaned and sanitized before use and after any interruption during which the food-contact surfaces may have become contaminated. Where equipment and utensils are used in a continuous production operation, the utensils and food-contact surfaces of the equipment shall be cleaned and sanitized as necessary.

(3) Non-food-contact surfaces of equipment used in the operation of food plants should be cleaned as frequently as necessary to protect against contamination of food.

(4) Single-service articles (such as utensils intended for one-time use, paper cups, and paper towels) should be stored in appropriate containers and shall be handled, dispensed, used, and disposed of in a manner that protects against contamination of food or food-contact surfaces.

(5) Sanitizing agents shall be adequate and safe under conditions of use. Any facility, procedure, or machine is acceptable for cleaning and sanitizing equipment and utensils if it is established that the facility, procedure, or machine will routinely render equipment and utensils clean and provide adequate cleaning and sanitizing treatment.

(e) *Storage and handling of cleaned portable equipment and utensils.* Cleaned and sanitized portable equipment with food-contact surfaces and utensils should be stored in a location and manner that protects food-contact surfaces from contamination.

110.37 Sanitary facilities and controls.

Each plant shall be equipped with adequate sanitary facilities and accommodations including, but not limited to:

(a) *Water supply.* The water supply shall be sufficient for the operations intended and shall be derived from an adequate source. Any water that contacts food or food-contact surfaces shall be safe and of adequate sanitary quality. Running water at a suitable temperature, and under pressure as needed, shall be provided in all areas where required for the processing of food, for the cleaning of equipment, utensils, and food-packaging materials, or for employee sanitary facilities.

(b) *Plumbing.* Plumbing shall be of adequate size and design and adequately installed and maintained to:

(1) Carry sufficient quantities of water to required locations throughout the plant.

(2) Properly convey sewage and liquid disposable waste from the plant.

(3) Avoid constituting a source of contamination to food, water supplies, equipment, or utensils or creating an unsanitary condition.

(4) Provide adequate floor drainage 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.

(5) Provide that there is not backflow from, or cross-connection between, piping systems that discharge waste water or sewage and piping systems that carry water for food or food manufacturing.

(c) *Sewage disposal.* Sewage disposal shall be made into an adequate sewerage system or disposed of through other adequate means.

(d) *Toilet facilities.* Each plant shall provide its employees with adequate, readily accessible toilet facilities. Compliance with this requirement may be accomplished by:

(1) Maintaining the facilities in a sanitary condition.

(2) Keeping the facilities in good repair at all times.

(3) Providing self-closing doors.

(4) Providing doors that do not open into areas where food is exposed to airborne contamination, except where alternate means have been taken to protect against such contamination (such as double doors or positive air-flow systems).

(e) *Hand-washing facilities.* Hand-washing facilities shall be adequate and convenient and be furnished with running water at a suitable temperature. Compliance with this requirement may be accomplished by providing:

(1) Hand-washing and, where appropriate, hand-sanitizing facilities at each location in the plant where good sanitary practices require employees to wash and/or sanitize their hands.

(2) Effective hand-cleaning and sanitizing preparations.

(3) Sanitary towel service or suitable drying devices.

(4) Devices or fixtures, such as water control valves, so designed and constructed to protect against recontamination of clean, sanitized hands.

(5) Readily understandable signs directing employees handling unprotected food, unprotected food-packaging materials, of food-contact surfaces to wash and, where appropriate, sanitize their hands before they start work, after each

absence from post of duty, and when their hands may have become soiled or contaminated. These signs may be posted in the processing room(s) and in all other areas where employees may handle such food, materials, or surfaces.

(6) Refuse receptacles that are constructed and maintained in a manner that protects against contamination of food.

(f) *Rubbish and offal disposal.* Rubbish and any offal shall be so conveyed, stored, and disposed of as to minimize the development of odor, minimize the potential for the waste becoming an attractant and harborage or breeding place for pests, and protect against contamination of food, food-contact surfaces, water supplies, and ground surfaces.

SUBPART C - EQUIPMENT

110.40 Equipment and utensils.

(a) All plant equipment and utensils shall be so designed and of such material and workmanship as to be adequately cleanable, and shall be properly maintained. The design, construction, and use of equipment and utensils shall preclude the adulteration of food with lubricants, fuel, metal fragments, contaminated water, or any other contaminants. All equipment should be so installed and maintained as to facilitate the cleaning of the equipment and of all adjacent spaces. Food-contact surfaces shall be corrosion-resistant when in contact with food. They shall be made of nontoxic materials and designed to withstand the environment of their intended use and the action of food, and, if applicable, cleaning compounds and sanitizing agents. Food-contact surfaces shall be maintained to protect food from being contaminated by any source, including unlawful indirect food additives.

(b) Seams on food-contact surfaces shall be smoothly bonded or maintained so as to minimize accumulation of food particles, dirt, and organic matter and thus

minimize the opportunity for growth of microorganisms.

(c) Equipment that is in the manufacturing or food-handling area and that does not come into contact with food shall be so constructed that it can be kept in a clean condition.

(d) Holding, conveying, and manufacturing systems, including gravimetric, pneumatic, closed, and automated systems, shall be of a design and construction that enables them to be maintained in an appropriate sanitary condition.

(e) Each freezer and cold storage compartment used to store and hold food capable of supporting growth of microorganisms shall be fitted with an indicating thermometer, temperature-measuring device, or temperature-recording device so installed as to show the temperature accurately within the compartment, and should be fitted with an automatic control for regulating temperature or with an automatic alarm system to indicate a significant temperature change in a manual operation.

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

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

SUBPART D - [RESERVED]

SUBPART E - PRODUCTION AND PROCESS CONTROLS

110.80 Processes and controls.

All operations in the receiving, inspecting, transporting, segregating, preparing, manufacturing, packaging, and

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

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

(2) Raw materials and other ingredients shall either not contain levels of microorganisms that may produce food poisoning or other disease in humans, or they shall be pasteurized or otherwise treated during manufacturing operations so that they no longer contain

levels that would cause the product to be adulterated within the meaning of the act. Compliance with this requirement may be verified by any effective means, including purchasing raw materials and other ingredients under a supplier's guarantee or certification.

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

(4) Raw materials, other ingredients, and rework susceptible to contamination with pests, undesirable microorganisms, or extraneous material shall comply with applicable Food and Drug Administration regulations, guidelines, and defect action levels for natural or unavoidable defects if a manufacturer wishes to use the materials in manufacturing food. Compliance with this requirement may be verified by any effective means, including purchasing the materials under a supplier's guarantee or certification, or examination of these materials for contamination.

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

(6) Frozen raw materials and other ingredients shall be kept frozen. If thawing is required prior to use, it shall be done in a

manner that prevents the raw materials and other ingredients from becoming adulterated within the meaning of the act.

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

(b) *Manufacturing operations.*

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

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

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

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

(ii) Maintaining frozen foods in a frozen state.

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

(iv) Heat treating acid or acidified foods to destroy mesophilic microorganisms when

those foods are to be held in hermetically sealed containers at ambient temperatures.

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

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

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

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

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

(9) Food, raw materials, and other ingredients that are adulterated within the meaning of the act shall be disposed of in a manner that protects against the contamination of other food. If the adulterated food is capable of being reconditioned, it shall be reconditioned using a method that has been proven to be effective or it shall be reexamined and found not to be adulterated within the

meaning of the act before being incorporated into other food.

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

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

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

(i) Using ingredients free of contamination.

(ii) Employing adequate heat processes where applicable.

(iii) Using adequate time and temperature controls.

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

(v) Cooling to an adequate temperature during manufacturing.

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

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

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

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

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

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

(v) Using sanitary handling procedures.

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

(i) Monitoring the a (INFERIOR w) of food.

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

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

(15) Food such as, but not limited to, acid and acidified food, that relies principally on the control of pH for preventing the growth of undesirable

microorganisms shall be monitored and maintained at a pH of 4.6 or below. Compliance with this requirement may be accomplished by any effective means, including employment of one or more of the following practices:

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

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

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

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

110.93 Warehousing and distribution.

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

SUBPART F - [RESERVED]

SUBPART G - DEFECT ACTION LEVELS

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

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

good manufacturing practice and uses these levels in deciding whether to recommend regulatory action.

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

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

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

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

APPENDIX 2

PROCESS CATEGORIES
(Pathogen Reduction/HACCP Regulation, 1996)

1. Not Heat Treated, Shelf-Stable (dried products, those controlled by water activity, pH, freeze dried, dehydrated, etc.)
2. Heat Treated, Shelf-Stable (rendered products, lard, etc.)
3. Heat Treated Not Fully Cooked, Not Shelf-Stable (ready to cook poultry, cold smoked and products smoked for trichinae, partially cooked battered, breaded, char-marked, batter set, and low temperature rendered products, etc.)
4. Products with Secondary Inhibitors, Not Shelf-Stable (products that are fermented, dried, salted, brine treated, etc., but are not shelf-stable)
5. Irradiation (includes all forms of approved irradiation procedures for poultry and pork)
6. Fully Cooked, Not Shelf Stable (products which have received a lethal kill step through a heating process, but must be kept refrigerated. This includes products such as fully cooked hams, cooked beef, roast beef, etc.).
7. Beef Slaughter
8. Pork Slaughter
9. Poultry Slaughter
10. Raw Products - not ground (all raw products which are not ground in their final form. This includes beef trimmings, tenderized cuts, steaks, roasts, chops, poultry parts, etc.)
11. Raw, Ground
12. Thermally Processed/Commercially Sterile
13. Mechanically Separated Species

APPENDIX 3

**Overview of Biological, Chemical and Physical Hazards
(Pathogen Reduction/HACCP Regulation, USDA, 1996)**

(Hazards are not limited to the following information.)

Biological Hazards: The following biological hazards should be considered:

Pathogenic microorganisms:

Bacillus cereus
Campylobacter jejuni
Clostridium botulinum
Clostridium perfringens
Escherichia coli O157:H7
Listeria monocytogenes
Salmonella spp
Staphylococcus aureus
Yersinia enterocolitica

Zoonotic agents:

Trichinella spiralis
Taenia saginata
Taenia solium
Toxoplasma gondii
Balantidium coli
Cryptosporidium spp.

Chemical Hazards: The following sources were identified.

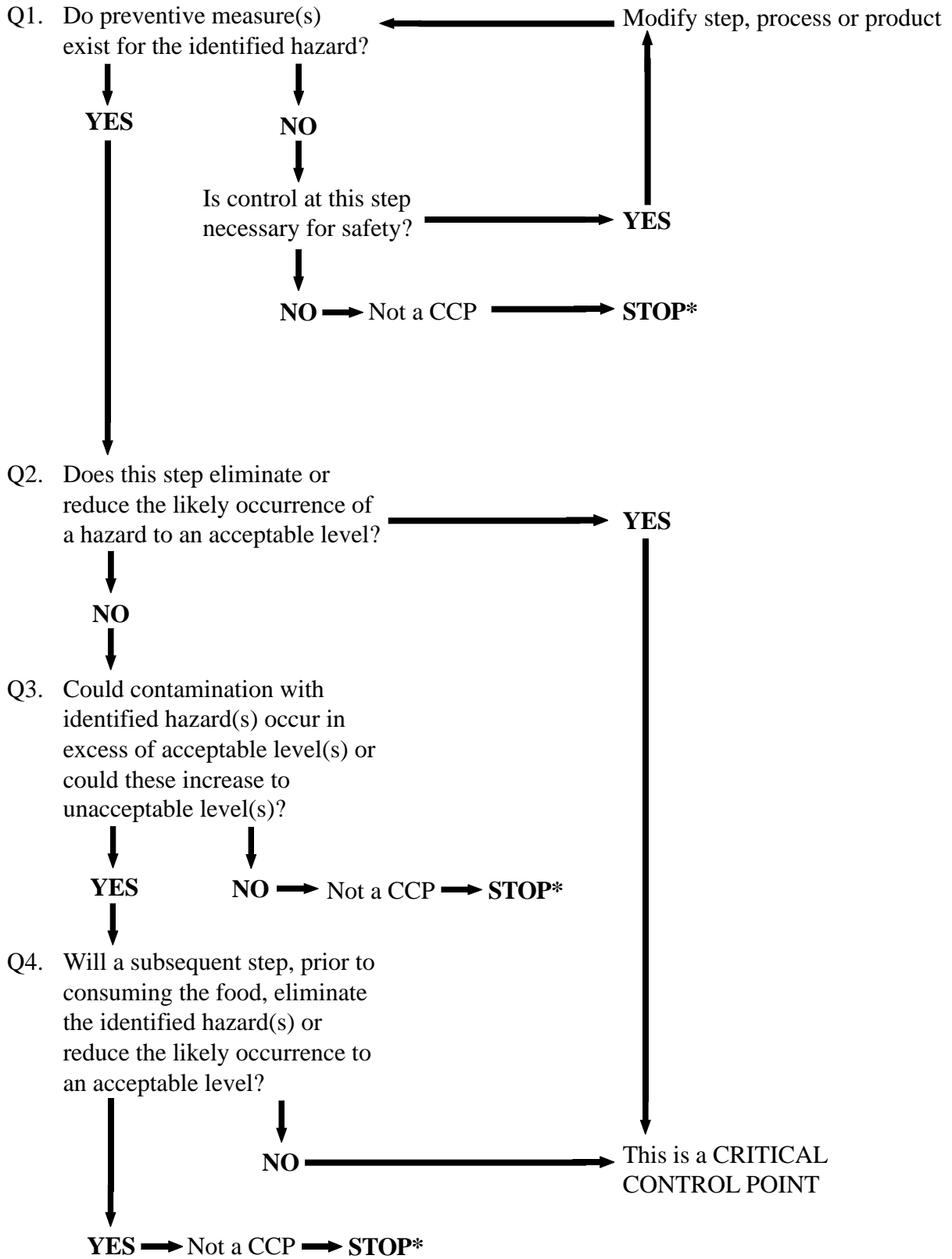
- 1) Agriculture chemicals: pesticides, herbicides, animal drugs, fertilizers, etc.
- 2) Plant chemicals: cleaners, sanitizers, oils, lubricants, paints, pesticides, etc.
- 3) Naturally-occurring toxicants: products of plant, animal or microbial metabolism such as aflatoxins, etc.
- 4) Food chemicals: preservatives, acids, food additives, sulfiting agents, processing aids, etc.
- 5) Environmental contaminants: lead, cadmium, mercury, arsenic, PCBs.

Physical Hazards:

Glass, metal, stones, plastics, bone, bullet/BB shots/needles, jewelry, etc.

APPENDIX 4

The NACMCF (1992) CCP Decision Tree
(Apply at each point where an identified hazard can be controlled.)



*Proceed to the next step in the selected process

APPENDIX 5

Below are listed the references used in the development of the USDA Model HACCP Plans. The first category includes generic HACCP references that were used as a basis for all ten model plans. The remaining references are divided by product category.

References for all HACCP Model Teams

1. Pearson and Dutson, editors, 1995. HACCP in Meat, Poultry, and Fish Processing. Blakie Academic & Professional, Glasgow.

Useful sections in particular are:

- Chapter 4 - meat and poultry slaughter, pp. 58 -71
- Chapter 5 - processed meats, pp. 72 - 107
- Chapter 7 - risk analysis, pp. 134 - 154
- Chapter 13 - predictive modeling, pp. 330 - 354

2. Stevenson and Bernard, editors, 1995. HACCP Establishing Hazard Analysis Critical Control Point Programs, A Workshop Manual. The Food Processors Institute, Washington, D.C.

Useful sections in particular are:

- Chapter 11 - forms for hazard analysis, CCP, limits, HACCP master sheet, example HACCP for breaded chicken

3. Baker, D. A., 1995. Application of modeling in HACCP plan development. *Int. J. Food Microbiol.* 25: 251 - 261.

4. AMI, 1994. HACCP: The Hazard Analysis and Critical Control Point System in the Meat and Poultry Industry. American Meat Institute Foundation, Washington, D.C.

Useful sections in particular are:

- Chapter 3 - microbiological hazards, pp. 15 - 26
- Chapter 4 - chemical hazards, pp. 27 - 32
- Chapter 5 - physical hazards, pp. 33 - 35
- Appendix A - NACMCF HACCP
- Appendix C - Model HACCP plans (beef slaughter, roast beef, ham, chicken slaughter, etc.)

5. Easter, M. C., et al. 1994. The role of HACCP in the management of food safety and quality. *J. Soc. Dairy Technol.* 47: 42 - 43.

6. Notermans, S., et al. 1994. The HACCP concept: Identification of potentially hazardous micro-organisms. *Food Microbiol.* 11: 203 - 214.

7. ICMFS, 1988. HACCP in Microbiological Safety and Quality. Blackwell Scientific Publications, Oxford.

Useful sections in particular are:

- Chapter 10 - raw meat and poultry, pp. 176 - 193
- Chapter 11 - roast beef, pp. 234 - 238
- Chapter 11 - canned ham, pp. 238 - 242

8. National Research Council, 1985. An Evaluation of the Role of Microbiological Criteria for Foods and Food Ingredients. National Academy Press, Washington, D.C.

Useful sections in particular are:

- Chapter 4 - microbiological hazards, pp. 72 - 103
 - Chapter 9 - raw meat, pp. 193 - 199
 - Chapter 9 - processed meats, pp. 199 - 216
-

References for Shelf-stable, Not-heat Treated (**Salami & Pepperoni**)

1. Hinkens, J. C., et al. 1996. Validation of Pepperoni Processes for Control of *Escherichia coli* O157:H7. J. Food Prot. In Press.
2. Nickelson, R., et al. 1996. Dry fermented sausage and *E. coli* O157:H7. National Cattlemen's Beef Association, Research Report No. 11-316, Chicago, IL.
3. AMI, 1995. Interim Good Manufacturing Practices for Fermented Dry and Semi-Dry Sausage Products. American Meat Institute, Washington, D.C.
4. Papa, F., et al. 1995. Production of Milano style salami of good quality and safety. Food Microbiol. 12: 9 - 12.
5. Campanini, M., et al. 1993. Behavior of *Listeria monocytogenes* during the maturation of naturally and artificially contaminated salami: effect of lactic-acid bacteria starter cultures. Inter. J. Food Microbiol. 20: 169 - 175.
6. Raccach, M. 1992. Some aspects of meat fermentation. Food Microbiol. 9: 55 - 65.
7. Leistner, F., 1992. The essentials of producing stable and safe raw fermented sausages. In: New Technologies for Meat and Meat Products. ECCEAMST, Utrecht. pp. 1 - 17.
8. Glass, K. A. and M. P. Doyle. 1989. Fate and thermal inactivation of *Listeria monocytogenes* in beaker sausage and pepperoni. J. Food Prot. 52: 226 - 231.
9. Smith, H. J., et al. 1989. Destruction of *Trichinella spiralis* during the preparation of 'dry cured' pork products prociutto, prociuttini and Genoa salami. Can. J. Vet. Res. 53: 80 - 83.
10. Johnson, J. L., et al. 1988. Fate of *Listeria monocytogenes* in tissues of experimentally infected cattle and in hard salami. Appl. Environ. Microbiol. 54: 497 - 501.
11. Martinez, E. J., et al. 1986. Combined effect of water activity, pH and additives on growth of *Staphylococcus aureus* in model salami systems. Food Microbiol. 3: 321 -329.
12. Collins-Thompson, D. L., et al. 1984. The Effect of Nitrite on the Growth of Pathogens during Manufacture of Dry and Semi-dry Sausage. Can. Inst. Food Sci. Technol. J. 17: 102 - 106.

References for Shelf-Stable, Heat Treated Product (**Snack Sticks & Jerky**)

1. AMSA, 1995. Flow Chart for Beef Jerky. American Meat Science Association.
2. CDC, 1995. Outbreak of Salmonellosis Associated with Beef Jerky - New Mexico, 1995. Morbidity and Mortality Weekly Report. 44: 785 - 787.
3. Bunic, Sava, et al. 1991. The Fate of *Listeria monocytogenes* in Fermented Sausages and in Vacuum-Packaged Frankfurters. J. Food Prot. 54: 413 - 417.
4. Dykes, Gary A., et al. 1991. Quantification of microbial populations associated with the manufacture of vacuum-packaged, smoked Vienna sausages. Int. J. Food Microbiol. 13: 239 - 248.

References for Not Shelf Stable, Heat Treated, Not Fully Cooked Product (**Chicken Patties & Smoked Sausage**)

1. FPI, 1995. Process Flow Description for Battered and Breaded Chicken Pieces. Chapter 11 - 14. In HACCP, Establishing Hazard Analysis Critical Control Point Programs. Food Processors Institute, Washington D.C.
2. AMSA, 1995. Flow Chart for Uncooked, Cured Summer Sausage. American Meat Science Association. Chicago, IL.
3. Yen, Lynn C., et al. Effect of Meat Curing Ingredients on Thermal Destruction of *Listeria monocytogenes* in Ground Pork. J. Food Prot. 54: 408 - 412.
4. Marcy, J. A., et al. 1988. Effect of Acid and Neutral Pyrophosphates on the Natural Bacterial Flora of a Cooked Meat System. J. Food Science. 53: 28 - 30.
5. Yi, Y. H., et al. 1987. Yields, Color, Moisture and Microbial Contents of Chicken Patties as Affected by Frying and Internal Temperatures. J. Food Sci. 52: 1183 - 1185.
6. Bushway, Alfred A., et al. 1984. Residual Nitrite Concentration and Total Plate Counts in White and Dark Chicken Patties. J. Food Prot. 47: 119 - 21.

References for Not Shelf Stable with Secondary Inhibitors (**Country Hams & Semi-dry Fermented Sausage**)

1. Houtsma, P. C., et al. 1996. Model for the combined effects of temperature, pH, and sodium lactate on growth rates of *Listeria innocua* in broth and bologna-type sausages. Appl. Environ. Microbiol. 62: 1616 - 1622.
2. Flores, L. M., et al. 1996. Evaluation of a phosphate to control pathogen growth in fresh and processed meat products. J. Food Prot. 59: 356 - 359.
3. Gonzalez-Hevia, M. Angeles, et al. 1996. Diagnosis by a Combination of Typing Methods of *Salmonella thyphimurium* Outbreak Associated with Cured Ham. J. Food Prot. 59: 426 - 428.
4. AMI. 1995. Interim Good Manufacturing Practices for Fermented Dry and Semi-Dry Sausage Product. American Meat Institute. Washington, D.C.
5. AMI, 1994. HACCP Plan for Ham. Appendix C, p. 99 - 101. In HACCP: The Hazard Analysis and Critical Control Point System in the Meat and Poultry Industry. American Meat Institute. Washington, D.C.
6. Bunic, Sava, et al. 1991. The fate of *Listeria monocytogenes* in Fermented Sausages and in Vacuum-Packaged Frankfurters. J. Food Prot. 54: 413 - 417.
7. Dykes, Gary A., et al. 1991. Quantification of microbial populations associated with the manufacture of vacuum-packaged, smoked Vienna sausages. Int. J. Food Microbiol. 13: 239 - 248.
8. Ockerman, H. W., et al. 1984. Effect of Tumbling and Tumbling Temperature on Surface and Subsurface Contamination of *Lactobacillus Plantarum* and Residual Nitrite in Cured Pork Shoulder. J. Food Science. 49: 1634 - 1635.
9. Collins-Thompson, D. L., et al. 1984. The Effect of Nitrite on the Growth of Pathogens during Manufacture of Dry and Semi-dry Sausage. Can. Inst. Food Sci. Technol. J. 17: 102 - 106.

10. Christian, J. A., 1982. Curing and Aging Country Hams. Reciprocal Meat Conference Proceedings. 35: 47 - 48.
11. Draughon, D. A., et al. 1981. Microbial Profiles of Country-Cured Hams Aged in Stockinettes, Barrier Bags, and Paraffin Wax. Appl. Environ. Microbiol. April 1981: 1078 - 1080.
12. Bartholomew, D. T., et al. 1980. Inhibition of *Staphylococcus* by lactic acid bacteria in Country-style Hams. J. Food Sci. 45: 420 - 425.
13. Cornish, D. G., et al. 1974. Accelerated Pork Processing: A Quantitative Study of Bacterial Flora of Cured and Smoked Hams. J. Food Science. 39: 605 - 606.

References for Irradiation (**Ground Pork & Poultry Parts**)

1. Tarte R. R., et al. 1996. Survival and injury of *Listeria monocytogenes*, *Listeria innocua* and *Listeria ivanovii* in ground pork following electron beam irradiation. J. Food Prot. 59: 596 - 600.
2. Renwick, Stephen P., et al. 1996. The RF Linear Accelerator in In-Lear E-Beam Processing of Beef and Poultry. Dairy Food Environ. Sanit. 16: 214 - 221.
3. Hashim, I. B., et al. 1996. Consumer Attitudes Toward Irradiated Poultry. Food Technol. March 1996: 77 - 80.
4. Robeck, Mark R., 1996. Product Liability Issues Related to Food Irradiation. Food Technol. February 1996: 78 - 82.
5. Murano, Elsa A., 1995. Irradiation of Fresh Meats. Food Technol. December 1995: 52 - 54.
6. Thayer, D. W., 1995. Use of Irradiation to Kill Pathogens on Meat and Poultry. J. Food Science. 15: 181 - 192.
7. AMI, 1995. Palatability, Color, and shelf Life of Low-Dose Irradiated Beef. American Meat Institute. Washington, D.C.
8. Murano, E. A., editor, 1995. Irradiation Processing (Chapter 1). In Food Irradiation A Sourcebook. Iowa State University Press. Ames, IA.
9. Monk, J. David, et al. 1994. Irradiation Inactivation of *Listeria monocytogenes* and *Staphylococcus aureus* in Low- and High-fat, Frozen and Refrigerated Ground Beef. J. Food Prot. 57: 969 - 974.
10. Clavero, M. Rocelle S., et al. 1994. Inactivation of *Escherichia coli* O157:H7, Salmonellae, and *Campylobacter jejuni* in Raw Ground Beef by Gamma Irradiation. App. Environ. Microbiol. June 1994: 2069 - 2075.
11. Radomyski, Tomasz, et al. 1994. Elimination of Pathogens of Significance in Food by Low-dose Irradiation: A Review. J. Food Prot. 57: 73 - 86.
12. FDA, 1994. Irradiation in the Production, Processing and Handling Of Food (Part 179). In Code of Federal Regulations. National Archives and Records Administration. Washington, D.C. 21: 385 - 390.
13. Thayer, D. W., et al. 1993. Extending Shelf Life of Poultry and Red Meat by Irradiation Processing. J. Food Prot. 56: 831 - 833.

14. Rodriguez, H. Ricardo, et al. 1993. Low-dose Gamma Irradiation and Refrigeration to Extend Shelf Life of Aerobically Packed Fresh Beef Round. *J. Food Prot.* 56: 505 - 509.
15. Thayer, D. W., et al. 1993. Elimination of *Escherichia coli* O157:H7 in Meats by Gamma Irradiation. *Appl. Environ. Microbiol.* April 1993: 1030 - 1034.
16. USDA, 1992. Irradiation of Poultry Products (Part 381). In *Federal Register/Rules and Regulation*. U.S. Department of Agriculture. Washington, D.C. 57: 43588 - 43600.
17. FDA, 1990. Irradiation in the Production, Processing and Handling of Food. In *Federal Register/Rules and Regulations*. Food and Drug Administration. Washington, D.C. 55: 18538 - 18544.
18. ASTM, 1989. Standard Guide for Selection and Application of Dosimetry Systems for Radiation Processing of Food. In *Annual Book of ASTM Standards*. American Society for Tests and Measures. Washington, D.C. 12.02: 785 - 788.
19. Patterson, Margaret, 1988. Sensitivity of bacteria to irradiation of poultry meat under various atmospheres. *Letters in Appl. Microbiol.* 7: 55 - 58.
20. FSIS, USDA, 1986. Irradiation of Pork for Control of *Trichinella spiralis* (Part 318). In *Federal Register/Rules and Regulations*. U.S. Department of Agriculture. Washington, D.C. 51: 1769 - 1771.
21. Codex, 1984. Codex General Standard for Irradiated Foods (Annex 2) (and other sections regarding irradiation). In *Codex Alimentarius*, Vol. XV. 1984.

References for Fully Cooked, Not Shelf Stable (**Fully Cooked Hams & Roast Beef**)

1. Carlier, V., et al. 1996. Heat resistance of *Listeria monocytogenes* (Phagovar 2389/2425/3274/2671/47/108/340): D- and Z- values in ham. *J. Food Prot.* 59: 588 - 591.
2. Carlier, V., et al. 1996. Destruction of *Listeria monocytogenes* during a ham cooking process. *J. Food Prot.* 59: 592 - 595.
3. AMSA, 1995. Flowchart for Boneless Ham. American Meat Science Association. Chicago, IL.
4. AMSA, 1995. Flowchart for Restructured Roast Beef. American Meat Science Association. Chicago, IL.
5. AMSA, 1995. Flowchart for Cooked Sausage. American Meat Science Association. Chicago, IL.
6. USDA, FSIS, 1994. Generic HACCP Model for Cooked Sausage. U.S. Department of Agriculture, Food Safety and Inspection Service. Washington, D.C.
7. Hudson, J. Andrew, et al. 1994. Growth of *Listeria monocytogenes*, *Aeromonas hydrophila*, and *Yersinia enterocolitica* on Vacuum and Saturated Carbon Dioxide Controlled Atmosphere-Packaged Sliced Roast Beef. *J. Food Prot.* 57: 204 - 208.
8. Cannon, J. E., et al. 1993. Acceptability and Shelf-life of Marinated Fresh and Precooked Pork. *J. Food Sci.* 58: 1249 - 1253.
9. Papadopoulos, L. S., et al. 1991. Effect of Sodium Lactate on Microbial and Chemical Composition of Cooked Beef during Storage. *J. Food Sci.* 56: 341 - 347.

10. Kapperud, Georg, 1991. *Yersinia enterocolitica* in food hygiene. Int. J. Food Microbiol. 12: 53 - 66.
11. Michel, M. E., et al. 1991. Pathogen Survival in Precooked Beef Products and Determination of Critical Control Points in Processing. J. Food Prot. 54: 767 - 772.
12. Makela, Pia M. et al. 1990. Raw Materials of Cooked Ring Sausages as a Source of Spoilage Lactic Acid Bacteria. J. Food Prot. 53: 965 - 968.
13. ICMSF, 1988. Cooking - roast beef (Section 11.5). In HACCP in Microbiological Safety and Quality. International Commission on Microbiological Specifications for Food of the International Union of Microbiological Societies. Blackwell Scientific Publications. Oxford, England. p. 234 - 238.
14. ICMSF, 1988. Curing - perishable canned ham for slicing (Section 11.6). In HACCP in Microbiological Safety and Quality. International Commission on Microbiological Specifications for Food of the International Union of Microbiological Societies. Blackwell Scientific Publications. Oxford, England. p. 238 - 242.
15. Cordray, Joseph C., et al. 1986. Restructured Pork from Hot Processed Sow Meat: Effect of Mechanical Tenderization and Liquid Smoke. J. Food Prot. 49: 639 - 642.
16. McDaniel, M. C., et al. 1984. Effect of Different Packaging Treatments on Microbiological and Sensory Evaluation of Precooked Beef Roasts. J. Food Prot. 47: 23 - 26.

References for Beef Slaughter (Steer/Heifer Carcass & Cow Carcass)

1. Dickson, J. S., 1996. Susceptibility of Preevisceration washed beef carcasses to contamination by *Escherichia coli* O157:H7 and salmonellae. J. Food Prot. 58: 1065 - 1068.
2. Gill, C. O., 1996. HACCP & Beef Carcass Dressing. Meat & Poultry. May 1996: 21 - 47.
3. Smith, G. C., et al. 1996. Fecal-material Removal and Bacterial-count Reduction by Trimming and/or Spray-washing of Beef External-fat Surfaces. In press.
4. Hardin, M. D., et al. 1995. Comparison of Methods for Decontamination from Beef Carcass Surfaces. J. Food Prot. 58: 368 - 374.
5. Meat Marketing & Technology, 1995. Early Results Positive on Steam Vacuuming. Meat Marketing & Technology. August 1995: 108.
6. Cutter, C. N., et al. 1995. Application of Chlorine to Reduce Populations of *Escherichia coli* on Beef. J. Food Safety. 15: 67 - 75.
7. Gill, C. O., 1995. Current and Emerging Approaches to Assuring the Hygienic Condition of Red Meats. Can. J. Anim. Sci. 75: 1 - 13.
8. Meat Marketing & Technology, 1994. Faster, More Sanitary Hide Removal Procedure Key to Successful Operation. Meat Marketing & Technology. August 1994: 52.
9. Barkate, M. L., et al. 1993. Hot Water Decontamination of Beef Carcasses for Reduction of Initial Bacteria Numbers. Meat Sci. 35: 397 - 401.
10. NACMCF, 1993. Generic HACCP for Raw Beef. Food Microbiol. 10: 449 - 488.

11. Gustavsson, Patrick, et al. 1993. Contamination of beef carcasses by psychrotrophic *Pseudomonas* and *Enterobacteriaceae* at different stages along the processing line. *Int. J. Food Microbiol.* 20: 67 - 83.
12. Jericho, Klaus W. F., et al. 1993. Visual Demerit and Microbiological Evaluation of Beef Carcasses: Methodology. *J. Food Prot.* 56: 114 - 119.
13. Hogue, Allan T., et al. 1993. Bacteria on Beef Briskets and Ground Beef: Correlation with Slaughter Volume and Antemortem Condemnation. *J. Food Prot.* 56: 110 - 113, 119.
14. Meat Marketing & Technology, 1993. Futuristic Slaughtering System to Begin Operation in Australia. *Meat Marketing & Technology.* August 1993: 48 - 50.
15. Clayton, R. Paul, 1992. Carcass Sanitizing Systems. *Proceedings: Meat Industry Research Conference, October 7, 1992.* 2: 8 - 24.
16. Smith, M. G., 1992. Destruction of Bacteria on Fresh Meat by Hot Water. *Epidemiol. Infect.* 109: 491 - 496.
17. Gill, C. O., 1991. Use of a temperature function integration technique to assess the hygienic adequacy of beef carcass cooling process. *Food Microbiol.* 8: 83 - 94.
18. Charlebois, R., et al. 1991. Surface Contamination of Beef Carcasses by Fecal Coliforms. *J. Food Prot.* 54: 950 - 956.

References for Pork Slaughter (**Market Hog Carcass & Sow Carcass**)

1. Pensabene, J. W., and W. Fiddler, 1996. Indole and skatole in fresh pork as possible markers of fecal contamination. *J. Food Prot.* 59: 663 - 665.
2. Van Netten, P., et al. 1995. Lactic acid decontamination of fresh pork carcasses: a pilot plant study. *Int. J. Food Microbiol.* 25: 1 - 9.
3. Gill, C. O., et al. 1995. Decontamination of commercial, polished pig carcasses with hot water. *Food Microbiol.* 12: 143 - 149.
4. Coates, K. J., et al. 1995. The contribution of carcass contamination and the boning process to microbial spoilage of aerobically stored pork. *Food Microbiol.* 12: 49 - 54.
5. Gill, C. O., et al. 1995. The presence of *Aeromonas*, *Listeria* and *Yersinia* in carcass processing equipment at two pig slaughtering plants. *Food Microbiol.* 12: 135 - 141.
6. Greer, G. Gordon, et al. 1995. Lactic acid inhibition of the growth of spoilage bacteria and cold tolerant pathogens on pork. *Int. J. Food Microbiol.* 25: 141 - 151.
7. Fu, A. H., et al. 1994. Microbial and Quality Characteristics of Pork Cuts from Carcasses Treated with Sanitizing Sprays. *J. Food Sci.* 59: 306 - 309.
8. Knudtson, Linda M., et al. 1993. Enterococci in Pork Processing. *J. Food Prot.* 56: 6 - 9.
9. Van Laack, Riette L. J. M., et al. 1993. Survival of Pathogenic Bacteria on Pork Loins as Influenced by Hot Processing and Packaging. *J. Food Prot.* 56: 847 - 851, 873.
10. Gill, C. O., et al. 1993. The presence of *Escherichia coli*, *Salmonella* and *Campylobacter* in pig carcass dehairing equipment. *Food Microbiol.* 10: 337 - 344.

11. Gill, C. O., et al. 1992. Assessment of the hygienic efficiencies of two commercial processes for cooling pig carcass. *Food Microbiol.* 9: 335 - 343.
12. Gill, C. O., et al. 1992. The contamination of pork with spoilage bacteria during commercial dressing, chilling and cutting of pig carcasses. *Int. J. Food Microbiol.* 16: 51 - 62.
13. Mafu, Akier A., et al. 1989. The Incidence of *Salmonella*, *Campylobacter*, and *Yersinia enterocolitica* in Swine Carcasses and the Slaughterhouse Environment. *J. Food Prot.* 52: 642 - 645.
14. Mendonca, A. F., et al. 1989. Microbiological, Chemical, and Physical Changes in Fresh, Vacuum-Packaged Pork Treated with Organic Acids and Salts. *J. Food Sci.* 54: 18 - 21.
15. Kotula, A. W., et al. 1988. Airborne Microorganisms in a Pork Processing Establishment. *J. Food Prot.* 51: 935 - 937.
16. Weakley, David F., et al. 1986. Effects of Packaging and Processing Procedures on the Quality and Shelf Life of Fresh Pork Loins. *J. Food Sci.* 51: 281 - 283.
17. Oosterom, J., et al. 1983. Survival of *Campylobacter jejuni* during Poultry Processing and Pig Slaughtering. *J. Food Prot.* 46: 702 - 706.
18. Cacciarelli, M. A., et al. 1983. Effects of Washing and Sanitizing on the Bacterial Flora of Vacuum-Packaged Pork Loins. *J. Food Prot.* 46: 231 - 234.

References for Poultry Slaughter (**Broiler Carcass & Turkey Carcass**)

1. Russell, S. M., et al. 1996. Spoilage Bacteria of Fresh Broiler Chicken Carcasses. *Poultry Sci.* 75: 2041 - 2047.
2. Russell, S. M., 1996. The Effect of Refrigerated and Frozen Storage on Populations of Mesophilic and Coliform Bacteria on Fresh Broiler Chicken Carcasses. *Poultry Sci.* 75: 2057 - 2060.
3. Raj, Mohan, 1995. Poultry Slaughter. *Meat Focus International.* Marck 1995: 113 - 118.
4. Lawrence, Lorna M., et al. 1995. Characterization of *Listeria monocytogenes* Isolated from Poultry Products and from the Poultry-Processing Environment by Random amplification of Polymorphic DNA and Multilocus Enzyme Electrophoresis. *Appl. Environ. Microbiol.* June 1995: 2139 - 2144.
5. Franco, C. M., et al. 1995. Determination of the Principal Sources of *Listeria* spp. Contamination in Poultry Meat and Poultry Processing Plant. *J. Food Prot.* 58: 1320 - 1325.
6. Kotula, Kathryn L., et al. 1995. Bacterial Contamination of Broiler Chickens before Scalding. *J. Food Prot.* 58: 1386 - 1388.
7. Li, Yanbin, et al. 1995. Electrical Treatment of Poultry Chiller Water to Destroy *Campylobacter jejuni*. *J. Food Prot.* 58: 1330 - 1334.
8. Blank, Greg, et al. 1995. Microbiological and Hydraulic Evaluation of Immersion Chilling for Poultry. *J. Food Prot.* 58: 1386 - 1388.

9. Clouser, C. S., et al. 1995. The Role of Defeathering in the Contamination of Turkey Skin by *Salmonella* species and *Listeria monocytogenes*. *Poult. Sci.* 74: 723 - 731.
10. Clouser, C. S., et al. 1995. Effect of Type of Defeathering System on *Salmonella* Cross-Contamination During Commercial Processing. *Poult. Sci.* 74: 732 - 741.
11. Mead, G. C., et al. 1994. Use of a marker organism in poultry processing to identify sites of cross-contamination and evaluate possible control measures. *Br. Poult. Sci.* 35: 354 - 354.
12. Lawrence, Lorna M., et al. 1994. Incidence of *Listeria spp.* and *Listeria monocytogenes* in a Poultry Processing Environment and in Poultry Products and Their Rapid Confirmation by Multiplex PCR. *Appl. Environ. Microbiol.* December 1994: 4600 - 4604.
13. Kim, Jeong - Weon, et al. 1993. Attachment of *Salmonella typhimurium* to Skins of Turkey that had been Defeathered through Three Different Systems: Scanning Electron Microscopic Examination. *J. Food Prot.* 56: 395 - 400.
14. Bailey, J. Stan, 1993. Control of *Salmonella* and *Campylobacter* in Poultry Production. A Summary of Work at Russell Research Center. *Poult. Sci.* 72: 1169 - 1173.
15. Mead, G. C., et al. 1993. Microbiological Survey of Five Poultry Processing Plants in the UK *Brit. Poult. Sci.* 34: 497 - 503.
16. Waldroup, A. L., 1993. Summary of Work to Control Pathogens in Poultry Processing. *Poult. Sci.* 72: 1177 - 1179.
17. Thayer, Stephan G., et al. 1993. Evaluation of Cross-Contamination on Automatic Viscera Removal Equipment. *Poult. Sci.* 72: 741 - 746.
18. James, William O., et al. 1993. Cost-Effective Techniques to Control Human Enteropathogens on Fresh Poultry. *Poult. Sci.* 72: 1174 - 1176.
19. Dickens, J. A., et al. 1992. The Effect of Air-Scrubbing on Moisture Pickup, Aerobic Plate Counts, Enterobacteriaceae, and the Incidence of Salmonellae on Artificially Inoculated Broiler Carcasses. *Poult. Sci.* 71: 560 - 564.
20. Renwick, Shane A., et al. 1993. Variability and Determinants of Carcass Bacterial Load at a Poultry Abattoir. *J. Food Prot.* 56: 694 - 699.
21. James, William O., et al. 1992. Profile of selected bacterial counts and *Salmonella* prevalence on raw poultry in a poultry slaughter establishment. *J. Am. Vet. Med. Assoc.* 200: 57 - 59.
22. Moye, C. J., et al. 1991. Poultry Processing, An innovative technology for salmonella control and shelf life extension. *Food Aust.* 43: 246 - 249.
23. Benedict, R. C., et al. 1991. Attachment and Removal of *Salmonella* spp. on Meat and Poultry Tissues. *J. Food Safety.* 11: 135 - 148.
24. Tokumaru, Masakazu, et al. 1990. Rates of detection of *Salmonella* and *Campylobacter* in meats in response to the sample size and the infection level of each species. *Int. J. Food Microbiol.* 13: 41 - 46.
25. Villarreal, Mario E., et al. 1990. The Incidence of *Salmonella* on Poultry Carcasses Following the Use of Slow Release Chlorine Dioxide (Alcide). *J. Food Prot.* 53: 465 - 467.

26. Lillard, H. S., 1989. Incidence and Recovery of Salmonellae and Other Bacteria from Commercially Processed Poultry Carcasses at Selected Pre- and Post-Evisceration Steps. J. Food Prot. 52: 88 - 91.
27. Genigeorgis, Constantin A., et al. 1989. Prevalence of *Listeria* spp. in Poultry Meat at the Supermarket and Slaughterhouse Level. J. Food Prot. 52: 618 - 624.
28. Carpenter, Sandra L., et al. 1989. Survival of *Listeria monocytogenes* on Processed Poultry. J. Food Sci. 54: 556 - 557.
29. Lillard, H. S., 1989. Factors Affecting the Persistence of *Salmonella* During the Processing of Poultry. J. Food Prot. 52: 829 - 832.
30. Cherrington, Christina A., et al. 1988. Persistence of *Escherichia coli* in a poultry processing plant. Letters Appl. Microbiol. 7: 141 - 143.
31. Izat, A. L., et al. 1988. Incidence and Level of *Campylobacter jejuni* in Broiler Processing. Poult. Sci. 67: 1568 - 1572.

References for Raw Other (**Beef Trimmings & Tenderized Cuts**)

1. Gill, C. O., et al. 1996. Hygienic effects of trimming and washing operations in beef-carcass-dressing process. J. Food Prot. 59: 666 - 669.
2. AMSA, 1995. Flowchart for Fresh Meat. American Meat Science Association. Chicago, IL.
3. Miller, M. F., et al. 1995. Microbiology of Hot-Fat-Trimmed Beef. J. Anim. Sci. 1368 - 1371.
4. Coates, K. J., et al. 1995. The contribution of carcass contamination and the boning process to microbial spoilage of aerobically stored pork. Food Microbiol. 12: 49 - 54.
5. Kotula, Kathryn L., et al. 1994. Microbiological and Sensory Attributes of Retail Cuts of Beef Treated with Acetic and Lactic Acid Solutions. J. Food Prot. 57: 665 - 670.
6. Blair, I. S., et al. 1994. Microbiological Examination of Pre-Storage and Post-Storage Intervention Beef. Meat Sci. 38: 155 - 161.
7. Gill, C. O., et al. 1993. Changes in the microflora on commercial beef trimmings during their collection, distribution and preparation for retail sale as ground beef. Int. J. Food Microbiol. 18: 321 - 332.